Universidad de Alcalá

Estación meteorológica basada en LPC1768.

ESCUELA POLITECNICA SUPERIOR

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Asignatura: Sistemas electrónicos digitales avanzados.

ESCUELA POLITÉCNICA SUPERIOR - UAH.

6 de noviembre de 2019.

Índice de contenido:

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Abstract.

Microcontrollers, also known as its acronym MCUs (Micro Controller Unit), are embedded systems which, nowadays, its computational power can overcome microprocessors designed in early 90s as P54C (an old intel processor family) which CPU clock were around 100 MHz and were expensive. Only 20 years later, MCUs overcame, with a remarkable lower cost, its computational power.

In this document, I will talk about an LPC1768 based embedded system which holds a Cortex M3 processor. This MCU has a 100 MHz CPU clock speed and has a Thumb/Thumb-2 subset architecture developed by ARM. In this case, the project to document has been developed in a Mini-DK2 card manufactured by NXP, which contains the following features:

- 100M Ethernet network interface.
- TFT color LCD with SPI interface.
- Two USB interfaces.
- Some sets of buttons, one of which can produce interrupts.
- Serial ISP download JTAG (the code can also be flashed via USB).
- SD card with SPI interface.
- Generic input and output ports (GPIO).
- A 12 bit ADC and 10 bit DAC.
- One memory protection unit divided by regions.
- One real time clock.
- Interrupt controller.
- A quadrature encoder interface.
- System of pulse width modulator (PWM) and other for motor control.
- An I2C bus and 3 SPI buses.
- Four timer modules.
- Four universal asynchronous receiver transmitter buses.
  (Reference from: www.hotmcu.com/lpc1768minidk2-development-board-p-55.html)

- NXP sponsors the user a manual (UM10360) which can be obtained by typing the following link: https://www.nxp.com/docs/en/user-guide/UM10360.pdf
- The IDE is MDK (Keil uVision4) for the Cortex M3 processor, it can be bought in ARM website.

The project to build in this embedded system consists in a weather station with the capacity to measure some weather conditions such as temperature or air pressure. It will be able to communicate with a computer via UART and it will contain a website reachable via Ethernet interface.

Capítulo 1: Introducción y objetivos.

Introducción.

Una estación meteorológica basada en LPC1768 puede llegar a necesitar un sistema de control medianamente complejo. Pasar de instrucciones máquina que utiliza el procesador de ARM (Cortex M3) a controlar sensores de manera simple y eficaz necesita varias capas de interfaces, esto es, la acción que realizan los sistemas operativos en cualquier tipo de máquina que necesite interacción sencilla con el usuario. Es por ello que definiré más adelante una estructura del sistema operativo que actúa como interfaz, tanto para los sensores como para el usuario, cuyo código estará contenido en memoria flash.

Para empezar, hablaré un poco sobre las características que tiene la placa que vamos a utilizar.

La placa **Mini-DK2** contiene en su interior un procesador de ARM llamado Cortex M3 que funciona a 100MHz de velocidad de reloj. Además, tiene un oscilador de cristal para los periféricos denominado XTAL de 12MHz. A continuación, en la *'Tabla 1.- Características de la placa Mini-DK2'* resumo la gran mayoría de sus características.

Característica.	*Número de elementos.*	*Notas.*
100M interfaz Ethernet	1	
Interfaz TFT de colores (LCD) con interfaz SPI.	1	
Puertos de propósito general (GPIO).	4 x 32	
Interfaz USB.	2	
Bus I2C	1	
Bus SPI	3	
Interfaz UART.	4	
Reloj en tiempo real.	2	
Oscilador de cristal.	1	12MHz
Módulos temporizadores y de captura.	4	
Módulo PWM.	1	
Módulo PWM especializado para motores.	1	
Acceso directo a memoria (DMA)	1	
Unidad de protección de memoria.	1	8 regiones
Conversor de analógico a digital.	1	12 bits
Conversor de digital a analógico.	1	10 bits
Memoria RAM.	1	64kB
Memoria flash.	1	512kB
Interfaz de encoder de cuadratura	1	
Slot de SD con interfaz SPI	1	
Interrupciones externas.	4	
Leds	N/A	
Interfaz de carga de código vía JTAG por ISP.	1	
Controlador de interrupciones anidadas (NVIC).	1	
Entrada de interrupción no enmascarable (NMI).	1	

Tabla 1.- Características de la placa Mini-DK2.

Para abordar la práctica hablaré de la estructura definida de ese 'sistema operativo' en el **Capítulo 3: Estructura del sistema** y más adelante explicaré cada parte específicamente. Cabe destacar que el código empleado utiliza una estructura jerárquica para controlar el sistema y utiliza variables como señales de comunicación entre diferentes zonas de código.

Más adelante explicaré qué sensores tiene el proyecto, qué miden cada uno de ellos y cómo funcionan a rasgos generales. Todo ello explicado en el **Capítulo 2: Componentes del sistema**.

Objetivos a cumplir.

Los objetivos establecidos para el cumplimiento de la práctica se pueden resumir en la siguiente tabla (Tabla 2.- Objetivos a cumplir):

Objetivo general.	**Objetivos específicos.**
Crear un menú táctil con el TFT de la tarjeta.	Crear un statechart.
	Manejar las librerías para la generación de caracteres y zonas en pantalla.
	Vincular todos los datos y señales de forma coherente.
	Permitir al usuario modificar variables del sistema.
	Permitir al usuario interactuar con el sistema.
	Calibrar la pantalla de manera estática o dinámica.
	Manejar el brillo de manera manual o automática con el módulo PWM.
Controlar un servo motor para la visualización de temperatura.	Ser capaz de alternar dos modos PWM para controlar el servo y el brillo a la vez.
	Ser capaz de dar valores coherentes a las variables PWM.
	Interconectar el módulo PWM con los datos.
Crear un servidor web accesible vía Ethernet	Manejar las librerías TCP-IP.
	Configurar variables para realizar una conexión TCP-IP.
	Escribir con lenguaje de marcado una página web.
	Crear funciones que interactúen con la página web mediante callbacks.
	Mantener una conexión TCP.
	Proporcionar datos a la página web.
	Recibir datos de solicitudes del usuario mediante la web.
Medir la velocidad del viento.	Realizar un análisis físico de cómo realizar las medidas.
	Realizar un análisis a nivel de electrónica de las medidas.
	Configurar un módulo temporizador para medir frecuencia de pulsos.
	Traducir los pulsos a medidas.
	Conexionar los datos recibidos sin que haya interferencias con todo el sistema anterior y posterior, incluyendo gestión de recursos de la tarjeta.

*Tener un reloj en tiempo real.**	Examinar si las medidas son precisas.
	Configurar el RTC de la tarjeta.
	Exportar los datos de manera coherente.
	Ser capaz de configurar la fecha, día y hora de manera manual.
	Mostrar por el TFT la hora actual.
Tener un sistema de control de bloqueo del sistema.	Conexionar los datos recibidos sin que haya interferencias con todo el sistema anterior y posterior, incluyendo gestión de recursos de la tarjeta.
	Configurar un Watchdog timer.
	Seleccionar una zona del código donde se ejecute con frecuencia, para cualquier estado de funcionamiento, la alimentación del Watchdog sin interferir con el sistema anterior y posterior.
	Elegir un valor adecuado para las variables del Watchdog timer.
	Examinar que este temporizador no salte de manera espuria.
Medir temperatura.	Comprender y manejar el protocolo OneWire.
	Comprender documentación en mandarín o en su defecto comprender documentación mal planificada en inglés*.
	Configurar un pin para un timer en modo captura.
	Gestionar los recursos para no quedarse sin timers ni interferir con el sistema anterior y posterior.
	Estructurar y traducir los datos recibidos adecuadamente.
Reproducir audio.	Configurar adecuadamente el DAC.
	Exportar vía DMA los datos solicitados.
	Gestionar la memoria de manera eficaz para tener 3 segundos de audio almacenados en memoria.
	Gestionar los recursos para no quedarse sin timers ni interferir con el sistema anterior y posterior.
	Configurar adecuadamente otro timer para reproducir el audio guardado en memoria.
	Hacer sonar el audio cada vez que una medida supera un umbral.
	Establecer dicho umbral para todas las medidas.
	Implementar un botón de reproducción del audio cada vez que el usuario lo desee.
	Seleccionar las variables adecuadas, así como la frecuencia de exportación del audio.
Grabar audio.	Configurar un ADC para tener dos modos de funcionamiento.
	Configurar un pin de la placa para leer audio.
	Seleccionar adecuadamente las variables, así como la frecuencia de muestreo del audio.
	Ser capaz de alternar ambos modos de funcionamiento del ADC sin interferir con

	las demás medidas y ser capaz de bloquearlas mientras se produce la grabación del audio.
	Exportar los datos de manera adecuada al sistema.
	Entrar en el modo de grabación cuando el usuario lo desee.
Medir el brillo.	Traducir de manera adecuada resistencia a voltaje y de voltaje a código del ADC.
	Escoger una resistencia de pull-up adecuada para el LDR seleccionado.
	Configurar el ADC en modo ráfaga sin que interfiera con la grabación de audio.
	Leer el código del ADC para traducirlo a nivel de brillo.
	Controlar automáticamente el brillo del LCD en función del dato.
	Examinar la validez de las medidas.
	Gestionar la frecuencia de muestreo.
Medir el índice UV.	Traducir de manera adecuada el código recibido al índice.
	Usar el modo del ADC ya configurado para esta medida sin interferir con el sistema anterior y posterior.
	Examinar la validez de las medidas.
	Exportar los datos al sistema.
Medir presión atmosférica.	Crear un controlador que sea capaz de leer registros de un sensor vía I2C.
	Examinar la validez de las medidas.
*Medir posición GPS[1].**	Conseguir leer un sensor GPS vía UART.
*Conexión WiFi.**	Conseguir conexionar un módulo WIFI vía UART a la placa.
	Ser capaz de modificar variables.
	Comprender los protocolos utilizados para conexionar un dispositivo WIFI con el módulo.
	Buscar una interfaz adecuada.
Conexión UART con un PC.	Conexionar el módulo UART del lpc1768 con el controlador de un ordenador convencional.
	Modificar variables mediante la conexión serie asíncrona.
	Conseguir exportar datos vía conexión seria asíncrona.

Tabla 2.- Objetivos a cumplir.

Como podemos observar, esta lista de objetivos a cumplir de manera obligatoria para el funcionamiento del sistema, contiene todo lo que debemos de realizar a grandes rasgos y será utilizada como guía para los siguientes capítulos.

[1] Los objetivos marcados con * representan objetivos opcionales pero que incluyen en su implementación modelos marcados como obligatorios.

Posibles mejoras al sistema en un futuro.

Pese a que los objetivos generales son muy completos, los objetivos opcionales son sólo suplementarios y añaden funciones extras a esta estación meteorológica para hacer pequeñas mejoras del sistema y que sea aún más completo. No tabularé los objetivos opcionales, que no prometo para nada cumplir, pero que puede que unas versiones futuras del proyecto aparezcan, son los que enumero a continuación y evalúo su complejidad:

- Añadir memoria extra con la interfaz SPI en la tarjeta SD.
  (Complejidad media)
- Añadir funcionalidad a la página web para modificar más variables del sistema.
  (Complejidad baja)
- Hacer un seguimiento histórico de los datos.
  (Complejidad baja)
- Exportar los datos a la comunidad.
  (Complejidad media)
- Mejorar la interfaz TFT.
  (Complejidad baja)
- Comunicarse con más estaciones del mismo tipo a gran distancia.
  (Complejidad alta)
- Realizar los objetivos marcados como * en el apartado anterior.
  (Complejidad media)

Capítulo 2: Componentes del sistema.

Mini-DK2

El componente fundamental de sistema es la tarjeta antes mencionada en el *Capítulo 1: Introducción y objetivos a cumplir.* Será la unidad de control y todos los sensores y aparatos electrónicos del sistema se conectan a este componente. Su función es ejecutar el sistema operativo antes mencionado en el Capítulo 1 y proporcionar control sobre todo el sistema. En la *Figura 1* podemos ver el esquema de pines de la tarjeta con la que vamos a trabajar. En la *Figura 2* podemos ver una imagen de la tarjeta.

Si desea ver las características generales de este componente puede recurrir a la *Tabla 1* o si desea más información, puede recurrir a su fabricante; NXP.

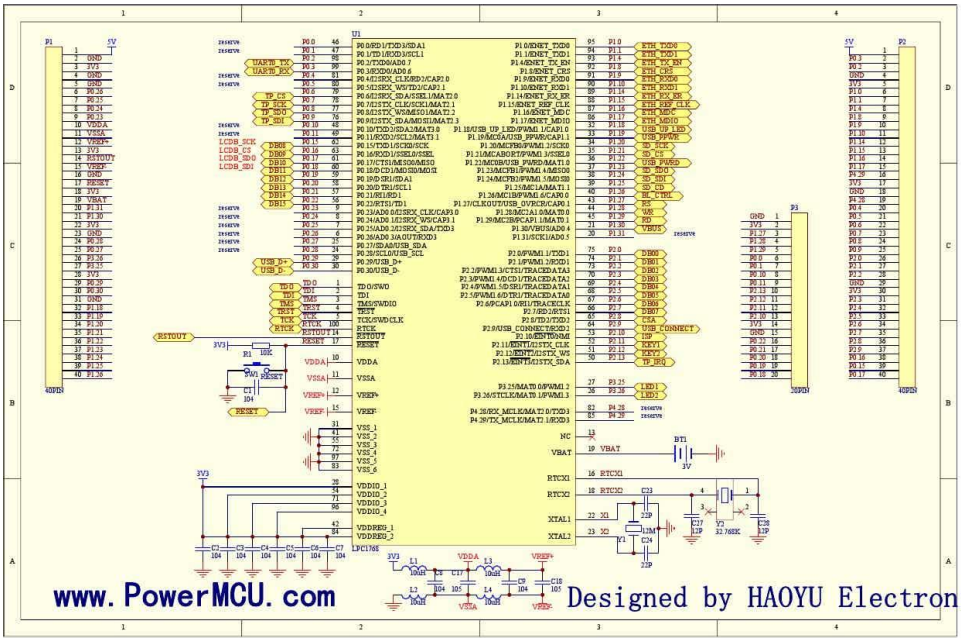


Figura 1.- Esquema general de la tarjeta Mini-DK2.

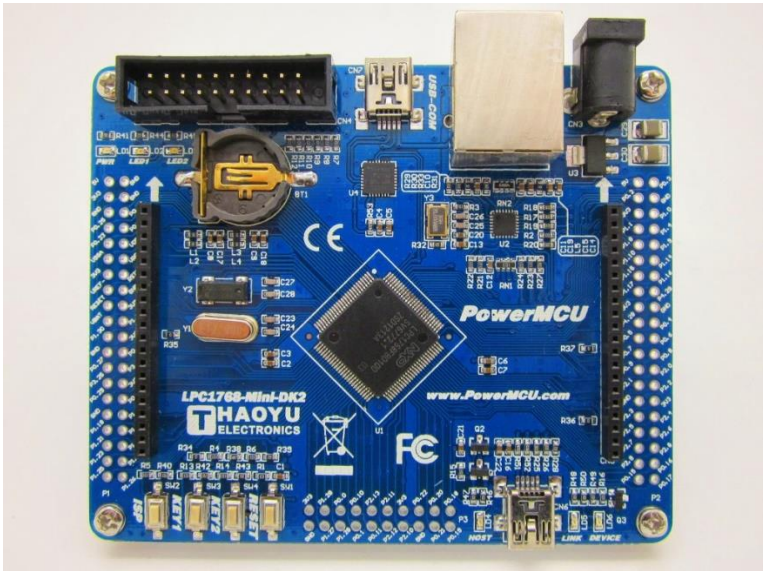


Figura 2.- Imagen de la tarjeta Mini-DK2.

Anemómetro.

Este componente nos permitirá medir la velocidad del viento. Se trata de un eje rotatorio conectado a tres cuencas de baja densidad que forman un ángulo de 120° entre ellas y permiten rotar sobre el eje si existe viento.

Tiene dos pines de salida que son cortocircuitados por zonas cada 90°, por lo que cada vuelta se cortocircuita dos veces.

Su funcionamiento consiste en generar cortocircuitos entre los dos pines de salida a medida que el eje va rotando, por lo que podemos generar pulsos cuadrados a medida que el eje rota si lo conectamos adecuadamente.

En la siguiente figura, *Figura 3* podemos ver una imagen de este anemómetro del cuál no he encontrado documentación.

Figura 3.- Anemómetro.

LDR.

Este componente nos permitirá medir la cantidad de brillo que hay en la zona de manera que este varía la resistencia entre sus dos patillas en función de la luz que recibe. Esto sigue una relación lineal con una tolerancia entre los LUX en el ambiente y la resistencia entre ambas patillas. Conectándolo adecuadamente podemos traducir mediante un divisor resistivo y **escogiendo un valor de pull-up adecuado** esta resistencia nos dará los LUX que mida.

En la *Figura 4* incluyo una imagen del LDR y en la *Figura 5* una gráfica en la mejor calidad que he encontrado que representa la relación resistencia-LUX del componente.

Figura 4.- LDR.

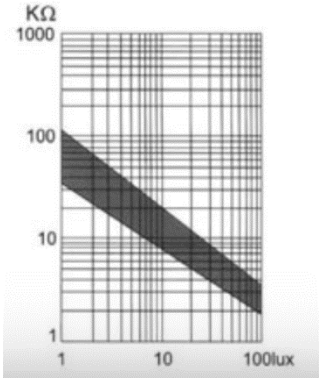


Figura 5.- Gráfica R-LUX

Sensor UV.

Este sensor nos permitirá medir el índice UV que reciba, este sensor traduce el índice UV que recibe a voltaje directamente sin necesidad de aplicar un circuito conversor resistivo como en los dos casos anteriores, en cambio, viene en forma de tarjeta pequeña con 3 pines de interés:

- Alimentación (+3.3V)
- Masa. (-0.0V)
- Salida de voltaje. [0,3.3V]

Este sensor mide la índice UV y saca un índice del 0 al 10 en forma de la siguiente ecuación:

$$Vo = \frac{Vcc \cdot IndiceUV}{IndiceUVmax}$$

En la *Figura 6* se muestra el sensor UV a utilizar (VMA30A)

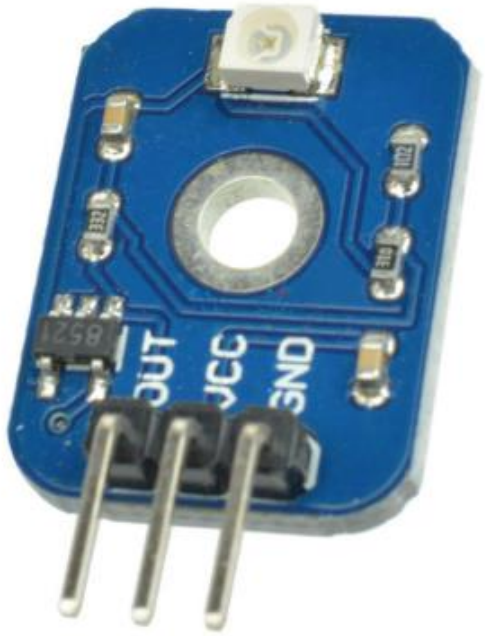


Figura 6.- Sensor UV30A.

Servo motor.

Este componente nos permitirá representar la temperatura que hay entre dos valores límite a elegir. El mínimo significará izquierda, mientras que el máximo de esa temperatura será a la derecha. Este servo controla el ángulo de posición en función de una señal modulada por pulso (PWM) y, en función de su ciclo de trabajo o tiempo a nivel alto, tendrá un ángulo u otro. En la *Figura 7* aparece una imagen del servo motor a utilizar (SG90) y en la *Figura 8* una gráfica del fabricante que sólo va a servir para identificar un problema que surge a raíz de utilizar la tarjeta Mni-DK2 con este servo.

Figura 7.- SG90, servo.

Como podemos observar en la *Figura 8* **la señal PWM generada ha de tener un valor a nivel alto de +5.0V**. Es por ello que esta gráfica sólo nos va a dar una referencia del periodo de la señal a generar, pero no del tiempo en alta, dado que estos servos se guían por la potencia recibida que depende de la amplitud del pulso y el voltaje. Habrá que hacer una corrección en potencia del pulso.

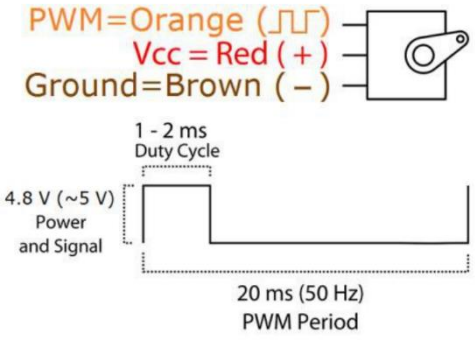


Figura 8.- Pulso a recibir.

Amplificador + altavoz.

Se utilizará un altavoz de 8Ω conectado a un amplificador de señal adaptado de 4 a 8Ω (PAM8320A) que contiene el siguiente patillaje:

- Vdc – +5.0V.
- GND - -0.0V.
- Shutdown – N/C.
- Audioin+ - Audio.
- Audioin- - GND.

Esta configuración permite pasar de una señal eléctrica de audio a audio en sí. En la Figura 9 muestro una imagen del amplificador soldado al altavoz de 8Ω.

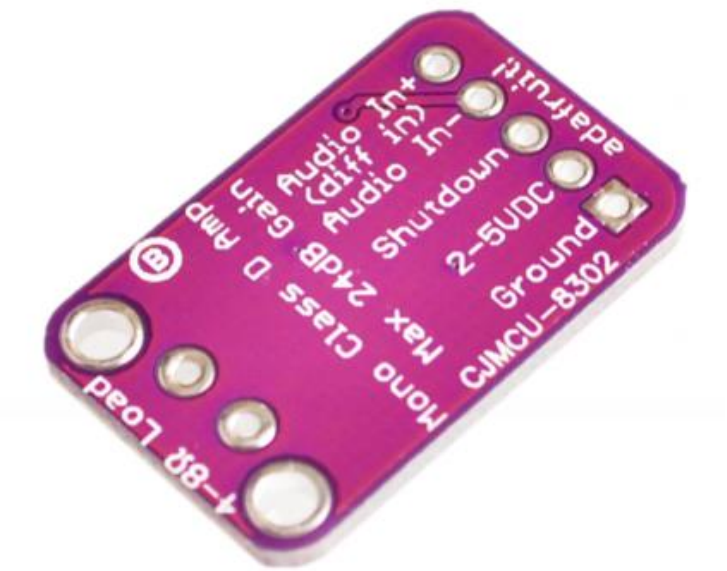
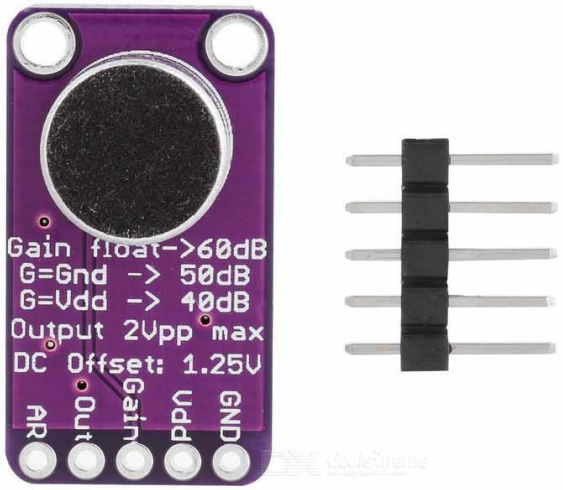


Figura 9.- PAM8320A + Altavoz



Micrófono.

Este micrófono (MAX9814) es un micrófono de alta calidad y bajo coste que nos permitirá hacer vibrar la señal continua con un offset de +1.25V (amplitud máxima de +2Vpp) en función del audio recibido. Directamente podemos convertir la señal por el pin de salida con la siguiente configuración del patillaje:

- AR – N/C
- Gain – N/C
- Out – Salida.
- Vdd - +3.3V
- GND - -0.0V

Figura 10.- MAX9814, micrófono.

Se podría configurar para que obtuviese ganancia personalizada, pero no conectar da una ganancia fija también que no tendremos en cuenta dado que nuestro objetivo no es mejorar la calidad de audio, sino simplemente tener una señal de audio. Lo mismo pasa con el pin AR, que fija el factor de compresión del audio; no conectarlo implica que tenga un valor fijo, dado que ambas entradas al aire no forman efecto de alta impedancia.

En la figura 10 tenemos una imagen de dicho micrófono (MAX9814) con parte de los valores más significativos de la datasheet impresa en la tarjeta.

Sensor de temperatura.

El sensor que medirá la humedad y la temperatura en interiores a utilizar será el DHT22. Este sensor pese a tener 4 patillas, una no hay que conectarla y la otra utiliza el protocolo OneWire. Las otras dos son de diferencia de potencial para alimentación. El conexionado es el siguiente, siendo ordenados los pines de izquierda a derecha:

- Pin 1 - +5V Vcc.
- Pin 2 - OneWire.
- Pin 3 - NC
- Pin 4 - 0V GND.

Cabe destacar que este sensor requiere de una resistencia de pull-up de 4k1Ω.

Figura 11.- Sensor DHT22.

Figura 12.- Módulo BMP180.

Sensor de presión.

El sensor a utilizar es un módulo que incorpora el sensor BMP180, que funciona por protocolo I2C.

Cabe destacar que el módulo contiene un regulador y las resistencias necesarias de pull-up para el funcionamiento de los pines SDA y SCL del protocolo. El conexionado del módulo es el siguiente:

- GND - -0.0V
- Vcc - +5.0V
- SDA - Datos I2C.
- SCL - Reloj I2C.

Este sensor utiliza un driver software que puede ser extraído del fabricante, pese a eso, se ha desarrollado un driver específico para estación meteorológica utilizado los mismos algoritmos que utiliza el driver del fabricante para leer los registros por I2C del sensor.

TFT.

Se utilizará un display táctil (TFT), para poder mostrar y recibir por pantalla datos relativos a la interfaz del usuario y variables ajustables del sistema. El panel se llama HY32-B y utiliza 8 bits para comunicarse. El conexionado de los 10 bits, los 8 anteriormente mencionados y dos de control se muestra a continuación:

Figura 13.- Panel TFT-LCD.

Puerto / pin utilizado.	Función que desempeña.
P0.6	Touchpannel – CS
P0.7	Touchpannel - SCK
P0.8	Touchpannel - SDO
P0.9	Touchpannel - SDI
P0.15	LCD-SCK
P0.16	LCD-CS
P0.17	LCD-SDO
P0.18	LCD-SDI
P1.26	Control del brillo por PWM.
P2.13	Interrupción del touchpannel.

Tabla 3.- Conexionado del TFT.

Capítulo 3: Estructura del sistema.

Durante este capítulo nos dedicaremos a analizar cómo he estructurado de manera general el sistema y cómo pretendo hacer funcionar y gestionar los recursos de la placa para que no interfieran entre ellos.

Cabe mencionar que este es un análisis que hay que hacer desde un principio y en mi caso no lo he podido hacer debido a que he tenido que añadir las cosas por partes separadas sin conocer el funcionamiento de las posteriores. Por ello, he tenido que aplicar la estrategia de: *la utilización de los menores recursos posibles para que funcione y ya añadiré más recursos si me sobran y si quiero mejorar la calidad*, cosa que si pudiese haber evitado lo hubiese hecho.

0. Esquema general.

Mi esquema se basa en ramificar jerárquicamente en torno a la interfaz de usuario, es decir, el menú, los demás módulos de control del sistema según la *Figura 1.*

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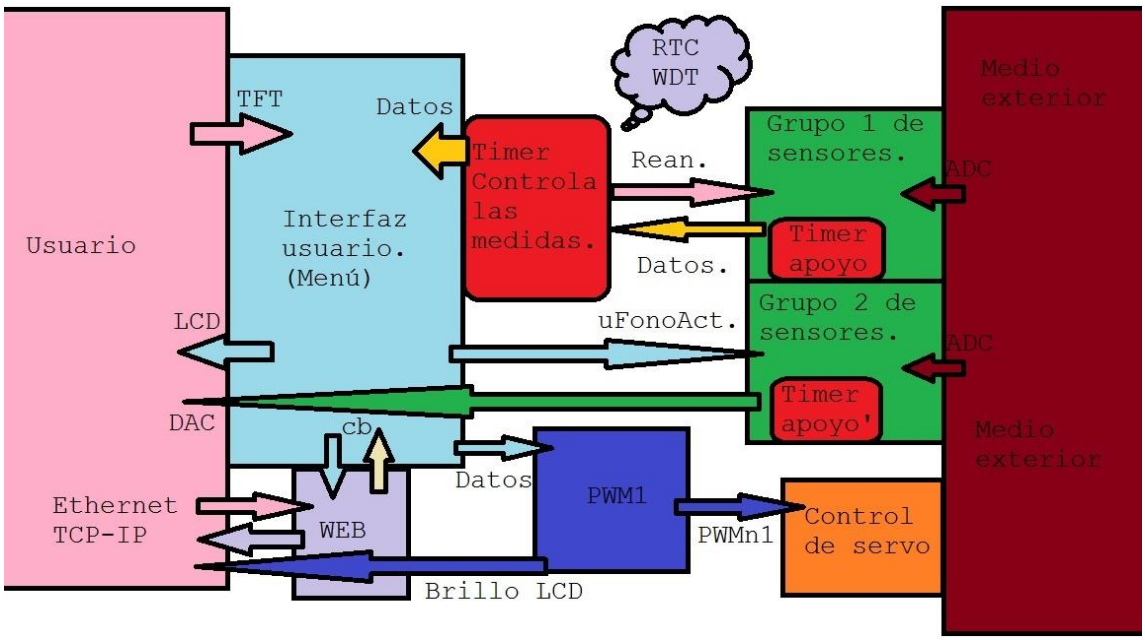


Figura 1.- Esquema de primera versión.

Cabe destacar que el esquema de la *Figura 1* es la primera versión. Es decir, sin que exista conexión UART posible ni WiFi. Añadiré una versión así más adelante que únicamente añade esos dos módulos.

El esquema en general consta de módulos que se comunican todos con la interfaz de usuario indirecta o directamente. Por eso que es un requema ramificado a partir de la interfaz de usuario (que actúa como sistema de control). También llama la atención un timer que controla las medidas. Esto lo explicaré en la sección de este mismo capítulo *Timer controlador de medidas*.

A grandes rasgos, existe un timer que controla las medidas del grupo 1, es por eso que he separado en dos grupos los sensores: los controlados por timer y los controlados por la interfaz de usuario; grupo 2. Evidentemente, los del grupo 2 son los correspondientes a grabar y

reproducir audio y los demás corresponden al grupo 1. El tiempo de muestreo es, por tanto, marcado dentro del timer que controla esos sensores para el grupo 1 y constante para el grupo 2 de sensores. Todos ellos leen del medio exterior los datos con el único ADC de la placa que consta de varios canales multiplexados.

El usuario interactúa con el interfaz de usuario mediante el TFT y el LCD, además es posible comunicarse mediante UART y mediante Ethernet (TCP-IP).

1. PWM1 y control de servo.

El módulo PWM se utiliza para controlar un servomotor que se encargará de monitorizar las medidas de temperatura y presión del sistema. Los datos son almacenados en memoria y el sistema se encarga de, cada vez que se leen los sensores, actualizar el módulo PWM para enviar un pulso de manera adecuada para que el servo se posicione en función de unos valores máximos y mínimos que pueden ser modificados por el usuario en todas sus interfaces.

La estación meteorológica utiliza el servo expuesto en el capítulo 2 y lo actualiza el manejador de interrupción del Timer0 del LPC1768.

2. WEB.

La interfaz web utiliza una pila de protocolos y librerías TCP-IP para proporcionar los recursos que permiten montar un servidor WEB integrado en el LPC1768. Mediante un compilador de CGI compila un archivo con extensión de formato CGI que incorpora un lenguaje de marcado HTML, para configurar la interfaz de usuario WEB. Más adelante se explica el funcionamiento.

3. Usuario.

El usuario puede interactuar con las diferentes interfaces que se presentan para leer los datos de la estación meteorológica. Además, este usuario puede modificar mediante todas sus interfaces los valores modificables del sistema.

- Interfaz WEB: Interfaz mediante un servidor WEB sobre un cable ethernet, se puede acceder mediante un navegador y el usuario puede modificar las variables del sistema excepto la hora actual.
- Interfaz UART: Interfaz mediante el protocolo de comunicación UART sobre un cable USB, se puede acceder mediante una aplicación que monitorice la conexión serie asíncrona como Termite (por ejemplo).
- Interfaz TFT-LCD: Interfaz mediante el protocolo de comunicación SPI sobre los pines de la placa MiniDK-2. El usuario lee por la pantalla del LCD la interfaz creada en el programa mediante la iluminación del array de pixeles. Además, el usuario puede modificar las variables del sistema desde la pantalla.

Las variables que el usuario puede modificar son: máximos y mínimos valores de alarma y presión. Si se superan, suena una alarma. La hora puede ser modificada, también el umbral de brillo, que es un valor expresando en segundos de el tiempo que permanece encendida la pantalla en el modo ULPM[2]. Otra variable a modificar es la selección del servo, es decir, qué variable (si presión o temperatura) es representada.

[2] Ultra Low Power Mode. Ver manual de usuario.

4. Medio exterior.

El medio exterior se utiliza para obtener los dartos, los sensores utilizan el medio exterior para obtener valores que la estación meteorológica lee mediante los diferentes protocolos.

5. Timer controlador de medidas.

Se utilizan varios módulos temporizadores para apoyar a los sensores. A continuación, se exponen las funcionalidades de cada uno de los times si se utilizasen:

- Timer 0: Controla las medidas, marca el tiempo de muestreo de cada uno de los sensores y se ocupa de actualizar el módulo PWM cada vez que interrumpe, en caso de haber cambiado un valor máximo o mínimo.
- Timer 1: Este Timer cumple **tres funciones**: la primera es utilizar el modo capture para medir los pulsos del **anemómetro**; la segunda es utilizar un MR (Match Register) para desactivar el **DAC** una vez haya acabado de reproducir audio; y la tercera es utilizada en caso de **grabar audio**, tener un MR que sirva para activar las cuentas.
- Timer 2: No usado.
- Timer 3: Sirve de apoyo al protocolo OneWire (actúa de contador).

6. Grupo de sensores 1.

Definimos como el primer grupo de sensores al grupo perteneciente al sensor BMP180 y DHT22, debido a que al tener incorporadas esperas activas es recomendable medirlo cuento menos. Cabe recalcar que estos sensores miden variables que no cambian con gran velocidad, por lo que pueden ser medidas cada 5 segundos incluso más si se desease ajustar. Estas variables con la temperatura, la presión y la humedad. En caso de querer medirlas más rápido, cambiar el símbolo CsCAP definido en el archivo Systemsymbols.h y poner un valor de cuentas adecuado para la función que se desee desempeñar.

7. Grupo de sensores 2.

Definimos como segundo grupo de sensores al grupo perteneciente a los sensores LDR y UVA. Debido a que necesitan un tiempo de muestreo más regular, la luz y el índice UV pueden cambiar rápidamente, por lo que es aconsejable medirlo con más frecuencia. Si se desease modificar el valor del tiempo de muestreo, referirse a CsADC definido en el archivo Systemsymbols.h y poner un valor de cuentas adecuado para la función que se desee desempeñar.

8. WDT.

El WatchDogTimer es un contador regresivo que si se deja llegar a 0 provoca un reinicio del sistema. Así, si el sistema es bloqueado, el WDT lo desbloquea reiniciando el sistema. Cabe destacar que la hora debe de ser ajustada de nuevo y todas las variables que el usuario haya modificado.

9. RTC.

El RTC es un reloj en tiempo real que sirve para tener un reloj en la estación meteorológica. Es un contador que se utiliza para mostrar por la página WEB y por pantalla la hora actual de las medidas.

10. UART.

Es un módulo que se encarga de transmitir y recibir información por el protocolo de comunicación seria asíncrona universal. Sirve como interfaz para que el usuario pueda recibir información de la estación y mandar comandos a la misma.

11. ADC.

El módulo ADC, es un módulo integrado en la placa que tiene la capacidad de codificar señales analógicas y convertirlas a un formato digital, esto permite leer señales analógicas, en nuestro caso, el sensor LDR y el UVA.

12. DMA + DAC.

Estos módulos actúan unidos. El DMA se encarga de liberar carga computacional al procesador, transfiriendo el valor de los datos del audio al siguiente módulo, el DAC, mediante una señal de inicio de conversión. Mientras que el DAC es un módulo que genera una señal analógica en función de un valor digital recibido. El funcionamiento reside en activar el DMA cuando se desee producir audio y desactivarlo cuando este termine, produciendo las transferencias de datos con el DMA y no con el procesador.

Se recuerda que el Timer encargado de desactivar la transferencia es el Timer 1.

Capítulo 4: Implementación del sistema.

En este capítulo veremos cómo se implementan tanto en software como en hardware los sistemas y módulos anteriormente mencionados en el *Capítulo 3: Estructura del sistema.* Intentando resolver tantos objetivos como nos sea posible a lo largo del capítulo. Además, se explica el fundamento de la solución adoptada.

En el Anexo I se incluye un esquemático de todo el **conexionado hardware del sistema**, cumpliendo las características del *Capítulo 2: Componentes del sistema.*

En el Anexo II se incluye el **código fuente**. Para leer las descripciones de las funciones y variables, leer en el código comentado de las secciones.

Carpeta MiniDK-2.

En esta carpeta se incluyen todas las carpetas del proyecto.

Carpeta README.

Contiene información del proyecto.

Carpeta Startup.

Contiene los ficheros de inicialización del sistema, así como librerías internas que utiliza el LPC1768 para iniciar. Incluyen las librerías:

- Startup_LPC17XX.s: Inicializa el sistema. La única variable modificada en este archivo es Stack_Size y se le ha otorgado un valor de 0x200.
- Core cm3.c: Inicializa el core.
- System LPC17XX.c: Ajusta variables y define macros internos sobre todo de los relojes de la placa MiniDK-2.

Carpeta Principal.

Contiene el programa principal en su interior, dentro del archivo main.c. En el programa principal se crean variables globales y punteros a dichas variables globales, para utilizarlas de manera más sencilla.

Dentro del programa principal sólo es necesario llamar a la función de configuración del sistema. Luego es necesario crear un bucle infinito para llamar a la función __mainLoop__() que está definida en Statechart.c y a la función __mantenerTCP__() que se encuentra en el archivo HTTP_SOURCE.c. La función __mainLoop__() es la máquina de estados que rige la interfaz de usuario por el LCD y __mantenerTCP__() mantiene la conexión TCP mediante la librería de TCP haciendo un llamado a la función main_TcpNet().

Cabe destacar que no todas las variables importadas se encuentran en este archivo, dado que sólo residen las de mayor importancia como pueden ser los datos almacenados y señalizadores del sistema.

Carpeta Menu.

En esta carpeta se encuentra la librería TouchPanel.c y el archivo responsable de generar la máquina de estados, Satatechart.c. En la *Figura 1.* Podemos observar la máquina de estados implementada en el archivo. La función __mainLoop__() se encarga de generar la máquina de estados, utilizando la variable global ESATADO como una variable de 8 bits que almacena el valor del estado que se quiere asignar. En este archivo se declara la variable MODIFICABLES, que contiene todos los valores modificables por el usuario en cualquiera de sus interfaces mencionados anteriormente.

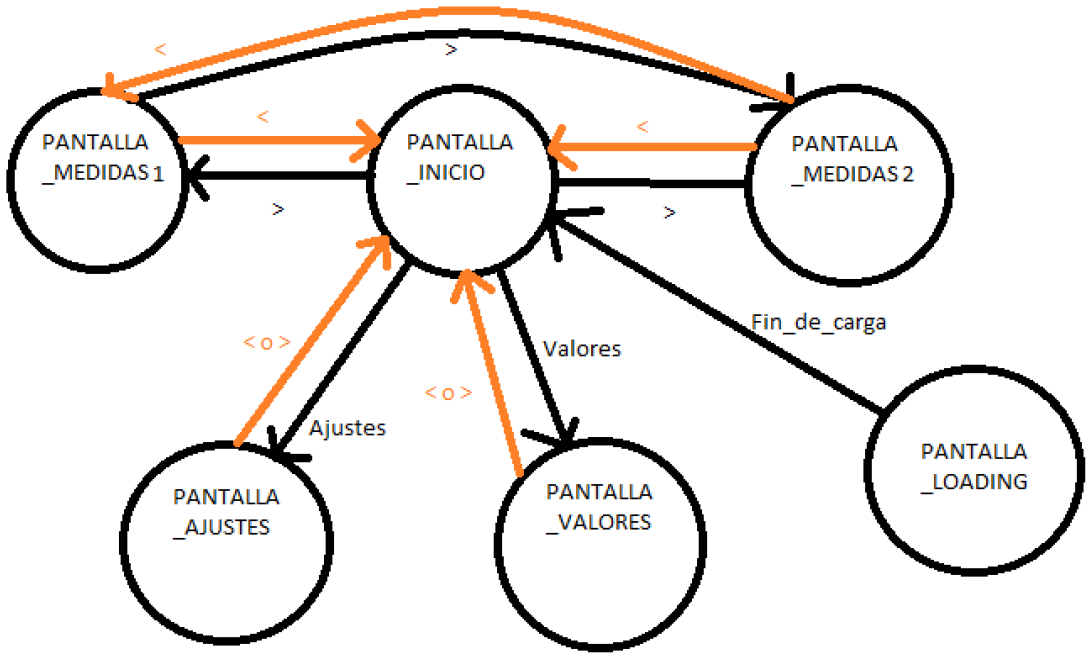


Figura 1.- Modelo de pantallas.

Además, se definen variables como Modo_brillo, Modo_energetico que guardan el estado del brillo, es decir, cualquiera de sus 4 niveles de brillo y el modo de ahorro de energía que se encuentra el sistema. La variable pressedTouchPannel refleja si se ha tocado la pantalla, para que se ilumine cuando esta, en su modo de ultra ahorro de energía; ULPM, se haya apagado.

Las variables internas __brilloFade y __brilloAuto, son variables que guardan si el sistema debe de apagar la pantalla o no (__brilloFade) y si deben de leer el LDR para proporcionar un control automático de brillo (__brilloAuto). El sistema cada iteración de la función principal, comprueba si __brilloAuto con ayuda del SysTickTimer cada 100ms si el estado es de brillo automático y actualiza el módulo PWM para proporcionar el pulso adecuado para generar un nivel de brillo que oscila entre el 20% y el 80% de luminosidad. Esto lo hace refiriéndose a la tabla en el archivo LUT.c, contretamente en el array Brillo2ciclo_LDR, que traduce el brillo al porcentaje del ciclo de trabajo del módulo PWM1.

Se definen variables de tipo zona que son variables que necesita la librería para generar la interfaz. Se le pasa como parámetro el exe X e Y y la longitud en X y en Y que ocupa el recuadro generado. Además, dichas variables admiten color y texto tanto como de la línea como del texto.

En el archivo se encuentran las siguientes funciones:

- __pintaX__(): pinta la pantalla X.
  Dentro de estas funciones puede haber más estados que representen un tipo de color, por ejemplo, existen unas barras de colores que son interfaces gráficas para que el usuario sepa la temperatura que hace en función de los valores máximos y mínimos de la misma, cambiando el color en función del porcentaje.
  Dentro de estas funciones se utilizan actualizadores, estos actualizadores sirven para actualizar el valor de los datos, es decir, mostrarlos por pantalla una vez sean medidos. Cuando un módulo termine de realizar una medida, este módulo debe de hacer un toogle al actualizador correspondiente para indicarle a la máquina de estados que se ha realizado un cambio en el valor de la medida y así poder mostrarla por pantalla.
- __configuraLCD__(): configura el LCD.
- squareButton(): Dibuja un botón cuadrado en función de la zona, los colores y un texto.
- squareBox(): Dibuja una caja en una zona de un color.
- checkTouchPanel(): Comprueba si se ha tocado un botón, además si se ha tocado cualquier zona de la pantalla, resetea el contador que apaga la pantalla en ULPM.
- ZoneNewPressed(): Comprueba si se ha tocado cierta zona de la pantalla, sirve para saber qué botón se ha pulsado. Si se toca la pantalla cuando esta ha sido apagada (esto sucede dentro del manejador del SysTickTimer) esta se recupera con un ciclo del 60% de PWM, es decir al 60% del brillo. Además, recupera las variables anteriormente mencionadas y resetea el contadorLuz, que es el contador encargado de controlar que no se supere el tiempo de apagar pantalla (este tiempo es modificable).

Dentro de cada pantalla, podemos visualizar o modificar variables.

- En la pantalla de medidas 1: Podemos ver los siguientes valores.
  - Velocidad del viento en m/s.
  - Humedad del aire en % relativo.
  - Claridad recibida en LUX.
  - Índice UV en UVs.
  - La altura respecto al nivel del mar en metros.
- En la pantalla de medidas 2:
  - Temperatura en °C.
  - Presión en mBar.
  - Gráfico de barras horizontales de colores para los valores máximos y mínimos de cada una.
- En la pantalla de ajustes: Podemos visualizar la IP del servidor WEB y además modificar las horas, minutos y segundos del reloj, además del día.
- En la pantalla de valores: Podemos modificar los valores de presión y temperatura máximos y mínimos que generan alarma, además de poder modificar si el servo representa la temperatura o la presión. El botón tendrá letras verdes para la presión y letras rojas para la temperatura. En dicho botón se representan los rangos máximos y mínimos de temperatura y presión a representar.

- En la pantalla de inicio: Podemos, además de acceder a otras pantallas, modificar el brillo, siendo 1 el mínimo y 4 el máximo. Además, está la selección de A que es brillo automático, lo que automáticamente le hace cambiar a LPM (Low power mode). También podemos grabar y reproducir audio con los botones de load y play, que lanzan las señales de grabar y reproducir audio. Desde esta pantalla podemos modificar el modo de ahorro de energía.

Importante:

Dentro de la librería TouchPanel.c, podemos encontrar una matriz denominada como matrix. Esta matriz contiene unos valores de calibración para calibrar la pantalla, cada una tiene sus valores y deberían de ser ajustados por el usuario. En caso de querer calibrar manualmente la pantalla cada vez que se inicia el sistema, descimentar la línea 68 del archivo configura.c, donde dice: //TouchPanel_Calibrate();.

Carpeta Setup.

En esta carpeta se encuentra el archivo de configuración configura.c. Se encarga de mandar a pintar las diversas pantallas de carga, de iniciar las variables y de mandar a configurar todos los módulos. Además, inicia el módulo PWM con el 90% de ciclo para el servo y 50% de brillo. Inicia las variables a cero y las modificables con el valor de las macros.

Temperatura: [-10,50]°C.

Presión: [500,1500]mBar.

Tiempo de brillo: [10]seg.

Variable medida:Temperatura.

Carpeta I2C.

En esta carpeta hay una librería de I2C (I2Clib.c) que contiene todo lo necesario para realizar las llamadas a las funciones de comunicación de I2C. (Mandar un byte, recibir un byte, recibir una dirección). Luego está el archivo que se encarga de utilizar la librería de I2C para leer el sensor BMP180.

En el archivo I2C.c podemos encontrar funciones que se encargan de usar la librería para leer los registros de acuerdo con la datasheet del fabricante (ver la hoja de datos de BMP180). Utiliza la lectura de ciertos registros del sensor para calibrarlo y luego llama a medirBMP(), que utiliza un algoritmo que leyendo ciertos registros y trabajando con ellos podemos obtener la temperatura y la presión. Cuando se desee medir, solo hace falta llamar a medirBMP() para que automáticamente guarde en la variable DATOS la presión y temperatura. Además, se calcula la altura sobre el nivel del mar con una fórmula proporcionada por el fabricante.

Nota: La función procesarDato() admite parámetros que en versiones anteriores servían para elegir presión o temperatura, en la versión final se incluyen la altura, temperatura y presión. Se ha decidido tomar

la temperatura con este sensor, dado que es de mayor calidad que el DHT22.

Carpeta Anemómetro.

En esta carpeta se encuentra Anemometro.c que incluye dos funciones, una de configuración y otra de medición. El anemómetro funciona de la siguiente manera: necesita una resistencia de pull up (vale la configuración estándar de la placa), dado que cada cuarto de vuelta del ciclo de giro cortocircuita ambas patillas, por lo que la conexión debe de ser input-masa, la resistencia de pull up debe de estar en el lado de input. Cada vuelta genera 2 pulsos, dado que cortocircuita en dos cuartos de ciclo, por lo que el anemómetro genera 2 pulsos por vuelta.

Dicho esto, podemos utilizar el módulo CAPTURE del Timer 1 para calcular la diferencia de tiempos entre el inicio o fin de ambos flancos (subida o bajada a elegir). Podemos calcular la velocidad que recorre el viento de la siguiente manera:

$$Distancia_{recorrida} = Perímetro_{anemometro} = \pi \cdot D_{anemómetro}$$

$$Tiempo_{medidoCapture} = \frac{Perímetro_{anemómetro}}{Pulsos_{vuelta} \cdot Velocidad_{viento}}$$

Podemos esperar a que se realicen dos pulsos y luego medir como si se hubiese realizado un pulso para reducir carga computacional:

$$Velocidad_{viento} = \frac{Perímetro_{anemómetro}}{Diferencia_{pulsos}} = \pi \cdot \frac{D}{T_{reloj} \cdot (CAPTURE_x - CAPTURE_{x-1})}$$

Medidas realizadas estiman el diámetro del anemómetro en **14 centímetros**.

Carpeta ADC.

En esta carpeta están los archivos necesarios para hacer funcionar todo el módulo del ADC y leer los sensores LDR y UVA30A. Además, se encuentra la lectura del micrófono. Los archivos inherentes son Ldr.c, uFono.c y UVA30A.c.

En el archivo LDR.c contiene toda la configuración del ADC, que se ejecuta en modo BURST. Dicha configuración realiza conversiones a todos los canales activados, que en este caso es el del LDR y el del UVA, podrían haberse metido más sensores sin ningún problema y sin aumentar la carga computacional, solo que se utilizan más pines del ADC en este modo BURST. El valor de CLKDIV es el máximo que se puede poner (0xFF), por dejar tiempo al ADC a que convierta con tranquilidad, podría reducirse dicho valor hasta cierto punto.

La interrupción que hace leer los registros del ADC es la penúltima, dado que hay un 'lag' de una conversión desde que se muestrea hasta que se produce la llamada al Handler del ADC. Cuando el Handler entra en acción, el último canal ya ha sido convertido. El penúltimo canal es del del LDR (1), por lo que la interrupción la provoca este fin de conversión.

En el archivo UVA30A.c sólo se configura el ADC para permitir un canal más en modo BURST, si no se ha configurado el LDR, el configurador del

UVA30A llama al del LDR primero, dado que hay que configurar todo el ADC primero para configurar que el UVA entre en modo BURST. El canal asociado al UVA es el 2.

Una vez teniendo las medidas en modo BURST, cuando se desee grabar el micrófono, se lanzará una señal que lo indique. Esta señal es la función lanzaUFONO(), que configura todo el ADC y el Timer 1 para que se obtengan muestras cada MATCH0, pare la conversión de audio y vuelva a medir en modo BURST. Cabe destacar que las medidas se bloquean mientras el modo audio está activado. Este bloque lo representa la variable YaPuedesMedir, que además se utiliza en el Handler del ADC para saber en qué modo (si BURST o audio) se encuentra el sistema. Una vez alcanzado el número de muestras del audio, se lanza la desactivación del ADC en modo audio y se recupera el contexto del ADC para el modo BURST, además de activar los actualizadores y de marcar que ya se puede medir en modo BURST.

La configuración del micrófono configura el ADC para que cada 8000kHz se obtenga una muestra de audio y se guarde en la variable AUDIO, que ocupa un total de 8 bits por muestra a 16000 bytes. 16kB de audio.

Dentro del manejador de la interrupción del ADC podemos encontrar dos modos:

- YaPuedesMedir = 0: Mete las muestras recibidas por el canal 0 al array definido para el AUDIO, cuando se alcanza el número de muestras MUESTRAS_AUDIO, se reconfigura el ADC para medir en modo BURST.
- YaPuedesMedir = 1: Lee los canales 1 y 2 del ADC por cada interrupción.
- Para obtener el brillo: Se lee el canal 1 del ADC, se calcula el porcentaje relativo de voltios del canal referido a 3.3V; luego se calcula su resistencia y se pasa dicho valor a una look-up-table para traducir dicho valor a LUX.

$$R_{LDR} = R_{pull} \cdot \frac{\frac{ADC_1}{0xFFF}}{1 - \frac{ADC_1}{0xFFF}}$$

- Para obtener el índice UV: Es una función lineal, por lo que se obtiene el porcentaje relativo respecto a 3.3V del canal 2 de entrada y se multiplica por el máximo.

$$Indice_{UV} = Indice_{maximo} \cdot 3.3V \cdot \frac{ADC_2}{0xFFF}$$

La resistencia de pull-up escogida son 70kOhm, debido a que linealiza mucho su respuesta. Es muy importante escoger una resistencia de pull-up adecuada, debido a que una pequeña variación en el error podría producir una gran variación de la resistencia. A continuación, gráficas que muestran dicho comportamiento.

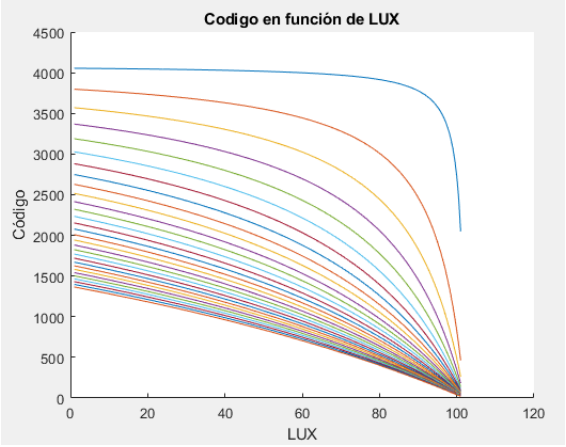


Figura 2.- Código en función de LUX.

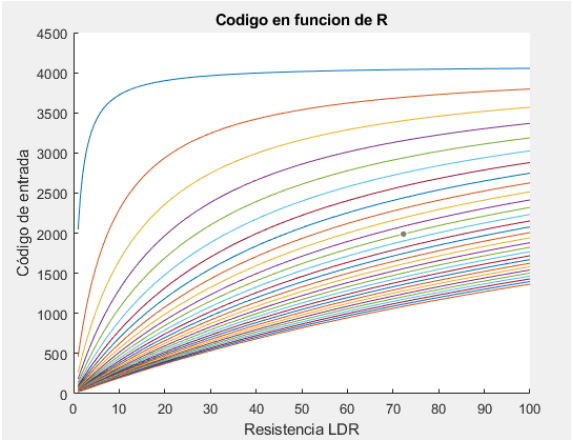


Figura 3.- 2 En función de los ohm.

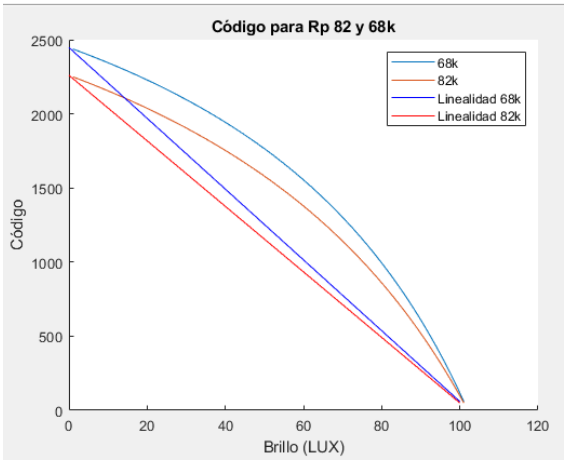


Figura 4.- Linealidad a 68 y 82k.

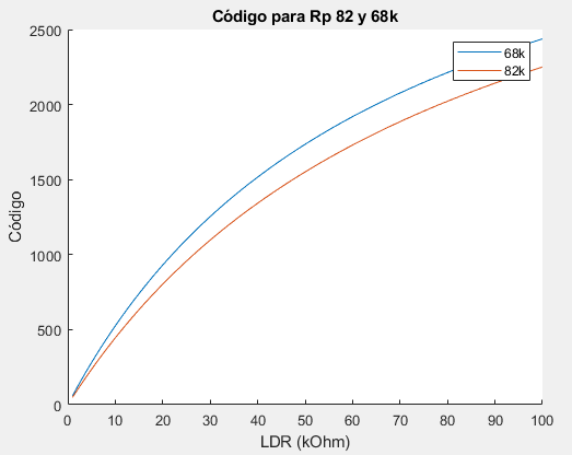


Figura 5.- 4 En función de los ohm.

Se han escogido valores de 68kohm debido a que son valores estándar y tienen una buena respuesta en la linealidad sin sacrificar mucho porcentaje del código que se ha recibido. Perdemos la mitad del rango, que podría arreglarse seleccionado una fuente de voltaje adecuada, pero ganamos linealidad y por ende, más margen de error.

Carpeta OneWire.

Pese a que el código de este apartado es muy claro y este sí está bien comentado, explico por encima las funciones que realiza.

En la datasheet del DTH22 especifican un protocolo de lectura de monofilo, lo que requiere que exista una configuración dinámica del pin de datos, para mandar una señal de inicio de conversión y configurar dicho GPIO como entrada. He utilizado GPIO como forma de lectura utilizando esperas activas del orden de los microsegundos ayudándome de el contador del Timer 3, dado que este no lo toca ningún otro módulo y estaba sin usar. Dado que realizando pruebas este sensor tiene una cantidad de ruido importante, utilizar el modo capture era realmente un desafío. Por lo que he optado utilizar esperas activas, que no dañan a penas la ejecutabilidad del programa dado que la relación ejecución/uso (0.076% del tiempo) es muy baja; se llama cada 5 segundos a la función en el Handler del Timer 0 y ocupa 3.8ms de media en realizarse. Algo parecido pasa con I2C que utiliza librerías de espera activa.

En este archivo se ejecuta el protcolo y se almacena en una variable local a mideTemperatura(), que es la señal de inicio de medida, que se llama Rx. Se divide en 4 etapas, marcadas en el código en el marcador @state:

- Inicio de medida: Se configura el pin como salida de datos y se crea un pull down, luego se configura como entrada.
- Señal de respuesta: Para esta señal, se espera recibir 50us de nivel bajo más otros 50 de nivel alto, con un margen de 10us. Esto se ejecuta sobra la función compruebarespuesta(). No se tiene en cuenta el tiempo que tarda el sensor en volver a poner el tiempo en alto, por lo que hay que esperar a que lo haga, con un valor de timeout de 45us.
- Lectura de datos: Se leen los datos en función de la duración del flanco de subida, si se excede el tiempo de timeout, se aborta la medición.
- Comprobación de checksum: Se lee el último byte y se compara con el algoritmo de checksum del fabricante. Si coincide, se insertan los nuevos datos, si no coincide se aborta la medida y se espera a la siguiente llamada.

Existe la función reinicia cuenta, que devuelve el valor del contador TC, que está reducido por un valor de 25, lo que provoca cuentas cada 1 us, y acto seguido lo reinicia. Por eso podemos obtener el valor del tiempo fácilmente.

Cabe destacar que si no se resuelven los márgenes, se sale de la función con un código de salida de 1 en la función compruebaRespuesta() y un código de 0 para la función LeerByte(). Los valores de timeout de datos son de 100us, si no se ha recibido un cambio en ese periodo, se sale de la medición y queda abortada.

Carpeta PWM.

En esta carpeta se encuentra todo lo referente al módulo PWM, residente en el archivo PWM.c. Existen dos funciones: __configuraPWM__() y modificaPulso(). El código está comentado y explica todos los input y output de las funciones.

- La función de configuración lo que hace es recibir una frecuencia para el pulso de PWM y los puertos y pines que se quieren activar. En nuestro caso sólo los pines 2_1 y 6_1, uno para el servomotor y otro para el brillo del LCD.
- La función modifica pulso, lo que hace es modificar el ciclo del pulso PWM, para cambiar su frecuencia, hay que reconfigurarlo. Las entradas son:
  - PWMn: El pin PWM seleccionado.
  - Modo: Indica si el siguiente argumento es para el servo o para el LCD.
  - Ciclo: Si es modo ciclo, se utiliza este ciclo de trabajo del módulo PWM.
  - Grados: Si es modo servo, se utiliza este argumento como los grados a los que debe inclinarse la aguja del servo.

  PARA EL MODO SERVO:
  - Mínimo: Valor mínimo del pulso a nivel alto en segundos.
  - Máximo: Valor máximo del pulso a nivel alto en segundos.

IMPORTANTE: Cabe destacar que el servomotor utiliza ciclos de 5V, cuando la placa LPC1768 utiliza ciclos de 3.3V. Esto es un problema dado que el servo parece utilizar la potencia del pulso y no precisamente su duración, es por ello por lo que no funciona de 0 a 180° y funciona de 45° a 135°. Esto puede corregirse modificando los valores de duración mínimo y máximo del pulso.

Experimentalmente se ha decidido que los valores por los que hay que multiplicar dichas constantes sean las siguientes:

- KMX: Constante del máximo = 1.3
- KMN: Constante del mínimo = 0.6

Lo que implica proporcionar más potencia al servo con la señal de 3.3V, dado que el mínimo disminuye y el máximo aumenta.

Las fórmulas utilizadas son, en función del ciclo o los grados, las siguientes:

$$MR_x = MR_0 \cdot \frac{Ciclo}{100}$$

$$MR_x = \left(Maximo + (Maximo - Minimo) \cdot \frac{Grados}{180}\right) \cdot \frac{1}{T_{reloj}} - 1$$

Carpeta DAC.

En esta carpeta se encuentra todo lo referente a la señalización y configuración del DAC. Para configurarlo, se utiliza el prototipo de función que se ha utilizado hasta ahora: __configuraDAC__(), que incluye la puesta a nivel alto de los LED de la placa, cuando están encendidos significa que está disponible la escritura de audio. Lo mismo para la lectura de audio. Esta función únicamente configura esos pines dado que el DAC se utiliza con el DMA y por ende se configura junto a él.

Las funciones activarDac() y desactivarDac() realizan la función de activación o desactivación del DAC.

Al activar el DAC, se activa el canal correspondiente del DMA, es decir, se manda una señal de incio. Además, se configura un Timer para llamar a desactivarDac() pasados los 2 segundos. Se apaga el LED de la placa que señaliza escritura de audio.

Para desactivar el DAC, se señala al sistema con el actualizador que se ha acabado el tiempo del DAC y desactiva el canal del DMA, es decir, se manda una señal al DMA de fin. Además, se enciende el led correspondiente a escritura de audio y se escribe un valor de 0 en el DAC, dado que no hay señal de salida una vez finalizada la conversión.

Carpeta Database.

En esta carpeta se encuentran todos los archivos referentes a look-up-tables (LUT.c) y transferencia de memoria (DMA.c). En el archivo LUT.c podemos ver que reside la función goto_LUT que admite los siguientes parámetros:

- Variable: Variable de entrada.
- LUTn: El tipo de tabla que vamos a usar.
- Ret_x: Son un grupo de parámetros por los que hay que señalar una dirección en la que se va a guardar el resultado. Los tipos admisibles son de enteros sin signo de 8 a 64 bits y flotantes.

Las tablas que existen son Brillo_LDR, que traduce el valor en ohmios medido por el ADC a brillo, y Brillo2Ciclo_LDR, que traduce la variable brillo o claridad expresada en LUX a un ciclo de trabajo para controlar el servomotor. Sólo el LDR utiliza estas tablas.

En el archivo de DMA.c existen tres funciones y las tres son de configuración.

La primera función es la función __configuraDMA__(), que genera un tono de 32 muestras y activa la salida analógica (P0.26). Luego hace una llamada a la función __configuraTono__(), que deja configurado el audio pregrabado, que es un tono de 400Hz. Este es activado si se supera el valor mínimo de la alarma. Si se superase el valor máximo, se llamaría a la función __configuraAudio__(), esta función configura el DMA para reproducir el audio grabado. En ambos casos las muestras son de 8 bits y se crea una estructura (LLI0) que contiene las direcciones de origen y destino de las transferencias, así como que el destino se incremente y el número de muestras a tranferir. Además, en ambos se configura que la transferencia es de memoria a periférico y que se transfiere al DAC. Dentro del DAC, hay que configurar que las transferencias son realizadas vía DMA.

La frecuencia a la que se transfieren las muestras son las siguientes:

- Para el tono:

$$T_{dma} = \frac{Num_{muestras}}{400Hz}$$

- Para el audio:

$$T_{dma} = \frac{Duracion_{audio}}{F_s} = 4kHz$$

Las funciones __configuraTono__() y __configuraAudio__() son llamadas si se exceden los valores límite de alarma, para que el DMA lance la transferencia ya sea por audio o por alarma pregrabada. Tras configurar el DMA así, se lanza un Timer (Timer 1), que desactiva el canal pasados 2 segundos.

Carpeta WDT.

Esta carpeta contiene los archivos referentes al WatchDogTimer, en WDT.c. Existen dos funciones:

- __configuraWDT__(): Se encarga de configurar el WDT, la configuración seleccionada es de un timeout de 10 segundos utilizando el reloj de Fclk/4. La acción a realizar tras vencer el temporizador es de reiniciar el sistema, por lo que es muy importante estar alimentando el WTD continuamente.
- alimentaWDT(): Es la función que reinicia el contador del WDT. Se escribe en su registro de alimentación el código 1 y acto seguido el código 2 para reiniciarlo y evitar el reinicio del sistema. El código 1 se define como 0xAA y el código 2 se define como 0x55.

Esto se hace cada ciclo de __mainLoop__(). Si no se entra a dicha función en 10 segundos, este temporizador reinicia el sistema. Esto evita bloqueos indeseados.

Carpeta UART.

Esta carpeta utiliza una librería proporcionada por la signatura SEDA de la UAH. Y el archivo UART0.c.

Dentro del archivo UART0.c podemos observar dos funciones, una de configuración y una de procesado del comando.

Respecto a la configuración, la función hace referencia a la librería para configurar, con 9600 baudios, el UART0 que es la conexión por USB (controlador de UART de la placa). En la librería se tiene una función para el cálculo de los registros de configuración de los baudios con un método iterativo. También se encuentra el manejador de la interrupción de UART0, que se activa cada byte recibido y por cada vez que el buffer de transmisión esté lleno.

Cuando se envía una cadena, hay que usar la función de la librería tx_cadena_UART0.

Para procesar el comando recibido, se guarda cada byte en un buffer (bufferx) y al recibir el carácter 13 (\r) se considera como acabado y se llama a la función de procesar comando: procesarComando(char * string).

Esta función tiene una máquina de estados implementada como se muestra en la figura 6. Donde se espera a recibir un tipo de comando para ejecutar una determinada acción. Los comandos pueden observarse en el Capítulo 6: Manual de usuario, en el apartado de UART.

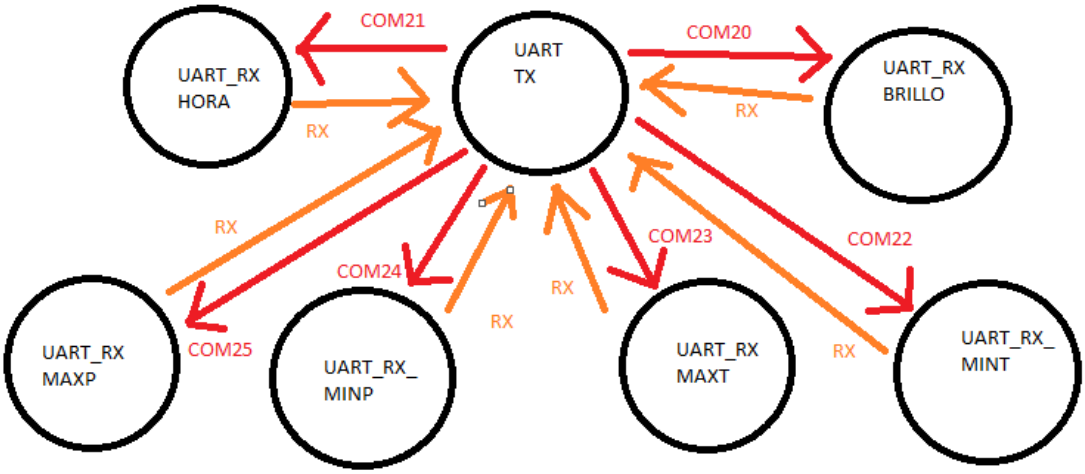


Figura 6.- Diagrama de estados de UART0.

Una vez obtenido el comando de modificación necesario, se procede a introducir el valor de la variable a modificar, el nombre del estado hace alusión a la variable a modificar. (Ver manual de usuario para más información sobre los comandos y el formato de salida).

La cadena a transmitir se guarda en un buffer y luego se transmite (UART0_BUFFER_TX[]) con la función de la librería (tx_cadena_UART0).

Carpeta TCP/IP.

En esta carpeta se encuentran los archivos referentes a la pila de protocolos TCP/IP que forman en servidor web. Se incluyen dos librerías: TCP_CM3.lib (la del fabricante) y EMAC_LPC17XX_LAN8720.c (la que se encarga del servicio sobre ethernet). Además, existe el archivo WEB.inp que guarda la orden de compilación:

index.cgi to WEB.C nopr root (../TCPIP)

Esta orden manda compilar el archivo CGI a otro llamado WEB.C que contiene la página web, convirtiendo el archivo de marcado en un objeto de C.

Luego se encuentran los siguientes archivos:

- HTTP_SOURCE.c: Contiene la configuración de la página web (__configuraWEB__()) que llama a la función init_TcpNet() de la librería, que inicia la conexión TCP. Además, encapsulo en __mantenerTCP__() a la función de la librería main_TcpNet() que es la que hay que llamar con cierta frecuencia (se encuentra en el programa main.c).
- NET_Config.c: Contiene la configuración de la conexión TCP, lo más relativo de este fichero se encuentra definido en el archivo miGlobal.h, que define la IP del servidor, el Gateway y la máscara subred. En este archivo se define con DEFAULT la ip 192.168.1.120 con un Gateway de 192.168.1.20 y una máscara subred de 255.255.255.0. Además, el usuario y la contraseña se definen como user y Alver respectivamente.
- Index.cgi: contiene el lenguaje de marcado en formato CGI y html de la página web a compilar. Esta pasa a convertirse en WEB.C.
- HTTP_CGI.c: Se encarga de la parte automática de la página web, mediante llamadas a callbacks y al método GET.

- Callbacks: se encuentra en la función cgi_func, función llamada cuando una línea de index.cgi empieza por la letra c. Se utiliza un espacio y una letra para determinar la acción de dicha callback:
  t para temperatura.
  v para velocidad del viento.
  p para presión.
  h para humedad.
  i para índice UV.
  b para brillo.
  a para altitudo.
  X no usado.
  Y no usado.
  A año.
  M mes.
  D día.
  H horas.
  T minutos.
  S segundos.
  Así podemos sacar por este callback y la función sprintf la variable en cuestión y poder representarla en el formato de la página WEB.
- GET: Se utiliza para enviar comandos a la estación, se define una tabla en la que se pueden escribir valores para enviar a la estación, todos los modificables comentados con anterioridad exceptuando la hora, que es modificable por pantalla y por UART. Primero se lee de la cadena si coincide la variable con las siguientes cadenas:
  Tmin= para temperatura mínimo.
  Tmax= para temperatura máxima.
  Pmin= para presión mínima.
  Pmax= para presión máxima.
  Vart= para seleccionar temperatura.
  Varp= para seleccionar presión.
  Si coincide con dicha string, se pasa a procesar el número que viene a continuación y se guarda en la variable en el campo de la estructura correspondiente MODIFICABLES.[campo].

Carpeta RTC.

Dentro de esta carpeta, se encuentra el archivo RTC.c, lo que contiene la configuración y el manejador de la interrupción del RTC. Se configura con __configuraRTC__() y se incicia el reloj a principios de año de 2020. Se configura para interrumpir cada segundo para actualizar una variable llamada Clock, que contiene una string con el valor de la fecha actual, además tiene un contador de segundos.

Carpeta Timers.

En esta carpeta se encuentra todo lo referido a los Timers, es la carpeta más importante dado que es donde se hacen todas las llamadas a las funciones de las demás carpetas. Dentro de esta carpeta se encuentran las configuraciones y los manejadores de interrupción de los temporizadores y del SysTickTimer.

- __configuraSysTick__(): Es la función que configura el SysTick para interrumpir cada 100ms.
- SysTick_Handler(): En esta función se hace una llamada a una función necesaria para la librería TCP/IP: timer_Tick(). Además, incrementa un contador (contadorLUZ) cada 100ms. Si este alcanza el tiempo límite sin tocar la pantalla (recuerdo que tocar la pantalla reinicia dicho contador) y este se encuentra en ULPM, esta desactiva el brillo automático y pasa a mandar una señal PWM de brillo del 1%. Por lo que se apaga, dejando un pequeño margen de luz del 1%.
- __configuraTimer0__(): Configura el Timer0 para interrumpir cada 0.5 segundos. En esta configuración se activan todos los timer a usar, aunque no el manejador de sus interrupciones.
- Timer0_IRQHandler(): En este manejador, tenemos tres funciones: medir el grupo 1 de sensores cada 0.5 segundos, medir el grupo 2 de sensores cada 5 segundos y actualizar el servo cada 0.5 segundos. Este temporizador controla el tiempo de muestreo.
- Timer1_IRQHandler(): Si interrumpe el MR1, se considera interrupción por fin de salida del DAC y se desactiva el mismo. Si interrumpe el modo capture del (CAP1.0), se considera que ha llegado un pulso del anemómetro y se llama a la función que lo mide. (Hay que tener en cuenta que quien activa el anemómetro es el Timer0 y se desactiva solo tras obtener una medida, si este no manda un pulso, la velocidad saldrá como 0 m/s indicando que no existe viento en ese momento).

Carpeta SDCARD.

Esta carpeta contiene los ficheros diskio.c, ff.c, SPI_MSD_Driver.c en caso de que en un futuro se quiera utilizar la tarjeta SD en la estación meteorológica. En esta versión no se incluye la tarjeta SD.

Carpeta CMSIS.

En esta carpeta se encuentra el software del fabricante CMSIS para utilizar en las librerías, varias de ellas utilizan los archivos de esta carpeta. Entre ellos se encuentran:

- lpc17xx_ssp.c.
- lpc17xx_pinsel.c
- lpc17xx_gpio.c
- lpc17xx_clkpwr.c
- lpc17xx_libcfg_default.c

Carpeta GLCD.

En esta carpeta se encuenta la librería que se encarga de comunicar los pines de la placa con el TFT, utilizando funciones para mandar datos por dichos pines. (Ver esquema del Anexo I).

Capítulo 5: Pruebas, ejecutabilidad y conclusiones.

En este capítulo se explican los bugs que puede llegar a tener la estación meteorológica en esta versión con pruebas que se han realizado. Luego un estudio de ejecutabilidad y una recapitulación de objetivos logrados.

Pruebas.

Pruebas realizadas con la estación concluyen que puede haber los siguientes bugs:

- Aparición de números en las medidas no deseables: Cuando se realiza una medida de una variable que por un momento se ha excedido de un valor alto, puede que, si al no cambiar de pantalla el valor se reduce lo suficiente como para pasar de 3 a 2 dígitos, por ejemplo, el último dígito no sea borrado de la pantalla y parezca que sigue ahí. Esto es resuelto cambiando de pantalla. Puede observarse reduciendo valores de alarma de presión cómo la letra acaba por duplicado. El error viene de las funciones de la librería TouchPanel.c.

- Caída de la conexión TCP: Depende del tiempo de ejecución y de lo que se haya realizado hasta el momento, puede haber una caída de la conexión TCP y que la página WEB se caiga, esto se resuelve reiniciando el sistema. La media medida en la que se produce este fallo oscila entre los 9 o 10 minutos de ejecución del programa, habiendo veces que no sucede y habiendo veces que al minuto 2 está caída.

- Bloqueo del sistema por caída de la conexión TCP: Depende de si se ha caído la conexión TCP o no, puede bloquearse el sistema por un error que denomina la librería como ERROR_FREE_MEMORY, que es un error de liberación de memoria. Inmediatamente este error reinicia el sistema debido al WatchDogTimer. Si no se cae la conexión TCP, este error no sucede. La media medida de este error oscila las 2:30 horas de ejecución, aunque si no se produce la caída no se forma, y aun produciéndose puede tardar bastante más en caerse. Su record medido es de 6 horas después de caerse la conexión TCP a los 8 minutos de ejecución. Este error es resuelto automáticamente con el WatchDogTimer.

Las medidas de la estación son bastante precisas para la calidad y el precio de los sensores utilizados. Aunque las pruebas realizadas no han sido posibles con el sensor UVA30A, se ha probado a simular su comportamiento y el comportamiento es correcto.

Ejecutabilidad.

Con el simulador de Keil uVision4 podemos obtener la diferencia de tiempos entre dos breakpoints y medir las diferentes tareas que componen el sistema, en la Tabla 1 se muestran las tareas, el tiempo máximo que hay para realizarlas, el tiempo mínimo que tardan en ser requeridas y el tiempo máximo que tardan en ejecutarse.

Tarea	Deadline (D)	T.mín (T)	T.ejec (R)	Unidades
RTC	1000	1000	0.41	ms
Timer0	500	500	1.21+0.69	ms
Timer0*	5000	5000	10.32	ms
SysTick	100	100	0.92	ms
UART	1.04	1.04	0.12	ms
ADC (microfono)	0.125	0.125	0.10	ms
WDT / Statechart.	10000	10000	108.729	ms

Tabla 1.- Datos de ejecutabilidad del sistema.

El RTC al interrumpir cada segundo y actualizar el reloj, su D = T es de ese segundo.

El Timer0 interrumpe cada 0.5s, siendo cada 5s el mayor tiempo de ejecución que tiene, incluyendo el protocolo OneWire e I2C que son los que incluyen esperas activas, es por eso por lo que incluyo dos Timer0, el largo cada 5s y el corto cada 500ms.

El SysTick tiene 100ms para mantener abierta la pila de protocolos TCP.

El Timer1 no tiene tiempo mínimo de ejecución, dado que lee los pulsos del anemómetro y cuando necesite y se cierra, esto está incluido en el tiempo de ejecución del Timer0 cada 500ms.

UART tiene que mandar 9600 bits por segundo y lanza 11 bits, 8 de datos y 1 de start y stop y otro de paridad.

WDT reinicia al sistema cada 10s, por lo que hay que el tiempo máximo es de 10s.

El ADC tiene una frecuencia de muestreo de 8000kHz, por lo que su tiempo de muestreo es el máximo que tenemos para ejecutar las funciones dentro del manejador.

Nota: Los valores 0.001 son valores que no se han conseguido medir dado que el simulador los ha considerado despreciables, dado que rondan el orden de las 3 o 4 líneas de código.

Nada es bloqueante excepto el ADC, pero como se ha comentado con anterioridad, cuando se mide con el ADC la voz, se bloquean las medidas, por lo que el Timer0 no ejecuta código. La suma de la duración de todas las tareas no es mayor que los 100ms del SysTick. Luego está la tarea del Statechart, pero al no estar en una interrupción su prioridad es mínima, por lo que la máxima interrupción de Statechart sería de 12ms aproximadamente en caso de que todo interrumpiese a la vez. Cosa que el usuario no notaría para nada.

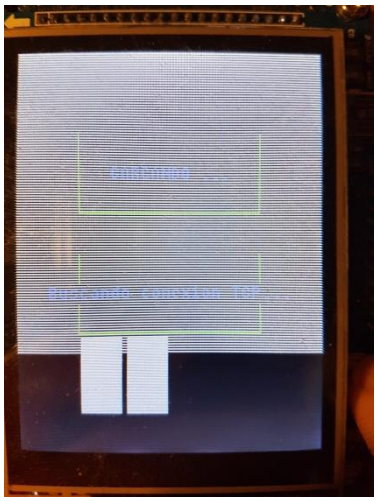
Conclusiones.

La práctica en su totalidad está completa, aunque no se han añadido muchos de los objetivos opcionales (sólo el RTC y el DMA y alguna mejora de la interfaz de pantalla de usuario), por lo general funciona muy bien en cuanto a lectura de sensores y funcionamiento de pantalla s refiere. La UART también funciona muy bien, aunque personalmente me gustaría mejorar los bugs que tiene la pila de protocolos TCP/IP que bloquean el sistema tras 4 o 5 horas de ejecución, de hecho, si comento la línea de configuración de TCP/IP, el sistema no se bloquea nunca al no ser que se mande el comando KILL (ver manual de usuario).

La parte más costosa ha sido el ADC y el DMA junto con la página WEB, dado que he tenido muchos problemas al leer el audio y reproducirlo. La poca documentación sobre DMA que disponía me ha hecho tener que referirme a ejemplos colgados en internet y el largo tiempo que me ha llevado modificar pequeñas variables de la página web para que funcione ha sido determinante para centrarme en la calidad de esta. Además, no disponía ninguna experiencia en html ni en diseño web, por lo que la página es un poco simplista, aunque hace lo que se requiere de ella sin muchos problemas excepto ese bloqueo ocasional.

Capítulo 6: Manual de usuario.

En este capítulo se redacta lo necesario que debe conocer alguien que no sabe el comportamiento interno de la estación y solo desea utilizarla, transparentemente del comportamiento interno que la misma realice. A continuación, para las diferentes interfaces, se resume su manual.



TFT.

La pantalla al ser iniciada muestra por pantalla una interfaz que muestra el porcentaje de carga o pasos realizados para finalizar su configuración. Una vez realizada, se pasa a la pantalla de inicio. La primera barra indica que se ha iniciado el sistema, la segunda que se está iniciando la conexión TCP, la tercera que se están generando variables de alto costo computacional y la cuarta que se están iniciando los módulos del sistema.

Figura 1.- Carga.

Pantalla de inicio:

Figura 2.- Inicio.

En esta pantalla se puede observar el reloj en la parte superior junto a dos flechas que permiten desplazarnos a las pantallas de medidas. Tras iniciar el sistema la fecha predeterminada son las 0:0:0 del día 1/1/2020. Más abajo podemos ver el botón de valores y el de ajustes que nos mandan a dichas pantallas.

Debajo de Nivel de brillo podemos seleccionar el nivel de brillo de la pantalla, del 1 al 4 en orden de brillo ascendente y automático a la derecha del todo. Presionar el botón de automático es sinónimo de pasar a modo de bajo consumo (LPM o LP). Si presionamos los botones HP automáticamente se selecciona el brillo 4, y seleccionando cualquier otro nivel de brillo se pasa al modo de alto consumo (HPM o HP). Si se presiona el botón de ULP se pasa al modo de muy bajo consumo, que, además de tener brillo automático, se apaga la pantalla si en un tiempo determinado y modificable no es utilizada por el usuario.

En esta pantalla se encuentra el botón de grabar y reproducir audio (Load en la esquina derecha y Play en la esquina izquierda respectivamente).

Figura 3.- Medidas (1).

Pantalla de medidas 1:

En esta pantalla podemos observar las medidas actuales, es decir, las últimas tomadas por la estación. En esta pantalla podemos observar las variables de altitud en metros, velocidad del viento en metros por segundo, humedad en porcentaje relativo, claridad en LUX e índice UV en UVs.

Además, podemos observar el reloj en la misma posición que la pantalla de inicio con las dos flechas de mover la pantalla, por lo que la interfaz superior sigue siendo la misma para cualquiera de las pantallas en la que nos encontremos.

Pantalla de medidas 2:

En esta pantalla podemos observar las medidas actuales, es decir, las últimas tomadas por la estación. En esta pantalla podemos observar las variables de presión y temperatura recibidas por el sensor BMP180, además de una interfaz gráfica que depende de los valores máximo y mínimo de la alarma de presión y temperatura. Esta interfaz consiste en una serie de barra de colores que cambia el color a medida que va habiendo más barras. Tener la barra vacía significa acercarse al valor mínimo mientras que tenerla llena significa acercarse al valor máximo. Además, se adjunta con el formato numérico.

Figura 4.- Medidas(2)

Figura 5.- Ajustes.

Pantalla de ajustes:

En esta pantalla se puede modificar fecha y la hora pulsando los botones de imncremento y decremento de la fila correspondiente (+ y - respectivamente). Además, podemos visualizar la IP que utiliza el servidor en el mismo momento que estamos visualizando el valor.

El valor por defecto de la dirección IP del servidor es 192.168.1.120, pero si es modificado, se mostrará el valor modificado para que el usuario sepa en todo momento la dirección a la que referirse.

Para retroceder a la pantalla de inicio basta ocn pulsar cualquier flecha de las situadas en las esquinas superiores.

Pantalla de valores:

En esta pantalla se pueden modificar los valores máximo y mínimo de la estación meteorlógica. Tanto de alarma de presión como de alarma de temperatura, valores máximos y mínimos. Pulsando las interfaces de incremento y decremento (+ y – respectivamente) podemos modifcar dichos valore. Al final de la pantalla podemos observar los límites mencionados.

Al lado de Pres (que indica presión) vemos dos números, el de la izquierda es el valor mínimo de alarma y el de la derecha el valor máximo.

Al lado de Temp (que indica temperatura) vemos dos números, el de la izquierda es el valor mínimo de alarma y el de la derecha el valor máximo.

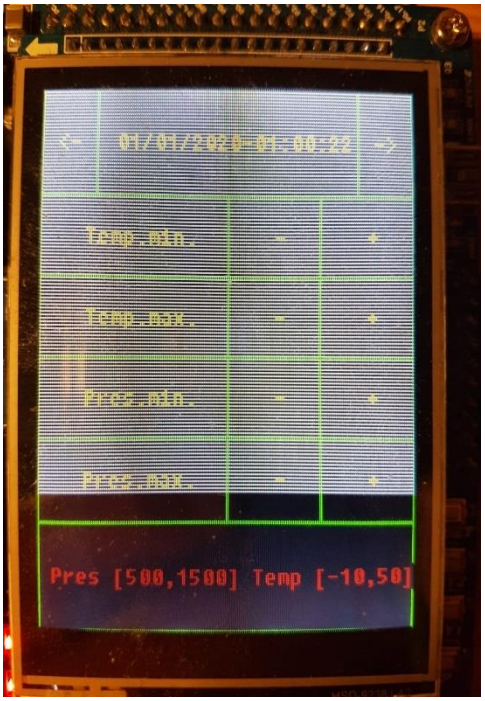


Figura 6.- Valores.

Además, si se toca la última línea que muestra la información de los valores mínimos y máximos, vemos que cambia de color, rojo indicando que se representa temperatura y verde que se representa presión, esto puede verse en el servomotor, que indica a su izquierda en su valor mínimo y a la derecha el máximo.

WEB.

La interfaz web consta de 3 partes, una tabla que se actualiza cada 20 segundos con los datos recibidos de la estación meteorológica, una segunda con la fecha de la medida y una tercera con los valores a modificar.

En la figura 7 podemos ver la interfaz WEB, en la última tabla pueden modificarse los siguientes valores:

- Valor mínimo de la alarma de temperatura. (°C)
- Valor máximo de la alarma de temperatura. (°C)
- Valor mínimo de la alarma de presión. (mBar.)
- Valor mínimo de la alarma de presión. (mBar.)
- Tiempo que tarda en apagarse la pantalla en ULPM (segundos).

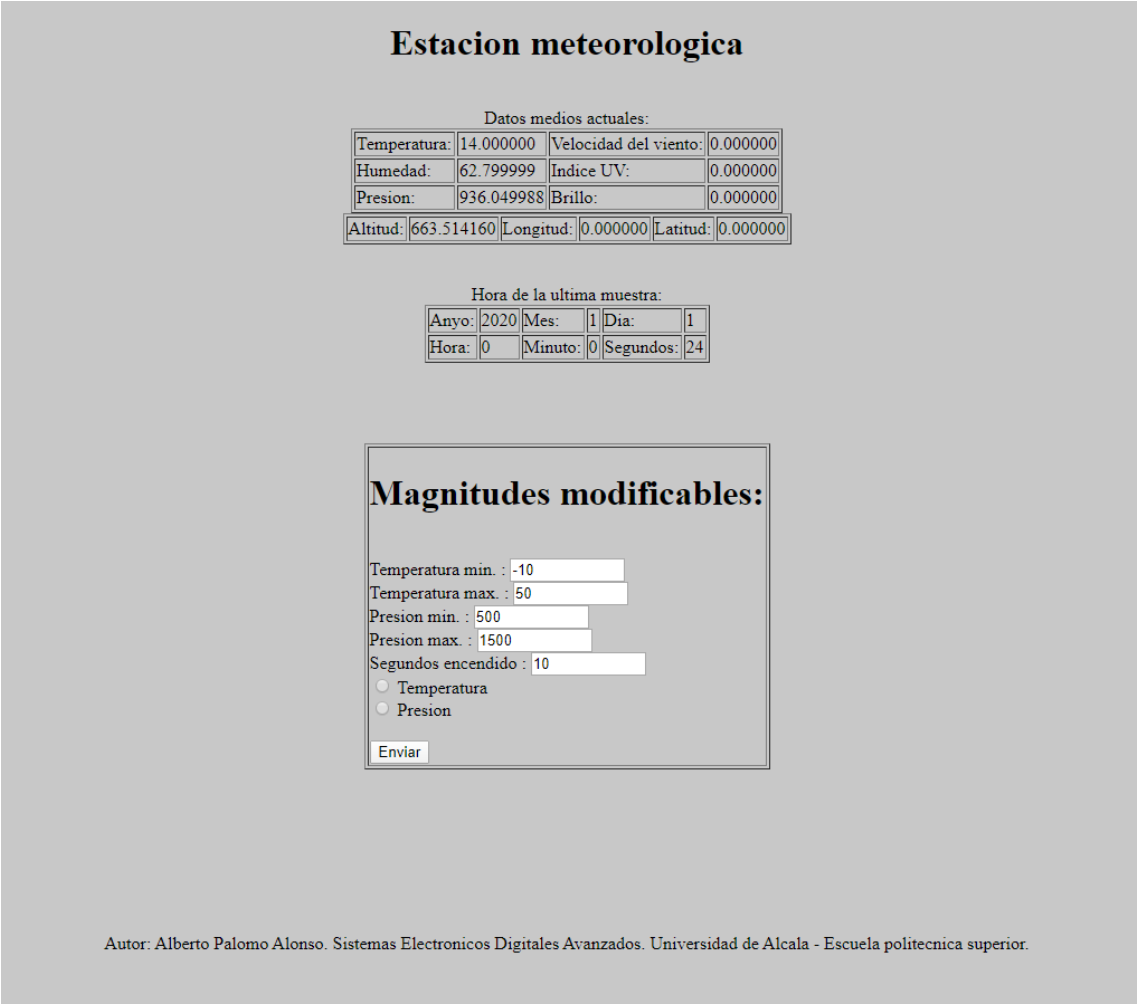


Figura 7.- Interfaz WEB.

Para configurar nuestro dispositivo que accede vía ethernet, debemos dirigirnos a nuestra configuración de IPv4. En Windows, eso es en la siguiente ruta:

- Configuración de Red e Internet/Cambiar opciones del Adaptador/Click detecho Ethernet/Priopiedades (root)/Protocolo de internet versión 4/Propiedades/Usar la siguiente dirección IP.

Por defecto está configurado que se utilice cualquier otra IP que no sea la del servidor, por ejemplo: 192.168.1.10.

Hay que configurar la máscara subred tal que sea: 255.255.255.0

La dirección de la puerta de enlace predeterminada o Gateway debe de ser: 192.168.1.20.

Estos valores pueden ser modificados dentro del código fuente del proyecto.

Para acceder a la web basta con conectar el cable ethernet al dispositivo y acceder a la dirección IP del servidor: 192.168.1.120 por defecto. Una vez entrando nos pedirán usuario y contraseña:

- Usuario: user
- Clave: Alver

Una vez introducido, deberíamos ser capaces de visualizar la interfaz WEB del servidor.

UART.

La interfaz UART es la interfaz USB del dispositivo – placa, con conectar un puerto USB mediante un cable USB-Micro USB al puerto de la tarjeta MINI-DK2 sería suficiente para iniciar la instalación automática del controlador.

Al realizar la instalación, se precisa de un monitor serie para podernos comunicar con un terminal serie, como puede ser Termite. La configuración del puerto serie debe de ser la siguiente:

- 9600 baudios.
- Paridad impar (odd).
- 8 bits por dato.
- 1 bit de stop.
- Append CR. (Sólo CR, el programa está hecho para interpretar sólo el carácter 13.)

Una vez realizada la configuración podemos comunicarnos con los siguientes comandos:

- GIVE [X]: Muestra por pantalla del dato [X] de la lista expuesta a continuación; sin los corchetes:

- IP
- TEMPERATURA
- PRESION
- VIENTO
- LUGAR
- INDICEUV
- HORA
- HUMEDAD
- BRILLO

  Cada uno haciendo referencia a la variable que indica en su propio nombre.

- SET [Y]: Configura la variable [Y] de la lista expuesta a continuación; sin los corchetes:

- BRILLO
- HORA
- MIN TEMP
- MAX TEMP
- MIN PRES
- MAX PRES
- TEMPERATURA
- PRESION

  Donde brillo es el tiempo que transcurre desde que no se toca la pantalla hasta que se apaga en modo ULPM, min representa mínimo y max representa máximo de los valores de alarma de TEMP, temperatura, y PRES, presión. TEMPERATURA activa la representación de la temperatura en el servomotor y PRESION la de presión en el servomotor.

- KILL: Cuelga el sistema en un while(1), activa el WatchDog.
- ABOUT: Muestra información del creador.
- HELP: Muestra información de la UART.
- HELP SET: Muestra la información del comando GIVE.
- HELP GIVE: Muestra la información del comando SET.

Referencias

https://github.com/iTzAlver/EstacionMeteorlogica.git

https://developer.arm.com/ip-products/processors/cortex-m/cortex-m3 [En línea] / aut. ARM.

https://www.amazon.es/Anem%C3%B3metro-Velocidad-Estaci%C3%B3n-Meteorol%C3%B3gica-Arduino/dp/B07BMVYBW9/ref=asc_df_B07BMVYBW9/?tag=googshopes-21&linkCode=df0&hvadid=300930138206&hvpos=1o1&hvnetw=g&hvrand=3634125468818365177&hvpone=&hvptwo=&hvqmt=&hvdev=c&h [En línea] / aut. anemómetro Imagen.

www.intel.com [En línea] / aut. Intel.

www.nxp.com [En línea] / aut. NXP.

www.powermcu.com [En línea] / aut. POWER MCU.

https://cloud.smartdraw.com/

www.blackboard.com

https://uah.blackboard.com/ultra/courses/_17817_1/cl/outline

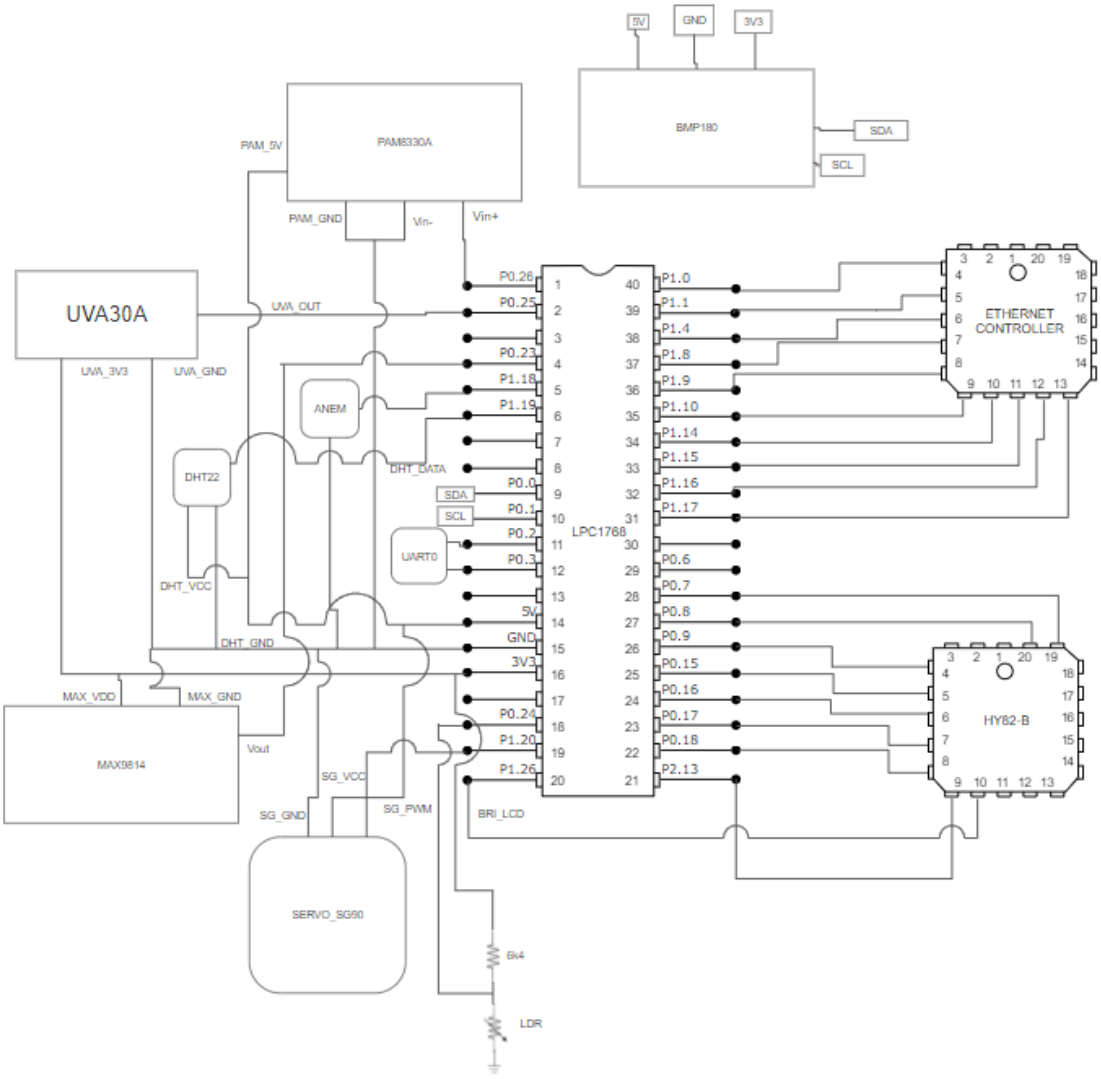
https://github.com/OCFreaks/LPC1768-Tutorial-Examples/blob/master/DHT11_Interfacing/main.c

Anexos.

A continuación, los anexos de la memoria de la estación meteorológica.

Anexo I – Esquemático.

En este anexo se adjunta un pequeño esquemático con la distribución de pines.



Anexo II – Código fuente.

NOTA: La tabulación en el programa Keil uVision4 debería de configurarse a 5 espacios para una lectura cómoda.

Readme.md

```
#       ESTACIÓN METEOROLÓGICA


*       Este proyecto consiste en una estación meteorológica inteligente que sea capaz de
obtener los datos de los sensores acoplados y de interactuar de manera inteligente con
el usuario.

*       Este proyecto ha sido elaborado por Alberto Palomo Alonso.

*       Este proyecto ha sido elaborado para la asignatura S.E.D.A de la UAH.


##      IMPORTANTE


*       Para la lectura del código ajustar el tabulador a 5 espacios/tab.

*       Las carpetas están ordenadas por funciones y periféricos.

*       Si el proyecto da error en el linker, es problema de la licencia de Keil.


##      REFERENCIAS


*       Los archivos en CMSIS son Firmware proporcionado.

*       Los archivos en GLCD  es código de API para el controlador ILI9325C.

*       El archivo leds.c es código proporcionado por la asignatura S.E.D.A de la UAH
como código ejemplo y no ha sufrido modificaciones.

*       El archivo menu.c es código proporcionado por la asignatura S.E.D.A de la UAH
como código ejemplo y no ha sufrido modificaciones.

*       El archivo TouchPanel.c de la sección Menu es código porporcionado por la
asignatura S.E.D.A de la uah como ejemplo y ha sufrido modificaciones.

*       Las modificaciones en TouchPanel.c son: incluir la libreria WDT y la llamada a la
función alimentaWDT() para el Watchdog.

*       En el archivo statechart.c y statechart.h se han modificado ligeramente funciones
y se han implementado.

*       El archivo uart.c y uart.h es código proporcionado por la asignatura S.E.D.A de
la UAH como código ejemplo y ha sufido ligeras modificaciones.

*       El archivo I2Clib.c es código proporcionado por la asignatura S.E.D.A de la UAH
como código ejemplo y no ha sufrido modificaciones.

*       Leer documentación del proyecto en Git.


##      Proyecto


*       Github:
        [EstacionMeterologica](https://github.com/iTzAlver/EstacionMeteorologica.git)

*       Gmail:  ialver.p@gmail.com
```

```
>       uah.es
>       arm.com
>       Alberto Palomo
```

Archivos extensión startup.

```
;/*****************************************************************************//**
; * @file     startup_LPC17xx.s
; * @brief    CMSIS Cortex-M3 Core Device Startup File for
; *           NXP LPC17xx Device Series
; * @version  V1.10
; * @date     06. April 2011
; *
; * @note
; * Copyright (C) 2009-2011 ARM Limited. All rights reserved.
; *
; * @par
; * ARM Limited (ARM) is supplying this software for use with Cortex-M
; * processor based microcontrollers.  This file can be freely distributed
; * within development tools that are supporting such ARM based processors.
; *
; * @par
; * THIS SOFTWARE IS PROVIDED "AS IS".  NO WARRANTIES, WHETHER EXPRESS, IMPLIED
; * OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF
; * MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE APPLY TO THIS SOFTWARE.
; * ARM SHALL NOT, IN ANY CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL, OR
; * CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.
; *
; *****************************************************************************/

; *------- <<< Use Configuration Wizard in Context Menu >>> ------------------

; <h> Stack Configuration
;   <o> Stack Size (in Bytes) <0x0-0xFFFFFFFF:8>
; </h>

Stack_Size      EQU     0x00000200

                AREA    STACK, NOINIT, READWRITE, ALIGN=3
Stack_Mem       SPACE   Stack_Size
```

```
__initial_sp


; <h> Heap Configuration
;   <o>  Heap Size (in Bytes) <0x0-0xFFFFFFFF:8>
; </h>

Heap_Size       EQU     0x00000200

                AREA    HEAP, NOINIT, READWRITE, ALIGN=3
__heap_base
Heap_Mem        SPACE   Heap_Size
__heap_limit


                PRESERVE8
                THUMB


; Vector Table Mapped to Address 0 at Reset

                AREA    RESET, DATA, READONLY
                EXPORT  __Vectors

__Vectors       DCD     __initial_sp              ; Top of Stack
                DCD     Reset_Handler             ; Reset Handler
                DCD     NMI_Handler               ; NMI Handler
                DCD     HardFault_Handler         ; Hard Fault Handler
                DCD     MemManage_Handler         ; MPU Fault Handler
                DCD     BusFault_Handler          ; Bus Fault Handler
                DCD     UsageFault_Handler        ; Usage Fault Handler
                DCD     0                         ; Reserved
                DCD     0                         ; Reserved
                DCD     0                         ; Reserved
                DCD     0                         ; Reserved
                DCD     SVC_Handler               ; SVCall Handler
                DCD     DebugMon_Handler          ; Debug Monitor Handler
                DCD     0                         ; Reserved
                DCD     PendSV_Handler            ; PendSV Handler
```

```
                DCD     SysTick_Handler           ; SysTick Handler

                ; External Interrupts
                DCD     WDT_IRQHandler            ; 16: Watchdog Timer
                DCD     TIMER0_IRQHandler         ; 17: Timer0
                DCD     TIMER1_IRQHandler         ; 18: Timer1
                DCD     TIMER2_IRQHandler         ; 19: Timer2
                DCD     TIMER3_IRQHandler         ; 20: Timer3
                DCD     UART0_IRQHandler          ; 21: UART0
                DCD     UART1_IRQHandler          ; 22: UART1
                DCD     UART2_IRQHandler          ; 23: UART2
                DCD     UART3_IRQHandler          ; 24: UART3
                DCD     PWM1_IRQHandler           ; 25: PWM1
                DCD     I2C0_IRQHandler           ; 26: I2C0
                DCD     I2C1_IRQHandler           ; 27: I2C1
                DCD     I2C2_IRQHandler           ; 28: I2C2
                DCD     SPI_IRQHandler            ; 29: SPI
                DCD     SSP0_IRQHandler           ; 30: SSP0
                DCD     SSP1_IRQHandler           ; 31: SSP1
                DCD     PLL0_IRQHandler           ; 32: PLL0 Lock (Main PLL)
                DCD     RTC_IRQHandler            ; 33: Real Time Clock
                DCD     EINT0_IRQHandler          ; 34: External Interrupt 0
                DCD     EINT1_IRQHandler          ; 35: External Interrupt 1
                DCD     EINT2_IRQHandler          ; 36: External Interrupt 2
                DCD     EINT3_IRQHandler          ; 37: External Interrupt 3
                DCD     ADC_IRQHandler            ; 38: A/D Converter
                DCD     BOD_IRQHandler            ; 39: Brown-Out Detect
                DCD     USB_IRQHandler            ; 40: USB
                DCD     CAN_IRQHandler            ; 41: CAN
                DCD     DMA_IRQHandler            ; 42: General Purpose DMA
                DCD     I2S_IRQHandler            ; 43: I2S
                DCD     ENET_IRQHandler           ; 44: Ethernet
                DCD     RIT_IRQHandler            ; 45: Repetitive Interrupt Timer
                DCD     MCPWM_IRQHandler          ; 46: Motor Control PWM
                DCD     QEI_IRQHandler            ; 47: Quadrature Encoder Interface
                DCD     PLL1_IRQHandler           ; 48: PLL1 Lock (USB PLL)
                DCD     USBActivity_IRQHandler    ; 49: USB Activity interrupt to wakeup
                DCD     CANActivity_IRQHandler    ; 50: CAN Activity interrupt to wakeup
```

```
                IF      :LNOT::DEF:NO_CRP
                AREA    |.ARM.__at_0x02FC|, CODE, READONLY
CRP_Key         DCD     0xFFFFFFFF
                ENDIF


                AREA    |.text|, CODE, READONLY


; Reset Handler

Reset_Handler   PROC
                EXPORT  Reset_Handler             [WEAK]
                IMPORT  SystemInit
                IMPORT  __main
                LDR     R0, =SystemInit
                BLX     R0
                LDR     R0, =__main
                BX      R0
                ENDP


; Dummy Exception Handlers (infinite loops which can be modified)

NMI_Handler     PROC
                EXPORT  NMI_Handler               [WEAK]
                B       .
                ENDP
HardFault_Handler\
                PROC
                EXPORT  HardFault_Handler         [WEAK]
                B       .
                ENDP
MemManage_Handler\
                PROC
                EXPORT  MemManage_Handler         [WEAK]
                B       .
                ENDP
```

```
BusFault_Handler\
                PROC
                EXPORT  BusFault_Handler          [WEAK]
                B       .
                ENDP
UsageFault_Handler\
                PROC
                EXPORT  UsageFault_Handler        [WEAK]
                B       .
                ENDP
SVC_Handler     PROC
                EXPORT  SVC_Handler               [WEAK]
                B       .
                ENDP
DebugMon_Handler\
                PROC
                EXPORT  DebugMon_Handler          [WEAK]
                B       .
                ENDP
PendSV_Handler  PROC
                EXPORT  PendSV_Handler            [WEAK]
                B       .
                ENDP
SysTick_Handler PROC
                EXPORT  SysTick_Handler           [WEAK]
                B       .
                ENDP

Default_Handler PROC

                EXPORT  WDT_IRQHandler            [WEAK]
                EXPORT  TIMER0_IRQHandler         [WEAK]
                EXPORT  TIMER1_IRQHandler         [WEAK]
                EXPORT  TIMER2_IRQHandler         [WEAK]
                EXPORT  TIMER3_IRQHandler         [WEAK]
                EXPORT  UART0_IRQHandler          [WEAK]
                EXPORT  UART1_IRQHandler          [WEAK]
                EXPORT  UART2_IRQHandler          [WEAK]
                EXPORT  UART3_IRQHandler          [WEAK]
```

```
                EXPORT  PWM1_IRQHandler           [WEAK]
                EXPORT  I2C0_IRQHandler           [WEAK]
                EXPORT  I2C1_IRQHandler           [WEAK]
                EXPORT  I2C2_IRQHandler           [WEAK]
                EXPORT  SPI_IRQHandler            [WEAK]
                EXPORT  SSP0_IRQHandler           [WEAK]
                EXPORT  SSP1_IRQHandler           [WEAK]
                EXPORT  PLL0_IRQHandler           [WEAK]
                EXPORT  RTC_IRQHandler            [WEAK]
                EXPORT  EINT0_IRQHandler          [WEAK]
                EXPORT  EINT1_IRQHandler          [WEAK]
                EXPORT  EINT2_IRQHandler          [WEAK]
                EXPORT  EINT3_IRQHandler          [WEAK]
                EXPORT  ADC_IRQHandler            [WEAK]
                EXPORT  BOD_IRQHandler            [WEAK]
                EXPORT  USB_IRQHandler            [WEAK]
                EXPORT  CAN_IRQHandler            [WEAK]
                EXPORT  DMA_IRQHandler            [WEAK]
                EXPORT  I2S_IRQHandler            [WEAK]
                EXPORT  ENET_IRQHandler           [WEAK]
                EXPORT  RIT_IRQHandler            [WEAK]
                EXPORT  MCPWM_IRQHandler          [WEAK]
                EXPORT  QEI_IRQHandler            [WEAK]
                EXPORT  PLL1_IRQHandler           [WEAK]
                EXPORT  USBActivity_IRQHandler    [WEAK]
                EXPORT  CANActivity_IRQHandler    [WEAK]

WDT_IRQHandler
TIMER0_IRQHandler
TIMER1_IRQHandler
TIMER2_IRQHandler
TIMER3_IRQHandler
UART0_IRQHandler
UART1_IRQHandler
UART2_IRQHandler
UART3_IRQHandler
PWM1_IRQHandler
I2C0_IRQHandler
I2C1_IRQHandler
```

```
I2C2_IRQHandler
SPI_IRQHandler
SSP0_IRQHandler
SSP1_IRQHandler
PLL0_IRQHandler
RTC_IRQHandler
EINT0_IRQHandler
EINT1_IRQHandler
EINT2_IRQHandler
EINT3_IRQHandler
ADC_IRQHandler
BOD_IRQHandler
USB_IRQHandler
CAN_IRQHandler
DMA_IRQHandler
I2S_IRQHandler
ENET_IRQHandler
RIT_IRQHandler
MCPWM_IRQHandler
QEI_IRQHandler
PLL1_IRQHandler
USBActivity_IRQHandler
CANActivity_IRQHandler

                B       .

                ENDP


                ALIGN


; User Initial Stack & Heap

                IF      :DEF:__MICROLIB

                EXPORT  __initial_sp
                EXPORT  __heap_base
                EXPORT  __heap_limit
```

```
                ELSE

                IMPORT  __use_two_region_memory
                EXPORT  __user_initial_stackheap
__user_initial_stackheap

                LDR     R0, =  Heap_Mem
                LDR     R1, =(Stack_Mem + Stack_Size)
                LDR     R2, = (Heap_Mem +  Heap_Size)
                LDR     R3, = Stack_Mem
                BX      LR

                ALIGN

                ENDIF


                END
```

Archivos extensión C.

```
/**************************************************************************//**
 * @file     core_cm3.c
 * @brief    CMSIS Cortex-M3 Core Peripheral Access Layer Source File
 * @version  V2.00
 * @date     13. September 2010
 *
 * @note
 * Copyright (C) 2009-2010 ARM Limited. All rights reserved.
 *
 * @par
 * ARM Limited (ARM) is supplying this software for use with Cortex-M
 * processor based microcontrollers.  This file can be freely distributed
 * within development tools that are supporting such ARM based processors.
 *
 * @par
 * THIS SOFTWARE IS PROVIDED "AS IS".  NO WARRANTIES, WHETHER EXPRESS, IMPLIED
 * OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF
```

```
 * MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE APPLY TO THIS SOFTWARE.
 * ARM SHALL NOT, IN ANY CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL, OR
 * CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.
 *
 ******************************************************************************/


#include <stdint.h>


/* define compiler specific symbols */
#if defined ( __CC_ARM   )
  #define __ASM            __asm                                      /*!< asm keyword
for ARM Compiler          */
  #define __INLINE         __inline                                   /*!< inline
keyword for ARM Compiler       */


#elif defined ( __ICCARM__ )
  #define __ASM           __asm                                       /*!< asm keyword
for IAR Compiler          */
  #define __INLINE        inline                                     /*!< inline
keyword for IAR Compiler. Only avaiable in High optimization mode! */


#elif defined   (  __GNUC__  )
  #define __ASM            __asm                                      /*!< asm keyword
for GNU Compiler          */
  #define __INLINE         inline                                     /*!< inline
keyword for GNU Compiler       */


#elif defined   (  __TASKING__  )
  #define __ASM            __asm                                      /*!< asm keyword
for TASKING Compiler      */
  #define __INLINE         inline                                     /*!< inline
keyword for TASKING Compiler   */


#endif



/* ###########################  Core Instruction Access  ######################### */


#if defined ( __CC_ARM   ) /*------------------ RealView Compiler -----------------*/


/** \brief  Reverse byte order (16 bit)


    This function reverses the byte order in two unsigned short values.
```

```
    \param [in]    value  Value to reverse
    \return               Reversed value
 */
#if (__ARMCC_VERSION < 400677)
__ASM uint32_t __REV16(uint32_t value)
{
  rev16 r0, r0
  bx lr
}
#endif /* __ARMCC_VERSION  */


/** \brief  Reverse byte order in signed short value

    This function reverses the byte order in a signed short value with sign extension to integer.

    \param [in]    value  Value to reverse
    \return               Reversed value
 */
#if (__ARMCC_VERSION < 400677)
__ASM int32_t __REVSH(int32_t value)
{
  revsh r0, r0
  bx lr
}
#endif /* __ARMCC_VERSION  */


/** \brief  Remove the exclusive lock

    This function removes the exclusive lock which is created by LDREX.

 */
#if (__ARMCC_VERSION < 400000)
__ASM void __CLREX(void)
{
  clrex
}
```

```
#endif /* __ARMCC_VERSION  */


#elif (defined (__ICCARM__)) /*---------------- ICC Compiler ----------------------*/
/* obsolete */
#elif (defined (__GNUC__)) /*------------------ GNU Compiler ----------------------*/
/* obsolete */
#elif (defined (__TASKING__)) /*--------------- TASKING Compiler -----------------*/
/* obsolete */
#endif


/* ###########################  Core Function Access  ########################### */

#if defined ( __CC_ARM   ) /*------------------ RealView Compiler ----------------*/

/** \brief  Get Control Register

    This function returns the content of the Control Register.

    \return               Control Register value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_CONTROL(void)
{
  mrs r0, control
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Set Control Register

    This function writes the given value to the Control Register.

    \param [in]    control  Control Register value to set
 */
#if       (__ARMCC_VERSION <  400000)
__ASM void __set_CONTROL(uint32_t control)
```

```
{
  msr control, r0
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get ISPR Register

    This function returns the content of the ISPR Register.

    \return               ISPR Register value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_IPSR(void)
{
  mrs r0, ipsr
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get APSR Register

    This function returns the content of the APSR Register.

    \return               APSR Register value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_APSR(void)
{
  mrs r0, apsr
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get xPSR Register
```

```
    This function returns the content of the xPSR Register.

    \return               xPSR Register value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_xPSR(void)
{
  mrs r0, xpsr
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get Process Stack Pointer

    This function returns the current value of the Process Stack Pointer (PSP).

    \return               PSP Register value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_PSP(void)
{
  mrs r0, psp
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Set Process Stack Pointer

    This function assigns the given value to the Process Stack Pointer (PSP).

    \param [in]    topOfProcStack  Process Stack Pointer value to set
 */
#if       (__ARMCC_VERSION <  400000)
__ASM void __set_PSP(uint32_t topOfProcStack)
{
  msr psp, r0
  bx lr
```

```
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get Main Stack Pointer

    This function returns the current value of the Main Stack Pointer (MSP).

    \return               MSP Register value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_MSP(void)
{
  mrs r0, msp
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Set Main Stack Pointer

    This function assigns the given value to the Main Stack Pointer (MSP).

    \param [in]    topOfMainStack  Main Stack Pointer value to set
 */
#if       (__ARMCC_VERSION <  400000)
__ASM void __set_MSP(uint32_t mainStackPointer)
{
  msr msp, r0
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get Base Priority

    This function returns the current value of the Base Priority register.

    \return               Base Priority register value
```

```
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t  __get_BASEPRI(void)
{
  mrs r0, basepri
  bx lr
}
#endif /*  __ARMCC_VERSION  */



/** \brief  Set Base Priority

    This function assigns the given value to the Base Priority register.

    \param [in]    basePri  Base Priority value to set
 */
#if       (__ARMCC_VERSION <  400000)
__ASM void __set_BASEPRI(uint32_t basePri)
{
  msr basepri, r0
  bx lr
}
#endif /*  __ARMCC_VERSION  */

/** \brief  Get Priority Mask

    This function returns the current state of the priority mask bit from the Priority
Mask Register.

    \return               Priority Mask value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t __get_PRIMASK(void)
{
  mrs r0, primask
  bx lr
}
#endif /*  __ARMCC_VERSION  */
```

```
/** \brief  Set Priority Mask

    This function assigns the given value to the Priority Mask Register.

    \param [in]    priMask  Priority Mask
 */
#if       (__ARMCC_VERSION <  400000)
__ASM void __set_PRIMASK(uint32_t priMask)
{
  msr primask, r0
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Get Fault Mask

    This function returns the current value of the Fault Mask Register.

    \return               Fault Mask value
 */
#if       (__ARMCC_VERSION <  400000)
__ASM uint32_t  __get_FAULTMASK(void)
{
  mrs r0, faultmask
  bx lr
}
#endif /*  __ARMCC_VERSION  */


/** \brief  Set the Fault Mask

     This function assigns the given value to the Fault Mask Register.

    \param [in]    faultMask  Fault Mask value value to set
 */
#if       (__ARMCC_VERSION <  400000)
__ASM void __set_FAULTMASK(uint32_t faultMask)
{
```

```
  msr faultmask, r0
  bx lr
}
#endif /*  __ARMCC_VERSION  */



#elif (defined (__ICCARM__)) /*---------------- ICC Compiler ---------------------*/
/* obsolete */
#elif (defined (__GNUC__)) /*------------------ GNU Compiler ---------------------*/
/* obsolete */
#elif (defined (__TASKING__)) /*--------------- TASKING Compiler -----------------*/
/* obsolete */
#endif



/*----------------------------------------------------------------------------//**
 * @file     system_LPC17xx.c
 * @brief    CMSIS Cortex-M3 Device System Source File for
 *           NXP LPC17xx Device Series
 * @version  V1.13
 * @date     18. April 2012
 *
 * @note
 * Copyright (C) 2009-2012 ARM Limited. All rights reserved.
 *
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 * CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.
 *
```

```
 *****************************************************************************/


#include <stdint.h>
#include "LPC17xx.h"


/** @addtogroup LPC17xx_System
 * @{
 */

/*
//-------- <<< Use Configuration Wizard in Context Menu >>> ------------------
*/

/*---------------------- Clock Configuration ----------------------------------
//
// <e> Clock Configuration
//   <h> System Controls and Status Register (SCS)
//     <o1.4>    OSCRANGE: Main Oscillator Range Select
//                       <0=>  1 MHz to 20 MHz
//                       <1=> 15 MHz to 25 MHz
//     <e1.5>       OSCEN: Main Oscillator Enable
//     </e>
//   </h>
//
//   <h> Clock Source Select Register (CLKSRCSEL)
//     <o2.0..1>   CLKSRC: PLL Clock Source Selection
//                       <0=> Internal RC oscillator
//                       <1=> Main oscillator
//                       <2=> RTC oscillator
//   </h>
//
//   <e3> PLL0 Configuration (Main PLL)
//     <h> PLL0 Configuration Register (PLL0CFG)
//                       <i> F_cco0 = (2 * M * F_in) / N
//                       <i> F_in must be in the range of 32 kHz to 50 MHz
//                       <i> F_cco0 must be in the range of 275 MHz to 550 MHz
//       <o4.0..14>  MSEL: PLL Multiplier Selection
```

```
//                     <6-32768><#-1>
//                     <i> M Value
//       <o4.16..23> NSEL: PLL Divider Selection
//                     <1-256><#-1>
//                     <i> N Value
//     </h>
//   </e>
//
//   <e5> PLL1 Configuration (USB PLL)
//     <h> PLL1 Configuration Register (PLL1CFG)
//                     <i> F_usb = M * F_osc or F_usb = F_cco1 / (2 * P)
//                     <i> F_cco1 = F_osc * M * 2 * P
//                     <i> F_cco1 must be in the range of 156 MHz to 320 MHz
//       <o6.0..4>   MSEL: PLL Multiplier Selection
//                     <1-32><#-1>
//                     <i> M Value (for USB maximum value is 4)
//       <o6.5..6>   PSEL: PLL Divider Selection
//                     <0=> 1
//                     <1=> 2
//                     <2=> 4
//                     <3=> 8
//                     <i> P Value
//     </h>
//   </e>
//
//   <h> CPU Clock Configuration Register (CCLKCFG)
//     <o7.0..7>  CCLKSEL: Divide Value for CPU Clock from PLL0
//                     <1-256><#-1>
//   </h>
//
//   <h> USB Clock Configuration Register (USBCLKCFG)
//     <o8.0..3>   USBSEL: Divide Value for USB Clock from PLL0
//                     <0-15>
//                     <i> Divide is USBSEL + 1
//   </h>
//
//   <h> Peripheral Clock Selection Register 0 (PCLKSEL0)
//     <o9.0..1>    PCLK_WDT: Peripheral Clock Selection for WDT
//                     <0=> Pclk = Cclk / 4
```

```
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.2..3>    PCLK_TIMER0: Peripheral Clock Selection for TIMER0
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.4..5>    PCLK_TIMER1: Peripheral Clock Selection for TIMER1
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.6..7>    PCLK_UART0: Peripheral Clock Selection for UART0
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.8..9>    PCLK_UART1: Peripheral Clock Selection for UART1
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.12..13>  PCLK_PWM1: Peripheral Clock Selection for PWM1
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.14..15>  PCLK_I2C0: Peripheral Clock Selection for I2C0
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.16..17>  PCLK_SPI: Peripheral Clock Selection for SPI
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.20..21>  PCLK_SSP1: Peripheral Clock Selection for SSP1
```

```
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.22..23>  PCLK_DAC: Peripheral Clock Selection for DAC
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.24..25>  PCLK_ADC: Peripheral Clock Selection for ADC
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o9.26..27>  PCLK_CAN1: Peripheral Clock Selection for CAN1
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 6
//     <o9.28..29>  PCLK_CAN2: Peripheral Clock Selection for CAN2
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 6
//     <o9.30..31>  PCLK_ACF: Peripheral Clock Selection for ACF
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 6
//   </h>
//
//   <h> Peripheral Clock Selection Register 1 (PCLKSEL1)
//     <o10.0..1>   PCLK_QEI: Peripheral Clock Selection for the Quadrature Encoder
Interface
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.2..3>   PCLK_GPIO: Peripheral Clock Selection for GPIOs
//                     <0=> Pclk = Cclk / 4
```

```
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.4..5>   PCLK_PCB: Peripheral Clock Selection for the Pin Connect Block
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.6..7>   PCLK_I2C1: Peripheral Clock Selection for I2C1
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.10..11> PCLK_SSP0: Peripheral Clock Selection for SSP0
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.12..13> PCLK_TIMER2: Peripheral Clock Selection for TIMER2
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.14..15> PCLK_TIMER3: Peripheral Clock Selection for TIMER3
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.16..17> PCLK_UART2: Peripheral Clock Selection for UART2
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.18..19> PCLK_UART3: Peripheral Clock Selection for UART3
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.20..21> PCLK_I2C2: Peripheral Clock Selection for I2C2
```

```
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.22..23> PCLK_I2S: Peripheral Clock Selection for I2S
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.26..27> PCLK_RIT: Peripheral Clock Selection for the Repetitive Interrupt
Timer
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.28..29> PCLK_SYSCON: Peripheral Clock Selection for the System Control Block
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//     <o10.30..31> PCLK_MC: Peripheral Clock Selection for the Motor Control PWM
//                     <0=> Pclk = Cclk / 4
//                     <1=> Pclk = Cclk
//                     <2=> Pclk = Cclk / 2
//                     <3=> Pclk = Cclk / 8
//   </h>
//
//   <h> Power Control for Peripherals Register (PCONP)
//     <o11.1>      PCTIM0: Timer/Counter 0 power/clock enable
//     <o11.2>      PCTIM1: Timer/Counter 1 power/clock enable
//     <o11.3>      PCUART0: UART 0 power/clock enable
//     <o11.4>      PCUART1: UART 1 power/clock enable
//     <o11.6>      PCPWM1: PWM 1 power/clock enable
//     <o11.7>      PCI2C0: I2C interface 0 power/clock enable
//     <o11.8>      PCSPI: SPI interface power/clock enable
//     <o11.9>      PCRTC: RTC power/clock enable
//     <o11.10>     PCSSP1: SSP interface 1 power/clock enable
//     <o11.12>     PCAD: A/D converter power/clock enable
//     <o11.13>     PCCAN1: CAN controller 1 power/clock enable
//     <o11.14>     PCCAN2: CAN controller 2 power/clock enable
```

```
//     <o11.15>     PCGPIO: GPIOs power/clock enable
//     <o11.16>     PCRIT: Repetitive interrupt timer power/clock enable
//     <o11.17>     PCMC: Motor control PWM power/clock enable
//     <o11.18>     PCQEI: Quadrature encoder interface power/clock enable
//     <o11.19>     PCI2C1: I2C interface 1 power/clock enable
//     <o11.21>     PCSSP0: SSP interface 0 power/clock enable
//     <o11.22>     PCTIM2: Timer 2 power/clock enable
//     <o11.23>     PCTIM3: Timer 3 power/clock enable
//     <o11.24>     PCUART2: UART 2 power/clock enable
//     <o11.25>     PCUART3: UART 3 power/clock enable
//     <o11.26>     PCI2C2: I2C interface 2 power/clock enable
//     <o11.27>     PCI2S: I2S interface power/clock enable
//     <o11.29>     PCGPDMA: GP DMA function power/clock enable
//     <o11.30>     PCENET: Ethernet block power/clock enable
//     <o11.31>     PCUSB: USB interface power/clock enable
//   </h>
//
//   <h> Clock Output Configuration Register (CLKOUTCFG)
//     <o12.0..3>   CLKOUTSEL: Selects clock source for CLKOUT
//                     <0=> CPU clock
//                     <1=> Main oscillator
//                     <2=> Internal RC oscillator
//                     <3=> USB clock
//                     <4=> RTC oscillator
//     <o12.4..7>   CLKOUTDIV: Selects clock divider for CLKOUT
//                     <1-16><#-1>
//     <o12.8>      CLKOUT_EN: CLKOUT enable control
//   </h>
//
// </e>
*/



/** @addtogroup LPC17xx_System_Defines  LPC17xx System Defines
  @{
 */

#define CLOCK_SETUP           1
```

```
#define SCS_Val               0x00000020
#define CLKSRCSEL_Val         0x00000001
#define PLL0_SETUP            1
#define PLL0CFG_Val           0x00050063
#define PLL1_SETUP            1
#define PLL1CFG_Val           0x00000023
#define CCLKCFG_Val           0x00000003
#define USBCLKCFG_Val         0x00000000
#define PCLKSEL0_Val          0x00000000
#define PCLKSEL1_Val          0x00000000
#define PCONP_Val             0x042887DE
#define CLKOUTCFG_Val         0x00000000


/*---------------------- Flash Accelerator Configuration -----------------------
//
// <e> Flash Accelerator Configuration
//   <o1.12..15> FLASHTIM: Flash Access Time
//               <0=> 1 CPU clock (for CPU clock up to 20 MHz)
//               <1=> 2 CPU clocks (for CPU clock up to 40 MHz)
//               <2=> 3 CPU clocks (for CPU clock up to 60 MHz)
//               <3=> 4 CPU clocks (for CPU clock up to 80 MHz)
//               <4=> 5 CPU clocks (for CPU clock up to 100 MHz)
//               <5=> 6 CPU clocks (for any CPU clock)
// </e>
*/
#define FLASH_SETUP           1
#define FLASHCFG_Val          0x00004000

/*
//-------- <<< end of configuration section >>> ------------------------------
*/

/*----------------------------------------------------------------------------
  Check the register settings
 *----------------------------------------------------------------------------*/
#define CHECK_RANGE(val, min, max)                ((val < min) || (val > max))
#define CHECK_RSVD(val, mask)                     (val & mask)
```

```
/* Clock Configuration -------------------------------------------------------*/
#if (CHECK_RSVD((SCS_Val),       ~0x00000030))
   #error "SCS: Invalid values of reserved bits!"
#endif

#if (CHECK_RANGE((CLKSRCSEL_Val), 0, 2))
   #error "CLKSRCSEL: Value out of range!"
#endif

#if (CHECK_RSVD((PLL0CFG_Val),   ~0x00FF7FFF))
   #error "PLL0CFG: Invalid values of reserved bits!"
#endif

#if (CHECK_RSVD((PLL1CFG_Val),   ~0x0000007F))
   #error "PLL1CFG: Invalid values of reserved bits!"
#endif

#if (PLL0_SETUP)             /* if PLL0 is used */
  #if (CCLKCFG_Val < 2)      /* CCLKSEL must be greater then 1 */
    #error "CCLKCFG: CCLKSEL must be greater then 1 if PLL0 is used!"
  #endif
#endif

#if (CHECK_RANGE((CCLKCFG_Val), 0, 255))
   #error "CCLKCFG: Value out of range!"
#endif

#if (CHECK_RSVD((USBCLKCFG_Val), ~0x0000000F))
   #error "USBCLKCFG: Invalid values of reserved bits!"
#endif

#if (CHECK_RSVD((PCLKSEL0_Val),   0x000C0C00))
   #error "PCLKSEL0: Invalid values of reserved bits!"
#endif

#if (CHECK_RSVD((PCLKSEL1_Val),   0x03000300))
   #error "PCLKSEL1: Invalid values of reserved bits!"
#endif
```

```
#if (CHECK_RSVD((PCONP_Val),      0x10100821))
   #error "PCONP: Invalid values of reserved bits!"
#endif

#if (CHECK_RSVD((CLKOUTCFG_Val), ~0x000001FF))
   #error "CLKOUTCFG: Invalid values of reserved bits!"
#endif

/* Flash Accelerator Configuration -----------------------------------------*/
#if (CHECK_RSVD((FLASHCFG_Val), ~0x0000F000))
   #error "FLASHCFG: Invalid values of reserved bits!"
#endif


/*----------------------------------------------------------------------------
  DEFINES
 *----------------------------------------------------------------------------*/

/*----------------------------------------------------------------------------
  Define clocks
 *----------------------------------------------------------------------------*/
#define XTAL        (12000000UL)        /* Oscillator frequency               */
#define OSC_CLK     (      XTAL)        /* Main oscillator frequency          */
#define RTC_CLK     (   32768UL)        /* RTC oscillator frequency           */
#define IRC_OSC     ( 4000000UL)        /* Internal RC oscillator frequency   */


/* F_cco0 = (2 * M * F_in) / N  */
#define __M               (((PLL0CFG_Val      ) & 0x7FFF) + 1)
#define __N               (((PLL0CFG_Val >> 16) & 0x00FF) + 1)
#define __FCCO(__F_IN)    ((2ULL * __M * __F_IN) / __N)
#define __CCLK_DIV        (((CCLKCFG_Val      ) & 0x00FF) + 1)

/* Determine core clock frequency according to settings */
 #if (PLL0_SETUP)
    #if   ((CLKSRCSEL_Val & 0x03) == 1)
        #define __CORE_CLK (__FCCO(OSC_CLK) / __CCLK_DIV)
    #elif ((CLKSRCSEL_Val & 0x03) == 2)
        #define __CORE_CLK (__FCCO(RTC_CLK) / __CCLK_DIV)
```

```
    #else
        #define __CORE_CLK (__FCCO(IRC_OSC) / __CCLK_DIV)
    #endif
 #else
    #if   ((CLKSRCSEL_Val & 0x03) == 1)
        #define __CORE_CLK (OSC_CLK         / __CCLK_DIV)
    #elif ((CLKSRCSEL_Val & 0x03) == 2)
        #define __CORE_CLK (RTC_CLK         / __CCLK_DIV)
    #else
        #define __CORE_CLK (IRC_OSC         / __CCLK_DIV)
    #endif
 #endif


/**
 * @}
 */


/** @addtogroup LPC17xx_System_Public_Variables  LPC17xx System Public Variables
  @{
 */
/*----------------------------------------------------------------------------
  Clock Variable definitions
 *----------------------------------------------------------------------------*/
uint32_t SystemCoreClock = __CORE_CLK;/*!< System Clock Frequency (Core Clock)*/


/**
 * @}
 */


/** @addtogroup LPC17xx_System_Public_Functions  LPC17xx System Public Functions
  @{
 */

/**
 * Update SystemCoreClock variable
 *
 * @param  none
```

```
 * @return none
 *
 * @brief  Updates the SystemCoreClock with current core Clock
 *         retrieved from cpu registers.
 */void SystemCoreClockUpdate (void)            /* Get Core Clock Frequency      */
{
  /* Determine clock frequency according to clock register values             */
  if (((LPC_SC->PLL0STAT >> 24) & 3) == 3) { /* If PLL0 enabled and connected */
    switch (LPC_SC->CLKSRCSEL & 0x03) {
      case 0:                               /* Int. RC oscillator => PLL0    */
      case 3:                               /* Reserved, default to Int. RC  */
        SystemCoreClock = (IRC_OSC *
                           ((2ULL * ((LPC_SC->PLL0STAT & 0x7FFF) + 1)))  /
                           (((LPC_SC->PLL0STAT >> 16) & 0xFF) + 1)       /
                           ((LPC_SC->CCLKCFG & 0xFF)+ 1));
        break;
      case 1:                               /* Main oscillator => PLL0       */
        SystemCoreClock = (OSC_CLK *
                           ((2ULL * ((LPC_SC->PLL0STAT & 0x7FFF) + 1)))  /
                           (((LPC_SC->PLL0STAT >> 16) & 0xFF) + 1)       /
                           ((LPC_SC->CCLKCFG & 0xFF)+ 1));
        break;
      case 2:                               /* RTC oscillator => PLL0        */
        SystemCoreClock = (RTC_CLK *
                           ((2ULL * ((LPC_SC->PLL0STAT & 0x7FFF) + 1)))  /
                           (((LPC_SC->PLL0STAT >> 16) & 0xFF) + 1)       /
                           ((LPC_SC->CCLKCFG & 0xFF)+ 1));
        break;
    }
  } else {
    switch (LPC_SC->CLKSRCSEL & 0x03) {
      case 0:                               /* Int. RC oscillator => PLL0    */
      case 3:                               /* Reserved, default to Int. RC  */
        SystemCoreClock = IRC_OSC / ((LPC_SC->CCLKCFG & 0xFF)+ 1);
        break;
      case 1:                               /* Main oscillator => PLL0       */
        SystemCoreClock = OSC_CLK / ((LPC_SC->CCLKCFG & 0xFF)+ 1);
        break;
      case 2:                               /* RTC oscillator => PLL0        */
```

```
        SystemCoreClock = RTC_CLK / ((LPC_SC->CCLKCFG & 0xFF)+ 1);
        break;
    }
  }

}

/**
 * Initialize the system
 *
 * @param  none
 * @return none
 *
 * @brief  Setup the microcontroller system.
 *         Initialize the System.
 */
void SystemInit (void)
{
#if (CLOCK_SETUP)                     /* Clock Setup                        */
  LPC_SC->SCS       = SCS_Val;
  if (LPC_SC->SCS & (1 << 5)) {             /* If Main Oscillator is enabled  */
    while ((LPC_SC->SCS & (1<<6)) == 0);/* Wait for Oscillator to be ready    */
  }

  LPC_SC->CCLKCFG   = CCLKCFG_Val;      /* Setup Clock Divider                */
  /* Periphral clock must be selected before PLL0 enabling and connecting
   * - according errata.lpc1768-16.March.2010 -
   */
  LPC_SC->PCLKSEL0  = PCLKSEL0_Val;     /* Peripheral Clock Selection         */
  LPC_SC->PCLKSEL1  = PCLKSEL1_Val;

  LPC_SC->CLKSRCSEL = CLKSRCSEL_Val;    /* Select Clock Source sysclk / PLL0  */

#if (PLL0_SETUP)
  LPC_SC->PLL0CFG   = PLL0CFG_Val;      /* configure PLL0                     */
  LPC_SC->PLL0FEED  = 0xAA;
  LPC_SC->PLL0FEED  = 0x55;

  LPC_SC->PLL0CON   = 0x01;             /* PLL0 Enable                        */
```

```
  LPC_SC->PLL0FEED  = 0xAA;
  LPC_SC->PLL0FEED  = 0x55;
  while (!(LPC_SC->PLL0STAT & (1<<26)));/* Wait for PLOCK0                    */

  LPC_SC->PLL0CON   = 0x03;             /* PLL0 Enable & Connect              */
  LPC_SC->PLL0FEED  = 0xAA;
  LPC_SC->PLL0FEED  = 0x55;
  while ((LPC_SC->PLL0STAT & ((1<<25) | (1<<24))) != ((1<<25) | (1<<24)));  /* Wait for
PLLC0_STAT & PLLE0_STAT */
#endif

#if (PLL1_SETUP)
  LPC_SC->PLL1CFG   = PLL1CFG_Val;
  LPC_SC->PLL1FEED  = 0xAA;
  LPC_SC->PLL1FEED  = 0x55;

  LPC_SC->PLL1CON   = 0x01;             /* PLL1 Enable                        */
  LPC_SC->PLL1FEED  = 0xAA;
  LPC_SC->PLL1FEED  = 0x55;
  while (!(LPC_SC->PLL1STAT & (1<<10)));/* Wait for PLOCK1                    */

  LPC_SC->PLL1CON   = 0x03;             /* PLL1 Enable & Connect              */
  LPC_SC->PLL1FEED  = 0xAA;
  LPC_SC->PLL1FEED  = 0x55;
  while ((LPC_SC->PLL1STAT & ((1<< 9) | (1<< 8))) != ((1<< 9) | (1<< 8)));  /* Wait for
PLLC1_STAT & PLLE1_STAT */
#else
  LPC_SC->USBCLKCFG = USBCLKCFG_Val;    /* Setup USB Clock Divider            */
#endif

  LPC_SC->PCONP     = PCONP_Val;        /* Power Control for Peripherals      */

  LPC_SC->CLKOUTCFG = CLKOUTCFG_Val;    /* Clock Output Configuration         */
#endif

#if (FLASH_SETUP == 1)                  /* Flash Accelerator Setup            */
  LPC_SC->FLASHCFG  = (LPC_SC->FLASHCFG & ~0x0000F000) | FLASHCFG_Val;
#endif
}
```

```
/**
 * @}
 */


/**
 * @}
 */


/**-------------------------------------------------------------------------------------
---------------------------------//
//             @filename              main.c
                                                                                    //
//             @version               0.00
       //
//             @author        Alberto Palomo Alonso
                                                                  //
//
       //
//             @brief         Código fuente del programa principal.
                                                                  //
//
       //
//             @category              Principal.
                                                                                    //
//
       //
//             @map                   @include
       //
//                                    @global
                                                                                    //
//                                    @main
                                                                                    //
//                                    @end
       //
//
       //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------//
//
       //
```

```
                                                                                    //
//            @include              Estos son los archivos utilizados con el código
fuente.                                                     //
//
       //
//-------------------------------------------------------------------------------------
--------------------------------**/
#ifndef HEADER
#define HEADER
#include       "header.h"
#endif
/**-------------------------------------------------------------------------------------
--------------------------------//
//
       //

                                                                                    //
//            @global       Programa principal, variables globales.
                                                                  //
//
       //
//-------------------------------------------------------------------------------------
--------------------------------**/
misDatos_t            objDATOS;                                 //     Objeto.
misDatos_t     *      DATOS = &objDATOS;                  //     Mis datos almacenados
en la variable objDATOS.
State_t                       objESTADO;                        //     Objeto.
State_t        *      ESTADO = &objESTADO;          //     Declarar como extern. (Hey,
compilador, creeme que hay una variable por ahí que se llama ESTADO)
Counters_t            objCOUNTERS;                  //     Objeto.
Counters_t     *      COUNTERS = &objCOUNTERS;      //     Declarar como extern. (Hey,
compilador, creeme que hay una variable por ahí que se llama COUNTERS)
actualizador_t        objACTUALIZADOR;                      //     Objeto.
actualizador_t *      ACTUALIZADOR = &objACTUALIZADOR; //  Declarar como extern. (Hey,
compilador, creeme que hay una variable por ahí que se llama ACTUALIZADOR)
/**-------------------------------------------------------------------------------------
--------------------------------//
//
       //

                                                                                    //
//            @main         Programa principal, inicio after-reset.
                                                                  //
```

```
//

        //

//              @ref                    __configuraPrograma__ ->      configura.h
                                                                      //

//                                      __mainLoop__                  ->      statechart.h
                                                                              //

//

        //

//-------------------------------------------------------------------------------------
--------------------------------**/

int main        ()

{

        __configuraPrograma__();

        while ( 1       )

        {

                __mainLoop__();

                __mantenerTCP__();

        }

}

/**-----------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                      //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------
--------------------------------**/









/**-----------------------------------------------------------------------------------
---------------------------------//

//              @filename               Statechart.c

        //

//              @version                0.00

        //
```

```
//             @author        Alberto Palomo Alonso
                                                                                    //
//
       //
//             @brief         Código fuente correspondiente a la máquina de estados que
compone el menú.                                    //
//
       //
//             @category              Principal.
                                                                                          //
//
       //
//             @map                   @include
       //
//                                    @global
                                                                                          //
//                                    @function
       //
//                                    @end
       //
//
       //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------//
//
       //


                                                                                          //
//             @include               Estos son los archivos utilizados en el statechart.
                                                                 //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------**/
#ifndef STATECHART
#define STATECHART
#include       "Statechart.h"
#endif
/**-----------------------------------------------------------------------------------
---------------------------------//
```

```
//

	//

                                                                                //
//		@global		Estas son las variables globales pertenecientes al
statechart.                                                     //

//

	//

//-------------------------------------------------------------------------------------
-------------------------------**/

extern uint8_t		Clock[23];

extern State_t		*	ESTADO;

extern misDatos_t	*	DATOS;

extern actualizador_t *	ACTUALIZADOR;

extern uint8_t			OWEjecutameExterno;

extern uint16_t			contadorLUZ;

modificables_t		MODIFICABLES;

char buffer[23];

uint8_t Modo_energetico=0;

uint8_t Modo_brillo=3;

uint8_t pressedTouchPanel;

uint8_t __brilloFade = 0;

uint8_t __brilloAuto = 0;

uint8_t Aux8;

//	ZONA DE PANTALLA DE INICIO.

screenZone_t	zona_0 =	{	0			,		0
	,	MAXIMOX		,	MAXIMOY*0.2	,	0	};	//	Marco
del reloj y botones de alante y atrás.

screenZone_t	zona_1 =	{	MAXIMOX*0.15	,		0		,
	MAXIMOX*0.7	,	MAXIMOY*0.2	,	0	};	//	Reloj.

screenZone_t	zona_2 =	{	MAXIMOX*0.85	,		0		,
	MAXIMOX*0.15	,	MAXIMOY*0.2	,	0	};	//	Derecha.

screenZone_t	zona_3 =	{	MAXIMOX*0	,		0		,
	MAXIMOX*0.15	,	MAXIMOY*0.2	,	0	};	//	Izquierda.

screenZone_t	zona_4 =	{	MAXIMOX*0		,	MAXIMOY*0.2	,
	MAXIMOX*0.5	,	MAXIMOY*0.3	,	0	};	//	Primer botón.

screenZone_t	zona_5 =	{	MAXIMOX*0.5	,	MAXIMOY*0.2	,
	MAXIMOX*0.5	,	MAXIMOY*0.3	,	0	};	//	Segundo botón.

screenZone_t	zona_6 =	{	MAXIMOX*0		,	MAXIMOY*0.5	,
	MAXIMOX		,	MAXIMOY*0.15	,	0	};	//	Brillo info.

screenZone_t	zona_7 =	{	MAXIMOX*0		,	MAXIMOY*0.65	,
	MAXIMOX*0.2	,	MAXIMOY*0.15	,	0	};	//	Primer botón
de brillo.

screenZone_t	zona_8 =	{	MAXIMOX*0.2	,	MAXIMOY*0.65	,
	MAXIMOX*0.2	,	MAXIMOY*0.15	,	0	};	//	Segundo botón
de brillo.
```

```
screenZone_t   zona_9 =      {      MAXIMOX*0.4    ,      MAXIMOY*0.65   ,
       MAXIMOX*0.2    ,      MAXIMOY*0.15   ,      0      };     //     Tercer botón
de brillo.

screenZone_t   zona_10 =     {      MAXIMOX*0.6    ,      MAXIMOY*0.65   ,
       MAXIMOX*0.2    ,      MAXIMOY*0.15   ,      0      };     //     Cuarto botón
de brillo.

screenZone_t   zona_11 =     {      MAXIMOX*0.8    ,      MAXIMOY*0.65   ,
       MAXIMOX*0.2    ,      MAXIMOY*0.15   ,      0      };     //     Brillo
automático.

screenZone_t   zona_12 =     {      MAXIMOX*0             ,      MAXIMOY*0.8    ,
       MAXIMOX*0.2    ,      MAXIMOY*0.2    ,      0      };     //     Botón de
audio.

screenZone_t   zona_13 =     {      MAXIMOX*0.2    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.2    ,      MAXIMOY*0.2    ,      0      };     //     Volumen = 1.

screenZone_t   zona_14 =     {      MAXIMOX*0.4    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.2    ,      MAXIMOY*0.2    ,      0      };     //     Volumen = 2.

screenZone_t   zona_15 =     {      MAXIMOX*0.6    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.2    ,      MAXIMOY*0.2    ,      0      };     //     Volumen = 3.

screenZone_t   zona_16 =     {      MAXIMOX*0.8    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.2    ,      MAXIMOY*0.2    ,      0      };     //     Botón de load.

//     ZONA DE MEDIDAS.

screenZone_t   zona_17 =     {      MAXIMOX*0             ,      MAXIMOY*0.2    ,
       MAXIMOX        ,      MAXIMOY*0.1    ,      0      };     //     Información de
página, medidas.

screenZone_t   zona_18 =     {      MAXIMOX*0             ,      MAXIMOY*0.3    ,
       MAXIMOX               ,      MAXIMOY*0.1    ,      0      };     //
       Localización.

screenZone_t   zona_19 =     {      MAXIMOX*0             ,      MAXIMOY*0.4    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Temperatura.

screenZone_t   zona_20 =     {      MAXIMOX*0             ,      MAXIMOY*0.55   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Humedad.

screenZone_t   zona_21 =     {      MAXIMOX*0             ,      MAXIMOY*0.70   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Presión.

screenZone_t   zona_22 =     {      MAXIMOX*0             ,      MAXIMOY*0.85   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     IndiceUV.

//     ZONAS DE DATOS.

screenZone_t   zona_23 =     {      MAXIMOX*0.5    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Valor de
temperatura.

screenZone_t   zona_24 =     {      MAXIMOX*0.5    ,      MAXIMOY*0.55   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Valor de
humedad.

screenZone_t   zona_25 =     {      MAXIMOX*0.5    ,      MAXIMOY*0.70   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Valor de
presión.

screenZone_t   zona_26 =     {      MAXIMOX*0.5    ,      MAXIMOY*0.85   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Valor de
IndiceUV.

//     ZONAS DE AJUSTES.

screenZone_t   zona_27 =     {      MAXIMOX*0             ,      MAXIMOY*0.2    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Horas.

screenZone_t   zona_28 =     {      MAXIMOX*0             ,      MAXIMOY*0.35   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Minutos.
```

```
screenZone_t   zona_29 =      {      MAXIMOX*0            ,      MAXIMOY*0.5    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Segundos.

screenZone_t   zona_30 =      {      MAXIMOX*0            ,      MAXIMOY*0.65   ,
       MAXIMOX*0.5    ,      MAXIMOY*0.15   ,      0      };     //     Dia.

screenZone_t   zona_31 =      {      MAXIMOX*0            ,      MAXIMOY*0.8    ,
       MAXIMOX              ,      MAXIMOY*0.2    ,      0      };     //     Slot
libre.

screenZone_t   zona_27m       =      {      MAXIMOX*0.5    ,      MAXIMOY*0.2    ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Resta horas.

screenZone_t   zona_28m       =      {      MAXIMOX*0.5    ,      MAXIMOY*0.35   ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Resta minutos.

screenZone_t   zona_29m       =      {      MAXIMOX*0.5    ,      MAXIMOY*0.5    ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Resta
segundos.

screenZone_t   zona_30m       =      {      MAXIMOX*0.5    ,      MAXIMOY*0.65   ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Resta dia.

screenZone_t   zona_27M       =      {      MAXIMOX*0.75   ,      MAXIMOY*0.2    ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Suma horas.

screenZone_t   zona_28M       =      {      MAXIMOX*0.75   ,      MAXIMOY*0.35   ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Suma minutos.

screenZone_t   zona_29M       =      {      MAXIMOX*0.75   ,      MAXIMOY*0.5    ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Suma segundos.

screenZone_t   zona_30M       =      {      MAXIMOX*0.75   ,      MAXIMOY*0.65   ,
       MAXIMOX*0.25   ,      MAXIMOY*0.15   ,      0      };     //     Suma dia.

//     ZONAS DE MEDIDAS 2 (VIENTO)

screenZone_t   zona_32 =      {      MAXIMOX*0            ,      MAXIMOY*0.2    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.2    ,      0      };     //     Velocidad del
viento.

screenZone_t   zona_32n       =      {      MAXIMOX*0.5    ,      MAXIMOY*0.2    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.2    ,      0      };     //     Velocidad del
viento.

screenZone_t   zona_33 =      {      MAXIMOX*0            ,      MAXIMOY*0.4    ,
       MAXIMOX              ,      MAXIMOY*0.2    ,      0      };     //
       Velocidad del viento.

screenZone_t   zona_34 =      {      MAXIMOX*0            ,      MAXIMOY*0.6    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.2    ,      0      };     //     Cantidad de
brillo.

screenZone_t   zona_34n       =      {      MAXIMOX*0.5    ,      MAXIMOY*0.6    ,
       MAXIMOX*0.5    ,      MAXIMOY*0.2    ,      0      };     //     Cantidad de
brillo.

screenZone_t   zona_35 =      {      MAXIMOX*0            ,      MAXIMOY*0.8    ,
       MAXIMOX              ,      MAXIMOY*0.2    ,      0      };     //
       Cantidad de brillo.

//     Display de barras.

screenZone_t   zona_350       =      {      MAXIMOX*0            ,      MAXIMOY*0.8
       ,      MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_351       =      {      MAXIMOX*0.1    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_352       =      {      MAXIMOX*0.2    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_353       =      {      MAXIMOX*0.3    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };
```

```
screenZone_t   zona_354      =      {      MAXIMOX*0.4    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_355      =      {      MAXIMOX*0.5    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_356      =      {      MAXIMOX*0.6    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_357      =      {      MAXIMOX*0.7    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_358      =      {      MAXIMOX*0.8    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_359      =      {      MAXIMOX*0.9    ,      MAXIMOY*0.8    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

//     Display de barras.

screenZone_t   zona_330      =      {      MAXIMOX*0.0    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_331      =      {      MAXIMOX*0.1    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_332      =      {      MAXIMOX*0.2    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_333      =      {      MAXIMOX*0.3    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_334      =      {      MAXIMOX*0.4    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_335      =      {      MAXIMOX*0.5    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_336      =      {      MAXIMOX*0.6    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_337      =      {      MAXIMOX*0.7    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_338      =      {      MAXIMOX*0.8    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_339      =      {      MAXIMOX*0.9    ,      MAXIMOY*0.4    ,
       MAXIMOX*0.1    ,      MAXIMOY*0.2    ,      0      };

//     Menú de carga.

screenZone_t   zona_lo0      =      {      MAXIMOX*0.2    ,      MAXIMOY*0.2    ,
       MAXIMOX*0.6    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_lo1      =      {      MAXIMOX*0.2    ,      MAXIMOY*0.5    ,
       MAXIMOX*0.6    ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_lo20     =      {      MAXIMOX*0.2    ,      MAXIMOY*0.7    ,
       MAXIMOX*0.15   ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_lo21     =      {      MAXIMOX*0.35   ,      MAXIMOY*0.7    ,
       MAXIMOX*0.15   ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_lo22     =      {      MAXIMOX*0.5    ,      MAXIMOY*0.7    ,
       MAXIMOX*0.15   ,      MAXIMOY*0.2    ,      0      };

screenZone_t   zona_lo23     =      {      MAXIMOX*0.65   ,      MAXIMOY*0.7    ,
       MAXIMOX*0.15   ,      MAXIMOY*0.2    ,      0      };

/**-------------------------------------------------------------------------------------
--------------------------------//

//

       //
```

```
                                                                                //
//              @function               __mainLoop__()
                                                                                //
//
        //
//              @brief          Esta función es la que se ejecuta en el bucle principal del
main. Debe contener                             //
//                                      todo el código ejecutable por el loop principal.
                                                                        //
//
        //
//-------------------------------------------------------------------------------------
--------------------------------**/
void    __mainLoop__(  void    )
{
        /**     @LOOP: Primera parte del programa.   */
        alimentaWDT();
        checkTouchPanel();
        if ( __brilloAuto && (SysTick->CTRL & 0x10000))     //      Cada 100 ms si el
brillo auto está activado.
        {
                goto_LUT( DATOS->Brillo, BRILLO2CICLO_LDR , none , &Aux8 , none , none);
                modificaPulso( PWM6     ,       MODO_CICLO      ,       Aux8    ,       none
        ,       none    ,       none    );
        }
        /**     @LOOP: Máquina de estados LCD.              */
        switch( ESTADO->CHART  )
        {
                case    PANTALLA_INICIO:
                        __pintaInicio__();
                        if (zoneNewPressed(   &zona_2))
                        {
                                ESTADO->CHART = PANTALLA_MEDIDAS1;
                                LCD_Clear(Black);
                        }
                        if (zoneNewPressed(   &zona_3))
                        {
                                ESTADO->CHART = PANTALLA_MEDIDAS2;
                                LCD_Clear(Black);
                        }
                        if (zoneNewPressed(   &zona_5))
```

```
                {
                        ESTADO->CHART = PANTALLA_AJUSTES;
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_4))
                {
                        ESTADO->CHART = PANTALLA_VALORES;
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_7))
                {
                        __brilloAuto = 0;
                        __brilloFade = 0;
                        modificaPulso( PWM6    ,       MODO_CICLO     ,       1
        ,       none    ,       none    ,       none    );
                        Modo_brillo = 0;
                        Modo_energetico       =       0;      //      HP.
                }
                if (zoneNewPressed(   &zona_8))
                {
                        __brilloAuto = 0;
                        __brilloFade = 0;
                        modificaPulso( PWM6    ,       MODO_CICLO     ,       20
        ,       none    ,       none    ,       none    );
                        Modo_brillo = 1;
                        Modo_energetico       =       0;      //      HP.
                }
                if (zoneNewPressed(   &zona_9))
                {
                        __brilloAuto = 0;
                        __brilloFade = 0;
                        modificaPulso( PWM6    ,       MODO_CICLO     ,       40
        ,       none    ,       none    ,       none    );
                        Modo_brillo = 2;
                        Modo_energetico       =       0;      //      HP.
                }
                if (zoneNewPressed(   &zona_10))
                {
                        modificaPulso( PWM6    ,       MODO_CICLO     ,       60
        ,       none    ,       none    ,       none    );
                        __brilloAuto = 0;
```

```
                        __brilloFade = 0;
                        Modo_brillo = 3;
                        Modo_energetico       =      0;     //     HP.
                }
                if (zoneNewPressed(   &zona_11))
                {
                        __brilloAuto = 1;
                        __brilloFade = 0;
                        Modo_brillo = 4;
                        Modo_energetico       =      1;     //     LP.
                }
                if (zoneNewPressed(   &zona_12))
                {
                        if     (      ACTUALIZADOR->Audiorev)
                        {
                                ACTUALIZADOR->Audiorev = 0;
                                __configuraAudio__();
                                activarDac();
                        }
                }
                if (zoneNewPressed(   &zona_16))
                {
                        if     (      ACTUALIZADOR->Audiorev)
                        {
                                ACTUALIZADOR->Audiorev = 0;
                                lanzaUFONO();
                        }
                }


                if (zoneNewPressed(   &zona_13))
                {
                        Modo_energetico       =      0;     //     HP.
                        __brilloAuto          =      0;     //     No hay brillo
auto.
                        Modo_brillo           =      3;     //     Brillo a tope.
                        modificaPulso( PWM6   ,      MODO_CICLO     ,      60
      ,      none   ,      none   ,      none   );
                        __brilloFade          =      0;
                }
```

```
                    if (zoneNewPressed(   &zona_14))
                    {
                           Modo_energetico       =      1;     //     LP.
                           Modo_brillo           =      4;     //     Brillo auto.
                           __brilloAuto          =      1;     //     Activo el
brillo automático.
                           __brilloFade          =      0;     //     No pueda
apagarse la pantalla.
                    }
                    if (zoneNewPressed(   &zona_15))
                    {
                           Modo_energetico       =      2;     //     ULP.
                           Modo_brillo           =      4;     //     Brillo auto.
                           __brilloAuto          =      1;     //     Activo el
brillo automático.
                           __brilloFade          =      1;     //     Que pueda
apagarse la pantalla.

                    }

                    break;

             case   PANTALLA_MEDIDAS1:
                    __pintaMedidas1__();
                    if (zoneNewPressed(   &zona_2))
                    {
                           ESTADO->CHART = PANTALLA_MEDIDAS2;
                           LCD_Clear(Black);
                    }
                    if (zoneNewPressed(   &zona_3))
                    {
                           ESTADO->CHART = PANTALLA_INICIO;
                           LCD_Clear(Black);
                    }
                    break;

             case   PANTALLA_MEDIDAS2:
                    __pintaMedidas2__();
                    if (zoneNewPressed(   &zona_2))
                    {
                           ESTADO->CHART = PANTALLA_INICIO;
```

```
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_3))
                {
                        ESTADO->CHART = PANTALLA_MEDIDAS1;
                        LCD_Clear(Black);
                }
                break;

        case    PANTALLA_AJUSTES:
                __pintaAjustes__();
                if (zoneNewPressed(   &zona_2))
                {
                        ESTADO->CHART = PANTALLA_INICIO;
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_3))
                {
                        ESTADO->CHART = PANTALLA_INICIO;
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_27m))
                {
                        LPC_RTC->HOUR--;
                }
                if (zoneNewPressed(   &zona_28m))
                {
                        LPC_RTC->MIN--;
                }
                if (zoneNewPressed(   &zona_29m))
                {
                        LPC_RTC->SEC--;
                }
                if (zoneNewPressed(   &zona_30m))
                {
                        LPC_RTC->DOM--;
                }
                if (zoneNewPressed(   &zona_27M))
                {
```

```
                        LPC_RTC->HOUR++;
                }
                if (zoneNewPressed(   &zona_28M))
                {
                        LPC_RTC->MIN++;
                }
                if (zoneNewPressed(   &zona_29M))
                {
                        LPC_RTC->SEC++;
                }
                if (zoneNewPressed(   &zona_30M))
                {
                        LPC_RTC->DOM++;
                }
                break;

        case    PANTALLA_LOADING:
                break;
        case PANTALLA_VALORES:
                __pintaValores__();
                if (zoneNewPressed(   &zona_2))
                {
                        ESTADO->CHART = PANTALLA_INICIO;
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_3))
                {
                        ESTADO->CHART = PANTALLA_INICIO;
                        LCD_Clear(Black);
                }
                if (zoneNewPressed(   &zona_27m))
                {
                        MODIFICABLES.Min_servo_t--;
                }
                if (zoneNewPressed(   &zona_28m))
                {
                        MODIFICABLES.Max_servo_t--;
                }
                if (zoneNewPressed(   &zona_29m))
```

```
                        {
                                MODIFICABLES.Min_servo_p -= 10;
                        }
                        if (zoneNewPressed(   &zona_30m))
                        {
                                MODIFICABLES.Max_servo_p -= 10;
                        }
                        if (zoneNewPressed(   &zona_27M))
                        {
                                MODIFICABLES.Min_servo_t++;
                        }
                        if (zoneNewPressed(   &zona_28M))
                        {
                                MODIFICABLES.Max_servo_t++;
                        }
                        if (zoneNewPressed(   &zona_29M))
                        {
                                MODIFICABLES.Min_servo_p += 10;
                        }
                        if (zoneNewPressed(   &zona_30M))
                        {
                                MODIFICABLES.Max_servo_p += 10;
                        }
                        if (zoneNewPressed(   &zona_31))
                        {
                                MODIFICABLES.Var_medida = 1 - MODIFICABLES.Var_medida;
                        }
                default:
                        break;
        };
}
/**-------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                        //
//              @function               __configuraLCD__()
                                                                                        //
```

```
//

	//

//		@brief		Esta función configura el TFT HY32B conectado al driver
ILI9325C                                                //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void	__configuraLCD__(	void	)

{

	TP_Init();

	LCD_Initializtion();

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                //

//		@function		__pintaInicio__()
                                                                                //

//

	//

//		@brief		Esta función pinta la pantalla de inicio.
                                                //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void	__pintaInicio__(	void	)

{

	squareButton(	&zona_1,	(char *)Clock		,	Yellow	,	Green
	);

	squareButton(	&zona_2,	"->"			,	Yellow	,
	Green	);

	squareButton(	&zona_3,	"<-"			,	Yellow	,
	Green	);

	squareButton(	&zona_4,	"Valores"		,	Yellow	,
	Green	);

	squareButton(	&zona_5,	"Ajustes"		,	Yellow	,
	Green	);

	squareButton(	&zona_6,	"Nivel de brillo:"	,	Yellow	,	Green
	);

	switch	(	Modo_brillo	)

	{
```

```
        case 0:

                squareButton(  &zona_7,      "1"                        ,
White   ,       White  );

                squareButton(  &zona_8,      "2"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_9,      "3"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_10      ,      "4"
,       Yellow  ,       Green  );

                squareButton(  &zona_11      ,      "A"
,       Yellow  ,       Green  );

                break;

        case 1:

                squareButton(  &zona_7,      "1"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_8,      "2"                        ,
White   ,       White  );

                squareButton(  &zona_9,      "3"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_10      ,      "4"
,       Yellow  ,       Green  );

                squareButton(  &zona_11      ,      "A"
,       Yellow  ,       Green  );

                break;

        case 2:

                squareButton(  &zona_7,      "1"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_8,      "2"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_9,      "3"                        ,
White   ,       White  );

                squareButton(  &zona_10      ,      "4"
,       Yellow  ,       Green  );

                squareButton(  &zona_11      ,      "A"
,       Yellow  ,       Green  );

                break;

        case 3:

                squareButton(  &zona_7,      "1"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_8,      "2"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_9,      "3"                        ,
Yellow  ,       Green  );

                squareButton(  &zona_10      ,      "4"
,       White   ,       White  );

                squareButton(  &zona_11      ,      "A"
,       Yellow  ,       Green  );

                break;
```

```
		case 4:

			squareButton(	&zona_7,	"1"				,
	Yellow	,	Green	);

			squareButton(	&zona_8,	"2"				,
	Yellow	,	Green	);

			squareButton(	&zona_9,	"3"				,
	Yellow	,	Green	);

			squareButton(	&zona_10	,	"4"
	,	Yellow	,	Green	);

			squareButton(	&zona_11	,	"A"
	,	White	,	White	);

			break;

	}

	squareButton(	&zona_12	,	"Play"		,	Yellow	,
	Green	);

	switch	(	Modo_energetico	)

	{

		case 0:

			squareButton(	&zona_13	,	"HP"
	,	Red		,	Red		);

			squareButton(	&zona_14	,	"LP"
	,	Yellow	,	Green	);

			squareButton(	&zona_15	,	"ULP"		,
	Yellow	,	Green	);

			break;

		case 1:

			squareButton(	&zona_13	,	"HP"
	,	Yellow	,	Green	);

			squareButton(	&zona_14	,	"LP"
	,	Blue		,	Blue		);

			squareButton(	&zona_15	,	"ULP"		,
	Yellow	,	Green	);

			break;

		case 2:

			squareButton(	&zona_13	,	"HP"
	,	Yellow	,	Green	);

			squareButton(	&zona_14	,	"LP"
	,	Yellow	,	Green	);

			squareButton(	&zona_15	,	"ULP"		,
	White	,	White	);

			break;

	}

	squareButton(	&zona_16	,	"Load"		,	Yellow	,
	Green	);

}

/**--------------------------------------------------------------------------------
--------------------------------//
```

```
//
        //
                                                                                    //
//              @function               __pintaAjustes__()
                                                                                    //
//
        //
//              @brief          Esta función pinta la pantalla de ajustes.
                                                        //
//
        //
//-------------------------------------------------------------------------------------
--------------------------------**/
void    __pintaAjustes__(     void    )
{
        squareButton(  &zona_1 ,       (char *)Clock          ,       Yellow ,       Green
        );
        squareButton(  &zona_2 ,       "->"                           ,       Yellow ,
        Green   );
        squareButton(  &zona_3 ,       "<-"                           ,       Yellow ,
        Green   );
        squareButton(  &zona_27        ,       "Horas"                ,       Yellow ,
        Green   );
        squareButton(  &zona_28        ,       "Minutos"                      ,       Yellow
        ,       Green   );
        squareButton(  &zona_29        ,       "Segundos"             ,       Yellow ,
        Green   );
        squareButton(  &zona_30        ,       "Dias"                 ,       Yellow ,
        Green   );
        sprintf((char *)buffer,        "IP:%d.%d.%d.%d"       ,       __IP1B ,       __IP2B
        ,       __IP3B ,       __IP4B );
        squareButton(  &zona_31        ,       (char*)buffer          ,       Yellow ,
        Green   );
        squareButton(  &zona_27m       ,       "-"                            ,       Yellow
        ,       Green   );
        squareButton(  &zona_28m       ,       "-"                            ,       Yellow
        ,       Green   );
        squareButton(  &zona_29m       ,       "-"                            ,       Yellow
        ,       Green   );
        squareButton(  &zona_30m       ,       "-"                            ,       Yellow
        ,       Green   );
        squareButton(  &zona_27M       ,       "+"                            ,       Yellow
        ,       Green   );
        squareButton(  &zona_28M       ,       "+"                            ,       Yellow
        ,       Green   );
        squareButton(  &zona_29M       ,       "+"                            ,       Yellow
        ,       Green   );
```

```
        squareButton(  &zona_30M      ,       "+"                           ,       Yellow
        ,       Green   );

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

        //


                                                                                      //

//              @function               __pintaValores__()
                                                                                      //

//

        //

//              @brief          Esta función pinta la pantalla de valores.
                                                                  //

//

        //

//-------------------------------------------------------------------------------------
--------------------------------**/

void    __pintaValores__(     void    )

{

        squareButton(  &zona_1 ,       (char *)Clock          ,       Yellow ,       Green
        );

        squareButton(  &zona_2 ,       "->"                           ,       Yellow ,
        Green   );

        squareButton(  &zona_3 ,       "<-"                           ,       Yellow ,
        Green   );

        squareButton(  &zona_27       ,       "Temp.min."             ,       Yellow ,
        Green   );

        squareButton(  &zona_28       ,       "Temp.max."             ,       Yellow ,
        Green   );

        squareButton(  &zona_29       ,       "Pres.min."             ,       Yellow ,
        Green   );

        squareButton(  &zona_30       ,       "Pres.max."             ,       Yellow ,
        Green   );

        sprintf((char *)buffer,       "Pres [%d,%d] Temp [%d,%d]"   ,
        (int)MODIFICABLES.Min_servo_p , (int)MODIFICABLES.Max_servo_p,
(int)MODIFICABLES.Min_servo_t, (int)MODIFICABLES.Max_servo_t);

        if ( MODIFICABLES.Var_medida )

        {

                squareButton(  &zona_31       ,       (char*)buffer          ,       Green
        ,       Green   );

        }

        else

        {

                squareButton(  &zona_31       ,       (char*)buffer          ,       Red
        ,       Green   );
```

```
	}
	squareButton(  &zona_27m	,	"-"			,	Yellow
	,	Green	);
	squareButton(  &zona_28m	,	"-"			,	Yellow
	,	Green	);
	squareButton(  &zona_29m	,	"-"			,	Yellow
	,	Green	);
	squareButton(  &zona_30m	,	"-"			,	Yellow
	,	Green	);
	squareButton(  &zona_27M	,	"+"			,	Yellow
	,	Green	);
	squareButton(  &zona_28M	,	"+"			,	Yellow
	,	Green	);
	squareButton(  &zona_29M	,	"+"			,	Yellow
	,	Green	);
	squareButton(  &zona_30M	,	"+"			,	Yellow
	,	Green	);
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                    //
//		@function		__pintaCargandoInicio__()
                                                                                //
//
	//
//		@brief		Esta función pinta la pantalla cargando incio.
                                                                                //
//
	//
//-------------------------------------------------------------------------------------
--------------------------------**/
void	__pintaCargandoInicio__(	void	)
{
	squareButton(  &zona_lo0	,	"CARGANDO ..."			,
	Blue	,	Green	);
	squareButton(  &zona_lo1	,	"Preparando el sistema..."	,	Blue
	,	Green	);
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
	//
```

```
                                                                                                    //
//              @function               __pintaCargandoSeno__()
                                                                                                    //
//
        //
//              @brief          Esta función pinta la pantalla cargando seno.
                                                                //
//
        //
//-------------------------------------------------------------------------------------------
--------------------------------**/
void    __pintaCargandoSeno__(void   )
{
        squareButton(  &zona_lo0      ,       "CARGANDO ..."                        ,
        Blue    ,       Green   );
        squareButton(  &zona_lo1      ,       "Creando muestras..." ,       Blue    ,
        Green   );
        squareBox(     &zona_lo20,    White   );
}
/**-----------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                                    //
//              @function               __pintaCargandoConexion__()
                                                                                                    //
//
        //
//              @brief          Esta función pinta la pantalla cargando conexión.
                                                                //
//
        //
//-------------------------------------------------------------------------------------------
--------------------------------**/
void    __pintaCargandoConexion__(   void   )
{
        squareButton(  &zona_lo0      ,       "CARGANDO ..."                        ,
        Blue    ,       Green   );
        squareButton(  &zona_lo1      ,       "Buscando conexion TCP..."    ,       Blue
        ,       Green   );
        squareBox(     &zona_lo20,    White   );
        squareBox(     &zona_lo21,    White   );
}
```

```
/**-------------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                        //

//             @function             __pintaCargandoIniciando__()
                                                                                  //

//

       //

//             @brief         Esta función pinta la pantalla cargando iniciando.
                                                 //

//

       //

//-------------------------------------------------------------------------------------------
--------------------------------**/

void   __pintaCargandoIniciando__(  void   )

{

       squareButton(  &zona_lo0      ,       "CARGANDO ..."                      ,
       Blue   ,      Green  );

       squareButton(  &zona_lo1      ,       "Iniciando modulos..."       ,      Blue
       ,      Green  );

       squareBox(     &zona_lo20,    White  );

       squareBox(     &zona_lo21,    White  );

       squareBox(     &zona_lo22,    White  );

}

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                        //

//             @function             __pintaCargandoDone__()
                                                                                        //

//

       //

//             @brief         Esta función pinta la pantalla cargando hecho.
                                                          //

//

       //

//-------------------------------------------------------------------------------------------
--------------------------------**/

void   __pintaCargandoDone__(void   )

{
```

```
        squareButton(  &zona_lo0      ,       "CARGADO"                          ,
        Blue    ,       Green   );

        squareButton(  &zona_lo1      ,       "100%"                      ,       Blue
        ,       Green   );

        squareBox(     &zona_lo20,    White   );

        squareBox(     &zona_lo21,    White   );

        squareBox(     &zona_lo22,    White   );

        squareBox(     &zona_lo22,    White   );

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

        //


                                                                                //

//              @function               __pintaMedidas1__()
                                                                                //

//

        //

//              @brief          Esta función pinta la primera pantalla de medidas.
                                                        //

//

        //

//-------------------------------------------------------------------------------------
--------------------------------**/

void    __pintaMedidas1__(    void    )

{

        squareButton(  &zona_1 ,       (char *)Clock          ,       Yellow ,       Green
        );

        squareButton(  &zona_2 ,       "->"                           ,       Yellow ,
        Green   );

        squareButton(  &zona_3 ,       "<-"                           ,       Yellow ,
        Green   );

        squareButton(  &zona_17       ,       "MEDIDAS ACTUALES"     ,       Yellow ,
        Green   );

        if      (       ACTUALIZADOR->TempRev )

        {

                sprintf((char*)buffer,"Altura: %.02f m.",    DATOS->Lugar.Altura);

                squareButton(  &zona_18       ,       (char *)buffer         ,       Yellow
        ,       Green   );

        }

        squareButton(  &zona_19       ,       "Vel. v.:"             ,       Yellow ,
        Green   );

        squareButton(  &zona_20       ,       "Humedad:"             ,       Yellow ,
        Green   );
```

```
        squareButton(  &zona_21       ,       "Claridad:"           ,       Yellow ,
        Green  );

        squareButton(  &zona_22       ,       "Incide UV:"          ,       Yellow ,
        Green  );

        if      (       ACTUALIZADOR->Anemometro )

        {

                sprintf((char*)buffer,"%.02f mps",   DATOS->VelViento);

                squareButton(  &zona_23       ,       (char *)buffer        ,       Yellow
        ,       Green  );

                ACTUALIZADOR->Anemometro = 0;

        }


        if      (       ACTUALIZADOR->TempRev )

        {

                sprintf((char*)buffer,"%.02f %%",    DATOS->Humedad);

                squareButton(  &zona_24       ,       (char *)buffer        ,       Yellow
        ,       Green  );

                ACTUALIZADOR->TempRev = 0;

        }

        sprintf((char*)buffer,"%.02f LUX",DATOS->Brillo);

        squareButton(  &zona_25       ,       (char *)buffer        ,       Yellow ,
        Green  );

        sprintf((char*)buffer,"%.02f UVs",   DATOS->IndiceUV);

        squareButton(  &zona_26       ,       (char *)buffer        ,       Yellow ,
        Green  );

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

        //


                                                                                //

//              @function              __pintaMedidas2__()
                                                                                //

//

        //

//              @brief         Esta función pinta la segunda pantalla de medidas.
                                                //

//

        //

//-------------------------------------------------------------------------------------
--------------------------------**/

void    __pintaMedidas2__(    void    )

{
```

```
	squareButton(  &zona_1 ,	(char *)Clock		,	Yellow ,	Green
	);

	squareButton(  &zona_2 ,	"->"				,	Yellow ,
	Green  );

	squareButton(  &zona_3 ,	"<-"				,	Yellow ,
	Green  );

	squareButton(  &zona_32	,	"Temperatura:"		,	Yellow ,
	Green  );

	if	(	ACTUALIZADOR->TempRev )

	{

		sprintf((char*)buffer,"%.02f dC",	DATOS->Temperatura);

		squareButton(  &zona_32n	,	(char *)buffer		,	Yellow
	,	Green  );

		sprintf((char*)buffer,"%.02f mBar.", DATOS->Presion);

		squareButton(  &zona_34n	,	(char *)buffer		,	Yellow
	,	Green  );

		ACTUALIZADOR->TempRev = 0;

	}					//	Digo que toca medir.

	switch  (	(int)(10*(DATOS->Temperatura - MIN_TEMP)/(MAX_TEMP - MIN_TEMP))
	)

	{

		case 0:

			squareBox( &zona_330 , Black);

			squareBox( &zona_331 , Black);

			squareBox( &zona_332 , Black);

			squareBox( &zona_333 , Black);

			squareBox( &zona_334 , Black);

			squareBox( &zona_335 , Black);

			squareBox( &zona_336 , Black);

			squareBox( &zona_337 , Black);

			squareBox( &zona_338 , Black);

			squareBox( &zona_339 , Black);

			break;

		case 1:

			squareBox( &zona_330 , White);

			squareBox( &zona_331 , Black);

			squareBox( &zona_332 , Black);

			squareBox( &zona_333 , Black);

			squareBox( &zona_334 , Black);

			squareBox( &zona_335 , Black);

			squareBox( &zona_336 , Black);

			squareBox( &zona_337 , Black);

			squareBox( &zona_338 , Black);
```

```
                squareBox( &zona_339 , Black);
                break;
        case 2:
                squareBox( &zona_330 , White);
                squareBox( &zona_331 , White);
                squareBox( &zona_332 , Black);
                squareBox( &zona_333 , Black);
                squareBox( &zona_334 , Black);
                squareBox( &zona_335 , Black);
                squareBox( &zona_336 , Black);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 3:
                squareBox( &zona_330 , Yellow);
                squareBox( &zona_331 , Yellow);
                squareBox( &zona_332 , Yellow);
                squareBox( &zona_333 , Black);
                squareBox( &zona_334 , Black);
                squareBox( &zona_335 , Black);
                squareBox( &zona_336 , Black);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 4:
                squareBox( &zona_330 , Yellow);
                squareBox( &zona_331 , Yellow);
                squareBox( &zona_332 , Yellow);
                squareBox( &zona_333 , Yellow);
                squareBox( &zona_334 , Black);
                squareBox( &zona_335 , Black);
                squareBox( &zona_336 , Black);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 5:
```

```
                squareBox( &zona_330 , Blue);
                squareBox( &zona_331 , Blue);
                squareBox( &zona_332 , Blue);
                squareBox( &zona_333 , Blue);
                squareBox( &zona_334 , Blue);
                squareBox( &zona_335 , Black);
                squareBox( &zona_336 , Black);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 6:
                squareBox( &zona_330 , Blue);
                squareBox( &zona_331 , Blue);
                squareBox( &zona_332 , Blue);
                squareBox( &zona_333 , Blue);
                squareBox( &zona_334 , Blue);
                squareBox( &zona_335 , Blue);
                squareBox( &zona_336 , Black);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 7:
                squareBox( &zona_330 , Green);
                squareBox( &zona_331 , Green);
                squareBox( &zona_332 , Green);
                squareBox( &zona_333 , Green);
                squareBox( &zona_334 , Green);
                squareBox( &zona_335 , Green);
                squareBox( &zona_336 , Green);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 8:
                squareBox( &zona_330 , Green);
                squareBox( &zona_331 , Green);
                squareBox( &zona_332 , Green);
```

```
                squareBox( &zona_333 , Green);
                squareBox( &zona_334 , Green);
                squareBox( &zona_335 , Green);
                squareBox( &zona_336 , Green);
                squareBox( &zona_337 , Green);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
                break;
        case 9:
                squareBox( &zona_330 , Red);
                squareBox( &zona_331 , Red);
                squareBox( &zona_332 , Red);
                squareBox( &zona_333 , Red);
                squareBox( &zona_334 , Red);
                squareBox( &zona_335 , Red);
                squareBox( &zona_336 , Red);
                squareBox( &zona_337 , Red);
                squareBox( &zona_338 , Red);
                squareBox( &zona_339 , Black);
                break;
        case 10:
                squareBox( &zona_330 , Red);
                squareBox( &zona_331 , Red);
                squareBox( &zona_332 , Red);
                squareBox( &zona_333 , Red);
                squareBox( &zona_334 , Red);
                squareBox( &zona_335 , Red);
                squareBox( &zona_336 , Red);
                squareBox( &zona_337 , Red);
                squareBox( &zona_338 , Red);
                squareBox( &zona_339 , Red);
                break;
        default:
                if ( DATOS->Temperatura > MIN_TEMP)
                {
                        squareBox( &zona_330 , Red);
                        squareBox( &zona_331 , Red);
                        squareBox( &zona_332 , Red);
                        squareBox( &zona_333 , Red);
```

```
                squareBox( &zona_334 , Red);
                squareBox( &zona_335 , Red);
                squareBox( &zona_336 , Red);
                squareBox( &zona_337 , Red);
                squareBox( &zona_338 , Red);
                squareBox( &zona_339 , Red);
        }
        if ( DATOS->Temperatura < MIN_TEMP)
        {
                squareBox( &zona_330 , Black);
                squareBox( &zona_331 , Black);
                squareBox( &zona_332 , Black);
                squareBox( &zona_333 , Black);
                squareBox( &zona_334 , Black);
                squareBox( &zona_335 , Black);
                squareBox( &zona_336 , Black);
                squareBox( &zona_337 , Black);
                squareBox( &zona_338 , Black);
                squareBox( &zona_339 , Black);
        }
};

squareButton( &zona_34 , "Presion:" , Yellow , Green );
switch ( (int)(10*(DATOS->Presion - MIN_PRES)/(MAX_PRES - MIN_PRES)) )
{
        case 0:
                squareBox( &zona_350 , Black);
                squareBox( &zona_351 , Black);
                squareBox( &zona_352 , Black);
                squareBox( &zona_353 , Black);
                squareBox( &zona_354 , Black);
                squareBox( &zona_355 , Black);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 1:
```

```
                squareBox( &zona_350 , White);
                squareBox( &zona_351 , Black);
                squareBox( &zona_352 , Black);
                squareBox( &zona_353 , Black);
                squareBox( &zona_354 , Black);
                squareBox( &zona_355 , Black);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 2:
                squareBox( &zona_350 , White);
                squareBox( &zona_351 , White);
                squareBox( &zona_352 , Black);
                squareBox( &zona_353 , Black);
                squareBox( &zona_354 , Black);
                squareBox( &zona_355 , Black);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 3:
                squareBox( &zona_350 , Yellow);
                squareBox( &zona_351 , Yellow);
                squareBox( &zona_352 , Yellow);
                squareBox( &zona_353 , Black);
                squareBox( &zona_354 , Black);
                squareBox( &zona_355 , Black);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 4:
                squareBox( &zona_350 , Yellow);
                squareBox( &zona_351 , Yellow);
                squareBox( &zona_352 , Yellow);
```

```
                squareBox( &zona_353 , Yellow);
                squareBox( &zona_354 , Black);
                squareBox( &zona_355 , Black);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 5:
                squareBox( &zona_350 , Blue);
                squareBox( &zona_351 , Blue);
                squareBox( &zona_352 , Blue);
                squareBox( &zona_353 , Blue);
                squareBox( &zona_354 , Blue);
                squareBox( &zona_355 , Black);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 6:
                squareBox( &zona_350 , Blue);
                squareBox( &zona_351 , Blue);
                squareBox( &zona_352 , Blue);
                squareBox( &zona_353 , Blue);
                squareBox( &zona_354 , Blue);
                squareBox( &zona_355 , Blue);
                squareBox( &zona_356 , Black);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 7:
                squareBox( &zona_350 , Green);
                squareBox( &zona_351 , Green);
                squareBox( &zona_352 , Green);
                squareBox( &zona_353 , Green);
                squareBox( &zona_354 , Green);
                squareBox( &zona_355 , Green);
```

```
                squareBox( &zona_356 , Green);
                squareBox( &zona_357 , Black);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 8:
                squareBox( &zona_350 , Green);
                squareBox( &zona_351 , Green);
                squareBox( &zona_352 , Green);
                squareBox( &zona_353 , Green);
                squareBox( &zona_354 , Green);
                squareBox( &zona_355 , Green);
                squareBox( &zona_356 , Green);
                squareBox( &zona_357 , Green);
                squareBox( &zona_358 , Black);
                squareBox( &zona_359 , Black);
                break;
        case 9:
                squareBox( &zona_350 , Red);
                squareBox( &zona_351 , Red);
                squareBox( &zona_352 , Red);
                squareBox( &zona_353 , Red);
                squareBox( &zona_354 , Red);
                squareBox( &zona_355 , Red);
                squareBox( &zona_356 , Red);
                squareBox( &zona_357 , Red);
                squareBox( &zona_358 , Red);
                squareBox( &zona_359 , Black);
                break;
        case 10:
                squareBox( &zona_350 , Red);
                squareBox( &zona_351 , Red);
                squareBox( &zona_352 , Red);
                squareBox( &zona_353 , Red);
                squareBox( &zona_354 , Red);
                squareBox( &zona_355 , Red);
                squareBox( &zona_356 , Red);
                squareBox( &zona_357 , Red);
                squareBox( &zona_358 , Red);
```

```
                squareBox( &zona_359 , Red);
                break;
        default:
                if ( DATOS->Presion > MAX_PRES)
                {
                        squareBox( &zona_350 , Red);
                        squareBox( &zona_351 , Red);
                        squareBox( &zona_352 , Red);
                        squareBox( &zona_353 , Red);
                        squareBox( &zona_354 , Red);
                        squareBox( &zona_355 , Red);
                        squareBox( &zona_356 , Red);
                        squareBox( &zona_357 , Red);
                        squareBox( &zona_358 , Red);
                        squareBox( &zona_359 , Red);
                }
                if ( DATOS->Presion < MIN_PRES)
                {
                        squareBox( &zona_350 , Black);
                        squareBox( &zona_351 , Black);
                        squareBox( &zona_352 , Black);
                        squareBox( &zona_353 , Black);
                        squareBox( &zona_354 , Black);
                        squareBox( &zona_355 , Black);
                        squareBox( &zona_356 , Black);
                        squareBox( &zona_357 , Black);
                        squareBox( &zona_358 , Black);
                        squareBox( &zona_359 , Black);
                }
        }
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                //
//              @function               squareButton()
                                                                                //
```

```
//

	//

//		@brief		Dibuja un botón cuadrado, con texto y colores.
                                                        //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void squareButton(screenZone_t* zone, char * text, uint16_t textColor, uint16_t
lineColor)

{

	LCD_DrawLine( zone->x, zone->y, zone->x + zone->size_x - 1, zone->y, lineColor);

	LCD_DrawLine( zone->x, zone->y, zone->x, zone->y + zone->size_y - 1, lineColor);

	LCD_DrawLine( zone->x, zone->y + zone->size_y - 1, zone->x + zone->size_x - 1,
zone->y + zone->size_y - 1, lineColor);

	LCD_DrawLine( zone->x + zone->size_x - 1, zone->y, zone->x + zone->size_x - 1,
zone->y + zone->size_y - 1, lineColor);

	GUI_Text(zone->x + zone->size_x/2 - (strlen(text)/2)*8, zone->y + zone->size_y/2
- 8, (uint8_t*) text, textColor, Black);

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                //

//		@function		squareBox()
                                                                                //

//

	//

//		@brief		Dibuja un cuadrado de un color.
                                                                //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void squareBox(screenZone_t* zone, uint16_t color)

{

	int i;

	for (i = 0; i < (zone->size_x - 4) ; i++)

	{

		LCD_DrawLine( zone->x + i + 2, zone->y + 2, zone->x + i + 2, zone->y +
zone->size_y - 2, color);

	}
```

```
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                          //
//              @function               checkTouchPanel()
                                                                                          //
//
        //
//              @brief          Verifica se si ha tocado la pantalla.
                                                                                //
//
        //
//-------------------------------------------------------------------------------------------
--------------------------------**/
void checkTouchPanel(void)
{
        Coordinate* coord;

        coord = Read_Ads7846();

        if (coord > 0) {
          getDisplayPoint(&display, coord, &matrix );
     pressedTouchPanel = 1;
   }
   else
     pressedTouchPanel = 0;
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                          //
//              @function               zoneNewPressed()
                                                                                          //
//
        //
//              @brief          Verifica si se ha presionado una cierta zona de la
pantalla.                                                       //
```

```
//

       //

//                          @zone   Zona a comprobar.
                                                                        //

//

       //

//                          @return 0 - Si no se ha producido un toque.
                                                    //

//                                        1 - Si se ha producido un toque.
                                                                        //

//

       //

//-------------------------------------------------------------------------------------
-------------------------------**/

int8_t zoneNewPressed(screenZone_t * zone)

{

       if (pressedTouchPanel == 1) {


              if ((display.x > zone->x) && (display.x < zone->x + zone->size_x) &&

                        (display.y > zone->y) && (display.y < zone->y + zone->size_y))

     {

        if (zone->pressed == 0)

        {

           zone->pressed = 1;

           return 1;

        }

                 return 0;

     }

       /**    @MOD:  Esto lo he añadido yo */

        if (contadorLUZ      >=     (FREQ_OVERFLOW_SYSTICK *
MODIFICABLES.TiempoBrillo))   //     Si se ha activado el apagar pantalla...

        {

              modificaPulso         (      PWM6,   MODO_CICLO     ,       60      ,
       none    ,      none                  ,      none                  );      //
       La enciendo como si hubiese habido un reset.

              Modo_brillo = 3;

              if     (      Modo_energetico > 1    )

              {

                     __brilloAuto = 1;

                     Modo_brillo = 4;

                     if     (      Modo_energetico == 2 )

                     {
```

```
                            __brilloFade = 1;
                        }
                }


        }
         contadorLUZ = 0;             //      Reseteo el contador de apagar la pantalla.
        }


   zone->pressed = 0;
        return 0;
}
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                    //
//              @end            ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------------
---------------------------------**/



/*****************************************Copyright
(c)*************************************************
**
**                                   http://www.powermcu.com
**
**--------------File Info-----------------------------------------------------------------
------------------
** File name:               TouchPanel.c
** Descriptions:            The TouchPanel application function
**
**-------------------------------------------------------------------------------------------
------------------
** Created by:              AVRman
** Created date:            2010-11-7
** Version:                 v1.0
** Descriptions:            The original version
**
```

```
**-------------------------------------------------------------------------------------------
-----------------
** Modified by:
** Modified date:
** Version:
** Descriptions:
**
********************************************************************************************
****************/

/* Includes ------------------------------------------------------------------*/
#include "GLCD.h"
#include "TouchPanel.h"


//------------------------------//
//      INCLUIDO POR ALBERTO PALOMO.
#ifndef WDT
#define WDT
#include       "WDT.h"
#endif
//------------------------------//


/* Private variables ---------------------------------------------------------*/
Matrix matrix = {17835,-368445,-20450106,515085,6180,-2018789910,-5820405};
Coordinate  display ;

/* DisplaySample LCD struct */
Coordinate ScreenSample[3];

/* LCD Calibration coordinates */
Coordinate DisplaySample[3] = {{45,45},{45,270}, {190,190}} ;

/* Private define ------------------------------------------------------------*/
#define THRESHOLD 80   /* Be careful: this parameter should be tuned for your board
                          to avoid measure glitches */

/*******************************************************************************
* Function Name  : TP_Init
```

```
* Description    : ADS7843 and SPI config
* Input          : None
* Output         : None
* Return         : None
* Attention              : None
*******************************************************************************/
void TP_Init(void)
{
        PINSEL_CFG_Type PinCfg;
    SSP_CFG_Type SSP_ConfigStruct;

        /*
         * Initialize SPI pin connect
         * P0.6  - TP_CS - used as GPIO
         * P0.7  - TP_SCK
         * P0.8  - TP_SDO
         * P0.9  - TP_SDI
         * P2.13 - TP_IRQ - used as GPIO
         */
        PinCfg.Funcnum = 2;
        PinCfg.OpenDrain = 0;
        PinCfg.Pinmode = 0;
        PinCfg.Portnum = 0;
        PinCfg.Pinnum = 7;
        PINSEL_ConfigPin(&PinCfg);
        PinCfg.Pinnum = 8;
        PINSEL_ConfigPin(&PinCfg);
        PinCfg.Pinnum = 9;
        PINSEL_ConfigPin(&PinCfg);

        PinCfg.Funcnum = 0;
        PinCfg.Portnum = 0;
        PinCfg.Pinnum = 6;
        PINSEL_ConfigPin(&PinCfg);

        PinCfg.Funcnum = 0;
        PinCfg.Portnum = 2;
        PinCfg.Pinnum = 13;
        PINSEL_ConfigPin(&PinCfg);
```

```
   /* P2.13 TP_IRQ is Input */
   GPIO_SetDir(TP_IRQ_PORT_NUM, (1<<TP_IRQ_PIN_NUM), 0);
        GPIO_SetValue(TP_IRQ_PORT_NUM, (1<<TP_IRQ_PIN_NUM));

   /* P0.6 TP_CS is output */
   GPIO_SetDir(TP_CS_PORT_NUM, (1<<TP_CS_PIN_NUM), 1);
        GPIO_SetValue(TP_CS_PORT_NUM, (1<<TP_CS_PIN_NUM));

        /* initialize SSP configuration structure to default */
        SSP_ConfigStructInit(&SSP_ConfigStruct);
        SSP_ConfigStruct.ClockRate = 500000;
        /* Initialize SSP peripheral with parameter given in structure above */
        SSP_Init(LPC_SSP1, &SSP_ConfigStruct);

        /* Enable SSP peripheral */
        SSP_Cmd(LPC_SSP1, ENABLE);
}

/*********************************************************************************
* Function Name  : DelayUS
* Description    : Delay used for SPI A/D converter
* Input          : - cnt: microseconds
* Output         : None
* Return         : None
* Attention             : None
*********************************************************************************/
static void DelayUS(uint32_t cnt)
{
  uint32_t i;
        alimentaWDT(); //      INCLUIDO POR ALBERTO PALOMO.
  for(i = 0;i<cnt;i++)
  {
     uint8_t us = 12; /* Value for one microsecond delay*/
     while (us--)
     {
       ;
     }
  }
```

```
}

/*******************************************************************************
* Function Name  : WR_CMD
* Description    : ADS7843 Command Write
* Input          : - cmd: command
* Output         : None
* Return         : None
* Attention              : None
*******************************************************************************/
static uint8_t WR_CMD (uint8_t cmd)
{
        /* wait for current SSP activity complete */
        while (SSP_GetStatus(LPC_SSP1, SSP_STAT_BUSY) ==  SET);

        SSP_SendData(LPC_SSP1, (uint16_t) cmd);

        while (SSP_GetStatus(LPC_SSP1, SSP_STAT_RXFIFO_NOTEMPTY) == RESET);

        return (SSP_ReceiveData(LPC_SSP1));
}

/*******************************************************************************
* Function Name  : RD_AD
* Description    : ADC read (one measure)
* Input          : None
* Output         : None
* Return         : ADS7843 measure
* Attention              : None
*******************************************************************************/
static int RD_AD(void)
{
        unsigned short buf,temp;

        temp = WR_CMD(0x00);
        buf = temp << 8;
        DelayUS(1);
        temp = WR_CMD(0x00);;
        buf |= temp;
```

```
        buf >>= 3;
        buf &= 0xfff;
        return buf;
}

/*********************************************************************************
* Function Name  : Read_X
* Description    : Configuration of X coordinate and read ADC
* Input          : None
* Output         : None
* Return         : ADS7843 X value read
* Attention              : None
*********************************************************************************/
int Read_X(void)
{
        int i;
        TP_CS(0);
        DelayUS(1);
        WR_CMD(CHX);
        DelayUS(1);
        i = RD_AD();
        TP_CS(1);
        return i;
}

/*********************************************************************************
* Function Name  : Read_Y
* Description    : Configuration of Y coordinate and read ADC
* Input          : None
* Output         : None
* Return         : ADS7843 Y value read
* Attention             : None
*********************************************************************************/
int Read_Y(void)
{
        int i;
        TP_CS(0);
        DelayUS(1);
        WR_CMD(CHY);
```

```
	DelayUS(1);
	i = RD_AD();
	TP_CS(1);
	return i;
}

/*****************************************************************************
* Function Name  : TP_GetAdXY
* Description    : Read X and Y
* Input          : None
* Output         : None
* Return         : ADS7843 X and Y measure
* Attention		 : None
*****************************************************************************/
void TP_GetAdXY(int *x,int *y)
{
	int adx,ady;
	adx = Read_X();
	DelayUS(1);
	ady = Read_Y();
	*x = adx;
	*y = ady;
}

/*****************************************************************************
* Function Name  : TP_DrawPoint
* Description    : Write a 2x2 pixel red square
* Input          : - Xpos: Row Coordinate
*                  - Ypos: Line Coordinate
* Output         : None
* Return         : None
* Attention		 : None
*****************************************************************************/
void TP_DrawPoint(uint16_t Xpos,uint16_t Ypos)
{
	LCD_SetPoint(Xpos,Ypos,0xf800);
	LCD_SetPoint(Xpos+1,Ypos,0xf800);
	LCD_SetPoint(Xpos,Ypos+1,0xf800);
	LCD_SetPoint(Xpos+1,Ypos+1,0xf800);
```

```
}

/*******************************************************************************
* Function Name  : DrawCross
* Description    : Draw a white cross
* Input          : - Xpos: Row Coordinate
*                  - Ypos: Line Coordinate
* Output         : None
* Return         : None
* Attention              : None
*******************************************************************************/
void DrawCross(uint16_t Xpos,uint16_t Ypos)
{
	LCD_DrawLine(Xpos-15,Ypos,Xpos-2,Ypos,0xffff);
	LCD_DrawLine(Xpos+2,Ypos,Xpos+15,Ypos,0xffff);
	LCD_DrawLine(Xpos,Ypos-15,Xpos,Ypos-2,0xffff);
	LCD_DrawLine(Xpos,Ypos+2,Xpos,Ypos+15,0xffff);

	LCD_DrawLine(Xpos-15,Ypos+15,Xpos-7,Ypos+15,RGB565CONVERT(184,158,131));
	LCD_DrawLine(Xpos-15,Ypos+7,Xpos-15,Ypos+15,RGB565CONVERT(184,158,131));

	LCD_DrawLine(Xpos-15,Ypos-15,Xpos-7,Ypos-15,RGB565CONVERT(184,158,131));
	LCD_DrawLine(Xpos-15,Ypos-7,Xpos-15,Ypos-15,RGB565CONVERT(184,158,131));

	LCD_DrawLine(Xpos+7,Ypos+15,Xpos+15,Ypos+15,RGB565CONVERT(184,158,131));
	LCD_DrawLine(Xpos+15,Ypos+7,Xpos+15,Ypos+15,RGB565CONVERT(184,158,131));

	LCD_DrawLine(Xpos+7,Ypos-15,Xpos+15,Ypos-15,RGB565CONVERT(184,158,131));
	LCD_DrawLine(Xpos+15,Ypos-15,Xpos+15,Ypos-7,RGB565CONVERT(184,158,131));
}

/*******************************************************************************
* Function Name  : Read_Ads7846
* Description    : Make nine TouchPanel measures, evaluate if there are too
*                  much noise and return the more mean of the more similar measures
* Input          : None
* Output         : None
* Return         : 0 - if no touch detected or a two noise measure
*                  * Coordinate - if touch detected with X,Y measures.
```

```
* Attention            : None
*******************************************************************************/
Coordinate *Read_Ads7846(void)
{
  static Coordinate  screen;
  int m0,m1,m2,TP_X[1],TP_Y[1],temp[3];
  uint8_t count=0;
  int buffer[2][9]={{0},{0}};
  do                                          /* Reapeat for 9 measures if touch*/
  {
    TP_GetAdXY(TP_X,TP_Y);
         buffer[0][count]=TP_X[0];
         buffer[1][count]=TP_Y[0];
         count++;
  }
  while(!TP_INT_IN&& count<9);  /* TP_INT_IN is low level active if touch */

  if(count==9)   /* if 9 measures available¨ */
  {
    /* Obtain three means of three X mesures each */
    temp[0]=(buffer[0][0] + buffer[0][1] + buffer[0][2])/3;
         temp[1]=(buffer[0][3] + buffer[0][4] + buffer[0][5])/3;
         temp[2]=(buffer[0][6] + buffer[0][7] + buffer[0][8])/3;

         /* Calculate the distance of X centroids */
         m0=temp[0]-temp[1];
         m1=temp[1]-temp[2];
         m2=temp[2]-temp[0];

         /* Obtain de absolute value */
         m0=m0>0?m0:(-m0);
    m1=m1>0?m1:(-m1);
         m2=m2>0?m2:(-m2);

        /* return 0 if three X distances are bigger than THESHOLD. This means no touch */
        if( m0>THRESHOLD  &&  m1>THRESHOLD  &&  m2>THRESHOLD ) return 0;

       /* Choose the two more similar centroids and obteain the mean. Choose the best X
measures */
       if(m0<m1)
```

```
        {
          if(m2<m0)
            screen.x=(temp[0]+temp[2])/2;
          else
            screen.x=(temp[0]+temp[1])/2;
        }
        else if(m2<m1)
          screen.x=(temp[0]+temp[2])/2;
        else
          screen.x=(temp[1]+temp[2])/2;

    /* Obtain three means of three Y mesures each */
    temp[0]=(buffer[1][0] + buffer[1][1] + buffer[1][2])/3;
         temp[1]=(buffer[1][3] + buffer[1][4] + buffer[1][5])/3;
         temp[2]=(buffer[1][6] + buffer[1][7] + buffer[1][8])/3;

         /* Calculate the distance of Y centroids */
         m0=temp[0]-temp[1];
         m1=temp[1]-temp[2];
         m2=temp[2]-temp[0];

         /* Obtain de absolute value */
         m0=m0>0?m0:(-m0);
         m1=m1>0?m1:(-m1);
         m2=m2>0?m2:(-m2);

        /* return 0 if three Y distances are bigger than THESHOLD. This means no touch */
         if(m0>THRESHOLD && m1>THRESHOLD && m2>THRESHOLD) return 0;

        /* Choose the two more similar centroids and obteain the mean. Choose the best Y
measures */
        if(m0<m1)
        {
          if(m2<m0)
            screen.y=(temp[0]+temp[2])/2;
          else
            screen.y=(temp[0]+temp[1])/2;
    }
        else if(m2<m1)
           screen.y=(temp[0]+temp[2])/2;
```

```
       else
          screen.y=(temp[1]+temp[2])/2;

   /* Fill the return struct if a touch detected and return 0 if no tocuch */
       return &screen;
  }
  return 0;
}

/**************************************************************************
* Function Name  : setCalibrationMatrix
* Description    : Calculate the calibration metrix
* Input          : None
* Output         : None
* Return         : Calibration matrix
*
* Attention             : None
**************************************************************************/
uint8_t setCalibrationMatrix( Coordinate * displayPtr,
                              Coordinate * screenPtr,
                              Matrix * matrixPtr)
{

  uint8_t retTHRESHOLD = 0 ;

  /* Divider = (X0-X2)*(Y1-Y2) - (X1-X2)*(Y0-Y2) */
  matrixPtr->Divider = ((screenPtr[0].x - screenPtr[2].x) * (screenPtr[1].y -
screenPtr[2].y)) -
                       ((screenPtr[1].x - screenPtr[2].x) * (screenPtr[0].y -
screenPtr[2].y)) ;

  if( matrixPtr->Divider == 0 )
  {
    retTHRESHOLD = 1;
  }
  else
  {
    /* An = ((XD0-XD2)*(Y1-Y2) - (XD1-XD2)*(Y0-Y2)) */
    matrixPtr->An = ((displayPtr[0].x - displayPtr[2].x) * (screenPtr[1].y -
screenPtr[2].y)) -
```

```
                    ((displayPtr[1].x - displayPtr[2].x) * (screenPtr[0].y -
screenPtr[2].y)) ;


        /* Bn = ((X0-X2)*(XD1-XD2) - (XD0-XD2)*(X1-X2))    */

    matrixPtr->Bn = ((screenPtr[0].x - screenPtr[2].x) * (displayPtr[1].x -
displayPtr[2].x)) -

                    ((displayPtr[0].x - displayPtr[2].x) * (screenPtr[1].x -
screenPtr[2].x)) ;


    /* Cn = (Y0*(X2*XD1 - X1*XD2) + Y1*(X0*XD2 - X2XD0) + Y2*(X1*XD0 - X0*XD1)) */

    matrixPtr->Cn = (screenPtr[2].x * displayPtr[1].x - screenPtr[1].x *
displayPtr[2].x) * screenPtr[0].y +

                    (screenPtr[0].x * displayPtr[2].x - screenPtr[2].x *
displayPtr[0].x) * screenPtr[1].y +

                    (screenPtr[1].x * displayPtr[0].x - screenPtr[0].x *
displayPtr[1].x) * screenPtr[2].y ;

    /* Dn = ((YD0-YD2)*(Y1-Y2) - (YD1-YD2)*(Y0-Y2)) */

    matrixPtr->Dn = ((displayPtr[0].y - displayPtr[2].y) * (screenPtr[1].y -
screenPtr[2].y)) -

                    ((displayPtr[1].y - displayPtr[2].y) * (screenPtr[0].y -
screenPtr[2].y)) ;


    /* En = ((X0-X2)*(YD1-YD2)-(YD0-YD2)*(X1-X2))   */

    matrixPtr->En = ((screenPtr[0].x - screenPtr[2].x) * (displayPtr[1].y -
displayPtr[2].y)) -

                    ((displayPtr[0].y - displayPtr[2].y) * (screenPtr[1].x -
screenPtr[2].x)) ;


    /* Fn = (Y0*(X2YD1-X1YD2) + Y1(X0YD2-X2YD0) + Y2(X1YD0-X0YD1))    */

    matrixPtr->Fn = (screenPtr[2].x * displayPtr[1].y - screenPtr[1].x *
displayPtr[2].y) * screenPtr[0].y +

                    (screenPtr[0].x * displayPtr[2].y - screenPtr[2].x *
displayPtr[0].y) * screenPtr[1].y +

                    (screenPtr[1].x * displayPtr[0].y - screenPtr[0].x *
displayPtr[1].y) * screenPtr[2].y ;

  }

  return( retTHRESHOLD ) ;

}


/******************************************************************************

* Function Name  : getDisplayPoint

* Description    : Translate AD measures to XY coordinates with calibration matrix

* Input          : None

* Output         : None

* Return         : 0 - No valid touch
```

```
*                   1 - Valid touch
*                   Coordinate struct with X and Y
* Attention              : None
*******************************************************************************/
uint8_t getDisplayPoint(Coordinate * displayPtr,
                        Coordinate * screenPtr,
                        Matrix * matrixPtr )
{
  uint8_t retTHRESHOLD = 0 ;

  if( matrixPtr->Divider != 0 )
  {
    /* X = An*x + Bn*y + Cn */
    displayPtr->x = ( (matrixPtr->An * screenPtr->x) +
                      (matrixPtr->Bn * screenPtr->y) +
                       matrixPtr->Cn
                    ) / matrixPtr->Divider ;
       /* Y = Dn*x + En*y + Fn */
    displayPtr->y = ( (matrixPtr->Dn * screenPtr->x) +
                      (matrixPtr->En * screenPtr->y) +
                       matrixPtr->Fn
                    ) / matrixPtr->Divider ;
  }
  else
  {
    retTHRESHOLD = 1;
  }
  return(retTHRESHOLD);
}

/*******************************************************************************
* Function Name  : TouchPanel_Calibrate
* Description    : Draw three crosses, receive the calibration touches and
*                  calculate calibration matrix
* Input          : None
* Output         : None
* Return         : None
* Attention              : None
*******************************************************************************/
```

```
void TouchPanel_Calibrate(void)
{
	uint8_t i;
	Coordinate * Ptr;
	for(i=0;i<3;i++)
	{
		LCD_Clear(Black);
		GUI_Text(10,10,"Touch crosshair to calibrate",0xffff,Black);
		DelayUS( 500 * 1000 );
		DrawCross(DisplaySample[i].x,DisplaySample[i].y);
		do
		{
			Ptr=Read_Ads7846();
		}
		while( Ptr == (void*)0 );
		ScreenSample[i].x= Ptr->x; ScreenSample[i].y= Ptr->y;
	}
	setCalibrationMatrix( &DisplaySample[0],&ScreenSample[0],&matrix ) ;
	LCD_Clear(Black);
}


/*************************************************************************************
*****************
      END FILE
*************************************************************************************
*****************/



/**-------------------------------------------------------------------------------------
---------------------------------//
//             @filename             configura.c
                                                                                    //
//             @version              0.00
	//
//             @author        Alberto Palomo Alonso
                                                                        //
//
	//
//             @brief         Código que configura y llama a las funciones de
configuración para hacer un Setup del programa.//
//
	//
```

```
//             @category             Principal.
                                                                                    //
//
        //
//             @map                  @include
        //
//                                   @funcion
        //
//                                   @end
        //
//
        //
//
        //
//----------------------------------------------------------------------------------
---------------------------------//
//
        //

                                                                                    //
//             @include              Estos son los archivos utilizados en el código de
configuración.                                          //
//
        //
//----------------------------------------------------------------------------------
---------------------------------**/
#ifndef        CONFIGURA
#define CONFIGURA
#include "configura.h"
#endif
extern State_t        *       ESTADO;
extern misDatos_t     *       DATOS;
extern modificables_t MODIFICABLES;
/**--------------------------------------------------------------------------------
---------------------------------//
//
        //

                                                                                    //
//             @funcion              Esta función configura el programa entero.
                                                                  //
```

```
//

	//

//		@ref			__configuraPWM__		->	PWM.h
//
//				modificaPulso			->	PWM.h
//
//				__configuraLCD__		->	Statechart.h
//

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void __configuraPrograma__(   void   )

{

	__configuraLCD__		();

	LCD_Clear(Black);

	__pintaCargandoInicio__		();

	__iniciaVariables__		();

	LCD_Clear(Black);

	__pintaCargandoSeno__ ();

	//	Añadir generación de variables de alto costo computacional.

	LCD_Clear(Black);

	__pintaCargandoConexion__();

	__configuraWEB__		();

	LCD_Clear(Black);

	__pintaCargandoIniciando__();

	__configuraSysTick__  ();

	__configuraTimer0__		();

	__configuraLDR__		();

	__configuraUVA30A__		();

	__configuraUFONO__		();

	__configuraRTC__		();

	__configuraPWM__	(	Fpwm	,	ACTIVOS_2_1 | ACTIVOS_6_1	);

	modificaPulso		(	PWM2,	MODO_SERVO	,	none	,	90
	,	MINIMO_SERVO	,	MAXIMO_SERVO	);

	modificaPulso		(	PWM6,	MODO_CICLO	,	50	,	none
	,	none			,	none			);

	__configuraWDT__		();

	__configuraDAC__		();

	__configuraDMA__		();

	__configuraOW__		();

	__configuraAnemometro__		();
```

```
	__configuraUART0__		();
//	__configuraUART3__		();
	__configuraI2C__		();
#ifndef DEBUG
//	TouchPanel_Calibrate();
#endif
	LCD_Clear(Black);
	__pintaCargandoDone__ ();
	LCD_Clear(Black);
	ESTADO->CHART = PANTALLA_INICIO;
}
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
	//
                                                                                        //
//		@funcion		__iniciaVariables__()
                                                                                //
//
	//
//		@brief		Esta función inicia las variables del sistema para que
tengan un momento inicial.		//
//
	//
//-------------------------------------------------------------------------------------------
---------------------------------**/
void __iniciaVariables__()
{
	ESTADO->CHART = PANTALLA_LOADING;
	DATOS->Temperatura		= 0;
	DATOS->Humedad			= 0;
	DATOS->Presion			= 0;
	DATOS->VelViento		= 0;
	DATOS->IndiceUV			= 0;
	DATOS->Lugar.Altura		= 0;
	DATOS->Lugar.Longitud = 0;
	DATOS->Lugar.Latitud  = 0;

	MODIFICABLES.Max_servo_t	=	(float)MAXIMO_TEMPERATURA;
	MODIFICABLES.Min_servo_t	=	(float)MINIMO_TEMPERATURA;
```

```
	MODIFICABLES.Max_servo_p	=	(float)MAXIMO_PRESION;

	MODIFICABLES.Min_servo_p	=	(float)MINIMO_PRESION;

	MODIFICABLES.TiempoBrillo	=	10;

	MODIFICABLES.Var_medida		=	0;		//	0 la
temperatura, 1 la presión.

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                        //

//		@end		ENDFILE.

	//

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/




/**-------------------------------------------------------------------------------------
--------------------------------//

//		@filename		I2C.c
                                                                                //

//		@version		0.00

	//

//		@author		Alberto Palomo Alonso
                                                                        //

//

	//

//		@brief		Este es el programa que recoge la comunicación por I2C.
                                                //

//

	//

//		@category		Opcional.

	//

//

	//

//		@map			@include

	//

//				@variables
                                                                                //
```

```
//                                  @function

        //

//                                  @end

        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                    //

//              @include                Includes pertenecientes a la comunicación por I2C.
                                                                    //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef I2C

#define I2C

#include       "I2C.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                  //

//              @variables              Variables del fichero.
                                                                        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

//      Variables globales y externas.

BMP_t   COEF                    ;

extern  misDatos_t      *       DATOS;

uint8_t TemperaturaConBmp       =       0;

uint8_t LecturaBMP0     ;

uint8_t LecturaBMP1     ;

uint16_t        LecturaBMP      ;

float temperatura;
```

```
float presion;

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                        //

//		@function		__configuraI2C__()
                                                                                        //

//

	//

//		@brief		Esta función es la que configura el protocolo I2C.
                                                //

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/

void	__configuraI2C__	(	void	)

{

	__calibraBMP();

}

void __calibraBMP()

{

	I2CSendAddr(	BMP_ADD,	WRITE	);

	I2CSendByte(	AC1	);

	I2CSendAddr(	BMP_ADD,	READ	);

	COEF.ac1	=	I2CGetByte(	SACK	)	<< 8;

	COEF.ac1	|=	I2CGetByte(	NACK	);

	I2CSendStop();


	I2CSendAddr(	BMP_ADD,	WRITE	);

	I2CSendByte(	AC2	);

	I2CSendAddr(	BMP_ADD,	READ	);

	COEF.ac2	=	I2CGetByte(	SACK	)	<< 8;

	COEF.ac2	|=	I2CGetByte(	NACK	);

	I2CSendStop();


	I2CSendAddr(	BMP_ADD,	WRITE	);

	I2CSendByte(	AC3	);

	I2CSendAddr(	BMP_ADD,	READ	);

	COEF.ac3	=	I2CGetByte(	SACK	)	<< 8;
```

```
COEF.ac3       |=     I2CGetByte(    NACK    );
I2CSendStop();

I2CSendAddr(   BMP_ADD,      WRITE   );
I2CSendByte(   AC4     );
I2CSendAddr(   BMP_ADD,      READ    );
COEF.ac4       =      I2CGetByte(    SACK    )       << 8;
COEF.ac4       |=     I2CGetByte(    NACK    );
I2CSendStop();

I2CSendAddr(   BMP_ADD,      WRITE   );
I2CSendByte(   AC5     );
I2CSendAddr(   BMP_ADD,      READ    );
COEF.ac5       =      I2CGetByte(    SACK    )       << 8;
COEF.ac5       |=     I2CGetByte(    NACK    );
I2CSendStop();

       I2CSendAddr(   BMP_ADD,      WRITE   );
I2CSendByte(   AC6     );
I2CSendAddr(   BMP_ADD,      READ    );
COEF.ac6       =      I2CGetByte(    SACK    )       << 8;
COEF.ac6       |=     I2CGetByte(    NACK    );
I2CSendStop();

I2CSendAddr(   BMP_ADD,      WRITE   );
I2CSendByte(   B1      );
I2CSendAddr(   BMP_ADD,      READ    );
COEF.b1 =      I2CGetByte(    SACK    )       << 8;
COEF.b2 |=     I2CGetByte(    NACK    );
I2CSendStop();

I2CSendAddr(   BMP_ADD,      WRITE   );
I2CSendByte(   B2      );
I2CSendAddr(   BMP_ADD,      READ    );
COEF.b2 =      I2CGetByte(    SACK    )       << 8;
COEF.b2 |=     I2CGetByte(    NACK    );
I2CSendStop();

I2CSendAddr(   BMP_ADD,      WRITE   );
```

```
        I2CSendByte(   MB      );
        I2CSendAddr(   BMP_ADD,       READ    );
        COEF.mb =      I2CGetByte(    SACK    )       << 8;
        COEF.mb |=     I2CGetByte(    NACK    );
        I2CSendStop();

        I2CSendAddr(   BMP_ADD,       WRITE   );
        I2CSendByte(   MC      );
        I2CSendAddr(   BMP_ADD,       READ    );
        COEF.mc =      I2CGetByte(    SACK    )       << 8;
        COEF.mc |=     I2CGetByte(    NACK    );
        I2CSendStop();

        I2CSendAddr(   BMP_ADD,       WRITE   );
        I2CSendByte(   MD      );
        I2CSendAddr(   BMP_ADD,       READ    );
        COEF.md =      I2CGetByte(    SACK    )       << 8;
        COEF.md |=     I2CGetByte(    NACK    );
        I2CSendStop();
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                        //
//              @function               procesarDato()
                                                                                        //
//
        //
//              @brief          Procesa el dato guardado en la variable LecturaBMP.
                                                        //
//
        //
//-------------------------------------------------------------------------------------------
--------------------------------**/
void    procesarDato    (       uint8_t Tipo    )
{
        DATOS->Presion          =       presion*0.01;
        DATOS->Temperatura      =       temperatura;
        DATOS->Lugar.Altura =     (float)44330*( 1 - pow((presion / 101325 ),(1/5.255)));
```

```
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                        //
//		@function		pedirDatoReg()
                                                                                        //
//
	//
//		@brief		Pide un dato al sensor I2C de 16 bits especificando el
registro.                                                       //
//
	//
//-------------------------------------------------------------------------------------------
--------------------------------**/
void	pedirDatoReg	(	uint8_t REG	)
{
	irRegistro(	REG	);
	pedirDato	();
	procesarDato(	PRESION_BMP	);
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                        //
//		@function		pedirDato()
                                                                                        //
//
	//
//		@brief		Pide un dato al sensor I2C de 16 bits.
                                                                        //
//
	//
//-------------------------------------------------------------------------------------------
--------------------------------**/
void	pedirDato	(	void	)
{
	I2CSendAddr(	BMP_ADD,	READ	)		;		//	Mandar
la dirección en modo lectura.
```

```
	LecturaBMP0	=	I2CGetByte (	SACK	)	;		//	Leo el
primer byte.

	LecturaBMP1	=	I2CGetByte (	NACK ) ;		//	Leo el segundo
byte.

	I2CSendStop()						;		//
	Mando el fin de la comunicación.

	LecturaBMP	=	(LecturaBMP0 << 8) | LecturaBMP1;	//	Todo al buffer
de 16 bits.

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//

//
//		@function		irRegistro()
//

//

	//

//		@brief		Accede al registro REG de la memoria EPROM.
//

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

void irRegistro	(	uint8_t REG	)	//	Acceso al registro REG del
sensor.

{

	I2CSendAddr(	BMP_ADD,	WRITE);//	Selecciono BMP.

	I2CSendByte(		REG		);		//	Selecciono el registro
de presión.

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//

//
//		@function		bmp180_get_pressure()
//

//

	//

//		@brief		No hablo el mismo idioma que el creador del driver, pero
parece que devuelve la presión.		//
```

```
//

	//

//		@ref			Extraido de
https://github.com/BoschSensortec/BMP180_driver; referido por la datasheet.
	//

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

uint16_t obtenerDato	(	uint8_t REG	)

{

	uint16_t	RETVAL;

	I2CSendAddr(	BMP_ADD,	WRITE	);

	I2CSendByte(	REG	);

	I2CSendAddr(	BMP_ADD,	READ	);

	RETVAL	=	I2CGetByte(	SACK	)	<< 8;

	RETVAL	|=	I2CGetByte(	NACK	);

	I2CSendStop();

	return RETVAL;

}

void	mandaDato	(	uint8_t REG	,	uint8_t DATA)

{

	I2CSendAddr(	BMP_ADD,	WRITE	);

	I2CSendByte(	REG	);

	I2CSendByte(	DATA	);

	I2CSendStop();

}


void medirBMP()

{

	int i;

	long	UT, UP , X1 , X2 , X3 , B3 , B5 , B6 , T , p;

	unsigned long B4, B7;

	mandaDato		(	0xF4	,	0x2E	);

	//Espera 4.7ms.

	for ( i = 0; i < 1000; i++)

	{

		I2Cdelay();

	}

	//Espera activa corta!

	UT = obtenerDato	(	0xF6);
```

```
	mandaDato		(	0xF4	,	0x34	);
	//Esperar 4.7ms.
	for ( i = 0; i < 1000; i++)
	{
		I2Cdelay();
	}
	//Espera activa corta!
	UP = obtenerDato	(	0xF6);
	X1 = (UT - COEF.ac6) * COEF.ac5 / 32768;
	X2 = COEF.mc * 2048 / (X1 + COEF.md);
	B5 = X1 + X2;
	T  = ((B5 + 8) >> 4);

	B6 = B5 - 4000;
	X1 = (COEF.b2 * ((B6 * B6) >> 12)) >> 11;
	X2 = (COEF.ac2 * B6) >> 11;
	X3 = X1 + X2;
	B3 = ((COEF.ac1 * 4 + X3) + 2) / 4;
	X1 = (COEF.ac3 * B6) >> 13;
	X2 = (COEF.b1 * ((B6 * B6) >> 12)) >> 16;
	X3 = (X1 + X2 + 2) >> 2;
	B4 = COEF.ac4 * (unsigned long)(X3 + 32768) >> 15;
	B7 = ((unsigned long)UP - B3)*(50000);

	if	(B7 < 0x80000000)
	{
		p = (B7*2) / B4;
	}
	else
	{
		p = (B7 / B4) * 2;
	}

	X1 = (p >> 8)*(p >> 8);
	X1 = (X1 * 3038 >> 16);
	X2 = (-7357 * p) >> 16;
	p = p + ((X1 + X2 + 3791) >> 4);
//	temperatura	= (float)(28.0/107.0)*((float)T)/10;
//	presion		= (float)(936.0/1150.0)*(float)p;
```

```
        temperatura    = ((float)T)/10;
        presion        = (float)p;
        procesarDato(0);
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
        //
//              @end           ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------------
--------------------------------**/



/*********************************/
/*Funciones de control del bus I2C*/
/* SDA=P0.0 y SCL=P0.1            */
/*********************************/
#ifndef I2C
#define I2C
#include "I2C.h"
#endif


void I2Cdelay(void)                                                              //
        Retardo minimo de 4.7 us
{
        unsigned char i;
        for(    i=0     ;       i       <       DELAYTOTAL     ;       i++     );      //
        Modificar límite para garantizar los tiempos (Bus standar -->F_max=100kHz)
}


//Genera un pulso de reloj (1 ciclo)
void pulso_SCL(void)
{
         LPC_GPIO0->FIOSET=(1<<SCL);  // Genera pulso de reloj (nivel alto)
         I2Cdelay();
         LPC_GPIO0->FIOCLR=(1<<SCL);  // Nivel bajo
         I2Cdelay();
}
```

```
void I2CSendByte(unsigned char byte)

{

	unsigned char i;

	for(i=0;i<8;i++){


		if (byte &0x80)  LPC_GPIO0->FIOSET=(1<<SDA); // envia cada bit,
comenzando por el MSB

		else  LPC_GPIO0->FIOCLR=(1<<SDA);

		byte = byte <<1;		// Siguiente bit

		pulso_SCL();

	}


	//	Leer ACK que envía el Slave (el Master ha de enviar un pulso de reloj)

	//	CONFIGURAR PIN SDA COMO ENTRADA;

	//	espera ACK(config. pin como entrada)

	LPC_GPIO0->FIODIR&=~(1<<SDA);

	pulso_SCL();


	// CONFIGURA PIN SDA COMO SALIDA;

	LPC_GPIO0->FIODIR|=(1<<SDA);		// Dejamos SDA de nuevo como salida

}



//Función que envía START + Byte de dirección del Slave (con bit LSB inicando R/W)

void I2CSendAddr(unsigned char addr, unsigned char rw)

{

	//CONFIGURAR PINs SDA, SCL COMO SALIDAS;

	// Por si se nos olvidada en la conf. general.

	LPC_GPIO0->FIODIR|=(1<<SDA)|(1<<SCL);


	LPC_GPIO0->FIOSET|=(1<<SDA)|(1<<SCL);		// SDA y SCL a nivel alto
para garantizar el

								// nivel de
reposo del bus + tiempo.

	I2Cdelay();

	LPC_GPIO0->FIOCLR|=(1<<SDA);
	//condicion de START: Bajar SDA y luego SCL

	I2Cdelay();

	LPC_GPIO0->FIOCLR|=(1<<SCL);

	I2Cdelay();
```

```
	I2CSendByte((addr=addr<<1) + rw);  //envia byte de direccion
                                                        //addr, direccion (7bits)
                                                        //rw=1, lectura
                                                        //rw=0, escritura

}


// Función para leer un Byte del Slave. El Master envía al final de la lectura
// el bit ACK o NACK (si es último byte leído) que se pasa como argumento de la función.
unsigned char I2CGetByte(unsigned char ACK)
{
	// ACK = 0, para cualquier byte que no sea el ultimo.
	// ACK = 1 (NACK), despues de leer el ultimo byte
	unsigned char i, byte;
	//CONFIGURAR PIN SDA COMO ENTRADA;   //configura pin SDA como entrada
	LPC_GPIO0->FIODIR&=~(1<<SDA);
	for(i=0;i<8;i++){                                   //lee un bit comenzando por
el MSB

		LPC_GPIO0->FIOSET=(1<<SCL);//mientras SCL=1
		I2Cdelay();
		byte=byte<<1;
		if(LPC_GPIO0->FIOPIN&(1<<SDA)) byte++;                    //Si leemos
"1" sumamos para introducir el "1"
		LPC_GPIO0->FIOCLR=(1<<SCL);                               //Si leemos
"0" solo desplazamos (se introduce un "0")
		I2Cdelay();
	       }

	//CONFIGURAR PIN SDA COMO SALIDA;
	// Master envía un ACK por cada byte leído.
	LPC_GPIO0->FIODIR|=(1<<SDA);

	if(ACK)LPC_GPIO0->FIOSET=(1<<SDA);          // ACK o (NACK) es funcion del
último byte leído
	else LPC_GPIO0->FIOCLR=(1<<SDA);

	pulso_SCL();                                        // Pulso de reloj para su
envío
	return (byte);
```

```
}



void I2CSendStop(void)

{

	LPC_GPIO0->FIOCLR=(1<<SDA);

	I2Cdelay();

	LPC_GPIO0->FIOSET=(1<<SCL);		// Subir SCL, y después SDA!! para dejar
el bus en reposo

	I2Cdelay();

	LPC_GPIO0->FIOSET=(1<<SDA);

	I2Cdelay();

}



/**-------------------------------------------------------------------------------------
---------------------------------//

//		@filename		Anemometro.c
                                                                                //

//		@version		2.00

	//

//		@author		Alberto Palomo Alonso
                                                                //

//

	//

//		@brief		Este es el programa donde se encuentran las funciones
correspondientes al                                  //

//                                      anemómetro de la estación.
                                                                //

//

	//

//

	//

//		@category		Medida.
                                                                //

//

	//

//		@map			@include

	//

//                                      @variables
                                                                //
```

```
//                                  @function

        //

//                                  @end

        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                    //

//              @include                Includes pertenecientes al módulo del anemómetro.
                                                                                //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef ANEMOMETRO

#define ANEMOMETRO

#include       "Anemometro.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                  //

//              @variables              Variables del fichero.
                                                                          //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

uint8_t CAPcont         =       2*PULSOS_VUELTA;

uint8_t SLAYERcont      =       0;

uint32_t        CLKbuff[]               =       {0 , 0};

extern  misDatos_t      *       DATOS;

extern  actualizador_t *        ACTUALIZADOR;

float   aux_viento      =       0;

/**-----------------------------------------------------------------------------------
---------------------------------//
```

```
//
	//
                                                                                    //
//		@function		__configuraAnemometro__()
                                                                                    //
//
	//
//-------------------------------------------------------------------------------------
------------------------------**/
void __configuraAnemometro__()
{
	LPC_PINCON->PINMODE3	&=	~(PULL_UP << (2*2));		//	PULL_UP
	LPC_PINCON->PINMODE3	|=	PULL_UP << (2*2);		//	PULL_UP
	LPC_PINCON->PINSEL3		&=	~((CAPTURE_FUNCION) << (2*2));//
	CAPTURE1.0
	LPC_PINCON->PINSEL3		|=	(CAPTURE_FUNCION) << (2*2);	//
	CAPTURE1.0
	LPC_TIM1->CTCR			|=	CTCR_MASCARA;			//
	Flanco de subida.
	LPC_TIM1->CCR			|=	CCR_MASCARA_EN;			//
	Inicio con interrupción.
	LPC_SC->PCONP			|=	TIMER1_BIT;			//
	Activo el módulo del timer 1.
	LPC_TIM1->PR			=	0;
	//	Sin prescaler.
	LPC_TIM1->TCR			|=	RESET_TIMER_TCR;		//
	Reseteo el contador.
	LPC_TIM1->TCR			&=	~RESET_TIMER_TCR;		//	Reseteo
el contador.
	LPC_TIM1->TCR			|=	0x1;
	//	Que cuente.
	LPC_PINCON->PINSEL3		|=	0x3	<<	4;
	//	Entrada como CAP1.0.
	NVIC_EnableIRQ(	TIMER1_IRQn	);
}
/**-------------------------------------------------------------------------------------
---------------------------------//
//
	//
                                                                                    //
//		@HANDLER		mideAnemometro()
                                                                                    //
//
	//
```

```
//            @brief        Es la medidas del anemómetro, se suicida al acabar y es reanimada por el reanimador cada 5s. //
//
       //
//-------------------------------------------------------------------------------------------------------------------**/
void mideAnemometro()
{
                                    /**    @WARNING:     Esto me parece un poco sucio, pero es la única manera de que no se generen
                                                         interrupciones espúrias utilizando únicamente recursos sorftware. Idealmente
                                                         no debería usar delays y mucho menos en interrupciones. Si no uso esto se generan
                                                         varias interrupciones por flanco debido al ruido. Esto se arregla con un condensador
                                                         a masa en la entrada, pero es perder recursos hardware y he decidido perderlos
                                                         mediante software.*/
                                    int i;
                                    for(i = 0; i < 30000; i++) {}
                                    /**    @TODO Poner condensadores entre Vin y masa del capture 1.0 para evitar doble int en flancos ascendentes.*/


       LPC_TIM1->IR = 1 << 4;                                    //     Desactivo la interrupción.
       CAPcont++;                                                //     Incremento el contador de pulsos.
       if     (      CAPcont       >=     PULSOS_VUELTA  )      /**    @WARNING: Se generan __UN__ interrupciones por pulso y 2*PULSOS_VUELTA por vuelta.*/
       {
              CLKbuff[1] = CLKbuff[0];                           //     Almaceno el valor anterior.
              CLKbuff[0] = LPC_TIM1->CR0;                        //     Cargo el valor actual.
              CAPcont = 0;                                       //     Reseteo el contador de pulsos.
              aux_viento     =
       Ftick*(float)PI*(float)DIAMETRO_ANEMOMETRO/((float)100*(float)((uint32_t)CLKbuff[0] - (uint32_t)CLKbuff[1]));  // Metros / segundo.
              SLAYERcont++;                                      //     Hay warmup, aumento el slayer.
              if (   SLAYERcont == WARMUP_CICLOS )
              {
                     LPC_TIM1->CCR  |=     ~CCR_MASCARA_DIS;     //     Slay capture. OJO: QUE HAY QUE REVIVIRLO.
```

```
                        SLAYERcont = 0;                                         //      Reseteo
el slayer.
                        DATOS->VelViento = aux_viento;              //      Guardo el
valor calentado.
                        ACTUALIZADOR->AnemometroRev = 0;            //      Digo que he
medido al timer.
                        ACTUALIZADOR->Anemometro = 1;               //      Digo que he
medido al statechart.
                }
                else
                {
                        LPC_TIM1->CCR  |=      CCR_MASCARA_EN;      //      Si no, está
activado.
                }
        }
}
/**-------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                //
//              @end            ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------
---------------------------------**/



/**-------------------------------------------------------------------------------------
---------------------------------//
//              @filename               LDR.c
                                                                                        //
//              @version                0.00
        //
//              @author         Alberto Palomo Alonso
                                                                                //
//
        //
//              @brief          Código fuente que contiene las funciones para LDR (ADC).
                                                        //
//
        //
```

```
//             @category             Periférico.
                                                                                    //
//
        //
//             @map                  @include
        //
//                                   @VARIABLES
                                                                                    //
//                                   @funcion
        //
//                                   @end
        //
//
        //
//
        //
//----------------------------------------------------------------------------------
---------------------------------//
//
        //

                                                                                    //
//             @include              Estos son los archivos utilizados en el código de
LDR.                                                                  //
//
        //
//----------------------------------------------------------------------------------
---------------------------------**/
#ifndef LDR
#define LDR
#include       "LDR.h"
#endif
/**--------------------------------------------------------------------------------
---------------------------------//
//
        //

                                                                                    //
//             @variables            Variables del fichero.
                                                                      //
//
        //
```

```
//-------------------------------------------------------------------------------------------
------------------------------**/

extern misDatos_t     *       DATOS;

float   BUFFER_BRILLO = 0;

float   BUFFER_UVA    = 0;

extern actualizador_t *       ACTUALIZADOR;

extern uint8_t YaPuedesMedir;

uint32_t       contador;

uint8_t AUDIO[MUESTRAS_AUDIO];

/**-----------------------------------------------------------------------------------------
------------------------------//

//

        //


                                                                                        //

//              @funcion        __configuraLDR__()
                                                                                        //

//

        //

//              @brief  Esta función configura el ADC y el LDR
                                                                        //

//

        //

//-------------------------------------------------------------------------------------------
------------------------------**/

void    __configuraLDR__()

{

        LPC_SC->PCONP                   |=      PCONP_ADC_ON;           //      Enciendo el
ADClock.

        LPC_PINCON->PINSEL1             |=      PINSEL_ADC01;           //      AD0.1

        LPC_PINCON->PINMODE1    &=      ~PINMODE_ADC01;         //      AD0.1

        LPC_ADC->ADCR                   |=      BRUST_PIN                       //      Modo
ráfaga.

                                                |       SEL_CANAL1              //      AD0.1
activado.

                                                |       ADC_POWER                       //
        Empiezo ENCENDIENDO el ADC.

                                                |       CLK_DIV_MAX;            //      Clkdiv
hace que Fadc = Fclk/256, inferior al umbral de 13MHz. (Ojo: clkdiv = 0 implica que no
funcione en placa).

        LPC_ADC->ADINTEN                |=      SEL_CANAL1;             //      Genera
interrupción el canal 1.      (Debería ser el penúltimo)

        ACTUALIZADOR->LDRrev    =       1;                              //      Inicia para
activar.

        LPC_ADC->ADINTEN                &=      ~(SEL_CANAL_GLOBAL);//Apago la interrupción
global.
```

```
	NVIC_EnableIRQ(	ADC_IRQn	);
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
	//
//		@HANDLER	ADC_IRQHandler()
//
	//
//		@brief Esta función gestiona la interrupción del ADC.
//
	//
//----------------------------------------------------------------------------------------
--------------------------------**/
void	ADC_IRQHandler()
{
	switch( YaPuedesMedir )
	{
		case 1:
			LPC_ADC->ADCR		&=	~BRUST_PIN;
	Mato el BURST.
			BUFFER_BRILLO		=	(float)((LPC_ADC-
>ADDR1&(0xFFF0)) >> 4);
	Empieza a partir del bit 4.
			BUFFER_BRILLO		/=	(float)0xFFF;	//*rel
	Relacción de código. (Código/Código máximo)
			BUFFER_BRILLO		=
	RESISTENCIA_PULL*(BUFFER_BRILLO)/(1.00 - BUFFER_BRILLO);
	//	Leo el ADC. (Ressitencia del LDR en kOhms)
			goto_LUT(	BUFFER_BRILLO	,	BRILLO_LDR_NOLUT,	(float
*)&DATOS->Brillo	,	none	,	none	,	none	);	//
	Traduzco resistencias a LUX.
			BUFFER_UVA		=	(float)((LPC_ADC-
>ADDR2&(0xFFF0)) >> 4);
	Empieza a partir del bit 4.
			DATOS->IndiceUV		=
	(float)VINDICE*VREF*BUFFER_UVA/(float)(0xFFF);
		//	Traducción del código al índice.
			ACTUALIZADOR->LDRrev	=	1;
	Digo que el LDR ha sido leido.
```

```
                        //ACTUALIZADOR->LDR           =       1;

        //      Señal al LCD para que muestre por pantalla.

                        break;

                case 0:

                        AUDIO[contador]         =       (uint8_t)((0xFF) & LPC_ADC->ADDR0 >>
(4+4));         //      El ADC es de 12 bits y las muestras de 8 bits, por lo que hay que
reducir los 4 LSB.

                        if (contador++ >= MUESTRAS_AUDIO - 1)

                        {

                                        contador                        =       0;
        //      Reseteo el contador.

                                        LPC_TIM1->MCR           =       0;              //
        No interrumpe el MR0.

                                        ACTUALIZADOR->Audiorev = 1;             //
        Señalizo el fin del audio.

                                        recuperaContexto();                             //
        Recupero el contexto del ADC.

                        }

                        break;

        }

}

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/




/**-------------------------------------------------------------------------------------------
---------------------------------//

//              @filename               uFono.c
                                                                                        //

//              @version                1.00

        //

//              @author         Alberto Palomo Alonso
                                                                        //
```

```
//

	//

//		@brief		Código que contiene todo lo relaccionado con el micrófono.
                                                    //

//

	//

//		@category		Opcional.

	//

//

	//

//		@map			@include

	//

//                                  @variables
                                                                                    //

//                                  @funcion

	//

//                                  @end

	//

//

	//

//

	//

//-----------------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                    //

//		@include		Estos son los archivos utilizados para el auido del
micrófono.                                                  //

//

	//

//-----------------------------------------------------------------------------------------
---------------------------------**/

#ifndef UFONO

#define UFONO

#include	"uFono.h"

#endif

/**-----------------------------------------------------------------------------------------
---------------------------------//

//
```

```
	//

                                                                                //
//		@variables		Variables del fichero.
                                                                //
//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

extern uint8_t Timer2_MODO;

uint8_t YaPuedesMedir = 1;

uint32_t	ADC_ConfigBuffer;

uint32_t  ADC_IntenBuffer;

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                //
//		@funcion	__configuraUFONO__()
                                                                        //
//

	//

//		@ref		Configura todo lo necesario para la lectura de audio.
                                                                //
//

	//

//		@WARNING	Utiliza variables de bloqueo.
                                                                        //
//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void __configuraUFONO__()

{

//	LPC_PINCON->PINSEL1 |= ~(0x3 << (2*PIN_UFONO));

	LPC_PINCON->PINSEL1 |= (FUNC_ADC << (2*PIN_UFONO));


	//	NEW:

	LPC_TIM1->MR0  =	Fclk*TsAudio - 1;	//	Cada MR0 se genera una
interrupción de leer el audio.

	LPC_TIM1->TCR  =	0x2;			//	Reset al contador.

	LPC_TIM1->TCR  =	0x1;			//	Activo contador.
```

```
	LPC_TIM1->MCR  =    0x0;                            //     MR0 que NO genera la
interrupción.
	NVIC_EnableIRQ(       TIMER1_IRQn    );     //     Activo interrupción.
}
/**-------------------------------------------------------------------------------------
---------------------------------//
//
	//
                                                                                    //
//             @funcion       lanzaUFONO()
                                                                                    //
//
	//
//             @ref           Lanza la lectura de audio.
                                                                                //
//
	//
//-------------------------------------------------------------------------------------
---------------------------------**/
void   lanzaUFONO()
{
	//     Preparo el contexto.
	YaPuedesMedir          =      0;                                    //     Bloqueo
el ADC para el audio.
	LPC_GPIO3->FIOSET      =      (      1      <<     LECTURA_AUDIO);       //
	Señalizo lectura de audio.
	Timer2_MODO            =      MODO_ENTRADA;                //     Indico que el
audio está siendo grabado.
	ADC_ConfigBuffer       =      LPC_ADC->ADCR;               //     Guardo el
contexto de la configuración.
	ADC_IntenBuffer        =      LPC_ADC->ADINTEN;            //     Guardo el
contexto de la configuración de interrupciones.
	//     Configurar ADC.
	LPC_ADC->ADINTEN       =      1;                                    //     No
quiero interrupciones por conversión excepto en AD0.0.
	LPC_ADC->ADCR          &=     ~0xFF;                       //     Borro el sel
entero, sólo voy a usar un canal.
	LPC_ADC->ADCR          |=     CANAL_ADC_UF;                //     Canal para el
audio.
	//
	LPC_ADC->ADCR          &=     ~(0xFF << 8);                //     Borro el
clkdiv.
	LPC_ADC->ADCR          |=     (0x1 << 8);                  //     CLKDiv a 1.
	//     Empiezo con la conversión.
```

```
	LPC_ADC->ADCR  &=	~BRUST_PIN;				//	QUITO EL MODO
BURST.		//	Reanimo el timer.

	LPC_ADC->ADCR  &=	~(0x7 << 24);				//	Configuro el
start.

	LPC_ADC->ADCR  |=	ADC_START;				//	Configuro el
start.

	//	Activo el timer.

	LPC_TIM1->MCR  =	0x2;					//	Reset
on match.

	LPC_TIM1->TCR  =	0x2;					//	Que
resetee.

	LPC_TIM1->TCR  =	0x1;					//	Que
cuente.

	LPC_TIM1->EMR  =	0x31;				//	Activo el
Match0 en modo toogle.

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//

//
//		@funcion	recuperaContexto()
//
//

	//

//		@ref		Desbloquea los recursos utilizados para la lectura de
audio.		//

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

void recuperaContexto()

{

	//	Recupero el contexto.

	if (	Timer2_MODO == MODO_ENTRADA	)		//	Si toca
recuperar...

	{

		LPC_ADC->ADCR		=	ADC_ConfigBuffer;	//	Cargo el
contexto de la configuración.

		LPC_ADC->ADINTEN	=	ADC_IntenBuffer;	//	Cargo el
contexto de la configuración de interrupciones.

		LPC_ADC->ADCR		&=	~(0x7 << 24);		//	Borro el START
del ADC.

		LPC_ADC->ADCR		|=	(0xFF << 8);		//	CLKDIV max.

		YaPuedesMedir		=	1;				//
	Desbloqueo el ADC.
```

```
                LPC_GPIO3->FIOCLR     =       (       1       <<      LECTURA_AUDIO);
        //      Señalizo fin de lectura.

                Timer2_MODO           =       MODO_SALIDA;          //      Default modo
salida.

        }

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/




/**-------------------------------------------------------------------------------------
---------------------------------//

//              @filename               UVA30A.c

        //

//              @version                0.00

        //

//              @author         Alberto Palomo Alonso
                                                                                //

//

        //

//              @brief          Código fuente que contiene las funciones para UVA30A (ADC).
                                                                        //

//

        //

//              @category               Periférico.
                                                                                        //

//

        //

//              @map                    @include

        //

//                                      @funcion

        //
```

```
//                                  @end

        //

//

        //

//

        //

//------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                          //

//              @include              Estos son los archivos utilizados en el código de
configuración del UVA.                                  //

//

        //

//------------------------------------------------------------------------------------------
---------------------------------**/

#ifndef UVA30A

#define UVA30A

#include       "UVA30A.h"

#endif

/**----------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @funcion        __configuraUVA30A__()
                                                                                  //

//

        //

//              @ref            Configura todo lo necesario para que el UVA30A lea el
índice UV.                                                      //

//

        //

//------------------------------------------------------------------------------------------
---------------------------------**/

void    __configuraUVA30A__()

{

        if ( !LDR_primero )

        {
```

```
                __configuraLDR__();
        }
        LPC_PINCON->PINSEL1           |=      PINSEL_ADC02;         //      AD0.2




        LPC_PINCON->PINMODE1   &=     ~PINMODE_ADC02;       //      AD0.2
        LPC_ADC->ADCR                 |=      SEL_CANAL2;           //      AD0.2
}
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                //
//              @end            ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------------
---------------------------------**/



/**-------------------------------------------------------------------------------------------
---------------------------------//
//              @filename               OneWire.c
        //
//              @version                4.01
        //
//              @author         Alberto Palomo Alonso
                                                                                //
//
        //
//              @brief          Código que configura el protocolo monohilo del sensor de
temperatura y humedad.                          //
//
        //
//              @category               Opcional.
        //
//
        //
```

```
//             @map                    @include

       //

//                                     @variables

//                                     @funcion

       //

//                                     @end

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                                       //

//             @include                Estos son los archivos utilizados para el protocolo
OneWire.                                                    //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef ONEWIRE

#define ONEWIRE

#include       "OneWire.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                                       //

//             @variables              Variables del fichero.
                                                                  //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

uint32_t reiniciaCuenta              (      void    );

void   inicializaT3                  (      void    );

void _delayUS                        (      uint16_t usegundos    );
```

```
uint8_t        compruebaRespuesta     (       void    );

uint8_t leerByte                      (       void    );

//      Externo:

extern misDatos_t             *       DATOS;

uint32_t       TRAZA   [100];

uint32_t  HOLD        [100];

int p;

uint8_t Checksum;

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @function               __configuraOW__()
                                                                                        //

//

        //

//              @brief          Configura los pines y los recursos utilizados para el
protocolo OneWire.                                      //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void __configuraOW__()

{

        inicializaT3();

        reiniciaCuenta();

}

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @function               mideTemperatura()
                                                                                        //

//

        //

//              @brief          Configura los pines y los recursos utilizados para el
protocolo OneWire.                                      //

//

        //
```

```
//-------------------------------------------------------------------------------------------
------------------------------**/
void   mideTemperatura       (      void   )
{
       int i;
       uint8_t Check[4] = {0,0,0,0};
       uint32_t Rx                          =      0;
       uint8_t Checksum_Recibido     =      0;
       p = 0;
       Checksum = 0;
       /**     @state: Estado en el que mandamos la señal de petición.     */
       CONFIG_OUT;
       CLEAR_PIN;
       _delayUS(18000);
       CONFIG_IN;
       /**     @state: Esperamos la respuesta.
       */
       if (   compruebaRespuesta()  )
       {
              //     ERROR A AL ESPERAR LA RESPUESTA DEL SENSOR...
              return;
       }
       /**     @state: Leemos los 5 bytes...                                          */
       for(i = 0; i < 4; i++)
       {
              Rx |= (leerByte() << (3-i)*8);
       }
       Checksum_Recibido = leerByte();
       /**     @state: Procesamos Rx.        */
       Check[0]       =      ((Rx & (0xFF000000)) >> 6*4);
       Check[1]       =      ((Rx & (0x00FF0000)) >> 4*4);
       Check[2]       =      ((Rx & (0x0000FF00)) >> 2*4);
       Check[3]       =      ((Rx & (0x000000FF)) >> 0*4);
       Checksum = Check[0] + Check[1] + Check[2] + Check[3] ;

       if( Checksum == Checksum_Recibido )
       {
              DATOS->Humedad        = (float)(((Rx >> 16) & 0xFFFF)/10.0);
              DATOS->Temperatura    = (float)(((Rx >> 00) & 0xFFFF)/10.0);
       }
```

```
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                    //
//		@function		reiniciaCuenta()
                                                                                    //
//
	//
//		@brief		Reinicia el contador del timer 3.
                                                                        //
//
	//
//		@ret			Retorna el valor de la cuenta antes de reiniciarla.
                                                        //
//
	//
//-------------------------------------------------------------------------------------
--------------------------------**/
uint32_t reiniciaCuenta()
{
	uint32_t retval =	US_AHORA;
	LPC_TIM3->TCR  =	2;	//	Reinicia timer.
	LPC_TIM3->TCR  =	1;	//	Activa cuentas.
	return retval;
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                    //
//		@function		inicializaT3()
                                                                                    //
//
	//
//		@brief		Configura el timer 3 para utilizarlo para el OneWire.
                                                        //
//
	//
```

```
//-------------------------------------------------------------------------------------------
-------------------------------**/

void inicializaT3()

{

	LPC_SC->PCONP  |=	(1	<<	23);	//	Activo el timer 3.

	LPC_TIM3->CTCR =	0;			//	Contar por prescaler.

	LPC_TIM3->PR   =	24;			//	Cuentas cada 1us.

}

/**-----------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                        //

//		@function		_delayUS()
                                                                                        //

//

	//

//		@brief		Espera activa de [ usegundos ] microsegundos.
                                                                //

//

	//

//-------------------------------------------------------------------------------------------
-------------------------------**/

void	_delayUS(	uint16_t	usegundos	)

{

	reiniciaCuenta();

	while	(US_AHORA < usegundos) {}

}

/**-----------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                        //

//		@function		compruebaRespuesta()
                                                                                //

//

	//

//		@brief		Comprueba si el sensor ha respondido apropiadamente.
                                                                //

//

	//
```

```
//            @ret                  Retorna 0 si todo ha ido bien, 1 si no.
                                                                        //
//

      //

//-------------------------------------------------------------------------------------
--------------------------------**/

uint8_t compruebaRespuesta()

{

      uint32_t      Tiempo = 0;

      /**    @state: Esperamos que el sensor responda con un pull down...      */

      reiniciaCuenta();

      while  (      ENTRADA &&     US_AHORA < 45)              //     Si la entrada
está a nivel alto y no han pasado 45 us...

      {


      //     Mantente en espera.

      }

      Tiempo = reiniciaCuenta();                                //     Me
quedo con cuentos us han pasado.

      TRAZA[p++] = Tiempo;  //!!!!!

      if (   Tiempo < 5 || Tiempo > 45)                         //     Si el
márgen de pull down del sensor no es el adecuado.

      {

            return 1;
      //     Exit error code.

      }

      /**    @state: Esperamos la respuesta del sensor...                      */

      reiniciaCuenta();

      while  (      ENTRADA == 0   &&     US_AHORA < 100)       //     Tiempo nivel
bajo...

      {



      }

      Tiempo = reiniciaCuenta();

      TRAZA[p++] = Tiempo;  //!!!!!

      if (   Tiempo < 70 || Tiempo > 90)                        //     Si el
tiempo de pull down no es adecuado...

      {

            return 1;
      //     Exit error code.

      }

      reiniciaCuenta();

      while  (      ENTRADA              &&     US_AHORA < 100)       //     Tiempo
nivel alto...
```

```
	{


	}
	Tiempo = reiniciaCuenta();
	TRAZA[p++] = Tiempo;  //!!!!!
	if (   Tiempo < 70 || Tiempo > 90)                                  //     Si el
tiempo de pull down no es adecuado...
	{
		return 1;
	//	Exit error code.
	}
	return 0;
	//	Respuesta correcta.
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                    //
//		@function		leerByte()
                                                                                    //
//
	//
//		@brief		Lee 8 bits en ráfaga del sensor.
                                                                    //
//
	//
//-------------------------------------------------------------------------------------
--------------------------------**/
uint8_t leerByte(	void	)
{
	int i;
	uint8_t Rx=0;
	uint32_t Tiempo = 0;
	for (i = 0; i < 8; i++)
	{
		reiniciaCuenta();
		while (ENTRADA == 0   &&	US_AHORA < 100)		//
	Mientras la entrada valga 0...
		{

	//	Mantenernos esperando.
```

```
		}

		Tiempo = reiniciaCuenta();

		TRAZA[p++] = Tiempo;  //!!!!!

		if (Tiempo < 40 || Tiempo > 67)                                    //
	Si el tiempo está fuera del margen.

		{

			return 0;
	//	Error al leer el bit, retorna 0.

		}

		Tiempo = 0;

		reiniciaCuenta();

		while  (	ENTRADA &&	US_AHORA	<	100)		//
	Mientras la entrada valga 1...

		{


	//	Mantenernos esperando.

		}

		Tiempo = reiniciaCuenta();

		TRAZA[p++] = Tiempo;  //!!!!!

		if (   Tiempo > 60 && Tiempo < 80)                                 //
	Si entra en el márgen del 1...

		{

			Rx	|=	1 << (7-i);
	//	Añadimos un 1.

		}

		else

		{

			if ( Tiempo < 10 || Tiempo >  100)                         //
	Si se ha salido del márgen...

			{

				return 0;
	//	Error al leer el bit, retorna 0.

			}

		}



	}

	return Rx;

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                        //
```

```
//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/



/**-------------------------------------------------------------------------------------
--------------------------------//

//             @filename              PWM.c
                                                                                    //

//             @version               0.00

       //

//             @author        Alberto Palomo Alonso
                                                                        //

//

       //

//             @brief         Este es el programa donde están definidas las funciones a
utilizar en el módulo                        //

//                                    PWM dedicado al proyecto de Sistemas electrónicos
digitales avanzados (UAH - EPS).                    //

//

       //

//

       //

//             @category              Opcional.

       //

//

       //

//             @map                   @include

       //

//                                    @variables
                                                                                    //

//                                    @function

       //

//                                    @end

       //

//

       //

//             |---|   |              |      |\      /|
                                                                                    //
```

```
//            |   |   |         |   | \  / |                                                                  //
//            |---|    |       |           |  \/  |                                                                  //
//            |                |   | |           |        |
       //
//            |                 | |       |        |                                                                  //
//
       //
//-------------------------------------------------------------------------------------------------------------------//
//
       //
                                                                                                                       //
//            @include              Includes pertenecientes al módulo del PWM.                                         //
//
       //
//-------------------------------------------------------------------------------------------------------------------**/
#ifndef PWM
#define PWM
#include "PWM.h"
#endif
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include       "Systemsymbols.h"
#endif
/**-------------------------------------------------------------------------------------------------------------------//
//
       //
                                                                                                                       //
//            @variables            Variables del fichero.                                                           //
//
       //
//-------------------------------------------------------------------------------------------------------------------**/
extern Counters_t     *       COUNTERS;
```

```
/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                        //

//		@function		__configuraPWM__()
                                                                                        //

//

	//

//		@brief		Configura el PWM en función de la frecuencia a utilizar y
que PWM se quieren usar.		//

//				El primer byte activa las del puerto 2 y las del
segundo las del otro puerto en orden	//

//				ascendente.
                                                                                        //

//

	//

//			@FrecuenciaPWM		Frecuencia a la que se desea ajustar el
ciclo PWM. En Hz.					//

//			@CualesPWM		Máscara que define los PWM a configurar, los
6 primeros bits corresponden al		//

//						puerto 2. Del 9° bit al 14° bit
corresponden al puerto 1. En orden ascendente		//

//						desde del PWM1.1 al PWM1.6
                                                                //

//

	//

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/

void __configuraPWM__(float   FrecuenciaPWM  ,      uint16_t       CualesPWM      )

{

	LPC_SC->PCONP		|=	PCONP_MASK;
		// Enciendo el PWM.

	LPC_PWM1->MR0		=	((uint32_t)(Ftick/FrecuenciaPWM) - 1);
	// Configuro la frecuencia.

	LPC_PWM1->TCR		|=	TCR_MASK;
			// Activo el PWM.

	LPC_PWM1->MCR		&=	~TODO_1_32;
		// Reset al MCR.

	LPC_PWM1->MCR	|=	0x2;
		// Ahora el MR0 resetea el contador.

	LPC_PINCON->PINSEL4 &=	~0xFFF;
		// Reset en pines PWM puerto 2.
```

```
	LPC_PINCON->PINSEL3 &=~0x33CF30;
	// Reset en pines PWM puerto 1.


	for (COUNTERS->i = 0; COUNTERS->i < 6; (COUNTERS->i)++)
	// Para el puerto 2: seleccionados.

	{

		if (	(CualesPWM >> COUNTERS->i) & ~0xFFFE)
		// Miro si está seleccionado el iésimo.

		{

			LPC_PINCON->PINSEL4	|= (FUNC1	<< (2*COUNTERS->i));  //
Pongo la función 1 en los pines PWM.

			LPC_PWM1->PCR |= (0x1 << (COUNTERS->i + 0x9));
	// Pongo la función de enable output en el PWM.

		}

	}

	/**	@REMARK:	Esto se configuraría como open drain sobre todo por no
perder potencia, pero prefiero aseugrar con pull.*/

	for (COUNTERS->i = 6; COUNTERS->i < 12; (COUNTERS->i)++)
	// Para el otro puerto: seleccionados.

	{

		if (	(CualesPWM >> (COUNTERS->i + 2)) & ~0xFFFE)
		// Miro si está seleccionado el iésimo.

		{

			LPC_PWM1->PCR |= (0x1 << (COUNTERS->i - 0x6 + 0x9));
	// Pongo la función de enable output en el PWM.

			switch (COUNTERS->i)
		// Pongo la función 2 en los pines PWM.

			{

				case 6:

					LPC_PINCON->PINSEL3	|=	FUNC2 <<	2*2;

//					LPC_PINCON->PINMODE3	|=	OPEN_DRAIN <<	2*2;

					break;

				case 7:

					LPC_PINCON->PINSEL3	|=	FUNC2 <<	2*4;

//					LPC_PINCON->PINMODE3	|=	OPEN_DRAIN <<	2*4;

					break;

				case 8:

					LPC_PINCON->PINSEL3	|=	FUNC2 <<	2*5;

//					LPC_PINCON->PINMODE3	|=	OPEN_DRAIN <<	2*5;

					break;

				case 9:

					LPC_PINCON->PINSEL3	|=	FUNC2 <<	2*7;

//					LPC_PINCON->PINMODE3	|=	OPEN_DRAIN <<	2*7;

					break;
```

```
                                case 10:
                                        LPC_PINCON->PINSEL3    |=     FUNC2 <<       2*8;
//                                      LPC_PINCON->PINMODE3   |=     OPEN_DRAIN <<  2*8;
                                        break;
                                case 11:
                                        LPC_PINCON->PINSEL3    |=     FUNC2 <<       2*10;
//                                      LPC_PINCON->PINMODE3   |=     OPEN_DRAIN <<  2*8;
                                        break;
                                default:
                                        break;
                        }
                }
        }
        COUNTERS->i = 0;
                        // Dejo el contador a 0.
}
/**-------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                        //
//              @function               modificaPulso()
                                                                                        //
//
        //
//              @brief          Configura el  pulso de PWM en función del ciclo de trabajo
o de valores de oscilación              //
//                                      si se encuentra en modo servo.
                                                                                //
//
        //
//                              @PWMn   Selecciona el PWM1.n a modificar.
                                                                        //
//                              @Modo   Selecciona si modo servo (valores)o modo ciclo (en
porcentaje).                                    //
//                              @Ciclo  Selecciona el ciclo de trabajo para el modo ciclo.
                                        //
//                              @Grados Selecciona los grados a rotar el servo en modo
servo.                                          //
//                              @Minimo Selecciona el mínimo valor de Ton del ciclo PWM. En
segundos.                                       //
//                              @Maximo Selecciona el máximo valor de Ton del ciclo PWM. En
segundos.                                       //
```

```
//

	//

//

	//

//

	//

//

	//

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void	modificaPulso( uint32_t	PWMn	,	uint8_t Modo	,	uint8_t Ciclo
	,	uint8_t Grados, float Minimo	,	float	Maximo	)

{

	if (PWMn > 3)

	{

		PWMn += 6;	//	Debido a la asimétrica distribución de los
registros.

	}


	Minimo *= KMN;		//	Definitivamente había algo mal.

	Maximo *= KMX;		//	Estos servos utilizan la potencia del pulso
y no precisamente su duración.


	/**	@REMARK:	La potencia entregada no es la debida. En la datasheet
especifica pulsos del rango de 5V, se ofrece uno

				de 3.3V, se ha podido usar un transistor, pero deduzco que
estos servos utilizan la potencia de la señal

				PWM para obtener el ángulo y modificando los tiempos
podemos entregar más potencia de señal.*/


	switch( Modo	)

	{

		case MODO_CICLO:	// Escribo en LPC_PWM1->MRn el valor
correspondiente al porcentaje de MR0; < 1.

			*(__IO uint32_t *)((uint32_t)&(LPC_PWM1->MR0) +
(uint32_t)(0x4*PWMn)) = (uint32_t)((float)(LPC_PWM1->MR0)*((float)Ciclo/(float)100));

			break;

		case MODO_SERVO:	// Escribo en LPC_PWM1->MRn el valor
correspondiente al tiempo Ton en función del grado.

			*(__IO uint32_t *)((uint32_t)&(LPC_PWM1->MR0) +
(uint32_t)(0x4*PWMn)) = (uint32_t)((Ftick*(Minimo + (Maximo -
Minimo)*(float)(Grados/(float)(180)))- (float)1));
```

```
                        break;
                default:
                        break;
        }
                if (PWMn > 3)
        {
                PWMn -= 6;      //      Devolvemos PWMn a su estado oriegen.
        }
        LPC_PWM1->LER |= 0x1 << PWMn | 0x1;          // Activo el load de los MR0 y MRn.
}
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                //
//              @end            ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------------
---------------------------------**/



/**-------------------------------------------------------------------------------------------
---------------------------------//
//              @filename               DAC.c
                                                                                        //
//              @version                6.01
        //
//              @author         Alberto Palomo Alonso
                                                                                //
//
        //
//              @brief          Código fuente que contiene las funciones para audio (DAC).
                                                        //
//
        //
//              @category               Periférico.
                                                                                        //
//
        //
```

```
//             @map                    @include

       //

//                                     @variables
                                                                                    //

//                                     @funcion

       //

//                                     @end

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @include                Estos son los archivos utilizados en el código de
LDR.                                                                  //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef DAC

#define DAC

#include       "DAC.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @variables              Variables del fichero.
                                                                        //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

extern actualizador_t *       ACTUALIZADOR;

/**-----------------------------------------------------------------------------------
---------------------------------//
```

```
//
	//
                                                                                    //
//		@funcion		__configuraDAC__()
                                                                                    //
//
	//
//		@brief		Función de configuración del DAC y su timer (Timer2).
                                                        //
//
	//
//		@REMARK:		Para activar un periodo del DAC (2 segundos)
                                                                //
                                                                        //
//
	//
//------------------------------------------------------------------------------------------
--------------------------------**/
void __configuraDAC__()
{
	LPC_GPIO3->FIODIR	|=	(1	<<	LECTURA_AUDIO  ) | (1 <<
	ESCRITURA_AUDIO);		// Leds de lectura / escritura de audio.
	LPC_GPIO3->FIOCLR	=	(1	<<	LECTURA_AUDIO);
                                //Turn ON LED1
	LPC_GPIO3->FIOCLR	=	(1	<<	ESCRITURA_AUDIO);
                                //Turn ON LED2
}
/**------------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                    //
//		@funcion		activarDac()
                                                                                    //
//
	//
//		@brief		Señal de activar el timer del DAC.
                                                                //
//
	//
//		@REMARK:		Utiliza DMA.
                                                                                    //
```

```
//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void activarDac()

{

	/**	@TODO: DMA*/

	LPC_GPDMACH0->DMACCConfig	|=	1;
		//	Activo el DMA.

	LPC_TIM1->MCR				=	(1	<<3	)	|	(1
	<<	4);		//	Activo la interrupción por MR1 y reset por MR1.

	LPC_TIM1->MR1				=	(Fclk*DURACION_AUDIO) - 1;
	//	Valor de MR1.

	LPC_TIM1->TCR				=	0x2;
			//	Reset del timer.

	LPC_TIM1->TCR				=	0x1;
			//	El timer cuenta.

	ACTUALIZADOR->Audiorev		=	0;
		//	Señalizo el bloqueo de audio.

	LPC_GPIO3->FIOSET			=	(	1	<<
	ESCRITURA_AUDIO);		//	Señaizo escritura de audio.

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                //

//		@funcion		activarDac()
                                                                                //

//

	//

//		@brief		Señal de activar el timer del DAC.
                                                                    //

//

	//

//		@REMARK:		Activador del DAC.
                                                                                //


//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void desactivarDAC()

{
```

```
	LPC_GPDMACH0->DMACCConfig	&=	~0x1;
	//	Desactivo el DMA.

	ACTUALIZADOR->Audiorev		=	1;
		//	Señalizo el fin del DAC.

	LPC_GPIO3->FIOCLR			=	(	1	<<
	ESCRITURA_AUDIO);		//	Señaizo escritura de audio.

	LPC_TIM1->MCR				&=	~(7	<<	3);
			//	Desactivo la interrupción por MR1 y reset tras MR1.

	LPC_DAC->DACR				=	0;
			//	No hay señal de salida.

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                        //

//		@end		ENDFILE.

	//

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/




/**-------------------------------------------------------------------------------------
---------------------------------//

//		@filename		LUT.c
                                                                                //

//		@version		0.00

	//

//		@author		Alberto Palomo Alonso
                                                                        //

//

	//

//		@brief		Este es el programa donde se encuentran las look up tables
que optimizan                           //

//                              el uso de cpu sacrificando memoria, pero como uso
una SD la memoria no es                                 //

//                              un problema grande.
                                                                                //

//

	//

//		@category		Opcional.

	//
```

```
//

	//

//		@map			@include

	//

//					@variables
                                                                                //

//					@LUT

	//

//					@function

	//

//					@end

	//

//

	//

//-------------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                //

//		@include		Includes pertenecientes al módulo del anemómetro.
                                                                        //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef LUT

#define LUT

#include	"LUT.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                //

//		@variables		Variables del fichero.
                                                                      //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/
```

```
uint8_t PREGRABADA[MUESTRAS_SENO];

extern uint8_t *      AUDIO;

/**-------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                //
//             @LUT                    LookUpTables
                                                                                //

//

       //

//             @brief         Bases de datos.
                                                                          //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/

uint8_t Brillo2ciclo_LDR[] =

{

       13     ,      20     ,      25     ,      30     ,      35     ,      40
       ,      45     ,      50     ,      55     ,      60     ,

       65     ,      70     ,      75     ,      80


                                                                        };

uint8_t Brillo_LDR[]   =

{

       21     ,      1      ,      5      ,      10     ,      15     ,      20
       ,      25     ,      30     ,      35     ,      40     ,

       45     ,      50     ,      65     ,      60     ,      65     ,      70
       ,      75     ,      80     ,      85     ,      90     ,

       95     ,      100


                                                                        };

/**-------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                //
//             @function              goto_LUT()
                                                                                //

//

       //
```

```
//             @brief         Esta función es la que mira las LUT y obtiene el dato que
queremos de la base                          //
//                                    de datos.
       //
//
       //
//-------------------------------------------------------------------------------------
--------------------------------**/
void goto_LUT( float variable , uint8_t LUTn , float * ret_flotante , uint8_t * ret_int8
, uint16_t * ret_int16 , uint32_t * ret_int32)
{
       switch( LUTn )
       {
              case BRILLO_LDR:
                     *ret_flotante = Brillo_LDR[          (uint8_t)(((variable -
LDRRESISTENCIA_MIN)   /(LDRRESISTENCIA_MAX - LDRRESISTENCIA_MIN)) *Brillo_LDR[0]) + 1];
                     break;
              case   BRILLO2CICLO_LDR:
                     *ret_int8      = Brillo2ciclo_LDR[          (uint8_t)(((variable -
BRILLO_MIN)                  /(BRILLO_MAX - BRILLO_MIN))
       *Brillo2ciclo_LDR[0]) + 1];
                     break;
              case   INDICE_UVA:
                     *ret_flotante = variable;     //      El output DC corresponde al
índice, es muy sencillo traducirlo, se recomienda no llamar a esta función en este modo.
                     break;
              case BRILLO_LDR_NOLUT:
                     *ret_flotante = -(1.0102)*variable + 102.0204;
                     if (*ret_flotante < 0)
                     {
                            *ret_flotante = 0;
                     }
              default:
                     break;
       }
}
/**-------------------------------------------------------------------------------------
--------------------------------//
//
       //
                                                                    //
```

```
//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/



/**-------------------------------------------------------------------------------------
--------------------------------//

//             @filename              DMA.c
                                                                                    //

//             @version               0.00

       //

//             @author        Alberto Palomo Alonso
                                                                          //

//

       //

//             @brief         Código fuente que contiene las funciones para audio (DMA).
                                                  //

//

       //

//             @category              Periférico.
                                                                                    //

//

       //

//             @map                   @include

       //

//                                    @variables
                                                                                    //

//                                    @funcion

       //

//                                    @end

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------//

//

       //
```

```
                                                                                //
//              @include                Estos son los archivos utilizados en el código de
LDR.                                                                            //
//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#ifndef DMA

#define DMA

#include        "DMA.h"

#endif

/**-----------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                //
//              @variables              Variables del fichero.
                                                                        //
//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

extern actualizador_t *       ACTUALIZADOR;

extern uint8_t AUDIO[MUESTRAS_AUDIO];

DMA_t   LLI0;

uint8_t sinusoide[N_samples_wave];

/**-----------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                //
//              @funcion                __configuraDMA__()
                                                                                //
//

        //

//              @brief          Función de configuración del DMA.
                                                                        //
//

        //
```

```
//             @REMARK:              Para activar un periodo del DAC (2 segundos)
                                                                        //
                                                                                //

//

       //

//-------------------------------------------------------------------------------------------
--------------------------------**/

void __configuraDMA__ (void)

{

       int i;

       for(i=0; i < N_samples_wave; i++)

       {

              sinusoide[i] = (int)(127 + 127*sin(2*PI*i/N_samples_wave)); // DACR bit
6-15 VALUE (valor ya desplazado!!!)

       }

       LPC_PINCON->PINSEL1 |= (2<<20);
       // enable AOUT (P0.26) pin

       __configuraTono__();

}

/**-----------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                        //

//             @funcion              __configuraTono__()
                                                                                        //

//

       //

//             @brief         Función de configuración del tono.
                                                                        //

//

       //

//-------------------------------------------------------------------------------------------
--------------------------------**/

void __configuraTono__()

{

    // Linked CH0

       LLI0.source      = (uint32_t) &sinusoide[0];

       LLI0.destination = (uint32_t) &(LPC_DAC->DACR) + 1;

       LLI0.next        = (uint32_t) &LLI0;

       LLI0.control     = 1<<26 | 0<<21 | 0<<18 | N_samples_wave; //Transfersize=
N_samples_wave, SWidth=8bits, DWidth=8bits, Source Increment
```

```
	LPC_SC->PCONP  |= (1<<29);
                  // Power DMA

	LPC_GPDMA->DMACConfig = 1;                          // enable the GPDMA
controller

	LPC_GPDMA->DMACSync   = (1<<6);                                          //
enable synchro logic for all reqs


	LPC_GPDMACH0->DMACCSrcAddr  = (uint32_t) &sinusoide[0];

	LPC_GPDMACH0->DMACCDestAddr = (uint32_t) &(LPC_DAC->DACR) + 1;

	LPC_GPDMACH0->DMACCLLI      = (uint32_t) &LLI0; // linked lists for ch0

	LPC_GPDMACH0->DMACCControl  = N_samples_wave   // transfer size (0 - 11) = 32
muestras /ciclo

                            | (0 << 12)            // source burst size (12 - 14) = 1

                            | (0 << 15)            // destination burst size (15 - 17)
= 1

                            | (0 << 18)            // source width (18 - 20) = 32 bit
                              CAMBIADO

                            | (0 << 21)            // destination width (21 - 23) = 32
bit                          NO CAMBIADO

                            | (0 << 24)            // source AHB select (24) = AHB 0

                            | (0 << 25)            // destination AHB select (25) = AHB
0

                            | (1 << 26)            // source increment (26) = increment

                            | (0 << 27)            // destination increment (27) = no
increment

                            | (0 << 28)            // mode select (28) = access in user
mode

                            | (0 << 29)            // (29) = access not bufferable

                            | (0 << 30)            // (30) = access not cacheable

                            | (0 << 31);           // terminal count interrupt disabled

	LPC_GPDMACH0->DMACCConfig   =  0
	// channel enabled (0)

                          | (0 << 1)                                             //
source peripheral (1 - 5) = none

                          | (7 << 6)                                             //
destination peripheral (6 - 10) = DAC

                          | (1 << 11)                                            // flow
control (11 - 13) = MEM to PERF

                          | (0 << 14)                                            // (14)
= mask out error interrupt

                          | (0 << 15)                                            // (15)
= mask out terminal count interrupt

                          | (0 << 16)                                            // (16)
= no locked transfers
```

```
                        | (0 << 18);                                                    // (27)
= no HALT


        //F_out (salida del DAC)

        LPC_DAC->DACCNTVAL = Fclk/N_samples_wave/Ftono -1;  // (Ts DAC = F_out/N_samples
< Tsetup DAC = 1useg. !!!!)


        /* DMA, timer running, dbuff */

        LPC_DAC->DACCTRL   = 1<<3 | 1<<2 | 1<<1;

        ACTUALIZADOR->Audiorev = 1;

}

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @funcion              __configuraAudio__()
                                                                                //

//

        //

//              @brief          Función de configuración del audio.
                                                        //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void __configuraAudio__()

{

    // Linked CH0

        LLI0.source      = (uint32_t) AUDIO;

        LLI0.destination = (uint32_t) &(LPC_DAC->DACR) + 1;

        LLI0.next        = (uint32_t) &LLI0;

        LLI0.control     = 1<<26 | 0<<21 | 0<<18 | MUESTRAS_AUDIO;         //
        Incremento origen, MUESTRAS_AUDIO muestras, 8 bits todo.


        LPC_SC->PCONP                 |=      (1<<29);
        //      Enciendo el DMA.

        LPC_GPDMA->DMACConfig =       1;                            //      Activo el
controlador del DMA.

        LPC_GPDMA->DMACSync   =       (1<<6);                       //      Sincronización
de registros.
```

```
	LPC_GPDMACH0->DMACCSrcAddr  = (uint32_t) AUDIO;                    //      Empieza
en AUDIO.

	LPC_GPDMACH0->DMACCDestAddr = (uint32_t) &(LPC_DAC->DACR) + 1;     //      Ve a
DACR + 2.

	LPC_GPDMACH0->DMACCLLI      = (uint32_t) &LLI0; // linked lists for ch0

	LPC_GPDMACH0->DMACCControl  = MUESTRAS_AUDIO   // transfer size (0 - 11) = 32
muestras /ciclo

                            | (0 << 12)            // source burst size (12 - 14) = 1

                            | (0 << 15)            // destination burst size (15 - 17)
= 1

                            | (0 << 18)            // source width (18 - 20) = 32 bit

                            | (2 << 21)            // destination width (21 - 23) = 32
bit

                            | (0 << 24)            // source AHB select (24) = AHB 0

                            | (0 << 25)            // destination AHB select (25) = AHB
0

                            | (1 << 26)            // source increment (26) = increment

                            | (0 << 27)            // destination increment (27) = no
increment

                            | (0 << 28)            // mode select (28) = access in user
mode

                            | (0 << 29)            // (29) = access not bufferable

                            | (0 << 30)            // (30) = access not cacheable

                            | (0 << 31);           // terminal count interrupt disabled

	LPC_GPDMACH0->DMACCConfig   =  0
	// channel enabled (0)

                          | (0 << 1)                                              //
source peripheral (1 - 5) = none

                          | (7 << 6)                                              //
destination peripheral (6 - 10) = DAC

                          | (1 << 11)                                             // flow
control (11 - 13) = MEM to PERF

                          | (0 << 14)                                             // (14)
= mask out error interrupt

                          | (0 << 15)                                             // (15)
= mask out terminal count interrupt

                          | (0 << 16)                                             // (16)
= no locked transfers

                          | (0 << 18);                                            // (27)
= no HALT


	//F_out (salida del DAC)

	LPC_DAC->DACCNTVAL = (Fclk/4000) - 1;  // (Ts DAC = TsAudio  < Tsetup DAC =
1useg. !!!!)


	/* DMA, timer running, dbuff */

	LPC_DAC->DACCTRL   = 1<<3 | 1<<2 | 1<<1;
```

```
        ACTUALIZADOR->Audiorev = 1;
}
/**--------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                //
//              @end            ENDFILE.
        //
//
        //
//------------------------------------------------------------------------------------
---------------------------------**/









/**--------------------------------------------------------------------------------------
---------------------------------//
//              @filename               WDT.c
                                                                                        //
//              @version                0.00
        //
//              @author         Alberto Palomo Alonso
                                                                                //
//
        //
//              @brief          Código fuente del configurado del WDT.
                                                                                //
//
        //
//              @category               Interno.
        //
//
        //
//              @map                    @include
        //
```

```
//                                  @function

        //

//                                  @end

        //

//

        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @include              Estos son los archivos utilizados con el código del
WDT.                                                    //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef WDT

#define WDT

#include       "WDT.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @function      __configuraWDT__()
                                                                                        //

//

        //

//              @brief  Función que configura el WDT como un contador que observa si se ha
bloqueado el programa.              //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

void    __configuraWDT__()

{
```

```
	LPC_WDT->WDTC		=	Fwdt*WATCHDOG_TIMEOUT ;	//	Timeout de
WATCHDOG_TIMEOUT segundos.

	LPC_WDT->WDCLKSEL	=	WDCLKSEL_MASK		;	//	Se
selecciona el reloj que se desea para el WDT.

	LPC_WDT->WDMOD		=	WDMOD_MASK		;	//	Se
selecciona la acción a realizar si WDT llega a cero.

	alimentaWDT();

}

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                                        //

//		@function	alimentaWDT()
                                                                                        //

//

	//

//		@brief	Función que evita que el contador del WatchDogTimer llegue a 0.
                                                        //

//

	//

//-------------------------------------------------------------------------------------------
---------------------------------**/

void	alimentaWDT()

{

	LPC_WDT->WDFEED		=	WDT_CODIGO1;

	LPC_WDT->WDFEED		=	WDT_CODIGO2;

}

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                        //

//		@end		ENDFILE.

	//

//

	//

//-------------------------------------------------------------------------------------------
---------------------------------**/
```

```
/**-------------------------------------------------------------------------------------
---------------------------------//

//            @filename             UART0.c
                                                                                    //

//            @version              2.01

      //

//            @author        Alberto Palomo Alonso
                                                                  //

//

      //

//            @brief         Este es el programa que recoge la transmisión por UART0.
                                                  //

//

      //

//            @category             Opcional.

      //

//

      //

//            @map                  @include

      //

//                                  @variables
                                                                                    //

//                                  @function

      //

//                                  @end

      //

//

      //

//-------------------------------------------------------------------------------------
---------------------------------//

//

      //


                                                                                    //

//            @include              Includes pertenecientes a la transmisión asíncrona.
                                                        //

//

      //

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef UART0
```

```
#define UART0

#include       "UART0.h"

#endif

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                                              //

//             @variables            Variables del fichero.
                                                                                    //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

//     Variables globales y externas.

char UART0_BUFFER_TX[CADMAX + 1];

extern char bufferx[30];

extern misDatos_t * DATOS;

extern uint8_t Clock[23];

uint8_t EstadoUART0 = UART_TX;

extern modificables_t MODIFICABLES;

uint8_t Inmortal = 0;

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                                              //

//             @function             __configuraUART0__()
                                                                                        //

//

       //

//             @brief         Esta función es la que configura el UART0 para transmisión
y recepción.                                    //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void    __configuraUART0__(   void    )                              //     Configurado a
9600 baudios.

{

       uart0_init(9600);
```

```
	tx_cadena_UART0(	"Hola.\n"	);
}
/**-------------------------------------------------------------------------------------------
-------------------------------//
//
	//
                                                                                        //
//		@function		procesarComando()
                                                                                        //
//
	//
//		@brief		Esta función manda el UART0_BUFFER_TX a la salida TX del
UART0.                                                  //
//
	//
//		@input		char * Buff:	El buffer donde está contenido el comando.
                                                        //
//
	//
//		@ret			Devuelve 1 si ha sido exitoso y 0 si no se ha
obtenido el comando.                                    //
//
	//
//-------------------------------------------------------------------------------------------
-------------------------------**/
uint8_t procesarComando(	char	*	Buff	)
{
	uint8_t		retval = 0;
	switch( EstadoUART0 )
	{
		case UART_TX:
			/**	SECCIÓN PARA LOS COMANDOS DE TIPO 0: ABOUT*/
			if	(	!strcmp(	Buff	,	COM0	)	)
			{
				retval = 1;
				strcpy(UART0_BUFFER_TX	,	"\n Autor: \t Alberto
Palomo Alonso \n Version: \t 2.1.0 \n Sistemas Electronicos Digitales Avanzados \t UAH
\n"	);
			}
			/**	SECCIÓN PARA LOS COMANDOS DE TIPO 1: GIVE*/
			if	(	!strcmp(	Buff	,	COM10)	)
			{
```

```
                        if ( !Inmortal )
                        {
                                strcpy (      UART0_BUFFER_TX       ,
        "\nSUGAR n.n\n");
                                Inmortal = 1;
                                retval = 1;
                        }
                }
                if      (       !strcmp(       Buff    ,       COM11) )
                {
                        sprintf(      UART0_BUFFER_TX       ,       "\nIP:
%d.%d.%d.%d \n", __IP1B, __IP2B, __IP3B, __IP4B);
                        retval = 1;
                }
                if      (       !strcmp(       Buff    ,       COM12) )
                {
                        sprintf(      UART0_BUFFER_TX       ,
        "\nTEMPERATURA: %f °C\n", DATOS->Temperatura);

                        retval = 1;
                }
                if      (       !strcmp(       Buff    ,       COM13) )
                {
                        sprintf(      UART0_BUFFER_TX       ,       "\nPRESION: %f
mBar.\n", DATOS->Presion);
                        retval = 1;
                }
                if      (       !strcmp(       Buff    ,       COM14) )
                {
                        sprintf(      UART0_BUFFER_TX       ,       "\nVELOCIDAD
DEL VIENTO: %f m./s.\n", DATOS->VelViento);
                        retval = 1;
                }
                if      (       !strcmp(       Buff    ,       COM15) )
                {
                        sprintf(      UART0_BUFFER_TX       ,       "\nX: NA
\nY: NA  \nZ: %f m.\n", DATOS->Lugar.Altura);
                        retval = 1;
                }
                if      (       !strcmp(       Buff    ,       COM16) )
                {
                        sprintf(      UART0_BUFFER_TX       ,       "\nINDICE UV:
%f\n", DATOS->IndiceUV);
```

```
                        retval = 1;
                }
                if      (       !strcmp(        Buff    ,       COM17)  )
                {
                        strcpy  (       UART0_BUFFER_TX         ,       (const char
*)Clock);
                        retval = 1;
                }
                if      (       !strcmp(        Buff    ,       COM18)  )
                {
                        sprintf(        UART0_BUFFER_TX         ,       "\nHUMEDAD: %f
\n", 0.01*DATOS->Humedad);
                        retval = 1;
                }
                if      (       !strcmp(        Buff    ,       COM19)  )
                {
                        sprintf(        UART0_BUFFER_TX         ,       "\nBRILLO: %f
LUX.\n", DATOS->Brillo);
                        retval = 1;
                }
                /**     SECCIÓN PARA LOS COMANDOS DE TIPO 3: KILL*/
                if      (       !strcmp(        Buff    ,       COM3    )       )
                {
                        while ( !Inmortal );
                        strcpy(UART0_BUFFER_TX          ,       "Demasiado dulce como
para matarlo, mejor para otra ocasion...\n");
                        retval = 1;
                }
                /**     SECCIÓN PARA LOS COMANDOS DE TIPO 4: HELP    */
                if      (       !strcmp(        Buff    ,       COM4    )       )
                {
                        strcpy(UART0_BUFFER_TX          ,       "Informacion:\n\n
ABOUT: Muestra info. del sistema.\n GIVE: Proporciona el dato deseado.\n KILL: Cuelga el
programa.\n SET: Modifica variables.\n"     );
                        retval = 1;
                }
                if      (       !strcmp(        Buff    ,       COM41   )       )
                {
                        strcpy(UART0_BUFFER_TX          ,       "\nGIVE + [IP,
TEMPERATURA, PRESION, BRILLO, LUGAR, VIENTO, INDICEUV, HORA, HUMEDAD]\n"  );
                        retval = 1;
                }
                if      (       !strcmp(        Buff    ,       COM42   )       )
```

```
                        {
                                strcpy(UART0_BUFFER_TX       ,      "\nSET + [BRILLO,
HORA, MIN TEMP, MAX TEMP, MIN PRES, MAX PRES, TEMPERATURA, PRESION]\n"    );
                                retval = 1;
                        }
                        /**     CONTROL DE ERROR:     */
                        if (    !retval)
                        {
                                strcpy(UART0_BUFFER_TX,      "Error: comando no definido,
escriba 'HELP' para ver la lista.\n");
                        }
                        /** SECCIÓN PARA LOS COMANDOS DE TIPO 2:    SET     */
                        if      (       !strcmp(       Buff    ,       COM20   )       )
                        {
                                strcpy(UART0_BUFFER_TX       ,      "Introduzca los
segundos de brillo: \n"       );
                                retval = 1;
                                EstadoUART0 = UART_RX_BRILLO;
                        }
                        if      (       !strcmp(       Buff    ,       COM21   )       )
                        {
                                strcpy(UART0_BUFFER_TX       ,      "Introduzca la fecha
separada por espacios: \n"    );
                                retval = 1;
                                EstadoUART0 = UART_RX_HORA;
                        }
                        if      (       !strcmp(       Buff    ,       COM22   )       )
                        {
                                strcpy(UART0_BUFFER_TX       ,      "Introduzca el valor
minimo de temperatura: \n"    );
                                retval = 1;
                                EstadoUART0 = UART_RX_MINT;
                        }
                        if      (       !strcmp(       Buff    ,       COM23   )       )
                        {
                                strcpy(UART0_BUFFER_TX       ,      "Introduzca el valor
maximo de temperatura: \n"    );
                                retval = 1;
                                EstadoUART0 = UART_RX_MAXT;
                        }
                        if      (       !strcmp(       Buff    ,       COM24   )       )
                        {
```

```
                        strcpy(UART0_BUFFER_TX      ,      "Introducza el valor
minimo de presion: \n");
                        retval = 1;
                        EstadoUART0 = UART_RX_MINP;
                }
                if      (      !strcmp(      Buff    ,      COM25   )      )
                {
                        strcpy(UART0_BUFFER_TX      ,      "Introducza el valor
maximo de presion: \n");
                        retval = 1;
                        EstadoUART0 = UART_RX_MAXP;
                }
                if      (      !strcmp(      Buff    ,      COM27   )      )
                {
                        strcpy(UART0_BUFFER_TX      ,      "Ahora medimos
presion... \n" );
                        retval = 1;
                        MODIFICABLES.Var_medida = 1;
                }
                if      (      !strcmp(      Buff    ,      COM26   )      )
                {
                        strcpy(UART0_BUFFER_TX      ,      "Ahora medimos
temperatura... \n"    );
                        retval = 1;
                        MODIFICABLES.Var_medida = 0;
                }
                break;

        case UART_RX_BRILLO:
                sscanf(bufferx,      "%d"    ,      &MODIFICABLES.TiempoBrillo);
                strcpy(UART0_BUFFER_TX              ,      "Tiempo de hold
cambiado.\n"   );
                EstadoUART0 = UART_TX;
                break;
        case UART_RX_MINT:
                sscanf(bufferx,      "%f"    ,      &MODIFICABLES.Min_servo_t);
                strcpy(UART0_BUFFER_TX              ,      "Cota minima de
temperatura cambiada.\n"     );
                EstadoUART0 = UART_TX;
                break;
        case UART_RX_MAXT:
                sscanf(bufferx,      "%f"    ,      &MODIFICABLES.Max_servo_t);
```

```
                        strcpy(UART0_BUFFER_TX              ,      "Cota maxima de
temperatura cambiada.\n"     );

                        EstadoUART0 = UART_TX;

                        break;

                case UART_RX_MINP:

                        sscanf(bufferx,      "%f"    ,      &MODIFICABLES.Min_servo_p);

                        strcpy(UART0_BUFFER_TX              ,      "Cota minima de
presion cambiada.\n"  );

                        EstadoUART0 = UART_TX;

                        break;

                case UART_RX_MAXP:

                        sscanf(bufferx,      "%f"    ,      &MODIFICABLES.Max_servo_p);

                        strcpy(UART0_BUFFER_TX              ,      "Cota maxima de
presion cambiada.\n"  );

                        EstadoUART0 = UART_TX;

                        break;

                case UART_RX_HORA:

                        sscanf(bufferx,      "%d %d %d %d %d %d"    ,      (int
*)&LPC_RTC->DOM , (int *)&LPC_RTC->MONTH, (int *)&LPC_RTC->YEAR, (int *)&LPC_RTC->HOUR,
(int *)&LPC_RTC->MIN, (int *)&LPC_RTC->SEC);

                        strcpy(UART0_BUFFER_TX              ,      "Hora cambiada...\n"
        );

                        EstadoUART0 = UART_TX;

                        break;


        }

        tx_cadena_UART0(UART0_BUFFER_TX);

        /**     ZONA RETURN    */

        return retval;

}

/**--------------------------------------------------------------------------------------
---------------------------------//

//

        //

                                                                //

//              @end            ENDFILE.

        //

//

        //

//------------------------------------------------------------------------------------
-------------------------------**/
```

```
/* uart.c
 * contiene las funciones:

 1  UART0_IRQHandler(void)
 2  tx_cadena_UART0(char *ptr)
 3  uart0_set_baudrate(unsigned int baudrate)
 4  uart0_init(int baudrate)

 */
#include <LPC17xx.h>
#include "uart.h"

char bufferx[30];     // Buffer de recepción
char *ptr_rx;  // puntero de recepción
char rx_completa;// Flag de recepción de cadena completa que se activa al recibir
CR(0x0D)
char *ptr_tx;                 // puntero de transmisión
char tx_completa;             // Flag de transmisión de cadena completa



/*
 * UART0 interrupt handler
 */

void UART0_IRQHandler(void) {

    switch(LPC_UART0->IIR&0x0E) {

       case 0x04:                                                    /* RBR,
Receiver Buffer Ready */
       *ptr_rx=LPC_UART0->RBR;                              /* lee el dato recibido y lo
almacena */
           if (*ptr_rx++ ==13)                             // Caracter return --> Cadena
completa
                                          {
                                                *ptr_rx=0;            /* Añadimos el
caracter null para tratar los datos recibidos como una cadena*/
                                                rx_completa = 1;/* rx completa */
                                                procesarComando( bufferx );
                                                ptr_rx=bufferx;       /* puntero al
inicio del buffer para nueva recepción */
```

```
                                        }
                break;


   case 0x02:                                                   /* THRE, Transmit
Holding Register empty */
                if (*ptr_tx!=0) LPC_UART0->THR=*ptr_tx++;    /* carga un nuevo dato para
ser transmitido */
                else tx_completa=1;
                break;


    }
}


// Función para enviar una cadena de texto
// El argumento de entrada es la dirección de la cadena, o
// directamente la cadena de texto entre comillas
void tx_cadena_UART0(char *cadena)
{
ptr_tx=cadena;
tx_completa=0;
LPC_UART0->THR=*ptr_tx++;      // IMPORTANTE: Introducir un carácter al comienzo para
iniciar TX o
}                                                   // activar flag interrupción por
registro transmisor vacio



static int uart0_set_baudrate(unsigned int baudrate) {
    int errorStatus = -1; //< Failure

    // UART clock (FCCO / PCLK_UART0)
   // unsigned int uClk = SystemCoreClock / 4;
    unsigned int uClk =SystemCoreClock/4;
    unsigned int calcBaudrate = 0;
    unsigned int temp = 0;

    unsigned int mulFracDiv, dividerAddFracDiv;
    unsigned int divider = 0;
    unsigned int mulFracDivOptimal = 1;
    unsigned int dividerAddOptimal = 0;
    unsigned int dividerOptimal = 0;
```

```
    unsigned int relativeError = 0;
    unsigned int relativeOptimalError = 100000;

    uClk = uClk >> 4; /* div by 16 */

    /*
     *  The formula is :
     * BaudRate= uClk * (mulFracDiv/(mulFracDiv+dividerAddFracDiv) / (16 * DLL)
     *
     * The value of mulFracDiv and dividerAddFracDiv should comply to the following
expressions:
     * 0 < mulFracDiv <= 15, 0 <= dividerAddFracDiv <= 15
     */
    for (mulFracDiv = 1; mulFracDiv <= 15; mulFracDiv++) {
        for (dividerAddFracDiv = 0; dividerAddFracDiv <= 15; dividerAddFracDiv++) {
            temp = (mulFracDiv * uClk) / (mulFracDiv + dividerAddFracDiv);

            divider = temp / baudrate;
            if ((temp % baudrate) > (baudrate / 2))
                divider++;

            if (divider > 2 && divider < 65536) {
                calcBaudrate = temp / divider;

                if (calcBaudrate <= baudrate) {
                    relativeError = baudrate - calcBaudrate;
                } else {
                    relativeError = calcBaudrate - baudrate;
                }

                if (relativeError < relativeOptimalError) {
                    mulFracDivOptimal = mulFracDiv;
                    dividerAddOptimal = dividerAddFracDiv;
                    dividerOptimal = divider;
                    relativeOptimalError = relativeError;
                    if (relativeError == 0)
                        break;
                }
            }
```

```
        }

        if (relativeError == 0)
            break;
    }

    if (relativeOptimalError < ((baudrate * UART_ACCEPTED_BAUDRATE_ERROR) / 100)) {

        LPC_UART0->LCR |= DLAB_ENABLE;      // importante poner a 1
        LPC_UART0->DLM = (unsigned char) ((dividerOptimal >> 8) & 0xFF);
        LPC_UART0->DLL = (unsigned char) dividerOptimal;
        LPC_UART0->LCR &= ~DLAB_ENABLE;     // importante poner a 0

        LPC_UART0->FDR = ((mulFracDivOptimal << 4) & 0xF0) | (dividerAddOptimal & 0x0F);

        errorStatus = 0; //< Success
    }

    return errorStatus;
}

void uart0_init(int baudrate) {

    LPC_PINCON->PINSEL0|=(1<<4)|(1<<6);// Change P0.2 and P0.3 mode to TXD0 and RXD0
    ptr_rx = bufferx;
    LPC_UART0->LCR &= ~STOP_1_BIT & ~PARITY_NONE; // Set 8N1 mode (8 bits/dato, sin
pariad, y 1 bit de stop)
    LPC_UART0->LCR |= CHAR_8_BIT | 1 << 3;  /**     @CHANGED:      CHAR_8_BIT AÑADIDO POR
ALBERTO PALOMO.*/

    uart0_set_baudrate(baudrate);// Set the baud rate

    LPC_UART0->IER = THRE_IRQ_ENABLE|RBR_IRQ_ENABLE;// Enable UART TX and RX interrupt
(for LPC17xx UART)
    NVIC_EnableIRQ(UART0_IRQn);// Enable the UART interrupt (for Cortex-CM3 NVIC)

}
```

```
/**-------------------------------------------------------------------------------------
--------------------------------//
//              @filename               HTTP_SOURCE.c
                                                                                        //
//              @version                0.00
        //
//              @author         Alberto Palomo Alonso
                                                                        //
//
        //
//              @brief          Código que configura la página WEB.
                                                                //
//
        //
//              @category               Opcional.
        //
//
        //
//              @map                    @include
        //
//                                      @funcion
        //
//                                      @end
        //
//
        //
//
        //
//-------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                        //
//              @include                Estos son los archivos utilizados en el código de
configuración.                                                  //
//
        //
//-------------------------------------------------------------------------------------
--------------------------------**/
```

```
#ifndef HTTPSOURCE
#define HTTPSOURCE
#include       "HTTP_SOURCE.h"
#endif

void __configuraWEB__()
{
        init_TcpNet(); //      Inicializamos TcpNet(RTL.h).
}

void __mantenerTCP__()
{
        main_TcpNet();
}
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
        //

                                                                                //
//              @end            ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------------
---------------------------------**/



/*----------------------------------------------------------------------------
 *      RL-ARM - TCPnet
 *----------------------------------------------------------------------------
 *      Name:    NET_CONFIG.C
 *      Purpose: Configuration of RL TCPnet by user
 *      Rev.:    V4.72
 *----------------------------------------------------------------------------
 *      This code is part of the RealView Run-Time Library.
 *      Copyright (c) 2004-2013 KEIL - An ARM Company. All rights reserved.
 *---------------------------------------------------------------------------*/

#include <Net_Config.h>
```

```
#include       "miGlobal.h"

//-------- <<< Use Configuration Wizard in Context Menu >>> -----------------
//
// <h>System Definitions
// =====================
// <i> Global TCPnet System definitions
//   <s.15>Local Host Name
//   <i> This is the name under which embedded host
//   <i> can be accessed on a local area network.
//   <i> Default: "mcb2300"
#define LHOST_NAME     "MiniDK2"

//   <o>Memory Pool size <1536-262144:4><#/4>
//   <i> This is the size of a memory pool in bytes. Buffers for
//   <i> TCPnet packets are allocated from this memory pool.
//   <i> Default: 8000 bytes
#define MEM_SIZE       3000

//   <o>Tick Timer interval <10=> 10 ms <20=> 20 ms <25=> 25 ms
//                          <40=> 40 ms <50=> 50 ms <100=> 100 ms
//                          <200=> 200 ms
//   <i> System Tick Timer interval for software timers
//   <i> Default: 100 ms
#define TICK_INTERVAL  100

// </h>
// <e>Ethernet Network Interface
// =============================
// <i> Enable or disable Ethernet Network Interface
#define ETH_ENABLE     1

//   <h>MAC Address
//   ==============
//   <i> Local Ethernet MAC Address
//   <i> Value FF:FF:FF:FF:FF:FF is not allowed.
//   <i> It is an ethernet Broadcast MAC address.
//     <o>Address byte 1 <0x00-0xff:2>
//     <i> LSB is an ethernet Multicast bit.
```

```
//     <i> Must be 0 for local MAC address.
//     <i> Default: 0x00
#define _MAC1          0xE0

//     <o>Address byte 2 <0x00-0xff>
//     <i> Default: 0x30
#define _MAC2          0xF8

//     <o>Address byte 3 <0x00-0xff>
//     <i> Default: 0x6C
#define _MAC3          0x46

//     <o>Address byte 4 <0x00-0xff>
//     <i> Default: 0x00
#define _MAC4          0x35

//     <o>Address byte 5 <0x00-0xff>
//     <i> Default: 0x00
#define _MAC5          0x45

//     <o>Address byte 6 <0x00-0xff>
//     <i> Default: 0x01
#define _MAC6          0xBC

//   </h>
//   <h>IP Address
//   =============
//   <i> Local Static IP Address
//   <i> Value 255.255.255.255 is not allowed.
//   <i> It is a Broadcast IP address.
//     <o>Address byte 1 <0-255>
//     <i> Default: 192
#define _IP1           __IP1B

//     <o>Address byte 2 <0-255>
//     <i> Default: 168
#define _IP2           __IP2B

//     <o>Address byte 3 <0-255>
```

```
//     <i> Default: 0
#define _IP3           __IP3B

//     <o>Address byte 4 <0-255>
//     <i> Default: 100
#define _IP4           __IP4B

//   </h>
//   <h>Subnet mask
//   ==============
//   <i> Local Subnet mask
//     <o>Mask byte 1 <0-255>
//     <i> Default: 255
#define _MSK1          __MASK1B

//     <o>Mask byte 2 <0-255>
//     <i> Default: 255
#define _MSK2          __MASK2B

//     <o>Mask byte 3 <0-255>
//     <i> Default: 255
#define _MSK3          __MASK3B

//     <o>Mask byte 4 <0-255>
//     <i> Default: 0
#define _MSK4          __MASK4B

//   </h>
//   <h>Default Gateway
//   ==================
//   <i> Default Gateway IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 192
#define _GW1           __GW1B

//     <o>Address byte 2 <0-255>
//     <i> Default: 168
#define _GW2           __GW2B
```

```
//     <o>Address byte 3 <0-255>
//     <i> Default: 0
#define _GW3           __GW3B

//     <o>Address byte 4 <0-255>
//     <i> Default: 254
#define _GW4           __GW4B

//   </h>
//   <h>Primary DNS Server
//   =====================
//   <i> Primary DNS Server IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 194
#define _pDNS1         192

//     <o>Address byte 2 <0-255>
//     <i> Default: 25
#define _pDNS2         168

//     <o>Address byte 3 <0-255>
//     <i> Default: 2
#define _pDNS3         5

//     <o>Address byte 4 <0-255>
//     <i> Default: 129
#define _pDNS4         1

//   </h>
//   <h>Secondary DNS Server
//   =======================
//   <i> Secondary DNS Server IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 194
#define _sDNS1         194

//     <o>Address byte 2 <0-255>
//     <i> Default: 25
#define _sDNS2         25
```

```
//     <o>Address byte 3 <0-255>
//     <i> Default: 2
#define _sDNS3         2

//     <o>Address byte 4 <0-255>
//     <i> Default: 130
#define _sDNS4         130

//   </h>
//   <h>ARP Definitions
//   ==================
//   <i> Address Resolution Protocol Definitions
//     <o>Cache Table size <5-100>
//     <i> Number of cached hardware/IP addresses
//     <i> Default: 10
#define ARP_TABSIZE    10

//     <o>Cache Timeout in seconds <5-255>
//     <i> A timeout for a cached hardware/IP addresses
//     <i> Default: 150
#define ARP_TIMEOUT    150

//     <o>Number of Retries <0-20>
//     <i> Number of Retries to resolve an IP address
//     <i> before ARP module gives up
//     <i> Default: 4
#define ARP_MAXRETRY   4

//     <o>Resend Timeout in seconds <1-10>
//     <i> A timeout to resend the ARP Request
//     <i> Default: 2
#define ARP_RESEND     2

//     <q>Send Notification on Address changes
//     <i> When this option is enabled, the embedded host
//     <i> will send a Gratuitous ARP notification at startup,
//     <i> or when the device IP address has changed.
//     <i> Default: Disabled
```

```
#define ARP_NOTIFY     0

//   </h>
//   <e>IGMP Group Management
//   ========================
//   <i> Enable or disable Internet Group Management Protocol
#define IGMP_ENABLE    0

//     <o>Membership Table size <2-50>
//     <i> Number of Groups this host can join
//     <i> Default: 5
#define IGMP_TABSIZE   5

//   </e>
//   <q>NetBIOS Name Service
//   =======================
//   <i> When this option is enabled, the embedded host can be
//   <i> accessed by his name on the local LAN using NBNS protocol.
#define NBNS_ENABLE    0

//   <e>Dynamic Host Configuration
//   =============================
//   <i> When this option is enabled, local IP address, Net Mask
//   <i> and Default Gateway are obtained automatically from
//   <i> the DHCP Server on local LAN.
#define DHCP_ENABLE    0

//     <s.40>Vendor Class Identifier
//     <i> This value is optional. If specified, it is added
//     <i> to DHCP request message, identifying vendor type.
//     <i> Default: ""
#define DHCP_VCID      ""

//     <q>Bootfile Name
//     <i> This value is optional. If enabled, the Bootfile Name
//     <i> (option 67) is also requested from DHCP server.
//     <i> Default: disabled
#define DHCP_BOOTF     0
```

```
//     <q>NTP Servers
//     <i> This value is optional. If enabled, a list of NTP Servers
//     <i> (option 42) is also requested from DHCP server.
//     <i> Default: disabled
#define DHCP_NTPSRV    0

//   </e>
// </e>

// <e>PPP Network Interface
// ========================
// <i> Enable or disable PPP Network Interface
#define PPP_ENABLE     0

//   <h>IP Address
//   =============
//   <i> Local Static IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 192
#define _IP1P          192

//     <o>Address byte 2 <0-255>
//     <i> Default: 168
#define _IP2P          168

//     <o>Address byte 3 <0-255>
//     <i> Default: 125
#define _IP3P          125

//     <o>Address byte 4 <0-255>
//     <i> Default: 1
#define _IP4P          1

//   </h>
//   <h>Subnet mask
//   ==============
//   <i> Local Subnet mask
//     <o>Mask byte 1 <0-255>
//     <i> Default: 255
```

```
#define _MSK1P         255

//     <o>Mask byte 2 <0-255>
//     <i> Default: 255
#define _MSK2P         255

//     <o>Mask byte 3 <0-255>
//     <i> Default: 255
#define _MSK3P         255

//     <o>Mask byte 4 <0-255>
//     <i> Default: 0
#define _MSK4P         0

//   </h>
//   <h>Primary DNS Server
//   =====================
//   <i> Primary DNS Server IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 194
#define _pDNS1P        194

//     <o>Address byte 2 <0-255>
//     <i> Default: 25
#define _pDNS2P        25

//     <o>Address byte 3 <0-255>
//     <i> Default: 2
#define _pDNS3P        2

//     <o>Address byte 4 <0-255>
//     <i> Default: 129
#define _pDNS4P        129

//   </h>
//   <h>Secondary DNS Server
//   =======================
//   <i> Secondary DNS Server IP Address
//     <o>Address byte 1 <0-255>
```

```
//     <i> Default: 194
#define _sDNS1P        194

//     <o>Address byte 2 <0-255>
//     <i> Default: 25
#define _sDNS2P        25

//     <o>Address byte 3 <0-255>
//     <i> Default: 2
#define _sDNS3P        2

//     <o>Address byte 4 <0-255>
//     <i> Default: 130
#define _sDNS4P        130

//   </h>
//   <e>Logon Authentication
//   ======================
//   <i> Enable or disable user authentication
#define PPP_AUTHEN     1

//     <q>Unsecured password (PAP)
//     <i>Allow or use Password Authentication Protocol.
#define PPP_PAPEN      1

//     <q>Secured password (CHAP-MD5)
//     <i>Request or use Challenge Handshake Authentication
//     <i>Protocol with MD5 digest algorithm.
#define PPP_CHAPEN     1

//   </e>
//   <q>Obtain Client IP address automatically
//   ========================================
//   <i> This option only applies when PPP Dial-up is used to dial
//   <i> to remote PPP Server. If checked, network connection
//   <i> dynamically obtains an IP address from remote PPP Server.
#define PPP_GETIP      1

//   <q>Use Default Gateway on remote Network
```

```
//   ========================================
//   <i> This option only applies when both Ethernet and PPP Dial-up
//   <i> are used. If checked, data that cannot be sent to local LAN
//   <i> is forwarded to Dial-up network instead.
#define PPP_DEFGW      1

//   <o>Async Control Character Map <0x0-0xffffffff>
//   <i> A bit-map of control characters 0-31, which are
//   <i> transmitted escaped as a 2 byte sequence.
//   <i> For XON/XOFF set this value to: 0x000A 0000
//   <i> Default: 0x00000000
#define PPP_ACCM       0x00000000

//   <o>LCP Echo Interval in seconds <0-3600>
//   <i> If no frames are received within this interval, PPP sends an
//   <i> Echo Request and expects an Echo Response from the peer.
//   <i> If the response is not received, the link is terminated.
//   <i> A value of 0 disables the LCP Echo test.
//   <i> Default: 30
#define PPP_ECHOTOUT   30

//   <o>Number of Retries <0-20>
//   <i> How many times PPP will try to retransmit data
//   <i> before giving up. Increase this value for links
//   <i> with low baud rates or high latency.
//   <i> Default: 3
#define PPP_MAXRETRY   3

//   <o>Retry Timeout in seconds <1-10>
//   <i> If no response received within this time frame,
//   <i> PPP module will try to resend the data again.
//   <i> Default: 2
#define PPP_RETRYTOUT  2

// </e>
// <e>SLIP Network Interface
// ========================
// <i> Enable or disable SLIP Network Interface
#define SLIP_ENABLE    0
```

```
//   <h>IP Address
//   =============
//   <i> Local Static IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 192
#define _IP1S          192

//     <o>Address byte 2 <0-255>
//     <i> Default: 168
#define _IP2S          168

//     <o>Address byte 3 <0-255>
//     <i> Default: 225
#define _IP3S          225

//     <o>Address byte 4 <0-255>
//     <i> Default: 1
#define _IP4S          1

//   </h>
//   <h>Subnet mask
//   ==============
//   <i> Local Subnet mask
//     <o>Mask byte 1 <0-255>
//     <i> Default: 255
#define _MSK1S         255

//     <o>Mask byte 2 <0-255>
//     <i> Default: 255
#define _MSK2S         255

//     <o>Mask byte 3 <0-255>
//     <i> Default: 255
#define _MSK3S         255

//     <o>Mask byte 4 <0-255>
//     <i> Default: 0
#define _MSK4S         0
```

```
//   </h>
//   <h>Primary DNS Server
//   ====================
//   <i> Primary DNS Server IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 194
#define _pDNS1S        194

//     <o>Address byte 2 <0-255>
//     <i> Default: 25
#define _pDNS2S        25

//     <o>Address byte 3 <0-255>
//     <i> Default: 2
#define _pDNS3S        2

//     <o>Address byte 4 <0-255>
//     <i> Default: 129
#define _pDNS4S        129

//   </h>
//   <h>Secondary DNS Server
//   ======================
//   <i> Secondary DNS Server IP Address
//     <o>Address byte 1 <0-255>
//     <i> Default: 194
#define _sDNS1S        194

//     <o>Address byte 2 <0-255>
//     <i> Default: 25
#define _sDNS2S        25

//     <o>Address byte 3 <0-255>
//     <i> Default: 2
#define _sDNS3S        2

//     <o>Address byte 4 <0-255>
//     <i> Default: 130
```

```
#define _sDNS4S        130

//   </h>
//   <q>Use Default Gateway on remote Network
//   ========================================
//   <i> This option only applies when both Ethernet and SLIP Dial-up
//   <i> are used. If checked, data that cannot be sent to local LAN
//   <i> is forwarded to Dial-up network instead.
#define SLIP_DEFGW     1

// </e>
// <e>UDP Sockets
// ==============
// <i> Enable or disable UDP Sockets
#define UDP_ENABLE     1

//   <o>Number of UDP Sockets <1-20>
//   <i> Number of available UDP sockets
//   <i> Default: 5
#define UDP_NUMSOCKS   2

// </e>
// <e>TCP Sockets
// ==============
// <i> Enable or disable TCP Sockets
#define TCP_ENABLE     1

//   <o>Number of TCP Sockets <1-20>
//   <i> Number of available TCP sockets
//   <i> Default: 5
#define TCP_NUMSOCKS   12

//   <o>Number of Retries <0-20>
//   <i> How many times TCP module will try to retransmit data
//   <i> before giving up. Increase this value for high-latency
//   <i> and low_throughput networks.
//   <i> Default: 5
#define TCP_MAXRETRY   5
```

```
//   <o>Retry Timeout in seconds <1-10>
//   <i> If data frame not acknowledged within this time frame,
//   <i> TCP module will try to resend the data again.
//   <i> Default: 4
#define TCP_RETRYTOUT  4

//   <o>Default Connect Timeout in seconds <1-600>
//   <i> Default TCP Socket Keep Alive timeout. When it expires
//   <i> with no TCP data frame send, TCP Connection is closed.
//   <i> Default: 120
#define TCP_DEFTOUT    120

//   <o>Maximum Segment Size <536-1460>
//   <i> The Maximum Segment Size specifies the maximum
//   <i> number of bytes in the TCP segment's Data field.
//   <i> Default: 1460
#define TCP_MAXSEGSZ   1460

//   <o>Receive Window Size <536-65535>
//   <i> Receive Window Size specifies the size of data,
//   <i> that the socket is able to buffer in flow-control mode.
//   <i> Default: 4380
#define TCP_RECWINSZ   4380

/* TCP fixed timeouts */
#define TCP_INIT_RETRY_TOUT 1     /* TCP initial Retransmit period in sec.   */
#define TCP_SYN_RETRY_TOUT  2     /* TCP SYN frame retransmit period in sec. */
#define TCP_CONRETRY        7     /* Number of retries to establish a conn.  */

// </e>
// <e>HTTP Server
// ==============
// <i> Enable or disable HTTP Server
#define HTTP_ENABLE    1

//   <o>Number of HTTP Sessions <1-10>
//   <i> Number of simultaneously active HTTP Sessions.
//   <i> Default: 3
#define HTTP_NUMSESS   6
```

```
//   <o>Port Number <1-65535>
//   <i> Listening port number.
//   <i> Default: 80
#define HTTP_PORTNUM   80

//   <s.50>Server-Id header
//   <i> This value is optional. If specified, it overrides
//   <i> the default HTTP Server header from the library.
//   <i> Default: ""
#define HTTP_SRVID     ""

//   <e>Enable User Authentication
//     <i> When enabled, the user will have to authenticate
//     <i> himself by username and password before accessing
//     <i> any page on this Embedded WEB server.
#define HTTP_ENAUTH    1

//     <s.20>Authentication Realm
//     <i> Default: "Embedded WEB Server"
#define HTTP_AUTHREALM "Embedded WEB Server"

//     <s.15>Authentication Username
//     <i> Default: "admin"
#define HTTP_AUTHUSER  "user"

//     <s.15>Authentication Password
//     <i> Default: ""
#define HTTP_AUTHPASSW "Alver"

//   </e>
// </e>
// <e>Telnet Server
// ================
// <i> Enable or disable Telnet Server
#define TNET_ENABLE    0

//   <o>Number of Telnet Connections <1-10>
//   <i> Number of simultaneously active Telnet Connections.
```

```
//   <i> Default: 1
#define TNET_NUMSESS   2

//   <o>Port Number <1-65535>
//   <i> Listening port number.
//   <i> Default: 23
#define TNET_PORTNUM   23

//   <o>Idle Connection Timeout in seconds <0-3600>
//   <i> When timeout expires, the connection is closed.
//   <i> A value of 0 disables disconnection on timeout.
//   <i> Default: 120
#define TNET_IDLETOUT  120

//   <q>Disable Echo
//   <i> When disabled, the server will not echo
//   <i> characters it receives.
//   <i> Default: Not disabled
#define TNET_NOECHO    0

//   <e>Enable User Authentication
//   <i> When enabled, the user will have to authenticate
//   <i> himself by username and password before access
//   <i> to the system is allowed.
#define TNET_ENAUTH    1

//     <s.15>Authentication Username
//     <i> Default: "admin"
#define TNET_AUTHUSER  "admin"

//     <s.15>Authentication Password
//     <i> Default: ""
#define TNET_AUTHPASSW ""

//   </e>
// </e>
// <e>TFTP Server
// ==============
// <i> Enable or disable TFTP Server
```

```
#define TFTP_ENABLE    0

//   <o>Number of TFTP Sessions <1-10>
//   <i> Number of simultaneously active TFTP Sessions
//   <i> Default: 1
#define TFTP_NUMSESS   1

//   <o>Port Number <1-65535>
//   <i> Listening port number.
//   <i> Default: 69
#define TFTP_PORTNUM   69

//   <q>Enable Firewall Support
//   <i> Use the same Port Number to receive
//   <i> requests and send answers to clients.
//   <i> Default: Not Enabled
#define TFTP_ENFWALL   0

//   <o>Inactive Session Timeout in seconds <5-120>
//   <i> When timeout expires TFTP Session is closed.
//   <i> Default: 15
#define TFTP_DEFTOUT   15

//   <o>Number of Retries <1-10>
//   <i> How many times TFTP Server will try to
//   <i> retransmit the data before giving up.
//   <i> Default: 4
#define TFTP_MAXRETRY  4

// </e>
// <e>TFTP Client
// ==============
// <i> Enable or disable TFTP Client
#define TFTPC_ENABLE   0

//   <o>Block Size <128=>128   <256=>256   <512=>512
//                 <1024=>1024 <1428=>1428
//   <i> Size of transfer block in bytes.
//   <i> Default: 512
```

```
#define TFTPC_BLOCKSZ  512

//   <o>Number of Retries <1-10>
//   <i> How many times TFTP Client will try to
//   <i> retransmit the data before giving up.
//   <i> Default: 4
#define TFTPC_MAXRETRY 4

//   <o>Retry Timeout <2=>200 ms <5=>500 ms <10=>1 sec
//                    <20=>2 sec <50=>5 sec <100=>10 sec
//   <i> If data frame not acknowledged within this time frame,
//   <i> TFTP Client will try to resend the data again.
//   <i> Default: 500 ms
#define TFTPC_RETRYTO  5

// </e>
// <e>FTP Server
// ==============
// <i> Enable or disable FTP Server
#define FTP_ENABLE     0

//   <o>Number of FTP Sessions <1-10>
//   <i> Number of simultaneously active FTP Sessions
//   <i> Default: 1
#define FTP_NUMSESS    3

//   <o>Port Number <1-65535>
//   <i> Listening port number.
//   <i> Default: 21
#define FTP_PORTNUM    21

//   <s.50>Welcome Message
//   <i> This value is optional. If specified,
//   <i> it overrides the default welcome message.
//   <i> Default: ""
#define FTP_WELMSG     ""

//   <o>Idle Session Timeout in seconds <0-3600>
//   <i> When timeout expires, the connection is closed.
```

```
//   <i> A value of 0 disables disconnection on timeout.
//   <i> Default: 120
#define FTP_IDLETOUT   120

//   <e>Enable User Authentication
//   <i> When enabled, the user will have to authenticate
//   <i> himself by username and password before access
//   <i> to the system is allowed.
#define FTP_ENAUTH     1

//     <s.15>Authentication Username
//     <i> Default: "admin"
#define FTP_AUTHUSER   "admin"

//     <s.15>Authentication Password
//     <i> Default: ""
#define FTP_AUTHPASSW  ""

//   </e>
// </e>
// <e>FTP Client
// =============
// <i> Enable or disable FTP Client
#define FTPC_ENABLE    0

//     <o>Response Timeout in seconds <1-120>
//     <i> This is a time for FTP Client to wait for a response from
//     <i> the Server. If timeout expires, Client aborts operation.
//     <i> Default: 10
#define FTPC_DEFTOUT   10

//     <q>Passive mode (PASV)
//     <i> The client initiates a data connection to the server.
//     <i> Default: Not passive (Active)
#define FTPC_PASVMODE  0

// </e>
// <e>DNS Client
// =============
```

```
// <i> Enable or disable DNS Client
#define DNS_ENABLE     0

//     <o>Cache Table size <5-100>
//     <i> Number of cached DNS host names/IP addresses
//     <i> Default: 20
#define DNS_TABSIZE    20

// </e>
// <e>SMTP Client
// ==============
// <i> Enable or disable SMTP Client
#define SMTP_ENABLE    0

//     <o>Response Timeout in seconds <5-120>
//     <i> This is a time for SMTP Client to wait for a response from
//     <i> SMTP Server. If timeout expires, Client aborts operation.
//     <i> Default: 20
#define SMTP_DEFTOUT   20

// </e>
// <e>SNMP Agent
// =============
// <i> Enable or disable SNMP Agent
#define SNMP_ENABLE    0

//   <s.15>Community Name
//   <i> Defines where an SNMP message is destined for.
//   <i> Default: "public"
#define SNMP_COMMUNITY "public"

//   <o>Port Number <1-65535>
//   <i> Listening port number.
//   <i> Default: 161
#define SNMP_PORTNUM   161

//   <o>Trap Port Number <1-65535>
//   <i> Port number for Trap operations.
//   <i> Default: 162
```

```
#define SNMP_TRAPPORT  162

//   <h>Trap Server
//   ==============
//   <i> Trap Server IP Address
//   <o>Address byte 1 <0-255>
//   <i> Default: 192
#define SNMP_TRAPIP1   192

//   <o>Address byte 2 <0-255>
//   <i> Default: 168
#define SNMP_TRAPIP2   168

//   <o>Address byte 3 <0-255>
//   <i> Default: 0
#define SNMP_TRAPIP3   0

//   <o>Address byte 4 <0-255>
//   <i> Default: 100
#define SNMP_TRAPIP4   1

//   </h>
// </e>
// <e>SNTP Client
// ==============
// <i> Enable or disable SNTP Client
#define SNTP_ENABLE    0

//   <q>Broadcast Mode
//   =================
//   <i> Enable this option, if you have NTP/SNTP server
//   <i> on LAN, which is broadcasting NTP time messages.
//   <i> Disable this option to access public NTP server.
//   <i> Default: disabled
#define SNTP_BCMODE    0

//   <h>NTP Server
//   =============
//   <i> Server IP Address
```

```
//   <o>Address byte 1 <0-255>
//   <i> Default: 217
#define SNTP_SRVIP1    217

//   <o>Address byte 2 <0-255>
//   <i> Default: 79
#define SNTP_SRVIP2    79

//   <o>Address byte 3 <0-255>
//   <i> Default: 179
#define SNTP_SRVIP3    179

//   <o>Address byte 4 <0-255>
//   <i> Default: 106
#define SNTP_SRVIP4    106

//   </h>
// </e>
// <e>BSD Socket Interface
// ========================
// <i> Enable or disable Berkeley Socket Programming Interface
#define BSD_ENABLE     0

//   <o>Number of BSD Sockets <1-20>
//   <i> Number of available Berkeley Sockets
//   <i> Default: 2
#define BSD_NUMSOCKS   2

//   <o>Number of Streaming Server Sockets <0-20>
//   <i> Defines a number of Streaming (TCP) Server sockets,
//   <i> that listen for an incoming connection from the client.
//   <i> Default: 1
#define BSD_SRVSOCKS   1

//   <o>Receive Timeout in seconds <0-600>
//   <i> A timeout for socket receive in blocking mode.
//   <i> Timeout value of 0 means indefinite timeout.
//   <i> Default: 20
#define BSD_RCVTOUT    20
```

```
//   <q>Hostname Resolver
//   <i> Enable or disable Berkeley style hostname resolver.
#define BSD_GETHOSTEN  0

// </e>
//------------- <<< end of configuration section >>> ----------------------

/*----------------------------------------------------------------------------
 *      Fatal Error Handler
 *----------------------------------------------------------------------------*/

void sys_error (ERROR_CODE code) {
  /* This function is called when a fatal error is encountered. The normal */
  /* program execution is not possible anymore. Add your crytical error   .*/
  /* handler code here.                                                     */

  switch (code) {
    case ERR_MEM_ALLOC:
      /* Out of memory. */
      break;

    case ERR_MEM_FREE:
      /* Trying to release non existing memory block. */
      break;

    case ERR_MEM_CORRUPT:
      /* Memory Link pointer is Corrupted. */
      /* More data written than the size of allocated mem block. */
      break;

    case ERR_MEM_LOCK:
      /* Locked Memory management function (alloc/free) re-entered. */
      /* RTX multithread protection malfunctioning, not implemented */
      /* or interrupt disable is not functioning correctly. */
      break;

    case ERR_UDP_ALLOC:
      /* Out of UDP Sockets. */
```

```
      break;

    case ERR_TCP_ALLOC:
      /* Out of TCP Sockets. */
      break;

    case ERR_TCP_STATE:
      /* TCP State machine in undefined state. */
      break;
  }
  /* End-less loop */
  while (1);
}

/*----------------------------------------------------------------------------
 *      TCPnet Config Functions
 *----------------------------------------------------------------------------*/

#define  __NET_CONFIG__

#include <Net_lib.c>

/*----------------------------------------------------------------------------
 * end of file
 *----------------------------------------------------------------------------*/




/**-------------------------------------------------------------------------------------------
---------------------------------//
//             @filename             HTTP_CGI.c
                                                                                    //
//             @version              3.00
       //
//             @author        Alberto Palomo Alonso
                                                                  //
//
       //
//             @brief         Código que contiene las llamadas a las funciones de CGI.
                                                 //
```

```
//
        //
//              @category               Opcional.
        //
//
        //
//              @map                    @include
        //
//                                      @extern
                                                                                        //
//                                      @funcion
        //
//                                      @end
        //
//
        //
//
        //
//----------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                        //
//              @include                Estos son los archivos utilizados en el código de
configuración.                                                  //
//
        //
//----------------------------------------------------------------------------------------
---------------------------------**/
#ifndef HTTPCGI
#define HTTPCGI
#include        "HTTP_CGI.h"
#endif
/**--------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                        //
//              @extern         misDatos_t * DATOS -> main.c
                                                                        //
```

```
//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

extern misDatos_t	*	DATOS;

extern modificables_t MODIFICABLES;

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                    //

//		@function		cgi_process_var
                                                                                    //

//

	//

//		@brief		Utilizado para el método GET.
                                                                        //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void cgi_process_var  (	U8*	qs)

{

	U8 * var;

	var = (U8 *)alloc_mem(40);


	do

	{

		qs = http_get_var(qs , var, 40);

		if( var[0] )

		{

			if (str_scomp( var , (U8 *)"tmin="))

			{

				sscanf( (const char *)&var[5] , "%f" ,
&MODIFICABLES.Min_servo_t);

			}

			if (str_scomp( var , (U8 *)"tmax="))

			{

				sscanf( (const char *)&var[5] , "%f" ,
&MODIFICABLES.Max_servo_t);

			}
```

```
                        if (str_scomp( var , (U8 *)"pmin="))
                        {
                                sscanf( (const char *)&var[5] , "%f" ,
&MODIFICABLES.Min_servo_p);
                        }
                        if (str_scomp( var , (U8 *)"pmax="))
                        {
                                sscanf( (const char *)&var[5] , "%f" ,
&MODIFICABLES.Max_servo_p);
                        }
                        if (str_scomp( var , (U8 *)"bsec="))
                        {
                                sscanf( (const char *)&var[5] , "%d" ,
&MODIFICABLES.TiempoBrillo);
                        }
                        if (str_scomp( var , (U8 *)"vart="))
                        {
                                MODIFICABLES.Var_medida = 0;
                        }
                        if (str_scomp( var , (U8 *)"varp="))
                        {
                                MODIFICABLES.Var_medida = 1;
                        }
                }
        }while(qs);


        free_mem( (OS_FRAME *)var );
}
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                        //
//              @function               cgi_process_var
                                                                                        //
//
        //
//              @brief          NO UTILIZADO.
                                                                                //
//
        //
```

```
//-------------------------------------------------------------------------------------------
------------------------------**/

void cgi_process_data (      U8            tipo    ,      U8     *      qs     ,
       U16           longitud)

{

       //     NO UTILIZADO,  NO HAY PETICIONES EN ESTA VERSIÓN.

}

/**-----------------------------------------------------------------------------------------
------------------------------//

//

       //


                                                                                    //

//             @function             cgi_func()
                                                                                    //

//

       //

//             @brief         Función que es llamada por el CGI cada vez que se
socilicita una callback.                                    //

//                                    Obtiene una cadena de caracteres como parámetro de
CGI y actúa en consecuencia.                          //

//                                    En nuestro caso sólo llama a los datos y los
exporta a html.                                             //

//

       //

//                    @env                          Cadena de caracteres de entrada.
                                                                //

//                    @buff                 Salida de datos.
                                                                //

//                    @bufflen                      (No utilizado)Tamaño del buffer.
                                                                //

//                    @pcgui                (No utilizado)
                                                                //

//

       //

//                           @return        Tamaño de la cadena de salida en bytes.
                                                          //

//

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------------
------------------------------**/
```

```
U16 cgi_func                ( U8 * env , U8 * buff
      , U16 bufflen , U32 * pcgi)

{

      U32 longitud;


      switch( env[0] )

      {

            case  TEMPERATURA:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Temperatura  );

                  break;

            case  PRESION:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Presion      );

                  break;

            case  HUMEDAD:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Humedad      );

                  break;

            case  BRILLO:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Brillo       );

                  break;

            case  ALTITUD:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Lugar.Altura );

                  break;

            case  LATITUD:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Lugar.Latitud);

                  break;

            case  LONGITUD:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->Lugar.Longitud);

                  break;

            case  INDICEUV:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->IndiceUV     );

                  break;

            case  VELOCIDAD:

                  longitud = sprintf  ( (char*)buff  , (const char
*)&env[4]         , DATOS->VelViento    );

                  break;

            case ANYO:
```

```
                        longitud = sprintf    (       (char*)buff    ,       (const char
*)&env[4]               ,       LPC_RTC->YEAR         );

                        break;

                case MES:

                        longitud = sprintf    (       (char*)buff    ,       (const char
*)&env[4]               ,       LPC_RTC->MONTH        );

                        break;

                case DIA:

                        longitud = sprintf    (       (char*)buff    ,       (const char
*)&env[4]               ,       LPC_RTC->DOM          );

                        break;

                case HORAS:

                        longitud = sprintf    (       (char*)buff    ,       (const char
*)&env[4]               ,       LPC_RTC->HOUR         );

                        break;

                case MINUTOS:

                        longitud = sprintf    (       (char*)buff    ,       (const char
*)&env[4]               ,       LPC_RTC->MIN          );

                        break;

                case SEGUNDOS:

                        longitud = sprintf    (       (char*)buff    ,       (const char
*)&env[4]               ,       LPC_RTC->SEC          );

                        break;

                default:

                        longitud = sprintf    (       (char*)buff    ,       "<p>Y... que
quieres que ponga aqui? :v</p>");

                        break;

        }

        return  (       (U16)longitud  );

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                        //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/
```

```
/*----------------------------------------------------------------------------
 *      RL-ARM - TCPnet
 *----------------------------------------------------------------------------
 *      Name:    EMAC_LPC17xx.c
 *      Purpose: Driver for NXP LPC1768 EMAC Ethernet Controller
 *      Rev.:    V4.20
 *----------------------------------------------------------------------------
 *      This code is part of the RealView Run-Time Library.
 *      Copyright (c) 2004-2011 KEIL - An ARM Company. All rights reserved.
 *----------------------------------------------------------------------------
 *      Modified to be used with LAN8720 of MiniDk2 Board.
 *---------------------------------------------------------------------------*/

#include <Net_Config.h>
#include "EMAC_LPC17xx_LAN8720.h"        // LAN8720
#include <LPC17xx.h>                    /* LPC17xx definitions               */


//#define _10MBIT_
//#define _100MBIT_

typedef void (*IAP)(U32 *cmd, U32 *res);
IAP iap_entry = (IAP)0x1FFF1FF1;

/* The following macro definitions may be used to select the speed
   of the physical link:

  _10MBIT_   - connect at 10 MBit only
  _100MBIT_  - connect at 100 MBit only

  By default an autonegotiation of the link speed is used. This may take
  longer to connect, but it works for 10MBit and 100MBit physical links.     */

/* Net_Config.c */
extern U8 own_hw_adr[];
```

```
/* EMAC local DMA Descriptors. */
static            RX_Desc Rx_Desc[NUM_RX_FRAG];
static __align(8) RX_Stat Rx_Stat[NUM_RX_FRAG]; /* Must be 8-Byte alligned   */
static            TX_Desc Tx_Desc[NUM_TX_FRAG];
static            TX_Stat Tx_Stat[NUM_TX_FRAG];

/* EMAC local DMA buffers. */
static U32 rx_buf[NUM_RX_FRAG][ETH_FRAG_SIZE>>2];
static U32 tx_buf[NUM_TX_FRAG][ETH_FRAG_SIZE>>2];

/*-----------------------------------------------------------------------------
 *      EMAC Ethernet Driver Functions
 *-----------------------------------------------------------------------------
 *  Required functions for Ethernet driver module:
 *  a. Polling mode: - void init_ethernet ()
 *                   - void send_frame (OS_FRAME *frame)
 *                   - void poll_ethernet (void)
 *  b. Interrupt mode: - void init_ethernet ()
 *                     - void send_frame (OS_FRAME *frame)
 *                     - void int_enable_eth ()
 *                     - void int_disable_eth ()
 *                     - interrupt function
 *----------------------------------------------------------------------------*/

/* Local Function Prototypes */
static void rx_descr_init (void);
static void tx_descr_init (void);
static void write_PHY (U32 PhyReg, U16 Value);
static U16  read_PHY (U32 PhyReg);


/*--------------------------- comando setMac ---------------------------------*/
unsigned char setMac (unsigned short * p_mac,unsigned short mode)
{
  int i;

  if(mode==0){
    for(i=3;i<6;i++)
```

```
      own_hw_adr[i]=(unsigned char)*p_mac++;

    own_hw_adr[0]=MAC_CID_0;
    own_hw_adr[1]=MAC_CID_1;
    own_hw_adr[2]=MAC_CID_2;
  }
  else
  {
    for(i=0;i<6;i++)
      own_hw_adr[i]=(unsigned char)*p_mac++;
  }

  int_disable_eth ();

  /* Disable Rx and Tx*/
  LPC_EMAC->MAC1&= ~MAC1_REC_EN;
  /* Disable Rx */
  LPC_EMAC->Command&= ~CR_RX_EN & ~CR_TX_EN;
  //#define CR_RX_EN            0x00000001  /* Enable Receive                    */
  //#define CR_TX_EN            0x00000002  /* Enable Transmit                   */

  /* Set the Ethernet MAC Address registers */
  LPC_EMAC->SA0 = ((U32)own_hw_adr[5] << 8) | (U32)own_hw_adr[4];
  LPC_EMAC->SA1 = ((U32)own_hw_adr[3] << 8) | (U32)own_hw_adr[2];
  LPC_EMAC->SA2 = ((U32)own_hw_adr[1] << 8) | (U32)own_hw_adr[0];

  /* Reset all EMAC internal modules. */
  LPC_EMAC->MAC1|= (MAC1_RES_TX | MAC1_RES_MCS_TX | MAC1_RES_RX |
                    MAC1_RES_MCS_RX | MAC1_SIM_RES | MAC1_SOFT_RES);

  LPC_EMAC->Command|= (CR_REG_RES | CR_TX_RES | CR_RX_RES | CR_PASS_RUNT_FRM);

  int_enable_eth ();

       return 1;  //cambiar por una comprobación de si se ha comido la mac
}


/*--------------------------- init_ethernet ---------------------------------*/
```

```
void init_ethernet (void)
{
  /* Initialize the EMAC ethernet controller. */
  static U32 regv,tout,id1,id2;

  /* Power Up the EMAC controller. */
  LPC_SC->PCONP |= 0x40000000;

  /* Enable P1 Ethernet Pins. */
  LPC_PINCON->PINSEL2 = 0x50150105;

  /* LPC176x devices, no MDIO, MDC remap. */
  LPC_PINCON->PINSEL3 = (LPC_PINCON->PINSEL3 & ~0x0000000F) | 0x00000005;  //MDIO y MCLK
operativos

  /* Reset all EMAC internal modules. */
  LPC_EMAC->MAC1    = MAC1_RES_TX | MAC1_RES_MCS_TX | MAC1_RES_RX |
                      MAC1_RES_MCS_RX | MAC1_SIM_RES | MAC1_SOFT_RES;
  LPC_EMAC->Command = CR_REG_RES | CR_TX_RES | CR_RX_RES;

  /* A short delay after reset. */
  for (tout = 0; tout < 0x100; tout++) ;  //LAN8720

  /* Initialize MAC control registers. */
  LPC_EMAC->MAC1 = MAC1_PASS_ALL;  //accepts control frames: care
  LPC_EMAC->MAC2 = MAC2_CRC_EN | MAC2_PAD_EN;
  LPC_EMAC->MAXF = ETH_MAX_FLEN;  //1536
  LPC_EMAC->CLRT = CLRT_DEF;
  LPC_EMAC->IPGR = IPGR_DEF;

  //LPC_EMAC->Command = CR_RMII | CR_PASS_RUNT_FRM;  //DP83848C
  LPC_EMAC->Command = CR_RMII | CR_PASS_RUNT_FRM | CR_PASS_RX_FILT;  // LAN8720
                           //CR_MII must be enabled or eth will not work

  /* Enable and Reset Reduced MII interface. */
  LPC_EMAC->MCFG = MCFG_CLK_DIV64 | MCFG_RES_MII;    // LAN8720
  for (tout = 0; tout < 0x0100; tout++) ;            // LAN8720
  LPC_EMAC->MCFG = MCFG_CLK_DIV64;                   // LAN8720
```

```
  /* Reset Reduced MII Logic. */
  LPC_EMAC->SUPP = SUPP_RES_RMII;
  for (tout = 0; tout < 0x100; tout++) ;              //LAN8720
  LPC_EMAC->SUPP = 0;

  /* Put the PHY in reset mode */
  write_PHY (PHY_REG_BMCR, 0x8000);

  /* Wait for hardware reset to end. */
  for (tout = 0; tout < 0x100000; tout++)
        {
     regv = read_PHY (PHY_REG_BMCR);
     if (!(regv & 0x8800))
      break;  /* Reset complete, device not Power Down. */
   }

  /* Read PHY ID. */
  id1 = read_PHY (PHY_REG_IDR1);
  id2 = read_PHY (PHY_REG_IDR2);  //the 4 LSB may vary depending on the silicon rev num

  /* Check if this is a LAN8720_ID PHY. */
  if (((id1 << 16) | (id2 & 0xFFF0)) == LAN8720_ID)
  {
    /* Configure the PHY device */
#if defined (_10MBIT_)
    /* Connect at 10MBit */
    write_PHY (PHY_REG_BMCR, PHY_FULLD_10M);
#elif defined (_100MBIT_)
    /* Connect at 100MBit */
    write_PHY (PHY_REG_BMCR, PHY_FULLD_100M);
#else
    /* Use autonegotiation about the link speed. */
    write_PHY (PHY_REG_BMCR, PHY_AUTO_NEG);
    /* Wait to complete Auto_Negotiation. */
    for (tout = 0; tout < 0x100000; tout++)
    {
      regv = read_PHY (PHY_REG_BMSR);
      if (regv & 0x0020)
        break;          /* Autonegotiation Complete. */
```

```
    }
#endif
  }
  /* Check the link status. */
  for (tout = 0; tout < 0x10000; tout++)
  {
    regv = read_PHY (PHY_REG_BMSR); //LAN8720_ID
    if (regv & 0x0004)   //LAN8720_ID
      break;        /* Link is on. */
  }

  regv = read_PHY (PHY_REG_STS);  //LAN8720

  /* Configure Full/Half Duplex mode. */
  if (regv & 0x0010)
  {
    /* Full duplex is enabled. */
    LPC_EMAC->MAC2    |= MAC2_FULL_DUP;
    LPC_EMAC->Command |= CR_FULL_DUP;
    LPC_EMAC->IPGT     = IPGT_FULL_DUP;
  }
  else
  {
    /* Half duplex mode. */
    LPC_EMAC->IPGT = IPGT_HALF_DUP;
  }

  /* Configure 100MBit/10MBit mode. */
  if (regv & 0x0008)
  {
    /* 100MBit mode. */
    LPC_EMAC->SUPP = SUPP_SPEED;
  }
  else
  {
    /* 10MBit mode. */
    LPC_EMAC->SUPP = 0;
  }
```

```
  /* Set the Ethernet MAC Address registers */
  LPC_EMAC->SA0 = ((U32)own_hw_adr[5] << 8) | (U32)own_hw_adr[4];
  LPC_EMAC->SA1 = ((U32)own_hw_adr[3] << 8) | (U32)own_hw_adr[2];
  LPC_EMAC->SA2 = ((U32)own_hw_adr[1] << 8) | (U32)own_hw_adr[0];

  /* Initialize Tx and Rx DMA Descriptors */
  rx_descr_init ();
  tx_descr_init ();

  /* Receive Broadcast, Multicast and Perfect Match Packets */
  LPC_EMAC->RxFilterCtrl = RFC_MCAST_EN | RFC_BCAST_EN | RFC_PERFECT_EN;

  /* Enable EMAC interrupts. */
  LPC_EMAC->IntEnable = INT_RX_DONE | INT_TX_DONE;

  /* Reset all interrupts */
  LPC_EMAC->IntClear  = 0xFFFF;

  /* Enable receive and transmit mode of MAC Ethernet core */
  LPC_EMAC->Command  |= (CR_RX_EN | CR_TX_EN);
  LPC_EMAC->MAC1     |= MAC1_REC_EN;
}


/*---------------------------- int_enable_eth -------------------------------*/

void int_enable_eth (void) {
  /* Ethernet Interrupt Enable function. */
  NVIC_EnableIRQ(ENET_IRQn);
}


/*---------------------------- int_disable_eth ------------------------------*/

void int_disable_eth (void) {
  /* Ethernet Interrupt Disable function. */
  NVIC_DisableIRQ(ENET_IRQn);
}
```

```
/*--------------------------- send_frame ----------------------------------*/

void send_frame (OS_FRAME *frame) {
  /* Send frame to EMAC ethernet controller */
  U32 idx,len;
  U32 *sp,*dp;

  idx = LPC_EMAC->TxProduceIndex;
  sp  = (U32 *)&frame->data[0];
  dp  = (U32 *)Tx_Desc[idx].Packet;

  /* Copy frame data to EMAC packet buffers. */
  for (len = (frame->length + 3) >> 2; len; len--) {
    *dp++ = *sp++;
  }

  Tx_Desc[idx].Ctrl = (frame->length-1) | (TCTRL_INT | TCTRL_LAST);

  /* Start frame transmission. */
  if (++idx == NUM_TX_FRAG) idx = 0;
    LPC_EMAC->TxProduceIndex = idx;
}


/*--------------------------- interrupt_ethernet ---------------------------*/

void ENET_IRQHandler (void) {
  /* EMAC Ethernet Controller Interrupt function. */
  OS_FRAME *frame;
  U32 idx,int_stat,RxLen,info;
  U32 *sp,*dp;

  while ((int_stat = (LPC_EMAC->IntStatus & LPC_EMAC->IntEnable)) != 0) {
    LPC_EMAC->IntClear = int_stat;
    if (int_stat & INT_RX_DONE) {
      /* Packet received, check if packet is valid. */
      idx = LPC_EMAC->RxConsumeIndex;
      while (idx != LPC_EMAC->RxProduceIndex) {
```

```
        info = Rx_Stat[idx].Info;
        if (!(info & RINFO_LAST_FLAG)) {
          goto rel;
        }

        RxLen = (info & RINFO_SIZE) - 3;
        if (RxLen > ETH_MTU || (info & RINFO_ERR_MASK)) {
          /* Invalid frame, ignore it and free buffer. */
          goto rel;
        }
        /* Flag 0x80000000 to skip sys_error() call when out of memory. */
        frame = alloc_mem (RxLen | 0x80000000);
        /* if 'alloc_mem()' has failed, ignore this packet. */
        if (frame != NULL) {
          dp = (U32 *)&frame->data[0];
          sp = (U32 *)Rx_Desc[idx].Packet;
          for (RxLen = (RxLen + 3) >> 2; RxLen; RxLen--) {
            *dp++ = *sp++;
          }
          put_in_queue (frame);
        }
rel:    if (++idx == NUM_RX_FRAG) idx = 0;
        /* Release frame from EMAC buffer. */
        LPC_EMAC->RxConsumeIndex = idx;
      }
    }
    if (int_stat & INT_TX_DONE) {
      /* Frame transmit completed. */
    }
  }

}


/*---------------------------- rx_descr_init ---------------------------------*/

static void rx_descr_init (void) {
  /* Initialize Receive Descriptor and Status array. */
  U32 i;
```

```
  for (i = 0; i < NUM_RX_FRAG; i++) {
    Rx_Desc[i].Packet  = (U32)&rx_buf[i];
    Rx_Desc[i].Ctrl    = RCTRL_INT | (ETH_FRAG_SIZE-1);
    Rx_Stat[i].Info    = 0;
    Rx_Stat[i].HashCRC = 0;
  }

  /* Set EMAC Receive Descriptor Registers. */
  LPC_EMAC->RxDescriptor       = (U32)&Rx_Desc[0];
  LPC_EMAC->RxStatus           = (U32)&Rx_Stat[0];
  LPC_EMAC->RxDescriptorNumber = NUM_RX_FRAG-1;

  /* Rx Descriptors Point to 0 */
  LPC_EMAC->RxConsumeIndex  = 0;
}


/*--------------------------- tx_descr_init ---- ----------------------------*/

static void tx_descr_init (void) {
  /* Initialize Transmit Descriptor and Status array. */
  U32 i;

  for (i = 0; i < NUM_TX_FRAG; i++) {
    Tx_Desc[i].Packet = (U32)&tx_buf[i];
    Tx_Desc[i].Ctrl   = 0;
    Tx_Stat[i].Info   = 0;
  }

  /* Set EMAC Transmit Descriptor Registers. */
  LPC_EMAC->TxDescriptor       = (U32)&Tx_Desc[0];
  LPC_EMAC->TxStatus           = (U32)&Tx_Stat[0];
  LPC_EMAC->TxDescriptorNumber = NUM_TX_FRAG-1;

  /* Tx Descriptors Point to 0 */
  LPC_EMAC->TxProduceIndex  = 0;
}
```

```
/*--------------------------- output_MDIO -----------------------------------*/

#define delay()     __nop(); __nop(); __nop();

//static void output_MDIO (U32 val, U32 n) {
//  /* Output a value to the MII PHY management interface. */

//  for (val <<= (32 - n); n; val <<= 1, n--) {
//    if (val & 0x80000000) {
//      LPC_GPIO2->FIOSET = MDIO;
//    }
//    else {
//      LPC_GPIO2->FIOCLR = MDIO;
//    }
//    delay ();
//    LPC_GPIO2->FIOSET = MDC;
//    delay ();
//    LPC_GPIO2->FIOCLR = MDC;
//  }
//}

/*--------------------------- turnaround_MDIO -------------------------------*/

//static void turnaround_MDIO (void) {
//  /* Turnaround MDO is tristated. */

//  LPC_GPIO2->FIODIR &= ~MDIO;
//  LPC_GPIO2->FIOSET  = MDC;
//  delay ();
//  LPC_GPIO2->FIOCLR  = MDC;
//  delay ();
//}

/*--------------------------- input_MDIO ------------------------------------*/

//static U32 input_MDIO (void) {
//  /* Input a value from the MII PHY management interface. */
//  U32 i,val = 0;
```

```
//  for (i = 0; i < 16; i++) {
//    val <<= 1;
//    LPC_GPIO2->FIOSET = MDC;
//    delay ();
//    LPC_GPIO2->FIOCLR = MDC;
//    if (LPC_GPIO2->FIOPIN & MDIO) {
//      val |= 1;
//    }
//  }
//  return (val);
//}



/*---------------------------- write_PHY -----------------------------------*/


static void write_PHY (U32 PhyReg, U16 Value) {
  /* Write a data 'Value' to PHY register 'PhyReg'. */
  U32 tout;


  /* Hardware MII Management for LPC176x devices. */  // LAN8720
  LPC_EMAC->MADR = LAN8720_DEF_ADR | PhyReg;   //The device and registernumber that will
be accessed
  LPC_EMAC->MWTD = Value;                          //The value to write in the register


  /* Wait utill operation completed */
  for (tout = 0; tout < MII_WR_TOUT; tout++) {
    if ((LPC_EMAC->MIND & MIND_BUSY) == 0) {
      break;
    }
  }
}



/*---------------------------- read_PHY -----------------------------------*/


static U16 read_PHY (U32 PhyReg) {
  /* Read a PHY register 'PhyReg'. */
  U32 tout, val;
```

```
  LPC_EMAC->MADR = LAN8720_DEF_ADR | PhyReg;
  LPC_EMAC->MCMD = MCMD_READ;  //Set bit in the command register to execute a single
read

  /* Wait until operation completed */
  for (tout = 0; tout < MII_RD_TOUT; tout++) {
    if ((LPC_EMAC->MIND & MIND_BUSY) == 0) {
      break;
    }
  }
  LPC_EMAC->MCMD = 0;
  val = LPC_EMAC->MRDD;
  return (val);
}

/*-----------------------------------------------------------------------------
 * end of file
 *----------------------------------------------------------------------------*/




/*-----------------------------------------------------------------------------
 *      Generated by FCARM FILE CONVERTER V2.41
 *-----------------------------------------------------------------------------
 *      Name:    WEB.C
 *      Purpose: HTTP Web page, generated by the user.
 *      Note:    This is a generated file, do not modify !!!
 *-----------------------------------------------------------------------------
 *      This code is part of the RealView Run-Time Library.
 *      Copyright (c) 2004-2013 ARM Germany GmbH. All rights reserved.
 *----------------------------------------------------------------------------*/

#include <Net_Config.h>

/* Last-Modified: Sun, 19 Jan 2020 16:53:00 GMT */
const U32 FileMD = 1579452780;

/*----------------------------------------------------------------------------*/
```

```
static const U8 Web[2221] = {

  /*-- File: index.cgi, 2221 bytes --*/
  0x01,0x3C,0x21,0x44,0x4F,0x43,0x54,0x59,0x50,0x45,0x20,0x68,0x74,0x6D,0x6C,
  0x3E,0x20,0x3C,0x68,0x74,0x6D,0x6C,0x3E,0x20,0x3C,0x68,0x65,0x61,0x64,0x3E,
  0x20,0x3C,0x6D,0x65,0x74,0x61,0x20,0x63,0x6F,0x6E,0x74,0x65,0x6E,0x74,0x3D,
  0x22,0x74,0x65,0x78,0x74,0x2F,0x68,0x74,0x6D,0x6C,0x3B,0x20,0x63,0x68,0x61,
  0x72,0x73,0x65,0x74,0x3D,0x55,0x54,0x46,0x2D,0x38,0x22,0x20,0x68,0x74,0x74,
  0x70,0x2D,0x65,0x71,0x75,0x69,0x76,0x3D,0x22,0x63,0x6F,0x6E,0x74,0x65,0x6E,
  0x74,0x2D,0x74,0x79,0x70,0x65,0x22,0x3E,0x01,0x20,0x3C,0x6D,0x65,0x74,0x61,
  0x20,0x68,0x74,0x74,0x70,0x2D,0x65,0x71,0x75,0x69,0x76,0x3D,0x22,0x72,0x65,
  0x66,0x72,0x65,0x73,0x68,0x22,0x20,0x63,0x6F,0x6E,0x74,0x65,0x6E,0x74,0x3D,
  0x22,0x32,0x30,0x3B,0x20,0x75,0x72,0x6C,0x3D,0x68,0x74,0x74,0x70,0x3A,0x2F,
  0x2F,0x31,0x39,0x32,0x2E,0x31,0x36,0x38,0x2E,0x31,0x2E,0x31,0x32,0x30,0x2F,
  0x69,0x6E,0x64,0x65,0x78,0x2E,0x63,0x67,0x69,0x22,0x3E,0x20,0x3C,0x74,0x69,
  0x74,0x6C,0x65,0x3E,0x45,0x53,0x54,0x41,0x43,0x49,0x4F,0x4E,0x20,0x4D,0x45,
  0x54,0x45,0x4F,0x52,0x4F,0x4C,0x4F,0x47,0x49,0x43,0x41,0x3C,0x2F,0x74,0x69,
  0x74,0x6C,0x65,0x3E,0x01,0x20,0x3C,0x2F,0x68,0x65,0x61,0x64,0x3E,0x20,0x3C,
  0x62,0x6F,0x64,0x79,0x20,0x73,0x74,0x79,0x6C,0x65,0x3D,0x22,0x62,0x61,0x63,
  0x6B,0x67,0x72,0x6F,0x75,0x6E,0x64,0x2D,0x63,0x6F,0x6C,0x6F,0x72,0x3A,0x72,
  0x67,0x62,0x28,0x32,0x30,0x30,0x2C,0x32,0x30,0x30,0x2C,0x32,0x30,0x30,0x29,
  0x3B,0x22,0x3E,0x20,0x3C,0x68,0x31,0x20,0x61,0x6C,0x69,0x67,0x6E,0x3D,0x22,
  0x63,0x65,0x6E,0x74,0x65,0x72,0x22,0x3E,0x45,0x73,0x74,0x61,0x63,0x69,0x6F,
  0x6E,0x20,0x6D,0x65,0x74,0x65,0x6F,0x72,0x6F,0x6C,0x6F,0x67,0x69,0x63,0x61,
  0x3C,0x2F,0x68,0x31,0x3E,0x20,0x3C,0x62,0x72,0x20,0x2F,0x3E,0x01,0x20,0x3C,
  0x74,0x61,0x62,0x6C,0x65,0x20,0x61,0x6C,0x69,0x67,0x6E,0x3D,0x22,0x63,0x65,
  0x6E,0x74,0x65,0x72,0x22,0x20,0x62,0x6F,0x72,0x64,0x65,0x72,0x3D,0x22,0x31,
  0x22,0x3E,0x20,0x3C,0x63,0x61,0x70,0x74,0x69,0x6F,0x6E,0x3E,0x44,0x61,0x74,
  0x6F,0x73,0x20,0x6D,0x65,0x64,0x69,0x6F,0x73,0x20,0x61,0x63,0x74,0x75,0x61,
  0x6C,0x65,0x73,0x3A,0x3C,0x2F,0x63,0x61,0x70,0x74,0x69,0x6F,0x6E,0x3E,0x20,
  0x3C,0x74,0x72,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x54,0x65,0x6D,0x70,0x65,0x72,
  0x61,0x74,0x75,0x72,0x61,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,
  0x3E,0x02,0x74,0x20,0x22,0x20,0x25,0x66,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,
  0x20,0x3C,0x74,0x64,0x3E,0x56,0x65,0x6C,0x6F,0x63,0x69,0x64,0x61,0x64,0x20,
  0x64,0x65,0x6C,0x20,0x76,0x69,0x65,0x6E,0x74,0x6F,0x3A,0x3C,0x2F,0x74,0x64,
  0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x76,0x20,0x22,0x20,0x25,0x66,0x01,0x20,
  0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x2F,0x74,0x72,0x3E,0x20,0x3C,0x74,0x72,
  0x3E,0x20,0x3C,0x74,0x64,0x3E,0x48,0x75,0x6D,0x65,0x64,0x61,0x64,0x3A,0x3C,
```

```
0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x68,0x20,0x22,0x20,0x25,
0x66,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x49,0x6E,
0x64,0x69,0x63,0x65,0x20,0x55,0x56,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,
0x74,0x64,0x3E,0x02,0x69,0x20,0x22,0x20,0x25,0x66,0x01,0x20,0x3C,0x2F,0x74,
0x64,0x3E,0x20,0x3C,0x2F,0x74,0x72,0x3E,0x20,0x3C,0x74,0x72,0x3E,0x20,0x3C,
0x74,0x64,0x3E,0x50,0x72,0x65,0x73,0x69,0x6F,0x6E,0x3A,0x3C,0x2F,0x74,0x64,
0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x70,0x20,0x22,0x20,0x25,0x66,0x01,0x20,
0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x42,0x72,0x69,0x6C,0x6C,
0x6F,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x62,0x20,
0x22,0x20,0x25,0x66,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x2F,0x74,
0x72,0x3E,0x20,0x3C,0x2F,0x74,0x61,0x62,0x6C,0x65,0x3E,0x20,0x3C,0x74,0x61,
0x62,0x6C,0x65,0x20,0x61,0x6C,0x69,0x67,0x6E,0x3D,0x22,0x63,0x65,0x6E,0x74,
0x65,0x72,0x22,0x20,0x62,0x6F,0x72,0x64,0x65,0x72,0x3D,0x22,0x31,0x22,0x3E,
0x20,0x3C,0x74,0x72,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x41,0x6C,0x74,0x69,0x74,
0x75,0x64,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x61,
0x20,0x22,0x20,0x25,0x66,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,
0x64,0x3E,0x4C,0x6F,0x6E,0x67,0x69,0x74,0x75,0x64,0x3A,0x3C,0x2F,0x74,0x64,
0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x78,0x20,0x22,0x20,0x25,0x66,0x01,0x20,
0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x4C,0x61,0x74,0x69,0x74,
0x75,0x64,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x79,
0x20,0x22,0x20,0x25,0x66,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x2F,
0x74,0x72,0x3E,0x20,0x3C,0x2F,0x74,0x61,0x62,0x6C,0x65,0x3E,0x20,0x3C,0x62,
0x72,0x3E,0x3C,0x2F,0x62,0x72,0x3E,0x20,0x3C,0x74,0x61,0x62,0x6C,0x65,0x20,
0x61,0x6C,0x69,0x67,0x6E,0x3D,0x22,0x63,0x65,0x6E,0x74,0x65,0x72,0x22,0x20,
0x62,0x6F,0x72,0x64,0x65,0x72,0x3D,0x22,0x31,0x22,0x3E,0x20,0x3C,0x63,0x61,
0x70,0x74,0x69,0x6F,0x6E,0x3E,0x48,0x6F,0x72,0x61,0x20,0x64,0x65,0x20,0x6C,
0x61,0x20,0x75,0x6C,0x74,0x69,0x6D,0x61,0x20,0x6D,0x75,0x65,0x73,0x74,0x72,
0x61,0x3A,0x3C,0x2F,0x63,0x61,0x70,0x74,0x69,0x6F,0x6E,0x3E,0x01,0x20,0x3C,
0x74,0x72,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x41,0x6E,0x79,0x6F,0x3A,0x3C,0x2F,
0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x41,0x20,0x22,0x20,0x25,0x64,
0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x4D,0x65,0x73,
0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x4D,0x20,0x22,
0x20,0x25,0x64,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,
0x44,0x69,0x61,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,
0x44,0x20,0x22,0x20,0x25,0x64,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,
0x74,0x72,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x48,0x6F,0x72,0x61,0x3A,0x3C,0x2F,
0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x48,0x20,0x22,0x20,0x25,0x64,
0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x4D,0x69,0x6E,
0x75,0x74,0x6F,0x3A,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,
```

```
0x54,0x20,0x22,0x20,0x25,0x64,0x01,0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,
0x74,0x64,0x3E,0x53,0x65,0x67,0x75,0x6E,0x64,0x6F,0x73,0x3A,0x3C,0x2F,0x74,
0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x02,0x53,0x20,0x22,0x20,0x25,0x64,0x01,
0x20,0x3C,0x2F,0x74,0x64,0x3E,0x20,0x3C,0x2F,0x74,0x72,0x3E,0x20,0x3C,0x2F,
0x74,0x61,0x62,0x6C,0x65,0x3E,0x20,0x3C,0x62,0x72,0x3E,0x3C,0x2F,0x62,0x72,
0x3E,0x20,0x3C,0x62,0x72,0x3E,0x3C,0x2F,0x62,0x72,0x3E,0x20,0x3C,0x74,0x61,
0x62,0x6C,0x65,0x20,0x73,0x74,0x69,0x6C,0x65,0x3D,0x22,0x77,0x69,0x64,0x74,
0x68,0x3A,0x20,0x31,0x30,0x30,0x25,0x22,0x20,0x62,0x6F,0x72,0x64,0x65,0x72,
0x3D,0x22,0x31,0x22,0x20,0x61,0x6C,0x69,0x67,0x6E,0x3D,0x22,0x63,0x65,0x6E,
0x74,0x65,0x72,0x22,0x3E,0x20,0x3C,0x74,0x62,0x6F,0x64,0x79,0x3E,0x20,0x3C,
0x74,0x72,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x01,0x20,0x3C,0x68,0x31,0x20,0x73,
0x74,0x79,0x6C,0x65,0x3D,0x22,0x20,0x74,0x65,0x78,0x74,0x2D,0x61,0x6C,0x69,
0x67,0x6E,0x3A,0x20,0x63,0x65,0x6E,0x74,0x65,0x72,0x3B,0x22,0x3E,0x20,0x4D,
0x61,0x67,0x6E,0x69,0x74,0x75,0x64,0x65,0x73,0x20,0x6D,0x6F,0x64,0x69,0x66,
0x69,0x63,0x61,0x62,0x6C,0x65,0x73,0x3A,0x20,0x3C,0x2F,0x68,0x31,0x3E,0x20,
0x3C,0x66,0x6F,0x72,0x6D,0x20,0x6D,0x65,0x74,0x68,0x6F,0x64,0x3D,0x22,0x47,
0x45,0x54,0x22,0x20,0x61,0x63,0x74,0x69,0x6F,0x6E,0x3D,0x22,0x69,0x6E,0x64,
0x65,0x78,0x2E,0x63,0x67,0x69,0x22,0x3E,0x01,0x20,0x3C,0x62,0x72,0x3E,0x20,
0x54,0x65,0x6D,0x70,0x65,0x72,0x61,0x74,0x75,0x72,0x61,0x20,0x6D,0x69,0x6E,
0x2E,0x20,0x3A,0x20,0x3C,0x69,0x6E,0x70,0x75,0x74,0x20,0x73,0x69,0x7A,0x65,
0x3D,0x22,0x31,0x30,0x22,0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,0x22,0x2D,0x31,
0x30,0x22,0x20,0x6E,0x61,0x6D,0x65,0x3D,0x22,0x74,0x6D,0x69,0x6E,0x22,0x20,
0x74,0x79,0x70,0x65,0x3D,0x22,0x74,0x65,0x78,0x74,0x22,0x3E,0x20,0x3C,0x62,
0x72,0x3E,0x20,0x54,0x65,0x6D,0x70,0x65,0x72,0x61,0x74,0x75,0x72,0x61,0x20,
0x6D,0x61,0x78,0x2E,0x20,0x3A,0x01,0x20,0x3C,0x69,0x6E,0x70,0x75,0x74,0x20,
0x73,0x69,0x7A,0x65,0x3D,0x22,0x31,0x30,0x22,0x20,0x76,0x61,0x6C,0x75,0x65,
0x3D,0x22,0x35,0x30,0x22,0x20,0x6E,0x61,0x6D,0x65,0x3D,0x22,0x74,0x6D,0x61,
0x78,0x22,0x20,0x74,0x79,0x70,0x65,0x3D,0x22,0x74,0x65,0x78,0x74,0x22,0x3E,
0x20,0x3C,0x62,0x72,0x3E,0x20,0x50,0x72,0x65,0x73,0x69,0x6F,0x6E,0x20,0x6D,
0x69,0x6E,0x2E,0x20,0x3A,0x01,0x20,0x3C,0x69,0x6E,0x70,0x75,0x74,0x20,0x73,
0x69,0x7A,0x65,0x3D,0x22,0x31,0x30,0x22,0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,
0x22,0x35,0x30,0x30,0x22,0x20,0x6E,0x61,0x6D,0x65,0x3D,0x22,0x70,0x6D,0x69,
0x6E,0x22,0x20,0x74,0x79,0x70,0x65,0x3D,0x22,0x74,0x65,0x78,0x74,0x22,0x3E,
0x20,0x3C,0x62,0x72,0x3E,0x20,0x50,0x72,0x65,0x73,0x69,0x6F,0x6E,0x20,0x6D,
0x61,0x78,0x2E,0x20,0x3A,0x01,0x20,0x3C,0x69,0x6E,0x70,0x75,0x74,0x20,0x73,
0x69,0x7A,0x65,0x3D,0x22,0x31,0x30,0x22,0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,
0x22,0x31,0x35,0x30,0x30,0x22,0x20,0x6E,0x61,0x6D,0x65,0x3D,0x22,0x70,0x6D,
0x61,0x78,0x22,0x20,0x74,0x79,0x70,0x65,0x3D,0x22,0x74,0x65,0x78,0x74,0x22,
0x3E,0x20,0x3C,0x62,0x72,0x3E,0x20,0x53,0x65,0x67,0x75,0x6E,0x64,0x6F,0x73,
```

```
  0x20,0x65,0x6E,0x63,0x65,0x6E,0x64,0x69,0x64,0x6F,0x20,0x3A,0x01,0x20,0x3C,
  0x69,0x6E,0x70,0x75,0x74,0x20,0x73,0x69,0x7A,0x65,0x3D,0x22,0x31,0x30,0x22,
  0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,0x22,0x31,0x30,0x22,0x20,0x6E,0x61,0x6D,
  0x65,0x3D,0x22,0x62,0x73,0x65,0x63,0x22,0x20,0x74,0x79,0x70,0x65,0x3D,0x22,
  0x74,0x65,0x78,0x74,0x22,0x3E,0x01,0x20,0x3C,0x62,0x72,0x3E,0x20,0x3C,0x69,
  0x6E,0x70,0x75,0x74,0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,0x22,0x73,0x69,0x22,
  0x20,0x74,0x79,0x70,0x65,0x3D,0x22,0x72,0x61,0x64,0x69,0x6F,0x22,0x20,0x6E,
  0x61,0x6D,0x65,0x3D,0x22,0x76,0x61,0x72,0x74,0x22,0x3E,0x20,0x54,0x65,0x6D,
  0x70,0x65,0x72,0x61,0x74,0x75,0x72,0x61,0x3C,0x62,0x72,0x3E,0x01,0x20,0x3C,
  0x69,0x6E,0x70,0x75,0x74,0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,0x22,0x73,0x69,
  0x22,0x20,0x74,0x79,0x70,0x65,0x3D,0x22,0x72,0x61,0x64,0x69,0x6F,0x22,0x20,
  0x6E,0x61,0x6D,0x65,0x3D,0x22,0x76,0x61,0x72,0x70,0x22,0x3E,0x20,0x50,0x72,
  0x65,0x73,0x69,0x6F,0x6E,0x3C,0x62,0x72,0x3E,0x20,0x3C,0x62,0x72,0x3E,0x20,
  0x3C,0x69,0x6E,0x70,0x75,0x74,0x20,0x76,0x61,0x6C,0x75,0x65,0x3D,0x22,0x45,
  0x6E,0x76,0x69,0x61,0x72,0x22,0x20,0x74,0x79,0x70,0x65,0x3D,0x22,0x73,0x75,
  0x62,0x6D,0x69,0x74,0x22,0x3E,0x20,0x3C,0x2F,0x66,0x6F,0x72,0x6D,0x3E,0x20,
  0x3C,0x2F,0x74,0x64,0x3E,0x01,0x20,0x3C,0x2F,0x74,0x72,0x3E,0x20,0x3C,0x2F,
  0x74,0x62,0x6F,0x64,0x79,0x3E,0x20,0x3C,0x2F,0x74,0x61,0x62,0x6C,0x65,0x3E,
  0x20,0x3C,0x62,0x72,0x3E,0x3C,0x2F,0x62,0x72,0x3E,0x20,0x3C,0x62,0x72,0x3E,
  0x3C,0x2F,0x62,0x72,0x3E,0x20,0x3C,0x62,0x72,0x3E,0x3C,0x2F,0x62,0x72,0x3E,
  0x20,0x3C,0x62,0x72,0x3E,0x3C,0x2F,0x62,0x72,0x3E,0x20,0x3C,0x74,0x61,0x62,
  0x6C,0x65,0x20,0x61,0x6C,0x69,0x67,0x6E,0x3D,0x22,0x63,0x65,0x6E,0x74,0x65,
  0x72,0x22,0x3E,0x20,0x3C,0x74,0x72,0x3E,0x01,0x20,0x3C,0x74,0x64,0x3E,0x41,
  0x75,0x74,0x6F,0x72,0x3A,0x20,0x41,0x6C,0x62,0x65,0x72,0x74,0x6F,0x20,0x50,
  0x61,0x6C,0x6F,0x6D,0x6F,0x20,0x41,0x6C,0x6F,0x6E,0x73,0x6F,0x2E,0x3C,0x2F,
  0x74,0x64,0x3E,0x20,0x3C,0x74,0x64,0x3E,0x53,0x69,0x73,0x74,0x65,0x6D,0x61,
  0x73,0x20,0x45,0x6C,0x65,0x63,0x74,0x72,0x6F,0x6E,0x69,0x63,0x6F,0x73,0x20,
  0x44,0x69,0x67,0x69,0x74,0x61,0x6C,0x65,0x73,0x20,0x41,0x76,0x61,0x6E,0x7A,
  0x61,0x64,0x6F,0x73,0x2E,0x3C,0x2F,0x74,0x64,0x3E,0x01,0x20,0x3C,0x74,0x64,
  0x3E,0x55,0x6E,0x69,0x76,0x65,0x72,0x73,0x69,0x64,0x61,0x64,0x20,0x64,0x65,
  0x20,0x41,0x6C,0x63,0x61,0x6C,0x61,0x20,0x2D,0x20,0x45,0x73,0x63,0x75,0x65,
  0x6C,0x61,0x20,0x70,0x6F,0x6C,0x69,0x74,0x65,0x63,0x6E,0x69,0x63,0x61,0x20,
  0x73,0x75,0x70,0x65,0x72,0x69,0x6F,0x72,0x2E,0x3C,0x2F,0x74,0x64,0x3E,0x20,
  0x3C,0x2F,0x74,0x72,0x3E,0x20,0x3C,0x2F,0x74,0x61,0x62,0x6C,0x65,0x3E,0x20,
  0x3C,0x2F,0x62,0x6F,0x64,0x79,0x3E,0x20,0x3C,0x2F,0x68,0x74,0x6D,0x6C,0x3E,
  0x00,
};

/*--------------------------------------------------------------------------*/
```

```
const HTTP_FILE FileTab[2] = {
  { 0xECD3FEF0, &Web[0]    },
  { 0x00000000, &Web[2221] }
};

/*-----------------------------------------------------------------------------
 * end of file
 *-----------------------------------------------------------------------------*/




/**-------------------------------------------------------------------------------------------
---------------------------------//
//             @filename             RTC.c
                                                                                    //
//             @version              0.00
       //
//             @author        Alberto Palomo Alonso
                                                                        //
//
       //
//             @brief         Código fuente del configurado y manejador del RTC.
                                                  //
//
       //
//             @category             Opcional.
       //
//
       //
//             @map                  @include
       //
//                                   @variables
                                                                                    //
//                                   @function
       //
//                                   @HANDLER
       //
//                                   @end
       //
```

```
//

	//

//

	//

//-------------------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                        //

//		@include		Estos son los archivos utilizados con el código del
RTC.                                                    //

//

	//

//-------------------------------------------------------------------------------------------
---------------------------------**/

#ifndef RTC

#define RTC

#include "RTC.h"

#endif

#ifndef STRING

#define STRING

#include <string.h>

#endif

#ifndef STDIO

#define STDIO

#include	<stdio.h>

#endif

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include	"Systemsymbols.h"

#endif

/**-----------------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                        //

//		@variables		Variables del fichero.
                                                                        //

//

	//
```

```
//-------------------------------------------------------------------------------------------
------------------------------**/

uint8_t Clock[23];

extern Counters_t     *       COUNTERS;

/**-----------------------------------------------------------------------------------------
--------------------------------//

//

        //


                                                                                        //

//              @function       __configuraRTC__()
                                                                                        //

//

        //

//              @brief  Función que configura el RTC como un contador que interrumpe cada
segundo.                                                //

//

        //

//                      @Tiempo Puntero a variable donde se almacena el tiempo actual.
                                                                //

//

        //

//-------------------------------------------------------------------------------------------
------------------------------**/

void __configuraRTC__( void )

{

        LPC_SC->PCONP           |= RTCMASK;                           // Activo el RTC.

        LPC_RTC->CCR            = CALIBRACION_RTC;                    // Calibro el RTC.

        LPC_RTC->CALIBRATION = CALIBRATION_VALUE;

        LPC_RTC->CCR            = 0x1;

        LPC_RTC->CIIR           |= INT_SEGUNDOS;                      // Interrupción del
RTC cada segundo.

        LPC_RTC->YEAR           =       2020;                         // Configuro el
registro

        LPC_RTC->MONTH          =       1;                                    //  que tiene
en cuenta

        LPC_RTC->DOM            =       1;                                    //  los dias,
meses,

        LPC_RTC->HOUR           =       0;                                    //  minutos y
segundos

        LPC_RTC->MIN            =       0;                                    //  del RTC.

        LPC_RTC->SEC            =       0;                                    //

        NVIC_EnableIRQ( RTC_IRQn);                                    // Habilito la
interrumpción del RTC.
```

```
	NVIC_SetPriority(	RTC_IRQn	,	0	);		// Se le
asigna prioridad alta.

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                                    //

//		@HANDLER	RTC_IRQHandler()
                                                                                    //

//

	//

//		@brief  Manejador de la interrupción RTC.
                                                                        //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

void RTC_IRQHandler( void )

{

	COUNTERS->Segundos		+= 0x1; // Incrementa el contador.

	LPC_RTC->ILR			|= 1;   // Borra el flag de interrupción.

	sprintf((char*)Clock,"%02d/%02d/%04d-%02d:%02d:%02d",LPC_RTC->DOM,LPC_RTC-
>MONTH,LPC_RTC->YEAR,LPC_RTC->HOUR,LPC_RTC->MIN,LPC_RTC->SEC);

//	if (COUNTERS->Segundos == 60)

//	{

//		__sumaMinReloj__();

//		COUNTERS->Segundos = 0;

//	}

}

/**-------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                        //

//		@end		ENDFILE.

	//

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/
```

```
/**-------------------------------------------------------------------------------------
--------------------------------//
//              @filename               Timers.c
        //
//              @version                7.00
        //
//              @author         Alberto Palomo Alonso
                                                                        //
//
        //
//              @brief          Código que configura y programa los manejadores de los
timers.                                         //
//
        //
//              @category               Principal.
                                                                                //
//
        //
//              @map                    @include
        //
//                                      @variables
                                                                                //
//                                      @funcion
        //
//                                      @end
        //
//
        //
//
        //
//-------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                //
//              @include                Estos son los archivos utilizados para los timers.
                                                        //
//
        //
```

```
//-------------------------------------------------------------------------------------------
-------------------------------**/

#ifndef TIMERS

#define TIMERS

#include       "Timers.h"

#endif

/**-----------------------------------------------------------------------------------------
-------------------------------//

//

       //


                                                                                          //

//             @variables            Variables del fichero.
                                                                    //

//

       //

//-------------------------------------------------------------------------------------------
-------------------------------**/

uint8_t                              TIM0_ticks     =       0;

uint8_t                              Timer2_MODO    =       MODO_SALIDA;

uint32_t                                    CAP11_BUFF     =       0;

//     Contador.

uint16_t                                    contadorLUZ    =       0;

//     Externos.

extern uint8_t               __brilloAuto;

extern uint8_t               __brilloFade;

extern uint8_t               YaPuedesMedir;

extern Counters_t     *      COUNTERS;

extern misDatos_t     *      DATOS;

extern actualizador_t *      ACTUALIZADOR;

extern uint8_t        *      AUDIO;

extern uint8_t        *      CAPcont;

extern modificables_t MODIFICABLES;

/**-----------------------------------------------------------------------------------------
-------------------------------//

//

       //


                                                                                          //

//             @function             __configuraSysTick__()
                                                                          //
```

```
//

	//

//		@brief		Configura el systick para desbordar cada 100 ms.
                                                        //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void __configuraSysTick__()

{

	SysTick->LOAD = (SystemCoreClock / FREQ_OVERFLOW_SYSTICK) - 1;	//	SysTick
configurado a desbordar cada 100 ms para TcpNet.

	SysTick->CTRL = MASCARA_CTRL_SYSTICK;
	//	Fcpu como clock y no activo la interrupción del SysTickTimer.

	SysTick_Config( SystemCoreClock / FREQ_OVERFLOW_SYSTICK);

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                //

//		@function		__configuraTimer0__()
                                                                    //

//

	//

//		@brief		Configura el Timer0 para nterrumpir cada Ts0 segundos.
                                                        //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void __configuraTimer0__()

{

	LPC_SC->PCONP |=	0x1 << 22 | 0x1 << 23 | 1 << 16;	//	Todos los
timer.

	LPC_SC->PCONP  |=	TIMER0_BIT;				//	Activo
el módulo del timer 0.

	LPC_TIM0->MCR  =	TIMER0_MCR_MASK;			//	Activo
el ISR y reseteo TC.

	LPC_TIM0->PR   =	0;					//
	Sin prescaler.

	LPC_TIM0->TCR  |=	ACTIVAR_TIMER;				//	Activo
el timer.

	LPC_TIM0->MR0  =	Ftick * Ts0 - 1;			//	Cargo
para que interrumpa cada 0.5s.
```

```
	NVIC_SetPriority(	TIMER0_IRQn	,	1	);		//	Para
que el ADC interrumpa bien.

	NVIC_EnableIRQ(	TIMER0_IRQn	);

}

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                                        //

//		@function		__configuraTimer1__()
                                                                                //

//

	//

//		@GOTO		¡DEFINIDO EN EL ANEMOMETRO! (Anemometro.c)
                                                                //

//

	//

//-------------------------------------------------------------------------------------------
---------------------------------**/

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                                        //

//		@function		__configuraTimer3__()
                                                                                //

//

	//

//		@GOTO		¡DEFINIDO EN EL ONEWIRE! (OneWire.c)
                                                                //

//

	//

//-------------------------------------------------------------------------------------------
---------------------------------**/

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

	//

                                                                                        //

//		@HANDLER		SysTick_Handler()
                                                                                        //
```

```
//

	//

//		@brief		Manejador de la interrupción del SysTick. Cada 100 ms se
realizan acciones.				//

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void SysTick_Handler()

{



	timer_tick();

	if (contadorLUZ	<	FREQ_OVERFLOW_SYSTICK *
(MODIFICABLES.TiempoBrillo))

	{

		contadorLUZ++;

	}

	else

	{

		if (__brilloFade)
	//	Si pasan 60s y el brillo automático está desactivado...

		{

			__brilloAuto = 0;

			__brilloFade = 0;

			modificaPulso( PWM6	,	MODO_CICLO	,	1	,
	none	,	none	,	none	);	//	Apago la pantalla.

		}

	}

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//



//

//		@HANDLER		TIMER0_IRQHandler()
//

//

	//

//		@brief		Manejador de la interrupción del Timer0. Reanima el
muestreo de los sensores.				//

//

	//
```

```
//-------------------------------------------------------------------------------------------
-------------------------------**/

//      Bloque 1:       Apoyo del timer 1:

//                                                      Temperatura + Humedad + Vel.Viento.

static void     _subAnemoTempe()

{

        LPC_TIM0->IR    =       LPC_TIM0->IR;                           //      Borro
interrupción.

        if(     !(TIM0_ticks % (uint8_t)CsCAP)        )                 //      Si toca
muestrear captures...

        {

                LPC_TIM1->CCR  |=      CCR_MASCARA_EN;                  //      Genera
interrupción el CAP1.0, ojo que se mata así en el timer 1.

                LPC_TIM1->CCR  |=      OW_CCR_MASCARA_EN;               //      Genera
interrupción el CAP1.1, ojo que se mata así en el timer 1.

                mideTemperatura();                                      //      Le digo
a la placa que lanze la señal de request.

                medirBMP();                                             //      Leo el
sensor de presión atmosférica.

                if ( !ACTUALIZADOR->AnemometroRev && YaPuedesMedir)      //      Si el
actualizador está a 0 (Es decir, no hay datos capturados).

                {

                        DATOS->VelViento = 0;                           //      No hay viento.

                        ACTUALIZADOR->Anemometro = 1;                   //      Ya está
medido, es 0 m/s.

                }

                ACTUALIZADOR->AnemometroRev = 0;                        //      Digo que ya he
medido.

                ACTUALIZADOR->TempRev =       1;

        }

}

//      Bloque 2:       ADC burst:

//                                              UVA + LDR.

static void     _subBurst()

{

        if(     !(TIM0_ticks % (uint8_t)CsADC)        )                 //      LDR +
UVA van el BURST.

        {

                if(     ACTUALIZADOR->LDRrev && YaPuedesMedir        )  //      Es
bloqueable por el audio.

                {

                        LPC_SC->PCONP                 |=      PCONP_ADC_ON;  //
        Enciendo el ADC.

                        ACTUALIZADOR->LDRrev  =       0;                //      Aviso
que no he medido aún.
```

```
                        LPC_ADC->ADCR                   &=      ~ADC_START;     //      Ojito
que es modo ráfaga, no hay start.
                        LPC_ADC->ADCR                   |=      BRUST_PIN;      //      Ráfaga.
                }
        }
}
//      Actualizo el servo.
void __subServo(        void    )
{
        if (    !MODIFICABLES.Var_medida        )
        {
                if (DATOS->Temperatura >= MODIFICABLES.Max_servo_t)
                {
                        modificaPulso           (       PWM2,   MODO_SERVO      ,       none
        ,       180     ,       MINIMO_SERVO    ,       MAXIMO_SERVO    );
                        if (ACTUALIZADOR->Audiorev)
                        {
                                ACTUALIZADOR->Audiorev = 0;
                                __configuraTono__();
                                activarDac();
                        }
                }
                if (DATOS->Temperatura <= MODIFICABLES.Min_servo_t)
                {
                        modificaPulso           (       PWM2,   MODO_SERVO      ,       none
        ,       0       ,       MINIMO_SERVO    ,       MAXIMO_SERVO    );
                        if (ACTUALIZADOR->Audiorev)
                        {
                                ACTUALIZADOR->Audiorev = 0;
                                __configuraAudio__();
                                activarDac();
                        }
                }
                modificaPulso           (       PWM2,   MODO_SERVO      ,       none    ,
        (180*(DATOS->Temperatura - MIN_TEMP)/(MAX_TEMP - MIN_TEMP))     ,
        MINIMO_SERVO    ,       MAXIMO_SERVO    );
        }
        else
        {
                if (DATOS->Presion >= MODIFICABLES.Max_servo_p)
                {
```

```
                        modificaPulso          (       PWM2,   MODO_SERVO     ,       none
        ,       180     ,       MINIMO_SERVO   ,       MAXIMO_SERVO   );

                        if (ACTUALIZADOR->Audiorev)

                        {

                                ACTUALIZADOR->Audiorev = 0;

                                __configuraTono__();

                                activarDac();

                        }

                }

                if (DATOS->Presion <= MODIFICABLES.Min_servo_p)

                {

                        modificaPulso          (       PWM2,   MODO_SERVO     ,       none
        ,       0       ,       MINIMO_SERVO   ,       MAXIMO_SERVO   );

                        if (ACTUALIZADOR->Audiorev)

                        {

                                ACTUALIZADOR->Audiorev = 0;

                                __configuraAudio__();

                                activarDac();

                        }

                }

                modificaPulso          (       PWM2,   MODO_SERVO     ,       none    ,
        (180*(DATOS->Presion - MIN_PRES)/(MAX_PRES - MIN_PRES))    ,       MINIMO_SERVO
        ,       MAXIMO_SERVO   );

        }

}

//      Ahora sí, el handler: Ojo que aquí es donde actualizo el servo.

void TIMER0_IRQHandler(       void    )

{

        _subAnemoTempe();

        _subBurst();

        TIM0_ticks++;

        __subServo();

}

/**-------------------------------------------------------------------------------------
--------------------------------//

//

        //

                                                                                        //

//              @HANDLER                TIMER1_IRQHandler()
                                                                                        //
```

```
//

	//

//		@ref			Ir a Anemómetro.c (comparte con OneWire.c)
                                                                        //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

void TIMER1_IRQHandler()

{

	uint8_t SWART  =	(uint8_t)(LPC_TIM1->IR);


	if	(SWART  &	CAP10_IR)

	{

		mideAnemometro();

	}

	if	(SWART  &	MR1_IR)

	{

		desactivarDAC();

	}

	LPC_TIM1->IR   =	LPC_TIM1->IR;			//	No pierdo nada en
asegurarme que se cierra el timer.

}

/**-----------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                //

//		@HANDLER		TIMER2_IRQHandler()
                                                                                //

//

	//

//		@brief		N/A
                                                                                //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

void TIMER2_IRQHandler()

{

	//	NO USADO.
```

```
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                        //
//		@HANDLER		TIMER3_IRQHandler()
                                                                                        //
//
	//
//		@brief		Timer de apoyo para el monohilo.
                                                                                //
//
	//
//-------------------------------------------------------------------------------------------
--------------------------------**/
//	USADO POR EL MONOHILO.
void	TIMER3_IRQHandler()
{
	//	NO USADO.
}
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
	//
                                                                                //
//		@end		ENDFILE.
	//
//
	//
//-------------------------------------------------------------------------------------------
--------------------------------**/
```

```
/****************************************Copyright
(c)*************************************************
**
**                                 http://www.powermcu.com
```

```
**
**--------------File Info-----------------------------------------------------------------
------------------
** File name:               diskio.c
** Descriptions:            The FATFS Diskio
**
**-------------------------------------------------------------------------------------
------------------
** Created by:              AVRman
** Created date:            2010-11-4
** Version:                 v1.0
** Descriptions:            The original version
**
**-------------------------------------------------------------------------------------
------------------
** Modified by:
** Modified date:
** Version:
** Descriptions:
**
**************************************************************************************
*****************/


/* Includes ------------------------------------------------------------------*/
#include "diskio.h"
#include "SPI_MSD_Driver.h"

/* Private variables ---------------------------------------------------------*/
extern MSD_CARDINFO CardInfo;



DSTATUS disk_initialize (
        BYTE drv                                /* Physical drive nmuber (0..) */
)
{
 int Status;

 switch (drv)
 {
        case 0 :
```

```
    Status = MSD_Init();
    if(Status == 0)
          return 0;
    else
          return STA_NOINIT;


       case 1 :
              return STA_NOINIT;


       case 2 :
              return STA_NOINIT;
  }
       return STA_NOINIT;
}




/*-----------------------------------------------------------------------*/
/* Return Disk Status                                                    */

DSTATUS disk_status (
       BYTE drv              /* Physical drive nmuber (0..) */
)
{
    switch (drv)
       {
         case 0 :

         /* translate the reslut code here  */

           return 0;

         case 1 :

         /* translate the reslut code here  */

           return 0;

         case 2 :
```

```
          /* translate the reslut code here  */

            return 0;

          default:

         break;
        }
        return STA_NOINIT;
}



/*-----------------------------------------------------------------------*/
/* Read Sector(s)                                                        */

DRESULT disk_read (
        BYTE drv,               /* Physical drive nmuber (0..) */
        BYTE *buff,             /* Data buffer to store read data */
        DWORD sector,  /* Sector address (LBA) */
        BYTE count              /* Number of sectors to read (1..255) */
)
{
  int Status;
  if( !count )
  {
    return RES_PARERR;  /* count²»ÄÜµÈÓÚ0£¬ñÔò·µ»Ø²ÎÊý´íÎó */
  }

  switch (drv)
  {

    case 0:
    if(count==1)            /* 1¸ösectorµÄ¶Á²Ù×÷ */
    {
          Status =  MSD_ReadSingleBlock( sector ,buff );
    }
    else                    /* ¶à¸ösectorµÄ¶Á²Ù×÷ */
```

```
    {
      Status = MSD_ReadMultiBlock( sector , buff ,count);
    }
    if(Status == 0)
    {
      return RES_OK;
    }
    else
    {
      return RES_ERROR;
    }

       case 1:
         break;

    case 2:
         break;

    default:
      break;

  }

  return RES_ERROR;
}




/*-----------------------------------------------------------------------*/
/* Write Sector(s)                                                       */

#if _READONLY == 0
DRESULT disk_write (
       BYTE drv,                    /* Physical drive nmuber (0..) */
       const BYTE *buff,             /* Data to be written */
       DWORD sector,         /* Sector address (LBA) */
       BYTE count                   /* Number of sectors to write (1..255) */
)
{
```

```
  int Status;
  if( !count )
  {
    return RES_PARERR;  /* count²»ÄÜµÈÓÚ0£¬·ñÔò·µ»Ø²ÎÊý´íÎó */
  }

  switch (drv)
  {
    case 0:
    if(count==1)            /* 1¸ösectorµÄ´²Ù×÷ */
    {
       Status = MSD_WriteSingleBlock( sector , (uint8_t *)(&buff[0]) );
    }
    else                    /* ¶à¸ösectorµÄ´²Ù×÷ */
    {
       Status = MSD_WriteMultiBlock( sector , (uint8_t *)(&buff[0]) , count );
    }
    if(Status == 0)
    {
       return RES_OK;
    }
    else
    {
       return RES_ERROR;
    }
    case 2:
          break;
    default :
       break;
  }
 return RES_ERROR;
}
#endif /* _READONLY */



/*-----------------------------------------------------------------------*/
/* Miscellaneous Functions                                               */
```

```
DRESULT disk_ioctl (
       BYTE drv,             /* Physical drive nmuber (0..) */
       BYTE ctrl,            /* Control code */
       void *buff            /* Buffer to send/receive control data */
)
{
    if (drv)
    {
        return RES_PARERR;  /* ½öÖ§³Öµ¥´ÅÅÌ²Ù×÷£¬ñÔò·µ»Ø²ÎÊý´íÎó */
    }

       MSD_GetCardInfo(&CardInfo);

       switch (ctrl)
       {
         case CTRL_SYNC :

              return RES_OK;

         case GET_SECTOR_COUNT :
           *(DWORD*)buff = CardInfo.Capacity/CardInfo.BlockSize;
           return RES_OK;

         case GET_BLOCK_SIZE :
           *(WORD*)buff = CardInfo.BlockSize;
           return RES_OK;

         case CTRL_POWER :
              break;

         case CTRL_LOCK :
              break;

         case CTRL_EJECT :
              break;

      /* MMC/SDC command */
         case MMC_GET_TYPE :
              break;
```

```
          case MMC_GET_CSD :
                break;

          case MMC_GET_CID :
                break;

          case MMC_GET_OCR :
                break;

          case MMC_GET_SDSTAT :
                break;
        }
        return RES_PARERR;
}

/* µÃµ½ÎÄ¼þCalendar¸ñÊ½µÄ¨Á¢ÈÕÆÚ,ÊÇDWORD get_fattime (void) Ä£¼» */

/*-----------------------------------------------------------------------*/
/* User defined function to give a current time to fatfs module          */
/* 31-25: Year(0-127 org.1980), 24-21: Month(1-12), 20-16: Day(1-31) */
/* 15-11: Hour(0-23), 10-5: Minute(0-59), 4-0: Second(0-29 *2) */
DWORD get_fattime (void)
{

    return 0;
}




/*-------------------------------------------------------------------------
------------------
      END FILE
-------------------------------------------------------------------------
-----------------*/




/*-----------------------------------------------------------------------/
/  FatFs - FAT file system module  R0.08a                 (C)ChaN, 2010
/-----------------------------------------------------------------------/
```

```
/ FatFs module is a generic FAT file system module for small embedded systems.
/ This is a free software that opened for education, research and commercial
/ developments under license policy of following terms.
/
/  Copyright (C) 2010, ChaN, all right reserved.
/
/ * The FatFs module is a free software and there is NO WARRANTY.
/ * No restriction on use. You can use, modify and redistribute it for
/   personal, non-profit or commercial products UNDER YOUR RESPONSIBILITY.
/ * Redistributions of source code must retain the above copyright notice.
/
/----------------------------------------------------------------------------/
/ Feb 26,'06 R0.00  Prototype.
/
/ Apr 29,'06 R0.01  First stable version.
/
/ Jun 01,'06 R0.02  Added FAT12 support.
/                   Removed unbuffered mode.
/                   Fixed a problem on small (<32M) partition.
/ Jun 10,'06 R0.02a Added a configuration option (_FS_MINIMUM).
/
/ Sep 22,'06 R0.03  Added f_rename().
/                   Changed option _FS_MINIMUM to _FS_MINIMIZE.
/ Dec 11,'06 R0.03a Improved cluster scan algorithm to write files fast.
/                   Fixed f_mkdir() creates incorrect directory on FAT32.
/
/ Feb 04,'07 R0.04  Supported multiple drive system.
/                   Changed some interfaces for multiple drive system.
/                   Changed f_mountdrv() to f_mount().
/                   Added f_mkfs().
/ Apr 01,'07 R0.04a Supported multiple partitions on a physical drive.
/                   Added a capability of extending file size to f_lseek().
/                   Added minimization level 3.
/                   Fixed an endian sensitive code in f_mkfs().
/ May 05,'07 R0.04b Added a configuration option _USE_NTFLAG.
/                   Added FSInfo support.
/                   Fixed DBCS name can result FR_INVALID_NAME.
/                   Fixed short seek (<= csize) collapses the file object.
/
```

```
/ Aug 25,'07 R0.05  Changed arguments of f_read(), f_write() and f_mkfs().
/                   Fixed f_mkfs() on FAT32 creates incorrect FSInfo.
/                   Fixed f_mkdir() on FAT32 creates incorrect directory.
/ Feb 03,'08 R0.05a Added f_truncate() and f_utime().
/                   Fixed off by one error at FAT sub-type determination.
/                   Fixed btr in f_read() can be mistruncated.
/                   Fixed cached sector is not flushed when create and close without
write.
/
/ Apr 01,'08 R0.06  Added fputc(), fputs(), fprintf() and fgets().
/                   Improved performance of f_lseek() on moving to the same or following
cluster.
/
/ Apr 01,'09 R0.07  Merged Tiny-FatFs as a buffer configuration option. (_FS_TINY)
/                   Added long file name support.
/                   Added multiple code page support.
/                   Added re-entrancy for multitask operation.
/                   Added auto cluster size selection to f_mkfs().
/                   Added rewind option to f_readdir().
/                   Changed result code of critical errors.
/                   Renamed string functions to avoid name collision.
/ Apr 14,'09 R0.07a Separated out OS dependent code on reentrant cfg.
/                   Added multiple sector size support.
/ Jun 21,'09 R0.07c Fixed f_unlink() can return FR_OK on error.
/                   Fixed wrong cache control in f_lseek().
/                   Added relative path feature.
/                   Added f_chdir() and f_chdrive().
/                   Added proper case conversion to extended char.
/ Nov 03,'09 R0.07e Separated out configuration options from ff.h to ffconf.h.
/                   Fixed f_unlink() fails to remove a sub-dir on _FS_RPATH.
/                   Fixed name matching error on the 13 char boundary.
/                   Added a configuration option, _LFN_UNICODE.
/                   Changed f_readdir() to return the SFN with always upper case on non-
LFN cfg.
/
/ May 15,'10 R0.08  Added a memory configuration option. (_USE_LFN = 3)
/                   Added file lock feature. (_FS_SHARE)
/                   Added fast seek feature. (_USE_FASTSEEK)
/                   Changed some types on the API, XCHAR->TCHAR.
/                   Changed fname member in the FILINFO structure on Unicode cfg.
/                   String functions support UTF-8 encoding files on Unicode cfg.
```

```
/ Aug 16,'10 R0.08a Added f_getcwd(). (_FS_RPATH = 2)
/                   Added sector erase feature. (_USE_ERASE)
/                   Moved file lock semaphore table from fs object to the bss.
/                   Fixed a wrong directory entry is created on non-LFN cfg when the
given name contains ';'.
/                   Fixed f_mkfs() creates wrong FAT32 volume.
/---------------------------------------------------------------------------*/


#include "ff.h"                     /* FatFs configurations and declarations */
#include "diskio.h"          /* Declarations of low level disk I/O functions */



/*--------------------------------------------------------------------------

   Module Private Definitions


---------------------------------------------------------------------------*/


#if _FATFS != 8255
#error Wrong include file (ff.h).
#endif



/* Definitions on sector size */
#if _MAX_SS != 512 && _MAX_SS != 1024 && _MAX_SS != 2048 && _MAX_SS != 4096
#error Wrong sector size.
#endif
#if _MAX_SS != 512
#define SS(fs)  ((fs)->ssize)  /* Multiple sector size */
#else
#define SS(fs)  512U                  /* Fixed sector size */
#endif



/* Reentrancy related */
#if _FS_REENTRANT
#if _USE_LFN == 1
#error Static LFN work area must not be used in re-entrant configuration.
#endif
#define ENTER_FF(fs)          { if (!lock_fs(fs)) return FR_TIMEOUT; }
```

```
#define LEAVE_FF(fs, res)     { unlock_fs(fs, res); return res; }

#else

#define ENTER_FF(fs)

#define LEAVE_FF(fs, res)     return res

#endif


#define ABORT(fs, res)        { fp->flag |= FA__ERROR; LEAVE_FF(fs, res); }



/* File shareing feature */

#if _FS_SHARE

#if _FS_READONLY

#error _FS_SHARE must be 0 on read-only cfg.

#endif

typedef struct {

       FATFS *fs;                          /* File ID 1, volume (NULL:blank entry) */

       DWORD clu;                          /* File ID 2, directory */

       WORD idx;                           /* File ID 3, directory index */

       WORD ctr;                           /* File open counter, 0:none,
0x01..0xFF:read open count, 0x100:write mode */

} FILESEM;

#endif



/* Misc definitions */

#define LD_CLUST(dir) (((DWORD)LD_WORD(dir+DIR_FstClusHI)<<16) |
LD_WORD(dir+DIR_FstClusLO))

#define ST_CLUST(dir,cl) {ST_WORD(dir+DIR_FstClusLO, cl); ST_WORD(dir+DIR_FstClusHI,
(DWORD)cl>>16);}



/* Character code support macros */

#define IsUpper(c)    (((c)>='A')&&((c)<='Z'))

#define IsLower(c)    (((c)>='a')&&((c)<='z'))

#define IsDigit(c)    (((c)>='0')&&((c)<='9'))


#if _DF1S             /* Code page is DBCS */


#ifdef _DF2S   /* Two 1st byte areas */

#define IsDBCS1(c)    (((BYTE)(c) >= _DF1S && (BYTE)(c) <= _DF1E) || ((BYTE)(c) >= _DF2S
&& (BYTE)(c) <= _DF2E))
```

```
#else                   /* One 1st byte area */
#define IsDBCS1(c)      ((BYTE)(c) >= _DF1S && (BYTE)(c) <= _DF1E)
#endif


#ifdef _DS3S   /* Three 2nd byte areas */
#define IsDBCS2(c)      (((BYTE)(c) >= _DS1S && (BYTE)(c) <= _DS1E) || ((BYTE)(c) >= _DS2S
&& (BYTE)(c) <= _DS2E) || ((BYTE)(c) >= _DS3S && (BYTE)(c) <= _DS3E))
#else                   /* Two 2nd byte areas */
#define IsDBCS2(c)      (((BYTE)(c) >= _DS1S && (BYTE)(c) <= _DS1E) || ((BYTE)(c) >= _DS2S
&& (BYTE)(c) <= _DS2E))
#endif


#else                   /* Code page is SBCS */


#define IsDBCS1(c)      0
#define IsDBCS2(c)      0


#endif /* _DF1S */



/* Name status flags */
#define NS                      11              /* Offset of name status byte */
#define NS_LOSS                 0x01    /* Out of 8.3 format */
#define NS_LFN          0x02    /* Force to create LFN entry */
#define NS_LAST                 0x04    /* Last segment */
#define NS_BODY                 0x08    /* Lower case flag (body) */
#define NS_EXT          0x10    /* Lower case flag (ext) */
#define NS_DOT          0x20    /* Dot entry */



/* FAT sub-type boundaries */
/* Note that the FAT spec by Microsoft says 4085 but Windows works with 4087! */
#define MIN_FAT16       4086    /* Minimum number of clusters for FAT16 */
#define MIN_FAT32       65526   /* Minimum number of clusters for FAT32 */



/* FatFs refers the members in the FAT structures as byte array instead of
/ structure member because there are incompatibility of the packing option
/ between compilers. */
```

```
#define BS_jmpBoot                  0
#define BS_OEMName                  3
#define BPB_BytsPerSec      11
#define BPB_SecPerClus      13
#define BPB_RsvdSecCnt      14
#define BPB_NumFATs                 16
#define BPB_RootEntCnt      17
#define BPB_TotSec16        19
#define BPB_Media                   21
#define BPB_FATSz16                 22
#define BPB_SecPerTrk       24
#define BPB_NumHeads        26
#define BPB_HiddSec                 28
#define BPB_TotSec32        32
#define BS_DrvNum                   36
#define BS_BootSig                  38
#define BS_VolID                    39
#define BS_VolLab                   43
#define BS_FilSysType       54
#define BPB_FATSz32                 36
#define BPB_ExtFlags        40
#define BPB_FSVer                   42
#define BPB_RootClus        44
#define BPB_FSInfo                  48
#define BPB_BkBootSec       50
#define BS_DrvNum32                 64
#define BS_BootSig32        66
#define BS_VolID32                  67
#define BS_VolLab32                 71
#define BS_FilSysType32             82
#define FSI_LeadSig                 0
#define FSI_StrucSig        484
#define FSI_Free_Count      488
#define FSI_Nxt_Free        492
#define MBR_Table                   446
#define BS_55AA                             510

#define DIR_Name                    0
#define DIR_Attr                    11
```

```
#define DIR_NTres                   12
#define DIR_CrtTime                 14
#define DIR_CrtDate                 16
#define DIR_FstClusHI         20
#define DIR_WrtTime                 22
#define DIR_WrtDate                 24
#define DIR_FstClusLO         26
#define DIR_FileSize          28
#define LDIR_Ord                    0
#define LDIR_Attr                   11
#define LDIR_Type                   12
#define LDIR_Chksum                 13
#define LDIR_FstClusLO        26



/*---------------------------------------------------------------*/
/* Work area                                                     */

#if _VOLUMES
static
FATFS *FatFs[_VOLUMES];       /* Pointer to the file system objects (logical drives) */
#else
#error Number of drives must not be 0.
#endif

static
WORD Fsid;                          /* File system mount ID */

#if _FS_RPATH
static
BYTE CurrVol;                 /* Current drive */
#endif

#if _FS_SHARE
static
FILESEM Files[_FS_SHARE];     /* File lock semaphores */
#endif
```

```
#if _USE_LFN == 0                   /* No LFN */
#define DEF_NAMEBUF                 BYTE sfn[12]
#define INIT_BUF(dobj)        (dobj).fn = sfn
#define FREE_BUF()

#elif _USE_LFN == 1                 /* LFN with static LFN working buffer */
static WCHAR LfnBuf[_MAX_LFN+1];
#define DEF_NAMEBUF                 BYTE sfn[12]
#define INIT_BUF(dobj)        { (dobj).fn = sfn; (dobj).lfn = LfnBuf; }
#define FREE_BUF()

#elif _USE_LFN == 2           /* LFN with dynamic LFN working buffer on the stack */
#define DEF_NAMEBUF                 BYTE sfn[12]; WCHAR lbuf[_MAX_LFN+1]
#define INIT_BUF(dobj)        { (dobj).fn = sfn; (dobj).lfn = lbuf; }
#define FREE_BUF()

#elif _USE_LFN == 3           /* LFN with dynamic LFN working buffer on the heap */
#define DEF_NAMEBUF                 BYTE sfn[12]; WCHAR *lfn
#define INIT_BUF(dobj)        { lfn = ff_memalloc((_MAX_LFN + 1) * 2); \
                                      if (!lfn) LEAVE_FF((dobj).fs,
FR_NOT_ENOUGH_CORE); \
                                      (dobj).lfn = lfn;   (dobj).fn =
sfn; }
#define FREE_BUF()                  ff_memfree(lfn)

#else
#error Wrong LFN configuration.
#endif




/*--------------------------------------------------------------------------

   Module Private Functions

--------------------------------------------------------------------------*/


/*--------------------------------------------------------------------------*/
```

```
/* String functions                                                        */
/*-------------------------------------------------------------------------*/

/* Copy memory to memory */
static
void mem_cpy (void* dst, const void* src, UINT cnt) {
	BYTE *d = (BYTE*)dst;
	const BYTE *s = (const BYTE*)src;

#if _WORD_ACCESS == 1
	while (cnt >= sizeof(int)) {
		*(int*)d = *(int*)s;
		d += sizeof(int); s += sizeof(int);
		cnt -= sizeof(int);
	}
#endif
	while (cnt--)
		*d++ = *s++;
}

/* Fill memory */
static
void mem_set (void* dst, int val, UINT cnt) {
	BYTE *d = (BYTE*)dst;

	while (cnt--)
		*d++ = (BYTE)val;
}

/* Compare memory to memory */
static
int mem_cmp (const void* dst, const void* src, UINT cnt) {
	const BYTE *d = (const BYTE *)dst, *s = (const BYTE *)src;
	int r = 0;

	while (cnt-- && (r = *d++ - *s++) == 0) ;
	return r;
}
```

```
/* Check if chr is contained in the string */
static
int chk_chr (const char* str, int chr) {
	while (*str && *str != chr) str++;
	return *str;
}



/*-----------------------------------------------------------------------*/
/* Request/Release grant to access the volume                            */
/*-----------------------------------------------------------------------*/
#if _FS_REENTRANT

static
int lock_fs (
	FATFS *fs		/* File system object */
)
{
	return ff_req_grant(fs->sobj);
}



static
void unlock_fs (
	FATFS *fs,		/* File system object */
	FRESULT res		/* Result code to be returned */
)
{
	if (res != FR_NOT_ENABLED &&
		res != FR_INVALID_DRIVE &&
		res != FR_INVALID_OBJECT &&
		res != FR_TIMEOUT) {
		ff_rel_grant(fs->sobj);
	}
}
#endif
```

```
/*----------------------------------------------------------------------*/
/* File shareing control functions                                      */
/*----------------------------------------------------------------------*/
#if _FS_SHARE

static
FRESULT chk_lock (    /* Check if the file can be accessed */
       DIR* dj,              /* Directory object pointing the file to be checked */
       int acc               /* Desired access (0:Read, 1:Write, 2:Delete/Rename) */
)
{
       UINT i, be;

       /* Search file semaphore table */
       for (i = be = 0; i < _FS_SHARE; i++) {
              if (Files[i].fs) {    /* Existing entry */
                     if (Files[i].fs == dj->fs &&         /* Check if the file matched
with an open file */
                            Files[i].clu == dj->sclust &&
                            Files[i].idx == dj->index) break;
              } else {                     /* Blank entry */
                     be++;
              }
       }
       if (i == _FS_SHARE)   /* The file is not opened */
              return (be || acc == 2) ? FR_OK : FR_TOO_MANY_OPEN_FILES;  /* Is there a
blank entry for new file? */

       /* The file has been opened. Reject any open against writing file and all write
mode open */
       return (acc || Files[i].ctr == 0x100) ? FR_LOCKED : FR_OK;
}



static
int enq_lock ( /* Check if an entry is available for a new file */
       FATFS* fs      /* File system object */
)
{
       UINT i;
```

```
	for (i = 0; i < _FS_SHARE && Files[i].fs; i++) ;
	return (i == _FS_SHARE) ? 0 : 1;
}


static
UINT inc_lock (	/* Increment file open counter and returns its index (0:int error) */
	DIR* dj,	/* Directory object pointing the file to register or increment */
	int acc		/* Desired access mode (0:Read, !0:Write) */
)
{
	UINT i;


	for (i = 0; i < _FS_SHARE; i++) {	/* Find the file */
		if (Files[i].fs == dj->fs &&
			Files[i].clu == dj->sclust &&
			Files[i].idx == dj->index) break;
	}

	if (i == _FS_SHARE) {			/* Not opened. Register it as new. */
		for (i = 0; i < _FS_SHARE && Files[i].fs; i++) ;
		if (i == _FS_SHARE) return 0; /* No space to register (int err) */
		Files[i].fs = dj->fs;
		Files[i].clu = dj->sclust;
		Files[i].idx = dj->index;
		Files[i].ctr = 0;
	}

	if (acc && Files[i].ctr) return 0;	/* Access violation (int err) */

	Files[i].ctr = acc ? 0x100 : Files[i].ctr + 1;	/* Set semaphore value */

	return i + 1;
}
```

```
static
FRESULT dec_lock (    /* Decrement file open counter */
        UINT i                /* Semaphore index */
)
{
        WORD n;
        FRESULT res;


        if (--i < _FS_SHARE) {
                n = Files[i].ctr;
                if (n == 0x100) n = 0;
                if (n) n--;
                Files[i].ctr = n;
                if (!n) Files[i].fs = 0;
                res = FR_OK;
        } else {
                res = FR_INT_ERR;
        }
        return res;
}


static
void clear_lock (     /* Clear lock entries of the volume */
        FATFS *fs
)
{
        UINT i;


        for (i = 0; i < _FS_SHARE; i++) {
                if (Files[i].fs == fs) Files[i].fs = 0;
        }
}
#endif



/*----------------------------------------------------------------------*/
```

```
/* Change window offset                                                  */
/*-----------------------------------------------------------------------*/


static
FRESULT move_window (
	FATFS *fs,		/* File system object */
	DWORD sector	/* Sector number to make appearance in the fs->win[] */
)					/* Move to zero only writes back dirty window */
{
	DWORD wsect;



	wsect = fs->winsect;
	if (wsect != sector) {/* Changed current window */
#if !_FS_READONLY
		if (fs->wflag) {	/* Write back dirty window if needed */
			if (disk_write(fs->drv, fs->win, wsect, 1) != RES_OK)
				return FR_DISK_ERR;
			fs->wflag = 0;
			if (wsect < (fs->fatbase + fs->fsize)) {	/* In FAT area */
				BYTE nf;
				for (nf = fs->n_fats; nf > 1; nf--) {	/* Reflect the
change to all FAT copies */
					wsect += fs->fsize;
					disk_write(fs->drv, fs->win, wsect, 1);
				}
			}
		}
#endif
		if (sector) {
			if (disk_read(fs->drv, fs->win, sector, 1) != RES_OK)
				return FR_DISK_ERR;
			fs->winsect = sector;
		}
	}


	return FR_OK;
}
```

```
/*-----------------------------------------------------------------------*/
/* Clean-up cached data                                                  */
/*-----------------------------------------------------------------------*/
#if !_FS_READONLY
static
FRESULT sync ( /* FR_OK: successful, FR_DISK_ERR: failed */
	FATFS *fs	/* File system object */
)
{
	FRESULT res;


	res = move_window(fs, 0);
	if (res == FR_OK) {
		/* Update FSInfo sector if needed */
		if (fs->fs_type == FS_FAT32 && fs->fsi_flag) {
			fs->winsect = 0;
			mem_set(fs->win, 0, 512);
			ST_WORD(fs->win+BS_55AA, 0xAA55);
			ST_DWORD(fs->win+FSI_LeadSig, 0x41615252);
			ST_DWORD(fs->win+FSI_StrucSig, 0x61417272);
			ST_DWORD(fs->win+FSI_Free_Count, fs->free_clust);
			ST_DWORD(fs->win+FSI_Nxt_Free, fs->last_clust);
			disk_write(fs->drv, fs->win, fs->fsi_sector, 1);
			fs->fsi_flag = 0;
		}
		/* Make sure that no pending write process in the physical drive */
		if (disk_ioctl(fs->drv, CTRL_SYNC, (void*)0) != RES_OK)
			res = FR_DISK_ERR;
	}

	return res;
}
#endif
```

```
/*-----------------------------------------------------------------------*/
/* Get sector# from cluster#                                             */
/*-----------------------------------------------------------------------*/


DWORD clust2sect (    /* !=0: Sector number, 0: Failed - invalid cluster# */
        FATFS *fs,            /* File system object */
        DWORD clst            /* Cluster# to be converted */
)
{
        clst -= 2;
        if (clst >= (fs->n_fatent - 2)) return 0;          /* Invalid cluster# */
        return clst * fs->csize + fs->database;
}




/*-----------------------------------------------------------------------*/
/* FAT access - Read value of a FAT entry                                */
/*-----------------------------------------------------------------------*/


DWORD get_fat (       /* 0xFFFFFFFF:Disk error, 1:Internal error, Else:Cluster status */
        FATFS *fs,    /* File system object */
        DWORD clst    /* Cluster# to get the link information */
)
{
        UINT wc, bc;
        BYTE *p;


        if (clst < 2 || clst >= fs->n_fatent)       /* Chack range */
                return 1;


        switch (fs->fs_type) {
        case FS_FAT12 :
                bc = (UINT)clst; bc += bc / 2;
```

```
			if (move_window(fs, fs->fatbase + (bc / SS(fs)))) break;
			wc = fs->win[bc % SS(fs)]; bc++;
			if (move_window(fs, fs->fatbase + (bc / SS(fs)))) break;
			wc |= fs->win[bc % SS(fs)] << 8;
			return (clst & 1) ? (wc >> 4) : (wc & 0xFFF);

		case FS_FAT16 :
			if (move_window(fs, fs->fatbase + (clst / (SS(fs) / 2)))) break;
			p = &fs->win[clst * 2 % SS(fs)];
			return LD_WORD(p);

		case FS_FAT32 :
			if (move_window(fs, fs->fatbase + (clst / (SS(fs) / 4)))) break;
			p = &fs->win[clst * 4 % SS(fs)];
			return LD_DWORD(p) & 0x0FFFFFFF;
		}

		return 0xFFFFFFFF;	/* An error occurred at the disk I/O layer */
}




/*-----------------------------------------------------------------------*/
/* FAT access - Change value of a FAT entry                              */
/*-----------------------------------------------------------------------*/
#if !_FS_READONLY

FRESULT put_fat (
		FATFS *fs,	/* File system object */
		DWORD clst,	/* Cluster# to be changed in range of 2 to fs->n_fatent - 1 */
		DWORD val	/* New value to mark the cluster */
)
{
		UINT bc;
		BYTE *p;
		FRESULT res;
```

```
	if (clst < 2 || clst >= fs->n_fatent) {		/* Check range */
		res = FR_INT_ERR;

	} else {
		switch (fs->fs_type) {
		case FS_FAT12 :
			bc = clst; bc += bc / 2;
			res = move_window(fs, fs->fatbase + (bc / SS(fs)));
			if (res != FR_OK) break;
			p = &fs->win[bc % SS(fs)];
			*p = (clst & 1) ? ((*p & 0x0F) | ((BYTE)val << 4)) : (BYTE)val;
			bc++;
			fs->wflag = 1;
			res = move_window(fs, fs->fatbase + (bc / SS(fs)));
			if (res != FR_OK) break;
			p = &fs->win[bc % SS(fs)];
			*p = (clst & 1) ? (BYTE)(val >> 4) : ((*p & 0xF0) | ((BYTE)(val >>
8) & 0x0F));
			break;

		case FS_FAT16 :
			res = move_window(fs, fs->fatbase + (clst / (SS(fs) / 2)));
			if (res != FR_OK) break;
			p = &fs->win[clst * 2 % SS(fs)];
			ST_WORD(p, (WORD)val);
			break;

		case FS_FAT32 :
			res = move_window(fs, fs->fatbase + (clst / (SS(fs) / 4)));
			if (res != FR_OK) break;
			p = &fs->win[clst * 4 % SS(fs)];
			val |= LD_DWORD(p) & 0xF0000000;
			ST_DWORD(p, val);
			break;

		default :
			res = FR_INT_ERR;
		}
		fs->wflag = 1;
	}
```

```
	return res;
}
#endif /* !_FS_READONLY */




/*-----------------------------------------------------------------------*/
/* FAT handling - Remove a cluster chain                                 */
/*-----------------------------------------------------------------------*/
#if !_FS_READONLY
static
FRESULT remove_chain (
	FATFS *fs,			/* File system object */
	DWORD clst			/* Cluster# to remove a chain from */
)
{
	FRESULT res;
	DWORD nxt;
#if _USE_ERASE
	DWORD scl = clst, ecl = clst, resion[2];
#endif

	if (clst < 2 || clst >= fs->n_fatent) {	/* Check range */
		res = FR_INT_ERR;

	} else {
		res = FR_OK;
		while (clst < fs->n_fatent) {		/* Not a last link? */
			nxt = get_fat(fs, clst);			/* Get cluster status */
			if (nxt == 0) break;				/* Empty cluster? */
			if (nxt == 1) { res = FR_INT_ERR; break; }	/* Internal error? */
			if (nxt == 0xFFFFFFFF) { res = FR_DISK_ERR; break; }	/* Disk error? */
			res = put_fat(fs, clst, 0);			/* Mark the cluster "empty" */
			if (res != FR_OK) break;
			if (fs->free_clust != 0xFFFFFFFF) {	/* Update FSInfo */
				fs->free_clust++;
```

```
                                fs->fsi_flag = 1;
                        }
#if _USE_ERASE
                        if (ecl + 1 == nxt) { /* Next cluster is contiguous */
                                ecl = nxt;
                        } else {                                /* End of contiguous clusters
*/
                                resion[0] = clust2sect(fs, scl);
        /* Start sector */
                                resion[1] = clust2sect(fs, ecl) + fs->csize - 1;    /* End
sector */
                                disk_ioctl(fs->drv, CTRL_ERASE_SECTOR, resion);
        /* Erase the block */
                                scl = ecl = nxt;
                        }
#endif
                        clst = nxt;    /* Next cluster */
                }
        }


        return res;
}
#endif




/*-----------------------------------------------------------------------*/
/* FAT handling - Stretch or Create a cluster chain                      */
/*-----------------------------------------------------------------------*/
#if !_FS_READONLY
static
DWORD create_chain (  /* 0:No free cluster, 1:Internal error, 0xFFFFFFFF:Disk error,
>=2:New cluster# */
        FATFS *fs,                      /* File system object */
        DWORD clst                      /* Cluster# to stretch. 0 means create a new chain.
*/
)
{
        DWORD cs, ncl, scl;
        FRESULT res;
```

```
	if (clst == 0) {		/* Create a new chain */
		scl = fs->last_clust;			/* Get suggested start point */
		if (!scl || scl >= fs->n_fatent) scl = 1;
	}
	else {				/* Stretch the current chain */
		cs = get_fat(fs, clst);			/* Check the cluster status */
		if (cs < 2) return 1;			/* It is an invalid cluster */
		if (cs < fs->n_fatent) return cs;	/* It is already followed by next cluster */
		scl = clst;
	}

	ncl = scl;				/* Start cluster */
	for (;;) {
		ncl++;						/* Next cluster */
		if (ncl >= fs->n_fatent) {		/* Wrap around */
			ncl = 2;
			if (ncl > scl) return 0;	/* No free cluster */
		}
		cs = get_fat(fs, ncl);			/* Get the cluster status */
		if (cs == 0) break;				/* Found a free cluster */
		if (cs == 0xFFFFFFFF || cs == 1)/* An error occurred */
			return cs;
		if (ncl == scl) return 0;		/* No free cluster */
	}

	res = put_fat(fs, ncl, 0x0FFFFFFF);  /* Mark the new cluster "last link" */
	if (res == FR_OK && clst != 0) {
		res = put_fat(fs, clst, ncl); /* Link it to the previous one if needed */
	}
	if (res == FR_OK) {
		fs->last_clust = ncl;			/* Update FSINFO */
		if (fs->free_clust != 0xFFFFFFFF) {
			fs->free_clust--;
			fs->fsi_flag = 1;
		}
	} else {
		ncl = (res == FR_DISK_ERR) ? 0xFFFFFFFF : 1;
```

```
	}


	return ncl;		/* Return new cluster number or error code */
}
#endif /* !_FS_READONLY */




/*-----------------------------------------------------------------------*/
/* Directory handling - Set directory index                              */
/*-----------------------------------------------------------------------*/

static
FRESULT dir_sdi (
	DIR *dj,		/* Pointer to directory object */
	WORD idx		/* Directory index number */
)
{
	DWORD clst;
	WORD ic;



	dj->index = idx;
	clst = dj->sclust;
	if (clst == 1 || clst >= dj->fs->n_fatent)	/* Check start cluster range */
		return FR_INT_ERR;
	if (!clst && dj->fs->fs_type == FS_FAT32)	/* Replace cluster# 0 with root cluster# if in FAT32 */
		clst = dj->fs->dirbase;

	if (clst == 0) {	/* Static table (root-dir in FAT12/16) */
		dj->clust = clst;
		if (idx >= dj->fs->n_rootdir)		/* Index is out of range */
			return FR_INT_ERR;
		dj->sect = dj->fs->dirbase + idx / (SS(dj->fs) / 32);	/* Sector# */
	}
	else {					/* Dynamic table (sub-dirs or root-dir in FAT32) */
		ic = SS(dj->fs) / 32 * dj->fs->csize;	/* Entries per cluster */
		while (idx >= ic) {	/* Follow cluster chain */
```

```
                        clst = get_fat(dj->fs, clst);                       /* Get next
cluster */
                        if (clst == 0xFFFFFFFF) return FR_DISK_ERR; /* Disk error */
                        if (clst < 2 || clst >= dj->fs->n_fatent)   /* Reached to end of
table or int error */
                                return FR_INT_ERR;
                        idx -= ic;
                }
                dj->clust = clst;
                dj->sect = clust2sect(dj->fs, clst) + idx / (SS(dj->fs) / 32);     /*
Sector# */
        }

        dj->dir = dj->fs->win + (idx % (SS(dj->fs) / 32)) * 32;    /* Ptr to the entry in
the sector */

        return FR_OK;  /* Seek succeeded */
}




/*-----------------------------------------------------------------------*/
/* Directory handling - Move directory index next                        */
/*-----------------------------------------------------------------------*/

static
FRESULT dir_next (    /* FR_OK:Succeeded, FR_NO_FILE:End of table, FR_DENIED:EOT and
could not stretch */
        DIR *dj,              /* Pointer to directory object */
        int stretch           /* 0: Do not stretch table, 1: Stretch table if needed */
)
{
        DWORD clst;
        WORD i;


        i = dj->index + 1;
        if (!i || !dj->sect)  /* Report EOT when index has reached 65535 */
                return FR_NO_FILE;

        if (!(i % (SS(dj->fs) / 32))) {      /* Sector changed? */
```

```
		dj->sect++;					/* Next sector */


		if (dj->clust == 0) { /* Static table */
			if (i >= dj->fs->n_rootdir)	/* Report EOT when end of table */
				return FR_NO_FILE;
		}
		else {					/* Dynamic table */
			if (((i / (SS(dj->fs) / 32)) & (dj->fs->csize - 1)) == 0) {
	/* Cluster changed? */
				clst = get_fat(dj->fs, dj->clust);
	/* Get next cluster */
				if (clst <= 1) return FR_INT_ERR;
				if (clst == 0xFFFFFFFF) return FR_DISK_ERR;
				if (clst >= dj->fs->n_fatent) {
	/* When it reached end of dynamic table */
#if !_FS_READONLY
					BYTE c;
					if (!stretch) return FR_NO_FILE;
	/* When do not stretch, report EOT */
					clst = create_chain(dj->fs, dj->clust);
	/* Stretch cluster chain */
					if (clst == 0) return FR_DENIED;
	/* No free cluster */
					if (clst == 1) return FR_INT_ERR;
					if (clst == 0xFFFFFFFF) return FR_DISK_ERR;
					/* Clean-up stretched table */
					if (move_window(dj->fs, 0)) return FR_DISK_ERR;
	/* Flush active window */
					mem_set(dj->fs->win, 0, SS(dj->fs));
	/* Clear window buffer */
					dj->fs->winsect = clust2sect(dj->fs, clst); /*
Cluster start sector */
					for (c = 0; c < dj->fs->csize; c++) {
	/* Fill the new cluster with 0 */
						dj->fs->wflag = 1;
						if (move_window(dj->fs, 0)) return
FR_DISK_ERR;
						dj->fs->winsect++;
					}
					dj->fs->winsect -= c;
	/* Rewind window address */
#else
					return FR_NO_FILE;			/* Report EOT
*/
#endif
```

```
                            }
                            dj->clust = clst;                           /* Initialize
data for new cluster */
                            dj->sect = clust2sect(dj->fs, clst);
                        }
                }
        }


        dj->index = i;
        dj->dir = dj->fs->win + (i % (SS(dj->fs) / 32)) * 32;


        return FR_OK;
}







/*-----------------------------------------------------------------------*/
/* LFN handling - Test/Pick/Fit an LFN segment from/to directory entry   */
/*-----------------------------------------------------------------------*/
#if _USE_LFN
static
const BYTE LfnOfs[] = {1,3,5,7,9,14,16,18,20,22,24,28,30}; /* Offset of LFN chars in the
directory entry */




static
int cmp_lfn (                   /* 1:Matched, 0:Not matched */
        WCHAR *lfnbuf,          /* Pointer to the LFN to be compared */
        BYTE *dir                       /* Pointer to the directory entry containing a part
of LFN */
)
{
        UINT i, s;
        WCHAR wc, uc;



        i = ((dir[LDIR_Ord] & 0xBF) - 1) * 13;      /* Get offset in the LFN buffer */
        s = 0; wc = 1;
        do {
                uc = LD_WORD(dir+LfnOfs[s]);  /* Pick an LFN character from the entry */
```

```
		if (wc) {	/* Last char has not been processed */
			wc = ff_wtoupper(uc);		/* Convert it to upper case */
			if (i >= _MAX_LFN || wc != ff_wtoupper(lfnbuf[i++]))	/* Compare it */
				return 0;				/* Not matched */
		} else {
			if (uc != 0xFFFF) return 0;	/* Check filler */
		}
	} while (++s < 13);				/* Repeat until all chars in the entry are checked */

	if ((dir[LDIR_Ord] & 0x40) && wc && lfnbuf[i])	/* Last segment matched but different length */
		return 0;

	return 1;						/* The part of LFN matched */
}



static
int pick_lfn (		/* 1:Succeeded, 0:Buffer overflow */
	WCHAR *lfnbuf,	/* Pointer to the Unicode-LFN buffer */
	BYTE *dir			/* Pointer to the directory entry */
)
{
	UINT i, s;
	WCHAR wc, uc;


	i = ((dir[LDIR_Ord] & 0x3F) - 1) * 13;	/* Offset in the LFN buffer */

	s = 0; wc = 1;
	do {
		uc = LD_WORD(dir+LfnOfs[s]);		/* Pick an LFN character from the entry */
		if (wc) {	/* Last char has not been processed */
			if (i >= _MAX_LFN) return 0;	/* Buffer overflow? */
			lfnbuf[i++] = wc = uc;		/* Store it */
		} else {
			if (uc != 0xFFFF) return 0;		/* Check filler */
```

```
                }
        } while (++s < 13);                                     /* Read all character
in the entry */

        if (dir[LDIR_Ord] & 0x40) {                             /* Put terminator if it is
the last LFN part */
                if (i >= _MAX_LFN) return 0;            /* Buffer overflow? */
                lfnbuf[i] = 0;
        }

        return 1;
}



#if !_FS_READONLY
static
void fit_lfn (
        const WCHAR *lfnbuf,  /* Pointer to the LFN buffer */
        BYTE *dir,                              /* Pointer to the directory entry */
        BYTE ord,                               /* LFN order (1-20) */
        BYTE sum                                /* SFN sum */
)
{
        UINT i, s;
        WCHAR wc;


        dir[LDIR_Chksum] = sum;                         /* Set check sum */
        dir[LDIR_Attr] = AM_LFN;                /* Set attribute. LFN entry */
        dir[LDIR_Type] = 0;
        ST_WORD(dir+LDIR_FstClusLO, 0);

        i = (ord - 1) * 13;                             /* Get offset in the LFN buffer */
        s = wc = 0;
        do {
                if (wc != 0xFFFF) wc = lfnbuf[i++];  /* Get an effective char */
                ST_WORD(dir+LfnOfs[s], wc);   /* Put it */
                if (!wc) wc = 0xFFFF;           /* Padding chars following last char */
        } while (++s < 13);
        if (wc == 0xFFFF || !lfnbuf[i]) ord |= 0x40;/* Bottom LFN part is the start of
LFN sequence */
```

```
	dir[LDIR_Ord] = ord;				/* Set the LFN order */
}


#endif
#endif




/*-----------------------------------------------------------------------*/
/* Create numbered name                                                  */
/*-----------------------------------------------------------------------*/
#if _USE_LFN
void gen_numname (
	BYTE *dst,			/* Pointer to generated SFN */
	const BYTE *src,	/* Pointer to source SFN to be modified */
	const WCHAR *lfn,	/* Pointer to LFN */
	WORD seq			/* Sequence number */
)
{
	BYTE ns[8], c;
	UINT i, j;



	mem_cpy(dst, src, 11);

	if (seq > 5) { /* On many collisions, generate a hash number instead of sequential number */
		do seq = (seq >> 1) + (seq << 15) + (WORD)*lfn++; while (*lfn);
	}

	/* itoa */
	i = 7;
	do {
		c = (seq % 16) + '0';
		if (c > '9') c += 7;
		ns[i--] = c;
		seq /= 16;
	} while (seq);
	ns[i] = '~';
```

```
	/* Append the number */
	for (j = 0; j < i && dst[j] != ' '; j++) {
		if (IsDBCS1(dst[j])) {
			if (j == i - 1) break;
			j++;
		}
	}
	do {
		dst[j++] = (i < 8) ? ns[i++] : ' ';
	} while (j < 8);
}
#endif




/*-----------------------------------------------------------------------*/
/* Calculate sum of an SFN                                               */
/*-----------------------------------------------------------------------*/
#if _USE_LFN
static
BYTE sum_sfn (
	const BYTE *dir		/* Ptr to directory entry */
)
{
	BYTE sum = 0;
	UINT n = 11;

	do sum = (sum >> 1) + (sum << 7) + *dir++; while (--n);
	return sum;
}
#endif




/*-----------------------------------------------------------------------*/
/* Directory handling - Find an object in the directory                  */
/*-----------------------------------------------------------------------*/
```

```
static
FRESULT dir_find (
	DIR *dj			/* Pointer to the directory object linked to the file name */
)
{
	FRESULT res;
	BYTE c, *dir;
#if _USE_LFN
	BYTE a, ord, sum;
#endif

	res = dir_sdi(dj, 0);			/* Rewind directory object */
	if (res != FR_OK) return res;

#if _USE_LFN
	ord = sum = 0xFF;
#endif
	do {
		res = move_window(dj->fs, dj->sect);
		if (res != FR_OK) break;
		dir = dj->dir;					/* Ptr to the directory entry of current index */
		c = dir[DIR_Name];
		if (c == 0) { res = FR_NO_FILE; break; }	/* Reached to end of table */
#if _USE_LFN	/* LFN configuration */
		a = dir[DIR_Attr] & AM_MASK;
		if (c == 0xE5 || ((a & AM_VOL) && a != AM_LFN)) {	/* An entry without valid data */
			ord = 0xFF;
		} else {
			if (a == AM_LFN) {			/* An LFN entry is found */
				if (dj->lfn) {
					if (c & 0x40) {			/* Is it start of LFN sequence? */
						sum = dir[LDIR_Chksum];
						c &= 0xBF; ord = c;	/* LFN start order */
						dj->lfn_idx = dj->index;
					}
					/* Check validity of the LFN entry and compare it with given name */
```

```
                                    ord = (c == ord && sum == dir[LDIR_Chksum] &&
cmp_lfn(dj->lfn, dir)) ? ord - 1 : 0xFF;
                            }
                        } else {                                    /* An SFN entry is
found */
                            if (!ord && sum == sum_sfn(dir)) break;     /* LFN
matched? */
                            ord = 0xFF; dj->lfn_idx = 0xFFFF;    /* Reset LFN sequence
*/
                            if (!(dj->fn[NS] & NS_LOSS) && !mem_cmp(dir, dj->fn, 11))
break; /* SFN matched? */
                        }
                }
#else           /* Non LFN configuration */
                if (!(dir[DIR_Attr] & AM_VOL) && !mem_cmp(dir, dj->fn, 11)) /* Is it a
valid entry? */
                        break;
#endif
                res = dir_next(dj, 0);        /* Next entry */
        } while (res == FR_OK);


        return res;
}




/*-----------------------------------------------------------------------*/
/* Read an object from the directory                                     */
/*-----------------------------------------------------------------------*/
#if _FS_MINIMIZE <= 1
static
FRESULT dir_read (
        DIR *dj                 /* Pointer to the directory object that pointing the entry
to be read */
)
{
        FRESULT res;
        BYTE c, *dir;
#if _USE_LFN
        BYTE a, ord = 0xFF, sum = 0xFF;
#endif
```

```
	res = FR_NO_FILE;
	while (dj->sect) {
		res = move_window(dj->fs, dj->sect);
		if (res != FR_OK) break;
		dir = dj->dir;					/* Ptr to the directory entry
of current index */
		c = dir[DIR_Name];
		if (c == 0) { res = FR_NO_FILE; break; }	/* Reached to end of table */
#if _USE_LFN	/* LFN configuration */
		a = dir[DIR_Attr] & AM_MASK;
		if (c == 0xE5 || (!_FS_RPATH && c == '.') || ((a & AM_VOL) && a !=
AM_LFN)) {	/* An entry without valid data */
			ord = 0xFF;
		} else {
			if (a == AM_LFN) {			/* An LFN entry is found */
				if (c & 0x40) {				/* Is it start of LFN
sequence? */
					sum = dir[LDIR_Chksum];
					c &= 0xBF; ord = c;
					dj->lfn_idx = dj->index;
				}
				/* Check LFN validity and capture it */
				ord = (c == ord && sum == dir[LDIR_Chksum] && pick_lfn(dj-
>lfn, dir)) ? ord - 1 : 0xFF;
			} else {					/* An SFN entry is
found */
				if (ord || sum != sum_sfn(dir))	/* Is there a valid
LFN? */
					dj->lfn_idx = 0xFFFF;		/* It has no LFN. */
				break;
			}
		}
#else		/* Non LFN configuration */
		if (c != 0xE5 && (_FS_RPATH || c != '.') && !(dir[DIR_Attr] & AM_VOL))
	/* Is it a valid entry? */
			break;
#endif
		res = dir_next(dj, 0);				/* Next entry */
		if (res != FR_OK) break;
	}

	if (res != FR_OK) dj->sect = 0;
```

```
	return res;

}

#endif




/*-----------------------------------------------------------------------*/

/* Register an object to the directory                                   */

/*-----------------------------------------------------------------------*/

#if !_FS_READONLY

static

FRESULT dir_register (/* FR_OK:Successful, FR_DENIED:No free entry or too many SFN
collision, FR_DISK_ERR:Disk error */

	DIR *dj			/* Target directory with object name to be created
*/

)

{

	FRESULT res;

	BYTE c, *dir;

#if _USE_LFN	/* LFN configuration */

	WORD n, ne, is;

	BYTE sn[12], *fn, sum;

	WCHAR *lfn;



	fn = dj->fn; lfn = dj->lfn;

	mem_cpy(sn, fn, 12);


	if (_FS_RPATH && (sn[NS] & NS_DOT))		/* Cannot create dot entry */

		return FR_INVALID_NAME;


	if (sn[NS] & NS_LOSS) {			/* When LFN is out of 8.3 format,
generate a numbered name */

		fn[NS] = 0; dj->lfn = 0;			/* Find only SFN */

		for (n = 1; n < 100; n++) {

			gen_numname(fn, sn, lfn, n);	/* Generate a numbered name */

			res = dir_find(dj);				/* Check if the name
collides with existing SFN */

			if (res != FR_OK) break;

		}

		if (n == 100) return FR_DENIED;		/* Abort if too many
collisions */
```

```
		if (res != FR_NO_FILE) return res;	/* Abort if the result is other than 'not collided' */
		fn[NS] = sn[NS]; dj->lfn = lfn;
	}

	if (sn[NS] & NS_LFN) {			/* When LFN is to be created, reserve an SFN + LFN entries. */
		for (ne = 0; lfn[ne]; ne++) ;
		ne = (ne + 25) / 13;
	} else {						/* Otherwise reserve only an SFN entry. */
		ne = 1;
	}

	/* Reserve contiguous entries */
	res = dir_sdi(dj, 0);
	if (res != FR_OK) return res;
	n = is = 0;
	do {
		res = move_window(dj->fs, dj->sect);
		if (res != FR_OK) break;
		c = *dj->dir;					/* Check the entry status */
		if (c == 0xE5 || c == 0) {	/* Is it a blank entry? */
			if (n == 0) is = dj->index;	/* First index of the contiguous entry */
			if (++n == ne) break;	/* A contiguous entry that required count is found */
		} else {
			n = 0;					/* Not a blank entry. Restart to search */
		}
		res = dir_next(dj, 1);		/* Next entry with table stretch */
	} while (res == FR_OK);

	if (res == FR_OK && ne > 1) {	/* Initialize LFN entry if needed */
		res = dir_sdi(dj, is);
		if (res == FR_OK) {
			sum = sum_sfn(dj->fn);	/* Sum of the SFN tied to the LFN */
			ne--;
			do {					/* Store LFN entries in bottom first */
				res = move_window(dj->fs, dj->sect);
				if (res != FR_OK) break;
```

```
                        fit_lfn(dj->lfn, dj->dir, (BYTE)ne, sum);
                        dj->fs->wflag = 1;
                        res = dir_next(dj, 0);/* Next entry */
                    } while (res == FR_OK && --ne);
                }
        }

#else   /* Non LFN configuration */
        res = dir_sdi(dj, 0);
        if (res == FR_OK) {
                do {    /* Find a blank entry for the SFN */
                        res = move_window(dj->fs, dj->sect);
                        if (res != FR_OK) break;
                        c = *dj->dir;
                        if (c == 0xE5 || c == 0) break;      /* Is it a blank entry? */
                        res = dir_next(dj, 1);               /* Next entry with table
stretch */
                } while (res == FR_OK);
        }
#endif

        if (res == FR_OK) {           /* Initialize the SFN entry */
                res = move_window(dj->fs, dj->sect);
                if (res == FR_OK) {
                        dir = dj->dir;
                        mem_set(dir, 0, 32);          /* Clean the entry */
                        mem_cpy(dir, dj->fn, 11);     /* Put SFN */
#if _USE_LFN
                        dir[DIR_NTres] = *(dj->fn+NS) & (NS_BODY | NS_EXT); /* Put NT flag
*/
#endif
                        dj->fs->wflag = 1;
                }
        }

        return res;
}
#endif /* !_FS_READONLY */
```

```
/*-----------------------------------------------------------------------*/
/* Remove an object from the directory                                   */
/*-----------------------------------------------------------------------*/
#if !_FS_READONLY && !_FS_MINIMIZE
static
FRESULT dir_remove (  /* FR_OK: Successful, FR_DISK_ERR: A disk error */
	DIR *dj			/* Directory object pointing the entry to be removed */
)
{
	FRESULT res;
#if _USE_LFN   /* LFN configuration */
	WORD i;

	i = dj->index; /* SFN index */
	res = dir_sdi(dj, (WORD)((dj->lfn_idx == 0xFFFF) ? i : dj->lfn_idx));	/* Goto the SFN or top of the LFN entries */
	if (res == FR_OK) {
		do {
			res = move_window(dj->fs, dj->sect);
			if (res != FR_OK) break;
			*dj->dir = 0xE5;			/* Mark the entry "deleted" */
			dj->fs->wflag = 1;
			if (dj->index >= i) break;	/* When reached SFN, all entries of the object has been deleted. */
			res = dir_next(dj, 0);		/* Next entry */
		} while (res == FR_OK);
		if (res == FR_NO_FILE) res = FR_INT_ERR;
	}

#else			/* Non LFN configuration */
	res = dir_sdi(dj, dj->index);
	if (res == FR_OK) {
		res = move_window(dj->fs, dj->sect);
		if (res == FR_OK) {
			*dj->dir = 0xE5;			/* Mark the entry "deleted" */
			dj->fs->wflag = 1;
		}
```

```
	}
#endif

	return res;
}
#endif /* !_FS_READONLY */




/*-----------------------------------------------------------------------*/
/* Pick a segment and create the object name in directory form           */
/*-----------------------------------------------------------------------*/

static
FRESULT create_name (
	DIR *dj,			/* Pointer to the directory object */
	const TCHAR **path	/* Pointer to pointer to the segment in the path string */
)
{
#ifdef _EXCVT
	static const BYTE excvt[] = _EXCVT;  /* Upper conversion table for extended chars */
#endif

#if _USE_LFN   /* LFN configuration */
	BYTE b, cf;
	WCHAR w, *lfn;
	UINT i, ni, si, di;
	const TCHAR *p;

	/* Create LFN in Unicode */
	si = di = 0;
	p = *path;
	lfn = dj->lfn;
	for (;;) {
		w = p[si++];					/* Get a character */
		if (w < ' ' || w == '/' || w == '\\') break;	/* Break on end of segment */
		if (di >= _MAX_LFN)				/* Reject too long name */
			return FR_INVALID_NAME;
```

```
#if !_LFN_UNICODE
		w &= 0xFF;
		if (IsDBCS1(w)) {				/* Check if it is a DBC 1st byte (always false on SBCS cfg) */
			b = (BYTE)p[si++];			/* Get 2nd byte */
			if (!IsDBCS2(b))
				return FR_INVALID_NAME;		/* Reject invalid sequence */
			w = (w << 8) + b;			/* Create a DBC */
		}
		w = ff_convert(w, 1);			/* Convert ANSI/OEM to Unicode */
		if (!w) return FR_INVALID_NAME;		/* Reject invalid code */
#endif
		if (w < 0x80 && chk_chr("\"*:<>\?|\x7F", w)) /* Reject illegal chars for LFN */
			return FR_INVALID_NAME;
		lfn[di++] = w;					/* Store the Unicode char */
	}
	*path = &p[si];						/* Return pointer to the next segment */
	cf = (w < ' ') ? NS_LAST : 0;		/* Set last segment flag if end of path */
#if _FS_RPATH
	if ((di == 1 && lfn[di-1] == '.') || /* Is this a dot entry? */
		(di == 2 && lfn[di-1] == '.' && lfn[di-2] == '.')) {
		lfn[di] = 0;
		for (i = 0; i < 11; i++)
			dj->fn[i] = (i < di) ? '.' : ' ';
		dj->fn[i] = cf | NS_DOT;		/* This is a dot entry */
		return FR_OK;
	}
#endif
	while (di) {						/* Strip trailing spaces and dots */
		w = lfn[di-1];
		if (w != ' ' && w != '.') break;
		di--;
	}
	if (!di) return FR_INVALID_NAME;	/* Reject nul string */

	lfn[di] = 0;						/* LFN is created */

	/* Create SFN in directory form */
```

```
	mem_set(dj->fn, ' ', 11);
	for (si = 0; lfn[si] == ' ' || lfn[si] == '.'; si++) ;	/* Strip leading spaces and dots */
	if (si) cf |= NS_LOSS | NS_LFN;
	while (di && lfn[di - 1] != '.') di--;	/* Find extension (di<=si: no extension) */

	b = i = 0; ni = 8;
	for (;;) {
		w = lfn[si++];					/* Get an LFN char */
		if (!w) break;					/* Break on end of the LFN */
		if (w == ' ' || (w == '.' && si != di)) {	/* Remove spaces and dots */
			cf |= NS_LOSS | NS_LFN; continue;
		}

		if (i >= ni || si == di) {		/* Extension or end of SFN */
			if (ni == 11) {				/* Long extension */
				cf |= NS_LOSS | NS_LFN; break;
			}
			if (si != di) cf |= NS_LOSS | NS_LFN;	/* Out of 8.3 format */
			if (si > di) break;			/* No extension */
			si = di; i = 8; ni = 11;	/* Enter extension section */
			b <<= 2; continue;
		}

		if (w >= 0x80) {				/* Non ASCII char */
#ifdef _EXCVT
			w = ff_convert(w, 0);		/* Unicode -> OEM code */
			if (w) w = excvt[w - 0x80];	/* Convert extended char to upper (SBCS) */
#else
			w = ff_convert(ff_wtoupper(w), 0);	/* Upper converted Unicode -> OEM code */
#endif
			cf |= NS_LFN;				/* Force create LFN entry */
		}

		if (_DF1S && w >= 0x100) {		/* Double byte char (always false on SBCS cfg) */
			if (i >= ni - 1) {
				cf |= NS_LOSS | NS_LFN; i = ni; continue;
```

```
                        }
                        dj->fn[i++] = (BYTE)(w >> 8);
                } else {                                        /* Single byte char */
                        if (!w || chk_chr("+,;=[]", w)) {    /* Replace illegal chars for
SFN */
                                w = '_'; cf |= NS_LOSS | NS_LFN;/* Lossy conversion */
                        } else {
                                if (IsUpper(w)) {             /* ASCII large capital */
                                        b |= 2;
                                } else {
                                        if (IsLower(w)) {     /* ASCII small capital */
                                                b |= 1; w -= 0x20;
                                        }
                                }
                        }
                }
                dj->fn[i++] = (BYTE)w;
        }

        if (dj->fn[0] == 0xE5) dj->fn[0] = 0x05;     /* If the first char collides with
deleted mark, replace it with 0x05 */

        if (ni == 8) b <<= 2;
        if ((b & 0x0C) == 0x0C || (b & 0x03) == 0x03)       /* Create LFN entry when
there are composite capitals */
                cf |= NS_LFN;
        if (!(cf & NS_LFN)) {                                       /* When LFN is in 8.3
format without extended char, NT flags are created */
                if ((b & 0x03) == 0x01) cf |= NS_EXT;       /* NT flag (Extension has
only small capital) */
                if ((b & 0x0C) == 0x04) cf |= NS_BODY;      /* NT flag (Filename has only
small capital) */
        }

        dj->fn[NS] = cf;      /* SFN is created */

        return FR_OK;


#else  /* Non-LFN configuration */
        BYTE b, c, d, *sfn;
        UINT ni, si, i;
```

```
	const char *p;


	/* Create file name in directory form */

	sfn = dj->fn;

	mem_set(sfn, ' ', 11);

	si = i = b = 0; ni = 8;

	p = *path;

#if _FS_RPATH

	if (p[si] == '.') { /* Is this a dot entry? */

		for (;;) {

			c = (BYTE)p[si++];

			if (c != '.' || si >= 3) break;

			sfn[i++] = c;

		}

		if (c != '/' && c != '\\' && c > ' ') return FR_INVALID_NAME;

		*path = &p[si];
	/* Return pointer to the next segment */

		sfn[NS] = (c <= ' ') ? NS_LAST | NS_DOT : NS_DOT;   /* Set last segment
flag if end of path */

		return FR_OK;

	}

#endif

	for (;;) {

		c = (BYTE)p[si++];

		if (c <= ' ' || c == '/' || c == '\\') break;       /* Break on end of
segment */

		if (c == '.' || i >= ni) {

			if (ni != 8 || c != '.') return FR_INVALID_NAME;

			i = 8; ni = 11;

			b <<= 2; continue;

		}

		if (c >= 0x80) {                                /* Extended char? */

			b |= 3;                                         /* Eliminate NT flag
*/

#ifdef _EXCVT

			c = excvt[c-0x80];                      /* Upper conversion (SBCS) */

#else

#if !_DF1S     /* ASCII only cfg */

			return FR_INVALID_NAME;

#endif

#endif
```

```
		}
		if (IsDBCS1(c)) {				/* Check if it is a DBC 1st byte (always false on SBCS cfg) */
			d = (BYTE)p[si++];			/* Get 2nd byte */
			if (!IsDBCS2(d) || i >= ni - 1)	/* Reject invalid DBC */
				return FR_INVALID_NAME;
			sfn[i++] = c;
			sfn[i++] = d;
		} else {					/* Single byte code */
			if (chk_chr("\"*+,:;<=>\?[]|\x7F", c))	/* Reject illegal chrs for SFN */
				return FR_INVALID_NAME;
			if (IsUpper(c)) {			/* ASCII large capital? */
				b |= 2;
			} else {
				if (IsLower(c)) {		/* ASCII small capital? */
					b |= 1; c -= 0x20;
				}
			}
			sfn[i++] = c;
		}
	}
	*path = &p[si];						/* Return pointer to the next segment */
	c = (c <= ' ') ? NS_LAST : 0;		/* Set last segment flag if end of path */

	if (!i) return FR_INVALID_NAME;		/* Reject nul string */
	if (sfn[0] == 0xE5) sfn[0] = 0x05;	/* When first char collides with 0xE5, replace it with 0x05 */

	if (ni == 8) b <<= 2;
	if ((b & 0x03) == 0x01) c |= NS_EXT; /* NT flag (Name extension has only small capital) */
	if ((b & 0x0C) == 0x04) c |= NS_BODY;	/* NT flag (Name body has only small capital) */

	sfn[NS] = c;		/* Store NT flag, File name is created */

	return FR_OK;
#endif
}
```

```
/*-----------------------------------------------------------------------*/
/* Get file information from directory entry                             */
/*-----------------------------------------------------------------------*/
#if _FS_MINIMIZE <= 1
static
void get_fileinfo (           /* No return code */
       DIR *dj,                       /* Pointer to the directory object */
       FILINFO *fno           /* Pointer to the file information to be filled */
)
{
       UINT i;
       BYTE nt, *dir;
       TCHAR *p, c;


       p = fno->fname;
       if (dj->sect) {
              dir = dj->dir;
              nt = dir[DIR_NTres];          /* NT flag */
              for (i = 0; i < 8; i++) {     /* Copy name body */
                     c = dir[i];
                     if (c == ' ') break;
                     if (c == 0x05) c = (TCHAR)0xE5;
                     if (_USE_LFN && (nt & NS_BODY) && IsUpper(c)) c += 0x20;
#if _LFN_UNICODE
                     if (IsDBCS1(c) && i < 7 && IsDBCS2(dir[i+1]))
                            c = (c << 8) | dir[++i];
                     c = ff_convert(c, 1);
                     if (!c) c = '?';
#endif
                     *p++ = c;
              }
              if (dir[8] != ' ') {          /* Copy name extension */
                     *p++ = '.';
                     for (i = 8; i < 11; i++) {
                            c = dir[i];
```

```
                                if (c == ' ') break;
                                if (_USE_LFN && (nt & NS_EXT) && IsUpper(c)) c += 0x20;
#if _LFN_UNICODE
                                if (IsDBCS1(c) && i < 10 && IsDBCS2(dir[i+1]))
                                        c = (c << 8) | dir[++i];
                                c = ff_convert(c, 1);
                                if (!c) c = '?';
#endif
                                *p++ = c;
                        }
                }
                fno->fattrib = dir[DIR_Attr];                   /* Attribute */
                fno->fsize = LD_DWORD(dir+DIR_FileSize);     /* Size */
                fno->fdate = LD_WORD(dir+DIR_WrtDate);          /* Date */
                fno->ftime = LD_WORD(dir+DIR_WrtTime);          /* Time */
        }
        *p = 0;         /* Terminate SFN str by a \0 */

#if _USE_LFN
        if (fno->lfname && fno->lfsize) {
                TCHAR *tp = fno->lfname;
                WCHAR w, *lfn;

                i = 0;
                if (dj->sect && dj->lfn_idx != 0xFFFF) {/* Get LFN if available */
                        lfn = dj->lfn;
                        while ((w = *lfn++) != 0) {                 /* Get an LFN char */
#if !_LFN_UNICODE
                                w = ff_convert(w, 0);               /* Unicode -> OEM
conversion */
                                if (!w) { i = 0; break; }           /* Could not convert,
no LFN */
                                if (_DF1S && w >= 0x100)            /* Put 1st byte if it
is a DBC (always false on SBCS cfg) */
                                        tp[i++] = (TCHAR)(w >> 8);
#endif
                                if (i >= fno->lfsize - 1) { i = 0; break; } /* Buffer
overflow, no LFN */
                                tp[i++] = (TCHAR)w;
                        }
                }
```

```
                tp[i] = 0;      /* Terminate the LFN str by a \0 */
        }
#endif
}
#endif /* _FS_MINIMIZE <= 1 */




/*-----------------------------------------------------------------------*/
/* Follow a file path                                                    */
/*-----------------------------------------------------------------------*/


static
FRESULT follow_path ( /* FR_OK(0): successful, !=0: error code */
        DIR *dj,                        /* Directory object to return last directory and
found object */
        const TCHAR *path       /* Full-path string to find a file or directory */
)
{
        FRESULT res;
        BYTE *dir, ns;



#if _FS_RPATH
        if (*path == '/' || *path == '\\') { /* There is a heading separator */
                path++; dj->sclust = 0;                 /* Strip it and start from the root
dir */
        } else {                                                        /* No heading
separator */
                dj->sclust = dj->fs->cdir;      /* Start from the current dir */
        }
#else
        if (*path == '/' || *path == '\\')      /* Strip heading separator if exist */
                path++;
        dj->sclust = 0;                                                 /* Start from the root
dir */
#endif


        if ((UINT)*path < ' ') {                        /* Nul path means the start
directory itself */
                res = dir_sdi(dj, 0);
```

```
		dj->dir = 0;


	} else {					/* Follow path */
		for (;;) {
			res = create_name(dj, &path); /* Get a segment */
			if (res != FR_OK) break;
			res = dir_find(dj);			/* Find it */
			ns = *(dj->fn+NS);
			if (res != FR_OK) {			/* Failed to find the object */
				if (res != FR_NO_FILE) break; /* Abort if any hard error occured */
				/* Object not found */
				if (_FS_RPATH && (ns & NS_DOT)) {	/* If dot entry is not exit */
					dj->sclust = 0; dj->dir = 0;  /* It is the root dir */
					res = FR_OK;
					if (!(ns & NS_LAST)) continue;
				} else {
	/* Could not find the object */
					if (!(ns & NS_LAST)) res = FR_NO_PATH;
				}
				break;
			}
			if (ns & NS_LAST) break;			/* Last segment match. Function completed. */
			dir = dj->dir;						/* There is next segment. Follow the sub directory */
			if (!(dir[DIR_Attr] & AM_DIR)) {	/* Cannot follow because it is a file */
				res = FR_NO_PATH; break;
			}
			dj->sclust = LD_CLUST(dir);
		}
	}


	return res;
}
```

```
/*-----------------------------------------------------------------------*/
/* Load boot record and check if it is an FAT boot record                */
/*-----------------------------------------------------------------------*/

static
BYTE check_fs (       /* 0:The FAT BR, 1:Valid BR but not an FAT, 2:Not a BR, 3:Disk error */
        FATFS *fs,     /* File system object */
        DWORD sect     /* Sector# (lba) to check if it is an FAT boot record or not */
)
{
        if (disk_read(fs->drv, fs->win, sect, 1) != RES_OK) /* Load boot record */
                return 3;
        if (LD_WORD(&fs->win[BS_55AA]) != 0xAA55)           /* Check record signature (always placed at offset 510 even if the sector size is >512) */
                return 2;

        if ((LD_DWORD(&fs->win[BS_FilSysType]) & 0xFFFFFF) == 0x544146)    /* Check "FAT" string */
                return 0;
        if ((LD_DWORD(&fs->win[BS_FilSysType32]) & 0xFFFFFF) == 0x544146)
                return 0;

        return 1;
}




/*-----------------------------------------------------------------------*/
/* Check if the file system object is valid or not                       */
/*-----------------------------------------------------------------------*/

static
FRESULT chk_mounted ( /* FR_OK(0): successful, !=0: any error occurred */
        const TCHAR **path,   /* Pointer to pointer to the path name (drive number) */
        FATFS **rfs,          /* Pointer to pointer to the found file system object */
        BYTE chk_wp                   /* !=0: Check media write protection for write access */
)
{
```

```
	BYTE fmt, b, *tbl;
	UINT vol;
	DSTATUS stat;
	DWORD bsect, fasize, tsect, sysect, nclst, szbfat;
	WORD nrsv;
	const TCHAR *p = *path;
	FATFS *fs;


	/* Get logical drive number from the path name */
	vol = p[0] - '0';					/* Is there a drive number? */
	if (vol <= 9 && p[1] == ':') {			/* Found a drive number, get and strip it */
		p += 2; *path = p;				/* Return pointer to the path name */
	} else {							/* No drive number is given */
#if _FS_RPATH
		vol = CurrVol;					/* Use current drive */
#else
		vol = 0;						/* Use drive 0 */
#endif
	}


	/* Check if the logical drive is valid or not */
	if (vol >= _VOLUMES)				/* Is the drive number valid? */
		return FR_INVALID_DRIVE;
	*rfs = fs = FatFs[vol];				/* Return pointer to the corresponding file system object */
	if (!fs) return FR_NOT_ENABLED;		/* Is the file system object available? */


	ENTER_FF(fs);						/* Lock file system */


	if (fs->fs_type) {					/* If the logical drive has been mounted */
		stat = disk_status(fs->drv);
		if (!(stat & STA_NOINIT)) {		/* and the physical drive is kept initialized (has not been changed), */
#if !_FS_READONLY
			if (chk_wp && (stat & STA_PROTECT))	/* Check write protection if needed */
				return FR_WRITE_PROTECTED;
```

```
#endif
                        return FR_OK;                           /* The file system object is
valid */
                }
        }


        /* The logical drive must be mounted. */
        /* Following code attempts to mount a volume. (analyze BPB and initialize the fs
object) */


        fs->fs_type = 0;                                        /* Clear the file system
object */
        fs->drv = (BYTE)LD2PD(vol);                 /* Bind the logical drive and a
physical drive */
        stat = disk_initialize(fs->drv);     /* Initialize low level disk I/O layer */
        if (stat & STA_NOINIT)                          /* Check if the initialization
succeeded */
                return FR_NOT_READY;                /* Failed to initialize due to no
media or hard error */
#if _MAX_SS != 512                                      /* Get disk sector size
(variable sector size cfg only) */
        if (disk_ioctl(fs->drv, GET_SECTOR_SIZE, &fs->ssize) != RES_OK)
                return FR_DISK_ERR;
#endif
#if !_FS_READONLY
        if (chk_wp && (stat & STA_PROTECT))  /* Check disk write protection if needed */
                return FR_WRITE_PROTECTED;
#endif
        /* Search FAT partition on the drive. Supports only generic partitionings, FDISK
and SFD. */
        fmt = check_fs(fs, bsect = 0);              /* Check sector 0 if it is a VBR */
        if (fmt == 1) {                                             /* Not an FAT-VBR, the
disk may be partitioned */
                /* Check the partition listed in top of the partition table */
                tbl = &fs->win[MBR_Table + LD2PT(vol) * 16];/* Partition table */
                if (tbl[4]) {
        /* Is the partition existing? */
                        bsect = LD_DWORD(&tbl[8]);                                  /*
Partition offset in LBA */
                        fmt = check_fs(fs, bsect);                                  /*
Check the partition */
                }
        }
        if (fmt == 3) return FR_DISK_ERR;
```

```
	if (fmt) return FR_NO_FILESYSTEM;					/* No FAT volume is found */


	/* Following code initializes the file system object */


	if (LD_WORD(fs->win+BPB_BytsPerSec) != SS(fs))		/* (BPB_BytsPerSec must be equal to the physical sector size) */
		return FR_NO_FILESYSTEM;


	fasize = LD_WORD(fs->win+BPB_FATSz16);				/* Number of sectors per FAT */
	if (!fasize) fasize = LD_DWORD(fs->win+BPB_FATSz32);
	fs->fsize = fasize;


	fs->n_fats = b = fs->win[BPB_NumFATs];				/* Number of FAT copies */
	if (b != 1 && b != 2) return FR_NO_FILESYSTEM;		/* (Must be 1 or 2) */
	fasize *= b;
	/* Number of sectors for FAT area */


	fs->csize = b = fs->win[BPB_SecPerClus];			/* Number of sectors per cluster */
	if (!b || (b & (b - 1))) return FR_NO_FILESYSTEM;	/* (Must be power of 2) */


	fs->n_rootdir = LD_WORD(fs->win+BPB_RootEntCnt);	/* Number of root directory entries */
	if (fs->n_rootdir % (SS(fs) / 32)) return FR_NO_FILESYSTEM;	/* (BPB_RootEntCnt must be sector aligned) */


	tsect = LD_WORD(fs->win+BPB_TotSec16);				/* Number of sectors on the volume */
	if (!tsect) tsect = LD_DWORD(fs->win+BPB_TotSec32);


	nrsv = LD_WORD(fs->win+BPB_RsvdSecCnt);				/* Number of reserved sectors */
	if (!nrsv) return FR_NO_FILESYSTEM;					/* (BPB_RsvdSecCnt must not be 0) */


	/* Determine the FAT sub type */
	sysect = nrsv + fasize + fs->n_rootdir / (SS(fs) / 32);	/* RSV+FAT+DIR */
	if (tsect < sysect) return FR_NO_FILESYSTEM;		/* (Invalid volume size) */
	nclst = (tsect - sysect) / fs->csize;				/* Number of clusters */
	if (!nclst) return FR_NO_FILESYSTEM;				/* (Invalid volume size) */
```

```
	fmt = FS_FAT12;

	if (nclst >= MIN_FAT16) fmt = FS_FAT16;

	if (nclst >= MIN_FAT32) fmt = FS_FAT32;


	/* Boundaries and Limits */

	fs->n_fatent = nclst + 2;					/* Number of FAT entries */

	fs->database = bsect + sysect;					/* Data start sector */

	fs->fatbase = bsect + nrsv;				/* FAT start sector */

	if (fmt == FS_FAT32) {

		if (fs->n_rootdir) return FR_NO_FILESYSTEM;	/* (BPB_RootEntCnt must be 0) */

		fs->dirbase = LD_DWORD(fs->win+BPB_RootClus);	/* Root directory start cluster */

		szbfat = fs->n_fatent * 4;				/* (Required FAT size) */

	} else {

		if (!fs->n_rootdir)   return FR_NO_FILESYSTEM;	/* (BPB_RootEntCnt must not be 0) */

		fs->dirbase = fs->fatbase + fasize;			/* Root directory start sector */

		szbfat = (fmt == FS_FAT16) ?				/* (Required FAT size) */

			fs->n_fatent * 2 : fs->n_fatent * 3 / 2 + (fs->n_fatent & 1);

	}

	if (fs->fsize < (szbfat + (SS(fs) - 1)) / SS(fs))   /* (FAT size must not be less than FAT sectors */

		return FR_NO_FILESYSTEM;


#if !_FS_READONLY

	/* Initialize cluster allocation information */

	fs->free_clust = 0xFFFFFFFF;

	fs->last_clust = 0;


	/* Get fsinfo if available */

	if (fmt == FS_FAT32) {

		fs->fsi_flag = 0;

		fs->fsi_sector = bsect + LD_WORD(fs->win+BPB_FSInfo);

		if (disk_read(fs->drv, fs->win, fs->fsi_sector, 1) == RES_OK &&

			LD_WORD(fs->win+BS_55AA) == 0xAA55 &&

			LD_DWORD(fs->win+FSI_LeadSig) == 0x41615252 &&

			LD_DWORD(fs->win+FSI_StrucSig) == 0x61417272) {
```

```
                                fs->last_clust = LD_DWORD(fs->win+FSI_Nxt_Free);
                                fs->free_clust = LD_DWORD(fs->win+FSI_Free_Count);
                        }
                }
        #endif
                fs->fs_type = fmt;              /* FAT sub-type */
                fs->id = ++Fsid;                /* File system mount ID */
                fs->winsect = 0;                /* Invalidate sector cache */
                fs->wflag = 0;
        #if _FS_RPATH
                fs->cdir = 0;                   /* Current directory (root dir) */
        #endif
        #if _FS_SHARE                           /* Clear file lock semaphores */
                clear_lock(fs);
        #endif

                return FR_OK;
        }




        /*-----------------------------------------------------------------------*/
        /* Check if the file/dir object is valid or not                          */
        /*-----------------------------------------------------------------------*/

        static
        FRESULT validate (      /* FR_OK(0): The object is valid, !=0: Invalid */
                FATFS *fs,              /* Pointer to the file system object */
                WORD id                 /* Member id of the target object to be checked */
        )
        {
                if (!fs || !fs->fs_type || fs->id != id)
                        return FR_INVALID_OBJECT;

                ENTER_FF(fs);           /* Lock file system */

                if (disk_status(fs->drv) & STA_NOINIT)
                        return FR_NOT_READY;
```

```
	return FR_OK;
}



/*-----------------------------------------------------------------------

   Public Functions

-----------------------------------------------------------------------*/



/*-----------------------------------------------------------------------*/
/* Mount/Unmount a Logical Drive                                         */
/*-----------------------------------------------------------------------*/

FRESULT f_mount (
	BYTE vol,		/* Logical drive number to be mounted/unmounted */
	FATFS *fs		/* Pointer to new file system object (NULL for unmount)*/
)
{
	FATFS *rfs;



	if (vol >= _VOLUMES)			/* Check if the drive number is valid */
		return FR_INVALID_DRIVE;
	rfs = FatFs[vol];				/* Get current fs object */


	if (rfs) {
#if _FS_SHARE
		clear_lock(rfs);
#endif
#if _FS_REENTRANT					/* Discard sync object of the
current volume */
		if (!ff_del_syncobj(rfs->sobj)) return FR_INT_ERR;
#endif
		rfs->fs_type = 0;			/* Clear old fs object */
```

```
	}


	if (fs) {
		fs->fs_type = 0;				/* Clear new fs object */
#if _FS_REENTRANT					/* Create sync object for the new volume */
		if (!ff_cre_syncobj(vol, &fs->sobj)) return FR_INT_ERR;
#endif
	}
	FatFs[vol] = fs;				/* Register new fs object */


	return FR_OK;
}




/*-----------------------------------------------------------------------*/
/* Open or Create a File                                                 */
/*-----------------------------------------------------------------------*/

FRESULT f_open (
	FIL *fp,			/* Pointer to the blank file object */
	const TCHAR *path,	/* Pointer to the file name */
	BYTE mode			/* Access mode and file open mode flags */
)
{
	FRESULT res;
	DIR dj;
	BYTE *dir;
	DEF_NAMEBUF;



	fp->fs = 0;			/* Clear file object */

#if !_FS_READONLY
	mode &= FA_READ | FA_WRITE | FA_CREATE_ALWAYS | FA_OPEN_ALWAYS | FA_CREATE_NEW;
	res = chk_mounted(&path, &dj.fs, (BYTE)(mode & ~FA_READ));
#else
	mode &= FA_READ;
```

```
	res = chk_mounted(&path, &dj.fs, 0);
#endif
	INIT_BUF(dj);
	if (res == FR_OK)
		res = follow_path(&dj, path); /* Follow the file path */
	dir = dj.dir;

#if !_FS_READONLY	/* R/W configuration */
	if (res == FR_OK) {
		if (!dir)	/* Current dir itself */
			res = FR_INVALID_NAME;
#if _FS_SHARE
		else
			res = chk_lock(&dj, (mode & ~FA_READ) ? 1 : 0);
#endif
	}
	/* Create or Open a file */
	if (mode & (FA_CREATE_ALWAYS | FA_OPEN_ALWAYS | FA_CREATE_NEW)) {
		DWORD dw, cl;

		if (res != FR_OK) {				/* No file, create new */
			if (res == FR_NO_FILE)		/* There is no file to open, create a new entry */
#if _FS_SHARE
				res = enq_lock(dj.fs) ? dir_register(&dj) : FR_TOO_MANY_OPEN_FILES;
#else
				res = dir_register(&dj);
#endif
			mode |= FA_CREATE_ALWAYS;		/* File is created */
			dir = dj.dir;					/* New entry */
		}
		else {							/* Any object is already existing */
			if (mode & FA_CREATE_NEW) {		/* Cannot create new */
				res = FR_EXIST;
			} else {
				if (dir[DIR_Attr] & (AM_RDO | AM_DIR))	/* Cannot overwrite it (R/O or DIR) */
					res = FR_DENIED;
			}
```

```
		}
		if (res == FR_OK && (mode & FA_CREATE_ALWAYS)) {	/* Truncate it if overwrite mode */
			dw = get_fattime();					/* Created time */
			ST_DWORD(dir+DIR_CrtTime, dw);
			dir[DIR_Attr] = 0;					/* Reset attribute */
			ST_DWORD(dir+DIR_FileSize, 0);		/* size = 0 */
			cl = LD_CLUST(dir);					/* Get start cluster */
			ST_CLUST(dir, 0);					/* cluster = 0 */
			dj.fs->wflag = 1;
			if (cl) {							/* Remove the cluster chain if exist */
				dw = dj.fs->winsect;
				res = remove_chain(dj.fs, cl);
				if (res == FR_OK) {
					dj.fs->last_clust = cl - 1;	/* Reuse the cluster hole */
					res = move_window(dj.fs, dw);
				}
			}
		}
	}
	else {	/* Open an existing file */
		if (res == FR_OK) {					/* Follow succeeded */
			if (dir[DIR_Attr] & AM_DIR) {		/* It is a directory */
				res = FR_NO_FILE;
			} else {
				if ((mode & FA_WRITE) && (dir[DIR_Attr] & AM_RDO)) /* R/O violation */
					res = FR_DENIED;
			}
		}
	}
	if (res == FR_OK) {
		if (mode & FA_CREATE_ALWAYS)		/* Set file change flag if created or overwritten */
			mode |= FA__WRITTEN;
		fp->dir_sect = dj.fs->winsect;			/* Pointer to the directory entry */
```

```
		fp->dir_ptr = dir;
#if _FS_SHARE
		fp->lockid = inc_lock(&dj, (mode & ~FA_READ) ? 1 : 0);
		if (!fp->lockid) res = FR_INT_ERR;
#endif
	}

#else				/* R/O configuration */
	if (res == FR_OK) {					/* Follow succeeded */
		if (!dir) {					/* Current dir itself */
			res = FR_INVALID_NAME;
		} else {
			if (dir[DIR_Attr] & AM_DIR)	/* It is a directory */
				res = FR_NO_FILE;
		}
	}
#endif
	FREE_BUF();

	if (res == FR_OK) {
		fp->flag = mode;				/* File access mode */
		fp->org_clust =	LD_CLUST(dir);		/* File start cluster */
		fp->fsize = LD_DWORD(dir+DIR_FileSize);	/* File size */
		fp->fptr = 0;					/* File pointer */
		fp->dsect = 0;
#if _USE_FASTSEEK
		fp->cltbl = 0;					/* No cluster link map table */
#endif
		fp->fs = dj.fs; fp->id = dj.fs->id;	/* Validate file object */
	}

	LEAVE_FF(dj.fs, res);
}



/*-----------------------------------------------------------------------*/
```

```
/* Read File                                                              */
/*-----------------------------------------------------------------------*/


FRESULT f_read (
	FIL *fp,		/* Pointer to the file object */
	void *buff,		/* Pointer to data buffer */
	UINT btr,		/* Number of bytes to read */
	UINT *br		/* Pointer to number of bytes read */
)
{
	FRESULT res;
	DWORD clst, sect, remain;
	UINT rcnt, cc;
	BYTE csect, *rbuff = buff;



	*br = 0;	/* Initialize byte counter */


	res = validate(fp->fs, fp->id);					/* Check
validity of the object */
	if (res != FR_OK) LEAVE_FF(fp->fs, res);
	if (fp->flag & FA__ERROR)					/* Check abort
flag */
		LEAVE_FF(fp->fs, FR_INT_ERR);
	if (!(fp->flag & FA_READ))					/* Check
access mode */
		LEAVE_FF(fp->fs, FR_DENIED);
	remain = fp->fsize - fp->fptr;
	if (btr > remain) btr = (UINT)remain;			/* Truncate btr by
remaining bytes */


	for ( ;  btr;                                                   /*
Repeat until all data transferred */
		rbuff += rcnt, fp->fptr += rcnt, *br += rcnt, btr -= rcnt) {
		if ((fp->fptr % SS(fp->fs)) == 0) {		/* On the sector
boundary? */
			csect = (BYTE)(fp->fptr / SS(fp->fs) & (fp->fs->csize - 1));
	/* Sector offset in the cluster */
			if (!csect) {                                   /* On
the cluster boundary? */
				clst = (fp->fptr == 0) ?		/* On the top
of the file? */
					fp->org_clust : get_fat(fp->fs, fp->curr_clust);
```

```
                            if (clst <= 1) ABORT(fp->fs, FR_INT_ERR);
                            if (clst == 0xFFFFFFFF) ABORT(fp->fs, FR_DISK_ERR);
                            fp->curr_clust = clst;                      /* Update
current cluster */
                        }
                        sect = clust2sect(fp->fs, fp->curr_clust);  /* Get current sector
*/
                        if (!sect) ABORT(fp->fs, FR_INT_ERR);
                        sect += csect;
                        cc = btr / SS(fp->fs);                          /* When
remaining bytes >= sector size, */
                        if (cc) {
       /* Read maximum contiguous sectors directly */
                            if (csect + cc > fp->fs->csize)             /* Clip at
cluster boundary */
                                cc = fp->fs->csize - csect;
                            if (disk_read(fp->fs->drv, rbuff, sect, (BYTE)cc) !=
RES_OK)
                                ABORT(fp->fs, FR_DISK_ERR);
#if !_FS_READONLY && _FS_MINIMIZE <= 2                          /* Replace one of the
read sectors with cached data if it contains a dirty sector */
#if _FS_TINY
                            if (fp->fs->wflag && fp->fs->winsect - sect < cc)
                                mem_cpy(rbuff + ((fp->fs->winsect - sect) * SS(fp-
>fs)), fp->fs->win, SS(fp->fs));
#else
                            if ((fp->flag & FA__DIRTY) && fp->dsect - sect < cc)
                                mem_cpy(rbuff + ((fp->dsect - sect) * SS(fp->fs)),
fp->buf, SS(fp->fs));
#endif
#endif
                            rcnt = SS(fp->fs) * cc;                         /*
Number of bytes transferred */
                            continue;
                        }
#if !_FS_TINY
#if !_FS_READONLY
                        if (fp->flag & FA__DIRTY) {                     /* Write
sector I/O buffer if needed */
                            if (disk_write(fp->fs->drv, fp->buf, fp->dsect, 1) !=
RES_OK)
                                ABORT(fp->fs, FR_DISK_ERR);
                            fp->flag &= ~FA__DIRTY;
                        }
#endif
```

```
                        if (fp->dsect != sect) {                            /* Fill sector
buffer with file data */
                                if (disk_read(fp->fs->drv, fp->buf, sect, 1) != RES_OK)
                                        ABORT(fp->fs, FR_DISK_ERR);
                        }
#endif
                        fp->dsect = sect;
                }
                rcnt = SS(fp->fs) - (fp->fptr % SS(fp->fs));/* Get partial sector data
from sector buffer */
                if (rcnt > btr) rcnt = btr;
#if _FS_TINY
                if (move_window(fp->fs, fp->dsect))                 /* Move sector window
*/
                        ABORT(fp->fs, FR_DISK_ERR);
                mem_cpy(rbuff, &fp->fs->win[fp->fptr % SS(fp->fs)], rcnt); /* Pick
partial sector */
#else
                mem_cpy(rbuff, &fp->buf[fp->fptr % SS(fp->fs)], rcnt);     /* Pick
partial sector */
#endif
        }

        LEAVE_FF(fp->fs, FR_OK);
}




#if !_FS_READONLY
/*-----------------------------------------------------------------------*/
/* Write File                                                            */
/*-----------------------------------------------------------------------*/

FRESULT f_write (
        FIL *fp,                        /* Pointer to the file object */
        const void *buff,       /* Pointer to the data to be written */
        UINT btw,                       /* Number of bytes to write */
        UINT *bw                        /* Pointer to number of bytes written */
)
{
        FRESULT res;
```

```
	DWORD clst, sect;
	UINT wcnt, cc;
	const BYTE *wbuff = buff;
	BYTE csect;



	*bw = 0;	/* Initialize byte counter */


	res = validate(fp->fs, fp->id);					/* Check
validity of the object */
	if (res != FR_OK) LEAVE_FF(fp->fs, res);
	if (fp->flag & FA__ERROR)					/* Check abort
flag */
		LEAVE_FF(fp->fs, FR_INT_ERR);
	if (!(fp->flag & FA_WRITE))					/* Check
access mode */
		LEAVE_FF(fp->fs, FR_DENIED);
	if (fp->fsize + btw < fp->fsize) btw = 0;	/* File size cannot reach 4GB
*/


	for ( ;  btw;							/*
Repeat until all data transferred */
		wbuff += wcnt, fp->fptr += wcnt, *bw += wcnt, btw -= wcnt) {
		if ((fp->fptr % SS(fp->fs)) == 0) {		/* On the sector
boundary? */
			csect = (BYTE)(fp->fptr / SS(fp->fs) & (fp->fs->csize - 1));
	/* Sector offset in the cluster */
			if (!csect) {					/* On
the cluster boundary? */
				if (fp->fptr == 0) {			/* On the top
of the file? */
					clst = fp->org_clust;		/* Follow from
the origin */
					if (clst == 0)				/* When
there is no cluster chain, */
						fp->org_clust = clst = create_chain(fp->fs,
0);	/* Create a new cluster chain */
				} else {
	/* Middle or end of the file */
					clst = create_chain(fp->fs, fp->curr_clust);
	/* Follow or stretch cluster chain */
				}
				if (clst == 0) break;			/* Could not
allocate a new cluster (disk full) */
				if (clst == 1) ABORT(fp->fs, FR_INT_ERR);
				if (clst == 0xFFFFFFFF) ABORT(fp->fs, FR_DISK_ERR);
```

```
                                fp->curr_clust = clst;                      /* Update
current cluster */
                        }
#if _FS_TINY
                        if (fp->fs->winsect == fp->dsect && move_window(fp->fs, 0))
        /* Write back data buffer prior to following direct transfer */
                                ABORT(fp->fs, FR_DISK_ERR);
#else
                        if (fp->flag & FA__DIRTY) {          /* Write back data buffer
prior to following direct transfer */
                                if (disk_write(fp->fs->drv, fp->buf, fp->dsect, 1) !=
RES_OK)
                                        ABORT(fp->fs, FR_DISK_ERR);
                                fp->flag &= ~FA__DIRTY;
                        }
#endif
                        sect = clust2sect(fp->fs, fp->curr_clust);  /* Get current sector
*/
                        if (!sect) ABORT(fp->fs, FR_INT_ERR);
                        sect += csect;
                        cc = btw / SS(fp->fs);                              /* When
remaining bytes >= sector size, */
                        if (cc) {
        /* Write maximum contiguous sectors directly */
                                if (csect + cc > fp->fs->csize)             /* Clip at
cluster boundary */
                                        cc = fp->fs->csize - csect;
                                if (disk_write(fp->fs->drv, wbuff, sect, (BYTE)cc) !=
RES_OK)
                                        ABORT(fp->fs, FR_DISK_ERR);
#if _FS_TINY
                                if (fp->fs->winsect - sect < cc) {   /* Refill sector cache
if it gets dirty by the direct write */
                                        mem_cpy(fp->fs->win, wbuff + ((fp->fs->winsect -
sect) * SS(fp->fs)), SS(fp->fs));
                                        fp->fs->wflag = 0;
                                }
#else
                                if (fp->dsect - sect < cc) {         /* Refill sector cache
if it gets dirty by the direct write */
                                        mem_cpy(fp->buf, wbuff + ((fp->dsect - sect) *
SS(fp->fs)), SS(fp->fs));
                                        fp->flag &= ~FA__DIRTY;
                                }
#endif
```

```
                            wcnt = SS(fp->fs) * cc;                             /*
Number of bytes transferred */
                            continue;
                        }
#if _FS_TINY
                        if (fp->fptr >= fp->fsize) {                /* Avoid silly buffer
filling at growing edge */
                            if (move_window(fp->fs, 0)) ABORT(fp->fs, FR_DISK_ERR);
                            fp->fs->winsect = sect;
                        }
#else
                        if (fp->dsect != sect) {                            /* Fill sector
buffer with file data */
                            if (fp->fptr < fp->fsize &&
                                    disk_read(fp->fs->drv, fp->buf, sect, 1) != RES_OK)
                                        ABORT(fp->fs, FR_DISK_ERR);
                        }
#endif
                        fp->dsect = sect;
                }
                wcnt = SS(fp->fs) - (fp->fptr % SS(fp->fs));/* Put partial sector into
file I/O buffer */
                if (wcnt > btw) wcnt = btw;
#if _FS_TINY
                if (move_window(fp->fs, fp->dsect))                 /* Move sector window
*/
                        ABORT(fp->fs, FR_DISK_ERR);
                mem_cpy(&fp->fs->win[fp->fptr % SS(fp->fs)], wbuff, wcnt); /* Fit partial
sector */
                fp->fs->wflag = 1;
#else
                mem_cpy(&fp->buf[fp->fptr % SS(fp->fs)], wbuff, wcnt);     /* Fit partial
sector */
                fp->flag |= FA__DIRTY;
#endif
        }


        if (fp->fptr > fp->fsize) fp->fsize = fp->fptr;     /* Update file size if needed
*/
        fp->flag |= FA__WRITTEN;                                            /* Set file
change flag */


        LEAVE_FF(fp->fs, FR_OK);
```

```
}




/*-----------------------------------------------------------------------*/
/* Synchronize the File Object                                           */
/*-----------------------------------------------------------------------*/

FRESULT f_sync (
	FIL *fp		/* Pointer to the file object */
)
{
	FRESULT res;
	DWORD tim;
	BYTE *dir;


	res = validate(fp->fs, fp->id);			/* Check validity of the object */
	if (res == FR_OK) {
		if (fp->flag & FA__WRITTEN) { /* Has the file been written? */
#if !_FS_TINY  /* Write-back dirty buffer */
			if (fp->flag & FA__DIRTY) {
				if (disk_write(fp->fs->drv, fp->buf, fp->dsect, 1) !=
RES_OK)
					LEAVE_FF(fp->fs, FR_DISK_ERR);
				fp->flag &= ~FA__DIRTY;
			}
#endif
			/* Update the directory entry */
			res = move_window(fp->fs, fp->dir_sect);
			if (res == FR_OK) {
				dir = fp->dir_ptr;
				dir[DIR_Attr] |= AM_ARC;
	/* Set archive bit */
				ST_DWORD(dir+DIR_FileSize, fp->fsize);		/*
Update file size */
				ST_CLUST(dir, fp->org_clust);			/*
Update start cluster */
				tim = get_fattime();
	/* Update updated time */
				ST_DWORD(dir+DIR_WrtTime, tim);
```

```
                                fp->flag &= ~FA__WRITTEN;
                                fp->fs->wflag = 1;
                                res = sync(fp->fs);
                        }
                }
        }

        LEAVE_FF(fp->fs, res);
}


#endif /* !_FS_READONLY */




/*-----------------------------------------------------------------------*/
/* Close File                                                            */
/*-----------------------------------------------------------------------*/

FRESULT f_close (
        FIL *fp        /* Pointer to the file object to be closed */
)
{
        FRESULT res;

#if _FS_READONLY
        FATFS *fs = fp->fs;
        res = validate(fs, fp->id);
        if (res == FR_OK) fp->fs = 0; /* Discard file object */
        LEAVE_FF(fs, res);

#else
        res = f_sync(fp);             /* Flush cached data */
#if _FS_SHARE
        if (res == FR_OK) {           /* Decrement open counter */
#if _FS_REENTRANT
                res = validate(fp->fs, fp->id);
                if (res == FR_OK) {
                        res = dec_lock(fp->lockid);
```

```
                        unlock_fs(fp->fs, FR_OK);
                }
#else
                res = dec_lock(fp->lockid);
#endif
        }
#endif
        if (res == FR_OK) fp->fs = 0; /* Discard file object */
        return res;
#endif
}




/*-----------------------------------------------------------------------*/
/* Current Drive/Directory Handlings                                     */
/*-----------------------------------------------------------------------*/

#if _FS_RPATH >= 1

FRESULT f_chdrive (
        BYTE drv                /* Drive number */
)
{
        if (drv >= _VOLUMES) return FR_INVALID_DRIVE;

        CurrVol = drv;

        return FR_OK;
}




FRESULT f_chdir (
        const TCHAR *path      /* Pointer to the directory path */
)
{
        FRESULT res;
```

```
	DIR dj;
	DEF_NAMEBUF;



	res = chk_mounted(&path, &dj.fs, 0);
	if (res == FR_OK) {
		INIT_BUF(dj);
		res = follow_path(&dj, path);		/* Follow the path */
		FREE_BUF();
		if (res == FR_OK) {				/* Follow completed */
			if (!dj.dir) {
				dj.fs->cdir = dj.sclust;	/* Start directory itself */
			} else {
				if (dj.dir[DIR_Attr] & AM_DIR)	/* Reached to the
directory */
					dj.fs->cdir = LD_CLUST(dj.dir);
				else
					res = FR_NO_PATH;		/* Reached but a file
*/
			}
		}
		if (res == FR_NO_FILE) res = FR_NO_PATH;
	}

	LEAVE_FF(dj.fs, res);
}



#if _FS_RPATH >= 2
FRESULT f_getcwd (
	TCHAR *path,	/* Pointer to the directory path */
	UINT sz_path	/* Size of path */
)
{
	FRESULT res;
	DIR dj;
	UINT i, n;
	DWORD ccl;
	TCHAR *tp;
	FILINFO fno;
```

```
	DEF_NAMEBUF;



	*path = 0;
	res = chk_mounted((const TCHAR**)&path, &dj.fs, 0); /* Get current volume */
	if (res == FR_OK) {
		INIT_BUF(dj);
		i = sz_path;		/* Bottom of buffer (dir stack base) */
		dj.sclust = dj.fs->cdir;			/* Start to follow upper dir from current dir */
		while ((ccl = dj.sclust) != 0) {	/* Repeat while current dir is a sub-dir */
			res = dir_sdi(&dj, 1);			/* Get parent dir */
			if (res != FR_OK) break;
			res = dir_read(&dj);
			if (res != FR_OK) break;
			dj.sclust = LD_CLUST(dj.dir); /* Goto parent dir */
			res = dir_sdi(&dj, 0);
			if (res != FR_OK) break;
			do {					/* Find the entry links to the child dir */
				res = dir_read(&dj);
				if (res != FR_OK) break;
				if (ccl == LD_CLUST(dj.dir)) break;  /* Found the entry */
				res = dir_next(&dj, 0);
			} while (res == FR_OK);
			if (res == FR_NO_FILE) res = FR_INT_ERR;/* It cannot be 'not found'. */
			if (res != FR_OK) break;
#if _USE_LFN
			fno.lfname = path;
			fno.lfsize = i;
#endif
			get_fileinfo(&dj, &fno);		/* Get the dir name and push it to the buffer */
			tp = fno.fname;
			if (_USE_LFN && *path) tp = path;
			for (n = 0; tp[n]; n++) ;
			if (i < n + 3) {
				res = FR_NOT_ENOUGH_CORE; break;
			}
			while (n) path[--i] = tp[--n];
```

```
                        path[--i] = '/';
                }
                tp = path;
                if (res == FR_OK) {
                        *tp++ = '0' + CurrVol;                /* Put drive number */
                        *tp++ = ':';
                        if (i == sz_path) {                           /* Root-dir */
                                *tp++ = '/';
                        } else {                                              /* Sub-dir */
                                do              /* Add stacked path str */
                                        *tp++ = path[i++];
                                while (i < sz_path);
                        }
                }
                *tp = 0;
                FREE_BUF();
        }

        LEAVE_FF(dj.fs, res);
}
#endif /* _FS_RPATH >= 2 */
#endif /* _FS_RPATH >= 1 */




#if _FS_MINIMIZE <= 2
/*-----------------------------------------------------------------------*/
/* Seek File R/W Pointer                                                 */
/*-----------------------------------------------------------------------*/

FRESULT f_lseek (
        FIL *fp,                /* Pointer to the file object */
        DWORD ofs               /* File pointer from top of file */
)
{
        FRESULT res;


        res = validate(fp->fs, fp->id);             /* Check validity of the object */
```

```
	if (res != FR_OK) LEAVE_FF(fp->fs, res);
	if (fp->flag & FA__ERROR)			/* Check abort flag */
		LEAVE_FF(fp->fs, FR_INT_ERR);

#if _USE_FASTSEEK
	if (fp->cltbl) {	/* Fast seek */
		DWORD cl, pcl, ncl, tcl, dsc, tlen, *tbl = fp->cltbl;
		BYTE csc;

		tlen = *tbl++;
		if (ofs == CREATE_LINKMAP) {	/* Create link map table */
			cl = fp->org_clust;
			if (cl) {
				do {
					if (tlen < 4) {		/* Not enough table items */
						res = FR_NOT_ENOUGH_CORE; break;
					}
					tcl = cl; ncl = 0;
					do {		/* Get a fragment and store the top and length */
						pcl = cl; ncl++;
						cl = get_fat(fp->fs, cl);
						if (cl <= 1) ABORT(fp->fs, FR_INT_ERR);
						if (cl == 0xFFFFFFFF) ABORT(fp->fs, FR_DISK_ERR);
					} while (cl == pcl + 1);
					*tbl++ = ncl; *tbl++ = tcl;
					tlen -= 2;
				} while (cl < fp->fs->n_fatent);
			}
			*tbl = 0;	/* Terminate table */

		} else {						/* Fast seek */
			if (ofs > fp->fsize)		/* Clip offset at the file size */
				ofs = fp->fsize;
			fp->fptr = ofs;				/* Set file pointer */
			if (ofs) {
				dsc = (ofs - 1) / SS(fp->fs);
				cl = dsc / fp->fs->csize;
				for (;;) {
```

```
                                        ncl = *tbl++;
                                        if (!ncl) ABORT(fp->fs, FR_INT_ERR);
                                        if (cl < ncl) break;
                                        cl -= ncl; tbl++;
                                }
                                fp->curr_clust = cl + *tbl;
                                csc = (BYTE)(dsc & (fp->fs->csize - 1));
                                dsc = clust2sect(fp->fs, fp->curr_clust);
                                if (!dsc) ABORT(fp->fs, FR_INT_ERR);
                                dsc += csc;
                                if (fp->fptr % SS(fp->fs) && dsc != fp->dsect) {
#if !_FS_TINY
#if !_FS_READONLY
                                        if (fp->flag & FA__DIRTY) {          /* Flush dirty
buffer if needed */
                                                if (disk_write(fp->fs->drv, fp->buf, fp-
>dsect, 1) != RES_OK)
                                                        ABORT(fp->fs, FR_DISK_ERR);
                                                fp->flag &= ~FA__DIRTY;
                                        }
#endif
                                        if (disk_read(fp->fs->drv, fp->buf, dsc, 1) !=
RES_OK)
                                                ABORT(fp->fs, FR_DISK_ERR);
#endif
                                        fp->dsect = dsc;
                                }
                        }
                }
        } else
#endif

        /* Normal Seek */
        {
                DWORD clst, bcs, nsect, ifptr;

                if (ofs > fp->fsize                                  /* In read-only mode,
clip offset with the file size */
#if !_FS_READONLY
                        && !(fp->flag & FA_WRITE)
#endif
```

```
                        ) ofs = fp->fsize;


                ifptr = fp->fptr;

                fp->fptr = nsect = 0;

                if (ofs) {

                        bcs = (DWORD)fp->fs->csize * SS(fp->fs);     /* Cluster size (byte)
*/

                        if (ifptr > 0 &&

                                (ofs - 1) / bcs >= (ifptr - 1) / bcs) {      /* When seek
to same or following cluster, */

                                fp->fptr = (ifptr - 1) & ~(bcs - 1); /* start from the
current cluster */

                                ofs -= fp->fptr;

                                clst = fp->curr_clust;

                        } else {
        /* When seek to back cluster, */

                                clst = fp->org_clust;                                   /*
start from the first cluster */

#if !_FS_READONLY

                                if (clst == 0) {
        /* If no cluster chain, create a new chain */

                                        clst = create_chain(fp->fs, 0);

                                        if (clst == 1) ABORT(fp->fs, FR_INT_ERR);

                                        if (clst == 0xFFFFFFFF) ABORT(fp->fs, FR_DISK_ERR);

                                        fp->org_clust = clst;

                                }

#endif

                                fp->curr_clust = clst;

                        }

                        if (clst != 0) {

                                while (ofs > bcs) {
        /* Cluster following loop */

#if !_FS_READONLY

                                        if (fp->flag & FA_WRITE) {                      /*
Check if in write mode or not */

                                                clst = create_chain(fp->fs, clst);   /*
Force stretch if in write mode */

                                                if (clst == 0) {
        /* When disk gets full, clip file size */

                                                        ofs = bcs; break;

                                                }

                                        } else

#endif
```

```
                                        clst = get_fat(fp->fs, clst); /* Follow
cluster chain if not in write mode */
                                        if (clst == 0xFFFFFFFF) ABORT(fp->fs, FR_DISK_ERR);
                                        if (clst <= 1 || clst >= fp->fs->n_fatent)
ABORT(fp->fs, FR_INT_ERR);
                                        fp->curr_clust = clst;
                                        fp->fptr += bcs;
                                        ofs -= bcs;
                                }
                                fp->fptr += ofs;
                                if (ofs % SS(fp->fs)) {
                                        nsect = clust2sect(fp->fs, clst);    /* Current
sector */
                                        if (!nsect) ABORT(fp->fs, FR_INT_ERR);
                                        nsect += ofs / SS(fp->fs);
                                }
                        }
                }
                if (fp->fptr % SS(fp->fs) && nsect != fp->dsect) {
#if !_FS_TINY
#if !_FS_READONLY
                        if (fp->flag & FA__DIRTY) {                  /* Flush dirty buffer
if needed */
                                if (disk_write(fp->fs->drv, fp->buf, fp->dsect, 1) !=
RES_OK)
                                        ABORT(fp->fs, FR_DISK_ERR);
                                fp->flag &= ~FA__DIRTY;
                        }
#endif
                        if (disk_read(fp->fs->drv, fp->buf, nsect, 1) != RES_OK)
                                ABORT(fp->fs, FR_DISK_ERR);
#endif
                        fp->dsect = nsect;
                }
#if !_FS_READONLY
                if (fp->fptr > fp->fsize) {                  /* Set change flag if the
file size is extended */
                        fp->fsize = fp->fptr;
                        fp->flag |= FA__WRITTEN;
                }
#endif
        }
```

```
	LEAVE_FF(fp->fs, res);
}



#if _FS_MINIMIZE <= 1
/*-----------------------------------------------------------------------*/
/* Create a Directroy Object                                             */
/*-----------------------------------------------------------------------*/

FRESULT f_opendir (
	DIR *dj,			/* Pointer to directory object to create */
	const TCHAR *path	/* Pointer to the directory path */
)
{
	FRESULT res;
	DEF_NAMEBUF;


	res = chk_mounted(&path, &dj->fs, 0);
	if (res == FR_OK) {
		INIT_BUF(*dj);
		res = follow_path(dj, path);		/* Follow the path to the directory */
		FREE_BUF();
		if (res == FR_OK) {					/* Follow completed */
			if (dj->dir) {					/* It is not the root dir */
				if (dj->dir[DIR_Attr] & AM_DIR) {	/* The object is a directory */
					dj->sclust = LD_CLUST(dj->dir);
				} else {					/* The object is not a directory */
					res = FR_NO_PATH;
				}
			}
			if (res == FR_OK) {
				dj->id = dj->fs->id;
				res = dir_sdi(dj, 0);		/* Rewind dir */
			}
```

```
		}
		if (res == FR_NO_FILE) res = FR_NO_PATH;
	}

	LEAVE_FF(dj->fs, res);
}




/*-----------------------------------------------------------------------*/
/* Read Directory Entry in Sequense                                      */
/*-----------------------------------------------------------------------*/

FRESULT f_readdir (
	DIR *dj,			/* Pointer to the open directory object */
	FILINFO *fno		/* Pointer to file information to return */
)
{
	FRESULT res;
	DEF_NAMEBUF;


	res = validate(dj->fs, dj->id);				/* Check validity of the
object */
	if (res == FR_OK) {
		if (!fno) {
			res = dir_sdi(dj, 0);			/* Rewind the directory
object */
		} else {
			INIT_BUF(*dj);
			res = dir_read(dj);				/* Read an directory
item */
			if (res == FR_NO_FILE) {		/* Reached end of dir */
				dj->sect = 0;
				res = FR_OK;
			}
			if (res == FR_OK) {				/* A valid entry is
found */
				get_fileinfo(dj, fno);		/* Get the object information
*/
```

```
                                res = dir_next(dj, 0);        /* Increment index for next
*/
                                if (res == FR_NO_FILE) {
                                        dj->sect = 0;
                                        res = FR_OK;
                                }
                        }
                        FREE_BUF();
                }
        }

        LEAVE_FF(dj->fs, res);
}




#if _FS_MINIMIZE == 0
/*-----------------------------------------------------------------------*/
/* Get File Status                                                       */
/*-----------------------------------------------------------------------*/

FRESULT f_stat (
        const TCHAR *path,    /* Pointer to the file path */
        FILINFO *fno          /* Pointer to file information to return */
)
{
        FRESULT res;
        DIR dj;
        DEF_NAMEBUF;


        res = chk_mounted(&path, &dj.fs, 0);
        if (res == FR_OK) {
                INIT_BUF(dj);
                res = follow_path(&dj, path); /* Follow the file path */
                if (res == FR_OK) {                         /* Follow completed */
                        if (dj.dir)           /* Found an object */
                                get_fileinfo(&dj, fno);
                        else                  /* It is root dir */
                                res = FR_INVALID_NAME;
```

```
                }
                FREE_BUF();
        }

        LEAVE_FF(dj.fs, res);
}




#if !_FS_READONLY
/*-----------------------------------------------------------------------*/
/* Get Number of Free Clusters                                           */
/*-----------------------------------------------------------------------*/

FRESULT f_getfree (
        const TCHAR *path,      /* Pointer to the logical drive number (root dir) */
        DWORD *nclst,           /* Pointer to the variable to return number of free
clusters */
        FATFS **fatfs           /* Pointer to pointer to corresponding file system object
to return */
)
{
        FRESULT res;
        DWORD n, clst, sect, stat;
        UINT i;
        BYTE fat, *p;



        /* Get drive number */
        res = chk_mounted(&path, fatfs, 0);
        if (res == FR_OK) {
                /* If free_clust is valid, return it without full cluster scan */
                if ((*fatfs)->free_clust <= (*fatfs)->n_fatent - 2) {
                        *nclst = (*fatfs)->free_clust;
                } else {
                        /* Get number of free clusters */
                        fat = (*fatfs)->fs_type;
                        n = 0;
                        if (fat == FS_FAT12) {
                                clst = 2;
```

```
                                do {
                                        stat = get_fat(*fatfs, clst);
                                        if (stat == 0xFFFFFFFF) { res = FR_DISK_ERR; break;
}
                                        if (stat == 1) { res = FR_INT_ERR; break; }
                                        if (stat == 0) n++;
                                } while (++clst < (*fatfs)->n_fatent);
                        } else {
                                clst = (*fatfs)->n_fatent;
                                sect = (*fatfs)->fatbase;
                                i = 0; p = 0;
                                do {
                                        if (!i) {
                                                res = move_window(*fatfs, sect++);
                                                if (res != FR_OK) break;
                                                p = (*fatfs)->win;
                                                i = SS(*fatfs);
                                        }
                                        if (fat == FS_FAT16) {
                                                if (LD_WORD(p) == 0) n++;
                                                p += 2; i -= 2;
                                        } else {
                                                if ((LD_DWORD(p) & 0x0FFFFFFF) == 0) n++;
                                                p += 4; i -= 4;
                                        }
                                } while (--clst);
                        }
                        (*fatfs)->free_clust = n;
                        if (fat == FS_FAT32) (*fatfs)->fsi_flag = 1;
                        *nclst = n;
                }
        }
        LEAVE_FF(*fatfs, res);
}




/*-----------------------------------------------------------------------*/
/* Truncate File                                                         */
```

```
/*-----------------------------------------------------------------------*/


FRESULT f_truncate (
	FIL *fp		/* Pointer to the file object */
)
{
	FRESULT res;
	DWORD ncl;



	res = validate(fp->fs, fp->id);			/* Check validity of the object */
	if (res == FR_OK) {
		if (fp->flag & FA__ERROR) {			/* Check abort flag */
			res = FR_INT_ERR;
		} else {
			if (!(fp->flag & FA_WRITE))		/* Check access mode */
				res = FR_DENIED;
		}
	}
	if (res == FR_OK) {
		if (fp->fsize > fp->fptr) {
			fp->fsize = fp->fptr; /* Set file size to current R/W point */
			fp->flag |= FA__WRITTEN;
			if (fp->fptr == 0) {  /* When set file size to zero, remove entire
cluster chain */
				res = remove_chain(fp->fs, fp->org_clust);
				fp->org_clust = 0;
			} else {				/* When truncate a part of
the file, remove remaining clusters */
				ncl = get_fat(fp->fs, fp->curr_clust);
				res = FR_OK;
				if (ncl == 0xFFFFFFFF) res = FR_DISK_ERR;
				if (ncl == 1) res = FR_INT_ERR;
				if (res == FR_OK && ncl < fp->fs->n_fatent) {
					res = put_fat(fp->fs, fp->curr_clust, 0x0FFFFFFF);
					if (res == FR_OK) res = remove_chain(fp->fs, ncl);
				}
			}
		}
		if (res != FR_OK) fp->flag |= FA__ERROR;
```

```
	}

	LEAVE_FF(fp->fs, res);
}




/*-----------------------------------------------------------------------*/
/* Delete a File or Directory                                            */
/*-----------------------------------------------------------------------*/

FRESULT f_unlink (
	const TCHAR *path		/* Pointer to the file or directory path */
)
{
	FRESULT res;
	DIR dj, sdj;
	BYTE *dir;
	DWORD dclst;
	DEF_NAMEBUF;


	res = chk_mounted(&path, &dj.fs, 1);
	if (res == FR_OK) {
		INIT_BUF(dj);
		res = follow_path(&dj, path);		/* Follow the file path */
		if (_FS_RPATH && res == FR_OK && (dj.fn[NS] & NS_DOT))
			res = FR_INVALID_NAME;			/* Cannot remove dot entry */
#if _FS_SHARE
		if (res == FR_OK) res = chk_lock(&dj, 2);	/* Cannot remove open file */
#endif
		if (res == FR_OK) {					/* The object is accessible */
			dir = dj.dir;
			if (!dir) {
				res = FR_INVALID_NAME;		/* Cannot remove the start directory */
			} else {
				if (dir[DIR_Attr] & AM_RDO)
```

```
                                        res = FR_DENIED;              /* Cannot remove R/O
object */
                        }
                        dclst = LD_CLUST(dir);
                        if (res == FR_OK && (dir[DIR_Attr] & AM_DIR)) {     /* Is it a
sub-dir? */
                                if (dclst < 2) {
                                        res = FR_INT_ERR;
                                } else {
                                        mem_cpy(&sdj, &dj, sizeof(DIR));     /* Check if
the sub-dir is empty or not */
                                        sdj.sclust = dclst;
                                        res = dir_sdi(&sdj, 2);              /* Exclude dot
entries */
                                        if (res == FR_OK) {
                                                res = dir_read(&sdj);
                                                if (res == FR_OK                     /* Not
empty dir */
#if _FS_RPATH
                                                || dclst == sdj.fs->cdir     /* Current dir
*/
#endif
                                                ) res = FR_DENIED;
                                                if (res == FR_NO_FILE) res = FR_OK;  /*
Empty */
                                        }
                                }
                        }
                        if (res == FR_OK) {
                                res = dir_remove(&dj);        /* Remove the directory entry
*/
                                if (res == FR_OK) {
                                        if (dclst)                           /* Remove the
cluster chain if exist */
                                                res = remove_chain(dj.fs, dclst);
                                        if (res == FR_OK) res = sync(dj.fs);
                                }
                        }
                }
                FREE_BUF();
        }
        LEAVE_FF(dj.fs, res);
}
```

```
/*-----------------------------------------------------------------------*/
/* Create a Directory                                                    */
/*-----------------------------------------------------------------------*/

FRESULT f_mkdir (
	const TCHAR *path		/* Pointer to the directory path */
)
{
	FRESULT res;
	DIR dj;
	BYTE *dir, n;
	DWORD dsc, dcl, pcl, tim = get_fattime();
	DEF_NAMEBUF;


	res = chk_mounted(&path, &dj.fs, 1);
	if (res == FR_OK) {
		INIT_BUF(dj);
		res = follow_path(&dj, path);		/* Follow the file path */
		if (res == FR_OK) res = FR_EXIST;		/* Any object with same name is already existing */
		if (_FS_RPATH && res == FR_NO_FILE && (dj.fn[NS] & NS_DOT))
			res = FR_INVALID_NAME;
		if (res == FR_NO_FILE) {				/* Can create a new directory */
			dcl = create_chain(dj.fs, 0);		/* Allocate a cluster for the new directory table */
			res = FR_OK;
			if (dcl == 0) res = FR_DENIED;		/* No space to allocate a new cluster */
			if (dcl == 1) res = FR_INT_ERR;
			if (dcl == 0xFFFFFFFF) res = FR_DISK_ERR;
			if (res == FR_OK)					/* Flush FAT */
				res = move_window(dj.fs, 0);
			if (res == FR_OK) {					/* Initialize the new directory table */
				dsc = clust2sect(dj.fs, dcl);
```

```
                                dir = dj.fs->win;
                                mem_set(dir, 0, SS(dj.fs));
                                mem_set(dir+DIR_Name, ' ', 8+3);     /* Create "." entry */
                                dir[DIR_Name] = '.';
                                dir[DIR_Attr] = AM_DIR;
                                ST_DWORD(dir+DIR_WrtTime, tim);
                                ST_CLUST(dir, dcl);
                                mem_cpy(dir+32, dir, 32);                    /* Create ".."
entry */
                                dir[33] = '.'; pcl = dj.sclust;
                                if (dj.fs->fs_type == FS_FAT32 && pcl == dj.fs->dirbase)
                                        pcl = 0;
                                ST_CLUST(dir+32, pcl);
                                for (n = dj.fs->csize; n; n--) {     /* Write dot entries
and clear following sectors */
                                        dj.fs->winsect = dsc++;
                                        dj.fs->wflag = 1;
                                        res = move_window(dj.fs, 0);
                                        if (res != FR_OK) break;
                                        mem_set(dir, 0, SS(dj.fs));
                                }
                        }
                        if (res == FR_OK) res = dir_register(&dj);  /* Register the object
to the directoy */
                        if (res != FR_OK) {
                                remove_chain(dj.fs, dcl);                    /* Could not
register, remove cluster chain */
                        } else {
                                dir = dj.dir;
                                dir[DIR_Attr] = AM_DIR;                              /*
Attribute */
                                ST_DWORD(dir+DIR_WrtTime, tim);              /* Created
time */
                                ST_CLUST(dir, dcl);                                  /*
Table start cluster */
                                dj.fs->wflag = 1;
                                res = sync(dj.fs);
                        }
                }
                FREE_BUF();
        }


        LEAVE_FF(dj.fs, res);
```

```
}




/*-----------------------------------------------------------------------*/
/* Change Attribute                                                      */
/*-----------------------------------------------------------------------*/

FRESULT f_chmod (
        const TCHAR *path,    /* Pointer to the file path */
        BYTE value,                   /* Attribute bits */
        BYTE mask                     /* Attribute mask to change */
)
{
        FRESULT res;
        DIR dj;
        BYTE *dir;
        DEF_NAMEBUF;



        res = chk_mounted(&path, &dj.fs, 1);
        if (res == FR_OK) {
                INIT_BUF(dj);
                res = follow_path(&dj, path);        /* Follow the file path */
                FREE_BUF();
                if (_FS_RPATH && res == FR_OK && (dj.fn[NS] & NS_DOT))
                        res = FR_INVALID_NAME;
                if (res == FR_OK) {
                        dir = dj.dir;
                        if (!dir) {                                     /* Is it a
root directory? */
                                res = FR_INVALID_NAME;
                        } else {                                        /* File or sub
directory */
                                mask &= AM_RDO|AM_HID|AM_SYS|AM_ARC; /* Valid attribute
mask */
                                dir[DIR_Attr] = (value & mask) | (dir[DIR_Attr] &
(BYTE)~mask);  /* Apply attribute change */
                                dj.fs->wflag = 1;
                                res = sync(dj.fs);
```

```
                        }
                }
        }

        LEAVE_FF(dj.fs, res);
}




/*-----------------------------------------------------------------------*/
/* Change Timestamp                                                      */
/*-----------------------------------------------------------------------*/

FRESULT f_utime (
        const TCHAR *path,    /* Pointer to the file/directory name */
        const FILINFO *fno    /* Pointer to the time stamp to be set */
)
{
        FRESULT res;
        DIR dj;
        BYTE *dir;
        DEF_NAMEBUF;


        res = chk_mounted(&path, &dj.fs, 1);
        if (res == FR_OK) {
                INIT_BUF(dj);
                res = follow_path(&dj, path); /* Follow the file path */
                FREE_BUF();
                if (_FS_RPATH && res == FR_OK && (dj.fn[NS] & NS_DOT))
                        res = FR_INVALID_NAME;
                if (res == FR_OK) {
                        dir = dj.dir;
                        if (!dir) {                                 /* Root directory */
                                res = FR_INVALID_NAME;
                        } else {                                    /* File or sub-
directory */
                                ST_WORD(dir+DIR_WrtTime, fno->ftime);
                                ST_WORD(dir+DIR_WrtDate, fno->fdate);
```

```
                                dj.fs->wflag = 1;
                                res = sync(dj.fs);
                        }
                }
        }

        LEAVE_FF(dj.fs, res);
}




/*-----------------------------------------------------------------------*/
/* Rename File/Directory                                                 */
/*-----------------------------------------------------------------------*/

FRESULT f_rename (
        const TCHAR *path_old,/* Pointer to the old name */
        const TCHAR *path_new /* Pointer to the new name */
)
{
        FRESULT res;
        DIR djo, djn;
        BYTE buf[21], *dir;
        DWORD dw;
        DEF_NAMEBUF;


        res = chk_mounted(&path_old, &djo.fs, 1);
        if (res == FR_OK) {
                djn.fs = djo.fs;
                INIT_BUF(djo);
                res = follow_path(&djo, path_old);          /* Check old object */
                if (_FS_RPATH && res == FR_OK && (djo.fn[NS] & NS_DOT))
                        res = FR_INVALID_NAME;
#if _FS_SHARE
                if (res == FR_OK) res = chk_lock(&djo, 2);
#endif
                if (res == FR_OK) {                                     /* Old object
is found */
```

```
                        if (!djo.dir) {                                         /* Is
root dir? */
                                res = FR_NO_FILE;
                        } else {
                                mem_cpy(buf, djo.dir+DIR_Attr, 21);         /* Save the
object information except for name */
                                mem_cpy(&djn, &djo, sizeof(DIR));           /* Check new
object */
                                res = follow_path(&djn, path_new);
                                if (res == FR_OK) res = FR_EXIST;           /* The new
object name is already existing */
                                if (res == FR_NO_FILE) {                            /* Is
it a valid path and no name collision? */
/* Start critical section that any interruption or error can cause cross-link */
                                        res = dir_register(&djn);                   /*
Register the new entry */
                                        if (res == FR_OK) {
                                                dir = djn.dir;
        /* Copy object information except for name */
                                                mem_cpy(dir+13, buf+2, 19);
                                                dir[DIR_Attr] = buf[0] | AM_ARC;
                                                djo.fs->wflag = 1;
                                                if (djo.sclust != djn.sclust &&
(dir[DIR_Attr] & AM_DIR)) {         /* Update .. entry in the directory if needed */
                                                        dw = clust2sect(djn.fs,
LD_CLUST(dir));
                                                        if (!dw) {
                                                                res = FR_INT_ERR;
                                                        } else {
                                                                res = move_window(djn.fs,
dw);
                                                                dir = djn.fs->win+32; /* ..
entry */
                                                                if (res == FR_OK && dir[1] ==
'.') {
                                                                        dw = (djn.fs->fs_type
== FS_FAT32 && djn.sclust == djn.fs->dirbase) ? 0 : djn.sclust;
                                                                        ST_CLUST(dir, dw);
                                                                        djn.fs->wflag = 1;
                                                                }
                                                        }
                                                }
                                                if (res == FR_OK) {
                                                        res = dir_remove(&djo);
        /* Remove old entry */
                                                        if (res == FR_OK)
```

```
                                                        res = sync(djo.fs);
                                                }
                                        }
/* End critical section */
                                }
                        }
                }
                FREE_BUF();
        }
        LEAVE_FF(djo.fs, res);
}


#endif /* !_FS_READONLY */
#endif /* _FS_MINIMIZE == 0 */
#endif /* _FS_MINIMIZE <= 1 */
#endif /* _FS_MINIMIZE <= 2 */




/*-----------------------------------------------------------------------*/
/* Forward data to the stream directly (available on only tiny cfg)      */
/*-----------------------------------------------------------------------*/
#if _USE_FORWARD && _FS_TINY


FRESULT f_forward (
        FIL *fp,                                        /* Pointer to the file object
*/
        UINT (*func)(const BYTE*,UINT),      /* Pointer to the streaming function */
        UINT btr,                                       /* Number of bytes to forward
*/
        UINT *bf                                        /* Pointer to number of bytes
forwarded */
)
{
        FRESULT res;
        DWORD remain, clst, sect;
        UINT rcnt;
        BYTE csect;



        *bf = 0;       /* Initialize byte counter */
```

```
	res = validate(fp->fs, fp->id);					/* Check validity of the object */
	if (res != FR_OK) LEAVE_FF(fp->fs, res);
	if (fp->flag & FA__ERROR)					/* Check error flag */
		LEAVE_FF(fp->fs, FR_INT_ERR);
	if (!(fp->flag & FA_READ))					/* Check access mode */
		LEAVE_FF(fp->fs, FR_DENIED);

	remain = fp->fsize - fp->fptr;
	if (btr > remain) btr = (UINT)remain;			/* Truncate btr by remaining bytes */

	for ( ;  btr && (*func)(0, 0);					/* Repeat until all data transferred or stream becomes busy */
		fp->fptr += rcnt, *bf += rcnt, btr -= rcnt) {
		csect = (BYTE)(fp->fptr / SS(fp->fs) & (fp->fs->csize - 1));	/* Sector offset in the cluster */
		if ((fp->fptr % SS(fp->fs)) == 0) {			/* On the sector boundary? */
			if (!csect) {						/* On the cluster boundary? */
				clst = (fp->fptr == 0) ?			/* On the top of the file? */
					fp->org_clust : get_fat(fp->fs, fp->curr_clust);
				if (clst <= 1) ABORT(fp->fs, FR_INT_ERR);
				if (clst == 0xFFFFFFFF) ABORT(fp->fs, FR_DISK_ERR);
				fp->curr_clust = clst;			/* Update current cluster */
			}
		}
		sect = clust2sect(fp->fs, fp->curr_clust);  /* Get current data sector */
		if (!sect) ABORT(fp->fs, FR_INT_ERR);
		sect += csect;
		if (move_window(fp->fs, sect))				/* Move sector window */
			ABORT(fp->fs, FR_DISK_ERR);
		fp->dsect = sect;
		rcnt = SS(fp->fs) - (WORD)(fp->fptr % SS(fp->fs));  /* Forward data from sector window */
		if (rcnt > btr) rcnt = btr;
		rcnt = (*func)(&fp->fs->win[(WORD)fp->fptr % SS(fp->fs)], rcnt);
		if (!rcnt) ABORT(fp->fs, FR_INT_ERR);
```

```
	}

	LEAVE_FF(fp->fs, FR_OK);
}
#endif /* _USE_FORWARD */



#if _USE_MKFS && !_FS_READONLY
/*-----------------------------------------------------------------------*/
/* Create File System on the Drive                                       */
/*-----------------------------------------------------------------------*/
#define N_ROOTDIR	512		/* Multiple of 32 */
#define N_FATS		1		/* 1 or 2 */


FRESULT f_mkfs (
	BYTE drv,		/* Logical drive number */
	BYTE sfd,		/* Partitioning rule 0:FDISK, 1:SFD */
	UINT au			/* Allocation unit size [bytes] */
)
{
	static const WORD vst[] = { 1024,   512,  256,  128,   64,    32,   16,    8,
4,    2,   0};
	static const WORD cst[] = {32768, 16384, 8192, 4096, 2048, 16384, 8192, 4096,
2048, 1024, 512};
	BYTE fmt, md, *tbl;
	DWORD n_clst, vs, n, wsect;
	UINT i;
	DWORD b_vol, b_fat, b_dir, b_data;	/* Offset (LBA) */
	DWORD n_vol, n_rsv, n_fat, n_dir;	/* Size */
	FATFS *fs;
	DSTATUS stat;


	/* Check mounted drive and clear work area */
	if (drv >= _VOLUMES) return FR_INVALID_DRIVE;
	fs = FatFs[drv];
	if (!fs) return FR_NOT_ENABLED;
	fs->fs_type = 0;
```

```
	drv = LD2PD(drv);

	/* Get disk statics */
	stat = disk_initialize(drv);
	if (stat & STA_NOINIT) return FR_NOT_READY;
	if (stat & STA_PROTECT) return FR_WRITE_PROTECTED;
#if _MAX_SS != 512 /* Get disk sector size */
	if (disk_ioctl(drv, GET_SECTOR_SIZE, &SS(fs)) != RES_OK)
		return FR_DISK_ERR;
#endif
	if (disk_ioctl(drv, GET_SECTOR_COUNT, &n_vol) != RES_OK || n_vol < 128)
		return FR_DISK_ERR;
	b_vol = (sfd) ? 0 : 63;	/* Volume start sector */
	n_vol -= b_vol;
	if (au & (au - 1)) au = 0;	/* Check validity of the allocation unit size */
	if (!au) {	/* AU auto selection */
		vs = n_vol / (2000 / (SS(fs) / 512));
		for (i = 0; vs < vst[i]; i++) ;
		au = cst[i];
	}
	au /= SS(fs);	/* Number of sectors per cluster */
	if (au == 0) au = 1;
	if (au > 128) au = 128;

	/* Pre-compute number of clusters and FAT syb-type */
	n_clst = n_vol / au;
	fmt = FS_FAT12;
	if (n_clst >= MIN_FAT16) fmt = FS_FAT16;
	if (n_clst >= MIN_FAT32) fmt = FS_FAT32;

	/* Determine offset and size of FAT structure */
	if (fmt == FS_FAT32) {
		n_fat = ((n_clst * 4) + 8 + SS(fs) - 1) / SS(fs);
		n_rsv = 32;
		n_dir = 0;
	} else {
		n_fat = (fmt == FS_FAT12) ? (n_clst * 3 + 1) / 2 + 3 : (n_clst * 2) + 4;
		n_fat = (n_fat + SS(fs) - 1) / SS(fs);
		n_rsv = 1;
```

```
                n_dir = N_ROOTDIR * 32UL / SS(fs);
        }
        b_fat = b_vol + n_rsv;                          /* FAT area start sector */
        b_dir = b_fat + n_fat * N_FATS;                 /* Directory area start sector */
        b_data = b_dir + n_dir;                                 /* Data area start sector */
        if (n_vol < b_data + au) return FR_MKFS_ABORTED;    /* Too small volume */

        /* Align data start sector to erase block boundary (for flash memory media) */
        if (disk_ioctl(drv, GET_BLOCK_SIZE, &n) != RES_OK || !n || n > 32768) n = 1;
        n = (b_data + n - 1) & ~(n - 1);     /* Next nearest erase block from current
data start */
        n = (n - b_data) / N_FATS;
        if (fmt == FS_FAT32) {        /* FAT32: Move FAT offset */
                n_rsv += n;
                b_fat += n;
        } else {                                        /* FAT12/16: Expand FAT size */
                n_fat += n;
        }

        /* Determine number of cluster and final check of validity of the FAT sub-type */
        n_clst = (n_vol - n_rsv - n_fat * N_FATS - n_dir) / au;
        if (    (fmt == FS_FAT16 && n_clst < MIN_FAT16)
                || (fmt == FS_FAT32 && n_clst < MIN_FAT32))
                return FR_MKFS_ABORTED;

        /* Create partition table if required */
        if (sfd) {
                md = 0xF0;
        } else {
                DWORD n_disk = b_vol + n_vol;

                mem_set(fs->win, 0, SS(fs));
                tbl = fs->win+MBR_Table;
                ST_DWORD(tbl, 0x00010180);                      /* Partition start in CHS */
                if (n_disk < 63UL * 255 * 1024) {    /* Partition end in CHS */
                        n_disk = n_disk / 63 / 255;
                        tbl[7] = (BYTE)n_disk;
                        tbl[6] = (BYTE)((n_disk >> 2) | 63);
                } else {
                        ST_WORD(&tbl[6], 0xFFFF);
```

```
		}
		tbl[5] = 254;
		if (fmt != FS_FAT32)				/* System ID */
			tbl[4] = (n_vol < 0x10000) ? 0x04 : 0x06;
		else
			tbl[4] = 0x0c;
		ST_DWORD(tbl+8, 63);				/* Partition start in LBA */
		ST_DWORD(tbl+12, n_vol);			/* Partition size in LBA */
		ST_WORD(tbl+64, 0xAA55);			/* Signature */
		if (disk_write(drv, fs->win, 0, 1) != RES_OK)
			return FR_DISK_ERR;
		md = 0xF8;
	}

	/* Create volume boot record */
	tbl = fs->win;						/* Clear sector */
	mem_set(tbl, 0, SS(fs));
	mem_cpy(tbl, "\xEB\xFE\x90" "MSDOS5.0", 11);/* Boot code, OEM name */
	i = SS(fs);							/* Sector size */
	ST_WORD(tbl+BPB_BytsPerSec, i);
	tbl[BPB_SecPerClus] = (BYTE)au;			/* Sectors per cluster */
	ST_WORD(tbl+BPB_RsvdSecCnt, n_rsv);		/* Reserved sectors */
	tbl[BPB_NumFATs] = N_FATS;				/* Number of FATs */
	i = (fmt == FS_FAT32) ? 0 : N_ROOTDIR;	/* Number of rootdir entries */
	ST_WORD(tbl+BPB_RootEntCnt, i);
	if (n_vol < 0x10000) {					/* Number of total sectors */
		ST_WORD(tbl+BPB_TotSec16, n_vol);
	} else {
		ST_DWORD(tbl+BPB_TotSec32, n_vol);
	}
	tbl[BPB_Media] = md;					/* Media descriptor */
	ST_WORD(tbl+BPB_SecPerTrk, 63);			/* Number of sectors per track */
	ST_WORD(tbl+BPB_NumHeads, 255);			/* Number of heads */
	ST_DWORD(tbl+BPB_HiddSec, b_vol);		/* Hidden sectors */
	n = get_fattime();						/* Use current time as VSN */
	if (fmt == FS_FAT32) {
		ST_DWORD(tbl+BS_VolID32, n);		/* VSN */
		ST_DWORD(tbl+BPB_FATSz32, n_fat);	/* Number of sectors per FAT */
```

```
		ST_DWORD(tbl+BPB_RootClus, 2);			/* Root directory start cluster (2) */
		ST_WORD(tbl+BPB_FSInfo, 1);			/* FSInfo record offset (VBR+1) */
		ST_WORD(tbl+BPB_BkBootSec, 6);			/* Backup boot record offset (VBR+6) */
		tbl[BS_DrvNum32] = 0x80;			/* Drive number */
		tbl[BS_BootSig32] = 0x29;			/* Extended boot signature */
		mem_cpy(tbl+BS_VolLab32, "NO NAME    " "FAT32   ", 19);	/* Volume label, FAT signature */
	} else {
		ST_DWORD(tbl+BS_VolID, n);			/* VSN */
		ST_WORD(tbl+BPB_FATSz16, n_fat);	/* Number of sectors per FAT */
		tbl[BS_DrvNum] = 0x80;				/* Drive number */
		tbl[BS_BootSig] = 0x29;					/* Extended boot signature */
		mem_cpy(tbl+BS_VolLab, "NO NAME    " "FAT     ", 19);	/* Volume label, FAT signature */
	}
	ST_WORD(tbl+BS_55AA, 0xAA55);			/* Signature (Offset is fixed here regardless of sector size) */
	if (disk_write(drv, tbl, b_vol, 1) != RES_OK)/* Write original (VBR) */
		return FR_DISK_ERR;
	if (fmt == FS_FAT32)					/* Write backup (VBR+6) */
		disk_write(drv, tbl, b_vol + 6, 1);

	/* Initialize FAT area */
	wsect = b_fat;
	for (i = 0; i < N_FATS; i++) {
		mem_set(tbl, 0, SS(fs));			/* 1st sector of the FAT  */
		n = md;							/* Media descriptor byte */
		if (fmt != FS_FAT32) {
			n |= (fmt == FS_FAT12) ? 0x00FFFF00 : 0xFFFFFF00;
			ST_DWORD(tbl+0, n);				/* Reserve cluster #0-1 (FAT12/16) */
		} else {
			n |= 0xFFFFFF00;
			ST_DWORD(tbl+0, n);				/* Reserve cluster #0-1 (FAT32) */
			ST_DWORD(tbl+4, 0xFFFFFFFF);
			ST_DWORD(tbl+8, 0x0FFFFFFF);	/* Reserve cluster #2 for root dir */
		}
```

```
		if (disk_write(drv, tbl, wsect++, 1) != RES_OK)
			return FR_DISK_ERR;
		mem_set(tbl, 0, SS(fs));			/* Fill following FAT entries with zero */
		for (n = 1; n < n_fat; n++) {		/* This loop may take a time on FAT32 volume due to many single sector write */
			if (disk_write(drv, tbl, wsect++, 1) != RES_OK)
				return FR_DISK_ERR;
		}
	}

	/* Initialize root directory */
	i = (fmt == FS_FAT32) ? au : n_dir;
	do {
		if (disk_write(drv, tbl, wsect++, 1) != RES_OK)
			return FR_DISK_ERR;
	} while (--i);

#if _USE_ERASE /* Erase data area if needed */
	{
		DWORD eb[2];

		eb[0] = wsect; eb[1] = wsect + n_clst * au - 1;
		disk_ioctl(drv, CTRL_ERASE_SECTOR, eb);
	}
#endif

	/* Create FSInfo if needed */
	if (fmt == FS_FAT32) {
		ST_WORD(tbl+BS_55AA, 0xAA55);
		ST_DWORD(tbl+FSI_LeadSig, 0x41615252);
		ST_DWORD(tbl+FSI_StrucSig, 0x61417272);
		ST_DWORD(tbl+FSI_Free_Count, n_clst - 1);
		ST_DWORD(tbl+FSI_Nxt_Free, 0xFFFFFFFF);
		disk_write(drv, tbl, b_vol + 1, 1);  /* Write original (VBR+1) */
		disk_write(drv, tbl, b_vol + 7, 1);  /* Write backup (VBR+7) */
	}

	return (disk_ioctl(drv, CTRL_SYNC, (void*)0) == RES_OK) ? FR_OK : FR_DISK_ERR;
}
```

```
#endif /* _USE_MKFS && !_FS_READONLY */




#if _USE_STRFUNC
/*-----------------------------------------------------------------------*/
/* Get a string from the file                                            */
/*-----------------------------------------------------------------------*/
TCHAR* f_gets (
	TCHAR* buff,	/* Pointer to the string buffer to read */
	int len,		/* Size of string buffer (characters) */
	FIL* fil		/* Pointer to the file object */
)
{
	int n = 0;
	TCHAR c, *p = buff;
	BYTE s[2];
	UINT rc;



	while (n < len - 1) {		/* Read bytes until buffer gets filled */
		f_read(fil, s, 1, &rc);
		if (rc != 1) break;		/* Break on EOF or error */
		c = s[0];
#if _LFN_UNICODE				/* Read a character in UTF-8
encoding */
		if (c >= 0x80) {
			if (c < 0xC0) continue;	/* Skip stray trailer */
			if (c < 0xE0) {			/* Two-byte sequense */
				f_read(fil, s, 1, &rc);
				if (rc != 1) break;
				c = ((c & 0x1F) << 6) | (s[0] & 0x3F);
				if (c < 0x80) c = '?';
			} else {
				if (c < 0xF0) {		/* Three-byte sequense */
					f_read(fil, s, 2, &rc);
					if (rc != 2) break;
```

```
                                    c = (c << 12) | ((s[0] & 0x3F) << 6) | (s[1] &
0x3F);
                                    if (c < 0x800) c = '?';
                                } else {                        /* Reject four-byte sequense
*/
                                    c = '?';
                                }
                            }
                        }
#endif
#if _USE_STRFUNC >= 2
                if (c == '\r') continue;        /* Strip '\r' */
#endif
                *p++ = c;
                n++;
                if (c == '\n') break;           /* Break on EOL */
        }
        *p = 0;
        return n ? buff : 0;                    /* When no data read (eof or error), return
with error. */
}




#if !_FS_READONLY
#include <stdarg.h>
/*-----------------------------------------------------------------------*/
/* Put a character to the file                                           */
/*-----------------------------------------------------------------------*/
int f_putc (
        TCHAR c,        /* A character to be output */
        FIL* fil        /* Pointer to the file object */
)
{
        UINT bw, btw;
        BYTE s[3];



#if _USE_STRFUNC >= 2
        if (c == '\n') f_putc ('\r', fil);   /* LF -> CRLF conversion */
#endif
```

```
#if _LFN_UNICODE      /* Write the character in UTF-8 encoding */
        if (c < 0x80) {                       /* 7-bit */
                s[0] = (BYTE)c;
                btw = 1;
        } else {
                if (c < 0x800) {      /* 11-bit */
                        s[0] = (BYTE)(0xC0 | (c >> 6));
                        s[1] = (BYTE)(0x80 | (c & 0x3F));
                        btw = 2;
                } else {                      /* 16-bit */
                        s[0] = (BYTE)(0xE0 | (c >> 12));
                        s[1] = (BYTE)(0x80 | ((c >> 6) & 0x3F));
                        s[2] = (BYTE)(0x80 | (c & 0x3F));
                        btw = 3;
                }
        }
#else                         /* Write the character without conversion */
        s[0] = (BYTE)c;
        btw = 1;
#endif
        f_write(fil, s, btw, &bw);            /* Write the char to the file */
        return (bw == btw) ? 1 : EOF; /* Return the result */
}




/*-----------------------------------------------------------------------*/
/* Put a string to the file                                              */
/*-----------------------------------------------------------------------*/
int f_puts (
        const TCHAR* str,     /* Pointer to the string to be output */
        FIL* fil                      /* Pointer to the file object */
)
{
        int n;
```

```
	for (n = 0; *str; str++, n++) {
		if (f_putc(*str, fil) == EOF) return EOF;
	}
	return n;
}




/*-----------------------------------------------------------------------*/
/* Put a formatted string to the file                                    */
/*-----------------------------------------------------------------------*/
int f_printf (
	FIL* fil,                    /* Pointer to the file object */
	const TCHAR* str,     /* Pointer to the format string */
	...                                  /* Optional arguments... */
)
{
	va_list arp;
	BYTE f, r;
	UINT i, w;
	ULONG val;
	TCHAR c, d, s[16];
	int res, cc;


	va_start(arp, str);

	for (cc = res = 0; cc != EOF; res += cc) {
		c = *str++;
		if (c == 0) break;                  /* End of string */
		if (c != '%') {                             /* Non escape character */
			cc = f_putc(c, fil);
			if (cc != EOF) cc = 1;
			continue;
		}
		w = f = 0;
		c = *str++;
		if (c == '0') {                             /* Flag: '0' padding */
```

```
                f = 1; c = *str++;
            }
            while (IsDigit(c)) {          /* Precision */
                w = w * 10 + c - '0';
                c = *str++;
            }
            if (c == 'l' || c == 'L') {   /* Prefix: Size is long int */
                f |= 2; c = *str++;
            }
            if (!c) break;
            d = c;
            if (IsLower(d)) d -= 0x20;
            switch (d) {                        /* Type is... */
            case 'S' :                                  /* String */
                cc = f_puts(va_arg(arp, TCHAR*), fil); continue;
            case 'C' :                                  /* Character */
                cc = f_putc((TCHAR)va_arg(arp, int), fil); continue;
            case 'B' :                                  /* Binary */
                r = 2; break;
            case 'O' :                                  /* Octal */
                r = 8; break;
            case 'D' :                                  /* Signed decimal */
            case 'U' :                                  /* Unsigned decimal */
                r = 10; break;
            case 'X' :                                  /* Hexdecimal */
                r = 16; break;
            default:                                    /* Unknown */
                cc = f_putc(c, fil); continue;
            }

            /* Get an argument */
            val = (f & 2) ? va_arg(arp, long) : ((d == 'D') ? (long)va_arg(arp, int)
: va_arg(arp, unsigned int));
            if (d == 'D' && (val & 0x80000000)) {
                val = 0 - val;
                f |= 4;
            }
            /* Put it in numeral string */
            i = 0;
            do {
```

```
                        d = (TCHAR)(val % r); val /= r;
                        if (d > 9) {
                                d += 7;
                                if (c == 'x') d += 0x20;
                        }
                        s[i++] = d + '0';
                } while (val && i < sizeof(s) / sizeof(s[0]));
                if (f & 4) s[i++] = '-';
                cc = 0;
                while (i < w-- && cc != EOF) {
                        cc = f_putc((TCHAR)((f & 1) ? '0' : ' '), fil);
                        res++;
                }
                do {
                        cc = f_putc(s[--i], fil);
                        res++;
                } while (i && cc != EOF);
                if (cc != EOF) cc = 0;
        }

        va_end(arp);
        return (cc == EOF) ? cc : res;
}

#endif /* !_FS_READONLY */
#endif /* _USE_STRFUNC */



/*****************************************Copyright
(c)*****************************************************
**
**                                http://www.powermcu.com
**
**--------------File Info-----------------------------------------------------------------
------------------
** File name:               SPI_MSD_Driver.c
** Descriptions:            The SPI SD Card application function
**
**-------------------------------------------------------------------------------------
------------------
** Created by:              Ya Dan
```

```
** Created date:            2011-1-4
** Version:                 v1.0
** Descriptions:            The original version
**
**--------------------------------------------------------------------------------------------
------------------
** Modified by:
** Modified date:
** Version:
** Descriptions:
**
********************************************************************************************
*****************/

/* Includes ------------------------------------------------------------------*/
#include "SPI_MSD_Driver.h"
#include <stdio.h>

/* Private define ------------------------------------------------------------*/
#define PRINT_INFO  1

/* Private variables ---------------------------------------------------------*/
MSD_CARDINFO CardInfo;

/*******************************************************************************
* Function Name  : _spi_read_write
* Description    : None
* Input          : - data:
* Output         : None
* Return         : None
* Attention             : None
*******************************************************************************/
__inline int _spi_read_write(uint8_t data)
{
        /* wait for current SSP activity complete */
        while (SSP_GetStatus(LPC_SSP0, SSP_STAT_BUSY) ==  SET);

        SSP_SendData(LPC_SSP0, (uint16_t) data);

        while (SSP_GetStatus(LPC_SSP0, SSP_STAT_RXFIFO_NOTEMPTY) == RESET);
```

```
	return (SSP_ReceiveData(LPC_SSP0));
}

/*********************************************************************************
* Function Name  : MSD_SPI_Configuration
* Description    : SD Card SPI Configuration
* Input          : None
* Output         : None
* Return         : None
* Attention		 : None
*********************************************************************************/
void MSD_SPI_Configuration(void)
{
	PINSEL_CFG_Type PinCfg;
    SSP_CFG_Type SSP_ConfigStruct;
	/*
	 * Initialize SPI pin connect
	 * P1.25 - SD_CD - used as GPIO
	 * P1.20 - SCK
	 * P1.21 - SD_CS - used as GPIO
	 * P1.23 - MISO
	 * P1.24 - MOSI
	 */
	PinCfg.Funcnum = 3;
	PinCfg.OpenDrain = 0;
	PinCfg.Pinmode = 0;
	PinCfg.Portnum = 1;
	PinCfg.Pinnum = 20;
	PINSEL_ConfigPin(&PinCfg);
	PinCfg.Pinnum = 23;
	PINSEL_ConfigPin(&PinCfg);
	PinCfg.Pinnum = 24;
	PINSEL_ConfigPin(&PinCfg);
	PinCfg.Pinnum = 21;
	PinCfg.Funcnum = 0;
	PINSEL_ConfigPin(&PinCfg);
	PinCfg.Portnum = 1;
	PinCfg.Pinnum = 25;
```

```
        PinCfg.Funcnum = 0;
        PINSEL_ConfigPin(&PinCfg);

    /* P1.25 SD_CD is Input */
    GPIO_SetDir(SD_CD_PORT_NUM, (1<<SD_CD_PIN_NUM), 0);
        GPIO_SetValue(SD_CD_PORT_NUM, (1<<SD_CD_PIN_NUM));
    /* P1.21 SD_CS is output */
    GPIO_SetDir(SD_CS_PORT_NUM, (1<<SD_CS_PIN_NUM), 1);
        GPIO_SetValue(SD_CS_PORT_NUM, (1<<SD_CS_PIN_NUM));

        /* initialize SSP configuration structure to default */
        SSP_ConfigStructInit(&SSP_ConfigStruct);
        /* Initialize SSP peripheral with parameter given in structure above */
        SSP_Init(LPC_SSP0, &SSP_ConfigStruct);
        /* Enable SSP peripheral */

        _card_disable();

        MSD_SPIHighSpeed(0);

        SSP_Cmd(LPC_SSP0, ENABLE);
}

/*****************************************************************************
* Function Name  : MSD_SPIHighSpeed
* Description    : SD Card Speed Set
* Input          : - b_high: 1 = 4MHz, 0 = 500KHz
* Output         : None
* Return         : None
* Attention            : None
*****************************************************************************/
void MSD_SPIHighSpeed(uint8_t b_high)
{
    SSP_CFG_Type SSP_ConfigStruct;

        /* initialize SSP configuration structure to default */
        SSP_ConfigStructInit(&SSP_ConfigStruct);

        /* Speed select */
```

```
        if(b_high == 0)
        {
                SSP_ConfigStruct.ClockRate = 500000;
        }
        else
        {
            SSP_ConfigStruct.ClockRate = 4000000;
        }

        SSP_Init(LPC_SSP0, &SSP_ConfigStruct);

        SSP_Cmd(LPC_SSP0, ENABLE);
}

/*****************************************************************************
* Function Name  : MSD_Init
* Description    : SD Card initializtion
* Input          : None
* Output         : None
* Return         : None
* Attention             : None
*****************************************************************************/
int MSD_Init(void)
{
        uint8_t r1;
        uint8_t buff[6] = {0};
        uint16_t retry;

        MSD_SPI_Configuration();

        /* Check , if no card insert */
    if( _card_insert() )
        {
#ifdef PRINT_INFO
                printf("There is no card detected! \r\n");
#endif
          /* FATFS error flag */
      return -1;
        }
```

```
	/* Power on and delay some times */
	for(retry=0; retry<0x100; retry++)
	{
		_card_power_on();
	}

	/* Satrt send 74 clocks at least */
	for(retry=0; retry<10; retry++)
	{
		_spi_read_write(DUMMY_BYTE);
	}

	/* Start send CMD0 till return 0x01 means in IDLE state */
	for(retry=0; retry<0xFFF; retry++)
	{
		r1 = _send_command(CMD0, 0, 0x95);
		if(r1 == 0x01)
		{
			retry = 0;
			break;
		}
	}
	/* Timeout return */
	if(retry == 0xFFF)
	{
#ifdef PRINT_INFO
		printf("Reset card into IDLE state failed!\r\n");
#endif
		return 1;
	}

	/* Get the card type, version */
	r1 = _send_command_hold(CMD8, 0x1AA, 0x87);
	/* r1=0x05 -> V1.0 */
	if(r1 == 0x05)
	{
	  CardInfo.CardType = CARDTYPE_SDV1;
```

```
        /* End of CMD8, chip disable and dummy byte */
        _card_disable();
        _spi_read_write(DUMMY_BYTE);

        /* SD1.0/MMC start initialize */
        /* Send CMD55+ACMD41, No-response is a MMC card, otherwise is a SD1.0 card */
        for(retry=0; retry<0xFFF; retry++)
        {
           r1 = _send_command(CMD55, 0, 0);                    /* should be return
0x01 */
               if(r1 != 0x01)
               {
#ifdef PRINT_INFO
                     printf("Send CMD55 should return 0x01, response=0x%02x\r\n", r1);
#endif
                     return r1;
               }

               r1 = _send_command(ACMD41, 0, 0);                /* should be return
0x00 */
               if(r1 == 0x00)
               {
                     retry = 0;
                     break;
               }
        }

        /* MMC card initialize start */
        if(retry == 0xFFF)
        {
              for(retry=0; retry<0xFFF; retry++)
           {
                    r1 = _send_command(CMD1, 0, 0);            /* should be return
0x00 */
                     if(r1 == 0x00)
                     {
                           retry = 0;
                           break;
                     }
               }
```

```
                /* Timeout return */
                if(retry == 0xFFF)
                {
#ifdef PRINT_INFO
                      printf("Send CMD1 should return 0x00, response=0x%02x\r\n", r1);
#endif
                      return 2;
                }

               CardInfo.CardType = CARDTYPE_MMC;
#ifdef PRINT_INFO
               printf("Card Type                    : MMC\r\n");
#endif
          }
               /* SD1.0 card detected, print information */
#ifdef PRINT_INFO
          else
          {
                printf("Card Type                     : SD V1\r\n");
          }
#endif

          /* Set spi speed high */
          MSD_SPIHighSpeed(1);

          /* CRC disable */
          r1 = _send_command(CMD59, 0, 0x01);
          if(r1 != 0x00)
          {
#ifdef PRINT_INFO
                 printf("Send CMD59 should return 0x00, response=0x%02x\r\n", r1);
#endif
                 return r1;          /* response error, return r1 */
          }

          /* Set the block size */
          r1 = _send_command(CMD16, MSD_BLOCKSIZE, 0xFF);
          if(r1 != 0x00)
          {
```

```
#ifdef PRINT_INFO
                printf("Send CMD16 should return 0x00, response=0x%02x\r\n", r1);
#endif
                return r1;          /* response error, return r1 */
         }
   }

   /* r1=0x01 -> V2.x, read OCR register, check version */
   else if(r1 == 0x01)
   {
         /* 4Bytes returned after CMD8 sent  */
         buff[0] = _spi_read_write(DUMMY_BYTE);                              /* should be
0x00 */
         buff[1] = _spi_read_write(DUMMY_BYTE);                              /* should be
0x00 */
         buff[2] = _spi_read_write(DUMMY_BYTE);                              /* should be
0x01 */
         buff[3] = _spi_read_write(DUMMY_BYTE);                              /* should be
0xAA */

         /* End of CMD8, chip disable and dummy byte */
         _card_disable();
         _spi_read_write(DUMMY_BYTE);

         /* Check voltage range be 2.7-3.6V  */
         if(buff[2]==0x01 && buff[3]==0xAA)
         {
               for(retry=0; retry<0xFFF; retry++)
               {
                     r1 = _send_command(CMD55, 0, 0);                      /* should be
return 0x01 */
                     if(r1!=0x01)
                     {
#ifdef PRINT_INFO
                           printf("Send CMD55 should return 0x01,
response=0x%02x\r\n", r1);
#endif
                           return r1;
                     }

                     r1 = _send_command(ACMD41, 0x40000000, 0);  /* should be return
0x00 */
                     if(r1 == 0x00)
```

```
                        {
                                retry = 0;
                                break;
                        }
                }

                /* Timeout return */
                if(retry == 0xFFF)
                {
#ifdef PRINT_INFO
                        printf("Send ACMD41 should return 0x00, response=0x%02x\r\n", r1);
#endif
                        return 3;
                }

                /* Read OCR by CMD58 */
            r1 = _send_command_hold(CMD58, 0, 0);
            if(r1!=0x00)
            {
#ifdef PRINT_INFO
                        printf("Send CMD58 should return 0x00, response=0x%02x\r\n", r1);
#endif
             return r1;        /* response error, return r1 */
            }

            buff[0] = _spi_read_write(DUMMY_BYTE);
                buff[1] = _spi_read_write(DUMMY_BYTE);
                buff[2] = _spi_read_write(DUMMY_BYTE);
                buff[3] = _spi_read_write(DUMMY_BYTE);

                /* End of CMD58, chip disable and dummy byte */
                _card_disable();
                _spi_read_write(DUMMY_BYTE);

            /* OCR -> CCS(bit30)  1: SDV2HC   0: SDV2 */
            if(buff[0] & 0x40)
            {
           CardInfo.CardType = CARDTYPE_SDV2HC;
#ifdef PRINT_INFO
```

```
                printf("Card Type                    : SD V2HC\r\n");
#endif
            }
            else
            {
            CardInfo.CardType = CARDTYPE_SDV2;
#ifdef PRINT_INFO
                printf("Card Type                    : SD V2\r\n");
#endif
            }

               /* Set spi speed high */
               MSD_SPIHighSpeed(1);
               }
   }
   return 0;
}

/*****************************************************************************
* Function Name  : MSD_GetCardInfo
* Description    : Get SD Card Information
* Input          : None
* Output         : None
* Return         : 0£°NO_ERR; TRUE: Error
* Attention            : None
*****************************************************************************/
int MSD_GetCardInfo(PMSD_CARDINFO cardinfo)
{
  uint8_t r1;
  uint8_t CSD_Tab[16];
  uint8_t CID_Tab[16];

  /* Send CMD9, Read CSD */
  r1 = _send_command(CMD9, 0, 0xFF);
  if(r1 != 0x00)
  {
    return r1;
  }
```

```
  if(_read_buffer(CSD_Tab, 16, RELEASE))
  {
       return 1;
  }

  /* Send CMD10, Read CID */
  r1 = _send_command(CMD10, 0, 0xFF);
  if(r1 != 0x00)
  {
    return r1;
  }

  if(_read_buffer(CID_Tab, 16, RELEASE))
  {
       return 2;
  }

  /* Byte 0 */
  cardinfo->CSD.CSDStruct = (CSD_Tab[0] & 0xC0) >> 6;
  cardinfo->CSD.SysSpecVersion = (CSD_Tab[0] & 0x3C) >> 2;
  cardinfo->CSD.Reserved1 = CSD_Tab[0] & 0x03;
  /* Byte 1 */
  cardinfo->CSD.TAAC = CSD_Tab[1] ;
  /* Byte 2 */
  cardinfo->CSD.NSAC = CSD_Tab[2];
  /* Byte 3 */
  cardinfo->CSD.MaxBusClkFrec = CSD_Tab[3];
  /* Byte 4 */
  cardinfo->CSD.CardComdClasses = CSD_Tab[4] << 4;
  /* Byte 5 */
  cardinfo->CSD.CardComdClasses |= (CSD_Tab[5] & 0xF0) >> 4;
  cardinfo->CSD.RdBlockLen = CSD_Tab[5] & 0x0F;
  /* Byte 6 */
  cardinfo->CSD.PartBlockRead = (CSD_Tab[6] & 0x80) >> 7;
  cardinfo->CSD.WrBlockMisalign = (CSD_Tab[6] & 0x40) >> 6;
  cardinfo->CSD.RdBlockMisalign = (CSD_Tab[6] & 0x20) >> 5;
  cardinfo->CSD.DSRImpl = (CSD_Tab[6] & 0x10) >> 4;
  cardinfo->CSD.Reserved2 = 0; /* Reserved */
  cardinfo->CSD.DeviceSize = (CSD_Tab[6] & 0x03) << 10;
```

```
  /* Byte 7 */
  cardinfo->CSD.DeviceSize |= (CSD_Tab[7]) << 2;
  /* Byte 8 */
  cardinfo->CSD.DeviceSize |= (CSD_Tab[8] & 0xC0) >> 6;
  cardinfo->CSD.MaxRdCurrentVDDMin = (CSD_Tab[8] & 0x38) >> 3;
  cardinfo->CSD.MaxRdCurrentVDDMax = (CSD_Tab[8] & 0x07);
  /* Byte 9 */
  cardinfo->CSD.MaxWrCurrentVDDMin = (CSD_Tab[9] & 0xE0) >> 5;
  cardinfo->CSD.MaxWrCurrentVDDMax = (CSD_Tab[9] & 0x1C) >> 2;
  cardinfo->CSD.DeviceSizeMul = (CSD_Tab[9] & 0x03) << 1;
  /* Byte 10 */
  cardinfo->CSD.DeviceSizeMul |= (CSD_Tab[10] & 0x80) >> 7;
  cardinfo->CSD.EraseGrSize = (CSD_Tab[10] & 0x7C) >> 2;
  cardinfo->CSD.EraseGrMul = (CSD_Tab[10] & 0x03) << 3;
  /* Byte 11 */
  cardinfo->CSD.EraseGrMul |= (CSD_Tab[11] & 0xE0) >> 5;
  cardinfo->CSD.WrProtectGrSize = (CSD_Tab[11] & 0x1F);
  /* Byte 12 */
  cardinfo->CSD.WrProtectGrEnable = (CSD_Tab[12] & 0x80) >> 7;
  cardinfo->CSD.ManDeflECC = (CSD_Tab[12] & 0x60) >> 5;
  cardinfo->CSD.WrSpeedFact = (CSD_Tab[12] & 0x1C) >> 2;
  cardinfo->CSD.MaxWrBlockLen = (CSD_Tab[12] & 0x03) << 2;
  /* Byte 13 */
  cardinfo->CSD.MaxWrBlockLen |= (CSD_Tab[13] & 0xc0) >> 6;
  cardinfo->CSD.WriteBlockPaPartial = (CSD_Tab[13] & 0x20) >> 5;
  cardinfo->CSD.Reserved3 = 0;
  cardinfo->CSD.ContentProtectAppli = (CSD_Tab[13] & 0x01);
  /* Byte 14 */
  cardinfo->CSD.FileFormatGrouop = (CSD_Tab[14] & 0x80) >> 7;
  cardinfo->CSD.CopyFlag = (CSD_Tab[14] & 0x40) >> 6;
  cardinfo->CSD.PermWrProtect = (CSD_Tab[14] & 0x20) >> 5;
  cardinfo->CSD.TempWrProtect = (CSD_Tab[14] & 0x10) >> 4;
  cardinfo->CSD.FileFormat = (CSD_Tab[14] & 0x0C) >> 2;
  cardinfo->CSD.ECC = (CSD_Tab[14] & 0x03);
  /* Byte 15 */
  cardinfo->CSD.CSD_CRC = (CSD_Tab[15] & 0xFE) >> 1;
  cardinfo->CSD.Reserved4 = 1;

  if(cardinfo->CardType == CARDTYPE_SDV2HC)
```

```
  {
        /* Byte 7 */
        cardinfo->CSD.DeviceSize = (uint16_t)(CSD_Tab[8]) *256;
        /* Byte 8 */
        cardinfo->CSD.DeviceSize += CSD_Tab[9] ;
  }

  cardinfo->Capacity = cardinfo->CSD.DeviceSize * MSD_BLOCKSIZE * 1024;
  cardinfo->BlockSize = MSD_BLOCKSIZE;

  /* Byte 0 */
  cardinfo->CID.ManufacturerID = CID_Tab[0];
  /* Byte 1 */
  cardinfo->CID.OEM_AppliID = CID_Tab[1] << 8;
  /* Byte 2 */
  cardinfo->CID.OEM_AppliID |= CID_Tab[2];
  /* Byte 3 */
  cardinfo->CID.ProdName1 = CID_Tab[3] << 24;
  /* Byte 4 */
  cardinfo->CID.ProdName1 |= CID_Tab[4] << 16;
  /* Byte 5 */
  cardinfo->CID.ProdName1 |= CID_Tab[5] << 8;
  /* Byte 6 */
  cardinfo->CID.ProdName1 |= CID_Tab[6];
  /* Byte 7 */
  cardinfo->CID.ProdName2 = CID_Tab[7];
  /* Byte 8 */
  cardinfo->CID.ProdRev = CID_Tab[8];
  /* Byte 9 */
  cardinfo->CID.ProdSN = CID_Tab[9] << 24;
  /* Byte 10 */
  cardinfo->CID.ProdSN |= CID_Tab[10] << 16;
  /* Byte 11 */
  cardinfo->CID.ProdSN |= CID_Tab[11] << 8;
  /* Byte 12 */
  cardinfo->CID.ProdSN |= CID_Tab[12];
  /* Byte 13 */
  cardinfo->CID.Reserved1 |= (CID_Tab[13] & 0xF0) >> 4;
  /* Byte 14 */
```

```
  cardinfo->CID.ManufactDate = (CID_Tab[13] & 0x0F) << 8;
  /* Byte 15 */
  cardinfo->CID.ManufactDate |= CID_Tab[14];
  /* Byte 16 */
  cardinfo->CID.CID_CRC = (CID_Tab[15] & 0xFE) >> 1;
  cardinfo->CID.Reserved2 = 1;

  return 0;
}

/*******************************************************************************
* Function Name  : _read_buffer
* Description    : None
* Input          : - *buff:
*                                - len:
*                                - release:
* Output         : None
* Return         : 0f°NO_ERR; TRUE: Error
* Attention             : None
*******************************************************************************/
int _read_buffer(uint8_t *buff, uint16_t len, uint8_t release)
{
  uint8_t r1;
  uint16_t retry;

  /* Card enable, Prepare to read    */
  _card_enable();

  /* Wait start-token 0xFE */
  for(retry=0; retry<2000; retry++)
  {
        r1 = _spi_read_write(DUMMY_BYTE);
        if(r1 == 0xFE)
        {
                retry = 0;
                break;
        }
  }
```

```
  /* Timeout return   */
  if(retry == 2000)
  {
        _card_disable();
        return 1;
  }

  /* Start reading */
  for(retry=0; retry<len; retry++)
  {
     *(buff+retry) = _spi_read_write(DUMMY_BYTE);
  }

  /* 2bytes dummy CRC */
  _spi_read_write(DUMMY_BYTE);
  _spi_read_write(DUMMY_BYTE);

  /* chip disable and dummy byte */
  if(release)
  {
        _card_disable();
        _spi_read_write(DUMMY_BYTE);
  }

  return 0;
}

/*****************************************************************************
* Function Name  : MSD_ReadSingleBlock
* Description    : None
* Input          : - sector:
*                                - buffer:
* Output         : None
* Return         : None
* Attention             : None
*****************************************************************************/
int MSD_ReadSingleBlock(uint32_t sector, uint8_t *buffer)
{
  uint8_t r1;
```

```
  /* if ver = SD2.0 HC, sector need <<9 */
  if(CardInfo.CardType != CARDTYPE_SDV2HC)
  {
        sector = sector<<9;
  }

  /* Send CMD17 : Read single block command */
  r1 = _send_command(CMD17, sector, 0);

  if(r1 != 0x00)
  {
        return 1;
  }

  /* Start read and return the result */
  r1 = _read_buffer(buffer, MSD_BLOCKSIZE, RELEASE);

  /* Send stop data transmit command - CMD12 */
  _send_command(CMD12, 0, 0);

  return r1;
}

/*****************************************************************************
* Function Name  : MSD_ReadMultiBlock
* Description    : None
* Input          : - sector:
*                                  - buffer:
*                   - NbrOfSector:
* Output         : None
* Return         : None
* Attention             : None
*****************************************************************************/
int MSD_ReadMultiBlock(uint32_t sector, uint8_t *buffer, uint32_t NbrOfSector)
{
  uint8_t r1;
  uint32_t i;
```

```
  /* if ver = SD2.0 HC, sector need <<9 */
  if(CardInfo.CardType != CARDTYPE_SDV2HC)
  {
        sector = sector<<9;
  }

  /* Send CMD18 : Read multi block command */
  r1 = _send_command(CMD18, sector, 0);
  if(r1 != 0x00)
  {
     return 1;
  }

  /* Start read       */
  for(i=0; i<NbrOfSector; i++)
  {
     if(_read_buffer(buffer+i*MSD_BLOCKSIZE, MSD_BLOCKSIZE, HOLD))
     {
                /* Send stop data transmit command - CMD12 */
                _send_command(CMD12, 0, 0);
                /* chip disable and dummy byte */
                _card_disable();
                return 2;
     }
  }

  /* Send stop data transmit command - CMD12 */
  _send_command(CMD12, 0, 0);

  /* chip disable and dummy byte */
  _card_disable();
  _spi_read_write(DUMMY_BYTE);

  return 0;
}

/*****************************************************************************
* Function Name  : MSD_WriteSingleBlock
* Description    : None
```

```
* Input          : - sector:
*                                - buffer:
* Output         : None
* Return         : None
* Attention             : None
*******************************************************************************/
int MSD_WriteSingleBlock(uint32_t sector, const uint8_t *buffer)
{
  uint8_t r1;
  uint16_t i;
  uint32_t retry;

  /* if ver = SD2.0 HC, sector need <<9 */
  if(CardInfo.CardType != CARDTYPE_SDV2HC)
  {
        sector = sector<<9;
  }

  /* Send CMD24 : Write single block command */
  r1 = _send_command(CMD24, sector, 0);

  if(r1 != 0x00)
  {
        return 1;
  }

  /* Card enable, Prepare to write */
  _card_enable();
  _spi_read_write(DUMMY_BYTE);
  _spi_read_write(DUMMY_BYTE);
  _spi_read_write(DUMMY_BYTE);
  /* Start data write token: 0xFE */
  _spi_read_write(0xFE);

  /* Start single block write the data buffer */
  for(i=0; i<MSD_BLOCKSIZE; i++)
  {
    _spi_read_write(*buffer++);
  }
```

```
  /* 2Bytes dummy CRC */
  _spi_read_write(DUMMY_BYTE);
  _spi_read_write(DUMMY_BYTE);

  /* MSD card accept the data */
  r1 = _spi_read_write(DUMMY_BYTE);
  if((r1&0x1F) != 0x05)
  {
    _card_disable();
    return 2;
  }

  /* Wait all the data programm finished */
  retry = 0;
  while(_spi_read_write(DUMMY_BYTE) == 0x00)
  {
        /* Timeout return */
        if(retry++ == 0x40000)
        {
           _card_disable();
           return 3;
        }
  }

  /* chip disable and dummy byte */
  _card_disable();
  _spi_read_write(DUMMY_BYTE);

  return 0;
}

/*******************************************************************************
* Function Name  : MSD_WriteMultiBlock
* Description    : None
* Input          : - sector:
*                                  - buffer:
*                   - NbrOfSector:
* Output         : None
```

```
* Return         : None
* Attention            : None
*******************************************************************************/
int MSD_WriteMultiBlock(uint32_t sector, const uint8_t *buffer, uint32_t NbrOfSector)
{
  uint8_t r1;
  uint16_t i;
  uint32_t n;
  uint32_t retry;

  /* if ver = SD2.0 HC, sector need <<9 */
  if(CardInfo.CardType != CARDTYPE_SDV2HC)
  {
        sector = sector<<9;
  }

  /* Send command ACMD23 berfore multi write if is not a MMC card */
  if(CardInfo.CardType != CARDTYPE_MMC)
  {
        _send_command(ACMD23, NbrOfSector, 0x00);
  }

  /* Send CMD25 : Write nulti block command */
  r1 = _send_command(CMD25, sector, 0);

  if(r1 != 0x00)
  {
        return 1;
  }

  /* Card enable, Prepare to write */
  _card_enable();
  _spi_read_write(DUMMY_BYTE);
  _spi_read_write(DUMMY_BYTE);
  _spi_read_write(DUMMY_BYTE);

  for(n=0; n<NbrOfSector; n++)
  {
       /* Start multi block write token: 0xFC */
```

```
        _spi_read_write(0xFC);

        for(i=0; i<MSD_BLOCKSIZE; i++)
        {
              _spi_read_write(*buffer++);
        }

        /* 2Bytes dummy CRC */
        _spi_read_write(DUMMY_BYTE);
        _spi_read_write(DUMMY_BYTE);

        /* MSD card accept the data */
        r1 = _spi_read_write(DUMMY_BYTE);
        if((r1&0x1F) != 0x05)
        {
           _card_disable();
           return 2;
        }

        /* Wait all the data programm finished     */
        retry = 0;
        while(_spi_read_write(DUMMY_BYTE) != 0xFF)
        {
              /* Timeout return */
              if(retry++ == 0x40000)
              {
                 _card_disable();
                 return 3;
              }
        }
  }

  /* Send end of transmit token: 0xFD */
  r1 = _spi_read_write(0xFD);
  if(r1 == 0x00)
  {
        return 4;
  }
```

```
  /* Wait all the data programm finished */
  retry = 0;
  while(_spi_read_write(DUMMY_BYTE) != 0xFF)
  {
        /* Timeout return */
        if(retry++ == 0x40000)
        {
            _card_disable();
            return 5;
        }
  }

  /* chip disable and dummy byte */
  _card_disable();
  _spi_read_write(DUMMY_BYTE);

  return 0;
}



/*******************************************************************************
* Function Name  : _send_command
* Description    : None
* Input          : - cmd:
*                                  - arg:
*                   - crc:
* Output         : None
* Return         : R1 value, response from card
* Attention             : None
*******************************************************************************/
int _send_command(uint8_t cmd, uint32_t arg, uint8_t crc)
{
  uint8_t r1;
  uint8_t retry;

  /* Dummy byte and chip enable */
  _spi_read_write(DUMMY_BYTE);
  _card_enable();
```

```
  /* Command, argument and crc */
  _spi_read_write(cmd | 0x40);
  _spi_read_write(arg >> 24);
  _spi_read_write(arg >> 16);
  _spi_read_write(arg >> 8);
  _spi_read_write(arg);
  _spi_read_write(crc);

  /* Wait response, quit till timeout */
  for(retry=0; retry<200; retry++)
  {
        r1 = _spi_read_write(DUMMY_BYTE);
        if(r1 != 0xFF)
        {
                break;
        }
  }

  /* Chip disable and dummy byte */
  _card_disable();
  _spi_read_write(DUMMY_BYTE);

  return r1;
}

/*****************************************************************************
* Function Name  : _send_command_hold
* Description    : None
* Input          : - cmd:
*                                - arg:
*                  - crc:
* Output         : None
* Return         : R1 value, response from card
* Attention             : None
*****************************************************************************/
int _send_command_hold(uint8_t cmd, uint32_t arg, uint8_t crc)
{
  uint8_t r1;
  uint8_t retry;
```

```
  /* Dummy byte and chip enable */
  _spi_read_write(DUMMY_BYTE);
  _card_enable();

  /* Command, argument and crc */
  _spi_read_write(cmd | 0x40);
  _spi_read_write(arg >> 24);
  _spi_read_write(arg >> 16);
  _spi_read_write(arg >> 8);
  _spi_read_write(arg);
  _spi_read_write(crc);

  /* Wait response, quit till timeout */
  for(retry=0; retry<200; retry++)
  {
        r1 = _spi_read_write(DUMMY_BYTE);
        if(r1 != 0xFF)
        {
                break;
        }
  }

  return r1;
}



/**********************************************************************
* $Id$         lpc17xx_ssp.c                         2010-06-18
*//**
* @file        lpc17xx_ssp.c
* @brief       Contains all functions support for SSP firmware library on LPC17xx
* @version     3.0
* @date        18. June. 2010
* @author      NXP MCU SW Application Team
*
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*
```

```
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* use without further testing or modification.
**********************************************************************/

/* Peripheral group ----------------------------------------------------------- */
/** @addtogroup SSP
 * @{
 */

/* Includes ------------------------------------------------------------------- */
#include "lpc17xx_ssp.h"
#include "lpc17xx_clkpwr.h"


/* If this source file built with example, the LPC17xx FW library configuration
 * file in each example directory ("lpc17xx_libcfg.h") must be included,
 * otherwise the default FW library configuration file must be included instead
 */
#ifdef __BUILD_WITH_EXAMPLE__
#include "lpc17xx_libcfg.h"
#else
#include "lpc17xx_libcfg_default.h"
#endif /* __BUILD_WITH_EXAMPLE__ */


#ifdef _SSP

/* Public Functions ----------------------------------------------------------- */
/** @addtogroup SSP_Public_Functions
 * @{
```

```
 */
static void setSSPclock (LPC_SSP_TypeDef *SSPx, uint32_t target_clock);

/*********************************************************************//**
 * @brief              Setup clock rate for SSP device
 * @param[in]  SSPx    SSP peripheral definition, should be:
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]  target_clock : clock of SSP (Hz)
 * @return             None
 **********************************************************************/
static void setSSPclock (LPC_SSP_TypeDef *SSPx, uint32_t target_clock)
{
    uint32_t prescale, cr0_div, cmp_clk, ssp_clk;

    CHECK_PARAM(PARAM_SSPx(SSPx));

    /* The SSP clock is derived from the (main system oscillator / 2),
       so compute the best divider from that clock */
    if (SSPx == LPC_SSP0){
       ssp_clk = CLKPWR_GetPCLK (CLKPWR_PCLKSEL_SSP0);
    } else if (SSPx == LPC_SSP1) {
       ssp_clk = CLKPWR_GetPCLK (CLKPWR_PCLKSEL_SSP1);
    } else {
       return;
    }

       /* Find closest divider to get at or under the target frequency.
          Use smallest prescale possible and rely on the divider to get
          the closest target frequency */
       cr0_div = 0;
       cmp_clk = 0xFFFFFFFF;
       prescale = 2;
       while (cmp_clk > target_clock)
       {
               cmp_clk = ssp_clk / ((cr0_div + 1) * prescale);
               if (cmp_clk > target_clock)
               {
                       cr0_div++;
```

```
                        if (cr0_div > 0xFF)
                        {
                                cr0_div = 0;
                                prescale += 2;
                        }
                }
        }

    /* Write computed prescaler and divider back to register */
    SSPx->CR0 &= (~SSP_CR0_SCR(0xFF)) & SSP_CR0_BITMASK;
    SSPx->CR0 |= (SSP_CR0_SCR(cr0_div)) & SSP_CR0_BITMASK;
    SSPx->CPSR = prescale & SSP_CPSR_BITMASK;
}

/**
 * @}
 */

/* Public Functions ----------------------------------------------------------- */
/** @addtogroup SSP_Public_Functions
 * @{
 */

/*********************************************************************//**
 * @brief              Initializes the SSPx peripheral according to the specified
*               parameters in the SSP_ConfigStruct.
 * @param[in]  SSPx    SSP peripheral selected, should be:
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]  SSP_ConfigStruct Pointer to a SSP_CFG_Type structure
*                    that contains the configuration information for the
*                    specified SSP peripheral.
 * @return             None
 **********************************************************************/
void SSP_Init(LPC_SSP_TypeDef *SSPx, SSP_CFG_Type *SSP_ConfigStruct)
{
        uint32_t tmp;

        CHECK_PARAM(PARAM_SSPx(SSPx));
```

```
	if(SSPx == LPC_SSP0) {
		/* Set up clock and power for SSP0 module */
		CLKPWR_ConfigPPWR (CLKPWR_PCONP_PCSSP0, ENABLE);
	} else if(SSPx == LPC_SSP1) {
		/* Set up clock and power for SSP1 module */
		CLKPWR_ConfigPPWR (CLKPWR_PCONP_PCSSP1, ENABLE);
	} else {
		return;
	}

	/* Configure SSP, interrupt is disable, LoopBack mode is disable,
	 * SSP is disable, Slave output is disable as default
	 */
	tmp = ((SSP_ConfigStruct->CPHA) | (SSP_ConfigStruct->CPOL) \
		| (SSP_ConfigStruct->FrameFormat) | (SSP_ConfigStruct->Databit))
		& SSP_CR0_BITMASK;
	// write back to SSP control register
	SSPx->CR0 = tmp;

	tmp = SSP_ConfigStruct->Mode & SSP_CR1_BITMASK;
	// Write back to CR1
	SSPx->CR1 = tmp;

	// Set clock rate for SSP peripheral
	setSSPclock(SSPx, SSP_ConfigStruct->ClockRate);
}

/*********************************************************************//**
 * @brief		De-initializes the SSPx peripheral registers to their
*                  default reset values.
 * @param[in]	SSPx	SSP peripheral selected, should be:
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @return		None
 **********************************************************************/
void SSP_DeInit(LPC_SSP_TypeDef* SSPx)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));
```

```
	if (SSPx == LPC_SSP0){
		/* Set up clock and power for SSP0 module */
		CLKPWR_ConfigPPWR (CLKPWR_PCONP_PCSSP0, DISABLE);
	} else if (SSPx == LPC_SSP1) {
		/* Set up clock and power for SSP1 module */
		CLKPWR_ConfigPPWR (CLKPWR_PCONP_PCSSP1, DISABLE);
	}
}

/*********************************************************************//**
* @brief		Get data size bit selected
* @param[in]	SSPx pointer to LPC_SSP_TypeDef structure, should be:
*				- LPC_SSP0: SSP0 peripheral
*				- LPC_SSP1: SSP1 peripheral
* @return		Data size, could be:
*				- SSP_DATABIT_4: 4 bit transfer
*				- SSP_DATABIT_5: 5 bit transfer
*				...
*				- SSP_DATABIT_16: 16 bit transfer
**********************************************************************/
uint8_t SSP_GetDataSize(LPC_SSP_TypeDef* SSPx)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));
	return (SSPx->CR0 & (0xF));
}

/*********************************************************************//**
* @brief		Fills each SSP_InitStruct member with its default value:
*				- CPHA = SSP_CPHA_FIRST
*				- CPOL = SSP_CPOL_HI
*				- ClockRate = 1000000
*				- Databit = SSP_DATABIT_8
*				- Mode = SSP_MASTER_MODE
*				- FrameFormat = SSP_FRAME_SSP
* @param[in]	SSP_InitStruct Pointer to a SSP_CFG_Type structure
*			which will be initialized.
* @return		None
**********************************************************************/
```

```
void SSP_ConfigStructInit(SSP_CFG_Type *SSP_InitStruct)
{
	SSP_InitStruct->CPHA = SSP_CPHA_FIRST;
	SSP_InitStruct->CPOL = SSP_CPOL_HI;
	SSP_InitStruct->ClockRate = 1000000;
	SSP_InitStruct->Databit = SSP_DATABIT_8;
	SSP_InitStruct->Mode = SSP_MASTER_MODE;
	SSP_InitStruct->FrameFormat = SSP_FRAME_SPI;
}


/*********************************************************************//**
 * @brief		Enable or disable SSP peripheral's operation
 * @param[in]	SSPx	SSP peripheral, should be:
 *				- LPC_SSP0: SSP0 peripheral
 *				- LPC_SSP1: SSP1 peripheral
 * @param[in]	NewState New State of SSPx peripheral's operation
 * @return		none
 **********************************************************************/
void SSP_Cmd(LPC_SSP_TypeDef* SSPx, FunctionalState NewState)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));
	CHECK_PARAM(PARAM_FUNCTIONALSTATE(NewState));

	if (NewState == ENABLE)
	{
		SSPx->CR1 |= SSP_CR1_SSP_EN;
	}
	else
	{
		SSPx->CR1 &= (~SSP_CR1_SSP_EN) & SSP_CR1_BITMASK;
	}
}

/*********************************************************************//**
 * @brief		Enable or disable Loop Back mode function in SSP peripheral
 * @param[in]	SSPx	SSP peripheral selected, should be:
 *					- LPC_SSP0: SSP0 peripheral
 *						- LPC_SSP1: SSP1 peripheral
```

```
 * @param[in]  NewState       New State of Loop Back mode, should be:
 *                                                  - ENABLE: Enable this function
 *                                                  - DISABLE: Disable this function
 * @return            None
 *********************************************************************/
void SSP_LoopBackCmd(LPC_SSP_TypeDef* SSPx, FunctionalState NewState)
{
        CHECK_PARAM(PARAM_SSPx(SSPx));
        CHECK_PARAM(PARAM_FUNCTIONALSTATE(NewState));

        if (NewState == ENABLE)
        {
                SSPx->CR1 |= SSP_CR1_LBM_EN;
        }
        else
        {
                SSPx->CR1 &= (~SSP_CR1_LBM_EN) & SSP_CR1_BITMASK;
        }
}

/*********************************************************************//**
 * @brief             Enable or disable Slave Output function in SSP peripheral
 * @param[in]  SSPx    SSP peripheral selected, should be:
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]  NewState       New State of Slave Output function, should be:
 *                                                  - ENABLE: Slave Output in normal
operation
 *                                                  - DISABLE: Slave Output is disabled.
This blocks
 *                                                  SSP controller from driving the
transmit data
 *                                                  line (MISO)
 * Note:              This function is available when SSP peripheral in Slave mode
 * @return            None
 *********************************************************************/
void SSP_SlaveOutputCmd(LPC_SSP_TypeDef* SSPx, FunctionalState NewState)
{
        CHECK_PARAM(PARAM_SSPx(SSPx));
        CHECK_PARAM(PARAM_FUNCTIONALSTATE(NewState));
```

```
	if (NewState == ENABLE)
	{
		SSPx->CR1 &= (~SSP_CR1_SO_DISABLE) & SSP_CR1_BITMASK;
	}
	else
	{
		SSPx->CR1 |= SSP_CR1_SO_DISABLE;
	}
}



/*********************************************************************//**
 * @brief		Transmit a single data through SSPx peripheral
 * @param[in]	SSPx	SSP peripheral selected, should be:
 *					- LPC_SSP0: SSP0 peripheral
 *					- LPC_SSP1: SSP1 peripheral
 * @param[in]	Data	Data to transmit (must be 16 or 8-bit long,
 *					this depend on SSP data bit number
configured)
 * @return		none
 **********************************************************************/
void SSP_SendData(LPC_SSP_TypeDef* SSPx, uint16_t Data)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));

	SSPx->DR = SSP_DR_BITMASK(Data);
}



/*********************************************************************//**
 * @brief		Receive a single data from SSPx peripheral
 * @param[in]	SSPx	SSP peripheral selected, should be
 *					- LPC_SSP0: SSP0 peripheral
 *					- LPC_SSP1: SSP1 peripheral
 * @return		Data received (16-bit long)
 **********************************************************************/
uint16_t SSP_ReceiveData(LPC_SSP_TypeDef* SSPx)
{
```

```
	CHECK_PARAM(PARAM_SSPx(SSPx));

	return ((uint16_t) (SSP_DR_BITMASK(SSPx->DR)));
}

/*********************************************************************//**
 * @brief		SSP Read write data function
 * @param[in]	SSPx	Pointer to SSP peripheral, should be
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]	dataCfg Pointer to a SSP_DATA_SETUP_Type structure that
 *                                          contains specified information about
transmit
 *                                          data configuration.
 * @param[in]	xfType	Transfer type, should be:
 *                                          - SSP_TRANSFER_POLLING: Polling mode
 *                                          - SSP_TRANSFER_INTERRUPT: Interrupt mode
 * @return		Actual Data length has been transferred in polling mode.
 *                          In interrupt mode, always return (0)
 *                          Return (-1) if error.
 * Note: This function can be used in both master and slave mode.
 **********************************************************************/
int32_t SSP_ReadWrite (LPC_SSP_TypeDef *SSPx, SSP_DATA_SETUP_Type *dataCfg, \
                                          SSP_TRANSFER_Type xfType)
{
	uint8_t *rdata8;
    uint8_t *wdata8;
	uint16_t *rdata16;
    uint16_t *wdata16;
    uint32_t stat;
    uint32_t tmp;
    int32_t dataword;

    dataCfg->rx_cnt = 0;
    dataCfg->tx_cnt = 0;
    dataCfg->status = 0;

	/* Clear all remaining data in RX FIFO */
	while (SSPx->SR & SSP_SR_RNE){
```

```
		tmp = (uint32_t) SSP_ReceiveData(SSPx);
	}


	// Clear status
	SSPx->ICR = SSP_ICR_BITMASK;
	if(SSP_GetDataSize(SSPx)>8)
		dataword = 1;
	else dataword = 0;


	// Polling mode ----------------------------------------------------------------
-----
	if (xfType == SSP_TRANSFER_POLLING){
		if (dataword == 0){
			rdata8 = (uint8_t *)dataCfg->rx_data;
			wdata8 = (uint8_t *)dataCfg->tx_data;
		} else {
			rdata16 = (uint16_t *)dataCfg->rx_data;
			wdata16 = (uint16_t *)dataCfg->tx_data;
		}
		while ((dataCfg->tx_cnt != dataCfg->length) || (dataCfg->rx_cnt !=
dataCfg->length)){
			if ((SSPx->SR & SSP_SR_TNF) && (dataCfg->tx_cnt != dataCfg-
>length)){
				// Write data to buffer
				if(dataCfg->tx_data == NULL){
					if (dataword == 0){
						SSP_SendData(SSPx, 0xFF);
						dataCfg->tx_cnt++;
					} else {
						SSP_SendData(SSPx, 0xFFFF);
						dataCfg->tx_cnt += 2;
					}
				} else {
					if (dataword == 0){
						SSP_SendData(SSPx, *wdata8);
						wdata8++;
						dataCfg->tx_cnt++;
					} else {
						SSP_SendData(SSPx, *wdata16);
						wdata16++;
						dataCfg->tx_cnt += 2;
```

```
                                }
                        }
                }

                // Check overrun error
                if ((stat = SSPx->RIS) & SSP_RIS_ROR){
                        // save status and return
                        dataCfg->status = stat | SSP_STAT_ERROR;
                        return (-1);
                }

                // Check for any data available in RX FIFO
                while ((SSPx->SR & SSP_SR_RNE) && (dataCfg->rx_cnt != dataCfg-
>length)){
                        // Read data from SSP data
                        tmp = SSP_ReceiveData(SSPx);

                        // Store data to destination
                        if (dataCfg->rx_data != NULL)
                        {
                                if (dataword == 0){
                                        *(rdata8) = (uint8_t) tmp;
                                        rdata8++;
                                } else {
                                        *(rdata16) = (uint16_t) tmp;
                                        rdata16++;
                                }
                        }
                        // Increase counter
                        if (dataword == 0){
                                dataCfg->rx_cnt++;
                        } else {
                                dataCfg->rx_cnt += 2;
                        }
                }
        }

        // save status
        dataCfg->status = SSP_STAT_DONE;
```

```
		if (dataCfg->tx_data != NULL){
			return dataCfg->tx_cnt;
		} else if (dataCfg->rx_data != NULL){
			return dataCfg->rx_cnt;
		} else {
			return (0);
		}
	}

	// Interrupt mode ---------------------------------------------------------------
-------
	else if (xfType == SSP_TRANSFER_INTERRUPT){

		while ((SSPx->SR & SSP_SR_TNF) && (dataCfg->tx_cnt != dataCfg->length)){
			// Write data to buffer
			if(dataCfg->tx_data == NULL){
				if (dataword == 0){
					SSP_SendData(SSPx, 0xFF);
					dataCfg->tx_cnt++;
				} else {
					SSP_SendData(SSPx, 0xFFFF);
					dataCfg->tx_cnt += 2;
				}
			} else {
				if (dataword == 0){
					SSP_SendData(SSPx, (*(uint8_t *)((uint32_t)dataCfg-
>tx_data + dataCfg->tx_cnt)));
					dataCfg->tx_cnt++;
				} else {
					SSP_SendData(SSPx, (*(uint16_t
*)((uint32_t)dataCfg->tx_data + dataCfg->tx_cnt)));
					dataCfg->tx_cnt += 2;
				}
			}

			// Check error
			if ((stat = SSPx->RIS) & SSP_RIS_ROR){
				// save status and return
				dataCfg->status = stat | SSP_STAT_ERROR;
				return (-1);
			}
```

```
                        // Check for any data available in RX FIFO
                        while ((SSPx->SR & SSP_SR_RNE) && (dataCfg->rx_cnt != dataCfg-
>length)){
                                // Read data from SSP data
                                tmp = SSP_ReceiveData(SSPx);

                                // Store data to destination
                                if (dataCfg->rx_data != NULL)
                                {
                                        if (dataword == 0){
                                                *(uint8_t *)((uint32_t)dataCfg->rx_data +
dataCfg->rx_cnt) = (uint8_t) tmp;
                                        } else {
                                                *(uint16_t *)((uint32_t)dataCfg->rx_data +
dataCfg->rx_cnt) = (uint16_t) tmp;
                                        }
                                }
                                // Increase counter
                                if (dataword == 0){
                                        dataCfg->rx_cnt++;
                                } else {
                                        dataCfg->rx_cnt += 2;
                                }
                        }
                }

                // If there more data to sent or receive
                if ((dataCfg->rx_cnt != dataCfg->length) || (dataCfg->tx_cnt != dataCfg-
>length)){
                        // Enable all interrupt
                        SSPx->IMSC = SSP_IMSC_BITMASK;
                } else {
                        // Save status
                        dataCfg->status = SSP_STAT_DONE;
                }
                return (0);
        }

        return (-1);
}
```

```
/*********************************************************************//**
 * @brief		Checks whether the specified SSP status flag is set or not
 * @param[in]	SSPx	SSP peripheral selected, should be:
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]	FlagType	Type of flag to check status, should be one
 *                                                  of following:
 *                                                  - SSP_STAT_TXFIFO_EMPTY: TX FIFO is
empty
 *                                                  - SSP_STAT_TXFIFO_NOTFULL: TX FIFO
is not full
 *                                                  - SSP_STAT_RXFIFO_NOTEMPTY: RX FIFO
is not empty
 *                                                  - SSP_STAT_RXFIFO_FULL: RX FIFO is
full
 *                                                  - SSP_STAT_BUSY: SSP peripheral is
busy
 * @return		New State of specified SSP status flag
 **********************************************************************/
FlagStatus SSP_GetStatus(LPC_SSP_TypeDef* SSPx, uint32_t FlagType)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));
	CHECK_PARAM(PARAM_SSP_STAT(FlagType));

	return ((SSPx->SR & FlagType) ? SET : RESET);
}

/*********************************************************************//**
 * @brief		Enable or disable specified interrupt type in SSP peripheral
 * @param[in]	SSPx	SSP peripheral selected, should be:
 *                                          - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]	IntType	Interrupt type in SSP peripheral, should be:
 *                          - SSP_INTCFG_ROR: Receive Overrun interrupt
 *                          - SSP_INTCFG_RT: Receive Time out interrupt
 *                          - SSP_INTCFG_RX: RX FIFO is at least half full interrupt
 *                          - SSP_INTCFG_TX: TX FIFO is at least half empty interrupt
 * @param[in]	NewState New State of specified interrupt type, should be:
 *                          - ENABLE: Enable this interrupt type
 *                          - DISABLE: Disable this interrupt type
 * @return		None
```

```
 * Note: We can enable/disable multi-interrupt type by OR multi value
 *********************************************************************/
void SSP_IntConfig(LPC_SSP_TypeDef *SSPx, uint32_t IntType, FunctionalState NewState)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));

	if (NewState == ENABLE)
	{
		SSPx->IMSC |= IntType;
	}
	else
	{
		SSPx->IMSC &= (~IntType) & SSP_IMSC_BITMASK;
	}
}

/*********************************************************************//**
 * @brief	Check whether the specified Raw interrupt status flag is
 *			set or not
 * @param[in]	SSPx	SSP peripheral selected, should be:
 *					- LPC_SSP0: SSP0 peripheral
 *					- LPC_SSP1: SSP1 peripheral
 * @param[in]	RawIntType	Raw Interrupt Type, should be:
 *				- SSP_INTSTAT_RAW_ROR: Receive Overrun interrupt
 *				- SSP_INTSTAT_RAW_RT: Receive Time out interrupt
 *				- SSP_INTSTAT_RAW_RX: RX FIFO is at least half full
interrupt
 *				- SSP_INTSTAT_RAW_TX: TX FIFO is at least half empty
interrupt
 * @return	New State of specified Raw interrupt status flag in SSP peripheral
 * Note: Enabling/Disabling specified interrupt in SSP peripheral does not
 *		effect to Raw Interrupt Status flag.
 *********************************************************************/
IntStatus SSP_GetRawIntStatus(LPC_SSP_TypeDef *SSPx, uint32_t RawIntType)
{
	CHECK_PARAM(PARAM_SSPx(SSPx));
	CHECK_PARAM(PARAM_SSP_INTSTAT_RAW(RawIntType));

	return ((SSPx->RIS & RawIntType) ? SET : RESET);
}
```

```
/*********************************************************************//**
 * @brief             Get Raw Interrupt Status register
 * @param[in]  SSPx   SSP peripheral selected, should be:
 *                                        - LPC_SSP0: SSP0 peripheral
 *                                        - LPC_SSP1: SSP1 peripheral
 * @return            Raw Interrupt Status (RIS) register value
 **********************************************************************/
uint32_t SSP_GetRawIntStatusReg(LPC_SSP_TypeDef *SSPx)
{
        CHECK_PARAM(PARAM_SSPx(SSPx));
        return (SSPx->RIS);
}

/*********************************************************************//**
 * @brief      Check whether the specified interrupt status flag is
 *                    set or not
 * @param[in]  SSPx   SSP peripheral selected, should be:
 *                                        - LPC_SSP0: SSP0 peripheral
 *                                        - LPC_SSP1: SSP1 peripheral
 * @param[in]  IntType Raw Interrupt Type, should be:
 *                            - SSP_INTSTAT_ROR: Receive Overrun interrupt
 *                            - SSP_INTSTAT_RT: Receive Time out interrupt
 *                            - SSP_INTSTAT_RX: RX FIFO is at least half full interrupt
 *                            - SSP_INTSTAT_TX: TX FIFO is at least half empty interrupt
 * @return     New State of specified interrupt status flag in SSP peripheral
 * Note: Enabling/Disabling specified interrupt in SSP peripheral effects
 *                    to Interrupt Status flag.
 **********************************************************************/
IntStatus SSP_GetIntStatus (LPC_SSP_TypeDef *SSPx, uint32_t IntType)
{
        CHECK_PARAM(PARAM_SSPx(SSPx));
        CHECK_PARAM(PARAM_SSP_INTSTAT(IntType));

        return ((SSPx->MIS & IntType) ? SET :RESET);
}

/*********************************************************************//**
 * @brief                          Clear specified interrupt pending in SSP peripheral
```

```
 * @param[in]  SSPx    SSP peripheral selected, should be:
 *                                  - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]  IntType Interrupt pending to clear, should be:
 *                                          - SSP_INTCLR_ROR: clears the "frame was
received when
 *                                          RxFIFO was full" interrupt.
 *                                          - SSP_INTCLR_RT: clears the "Rx FIFO was not
empty and
 *                                          has not been read for a timeout period"
interrupt.
 * @return             None
 **********************************************************************/
void SSP_ClearIntPending(LPC_SSP_TypeDef *SSPx, uint32_t IntType)
{
        CHECK_PARAM(PARAM_SSPx(SSPx));
        CHECK_PARAM(PARAM_SSP_INTCLR(IntType));

        SSPx->ICR = IntType;
}

/*********************************************************************//**
 * @brief                          Enable/Disable DMA function for SSP peripheral
 * @param[in]  SSPx    SSP peripheral selected, should be:
 *                                  - LPC_SSP0: SSP0 peripheral
 *                                          - LPC_SSP1: SSP1 peripheral
 * @param[in]  DMAMode Type of DMA, should be:
 *                                          - SSP_DMA_TX: DMA for the transmit FIFO
 *                                          - SSP_DMA_RX: DMA for the Receive FIFO
 * @param[in]  NewState       New State of DMA function on SSP peripheral,
 *                                          should be:
 *                                          - ENALBE: Enable this function
 *                                          - DISABLE: Disable this function
 * @return             None
 **********************************************************************/
void SSP_DMACmd(LPC_SSP_TypeDef *SSPx, uint32_t DMAMode, FunctionalState NewState)
{
        CHECK_PARAM(PARAM_SSPx(SSPx));
        CHECK_PARAM(PARAM_SSP_DMA(DMAMode));
        CHECK_PARAM(PARAM_FUNCTIONALSTATE(NewState));
```

```
	if (NewState == ENABLE)
	{
		SSPx->DMACR |= DMAMode;
	}
	else
	{
		SSPx->DMACR &= (~DMAMode) & SSP_DMA_BITMASK;
	}
}

/**
 * @}
 */

#endif /* _SSP */

/**
 * @}
 */

/* ---------------------------------- End Of File ------------------------------ */



/**********************************************************************
* $Id$		lpc17xx_pinsel.c				2010-05-21
*//**
* @file		lpc17xx_pinsel.c
* @brief	Contains all functions support for Pin connect block firmware
*			library on LPC17xx
* @version	2.0
* @date		21. May. 2010
* @author	NXP MCU SW Application Team
*
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```
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* warranty that such application will be suitable for the specified
* use without further testing or modification.
**********************************************************************/

/* Peripheral group ----------------------------------------------------------- */
/** @addtogroup PINSEL
 * @{
 */

/* Includes ------------------------------------------------------------------- */
#include "lpc17xx_pinsel.h"

/* Public Functions ----------------------------------------------------------- */

static void set_PinFunc ( uint8_t portnum, uint8_t pinnum, uint8_t funcnum);
static void set_ResistorMode ( uint8_t portnum, uint8_t pinnum, uint8_t modenum);
static void set_OpenDrainMode( uint8_t portnum, uint8_t pinnum, uint8_t modenum);

/*********************************************************************//**
 * @brief             Setup the pin selection function
 * @param[in]  portnum PORT number,
 *                            should be one of the following:
 *                            - PINSEL_PORT_0       : Port 0
 *                            - PINSEL_PORT_1       : Port 1
 *                            - PINSEL_PORT_2       : Port 2
 *                            - PINSEL_PORT_3       : Port 3
 *
 * @param[in]  pinnum  Pin number,
 *                            should be one of the following:
                              - PINSEL_PIN_0 : Pin 0
                              - PINSEL_PIN_1 : Pin 1
                              - PINSEL_PIN_2 : Pin 2
```

```
                            - PINSEL_PIN_3 : Pin 3
                            - PINSEL_PIN_4 : Pin 4
                            - PINSEL_PIN_5 : Pin 5
                            - PINSEL_PIN_6 : Pin 6
                            - PINSEL_PIN_7 : Pin 7
                            - PINSEL_PIN_8 : Pin 8
                            - PINSEL_PIN_9 : Pin 9
                            - PINSEL_PIN_10 : Pin 10
                            - PINSEL_PIN_11 : Pin 11
                            - PINSEL_PIN_12 : Pin 12
                            - PINSEL_PIN_13 : Pin 13
                            - PINSEL_PIN_14 : Pin 14
                            - PINSEL_PIN_15 : Pin 15
                            - PINSEL_PIN_16 : Pin 16
                            - PINSEL_PIN_17 : Pin 17
                            - PINSEL_PIN_18 : Pin 18
                            - PINSEL_PIN_19 : Pin 19
                            - PINSEL_PIN_20 : Pin 20
                            - PINSEL_PIN_21 : Pin 21
                            - PINSEL_PIN_22 : Pin 22
                            - PINSEL_PIN_23 : Pin 23
                            - PINSEL_PIN_24 : Pin 24
                            - PINSEL_PIN_25 : Pin 25
                            - PINSEL_PIN_26 : Pin 26
                            - PINSEL_PIN_27 : Pin 27
                            - PINSEL_PIN_28 : Pin 28
                            - PINSEL_PIN_29 : Pin 29
                            - PINSEL_PIN_30 : Pin 30
                            - PINSEL_PIN_31 : Pin 31

 * @param[in]  funcnum Function number,
 *                            should be one of the following:
 *                            - PINSEL_FUNC_0 : default function
 *                            - PINSEL_FUNC_1 : first alternate function
 *                            - PINSEL_FUNC_2 : second alternate function
 *                            - PINSEL_FUNC_3 : third alternate function
 *
 * @return           None
 **********************************************************************/
```

```
static void set_PinFunc ( uint8_t portnum, uint8_t pinnum, uint8_t funcnum)
{
	uint32_t pinnum_t = pinnum;
	uint32_t pinselreg_idx = 2 * portnum;
	uint32_t *pPinCon = (uint32_t *)&LPC_PINCON->PINSEL0;

	if (pinnum_t >= 16) {
		pinnum_t -= 16;
		pinselreg_idx++;
	}
	*(uint32_t *)(pPinCon + pinselreg_idx) &= ~(0x03UL << (pinnum_t * 2));
	*(uint32_t *)(pPinCon + pinselreg_idx) |= ((uint32_t)funcnum) << (pinnum_t * 2);
}

/*********************************************************************//**
 * @brief		Setup resistor mode for each pin
 * @param[in]	portnum PORT number,
 *				should be one of the following:
 *				- PINSEL_PORT_0	: Port 0
 *				- PINSEL_PORT_1	: Port 1
 *				- PINSEL_PORT_2	: Port 2
 *				- PINSEL_PORT_3	: Port 3
 * @param[in]	pinnum Pin number,
 *				should be one of the following:
 *				- PINSEL_PIN_0 : Pin 0
 *				- PINSEL_PIN_1 : Pin 1
 *				- PINSEL_PIN_2 : Pin 2
 *				- PINSEL_PIN_3 : Pin 3
 *				- PINSEL_PIN_4 : Pin 4
 *				- PINSEL_PIN_5 : Pin 5
 *				- PINSEL_PIN_6 : Pin 6
 *				- PINSEL_PIN_7 : Pin 7
 *				- PINSEL_PIN_8 : Pin 8
 *				- PINSEL_PIN_9 : Pin 9
 *				- PINSEL_PIN_10 : Pin 10
 *				- PINSEL_PIN_11 : Pin 11
 *				- PINSEL_PIN_12 : Pin 12
 *				- PINSEL_PIN_13 : Pin 13
 *				- PINSEL_PIN_14 : Pin 14
```

```
                            - PINSEL_PIN_15 : Pin 15
                            - PINSEL_PIN_16 : Pin 16
                            - PINSEL_PIN_17 : Pin 17
                            - PINSEL_PIN_18 : Pin 18
                            - PINSEL_PIN_19 : Pin 19
                            - PINSEL_PIN_20 : Pin 20
                            - PINSEL_PIN_21 : Pin 21
                            - PINSEL_PIN_22 : Pin 22
                            - PINSEL_PIN_23 : Pin 23
                            - PINSEL_PIN_24 : Pin 24
                            - PINSEL_PIN_25 : Pin 25
                            - PINSEL_PIN_26 : Pin 26
                            - PINSEL_PIN_27 : Pin 27
                            - PINSEL_PIN_28 : Pin 28
                            - PINSEL_PIN_29 : Pin 29
                            - PINSEL_PIN_30 : Pin 30
                            - PINSEL_PIN_31 : Pin 31

 * @param[in]  modenum: Mode number,
 *                            should be one of the following:
                            - PINSEL_PINMODE_PULLUP      : Internal pull-up resistor
                            - PINSEL_PINMODE_TRISTATE : Tri-state
                            - PINSEL_PINMODE_PULLDOWN : Internal pull-down resistor

 * @return            None
 *********************************************************************/
void set_ResistorMode ( uint8_t portnum, uint8_t pinnum, uint8_t modenum)
{
        uint32_t pinnum_t = pinnum;
        uint32_t pinmodereg_idx = 2 * portnum;
        uint32_t *pPinCon = (uint32_t *)&LPC_PINCON->PINMODE0;

        if (pinnum_t >= 16) {
                pinnum_t -= 16;
                pinmodereg_idx++ ;
        }

        *(uint32_t *)(pPinCon + pinmodereg_idx) &= ~(0x03UL << (pinnum_t * 2));
        *(uint32_t *)(pPinCon + pinmodereg_idx) |= ((uint32_t)modenum) << (pinnum_t * 2);
```

```
}

/*********************************************************************//**
 * @brief             Setup Open drain mode for each pin
 * @param[in]  portnum PORT number,
 *                            should be one of the following:
 *                            - PINSEL_PORT_0       : Port 0
 *                            - PINSEL_PORT_1       : Port 1
 *                            - PINSEL_PORT_2       : Port 2
 *                            - PINSEL_PORT_3       : Port 3
 *
 * @param[in]  pinnum  Pin number,
 *                            should be one of the following:
                              - PINSEL_PIN_0 : Pin 0
                              - PINSEL_PIN_1 : Pin 1
                              - PINSEL_PIN_2 : Pin 2
                              - PINSEL_PIN_3 : Pin 3
                              - PINSEL_PIN_4 : Pin 4
                              - PINSEL_PIN_5 : Pin 5
                              - PINSEL_PIN_6 : Pin 6
                              - PINSEL_PIN_7 : Pin 7
                              - PINSEL_PIN_8 : Pin 8
                              - PINSEL_PIN_9 : Pin 9
                              - PINSEL_PIN_10 : Pin 10
                              - PINSEL_PIN_11 : Pin 11
                              - PINSEL_PIN_12 : Pin 12
                              - PINSEL_PIN_13 : Pin 13
                              - PINSEL_PIN_14 : Pin 14
                              - PINSEL_PIN_15 : Pin 15
                              - PINSEL_PIN_16 : Pin 16
                              - PINSEL_PIN_17 : Pin 17
                              - PINSEL_PIN_18 : Pin 18
                              - PINSEL_PIN_19 : Pin 19
                              - PINSEL_PIN_20 : Pin 20
                              - PINSEL_PIN_21 : Pin 21
                              - PINSEL_PIN_22 : Pin 22
                              - PINSEL_PIN_23 : Pin 23
                              - PINSEL_PIN_24 : Pin 24
                              - PINSEL_PIN_25 : Pin 25
```

```
                              - PINSEL_PIN_26 : Pin 26
                              - PINSEL_PIN_27 : Pin 27
                              - PINSEL_PIN_28 : Pin 28
                              - PINSEL_PIN_29 : Pin 29
                              - PINSEL_PIN_30 : Pin 30
                              - PINSEL_PIN_31 : Pin 31

 * @param[in]  modenum  Open drain mode number,
 *                              should be one of the following:
 *                              - PINSEL_PINMODE_NORMAL : Pin is in the normal (not open
drain) mode
 *                              - PINSEL_PINMODE_OPENDRAIN : Pin is in the open drain mode
 *
 * @return             None
 *********************************************************************/
void set_OpenDrainMode( uint8_t portnum, uint8_t pinnum, uint8_t modenum)
{
        uint32_t *pPinCon = (uint32_t *)&LPC_PINCON->PINMODE_OD0;

        if (modenum == PINSEL_PINMODE_OPENDRAIN){
                *(uint32_t *)(pPinCon + portnum) |= (0x01UL << pinnum);
        } else {
                *(uint32_t *)(pPinCon + portnum) &= ~(0x01UL << pinnum);
        }
}

/* End of Public Functions ---------------------------------------------------- */

/* Public Functions ----------------------------------------------------------- */
/** @addtogroup PINSEL_Public_Functions
 * @{
 */
/*********************************************************************//**
 * @brief              Configure trace function
 * @param[in]  NewState State of the Trace function configuration,
 *                              should be one of the following:
 *                              - ENABLE : Enable Trace Function
 *                              - DISABLE : Disable Trace Function
 *
 * @return             None
```

```
 *********************************************************************/
void PINSEL_ConfigTraceFunc(FunctionalState NewState)
{
	if (NewState == ENABLE) {
		LPC_PINCON->PINSEL10 |= (0x01UL << 3);
	} else if (NewState == DISABLE) {
		LPC_PINCON->PINSEL10 &= ~(0x01UL << 3);
	}
}

/*********************************************************************//**
 * @brief		Setup I2C0 pins
 * @param[in]	i2cPinMode I2C pin mode,
 *				should be one of the following:
 *				- PINSEL_I2C_Normal_Mode : The standard drive mode
 *				- PINSEL_I2C_Fast_Mode : Fast Mode Plus drive mode
 *
 * @param[in]	filterSlewRateEnable  should be:
 *				- ENABLE: Enable filter and slew rate.
 *				- DISABLE: Disable filter and slew rate.
 *
 * @return		None
 *********************************************************************/
void PINSEL_SetI2C0Pins(uint8_t i2cPinMode, FunctionalState filterSlewRateEnable)
{
	uint32_t regVal;

	if (i2cPinMode == PINSEL_I2C_Fast_Mode){
		regVal = PINSEL_I2CPADCFG_SCLDRV0 | PINSEL_I2CPADCFG_SDADRV0;
	}

	if (filterSlewRateEnable == DISABLE){
		regVal = PINSEL_I2CPADCFG_SCLI2C0 | PINSEL_I2CPADCFG_SDAI2C0;
	}
	LPC_PINCON->I2CPADCFG = regVal;
}

/*********************************************************************//**
```

```
 * @brief              Configure Pin corresponding to specified parameters passed
 *                            in the PinCfg
 * @param[in]  PinCfg  Pointer to a PINSEL_CFG_Type structure
 *                     that contains the configuration information for the
 *                     specified pin.
 * @return             None
 *********************************************************************/
void PINSEL_ConfigPin(PINSEL_CFG_Type *PinCfg)
{
        set_PinFunc(PinCfg->Portnum, PinCfg->Pinnum, PinCfg->Funcnum);
        set_ResistorMode(PinCfg->Portnum, PinCfg->Pinnum, PinCfg->Pinmode);
        set_OpenDrainMode(PinCfg->Portnum, PinCfg->Pinnum, PinCfg->OpenDrain);
}


/**
 * @}
 */

/**
 * @}
 */

/* ---------------------------------- End Of File ------------------------------ */



/**************************************************************************
* $Id$         lpc17xx_gpio.c                      2010-05-21
*//**
* @file        lpc17xx_gpio.c
* @brief       Contains all functions support for GPIO firmware
*                     library on LPC17xx
* @version     2.0
* @date        21. May. 2010
* @author      NXP MCU SW Application Team
*
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```

```
*
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* warranty that such application will be suitable for the specified
* use without further testing or modification.
**********************************************************************/

/* Peripheral group ----------------------------------------------------------- */
/** @addtogroup GPIO
 * @{
 */

/* Includes ------------------------------------------------------------------- */
#include "lpc17xx_gpio.h"

/* If this source file built with example, the LPC17xx FW library configuration
 * file in each example directory ("lpc17xx_libcfg.h") must be included,
 * otherwise the default FW library configuration file must be included instead
 */
#ifdef __BUILD_WITH_EXAMPLE__
#include "lpc17xx_libcfg.h"
#else
#include "lpc17xx_libcfg_default.h"
#endif /* __BUILD_WITH_EXAMPLE__ */


#ifdef _GPIO

/* Private Functions ---------------------------------------------------------- */

static LPC_GPIO_TypeDef *GPIO_GetPointer(uint8_t portNum);
static GPIO_HalfWord_TypeDef *FIO_HalfWordGetPointer(uint8_t portNum);
```

```
static GPIO_Byte_TypeDef *FIO_ByteGetPointer(uint8_t portNum);

/*********************************************************************//**
 * @brief		Get pointer to GPIO peripheral due to GPIO port
 * @param[in]	portNum		Port Number value, should be in range from 0 to 4.
 * @return		Pointer to GPIO peripheral
 **********************************************************************/
static LPC_GPIO_TypeDef *GPIO_GetPointer(uint8_t portNum)
{
	LPC_GPIO_TypeDef *pGPIO = NULL;

	switch (portNum) {
	case 0:
		pGPIO = LPC_GPIO0;
		break;
	case 1:
		pGPIO = LPC_GPIO1;
		break;
	case 2:
		pGPIO = LPC_GPIO2;
		break;
	case 3:
		pGPIO = LPC_GPIO3;
		break;
	case 4:
		pGPIO = LPC_GPIO4;
		break;
	default:
		break;
	}

	return pGPIO;
}

/*********************************************************************//**
 * @brief		Get pointer to FIO peripheral in halfword accessible style
 *				due to FIO port
 * @param[in]	portNum		Port Number value, should be in range from 0 to 4.
 * @return		Pointer to FIO peripheral
```

```
 ***********************************************************************/
static GPIO_HalfWord_TypeDef *FIO_HalfWordGetPointer(uint8_t portNum)
{
	GPIO_HalfWord_TypeDef *pFIO = NULL;

	switch (portNum) {
	case 0:
		pFIO = GPIO0_HalfWord;
		break;
	case 1:
		pFIO = GPIO1_HalfWord;
		break;
	case 2:
		pFIO = GPIO2_HalfWord;
		break;
	case 3:
		pFIO = GPIO3_HalfWord;
		break;
	case 4:
		pFIO = GPIO4_HalfWord;
		break;
	default:
		break;
	}

	return pFIO;
}

/***********************************************************************//**
 * @brief		Get pointer to FIO peripheral in byte accessible style
 *				due to FIO port
 * @param[in]	portNum		Port Number value, should be in range from 0 to 4.
 * @return		Pointer to FIO peripheral
 ***********************************************************************/
static GPIO_Byte_TypeDef *FIO_ByteGetPointer(uint8_t portNum)
{
	GPIO_Byte_TypeDef *pFIO = NULL;

	switch (portNum) {
```

```
	case 0:
		pFIO = GPIO0_Byte;
		break;
	case 1:
		pFIO = GPIO1_Byte;
		break;
	case 2:
		pFIO = GPIO2_Byte;
		break;
	case 3:
		pFIO = GPIO3_Byte;
		break;
	case 4:
		pFIO = GPIO4_Byte;
		break;
	default:
		break;
	}

	return pFIO;
}

/* End of Private Functions --------------------------------------------------- */


/* Public Functions ----------------------------------------------------------- */
/** @addtogroup GPIO_Public_Functions
 * @{
 */


/* GPIO ----------------------------------------------------------------------------
*/

/*********************************************************************//**
 * @brief		Set Direction for GPIO port.
 * @param[in]	portNum		Port Number value, should be in range from 0 to 4
 * @param[in]	bitValue	Value that contains all bits to set direction,
 *                                          in range from 0 to 0xFFFFFFFF.
```

```
 *                                                  example: value 0x5 to set direction
for bit 0 and bit 1.
 * @param[in]  dir                   Direction value, should be:
 *                                                  - 0: Input.
 *                                                  - 1: Output.
 * @return            None
 *
 * Note: All remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 *********************************************************************/
void GPIO_SetDir(uint8_t portNum, uint32_t bitValue, uint8_t dir)
{
	LPC_GPIO_TypeDef *pGPIO = GPIO_GetPointer(portNum);

	if (pGPIO != NULL) {
		// Enable Output
		if (dir) {
			pGPIO->FIODIR |= bitValue;
		}
		// Enable Input
		else {
			pGPIO->FIODIR &= ~bitValue;
		}
	}
}



/*********************************************************************//**
 * @brief             Set Value for bits that have output direction on GPIO port.
 * @param[in]  portNum        Port number value, should be in range from 0 to 4
 * @param[in]  bitValue       Value that contains all bits on GPIO to set,
 *                                                  in range from 0 to 0xFFFFFFFF.
 *                                                  example: value 0x5 to set bit 0 and
bit 1.
 * @return            None
 *
 * Note:
 * - For all bits that has been set as input direction, this function will
 * not effect.
 * - For all remaining bits that are not activated in bitValue (value '0')
```

```
 * will not be effected by this function.
 ****************************************************************************/
void GPIO_SetValue(uint8_t portNum, uint32_t bitValue)
{
	LPC_GPIO_TypeDef *pGPIO = GPIO_GetPointer(portNum);

	if (pGPIO != NULL) {
		pGPIO->FIOSET = bitValue;
	}
}

/****************************************************************************//**
 * @brief		Clear Value for bits that have output direction on GPIO port.
 * @param[in]	portNum		Port number value, should be in range from 0 to 4
 * @param[in]	bitValue	Value that contains all bits on GPIO to clear,
 *                                                  in range from 0 to 0xFFFFFFFF.
 *                                                  example: value 0x5 to clear bit 0
and bit 1.
 * @return		None
 *
 * Note:
 * - For all bits that has been set as input direction, this function will
 * not effect.
 * - For all remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 ****************************************************************************/
void GPIO_ClearValue(uint8_t portNum, uint32_t bitValue)
{
	LPC_GPIO_TypeDef *pGPIO = GPIO_GetPointer(portNum);

	if (pGPIO != NULL) {
		pGPIO->FIOCLR = bitValue;
	}
}

/****************************************************************************//**
 * @brief		Read Current state on port pin that have input direction of GPIO
 * @param[in]	portNum		Port number to read value, in range from 0 to 4
 * @return		Current value of GPIO port.
 *
```

```
 * Note: Return value contain state of each port pin (bit) on that GPIO regardless
 * its direction is input or output.
 *********************************************************************/
uint32_t GPIO_ReadValue(uint8_t portNum)
{
	LPC_GPIO_TypeDef *pGPIO = GPIO_GetPointer(portNum);

	if (pGPIO != NULL) {
		return pGPIO->FIOPIN;
	}

	return (0);
}

/*********************************************************************//**
 * @brief		Enable GPIO interrupt (just used for P0.0-P0.30, P2.0-P2.13)
 * @param[in]	portNum		Port number to read value, should be: 0 or 2
 * @param[in]	bitValue	Value that contains all bits on GPIO to enable,
 *                                              in range from 0 to 0xFFFFFFFF.
 * @param[in]	edgeState	state of edge, should be:
 *                                              - 0: Rising edge
 *                                              - 1: Falling edge
 * @return		None
 *********************************************************************/
void GPIO_IntCmd(uint8_t portNum, uint32_t bitValue, uint8_t edgeState)
{
	if((portNum == 0)&&(edgeState == 0))
		LPC_GPIOINT->IO0IntEnR = bitValue;
	else if ((portNum == 2)&&(edgeState == 0))
		LPC_GPIOINT->IO2IntEnR = bitValue;
	else if ((portNum == 0)&&(edgeState == 1))
		LPC_GPIOINT->IO0IntEnF = bitValue;
	else if ((portNum == 2)&&(edgeState == 1))
		LPC_GPIOINT->IO2IntEnF = bitValue;
	else
		//Error
		while(1);
}
```

```
/*********************************************************************//**
 * @brief		Get GPIO Interrupt Status (just used for P0.0-P0.30, P2.0-P2.13)
 * @param[in]	portNum		Port number to read value, should be: 0 or 2
 * @param[in]	pinNum		Pin number, should be: 0..30(with port 0) and 0..13
 *                                                  (with port 2)
 * @param[in]	edgeState	state of edge, should be:
 *                                                  - 0: Rising edge
 *                                                  - 1: Falling edge
 * @return		Bool	could be:
 *                                              - ENABLE: Interrupt has been generated due
to a rising
 *                                                              edge on P0.0
 *                                              - DISABLE: A rising edge has not been
detected on P0.0
 **********************************************************************/
FunctionalState GPIO_GetIntStatus(uint8_t portNum, uint32_t pinNum, uint8_t edgeState)
{
	if((portNum == 0) && (edgeState == 0))//Rising Edge
		return ((FunctionalState)(((LPC_GPIOINT->IO0IntStatR)>>pinNum)& 0x1));
	else if ((portNum == 2) && (edgeState == 0))
		return ((FunctionalState)(((LPC_GPIOINT->IO2IntStatR)>>pinNum)& 0x1));
	else if ((portNum == 0) && (edgeState == 1))//Falling Edge
		return ((FunctionalState)(((LPC_GPIOINT->IO0IntStatF)>>pinNum)& 0x1));
	else if ((portNum == 2) && (edgeState == 1))
		return ((FunctionalState)(((LPC_GPIOINT->IO2IntStatF)>>pinNum)& 0x1));
	else
		//Error
		while(1);
}
/*********************************************************************//**
 * @brief		Clear GPIO interrupt (just used for P0.0-P0.30, P2.0-P2.13)
 * @param[in]	portNum		Port number to read value, should be: 0 or 2
 * @param[in]	bitValue	Value that contains all bits on GPIO to enable,
 *                                                  in range from 0 to 0xFFFFFFFF.
 * @return		None
 **********************************************************************/
void GPIO_ClearInt(uint8_t portNum, uint32_t bitValue)
{
	if(portNum == 0)
		LPC_GPIOINT->IO0IntClr = bitValue;
```

```
	else if (portNum == 2)
		LPC_GPIOINT->IO2IntClr = bitValue;
	else
		//Invalid portNum
		while(1);
}

/* FIO word accessible ------------------------------------------------------------------
*/
/* Stub function for FIO (word-accessible) style */

/**
 * @brief The same with GPIO_SetDir()
 */
void FIO_SetDir(uint8_t portNum, uint32_t bitValue, uint8_t dir)
{
	GPIO_SetDir(portNum, bitValue, dir);
}

/**
 * @brief The same with GPIO_SetValue()
 */
void FIO_SetValue(uint8_t portNum, uint32_t bitValue)
{
	GPIO_SetValue(portNum, bitValue);
}

/**
 * @brief The same with GPIO_ClearValue()
 */
void FIO_ClearValue(uint8_t portNum, uint32_t bitValue)
{
	GPIO_ClearValue(portNum, bitValue);
}

/**
 * @brief The same with GPIO_ReadValue()
 */
uint32_t FIO_ReadValue(uint8_t portNum)
{
```

```
	return (GPIO_ReadValue(portNum));
}

/**
 * @brief The same with GPIO_IntCmd()
 */
void FIO_IntCmd(uint8_t portNum, uint32_t bitValue, uint8_t edgeState)
{
	GPIO_IntCmd(portNum, bitValue, edgeState);
}

/**
 * @brief The same with GPIO_GetIntStatus()
 */
FunctionalState FIO_GetIntStatus(uint8_t portNum, uint32_t pinNum, uint8_t edgeState)
{
	return (GPIO_GetIntStatus(portNum, pinNum, edgeState));
}

/**
 * @brief The same with GPIO_ClearInt()
 */
void FIO_ClearInt(uint8_t portNum, uint32_t bitValue)
{
	GPIO_ClearInt(portNum, bitValue);
}
/*********************************************************************//**
 * @brief		Set mask value for bits in FIO port
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	bitValue	Value that contains all bits in to set,
 *                                                  in range from 0 to 0xFFFFFFFF.
 * @param[in]	maskValue	Mask value contains state value for each bit:
 *                                                  - 0: not mask.
 *                                                  - 1: mask.
 * @return		None
 *
 * Note:
 * - All remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
```

```
 * - After executing this function, in mask register, value '0' on each bit
 * enables an access to the corresponding physical pin via a read or write access,
 * while value '1' on bit (masked) that corresponding pin will not be changed
 * with write access and if read, will not be reflected in the updated pin.
 *********************************************************************/
void FIO_SetMask(uint8_t portNum, uint32_t bitValue, uint8_t maskValue)
{
	LPC_GPIO_TypeDef *pFIO = GPIO_GetPointer(portNum);
	if(pFIO != NULL) {
		// Mask
		if (maskValue){
			pFIO->FIOMASK |= bitValue;
		}
		// Un-mask
		else {
			pFIO->FIOMASK &= ~bitValue;
		}
	}
}



/* FIO halfword accessible -------------------------------------------------------
*/


/*********************************************************************//**
 * @brief		Set direction for FIO port in halfword accessible style
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	halfwordNum	HalfWord part number, should be 0 (lower) or 1(upper)
 * @param[in]	bitValue	Value that contains all bits in to set direction,
 *                                              in range from 0 to 0xFFFF.
 * @param[in]	dir                   Direction value, should be:
 *                                              - 0: Input.
 *                                              - 1: Output.
 * @return		None
 *
 * Note: All remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 *********************************************************************/
void FIO_HalfWordSetDir(uint8_t portNum, uint8_t halfwordNum, uint16_t bitValue, uint8_t
dir)
```

```
{
	GPIO_HalfWord_TypeDef *pFIO = FIO_HalfWordGetPointer(portNum);
	if(pFIO != NULL) {
		// Output direction
		if (dir) {
			// Upper
			if(halfwordNum) {
				pFIO->FIODIRU |= bitValue;
			}
			// lower
			else {
				pFIO->FIODIRL |= bitValue;
			}
		}
		// Input direction
		else {
			// Upper
			if(halfwordNum) {
				pFIO->FIODIRU &= ~bitValue;
			}
			// lower
			else {
				pFIO->FIODIRL &= ~bitValue;
			}
		}
	}
}


/*****************************************************************************//**
 * @brief		Set mask value for bits in FIO port in halfword accessible style
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	halfwordNum	HalfWord part number, should be 0 (lower) or 1(upper)
 * @param[in]	bitValue	Value that contains all bits in to set,
 *                                              in range from 0 to 0xFFFF.
 * @param[in]	maskValue	Mask value contains state value for each bit:
 *                                      - 0: not mask.
 *                                      - 1: mask.
 * @return		None
```

```
 *
 * Note:
 * - All remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 * - After executing this function, in mask register, value '0' on each bit
 * enables an access to the corresponding physical pin via a read or write access,
 * while value '1' on bit (masked) that corresponding pin will not be changed
 * with write access and if read, will not be reflected in the updated pin.
 **********************************************************************/
void FIO_HalfWordSetMask(uint8_t portNum, uint8_t halfwordNum, uint16_t bitValue,
uint8_t maskValue)
{
	GPIO_HalfWord_TypeDef *pFIO = FIO_HalfWordGetPointer(portNum);
	if(pFIO != NULL) {
		// Mask
		if (maskValue){
			// Upper
			if(halfwordNum) {
				pFIO->FIOMASKU |= bitValue;
			}
			// lower
			else {
				pFIO->FIOMASKL |= bitValue;
			}
		}
		// Un-mask
		else {
			// Upper
			if(halfwordNum) {
				pFIO->FIOMASKU &= ~bitValue;
			}
			// lower
			else {
				pFIO->FIOMASKL &= ~bitValue;
			}
		}
	}
}
```

```
/*********************************************************************//**
 * @brief             Set bits for FIO port in halfword accessible style
 * @param[in]  portNum        Port number, in range from 0 to 4
 * @param[in]  halfwordNum    HalfWord part number, should be 0 (lower) or 1(upper)
 * @param[in]  bitValue       Value that contains all bits in to set,
 *                                                  in range from 0 to 0xFFFF.
 * @return            None
 *
 * Note:
 * - For all bits that has been set as input direction, this function will
 * not effect.
 * - For all remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 *********************************************************************/
void FIO_HalfWordSetValue(uint8_t portNum, uint8_t halfwordNum, uint16_t bitValue)
{
	GPIO_HalfWord_TypeDef *pFIO = FIO_HalfWordGetPointer(portNum);
	if(pFIO != NULL) {
		// Upper
		if(halfwordNum) {
			pFIO->FIOSETU = bitValue;
		}
		// lower
		else {
			pFIO->FIOSETL = bitValue;
		}
	}
}


/*********************************************************************//**
 * @brief             Clear bits for FIO port in halfword accessible style
 * @param[in]  portNum        Port number, in range from 0 to 4
 * @param[in]  halfwordNum    HalfWord part number, should be 0 (lower) or 1(upper)
 * @param[in]  bitValue       Value that contains all bits in to clear,
 *                                                  in range from 0 to 0xFFFF.
 * @return            None
 *
 * Note:
```

```
 * - For all bits that has been set as input direction, this function will
 * not effect.
 * - For all remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 *********************************************************************/
void FIO_HalfWordClearValue(uint8_t portNum, uint8_t halfwordNum, uint16_t bitValue)
{
	GPIO_HalfWord_TypeDef *pFIO = FIO_HalfWordGetPointer(portNum);
	if(pFIO != NULL) {
		// Upper
		if(halfwordNum) {
			pFIO->FIOCLRU = bitValue;
		}
		// lower
		else {
			pFIO->FIOCLRL = bitValue;
		}
	}
}


/*********************************************************************//**
 * @brief		Read Current state on port pin that have input direction of GPIO
 *				in halfword accessible style.
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	halfwordNum	HalfWord part number, should be 0 (lower) or 1(upper)
 * @return		Current value of FIO port pin of specified halfword.
 * Note: Return value contain state of each port pin (bit) on that FIO regardless
 * its direction is input or output.
 *********************************************************************/
uint16_t FIO_HalfWordReadValue(uint8_t portNum, uint8_t halfwordNum)
{
	GPIO_HalfWord_TypeDef *pFIO = FIO_HalfWordGetPointer(portNum);
	if(pFIO != NULL) {
		// Upper
		if(halfwordNum) {
			return (pFIO->FIOPINU);
		}
		// lower
```

```
		else {
			return (pFIO->FIOPINL);
		}
	}
	return (0);
}


/* FIO Byte accessible ------------------------------------------------------- */

/*********************************************************************//**
 * @brief		Set direction for FIO port in byte accessible style
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	byteNum		Byte part number, should be in range from 0 to 3
 * @param[in]	bitValue	Value that contains all bits in to set direction,
 *                                              in range from 0 to 0xFF.
 * @param[in]	dir			Direction value, should be:
 *                                              - 0: Input.
 *                                              - 1: Output.
 * @return		None
 *
 * Note: All remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 **********************************************************************/
void FIO_ByteSetDir(uint8_t portNum, uint8_t byteNum, uint8_t bitValue, uint8_t dir)
{
	GPIO_Byte_TypeDef *pFIO = FIO_ByteGetPointer(portNum);
	if(pFIO != NULL) {
		// Output direction
		if (dir) {
			if (byteNum <= 3) {
				pFIO->FIODIR[byteNum] |= bitValue;
			}
		}
		// Input direction
		else {
			if (byteNum <= 3) {
				pFIO->FIODIR[byteNum] &= ~bitValue;
			}
```

```
		}
	}
}

/*********************************************************************//**
 * @brief		Set mask value for bits in FIO port in byte accessible style
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	byteNum		Byte part number, should be in range from 0 to 3
 * @param[in]	bitValue	Value that contains all bits in to set mask,
 *                                              in range from 0 to 0xFF.
 * @param[in]	maskValue	Mask value contains state value for each bit:
 *                                              - 0: not mask.
 *                                              - 1: mask.
 * @return		None
 *
 * Note:
 * - All remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 * - After executing this function, in mask register, value '0' on each bit
 * enables an access to the corresponding physical pin via a read or write access,
 * while value '1' on bit (masked) that corresponding pin will not be changed
 * with write access and if read, will not be reflected in the updated pin.
 **********************************************************************/
void FIO_ByteSetMask(uint8_t portNum, uint8_t byteNum, uint8_t bitValue, uint8_t
maskValue)
{
	GPIO_Byte_TypeDef *pFIO = FIO_ByteGetPointer(portNum);
	if(pFIO != NULL) {
		// Mask
		if (maskValue) {
			if (byteNum <= 3) {
				pFIO->FIOMASK[byteNum] |= bitValue;
			}
		}
		// Un-mask
		else {
			if (byteNum <= 3) {
				pFIO->FIOMASK[byteNum] &= ~bitValue;
			}
		}
```

```
	}
}


/*********************************************************************//**
 * @brief		Set bits for FIO port in byte accessible style
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	byteNum		Byte part number, should be in range from 0 to 3
 * @param[in]	bitValue	Value that contains all bits in to set,
 *                                              in range from 0 to 0xFF.
 * @return		None
 *
 * Note:
 * - For all bits that has been set as input direction, this function will
 * not effect.
 * - For all remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 **********************************************************************/
void FIO_ByteSetValue(uint8_t portNum, uint8_t byteNum, uint8_t bitValue)
{
	GPIO_Byte_TypeDef *pFIO = FIO_ByteGetPointer(portNum);
	if (pFIO != NULL) {
		if (byteNum <= 3){
			pFIO->FIOSET[byteNum] = bitValue;
		}
	}
}


/*********************************************************************//**
 * @brief		Clear bits for FIO port in byte accessible style
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	byteNum		Byte part number, should be in range from 0 to 3
 * @param[in]	bitValue	Value that contains all bits in to clear,
 *                                              in range from 0 to 0xFF.
 * @return		None
 *
 * Note:
 * - For all bits that has been set as input direction, this function will
```

```
 * not effect.
 * - For all remaining bits that are not activated in bitValue (value '0')
 * will not be effected by this function.
 ******************************************************************/
void FIO_ByteClearValue(uint8_t portNum, uint8_t byteNum, uint8_t bitValue)
{
	GPIO_Byte_TypeDef *pFIO = FIO_ByteGetPointer(portNum);
	if (pFIO != NULL) {
		if (byteNum <= 3){
			pFIO->FIOCLR[byteNum] = bitValue;
		}
	}
}



/******************************************************************//**
 * @brief		Read Current state on port pin that have input direction of GPIO
 *				in byte accessible style.
 * @param[in]	portNum		Port number, in range from 0 to 4
 * @param[in]	byteNum		Byte part number, should be in range from 0 to 3
 * @return		Current value of FIO port pin of specified byte part.
 * Note: Return value contain state of each port pin (bit) on that FIO regardless
 * its direction is input or output.
 ******************************************************************/
uint8_t FIO_ByteReadValue(uint8_t portNum, uint8_t byteNum)
{
	GPIO_Byte_TypeDef *pFIO = FIO_ByteGetPointer(portNum);
	if (pFIO != NULL) {
		if (byteNum <= 3){
			return (pFIO->FIOPIN[byteNum]);
		}
	}
	return (0);
}

/**
 * @}
 */
```

```
#endif /* _GPIO */

/**
 * @}
 */

/* ---------------------------------- End Of File ------------------------------ */


/*****************************************************************************
* $Id$         lpc17xx_clkpwr.c                              2010-06-18
*//**
* @file        lpc17xx_clkpwr.c
* @brief       Contains all functions support for Clock and Power Control
*                      firmware library on LPC17xx
* @version     3.0
* @date        18. June. 2010
* @author      NXP MCU SW Application Team
*
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*
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******************************************************************************/

/* Peripheral group ----------------------------------------------------------- */
/** @addtogroup CLKPWR
 * @{
 */
```

```
/* Includes ------------------------------------------------------------------ */
#include "lpc17xx_clkpwr.h"


/* Public Functions ----------------------------------------------------------- */
/** @addtogroup CLKPWR_Public_Functions
 * @{
 */

/*********************************************************************//**
 * @brief             Set value of each Peripheral Clock Selection
 * @param[in]  ClkType Peripheral Clock Selection of each type,
 *                          should be one of the following:
 *                          - CLKPWR_PCLKSEL_WDT                : WDT
                            - CLKPWR_PCLKSEL_TIMER0       : Timer 0
                            - CLKPWR_PCLKSEL_TIMER1       : Timer 1
                            - CLKPWR_PCLKSEL_UART0        : UART 0
                            - CLKPWR_PCLKSEL_UART1        : UART 1
                            - CLKPWR_PCLKSEL_PWM1         : PWM 1
                            - CLKPWR_PCLKSEL_I2C0         : I2C 0
                            - CLKPWR_PCLKSEL_SPI                : SPI
                            - CLKPWR_PCLKSEL_SSP1         : SSP 1
                            - CLKPWR_PCLKSEL_DAC                : DAC
                            - CLKPWR_PCLKSEL_ADC                : ADC
                            - CLKPWR_PCLKSEL_CAN1               : CAN 1
                            - CLKPWR_PCLKSEL_CAN2               : CAN 2
                            - CLKPWR_PCLKSEL_ACF                : ACF
                            - CLKPWR_PCLKSEL_QEI          : QEI
                            - CLKPWR_PCLKSEL_PCB                : PCB
                            - CLKPWR_PCLKSEL_I2C1         : I2C 1
                            - CLKPWR_PCLKSEL_SSP0         : SSP 0
                            - CLKPWR_PCLKSEL_TIMER2       : Timer 2
                            - CLKPWR_PCLKSEL_TIMER3       : Timer 3
                            - CLKPWR_PCLKSEL_UART2        : UART 2
                            - CLKPWR_PCLKSEL_UART3        : UART 3
                            - CLKPWR_PCLKSEL_I2C2         : I2C 2
                            - CLKPWR_PCLKSEL_I2S                : I2S
                            - CLKPWR_PCLKSEL_RIT                : RIT
```

```
                              - CLKPWR_PCLKSEL_SYSCON       : SYSCON
                              - CLKPWR_PCLKSEL_MC           : MC

 * @param[in]  DivVal  Value of divider, should be:
 *                              - CLKPWR_PCLKSEL_CCLK_DIV_4 : PCLK_peripheral = CCLK/4
 *                              - CLKPWR_PCLKSEL_CCLK_DIV_1 : PCLK_peripheral = CCLK/1
 *                              - CLKPWR_PCLKSEL_CCLK_DIV_2 : PCLK_peripheral = CCLK/2
 *
 * @return none
 *********************************************************************/
void CLKPWR_SetPCLKDiv (uint32_t ClkType, uint32_t DivVal)
{
        uint32_t bitpos;

        bitpos = (ClkType < 32) ? (ClkType) : (ClkType - 32);

        /* PCLKSEL0 selected */
        if (ClkType < 32)
        {
                /* Clear two bit at bit position */
                LPC_SC->PCLKSEL0 &= (~(CLKPWR_PCLKSEL_BITMASK(bitpos)));

                /* Set two selected bit */
                LPC_SC->PCLKSEL0 |= (CLKPWR_PCLKSEL_SET(bitpos, DivVal));
        }
        /* PCLKSEL1 selected */
        else
        {
                /* Clear two bit at bit position */
                LPC_SC->PCLKSEL1 &= ~(CLKPWR_PCLKSEL_BITMASK(bitpos));

                /* Set two selected bit */
                LPC_SC->PCLKSEL1 |= (CLKPWR_PCLKSEL_SET(bitpos, DivVal));
        }
}


/*********************************************************************//**
 * @brief              Get current value of each Peripheral Clock Selection
```

```
 * @param[in]  ClkType Peripheral Clock Selection of each type,
 *                           should be one of the following:
 *                           - CLKPWR_PCLKSEL_WDT               : WDT
                             - CLKPWR_PCLKSEL_TIMER0      : Timer 0
                             - CLKPWR_PCLKSEL_TIMER1      : Timer 1
                             - CLKPWR_PCLKSEL_UART0       : UART 0
                             - CLKPWR_PCLKSEL_UART1       : UART 1
                             - CLKPWR_PCLKSEL_PWM1        : PWM 1
                             - CLKPWR_PCLKSEL_I2C0        : I2C 0
                             - CLKPWR_PCLKSEL_SPI               : SPI
                             - CLKPWR_PCLKSEL_SSP1        : SSP 1
                             - CLKPWR_PCLKSEL_DAC               : DAC
                             - CLKPWR_PCLKSEL_ADC               : ADC
                             - CLKPWR_PCLKSEL_CAN1              : CAN 1
                             - CLKPWR_PCLKSEL_CAN2              : CAN 2
                             - CLKPWR_PCLKSEL_ACF               : ACF
                             - CLKPWR_PCLKSEL_QEI         : QEI
                             - CLKPWR_PCLKSEL_PCB               : PCB
                             - CLKPWR_PCLKSEL_I2C1        : I2C 1
                             - CLKPWR_PCLKSEL_SSP0        : SSP 0
                             - CLKPWR_PCLKSEL_TIMER2      : Timer 2
                             - CLKPWR_PCLKSEL_TIMER3      : Timer 3
                             - CLKPWR_PCLKSEL_UART2       : UART 2
                             - CLKPWR_PCLKSEL_UART3       : UART 3
                             - CLKPWR_PCLKSEL_I2C2        : I2C 2
                             - CLKPWR_PCLKSEL_I2S               : I2S
                             - CLKPWR_PCLKSEL_RIT               : RIT
                             - CLKPWR_PCLKSEL_SYSCON      : SYSCON
                             - CLKPWR_PCLKSEL_MC          : MC

 * @return            Value of Selected Peripheral Clock Selection
 *********************************************************************/
uint32_t CLKPWR_GetPCLKSEL (uint32_t ClkType)
{
        uint32_t bitpos, retval;

        if (ClkType < 32)
        {
                bitpos = ClkType;
```

```
		retval = LPC_SC->PCLKSEL0;
	}
	else
	{
		bitpos = ClkType - 32;
		retval = LPC_SC->PCLKSEL1;
	}

	retval = CLKPWR_PCLKSEL_GET(bitpos, retval);
	return retval;
}



/*********************************************************************//**
 * @brief		Get current value of each Peripheral Clock
 * @param[in]	ClkType Peripheral Clock Selection of each type,
 *				should be one of the following:
 *				- CLKPWR_PCLKSEL_WDT		: WDT
 *				- CLKPWR_PCLKSEL_TIMER0		: Timer 0
 *				- CLKPWR_PCLKSEL_TIMER1		: Timer 1
 *				- CLKPWR_PCLKSEL_UART0		: UART 0
 *				- CLKPWR_PCLKSEL_UART1		: UART 1
 *				- CLKPWR_PCLKSEL_PWM1		: PWM 1
 *				- CLKPWR_PCLKSEL_I2C0		: I2C 0
 *				- CLKPWR_PCLKSEL_SPI		: SPI
 *				- CLKPWR_PCLKSEL_SSP1		: SSP 1
 *				- CLKPWR_PCLKSEL_DAC		: DAC
 *				- CLKPWR_PCLKSEL_ADC		: ADC
 *				- CLKPWR_PCLKSEL_CAN1		: CAN 1
 *				- CLKPWR_PCLKSEL_CAN2		: CAN 2
 *				- CLKPWR_PCLKSEL_ACF		: ACF
 *				- CLKPWR_PCLKSEL_QEI		: QEI
 *				- CLKPWR_PCLKSEL_PCB		: PCB
 *				- CLKPWR_PCLKSEL_I2C1		: I2C 1
 *				- CLKPWR_PCLKSEL_SSP0		: SSP 0
 *				- CLKPWR_PCLKSEL_TIMER2		: Timer 2
 *				- CLKPWR_PCLKSEL_TIMER3		: Timer 3
 *				- CLKPWR_PCLKSEL_UART2		: UART 2
```

```
                            - CLKPWR_PCLKSEL_UART3        : UART 3
                            - CLKPWR_PCLKSEL_I2C2         : I2C 2
                            - CLKPWR_PCLKSEL_I2S                : I2S
                            - CLKPWR_PCLKSEL_RIT                : RIT
                            - CLKPWR_PCLKSEL_SYSCON       : SYSCON
                            - CLKPWR_PCLKSEL_MC           : MC

 * @return            Value of Selected Peripheral Clock
 *********************************************************************/
uint32_t CLKPWR_GetPCLK (uint32_t ClkType)
{
        uint32_t retval, div;

        retval = SystemCoreClock;
        div = CLKPWR_GetPCLKSEL(ClkType);

        switch (div)
        {
        case 0:
                div = 4;
                break;

        case 1:
                div = 1;
                break;

        case 2:
                div = 2;
                break;

        case 3:
                div = 8;
                break;
        }
        retval /= div;

        return retval;
}
```

```
/*********************************************************************//**
 * @brief             Configure power supply for each peripheral according to NewState
 * @param[in]  PPType  Type of peripheral used to enable power,
 *                                  should be one of the following:
 *                    -  CLKPWR_PCONP_PCTIM0              : Timer 0
                             -  CLKPWR_PCONP_PCTIM1              : Timer 1
                             -  CLKPWR_PCONP_PCUART0       : UART 0
                             -  CLKPWR_PCONP_PCUART1       : UART 1
                             -  CLKPWR_PCONP_PCPWM1              : PWM 1
                             -  CLKPWR_PCONP_PCI2C0              : I2C 0
                             -  CLKPWR_PCONP_PCSPI         : SPI
                             -  CLKPWR_PCONP_PCRTC         : RTC
                             -  CLKPWR_PCONP_PCSSP1              : SSP 1
                             -  CLKPWR_PCONP_PCAD                : ADC
                             -  CLKPWR_PCONP_PCAN1         : CAN 1
                             -  CLKPWR_PCONP_PCAN2         : CAN 2
                             -  CLKPWR_PCONP_PCGPIO              : GPIO
                             -  CLKPWR_PCONP_PCRIT         : RIT
                             -  CLKPWR_PCONP_PCMC          : MC
                             -  CLKPWR_PCONP_PCQEI         : QEI
                             -  CLKPWR_PCONP_PCI2C1        : I2C 1
                             -  CLKPWR_PCONP_PCSSP0              : SSP 0
                             -  CLKPWR_PCONP_PCTIM2              : Timer 2
                             -  CLKPWR_PCONP_PCTIM3              : Timer 3
                             -  CLKPWR_PCONP_PCUART2       : UART 2
                             -  CLKPWR_PCONP_PCUART3       : UART 3
                             -  CLKPWR_PCONP_PCI2C2              : I2C 2
                             -  CLKPWR_PCONP_PCI2S         : I2S
                             -  CLKPWR_PCONP_PCGPDMA       : GPDMA
                             -  CLKPWR_PCONP_PCENET              : Ethernet
                             -  CLKPWR_PCONP_PCUSB         : USB
 *
 * @param[in]  NewState       New state of Peripheral Power, should be:
 *                            - ENABLE       : Enable power for this peripheral
 *                            - DISABLE      : Disable power for this peripheral
 *
 * @return none
```

```
 *********************************************************************/
void CLKPWR_ConfigPPWR (uint32_t PPType, FunctionalState NewState)
{
	if (NewState == ENABLE)
	{
		LPC_SC->PCONP |= PPType & CLKPWR_PCONP_BITMASK;
	}
	else if (NewState == DISABLE)
	{
		LPC_SC->PCONP &= (~PPType) & CLKPWR_PCONP_BITMASK;
	}
}



/*********************************************************************//**
 * @brief		Enter Sleep mode with co-operated instruction by the Cortex-M3.
 * @param[in]	None
 * @return		None
 *********************************************************************/
void CLKPWR_Sleep(void)
{
	LPC_SC->PCON = 0x00;
	/* Sleep Mode*/
	__WFI();
}



/*********************************************************************//**
 * @brief		Enter Deep Sleep mode with co-operated instruction by the Cortex-
M3.
 * @param[in]	None
 * @return		None
 *********************************************************************/
void CLKPWR_DeepSleep(void)
{
    /* Deep-Sleep Mode, set SLEEPDEEP bit */
	SCB->SCR = 0x4;
	LPC_SC->PCON = 0x8;
	/* Deep Sleep Mode*/
	__WFI();
```

```
}



/*****************************************************************//**
 * @brief             Enter Power Down mode with co-operated instruction by the Cortex-
M3.
 * @param[in]  None
 * @return            None
 *********************************************************************/
void CLKPWR_PowerDown(void)
{
    /* Deep-Sleep Mode, set SLEEPDEEP bit */
        SCB->SCR = 0x4;
        LPC_SC->PCON = 0x09;
        /* Power Down Mode*/
        __WFI();
}



/*****************************************************************//**
 * @brief             Enter Deep Power Down mode with co-operated instruction by the
Cortex-M3.
 * @param[in]  None
 * @return            None
 *********************************************************************/
void CLKPWR_DeepPowerDown(void)
{
    /* Deep-Sleep Mode, set SLEEPDEEP bit */
        SCB->SCR = 0x4;
        LPC_SC->PCON = 0x03;
        /* Deep Power Down Mode*/
        __WFI();
}


/**
 * @}
 */


/**
 * @}
```

```
 */

/* ---------------------------------- End Of File ------------------------------ */



/**********************************************************************
* $Id$         lpc17xx_libcfg_default.c                            2010-05-21
*//**
* @file        lpc17xx_libcfg_default.c
* @brief       Library configuration source file (default), used to build
*                      library without examples
* @version     2.0
* @date        21. May. 2010
* @author      NXP MCU SW Application Team
*
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*
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* use without further testing or modification.
**********************************************************************/

/* Library group ----------------------------------------------------------- */
/** @addtogroup LIBCFG_DEFAULT
 * @{
 */

/* Includes ---------------------------------------------------------------- */
#include "lpc17xx_libcfg_default.h"
```

```
/* Public Functions ----------------------------------------------------------- */
/** @addtogroup LIBCFG_DEFAULT_Public_Functions
 * @{
 */

#ifndef __BUILD_WITH_EXAMPLE__

#ifdef  DEBUG
/*******************************************************************************
* @brief              Reports the name of the source file and the source line number
*                             where the CHECK_PARAM error has occurred.
* @param[in]   file Pointer to the source file name
* @param[in]    line assert_param error line source number
* @return             None
*******************************************************************************/
void check_failed(uint8_t *file, uint32_t line)
{
        /* User can add his own implementation to report the file name and line number,
         ex: printf("Wrong parameters value: file %s on line %d\r\n", file, line) */

        /* Infinite loop */
        while(1);
}
#endif /* DEBUG */

#endif /* __BUILD_WITH_EXAMPLE__ */

/**
 * @}
 */

/**
 * @}
 */

/* ------------------------------- End Of File ------------------------------ */
```

```
/*****************************************Copyright
(c)************************************************

**

**                                 http://www.powermcu.com

**

**--------------File Info-----------------------------------------------------------------
----------------

** File name:                AsciiLib.c

** Descriptions:             ASCII×Ö¿â  °áÏòÈ¡Ä£  8*16  ×¨Î²ÊÆÁÏÔÊ¾Éè¼Æ

**

**--------------------------------------------------------------------------------------------
----------------

** Created by:               AVRman

** Created date:             2010-11-2

** Version:                         1.0

** Descriptions:             The original version

**

**--------------------------------------------------------------------------------------------
----------------

** Modified by:

** Modified date:

** Version:

** Descriptions:

********************************************************************************************
****************/


/* Includes ------------------------------------------------------------------*/

#include "AsciiLib.h"


#ifdef ASCII_8X16_MS_Gothic

static unsigned char const AsciiLib[95][16] = {


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"
",0*/


{0x00,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x00,0x00,0x18,0x18,0x00,0x00},/*"!",
1*/


{0x36,0x24,0x48,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"""",
2*/
```

```
{0x00,0x24,0x24,0x24,0x24,0xFE,0x48,0x48,0x48,0x48,0xFC,0x48,0x48,0x48,0x48,0x00},/*"#",
3*/


{0x10,0x38,0x54,0x92,0x92,0x50,0x30,0x18,0x14,0x12,0x92,0x92,0x54,0x38,0x10,0x00},/*"$",
4*/


{0x00,0x62,0x92,0x94,0x94,0x68,0x08,0x10,0x20,0x2C,0x52,0x52,0x92,0x8C,0x00,0x00},/*"%",
5*/


{0x00,0x30,0x48,0x48,0x48,0x48,0x30,0x20,0x54,0x94,0x88,0x88,0x94,0x62,0x00,0x00},/*"&",
6*/


{0x30,0x30,0x10,0x20,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"'",
7*/


{0x04,0x08,0x10,0x10,0x20,0x20,0x20,0x20,0x20,0x20,0x20,0x10,0x10,0x08,0x04,0x00},/*"(",
8*/


{0x40,0x20,0x10,0x10,0x08,0x08,0x08,0x08,0x08,0x08,0x08,0x10,0x10,0x20,0x40,0x00},/*")",
9*/


{0x00,0x00,0x00,0x10,0x92,0x54,0x38,0x10,0x38,0x54,0x92,0x10,0x00,0x00,0x00,0x00},/*"*",
10*/


{0x00,0x00,0x00,0x00,0x10,0x10,0x10,0xFE,0x10,0x10,0x10,0x00,0x00,0x00,0x00,0x00},/*"+",
11*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x30,0x30,0x10,0x20,0x00},/*",",
12*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x7C,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"-
",13*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x30,0x30,0x00,0x00},/*".",
14*/


{0x00,0x02,0x02,0x04,0x04,0x08,0x08,0x10,0x20,0x20,0x40,0x40,0x80,0x80,0x00,0x00},/*"/",
15*/


{0x00,0x30,0x48,0x84,0x84,0x84,0x84,0x84,0x84,0x84,0x84,0x84,0x48,0x30,0x00,0x00},/*"0",
16*/


{0x00,0x10,0x70,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x00,0x00},/*"1",
17*/


{0x00,0x30,0x48,0x84,0x84,0x04,0x08,0x08,0x10,0x20,0x20,0x40,0x80,0xFC,0x00,0x00},/*"2",
18*/
```

```
{0x00,0x30,0x48,0x84,0x84,0x04,0x08,0x30,0x08,0x04,0x84,0x84,0x48,0x30,0x00,0x00},/*"3",
19*/


{0x00,0x08,0x08,0x18,0x18,0x28,0x28,0x48,0x48,0x88,0xFC,0x08,0x08,0x08,0x00,0x00},/*"4",
20*/


{0x00,0xFC,0x80,0x80,0x80,0xB0,0xC8,0x84,0x04,0x04,0x04,0x84,0x48,0x30,0x00,0x00},/*"5",
21*/


{0x00,0x30,0x48,0x84,0x84,0x80,0xB0,0xC8,0x84,0x84,0x84,0x84,0x48,0x30,0x00,0x00},/*"6",
22*/


{0x00,0xFC,0x04,0x04,0x08,0x08,0x08,0x10,0x10,0x10,0x20,0x20,0x20,0x20,0x00,0x00},/*"7",
23*/


{0x00,0x30,0x48,0x84,0x84,0x84,0x48,0x30,0x48,0x84,0x84,0x84,0x48,0x30,0x00,0x00},/*"8",
24*/


{0x00,0x30,0x48,0x84,0x84,0x84,0x84,0x4C,0x34,0x04,0x84,0x84,0x48,0x30,0x00,0x00},/*"9",
25*/


{0x00,0x00,0x00,0x00,0x00,0x30,0x30,0x00,0x00,0x00,0x00,0x30,0x30,0x00,0x00,0x00},/*":",
26*/


{0x00,0x00,0x00,0x00,0x00,0x30,0x30,0x00,0x00,0x00,0x00,0x30,0x30,0x10,0x20,0x00},/*";",
27*/


{0x00,0x00,0x04,0x08,0x10,0x20,0x40,0x80,0x40,0x20,0x10,0x08,0x04,0x00,0x00,0x00},/*"<",
28*/


{0x00,0x00,0x00,0x00,0x00,0x7C,0x00,0x00,0x00,0x7C,0x00,0x00,0x00,0x00,0x00,0x00},/*"=",
29*/


{0x00,0x00,0x80,0x40,0x20,0x10,0x08,0x04,0x08,0x10,0x20,0x40,0x80,0x00,0x00,0x00},/*">",
30*/


{0x00,0x30,0x48,0x84,0x84,0x04,0x08,0x10,0x20,0x20,0x00,0x00,0x30,0x30,0x00,0x00},/*"?",
31*/


{0x00,0x38,0x44,0x82,0x9A,0xAA,0xAA,0xAA,0xAA,0xAA,0x9C,0x80,0x42,0x3C,0x00,0x00},/*"@",
32*/


{0x00,0x10,0x10,0x28,0x28,0x28,0x28,0x44,0x44,0x44,0x7C,0x82,0x82,0x82,0x00,0x00},/*"A",
33*/
```

```
{0x00,0xF8,0x84,0x82,0x82,0x82,0x84,0xF8,0x84,0x82,0x82,0x82,0x84,0xF8,0x00,0x00},/*"B",
34*/


{0x00,0x38,0x44,0x82,0x82,0x80,0x80,0x80,0x80,0x80,0x82,0x82,0x44,0x38,0x00,0x00},/*"C",
35*/


{0x00,0xF8,0x84,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x84,0xF8,0x00,0x00},/*"D",
36*/


{0x00,0xFE,0x80,0x80,0x80,0x80,0x80,0xFC,0x80,0x80,0x80,0x80,0x80,0xFE,0x00,0x00},/*"E",
37*/


{0x00,0xFE,0x80,0x80,0x80,0x80,0x80,0xFC,0x80,0x80,0x80,0x80,0x80,0x80,0x00,0x00},/*"F",
38*/


{0x00,0x38,0x44,0x82,0x82,0x80,0x80,0x80,0x8E,0x82,0x82,0x82,0x46,0x3A,0x00,0x00},/*"G",
39*/


{0x00,0x82,0x82,0x82,0x82,0x82,0x82,0xFE,0x82,0x82,0x82,0x82,0x82,0x82,0x00,0x00},/*"H",
40*/


{0x00,0x38,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x38,0x00,0x00},/*"I",
41*/


{0x00,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x84,0x84,0x48,0x30,0x00,0x00},/*"J",
42*/


{0x00,0x82,0x84,0x84,0x88,0x90,0x90,0xA0,0xD0,0x88,0x88,0x84,0x82,0x82,0x00,0x00},/*"K",
43*/


{0x00,0x80,0x80,0x80,0x80,0x80,0x80,0x80,0x80,0x80,0x80,0x80,0x80,0xFE,0x00,0x00},/*"L",
44*/


{0x00,0x82,0x82,0xC6,0xC6,0xC6,0xC6,0xAA,0xAA,0xAA,0xAA,0x92,0x92,0x92,0x00,0x00},/*"M",
45*/


{0x00,0x82,0x82,0xC2,0xC2,0xA2,0xA2,0x92,0x92,0x8A,0x8A,0x86,0x86,0x82,0x00,0x00},/*"N",
46*/


{0x00,0x38,0x44,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x44,0x38,0x00,0x00},/*"O",
47*/


{0x00,0xF8,0x84,0x82,0x82,0x82,0x84,0xF8,0x80,0x80,0x80,0x80,0x80,0x80,0x00,0x00},/*"P",
48*/


{0x00,0x38,0x44,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x92,0x8A,0x44,0x3A,0x00,0x00},/*"Q",
49*/
```

```
{0x00,0xF8,0x84,0x82,0x82,0x82,0x84,0xF8,0x88,0x88,0x84,0x84,0x82,0x82,0x00,0x00},/*"R",
50*/


{0x00,0x38,0x44,0x82,0x82,0x80,0x60,0x18,0x04,0x02,0x82,0x82,0x44,0x38,0x00,0x00},/*"S",
51*/


{0x00,0xFE,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x00,0x00},/*"T",
52*/


{0x00,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x82,0x44,0x38,0x00,0x00},/*"U",
53*/


{0x00,0x82,0x82,0x82,0x44,0x44,0x44,0x44,0x28,0x28,0x28,0x10,0x10,0x10,0x00,0x00},/*"V",
54*/


{0x00,0x92,0x92,0x92,0x92,0xAA,0xAA,0xAA,0xAA,0x44,0x44,0x44,0x44,0x44,0x00,0x00},/*"W",
55*/


{0x00,0x82,0x82,0x44,0x44,0x28,0x28,0x10,0x28,0x28,0x44,0x44,0x82,0x82,0x00,0x00},/*"X",
56*/


{0x00,0x82,0x82,0x44,0x44,0x28,0x28,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x00,0x00},/*"Y",
57*/


{0x00,0xFE,0x02,0x04,0x04,0x08,0x08,0x10,0x20,0x20,0x40,0x40,0x80,0xFE,0x00,0x00},/*"Z",
58*/


{0x7C,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x40,0x7C,0x00},/*"[",
59*/


{0x00,0x82,0x82,0x44,0x44,0x28,0x28,0x7C,0x10,0x10,0x7C,0x10,0x10,0x10,0x00,0x00},/*"\",
60*/


{0x7C,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x04,0x7C,0x00},/*"]",
61*/


{0x10,0x28,0x44,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"^",
62*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0xFF},/*"_",
63*/


{0x30,0x30,0x10,0x20,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"'",
64*/
```

```
{0x00,0x00,0x00,0x00,0x00,0x00,0x78,0x84,0x04,0x3C,0x44,0x84,0x8C,0x76,0x00,0x00},/*"a",
65*/


{0x00,0x80,0x80,0x80,0x80,0x80,0xB8,0xC4,0x82,0x82,0x82,0x82,0xC4,0xB8,0x00,0x00},/*"b",
66*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x3C,0x42,0x80,0x80,0x80,0x80,0x42,0x3C,0x00,0x00},/*"c",
67*/


{0x00,0x02,0x02,0x02,0x02,0x02,0x3A,0x46,0x82,0x82,0x82,0x82,0x46,0x3A,0x00,0x00},/*"d",
68*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x38,0x44,0x82,0xFE,0x80,0x80,0x42,0x3C,0x00,0x00},/*"e",
69*/


{0x00,0x18,0x20,0x20,0x20,0x20,0xF8,0x20,0x20,0x20,0x20,0x20,0x20,0x20,0x00,0x00},/*"f",
70*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x3A,0x44,0x44,0x38,0x40,0x7C,0x82,0x82,0x7C,0x00},/*"g",
71*/


{0x00,0x80,0x80,0x80,0x80,0x80,0xB8,0xC4,0x82,0x82,0x82,0x82,0x82,0x82,0x00,0x00},/*"h",
72*/


{0x00,0x00,0x10,0x10,0x00,0x00,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x00,0x00},/*"i",
73*/


{0x00,0x00,0x10,0x10,0x00,0x00,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x60,0x00},/*"j",
74*/


{0x00,0x80,0x80,0x80,0x80,0x80,0x84,0x88,0x90,0xA0,0xD0,0x88,0x84,0x82,0x00,0x00},/*"k",
75*/


{0x00,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x00,0x00},/*"l",
76*/


{0x00,0x00,0x00,0x00,0x00,0x00,0xAC,0xD2,0x92,0x92,0x92,0x92,0x92,0x92,0x00,0x00},/*"m",
77*/


{0x00,0x00,0x00,0x00,0x00,0x00,0xB8,0xC4,0x82,0x82,0x82,0x82,0x82,0x82,0x00,0x00},/*"n",
78*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x38,0x44,0x82,0x82,0x82,0x82,0x44,0x38,0x00,0x00},/*"o",
79*/


{0x00,0x00,0x00,0x00,0x00,0x00,0xB8,0xC4,0x82,0x82,0x82,0xC4,0xB8,0x80,0x80,0x00},/*"p",
80*/
```

```
{0x00,0x00,0x00,0x00,0x00,0x00,0x3A,0x46,0x82,0x82,0x82,0x46,0x3A,0x02,0x02,0x00},/*"q",
81*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x2E,0x30,0x20,0x20,0x20,0x20,0x20,0x20,0x00,0x00},/*"r",
82*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x7C,0x82,0x80,0x60,0x1C,0x02,0x82,0x7C,0x00,0x00},/*"s",
83*/


{0x00,0x00,0x20,0x20,0x20,0x20,0xF8,0x20,0x20,0x20,0x20,0x20,0x20,0x18,0x00,0x00},/*"t",
84*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x82,0x82,0x82,0x82,0x82,0x82,0x46,0x3A,0x00,0x00},/*"u",
85*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x82,0x82,0x44,0x44,0x28,0x28,0x10,0x10,0x00,0x00},/*"v",
86*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x92,0x92,0x92,0xAA,0xAA,0x44,0x44,0x44,0x00,0x00},/*"w",
87*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x82,0x44,0x28,0x10,0x10,0x28,0x44,0x82,0x00,0x00},/*"x",
88*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x82,0x82,0x44,0x44,0x28,0x28,0x10,0x20,0xC0,0x00},/*"y",
89*/


{0x00,0x00,0x00,0x00,0x00,0x00,0xFE,0x04,0x08,0x10,0x20,0x40,0x80,0xFE,0x00,0x00},/*"z",
90*/


{0x1C,0x10,0x10,0x10,0x10,0x10,0x10,0x20,0x10,0x10,0x10,0x10,0x10,0x10,0x1C,0x00},/*"{",
91*/


{0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10,0x10},/*"|",
92*/


{0x70,0x10,0x10,0x10,0x10,0x10,0x10,0x08,0x10,0x10,0x10,0x10,0x10,0x10,0x70,0x00},/*"}",
93*/


{0x64,0x98,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"~",
94*/


};


#endif
```

```
#ifdef ASCII_8X16_System

static unsigned char const AsciiLib[95][16] = {

{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"
",0*/


{0x00,0x00,0x00,0x18,0x3C,0x3C,0x3C,0x18,0x18,0x00,0x18,0x18,0x00,0x00,0x00,0x00},/*"!",
1*/


{0x00,0x00,0x00,0x66,0x66,0x66,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"""",
2*/


{0x00,0x00,0x00,0x36,0x36,0x7F,0x36,0x36,0x36,0x7F,0x36,0x36,0x00,0x00,0x00,0x00},/*"#",
3*/


{0x00,0x18,0x18,0x3C,0x66,0x60,0x30,0x18,0x0C,0x06,0x66,0x3C,0x18,0x18,0x00,0x00},/*"$",
4*/


{0x00,0x00,0x70,0xD8,0xDA,0x76,0x0C,0x18,0x30,0x6E,0x5B,0x1B,0x0E,0x00,0x00,0x00},/*"%",
5*/


{0x00,0x00,0x00,0x38,0x6C,0x6C,0x38,0x60,0x6F,0x66,0x66,0x3B,0x00,0x00,0x00,0x00},/*"&",
6*/


{0x00,0x00,0x00,0x18,0x18,0x18,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"'",
7*/


{0x00,0x00,0x00,0x0C,0x18,0x18,0x30,0x30,0x30,0x30,0x30,0x18,0x18,0x0C,0x00,0x00},/*"(",
8*/


{0x00,0x00,0x00,0x30,0x18,0x18,0x0C,0x0C,0x0C,0x0C,0x0C,0x18,0x18,0x30,0x00,0x00},/*")",
9*/


{0x00,0x00,0x00,0x00,0x00,0x36,0x1C,0x7F,0x1C,0x36,0x00,0x00,0x00,0x00,0x00,0x00},/*"*",
10*/


{0x00,0x00,0x00,0x00,0x00,0x18,0x18,0x7E,0x18,0x18,0x00,0x00,0x00,0x00,0x00,0x00},/*"+",
11*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x1C,0x1C,0x0C,0x18,0x00,0x00},/*",",
12*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x7E,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"-
",13*/
```

```
{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x1C,0x1C,0x00,0x00,0x00,0x00},/*".",
14*/


{0x00,0x00,0x00,0x06,0x06,0x0C,0x0C,0x18,0x18,0x30,0x30,0x60,0x60,0x00,0x00,0x00},/*"/",
15*/


{0x00,0x00,0x00,0x1E,0x33,0x37,0x37,0x33,0x3B,0x3B,0x33,0x1E,0x00,0x00,0x00,0x00},/*"0",
16*/


{0x00,0x00,0x00,0x0C,0x1C,0x7C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x00,0x00,0x00,0x00},/*"1",
17*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x06,0x0C,0x18,0x30,0x60,0x7E,0x00,0x00,0x00,0x00},/*"2",
18*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x06,0x1C,0x06,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"3",
19*/


{0x00,0x00,0x00,0x30,0x30,0x36,0x36,0x36,0x66,0x7F,0x06,0x06,0x00,0x00,0x00,0x00},/*"4",
20*/


{0x00,0x00,0x00,0x7E,0x60,0x60,0x60,0x7C,0x06,0x06,0x0C,0x78,0x00,0x00,0x00,0x00},/*"5",
21*/


{0x00,0x00,0x00,0x1C,0x18,0x30,0x7C,0x66,0x66,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"6",
22*/


{0x00,0x00,0x00,0x7E,0x06,0x0C,0x0C,0x18,0x18,0x30,0x30,0x30,0x00,0x00,0x00,0x00},/*"7",
23*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x76,0x3C,0x6E,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"8",
24*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x66,0x66,0x3E,0x0C,0x18,0x38,0x00,0x00,0x00,0x00},/*"9",
25*/


{0x00,0x00,0x00,0x00,0x00,0x1C,0x1C,0x00,0x00,0x00,0x1C,0x1C,0x00,0x00,0x00,0x00},/*":",
26*/


{0x00,0x00,0x00,0x00,0x00,0x1C,0x1C,0x00,0x00,0x00,0x1C,0x1C,0x0C,0x18,0x00,0x00},/*";",
27*/


{0x00,0x00,0x00,0x06,0x0C,0x18,0x30,0x60,0x30,0x18,0x0C,0x06,0x00,0x00,0x00,0x00},/*"<",
28*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x7E,0x00,0x7E,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"=",
29*/
```

```
{0x00,0x00,0x00,0x60,0x30,0x18,0x0C,0x06,0x0C,0x18,0x30,0x60,0x00,0x00,0x00,0x00},/*">",
30*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x0C,0x18,0x18,0x00,0x18,0x18,0x00,0x00,0x00,0x00},/*"?",
31*/


{0x00,0x00,0x00,0x7E,0xC3,0xC3,0xCF,0xDB,0xDB,0xCF,0xC0,0x7F,0x00,0x00,0x00,0x00},/*"@",
32*/


{0x00,0x00,0x00,0x18,0x3C,0x66,0x66,0x66,0x7E,0x66,0x66,0x66,0x00,0x00,0x00,0x00},/*"A",
33*/


{0x00,0x00,0x00,0x7C,0x66,0x66,0x66,0x7C,0x66,0x66,0x66,0x7C,0x00,0x00,0x00,0x00},/*"B",
34*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x60,0x60,0x60,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"C",
35*/


{0x00,0x00,0x00,0x78,0x6C,0x66,0x66,0x66,0x66,0x66,0x6C,0x78,0x00,0x00,0x00,0x00},/*"D",
36*/


{0x00,0x00,0x00,0x7E,0x60,0x60,0x60,0x7C,0x60,0x60,0x60,0x7E,0x00,0x00,0x00,0x00},/*"E",
37*/


{0x00,0x00,0x00,0x7E,0x60,0x60,0x60,0x7C,0x60,0x60,0x60,0x60,0x00,0x00,0x00,0x00},/*"F",
38*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x60,0x60,0x6E,0x66,0x66,0x3E,0x00,0x00,0x00,0x00},/*"G",
39*/


{0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x7E,0x66,0x66,0x66,0x66,0x00,0x00,0x00,0x00},/*"H",
40*/


{0x00,0x00,0x00,0x3C,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x3C,0x00,0x00,0x00,0x00},/*"I",
41*/


{0x00,0x00,0x00,0x06,0x06,0x06,0x06,0x06,0x06,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"J",
42*/


{0x00,0x00,0x00,0x66,0x66,0x6C,0x6C,0x78,0x6C,0x6C,0x66,0x66,0x00,0x00,0x00,0x00},/*"K",
43*/


{0x00,0x00,0x00,0x60,0x60,0x60,0x60,0x60,0x60,0x60,0x60,0x7E,0x00,0x00,0x00,0x00},/*"L",
44*/
```

```
{0x00,0x00,0x00,0x63,0x63,0x77,0x6B,0x6B,0x6B,0x63,0x63,0x63,0x00,0x00,0x00,0x00},/*"M",
45*/


{0x00,0x00,0x00,0x63,0x63,0x73,0x7B,0x6F,0x67,0x63,0x63,0x63,0x00,0x00,0x00,0x00},/*"N",
46*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x66,0x66,0x66,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"O",
47*/


{0x00,0x00,0x00,0x7C,0x66,0x66,0x66,0x7C,0x60,0x60,0x60,0x60,0x00,0x00,0x00,0x00},/*"P",
48*/


{0x00,0x00,0x00,0x3C,0x66,0x66,0x66,0x66,0x66,0x66,0x66,0x3C,0x0C,0x06,0x00,0x00},/*"Q",
49*/


{0x00,0x00,0x00,0x7C,0x66,0x66,0x66,0x7C,0x6C,0x66,0x66,0x66,0x00,0x00,0x00,0x00},/*"R",
50*/


{0x00,0x00,0x00,0x3C,0x66,0x60,0x30,0x18,0x0C,0x06,0x66,0x3C,0x00,0x00,0x00,0x00},/*"S",
51*/


{0x00,0x00,0x00,0x7E,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x00,0x00,0x00,0x00},/*"T",
52*/


{0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x66,0x66,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"U",
53*/


{0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x66,0x66,0x66,0x3C,0x18,0x00,0x00,0x00,0x00},/*"V",
54*/


{0x00,0x00,0x00,0x63,0x63,0x63,0x6B,0x6B,0x6B,0x36,0x36,0x36,0x00,0x00,0x00,0x00},/*"W",
55*/


{0x00,0x00,0x00,0x66,0x66,0x34,0x18,0x18,0x2C,0x66,0x66,0x66,0x00,0x00,0x00,0x00},/*"X",
56*/


{0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x3C,0x18,0x18,0x18,0x18,0x00,0x00,0x00,0x00},/*"Y",
57*/


{0x00,0x00,0x00,0x7E,0x06,0x06,0x0C,0x18,0x30,0x60,0x60,0x7E,0x00,0x00,0x00,0x00},/*"Z",
58*/


{0x00,0x00,0x00,0x3C,0x30,0x30,0x30,0x30,0x30,0x30,0x30,0x30,0x30,0x3C,0x00},/*"[",
59*/


{0x00,0x00,0x00,0x60,0x60,0x30,0x30,0x18,0x18,0x0C,0x0C,0x06,0x06,0x00,0x00,0x00},/*"\",
60*/
```

```
{0x00,0x00,0x00,0x3C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x3C,0x00},/*"]",
61*/


{0x00,0x18,0x3C,0x66,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"^",
62*/


{0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0xFF,0x00},/*"_",
63*/


{0x00,0x00,0x00,0x18,0x18,0x18,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"'",
64*/


{0x00,0x00,0x00,0x00,0x00,0x3C,0x06,0x06,0x3E,0x66,0x66,0x3E,0x00,0x00,0x00,0x00},/*"a",
65*/


{0x00,0x00,0x00,0x60,0x60,0x7C,0x66,0x66,0x66,0x66,0x66,0x7C,0x00,0x00,0x00,0x00},/*"b",
66*/


{0x00,0x00,0x00,0x00,0x00,0x3C,0x66,0x60,0x60,0x60,0x66,0x3C,0x00,0x00,0x00,0x00},/*"c",
67*/


{0x00,0x00,0x00,0x06,0x06,0x3E,0x66,0x66,0x66,0x66,0x66,0x3E,0x00,0x00,0x00,0x00},/*"d",
68*/


{0x00,0x00,0x00,0x00,0x00,0x3C,0x66,0x66,0x7E,0x60,0x60,0x3C,0x00,0x00,0x00,0x00},/*"e",
69*/


{0x00,0x00,0x00,0x1E,0x30,0x30,0x30,0x7E,0x30,0x30,0x30,0x30,0x00,0x00,0x00,0x00},/*"f",
70*/


{0x00,0x00,0x00,0x00,0x00,0x3E,0x66,0x66,0x66,0x66,0x66,0x3E,0x06,0x06,0x7C,0x00},/*"g",
71*/


{0x00,0x00,0x00,0x60,0x60,0x7C,0x66,0x66,0x66,0x66,0x66,0x66,0x00,0x00,0x00,0x00},/*"h",
72*/


{0x00,0x00,0x18,0x18,0x00,0x78,0x18,0x18,0x18,0x18,0x18,0x7E,0x00,0x00,0x00,0x00},/*"i",
73*/


{0x00,0x00,0x0C,0x0C,0x00,0x3C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x0C,0x78,0x00},/*"j",
74*/


{0x00,0x00,0x00,0x60,0x60,0x66,0x66,0x6C,0x78,0x6C,0x66,0x66,0x00,0x00,0x00,0x00},/*"k",
75*/
```

```
{0x00,0x00,0x00,0x78,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x7E,0x00,0x00,0x00,0x00},/*"l",
76*/


{0x00,0x00,0x00,0x00,0x00,0x7E,0x6B,0x6B,0x6B,0x6B,0x6B,0x63,0x00,0x00,0x00,0x00},/*"m",
77*/


{0x00,0x00,0x00,0x00,0x00,0x7C,0x66,0x66,0x66,0x66,0x66,0x66,0x00,0x00,0x00,0x00},/*"n",
78*/


{0x00,0x00,0x00,0x00,0x00,0x3C,0x66,0x66,0x66,0x66,0x66,0x3C,0x00,0x00,0x00,0x00},/*"o",
79*/


{0x00,0x00,0x00,0x00,0x00,0x7C,0x66,0x66,0x66,0x66,0x66,0x7C,0x60,0x60,0x60,0x00},/*"p",
80*/


{0x00,0x00,0x00,0x00,0x00,0x3E,0x66,0x66,0x66,0x66,0x66,0x3E,0x06,0x06,0x06,0x00},/*"q",
81*/


{0x00,0x00,0x00,0x00,0x00,0x66,0x6E,0x70,0x60,0x60,0x60,0x00,0x00,0x00,0x00,0x00},/*"r",
82*/


{0x00,0x00,0x00,0x00,0x00,0x3E,0x60,0x60,0x3C,0x06,0x06,0x7C,0x00,0x00,0x00,0x00},/*"s",
83*/


{0x00,0x00,0x00,0x30,0x30,0x7E,0x30,0x30,0x30,0x30,0x30,0x1E,0x00,0x00,0x00,0x00},/*"t",
84*/


{0x00,0x00,0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x66,0x66,0x3E,0x00,0x00,0x00,0x00},/*"u",
85*/


{0x00,0x00,0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x66,0x3C,0x18,0x00,0x00,0x00,0x00},/*"v",
86*/


{0x00,0x00,0x00,0x00,0x00,0x63,0x6B,0x6B,0x6B,0x6B,0x36,0x36,0x00,0x00,0x00,0x00},/*"w",
87*/


{0x00,0x00,0x00,0x00,0x00,0x66,0x66,0x3C,0x18,0x3C,0x66,0x66,0x00,0x00,0x00,0x00},/*"x",
88*/


{0x00,0x00,0x00,0x00,0x00,0x66,0x66,0x66,0x66,0x66,0x66,0x3C,0x0C,0x18,0xF0,0x00},/*"y",
89*/


{0x00,0x00,0x00,0x00,0x00,0x7E,0x06,0x0C,0x18,0x30,0x60,0x7E,0x00,0x00,0x00,0x00},/*"z",
90*/


{0x00,0x00,0x00,0x0C,0x18,0x18,0x18,0x30,0x60,0x30,0x18,0x18,0x18,0x0C,0x00,0x00},/*"{",
91*/
```

```
{0x00,0x00,0x00,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x18,0x00},/*"|",
92*/


{0x00,0x00,0x00,0x30,0x18,0x18,0x18,0x0C,0x06,0x0C,0x18,0x18,0x18,0x30,0x00,0x00},/*"}",
93*/


{0x00,0x00,0x00,0x71,0xDB,0x8E,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00},/*"~",
94*/

};


#endif




/*****************************************************************************

* Function Name  : GetASCIICode

* Description    : È¡ASCIIÂë ÊýÝ

* Input          : - ASCII: ÊäÈëµÄASCIIÂë£¬Èç'A',BaseAddr »ùÖ·
¼´ASCIIÏÔÊ¾´úÂëÔÚFLASHÖÐµÄ´æ´¢Î»ÖÃ

* Output         : - *pBuffer: ´æ·ÅÊý¾ÝµÄ¸Õë

* Return         : None

* Attention            : None

*****************************************************************************/

void GetASCIICode(unsigned char* pBuffer,unsigned char ASCII)

{

   memcpy(pBuffer,AsciiLib[(ASCII - 32)] ,16);

}




/*****************************************************************************************
******************

      END FILE

*****************************************************************************************
*****************/







/***************************************Copyright
(c)************************************************

**

**                                  http://www.powermcu.com
```

```
**
**--------------File Info----------------------------------------------------------------
----------------
** File name:                  GLCD.h
** Descriptions:              TFT (IO)
**
**--------------------------------------------------------------------------------------
----------------
** Created by:                AVRman
** Created date:              2015-1-26
** Version:                           2.0
** Descriptions:              The original version
**
**--------------------------------------------------------------------------------------
----------------
** Modified by:
** Modified date:
** Version:
** Descriptions:
**************************************************************************************
****************/


/* Includes ------------------------------------------------------------------*/
#include <LPC17xx.H>
#include "GLCD.h"
#include "AsciiLib.h"



/* La orientación se modifica en GLCD.h */


/* Private variables ---------------------------------------------------------*/
static uint8_t LCD_Code;


/* Private define ------------------------------------------------------------*/
#define  ILI9320     0  /* 0x9320 */
#define  ILI9325     1  /* 0x9325 */
#define  ILI9325A    2  /* 0x9325A */
#define  ILI9325C    3  /* 0x9325C */
#define  ILI9325D    4  /* 0x9325D */
#define  ST7781      5  /* 0x7783 */
#define  LGDP4531    6  /* 0x4531 */
```

```
#define  SPFD5408B   7  /* 0x5408 */

#define  R61505U     8  /* 0x1505 0x0505 */

#define  HX8347A     9  /* 0x0047 */

#define  LGDP4535    10  /* 0x4535 */


/*****************************************************************************

* Function Name  : Lcd_Configuration

* Description    : Configures LCD Control lines

* Input          : None

* Output         : None

* Return         : None

* Attention            : None

*****************************************************************************/

static void LCD_Configuration(void)

{

       /* Configure the LCD Control pins */


       /* DB[0.7] = P2.0...P2.7 */

       LPC_GPIO2->FIODIR |= 0x000000FF;               /* P2.0...P2.7   Output DB[0..7]
*/


       /* DB[8.15]= P0.15...P0.22 */

       LPC_GPIO0->FIODIR |= 0x007F8000;
       /* P0.15...P0.22 Output DB[8..15]*/


       /*RS = P1.27, WR = P1.28, RD = P1.29*/

       LPC_GPIO1->FIODIR |= 0x38000000;
       /* P1.27...P1.29 Output */




       /*CS  = P2.8 */

       LPC_GPIO2->FIODIR |= 0x00000100;
/* P2.8 Output */


}


/*****************************************************************************

* Function Name  : LCD_Send

* Description    : LCDÐ´Êý¾Ý

* Input          : - byte: byte to be sent

* Output         : None
```

```
* Return         : None

* Attention            : None

*******************************************************************************/

static __attribute__((always_inline)) void LCD_Send (uint16_t byte)

{

       uint32_t temp;

       temp = byte;


       LPC_GPIO2->FIOPIN =  (LPC_GPIO2->FIOPIN & (~(0x000000FF))) | (temp & 0x00FF);
                                             /* Write D0..D7 */

       LPC_GPIO0->FIOPIN =  (LPC_GPIO0->FIOPIN & (~(0x007F8000))) | ((temp << 7) &
0x007F8000);        /* Write D8..D15 */

}


/*******************************************************************************

* Function Name  : LCD_Read

* Description    : LCD¶ÁÊý¾Ý

* Input          : - byte: byte to be read

* Output         : None

* Return         : ·µ»Ø¶ÁÈ¡µ½µÄÊý¾Ý

* Attention            : None

*******************************************************************************/

static __attribute__((always_inline)) uint16_t LCD_Read (void)

{

       uint32_t low,high;


       LPC_GPIO2->FIODIR &= ~(0x000000FF);             /* P2.0...P2.7   Input DB[0..7]
*/

       LPC_GPIO0->FIODIR &= ~(0x007F8000);                                      /*
P0.15...P0.22 Input DB[8..15]*/

       low  = LPC_GPIO2->FIOPIN & 0x000000ff;          /* Read D0..D7 */

       high = LPC_GPIO0->FIOPIN & 0x007f8000;          /* Read D8..D15 */

       low |= (high >> 7);


       LPC_GPIO2->FIODIR |= 0x000000FF;                /* P2.0...P2.7   Output DB[0..7]
*/

       LPC_GPIO0->FIODIR |= 0x007F8000;
       /* P0.15...P0.22 Output DB[8..15]*/


       return  low;

}
```

```
/*********************************************************************************
* Function Name  : LCD_WriteIndex
* Description    : LCDÐ´¼Ä´æÆ÷µØÖ·
* Input          : - index: ¼Ä´æÆ÷µØÖ·
* Output         : None
* Return         : None
* Attention             : None
*********************************************************************************/
static __attribute__((always_inline)) void LCD_WriteIndex(uint16_t index)
{
	LCD_CS(0);
	LCD_RS(0);
	LCD_RD(1);
	LCD_Send( index );
	LCD_WR(0);
	__nop();	/* delay */
	LCD_WR(1);
	LCD_CS(1);
}

/*********************************************************************************
* Function Name  : LCD_WriteData
* Description    : LCDÐ´¼Ä´æÆ÷ÊýÝ¾Ý
* Input          : - index: ¼Ä´æÆ÷ÊýÝ¾Ý
* Output         : None
* Return         : None
* Attention             : None
*********************************************************************************/
static __attribute__((always_inline)) void LCD_WriteData(uint16_t data)
{
	LCD_CS(0);
	LCD_RS(1);
	LCD_Send( data );
	LCD_WR(0);
	__nop();	/* delay */
	LCD_WR(1);
	LCD_CS(1);
}
```

```
/*******************************************************************************
* Function Name  : LCD_ReadData
* Description    : ¶ÁÈ¡¿ØÖÆ÷Êý¾Ý
* Input          : None
* Output         : None
* Return         : ·µ»Ø¶ÁÈ¡µ½µÄÊý¾Ý
* Attention             : None
*******************************************************************************/
static __attribute__((always_inline)) uint16_t LCD_ReadData(void)
{
	uint16_t value;

	LCD_CS(0);
	LCD_RS(1);
	LCD_WR(1);
	LCD_RD(0);
	value = LCD_Read();

	LCD_RD(1);
	LCD_CS(1);

	return value;
}

/*******************************************************************************
* Function Name  : LCD_WriteReg
* Description    : Writes to the selected LCD register.
* Input          : - LCD_Reg: address of the selected register.
*                  - LCD_RegValue: value to write to the selected register.
* Output         : None
* Return         : None
* Attention             : None
*******************************************************************************/
static __attribute__((always_inline)) void LCD_WriteReg(uint16_t LCD_Reg,uint16_t
LCD_RegValue)
{
	/* Write 16-bit Index, then Write Reg */
	LCD_WriteIndex(LCD_Reg);
	/* Write 16-bit Reg */
	LCD_WriteData(LCD_RegValue);
```

```
}

/*******************************************************************************
* Function Name  : LCD_WriteReg
* Description    : Reads the selected LCD Register.
* Input          : None
* Output         : None
* Return         : LCD Register Value.
* Attention             : None
*******************************************************************************/
static __attribute__((always_inline)) uint16_t LCD_ReadReg(uint16_t LCD_Reg)
{
        uint16_t LCD_RAM;

        /* Write 16-bit Index (then Read Reg) */
        LCD_WriteIndex(LCD_Reg);
        /* Read 16-bit Reg */
        LCD_RAM = LCD_ReadData();
        return LCD_RAM;
}

/*******************************************************************************
* Function Name  : LCD_SetCursor
* Description    : Sets the cursor position.
* Input          : - Xpos: specifies the X position.
*                  - Ypos: specifies the Y position.
* Output         : None
* Return         : None
* Attention             : None
*******************************************************************************/
static __attribute__((always_inline)) void LCD_SetCursor(uint16_t Xpos,uint16_t Ypos)
{
    #if  ( DISP_ORIENTATION == 90 ) || ( DISP_ORIENTATION == 270 )

        uint16_t temp = Xpos;

                        Xpos = Ypos;
                        Ypos = ( MAX_X - 1 ) - temp;
```

```
       #elif  ( DISP_ORIENTATION == 0 ) || ( DISP_ORIENTATION == 180 )

       #endif

  switch( LCD_Code )
  {
     default:          /* 0x9320 0x9325 0x5408 0x1505 0x0505 0x7783 0x4531 0x4535 */
          LCD_WriteReg(0x0020, Xpos );
          LCD_WriteReg(0x0021, Ypos );
             break;

     case HX8347A:     /* 0x0047 */
             LCD_WriteReg(0x02, Xpos>>8 );
             LCD_WriteReg(0x03, Xpos );

             LCD_WriteReg(0x06, Ypos>>8 );
             LCD_WriteReg(0x07, Ypos );

             break;
  }
}

/****************************************************************************
* Function Name  : delay_ms
* Description    : Delay Time
* Input          : - nCount: Delay Time
* Output         : None
* Return         : None
* Return         : None
* Attention            : None
****************************************************************************/
static void delay_ms(uint16_t ms)
{
       uint16_t i,j;
       for( i = 0; i < ms; i++ )
       {
              for( j = 0; j < 1141; j++ );
       }
}
```

```
/*******************************************************************************
* Function Name  : LCD_Initializtion
* Description    : Initialize TFT Controller.
* Input          : None
* Output         : None
* Return         : None
* Attention            : None
*******************************************************************************/
void LCD_Initializtion(void)
{
       uint16_t DeviceCode;


       LCD_Configuration();
       delay_ms(100);
       DeviceCode = LCD_ReadReg(0x0000);           /* read LCD ID */
       /*  recognition different screen£¬ use different Initialization*/
       if( DeviceCode == 0x9325 || DeviceCode == 0x9328 )
       {
              LCD_Code = ILI9325;


              LCD_WriteReg(0xB1, 0x00A5);                                  /* only
ILI9325C have oxB1 Register */
              DeviceCode = LCD_ReadReg(0x00B1);           /* only ILI9325C have oxB1
Register */
              if ( DeviceCode == 0x00A5)
              {
                     LCD_Code = ILI9325C;
                     LCD_WriteReg(0xB1, 0x0000);
              }
              else
              {
                     LCD_Code = ILI9325A;
              }
              LCD_WriteReg(0xE5, 0x78F0); /* set SRAM internal timing */
              LCD_WriteReg(0x01, 0x0100); /* set Driver Output Control */
              LCD_WriteReg(0x02, 0x0700); /* set 1 line inversion */
              LCD_WriteReg(0x03, 0x1030); /* set GRAM write direction and BGR=1 */
              LCD_WriteReg(0x04, 0x0000); /* Resize register */
              LCD_WriteReg(0x08, 0x0207); /* set the back porch and front porch */
```

```
            LCD_WriteReg(0x09, 0x0000); /* set non-display area refresh cycle
ISC[3:0] */
            LCD_WriteReg(0x0A, 0x0000); /* FMARK function */
            LCD_WriteReg(0x0C, 0x0000); /* RGB interface setting */
            LCD_WriteReg(0x0D, 0x0000); /* Frame marker Position */
            LCD_WriteReg(0x0F, 0x0000); /* RGB interface polarity */
            /*************Power On sequence ****************/
            LCD_WriteReg(0x10, 0x0000); /* SAP, BT[3:0], AP, DSTB, SLP, STB */
            LCD_WriteReg(0x11, 0x0007); /* DC1[2:0], DC0[2:0], VC[2:0] */
            LCD_WriteReg(0x12, 0x0000); /* VREG1OUT voltage */
            LCD_WriteReg(0x13, 0x0000); /* VDV[4:0] for VCOM amplitude */
            LCD_WriteReg(0x07, 0x0001);
            delay_ms(200);
            /* Dis-charge capacitor power voltage */
            LCD_WriteReg(0x10, 0x1090); /* SAP, BT[3:0], AP, DSTB, SLP, STB */
            LCD_WriteReg(0x11, 0x0227); /* Set DC1[2:0], DC0[2:0], VC[2:0] */
            delay_ms(50);                                          /* Delay 50ms
*/
            LCD_WriteReg(0x12, 0x001F);
            delay_ms(50);                                          /* Delay 50ms
*/
            LCD_WriteReg(0x13, 0x1500); /* VDV[4:0] for VCOM amplitude */
            LCD_WriteReg(0x29, 0x0027); /* 04 VCM[5:0] for VCOMH */
            LCD_WriteReg(0x2B, 0x000D); /* Set Frame Rate */
            delay_ms(50);                                          /* Delay 50ms
*/
            LCD_WriteReg(0x20, 0x0000); /* GRAM horizontal Address */
            LCD_WriteReg(0x21, 0x0000); /* GRAM Vertical Address */
            /* ----------- Adjust the Gamma Curve ---------- */
            LCD_WriteReg(0x30, 0x0000);
            LCD_WriteReg(0x31, 0x0707);
            LCD_WriteReg(0x32, 0x0307);
            LCD_WriteReg(0x35, 0x0200);
            LCD_WriteReg(0x36, 0x0008);
            LCD_WriteReg(0x37, 0x0004);
            LCD_WriteReg(0x38, 0x0000);
            LCD_WriteReg(0x39, 0x0707);
            LCD_WriteReg(0x3C, 0x0002);
            LCD_WriteReg(0x3D, 0x1D04);
            /* ------------------ Set GRAM area --------------- */
            LCD_WriteReg(0x50, 0x0000); /* Horizontal GRAM Start Address */
```

```
            LCD_WriteReg(0x51, 0x00EF); /* Horizontal GRAM End Address */
            LCD_WriteReg(0x52, 0x0000); /* Vertical GRAM Start Address */
            LCD_WriteReg(0x53, 0x013F); /* Vertical GRAM Start Address */
            LCD_WriteReg(0x60, 0xA700); /* Gate Scan Line */
            LCD_WriteReg(0x61, 0x0001); /* NDL,VLE, REV */
            LCD_WriteReg(0x6A, 0x0000); /* set scrolling line */
            /* -------------- Partial Display Control --------- */
            LCD_WriteReg(0x80, 0x0000);
            LCD_WriteReg(0x81, 0x0000);
            LCD_WriteReg(0x82, 0x0000);
            LCD_WriteReg(0x83, 0x0000);
            LCD_WriteReg(0x84, 0x0000);
            LCD_WriteReg(0x85, 0x0000);
            /* -------------- Panel Control ------------------- */
            LCD_WriteReg(0x90, 0x0010);
            LCD_WriteReg(0x92, 0x0600);
            LCD_WriteReg(0x07, 0x0133); /* 262K color and display ON */
        }
        else if( DeviceCode == 0x9320 || DeviceCode == 0x9300 )
        {
            LCD_Code = ILI9320;
            LCD_WriteReg(0x00,0x0000);
                LCD_WriteReg(0x01,0x0100);    /* Driver Output Contral */
                LCD_WriteReg(0x02,0x0700);    /* LCD Driver Waveform Contral */
                LCD_WriteReg(0x03,0x1018);    /* Entry Mode Set */

                LCD_WriteReg(0x04,0x0000);    /* Scalling Contral */
          LCD_WriteReg(0x08,0x0202);  /* Display Contral */
                LCD_WriteReg(0x09,0x0000);    /* Display Contral 3.(0x0000) */
                LCD_WriteReg(0x0a,0x0000);    /* Frame Cycle Contal.(0x0000) */
          LCD_WriteReg(0x0c,(1<<0));  /* Extern Display Interface Contral */
                LCD_WriteReg(0x0d,0x0000);    /* Frame Maker Position */
                LCD_WriteReg(0x0f,0x0000);    /* Extern Display Interface Contral 2. */

          delay_ms(100);                                    /* delay 100 ms */

                LCD_WriteReg(0x07,0x0101);    /* Display Contral */
          delay_ms(100);                                    /* delay 100 ms */
```

```
            LCD_WriteReg(0x10,(1<<12)|(0<<8)|(1<<7)|(1<<6)|(0<<4));    /* Power
Control 1.(0x16b0)    */

            LCD_WriteReg(0x11,0x0007);
                                                    /* Power Control 2 */

            LCD_WriteReg(0x12,(1<<8)|(1<<4)|(0<<0));
                   /* Power Control 3.(0x0138)   */

            LCD_WriteReg(0x13,0x0b00);
                                                    /* Power Control 4 */

            LCD_WriteReg(0x29,0x0000);
                                                    /* Power Control 7 */


            LCD_WriteReg(0x2b,(1<<14)|(1<<4));


            LCD_WriteReg(0x50,0);       /* Set X Start */

            LCD_WriteReg(0x51,239);           /* Set X End */

            LCD_WriteReg(0x52,0);         /* Set Y Start */

            LCD_WriteReg(0x53,319);           /* Set Y End */


            LCD_WriteReg(0x60,0x2700);    /* Driver Output Control */

            LCD_WriteReg(0x61,0x0001);    /* Driver Output Control */

            LCD_WriteReg(0x6a,0x0000);    /* Vertical Srcoll Control */


            LCD_WriteReg(0x80,0x0000);    /* Display Position? Partial Display 1 */

            LCD_WriteReg(0x81,0x0000);    /* RAM Address Start? Partial Display 1 */

            LCD_WriteReg(0x82,0x0000);    /* RAM Address End-Partial Display 1 */

            LCD_WriteReg(0x83,0x0000);    /* Displsy Position? Partial Display 2 */

            LCD_WriteReg(0x84,0x0000);    /* RAM Address Start? Partial Display 2 */

            LCD_WriteReg(0x85,0x0000);    /* RAM Address End? Partial Display 2 */


        LCD_WriteReg(0x90,(0<<7)|(16<<0));      /* Frame Cycle Contral.(0x0013)
       */
            LCD_WriteReg(0x92,0x0000);    /* Panel Interface Contral 2.(0x0000) */

            LCD_WriteReg(0x93,0x0001);    /* Panel Interface Contral 3. */

        LCD_WriteReg(0x95,0x0110);       /* Frame Cycle Contral.(0x0110)      */

            LCD_WriteReg(0x97,(0<<8));

            LCD_WriteReg(0x98,0x0000);    /* Frame Cycle Contral */


        LCD_WriteReg(0x07,0x0173);

       }

       else if( DeviceCode == 0x1505 || DeviceCode == 0x0505 )

       {

            LCD_Code = R61505U;
```

```
            /* initializing funciton */
            LCD_WriteReg(0xe5,0x8000);  /* Set the internal vcore voltage */
            LCD_WriteReg(0x00,0x0001);  /* start OSC */
            LCD_WriteReg(0x2b,0x0010);  /* Set the frame rate as 80 when the internal
resistor is used for oscillator circuit */
            LCD_WriteReg(0x01,0x0100);  /* s720  to  s1 ; G1 to G320 */
            LCD_WriteReg(0x02,0x0700);  /* set the line inversion */
            LCD_WriteReg(0x03,0x1018);  /* 65536 colors */
            LCD_WriteReg(0x04,0x0000);
            LCD_WriteReg(0x08,0x0202);  /* specify the line number of front and back
porch periods respectively */
            LCD_WriteReg(0x09,0x0000);
            LCD_WriteReg(0x0a,0x0000);
            LCD_WriteReg(0x0c,0x0000);  /* select  internal system clock */
            LCD_WriteReg(0x0d,0x0000);
            LCD_WriteReg(0x0f,0x0000);
            LCD_WriteReg(0x50,0x0000);  /* set windows adress */
            LCD_WriteReg(0x51,0x00ef);
            LCD_WriteReg(0x52,0x0000);
            LCD_WriteReg(0x53,0x013f);
            LCD_WriteReg(0x60,0x2700);
            LCD_WriteReg(0x61,0x0001);
            LCD_WriteReg(0x6a,0x0000);
            LCD_WriteReg(0x80,0x0000);
            LCD_WriteReg(0x81,0x0000);
            LCD_WriteReg(0x82,0x0000);
            LCD_WriteReg(0x83,0x0000);
            LCD_WriteReg(0x84,0x0000);
            LCD_WriteReg(0x85,0x0000);
            LCD_WriteReg(0x90,0x0010);
            LCD_WriteReg(0x92,0x0000);
            LCD_WriteReg(0x93,0x0003);
            LCD_WriteReg(0x95,0x0110);
            LCD_WriteReg(0x97,0x0000);
            LCD_WriteReg(0x98,0x0000);
            /* power setting function */
            LCD_WriteReg(0x10,0x0000);
            LCD_WriteReg(0x11,0x0000);
            LCD_WriteReg(0x12,0x0000);
            LCD_WriteReg(0x13,0x0000);
```

```
            delay_ms(100);
            LCD_WriteReg(0x10,0x17b0);
            LCD_WriteReg(0x11,0x0004);
            delay_ms(50);
            LCD_WriteReg(0x12,0x013e);
            delay_ms(50);
            LCD_WriteReg(0x13,0x1f00);
            LCD_WriteReg(0x29,0x000f);
            delay_ms(50);
            LCD_WriteReg(0x20,0x0000);
            LCD_WriteReg(0x21,0x0000);

            /* initializing function */
            LCD_WriteReg(0x30,0x0204);
            LCD_WriteReg(0x31,0x0001);
            LCD_WriteReg(0x32,0x0000);
            LCD_WriteReg(0x35,0x0206);
            LCD_WriteReg(0x36,0x0600);
            LCD_WriteReg(0x37,0x0500);
            LCD_WriteReg(0x38,0x0505);
            LCD_WriteReg(0x39,0x0407);
            LCD_WriteReg(0x3c,0x0500);
            LCD_WriteReg(0x3d,0x0503);

            /* display on */
            LCD_WriteReg(0x07,0x0173);
        }
        else if( DeviceCode == 0x5408 )
        {
            LCD_Code = SPFD5408B;

            LCD_WriteReg(0x0001,0x0100);    /* Driver Output Contral Register */
            LCD_WriteReg(0x0002,0x0700);      /* LCD Driving Waveform Contral */
            LCD_WriteReg(0x0003,0x1030);    /* Entry ModeÉèÖÃ */

            LCD_WriteReg(0x0004,0x0000);    /* Scalling Control register */
            LCD_WriteReg(0x0008,0x0207);    /* Display Control 2 */
            LCD_WriteReg(0x0009,0x0000);    /* Display Control 3 */
            LCD_WriteReg(0x000A,0x0000);    /* Frame Cycle Control */
```

```
            LCD_WriteReg(0x000C,0x0000);    /* External Display Interface Control 1 */
            LCD_WriteReg(0x000D,0x0000);      /* Frame Maker Position */
            LCD_WriteReg(0x000F,0x0000);    /* External Display Interface Control 2 */
            delay_ms(50);
            LCD_WriteReg(0x0007,0x0101);    /* Display Control */
            delay_ms(50);
            LCD_WriteReg(0x0010,0x16B0);      /* Power Control 1 */
            LCD_WriteReg(0x0011,0x0001);      /* Power Control 2 */
            LCD_WriteReg(0x0017,0x0001);      /* Power Control 3 */
            LCD_WriteReg(0x0012,0x0138);      /* Power Control 4 */
            LCD_WriteReg(0x0013,0x0800);      /* Power Control 5 */
            LCD_WriteReg(0x0029,0x0009);    /* NVM read data 2 */
            LCD_WriteReg(0x002a,0x0009);    /* NVM read data 3 */
            LCD_WriteReg(0x00a4,0x0000);
            LCD_WriteReg(0x0050,0x0000);    /* ÉèÖÃ²Ù×÷´°¿ÚµÄXÖá¿ªÊ¼ÁÐ */
            LCD_WriteReg(0x0051,0x00EF);    /* ÉèÖÃ²Ù×÷´°¿ÚµÄXÖá½áÊøÁÐ */
            LCD_WriteReg(0x0052,0x0000);    /* ÉèÖÃ²Ù×÷´°¿ÚµÄYÖá¿ªÊ¼ÐÐ */
            LCD_WriteReg(0x0053,0x013F);    /* ÉèÖÃ²Ù×÷´°¿ÚµÄYÖá½áÊøÐÐ */

            LCD_WriteReg(0x0060,0x2700);    /* Driver Output Control */
                                                                    /*
ÉèÖÃÆÁÄ»µÄãÊýÒÔ¼°É¨ÃèµÄÆðÊ¼ÐÐ */
            LCD_WriteReg(0x0061,0x0003);    /* Driver Output Control */
            LCD_WriteReg(0x006A,0x0000);    /* Vertical Scroll Control */

            LCD_WriteReg(0x0080,0x0000);    /* Display Position ¨C Partial Display 1
*/
            LCD_WriteReg(0x0081,0x0000);    /* RAM Address Start ¨C Partial Display 1
*/
            LCD_WriteReg(0x0082,0x0000);    /* RAM address End - Partial Display 1 */
            LCD_WriteReg(0x0083,0x0000);    /* Display Position ¨C Partial Display 2
*/
            LCD_WriteReg(0x0084,0x0000);    /* RAM Address Start ¨C Partial Display 2
*/
            LCD_WriteReg(0x0085,0x0000);    /* RAM address End ¨C Partail Display2 */
            LCD_WriteReg(0x0090,0x0013);    /* Frame Cycle Control */
            LCD_WriteReg(0x0092,0x0000);    /* Panel Interface Control 2 */
            LCD_WriteReg(0x0093,0x0003);    /* Panel Interface control 3 */
            LCD_WriteReg(0x0095,0x0110);    /* Frame Cycle Control */
            LCD_WriteReg(0x0007,0x0173);
        }
        else if( DeviceCode == 0x4531 )
```

```
	{
		LCD_Code = LGDP4531;
		/* Setup display */
		LCD_WriteReg(0x00,0x0001);
		LCD_WriteReg(0x10,0x0628);
		LCD_WriteReg(0x12,0x0006);
		LCD_WriteReg(0x13,0x0A32);
		LCD_WriteReg(0x11,0x0040);
		LCD_WriteReg(0x15,0x0050);
		LCD_WriteReg(0x12,0x0016);
		delay_ms(50);
		LCD_WriteReg(0x10,0x5660);
		delay_ms(50);
		LCD_WriteReg(0x13,0x2A4E);
		LCD_WriteReg(0x01,0x0100);
		LCD_WriteReg(0x02,0x0300);
		LCD_WriteReg(0x03,0x1030);
		LCD_WriteReg(0x08,0x0202);
		LCD_WriteReg(0x0A,0x0000);
		LCD_WriteReg(0x30,0x0000);
		LCD_WriteReg(0x31,0x0402);
		LCD_WriteReg(0x32,0x0106);
		LCD_WriteReg(0x33,0x0700);
		LCD_WriteReg(0x34,0x0104);
		LCD_WriteReg(0x35,0x0301);
		LCD_WriteReg(0x36,0x0707);
		LCD_WriteReg(0x37,0x0305);
		LCD_WriteReg(0x38,0x0208);
		LCD_WriteReg(0x39,0x0F0B);
		delay_ms(50);
		LCD_WriteReg(0x41,0x0002);
		LCD_WriteReg(0x60,0x2700);
		LCD_WriteReg(0x61,0x0001);
		LCD_WriteReg(0x90,0x0119);
		LCD_WriteReg(0x92,0x010A);
		LCD_WriteReg(0x93,0x0004);
		LCD_WriteReg(0xA0,0x0100);
		delay_ms(50);
		LCD_WriteReg(0x07,0x0133);
```

```
		delay_ms(50);
		LCD_WriteReg(0xA0,0x0000);
	}
	else if( DeviceCode == 0x4535 )
	{
		LCD_Code = LGDP4535;
		LCD_WriteReg(0x15, 0x0030);    /* Set the internal vcore voltage */
		LCD_WriteReg(0x9A, 0x0010);    /* Start internal OSC */
		LCD_WriteReg(0x11, 0x0020);       /* set SS and SM bit */
		LCD_WriteReg(0x10, 0x3428);       /* set 1 line inversion */
		LCD_WriteReg(0x12, 0x0002);       /* set GRAM write direction and BGR=1
*/
		LCD_WriteReg(0x13, 0x1038);       /* Resize register */
		delay_ms(40);
		LCD_WriteReg(0x12, 0x0012);       /* set the back porch and front porch
*/
		delay_ms(40);
		LCD_WriteReg(0x10, 0x3420);       /* set non-display area refresh cycle
ISC[3:0] */
		LCD_WriteReg(0x13, 0x3045);       /* FMARK function */
		delay_ms(70);
		LCD_WriteReg(0x30, 0x0000);      /* RGB interface setting */
		LCD_WriteReg(0x31, 0x0402);       /* Frame marker Position */
		LCD_WriteReg(0x32, 0x0307);      /* RGB interface polarity */
		LCD_WriteReg(0x33, 0x0304);      /* SAP, BT[3:0], AP, DSTB, SLP, STB */
		LCD_WriteReg(0x34, 0x0004);      /* DC1[2:0], DC0[2:0], VC[2:0] */
		LCD_WriteReg(0x35, 0x0401);      /* VREG1OUT voltage */
		LCD_WriteReg(0x36, 0x0707);      /* VDV[4:0] for VCOM amplitude */
		LCD_WriteReg(0x37, 0x0305);      /* SAP, BT[3:0], AP, DSTB, SLP, STB */
		LCD_WriteReg(0x38, 0x0610);      /* DC1[2:0], DC0[2:0], VC[2:0] */
		LCD_WriteReg(0x39, 0x0610);      /* VREG1OUT voltage */
		LCD_WriteReg(0x01, 0x0100);      /* VDV[4:0] for VCOM amplitude */
		LCD_WriteReg(0x02, 0x0300);      /* VCM[4:0] for VCOMH */
		LCD_WriteReg(0x03, 0x1030);      /* GRAM horizontal Address */
		LCD_WriteReg(0x08, 0x0808);      /* GRAM Vertical Address */
		LCD_WriteReg(0x0A, 0x0008);
		LCD_WriteReg(0x60, 0x2700);       /* Gate Scan Line */
		LCD_WriteReg(0x61, 0x0001);       /* NDL,VLE, REV */
		LCD_WriteReg(0x90, 0x013E);
		LCD_WriteReg(0x92, 0x0100);
		LCD_WriteReg(0x93, 0x0100);
```

```
		LCD_WriteReg(0xA0, 0x3000);
		LCD_WriteReg(0xA3, 0x0010);
		LCD_WriteReg(0x07, 0x0001);
		LCD_WriteReg(0x07, 0x0021);
		LCD_WriteReg(0x07, 0x0023);
		LCD_WriteReg(0x07, 0x0033);
		LCD_WriteReg(0x07, 0x0133);
	}
	else if( DeviceCode == 0x7783 )
	{
		LCD_Code = ST7781;
		/* Start Initial Sequence */
		LCD_WriteReg(0x00FF,0x0001);
		LCD_WriteReg(0x00F3,0x0008);
		LCD_WriteReg(0x0001,0x0100);
		LCD_WriteReg(0x0002,0x0700);
		LCD_WriteReg(0x0003,0x1030);
		LCD_WriteReg(0x0008,0x0302);
		LCD_WriteReg(0x0008,0x0207);
		LCD_WriteReg(0x0009,0x0000);
		LCD_WriteReg(0x000A,0x0000);
		LCD_WriteReg(0x0010,0x0000);
		LCD_WriteReg(0x0011,0x0005);
		LCD_WriteReg(0x0012,0x0000);
		LCD_WriteReg(0x0013,0x0000);
		delay_ms(50);
		LCD_WriteReg(0x0010,0x12B0);
		delay_ms(50);
		LCD_WriteReg(0x0011,0x0007);
		delay_ms(50);
		LCD_WriteReg(0x0012,0x008B);
		delay_ms(50);
		LCD_WriteReg(0x0013,0x1700);
		delay_ms(50);
		LCD_WriteReg(0x0029,0x0022);
		LCD_WriteReg(0x0030,0x0000);
		LCD_WriteReg(0x0031,0x0707);
		LCD_WriteReg(0x0032,0x0505);
		LCD_WriteReg(0x0035,0x0107);
```

```
            LCD_WriteReg(0x0036,0x0008);
            LCD_WriteReg(0x0037,0x0000);
            LCD_WriteReg(0x0038,0x0202);
            LCD_WriteReg(0x0039,0x0106);
            LCD_WriteReg(0x003C,0x0202);
            LCD_WriteReg(0x003D,0x0408);
            delay_ms(50);
            LCD_WriteReg(0x0050,0x0000);
            LCD_WriteReg(0x0051,0x00EF);
            LCD_WriteReg(0x0052,0x0000);
            LCD_WriteReg(0x0053,0x013F);
            LCD_WriteReg(0x0060,0xA700);
            LCD_WriteReg(0x0061,0x0001);
            LCD_WriteReg(0x0090,0x0033);
            LCD_WriteReg(0x002B,0x000B);
            LCD_WriteReg(0x0007,0x0133);
        }
        else    /* special ID */
        {
            DeviceCode = LCD_ReadReg(0x67);

            if( DeviceCode == 0x0047 )
            {
             LCD_Code = HX8347A;
             LCD_WriteReg(0x0042,0x0008);
             /* Gamma setting */
                LCD_WriteReg(0x0046,0x00B4);
                LCD_WriteReg(0x0047,0x0043);
                LCD_WriteReg(0x0048,0x0013);
                LCD_WriteReg(0x0049,0x0047);
                LCD_WriteReg(0x004A,0x0014);
                LCD_WriteReg(0x004B,0x0036);
                LCD_WriteReg(0x004C,0x0003);
                LCD_WriteReg(0x004D,0x0046);
                LCD_WriteReg(0x004E,0x0005);
                LCD_WriteReg(0x004F,0x0010);
                LCD_WriteReg(0x0050,0x0008);
                LCD_WriteReg(0x0051,0x000a);
                /* Window Setting */
```

```
LCD_WriteReg(0x0002,0x0000);
LCD_WriteReg(0x0003,0x0000);
LCD_WriteReg(0x0004,0x0000);
LCD_WriteReg(0x0005,0x00EF);
LCD_WriteReg(0x0006,0x0000);
LCD_WriteReg(0x0007,0x0000);
LCD_WriteReg(0x0008,0x0001);
LCD_WriteReg(0x0009,0x003F);
delay_ms(10);
LCD_WriteReg(0x0001,0x0006);
LCD_WriteReg(0x0016,0x00C8);
LCD_WriteReg(0x0023,0x0095);
LCD_WriteReg(0x0024,0x0095);
LCD_WriteReg(0x0025,0x00FF);
LCD_WriteReg(0x0027,0x0002);
LCD_WriteReg(0x0028,0x0002);
LCD_WriteReg(0x0029,0x0002);
LCD_WriteReg(0x002A,0x0002);
LCD_WriteReg(0x002C,0x0002);
LCD_WriteReg(0x002D,0x0002);
LCD_WriteReg(0x003A,0x0001);
LCD_WriteReg(0x003B,0x0001);
LCD_WriteReg(0x003C,0x00F0);
LCD_WriteReg(0x003D,0x0000);
delay_ms(20);
LCD_WriteReg(0x0035,0x0038);
LCD_WriteReg(0x0036,0x0078);
LCD_WriteReg(0x003E,0x0038);
LCD_WriteReg(0x0040,0x000F);
LCD_WriteReg(0x0041,0x00F0);
LCD_WriteReg(0x0038,0x0000);
/* Power Setting */
LCD_WriteReg(0x0019,0x0049);
LCD_WriteReg(0x0093,0x000A);
delay_ms(10);
LCD_WriteReg(0x0020,0x0020);
LCD_WriteReg(0x001D,0x0003);
LCD_WriteReg(0x001E,0x0000);
LCD_WriteReg(0x001F,0x0009);
```

```
                LCD_WriteReg(0x0044,0x0053);
                LCD_WriteReg(0x0045,0x0010);
                delay_ms(10);
                LCD_WriteReg(0x001C,0x0004);
                delay_ms(20);
                LCD_WriteReg(0x0043,0x0080);
                delay_ms(5);
                LCD_WriteReg(0x001B,0x000a);
                delay_ms(40);
                LCD_WriteReg(0x001B,0x0012);
                delay_ms(40);
                /* Display On Setting */
                LCD_WriteReg(0x0090,0x007F);
                LCD_WriteReg(0x0026,0x0004);
                delay_ms(40);
                LCD_WriteReg(0x0026,0x0024);
                LCD_WriteReg(0x0026,0x002C);
                delay_ms(40);
                LCD_WriteReg(0x0070,0x0008);
                LCD_WriteReg(0x0026,0x003C);
                LCD_WriteReg(0x0057,0x0002);
                LCD_WriteReg(0x0055,0x0000);
                LCD_WriteReg(0x0057,0x0000);
              }
       }
    delay_ms(50);   /* delay 50 ms */
}

/*****************************************************************************
* Function Name  : LCD_Clear
* Description    : ½«ÆÁÄ»Ìî³ä³ÉÖ¸¶¨µÄÑÕÉ«£¬ÈçÇåÆÁ£¬ÔòÌî³ä 0xffff
* Input          : - Color: Screen Color
* Output         : None
* Return         : None
* Attention            : None
*****************************************************************************/
void LCD_Clear(uint16_t Color)
{
       uint32_t index;
```

```
	if( LCD_Code == HX8347A )
	{
		LCD_WriteReg(0x02,0x00);
		LCD_WriteReg(0x03,0x00);

		LCD_WriteReg(0x04,0x00);
		LCD_WriteReg(0x05,0xEF);

		LCD_WriteReg(0x06,0x00);
		LCD_WriteReg(0x07,0x00);

		LCD_WriteReg(0x08,0x01);
		LCD_WriteReg(0x09,0x3F);
	}
	else
	{
		LCD_SetCursor(0,0);
	}

	LCD_WriteIndex(0x0022);
	for( index = 0; index < MAX_X * MAX_Y; index++ )
	{
		LCD_WriteData(Color);
	}
}

/*************************************************************************
* Function Name  : LCD_BGR2RGB
* Description    : RRRRRGGGGGGBBBBB ¸ÄÎª BBBBBGGGGGGRRRRR ¸ñÊ½
* Input          : - color: BRG ÑÕÉ«Öµ
* Output         : None
* Return         : RGB ÑÕÉ«Öµ
* Attention		 : ÄÚ²¿°¯Êýµ÷ÓÃ
*************************************************************************/
static uint16_t LCD_BGR2RGB(uint16_t color)
{
	uint16_t  r, g, b, rgb;
```

```
        b = ( color>>0 )  & 0x1f;
        g = ( color>>5 )  & 0x3f;
        r = ( color>>11 ) & 0x1f;

        rgb =  (b<<11) + (g<<5) + (r<<0);

        return( rgb );
}

/*****************************************************************************
* Function Name  : LCD_GetPoint
* Description    : »ñÈ¡Ö¸¶¨×ù±êµãÄÑÕÉ«Öµ
* Input          : - Xpos: Row Coordinate
*                  - Xpos: Line Coordinate
* Output         : None
* Return         : Screen Color
* Attention            : None
*****************************************************************************/
uint16_t LCD_GetPoint(uint16_t Xpos,uint16_t Ypos)
{
        uint16_t dummy;

        LCD_SetCursor(Xpos,Ypos);
        LCD_WriteIndex(0x0022);

        switch( LCD_Code )
        {
                case ST7781:
                case LGDP4531:
                case LGDP4535:
                case ILI9325C:
                case ILI9325D:
              dummy = LCD_ReadData();   /* Empty read */
              dummy = LCD_ReadData();
                     return  dummy;
            case HX8347A:
              {
                       uint8_t red,green,blue;
```

```
                            dummy = LCD_ReadData();   /* Empty read */

                        red = LCD_ReadData() >> 3;
                green = LCD_ReadData() >> 2;
                blue = LCD_ReadData() >> 3;
                dummy = (uint16_t) ( ( red<<11 ) | ( green << 5 ) | blue );
                    }
                return  dummy;

        default:      /* 0x9320 0x9325 0x5408 0x1505 0x0505 */
             dummy = LCD_ReadData();   /* Empty read */
             dummy = LCD_ReadData();
                    return  LCD_BGR2RGB( dummy );
       }
}

/*****************************************************************************
* Function Name  : LCD_SetPoint
* Description    : ÔÚÖ¸¶¨×ù±ê»-µã
* Input          : - Xpos: Row Coordinate
*                  - Ypos: Line Coordinate
* Output         : None
* Return         : None
* Attention             : None
*****************************************************************************/
void LCD_SetPoint(uint16_t Xpos,uint16_t Ypos,uint16_t point)
{
       if( Xpos >= MAX_X || Ypos >= MAX_Y )
       {
              return;
       }
       LCD_SetCursor(Xpos,Ypos);
       LCD_WriteReg(0x0022,point);
}

/*****************************************************************************
* Function Name  : LCD_DrawLine
* Description    : Bresenham's line algorithm
* Input          : - x1: AµãÐÐ×ù±ê
```

```
*                   - y1: AµãÁÐ×ù±ê
*                                 - x2: BµãÐÐ×ù±ê
*                                 - y2: BµãÁÐ×ù±ê
*                                 - color: ÏßÑÕÉ«
* Output          : None
* Return          : None
* Attention             : None
*******************************************************************************/
void LCD_DrawLine( uint16_t x0, uint16_t y0, uint16_t x1, uint16_t y1 , uint16_t color )
{
    short dx,dy;      /* ¶¨ÒåX YÖáÉÏÔö¼ÓµÄ±äÁ¿Öµ */
    short temp;       /* Æðµã ÖÕµã´óÐ¡±È½Ï ½»»»ÊÝ¾ÝÊ±µÄÐÐ¼ä±äÁ¿ */

    if( x0 > x1 )     /* XÖáÉÏÆðµã´óÚÖÕµã ½»»»ÊÝ¾Ý */
    {
           temp = x1;
              x1 = x0;
              x0 = temp;
    }
    if( y0 > y1 )     /* YÖáÉÏÆðµã´óÚÖÕµã ½»»»ÊÝ¾Ý */
    {
              temp = y1;
              y1 = y0;
              y0 = temp;
    }

       dx = x1-x0;        /* XÖá·½ÏòÉÏµÄÔöÁ¿ */
       dy = y1-y0;        /* YÖá·½ÏòÉÏµÄÔöÁ¿ */

    if( dx == 0 )     /* XÖáÉÏÃ»ÓÐÔöÁ¿ »-´¹Ö±Ïß */
    {
        do
        {
            LCD_SetPoint(x0, y0, color);   /* ÖðµãÏÔÊ¾ Ãè´¹Ö±Ïß */
            y0++;
        }
        while( y1 >= y0 );
              return;
    }
```

```
    if( dy == 0 )      /* YÖáÉÏÃ»ÓÐÔöÁ¿ »-Ë©Æ½Ö±Ïß */
    {
        do
        {
            LCD_SetPoint(x0, y0, color);    /* ÖðµãÏÔÊ¾ ÃèË©Æ½Ïß */
            x0++;
        }
        while( x1 >= x0 );
               return;
    }
       /* ²¼Ã¼É-°°Ä·(Bresenham)Ëã·¨»-Ïß */
    if( dx > dy )                           /* ¿¿½üXÖá */
    {
            temp = 2 * dy - dx;                 /* ¼ÆËãÏÂ¸öµãµÄÎ»ÖÃ */
        while( x0 != x1 )
        {
                LCD_SetPoint(x0,y0,color);      /* »-Æðµã */
                x0++;                           /* XÖáÉÏ¼Ó1 */
                if( temp > 0 )                  /* ÅÐ¶ÏÏÂÒ»¸öµãµÄÎ»ÖÃ */
                {
                    y0++;                       /* Î ªÓÒÉÏÏàÁÚµã£¬¼´£¨x0+1,y0+1£© */
                    temp += 2 * dy - 2 * dx;
                   }
            else
            {
                            temp += 2 * dy;             /* ÅÐ¶ÏÏÂÒ»¸öµãµÄÎ»ÖÃ */
                       }
        }
        LCD_SetPoint(x0,y0,color);
    }
    else
    {
            temp = 2 * dx - dy;                         /* ¿¿½üYÖá */
        while( y0 != y1 )
        {
                   LCD_SetPoint(x0,y0,color);
            y0++;
            if( temp > 0 )
            {
```

```
                x0++;
                temp+=2*dy-2*dx;
            }
            else
                      {
                temp += 2 * dy;
                      }
        }
        LCD_SetPoint(x0,y0,color);
       }
}

/*************************************************************************
* Function Name  : PutChar
* Description    : ½«LcdÆÁÉÏÈÎÒâÎ»ÖÃÏÔÊ¾Ò»¸ö×Ö·û
* Input          : - Xpos: Ë®Æ½×ø±ê
*                  - Ypos: ´¹Ö±×ø±ê
*                               - ASCI: ÏÔÊ¾µÄ×Ö·û
*                               - charColor: ×Ö·ûÑÕÉ«
*                               - bkColor: ±³¾°ÑÕÉ«
* Output         : None
* Return         : None
* Attention             : None
*************************************************************************/
void PutChar( uint16_t Xpos, uint16_t Ypos, uint8_t ASCI, uint16_t charColor, uint16_t
bkColor )
{
       uint16_t i, j;
    uint8_t buffer[16], tmp_char;
    GetASCIICode(buffer,ASCI);  /* È¡×ÖÄ£Êý¾Ý */
    for( i=0; i<16; i++ )
    {
        tmp_char = buffer[i];
        for( j=0; j<8; j++ )
        {
            if( (tmp_char >> 7 - j) & 0x01 == 0x01 )
            {
                LCD_SetPoint( Xpos + j, Ypos + i, charColor );  /* ×Ö·ûÑÕÉ« */
            }
            else
```

```
            {
                LCD_SetPoint( Xpos + j, Ypos + i, bkColor );  /* ±³¾°ÑÕÉ« */
            }
        }
    }
}

/*****************************************************************************
* Function Name  : GUI_Text
* Description    : ÔÚÖ¸¶¨×ù±êÏÔÊ¾×Ö·û´®
* Input          : - Xpos: ÐÐ×ù±ê
*                  - Ypos: ÁÐ×ù±ê
*                                - str: ×Ö·û´®
*                                - charColor: ×Ö·ûÑÕÉ«
*                                - bkColor: ±³¾°ÑÕÉ«
* Output         : None
* Return         : None
* Attention             : None
*****************************************************************************/
void GUI_Text(uint16_t Xpos, uint16_t Ypos, uint8_t *str,uint16_t Color, uint16_t
bkColor)
{
    uint8_t TempChar;
    do
    {
        TempChar = *str++;
        PutChar( Xpos, Ypos, TempChar, Color, bkColor );
        if( Xpos < MAX_X - 8 )
        {
            Xpos += 8;
        }
        else if ( Ypos < MAX_Y - 16 )
        {
            Xpos = 0;
            Ypos += 16;
        }
        else
        {
            Xpos = 0;
            Ypos = 0;
```

```
        }
    }
    while ( *str != 0 );
}



/*************************************************************************************************
*****************

      END FILE

*************************************************************************************************
****************/
```

Archivos extensión H.

```
#define DEFAULT


#ifdef  DEFAULT
#define __IP1B  192
#define __IP2B  168
#define __IP3B  1
#define __IP4B  120

#define __GW1B  192
#define __GW2B  168
#define __GW3B  1
#define __GW4B  20

#define __MASK1B       255
#define __MASK2B       255
#define __MASK3B       255
#define __MASK4B       0
#endif



/**-------------------------------------------------------------------------------------
--------------------------------//
//              @filename              header.h
        //
//              @version               0.00
        //
//              @author        Alberto Palomo Alonso
                                                                        //
//
        //
//              @brief         Cabezera del código fuente, agrupa todos los archivos.
                                                        //
//
        //
//              @category              Principal.
                                                                                //
//
        //
```

```
//            @map                  @include

       //

//                                  @end

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                                          //

//            @include              Incluye todos los archivos necesarios.
                                                                                  //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

//     Librería de registros.

#ifndef LPC17XX

#define LPC17XX

#include "LPC17XX.H"

#endif

//     Símbolos del sistema.

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include "Systemsymbols.h"

#endif

//     Pwm.

#ifndef        PWM

#define PWM

#include "PWM.h"

#endif

//     Configura

#ifndef CONFIGURA

#define CONFIGURA

#include "configura.h"

#endif
```

```
#ifndef STATECHART
#define STATECHART
#include "Statechart.h"
#endif
#ifndef GLCD
#define GLCD
#include       "GLCD.h"
#include       "TouchPanel.h"
#include       "menu.h"
#include       "leds.h"
#endif
#ifndef STATECHART
#define STATECHART
#include       "Statechart.h"
#endif
#ifndef  HTTPSOURCE
#define HTTPSOURCE
#include "HTTP_SOURCE.h"
#endif
#ifdef  DEBUG
#include       "DEBUG.h"
#endif
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                  //
//              @end           ENDFILE.
        //
//
        //
//-------------------------------------------------------------------------------------------
---------------------------------**/




/**-------------------------------------------------------------------------------------------
---------------------------------//
//              @filename             Statechart.c
                                                                                        //
```

```
//             @version              0.00
       //
//             @author        Alberto Palomo Alonso
                                                                    //
//
       //
//             @brief         Cabecera del código fuente de Statechart.c
                                                                  //
//
       //
//             @category              Principal.
                                                                                  //
//
       //
//             @map                   @include
       //
//                                    @private
       //
//                                    @types
                                                                                  //
//                                    @funcdef
       //
//                                    @end
       //
//
       //
//
       //
//----------------------------------------------------------------------------------------
----------------------------------//
//
       //


                                                                                  //
//             @include               Estos son los archivos utilizados con el
statechart.                                                                     //
//
       //
//----------------------------------------------------------------------------------------
----------------------------------**/
//     LCD
#ifndef GLCD
```

```
#define GLCD
#include       "GLCD.h"
#include       "TouchPanel.h"
#include       "menu.h"
#endif
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include       "Systemsymbols.h"
#endif
#ifndef STRING
#define STRING
#include       <string.h>
#endif
#ifndef WTD
#define WDT
#include "WDT.h"
#endif
#ifndef PWM
#define PWM
#include       "PWM.h"
#endif
#ifndef STDIO
#define STDIO
#include       <stdio.h>
#endif
#ifndef MIGLOBAL
#define MIGLOBAL
#include       "miGlobal.h"
#endif
#ifndef TIMERS
#define TIMERS
#include       "Timers.h"
#endif
#ifndef RTL
#define RTL
#include       "RTL.h"
#endif
#ifndef HTTPSOURCE
#define HTTPSOURCE
```

```
#include       "HTTP_SOURCE.h"

#endif

#ifndef LUT

#define LUT

#include "LUT.h"

#endif

#ifndef DAC

#define DAC

#include       "DAC.h"

#endif

#ifndef UFONO

#define UFONO

#include       "uFono.h"

#endif

#ifndef ONEWIRE

#define ONEWIRE

#include       "OneWire.h"

#endif

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @private              Estos son los símbolos correspondientes al
statechart.                                                                             //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#define PANTALLA_INICIO       0

#define PANTALLA_MEDIDAS1     1

#define PANTALLA_MEDIDAS2     2

#define PANTALLA_AJUSTES      3

#define PANTALLA_LOADING      4

#define PANTALLA_VALORES      5


#define MAXIMOX               240

#define MAXIMOY               320

#define CLEAR_BUFFER          "                         "
```

```
/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                        //

//		@types		Tipos utilizados en el statechart.   COPIADOS DE menu.c
                                                                //

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/

typedef struct {

	uint16_t x;

	uint16_t y;

	uint16_t size_x;

	uint16_t size_y;

	uint8_t  pressed;

}screenZone_t;

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                        //

//		@funcdef		Estas son las funciones correspondientes al
statechart.                                                     //

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/

void	__mainLoop__		(	void	);

void __configuraLCD__	(	void	);

void __pintaInicio__	(	void	);

void __pintaAjustes__	(	void	);

void	__pintaMedidas1__	(	void	);

void	__pintaMedidas2__	(	void	);

void squareButton		( screenZone_t *	zone		, char *
	text	, uint16_t	textColor	, uint16_t	lineColor);

void checkTouchPanel	(	void	);

int8_t zoneNewPressed (screenZone_t * zone		);

void squareBox		( screenZone_t *	zone		,	uint16_t
	color);
```

```
void __pintaCargandoSeno__    (      void   );

void __pintaCargandoConexion__(      void   );

void __pintaCargandoDone__    (      void   );

void __pintaCargandoInicio__  (      void   );

void __pintaCargandoIniciando__      (      void   );

void __pintaValores__         (      void   );

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                              //

//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/




/***************************************Copyright
(c)************************************************

**

**                                  http://www.powermcu.com

**

**--------------File Info-----------------------------------------------------------------
----------------

** File name:                GLCD.h

** Descriptions:             TFT (IO)

**

**-------------------------------------------------------------------------------------------
----------------

** Created by:               AVRman

** Created date:             2015-1-26

** Version:                           2.0

** Descriptions:             The original version

**

**-------------------------------------------------------------------------------------------
----------------

** Modified by:

** Modified date:
```

```
** Version:
** Descriptions:
*********************************************************************************
***************/

#ifndef __GLCD_H
#define __GLCD_H

#include <LPC17xx.H>

/* Private define ------------------------------------------------------------*/

/* LCD Interface */
#define PIN_CS    (1 << 8)
#define PIN_RS        (1 << 27)
#define PIN_WR        (1 << 28)
#define PIN_RD        (1 << 29)


#define LCD_CS(x)   ((x) ? (LPC_GPIO2->FIOSET = PIN_CS) : (LPC_GPIO2->FIOCLR = PIN_CS));
#define LCD_RS(x)   ((x) ? (LPC_GPIO1->FIOSET = PIN_RS) : (LPC_GPIO1->FIOCLR = PIN_RS));
#define LCD_WR(x)   ((x) ? (LPC_GPIO1->FIOSET = PIN_WR) : (LPC_GPIO1->FIOCLR = PIN_WR));
#define LCD_RD(x)   ((x) ? (LPC_GPIO1->FIOSET = PIN_RD) : (LPC_GPIO1->FIOCLR = PIN_RD));


/* Private define ------------------------------------------------------------*/
#define DISP_ORIENTATION  0  /* angle 0 90 */

#if  ( DISP_ORIENTATION == 90 ) || ( DISP_ORIENTATION == 270 )

#define  MAX_X  320
#define  MAX_Y  240

#elif  ( DISP_ORIENTATION == 0 ) || ( DISP_ORIENTATION == 180 )

#define  MAX_X  240
#define  MAX_Y  320

#endif
```

```
/* LCD color */
#define White          0xFFFF
#define Black          0x0000
#define Grey           0xF7DE
#define Blue           0x001F
#define Blue2          0x051F
#define Red            0xF800
#define Magenta        0xF81F
#define Green          0x07E0
#define Cyan           0x7FFF
#define Yellow         0xFFE0

/************************************************************************************
* Function Name  : RGB565CONVERT
* Description    : 24Î»×ª»»16Î»
* Input          : - red: R
*                  - green: G
*                             - blue: B
* Output         : None
* Return         : RGB ÑÕÉ«Öµ
* Attention            : None
************************************************************************************/
#define RGB565CONVERT(red, green, blue)\
(uint16_t)( (( red   >> 3 ) << 11 ) | \
(( green >> 2 ) << 5  ) | \
( blue  >> 3 ))

/* Private function prototypes -----------------------------------------------*/
void LCD_Initializtion(void);
void LCD_Clear(uint16_t Color);
uint16_t LCD_GetPoint(uint16_t Xpos,uint16_t Ypos);
void LCD_SetPoint(uint16_t Xpos,uint16_t Ypos,uint16_t point);
void LCD_DrawLine( uint16_t x0, uint16_t y0, uint16_t x1, uint16_t y1 , uint16_t color
);
void PutChar( uint16_t Xpos, uint16_t Ypos, uint8_t ASCI, uint16_t charColor, uint16_t
bkColor );
void GUI_Text(uint16_t Xpos, uint16_t Ypos, uint8_t *str,uint16_t Color, uint16_t
bkColor);
#endif
```

```
/*****************************************************************************************
*****************

      END FILE

*****************************************************************************************
*****************/



/**-------------------------------------------------------------------------------------
---------------------------------//

//             @filename             configura.h
                                                                                    //

//             @version              0.00

       //

//             @author        Alberto Palomo Alonso
                                                                          //

//

       //

//             @brief         Cabecera para el código de configuración.c
                                                          //

//

       //

//             @category             Principal.
                                                                                    //

//

       //

//             @map                  @include

       //

//                                   @private

       //

//                                   @funcdef

       //

//                                   @end

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------//

//

       //
```

```
                                                                                    //
//            @include              Estos son los archivos utilizados con el código de
configuración.                                    //
//
       //
//-------------------------------------------------------------------------------------
--------------------------------**/
// PWM
#ifndef PWM
#define PWM
#include       "PWM.h"
#endif
#ifndef GLCD
#define GLDC
#include       "GLCD.h"
#include       "TouchPanel.h"
#include       "menu.h"
#endif
#ifndef STATECHART
#define STATECHART
#include       "Statechart.h"
#endif
#ifndef RTC
#define RTC
#include       "RTC.h"
#endif
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include       "Systemsymbols.h"
#endif
#ifndef WDT
#define WDT
#include       "WDT.h"
#endif
#ifndef HTTP_SOURCE
#define HTTP_SOURCE
#include "HTTP_SOURCE.h"
#endif
#ifndef TIMERS
#define TIMERS
```

```
#include       "Timers.h"
#endif
#ifndef ANEMOMETRO
#define ANEMOMETRO
#include       "Anemometro.h"
#endif
#ifndef DAC
#define DAC
#include       "DAC.h"
#endif
#ifndef UVA30A
#define UVA30A
#include       "UVA30A.h"
#endif
#ifndef UFONO
#define UFONO
#include       "uFono.h"
#endif
#ifndef LUT
#define LUT
#include       "LUT.h"
#endif
#ifndef DMA
#define DMA
#include       "DMA.h"
#endif
#ifndef I2C
#define I2C
#include       "I2C.h"
#endif
#ifndef UART0
#define UART0
#include       "UART0.h"
#endif
#ifndef UART3
#define UART3
#include       "UART3.h"
#endif
/**-------------------------------------------------------------------------------------
--------------------------------//
```

```
//

	//

                                                                                    //

//		@private		Estos son los símbolos correspondientes a la
configuración.                                                          //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

#define ACTIVOS_TODOS2		0x003F

#define ACTIVOS_1_2		0x0001

#define ACTIVOS_2_2		0x0002

#define ACTIVOS_1_1		0x0100

#define ACTIVOS_2_1		0x0200

#define ACTIVOS_6_2		0x0020

#define ACTIVOS_6_1		0x2000


#define MAXIMO_PRESION		1500

#define MINIMO_PRESION		500

#define MAXIMO_TEMPERATURA	50

#define MINIMO_TEMPERATURA	-10

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                                    //

//		@funcdef		Estas son las funciones correspondientes a la
configuración.                                                  //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void __configuraPrograma__	(	void	);

void __iniciaVariables__		(	void	);

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//

                                                                        //
```

```
//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/




/**-------------------------------------------------------------------------------------
--------------------------------//

//             @filename              configura.h
                                                                                    //

//             @version               0.00

       //

//             @author        Alberto Palomo Alonso
                                                                          //

//

       //

//             @brief         Cabecera para el código de configuración.c
                                                          //

//

       //

//             @category              Principal.
                                                                                    //

//

       //

//             @map                   @include

       //

//                                    @private

       //

//                                    @funcdef

       //

//                                    @end

       //

//

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------//
```

```
//

       //

                                                                                    //
//            @include              Estos son los archivos utilizados con el código de
configuración.                                    //

//

       //

//-------------------------------------------------------------------------------------
-------------------------------**/

// PWM

#ifndef PWM

#define PWM

#include       "PWM.h"

#endif

#ifndef GLCD

#define GLDC

#include       "GLCD.h"

#include       "TouchPanel.h"

#include       "menu.h"

#endif

#ifndef STATECHART

#define STATECHART

#include       "Statechart.h"

#endif

#ifndef RTC

#define RTC

#include       "RTC.h"

#endif

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include       "Systemsymbols.h"

#endif

#ifndef WDT

#define WDT

#include       "WDT.h"

#endif

#ifndef HTTP_SOURCE

#define HTTP_SOURCE

#include "HTTP_SOURCE.h"
```

```
#endif
#ifndef TIMERS
#define TIMERS
#include       "Timers.h"
#endif
#ifndef ANEMOMETRO
#define ANEMOMETRO
#include       "Anemometro.h"
#endif
#ifndef DAC
#define DAC
#include       "DAC.h"
#endif
#ifndef UVA30A
#define UVA30A
#include       "UVA30A.h"
#endif
#ifndef UFONO
#define UFONO
#include       "uFono.h"
#endif
#ifndef LUT
#define LUT
#include       "LUT.h"
#endif
#ifndef DMA
#define DMA
#include       "DMA.h"
#endif
#ifndef I2C
#define I2C
#include       "I2C.h"
#endif
#ifndef UART0
#define UART0
#include       "UART0.h"
#endif
#ifndef UART3
#define UART3
```

```
#include       "UART3.h"

#endif

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                        //

//             @private              Estos son los símbolos correspondientes a la
configuración.                                                  //

//

       //

//-------------------------------------------------------------------------------------------
--------------------------------**/

#define ACTIVOS_TODOS2         0x003F

#define ACTIVOS_1_2            0x0001

#define ACTIVOS_2_2            0x0002

#define ACTIVOS_1_1            0x0100

#define ACTIVOS_2_1            0x0200

#define ACTIVOS_6_2            0x0020

#define ACTIVOS_6_1            0x2000


#define MAXIMO_PRESION         1500

#define MINIMO_PRESION         500

#define MAXIMO_TEMPERATURA     50

#define MINIMO_TEMPERATURA     -10

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                        //

//             @funcdef              Estas son las funciones correspondientes a la
configuración.                                          //

//

       //

//-------------------------------------------------------------------------------------------
--------------------------------**/

void __configuraPrograma__    (      void    );

void __iniciaVariables__              (      void    );

/**-------------------------------------------------------------------------------------------
--------------------------------//
```

```
//

       //


                                                                    //
//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/




/**-------------------------------------------------------------------------------------
--------------------------------//
//             @filename              Anemometro.h
                                                                                  //
//             @version               0.00

       //
//             @author        Alberto Palomo Alonso
                                                                  //
//

       //
//             @brief         Esta es la cabecera donde se declara todo lo utilizado en
el anemómetro.                                 //
//

       //
//             @category              Opcional.

       //

//

       //
//             @map                   @include

       //
//                                    @private

       //
//                                    @funcdef

       //
//                                    @end

       //

//

       //
```

```
//-------------------------------------------------------------------------------------------
---------------------------------//

//

        //

                                                                                          //

//              @include                Includes pertenecientes al módulo del PWM.
                                                                                  //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#ifndef LPC17XX

#define LPC17XX

#include        "LPC17XX.H"

#endif

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include "Systemsymbols.h"

#endif

#ifndef TIMERS

#define TIMERS

#include        "Timers.h"

#endif

/**-----------------------------------------------------------------------------------------
---------------------------------//

//

        //

                                                                                          //

//              @private                Estos son los símbolos correspondientes al
anemómetro.                                                                       //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#define PULSOS_VUELTA           2

#define DIAMETRO_ANEMOMETRO     14      // En centímetros.

#define PULSOS_CENTIMETRO       (float)PULSOS_VUELTA/((float)PI*(float)DIAMETRO_ANEMOMETRO)

#define CTCR_MASCARA            0x0     //      Dejar al TC contando.

#define CCR_MASCARA_EN          0x5     //      Generar interrupción.

#define CCR_MASCARA_DIS         0x4     //      Desactivar interrupción.
```

```
#define WARMUP_CICLOS          4       //      Ciclos de calentamiento.

#define CAPTURE_FUNCION        0x3     //      Capture 1.0.

#define PULL_UP                0x0     //      El pull.

#define CAP10_IR                       0x10    //      El IR de CAP1.0

#define MR1_IR                 0x00000002      //      El IR del MR1.

#define MR2_IR                 0x00000005      //      El IR del MR2 QUE SE JUNTA CON LA
DEL 0.

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @funcdef                Estas son las funciones correspondientes al
anemómetro.                                                             //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void __configuraAnemometro__  (       void    );

void    mideAnemometro                (       void    );

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                        //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/




/**-------------------------------------------------------------------------------------------
---------------------------------//

//              @filename               LDR.h
                                                                                        //

//              @version

        //

//              @author         Alberto Palomo Alonso
                                                                        //
```

```
//
	//
//		@brief		Cabecera para el código de LDR.c
//
//
	//
//		@category		Periférico.
//
//
	//
//		@map			@include
	//
//				@private
	//
//				@funcdef
	//
//				@end
	//
//
	//
//
	//
//-----------------------------------------------------------------------------------------
----------------------------------//
//
	//

//
//		@include		Estos son los archivos utilizados con el código de
configuración.
//
	//
//-----------------------------------------------------------------------------------------
----------------------------------**/
#ifndef LPC17xx
#define LPC17XX
#include	"LPC17XX.H"
#endif
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include	"Systemsymbols.h"
```

```
#endif

#ifndef LUT

#define LUT

#include       "LUT.h"

#endif

#ifndef DMA

#define DMA

#include       "DMA.h"

#endif

#ifndef UFONO

#define UFONO

#include       "uFono.h"

#endif

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                        //

//             @private              Estos son los símbolos correspondientes a la
configuración.                                                  //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#define PCONP_ADC_ON   (1 << 12)

#define PINSEL_ADC01   (1 << 16)

#define PINMODE_ADC01  (3 << 16)

#define BRUST_PIN              (1 << 16)

#define SEL_CANAL1     (1 << 1)

#define SEL_CANAL_GLOBAL       (1 << 8)

#define ADC_POWER              (1 << 21)

#define ADC_START              (0x6 << 24)

#define CLK_DIV_MAX    (0xFF << 8)


#define RESISTENCIA_PULL       70.00

#define LDRRESISTENCIA_MAX     100

#define LDRRESISTENCIA_MIN     1

#define BRILLO_MAX             100

#define BRILLO_MIN             1
```

```
#define VREF                            3.3

#define VINDICE                 10

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

        //


                                                                                                //

//              @funcdef                Estas son las funciones correspondientes a la
configuración.                                                  //

//

        //

//-------------------------------------------------------------------------------------------
--------------------------------**/

void __configuraLDR__ (         void    );

void ponAudioDMA                (       void    );

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

        //


                                                                                        //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------------
--------------------------------**/




/**-------------------------------------------------------------------------------------------
--------------------------------//

//              @filename               uFono.h
                                                                                                //

//              @version                0.00

        //

//              @author         Alberto Palomo Alonso
                                                                                        //

//

        //

//              @brief          Cabecera para configurar el audio del micrófono.
                                                                                        //
```

```
//
	//
//		@category		Opcional.
	//
//
	//
//		@map			@include
	//
//					@funcdef
	//
//					@end
	//
//
	//
//
	//
//----------------------------------------------------------------------------------------
--------------------------------//
//
	//

                                                                                //
//		@include		Estos son los archivos utilizados para el audio del
micrófono.                                                  //
//
	//
//----------------------------------------------------------------------------------------
--------------------------------**/
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include	"Systemsymbols.h"
#endif
#ifndef LPC17XX
#define LPC17XX
#include	"LPC17XX.H"
#endif
#ifndef TIMERS
#define TIMERS
#include	"Timers.h"
#endif
```

```
/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                        //

//		@private		Estos son los símbolos correspondientes al audio
del micrófono.                                                  //

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/

#define FUNC_ADC		0x1

#define PIN_UFONO		(23-16)

#define CANAL_ADC_UF	0x1

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                        //

//		@funcdef		Estas son las funciones correspondientes al audio
del micrófono.                                          //

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/

void __configuraUFONO__	(	void	);	//	Configuramos el micrófono.

void	lanzaUFONO		(	void	);	//	Lanzamos la carga de audio.

void recuperaContexto (	void	);	//	Recupera el ADC para lanzar las
muestras.

/**-------------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                        //

//		@end		ENDFILE.

	//

//

	//

//-------------------------------------------------------------------------------------------
--------------------------------**/
```

```
/**-------------------------------------------------------------------------------------
---------------------------------//
//            @filename             UVA30A.h
       //
//            @version              0.00
       //
//            @author        Alberto Palomo Alonso
                                                                    //
//
       //
//            @brief         Cabecera para el código de UVA30A.c
                                                                  //
//
       //
//            @category             Periférico.
                                                                                  //
//
       //
//            @map                  @include
       //
//                                  @private
       //
//                                  @funcdef
       //
//                                  @end
       //
//
       //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------//
//
       //
                                                                                  //
//            @include              Estos son los archivos utilizados con el código de
configuración.                                  //
```

```
//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

#ifndef LPC17xx

#define LPC17XX

#include	"LPC17XX.H"

#endif

#ifndef LDR

#define LDR

#include	"LDR.h"

#endif

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                    //

//		@private		Estos son los símbolos correspondientes a la
configuración.                                                  //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

#define LDR_primero    1

#define PINSEL_ADC02   (1 << 18)

#define PINMODE_ADC02  (3 << 18)

#define SEL_CANAL2     (1 << 2)

/**-------------------------------------------------------------------------------------
--------------------------------//

//

	//


                                                                                  //

//		@funcdef		Estas son las funciones correspondientes a la
configuración.                                          //

//

	//

//-------------------------------------------------------------------------------------
--------------------------------**/

void	__configuraUVA30A__(  void   );
```

```
/**-------------------------------------------------------------------------------------------
--------------------------------//
//
       //
                                                                                  //
//             @end           ENDFILE.
       //
//
       //
//-------------------------------------------------------------------------------------------
--------------------------------**/




/**-------------------------------------------------------------------------------------------
--------------------------------//
//             @filename              OneWire.h
       //
//             @version               0.00
       //
//             @author        Alberto Palomo Alonso
                                                                                  //
//
       //
//             @brief         Cabecera para configurar el protocolo OneWire.
                                                          //
//
       //
//             @category              Opcional.
       //
//
       //
//             @map                   @include
       //
//                                    @funcdef
       //
//                                    @end
       //
//
       //
```

```
//

       //

//-------------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                          //

//            @include              Estos son los archivos utilizados para el protocolo
OneWire.                                                  //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include       "Systemsymbols.h"

#endif

/**-----------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                        //

//            @private              Estos son los símbolos correspondientes al
protocolo OneWire.                                              //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#define SIZEOF_TRAMA                  40             //     Tamaño del array como buffer
de 8 bits.

#define SIZEOF_SLOT                   8              //     Los últimos 8 bits son el
checksum.


#define OW_RESET_BAJO                 0.018   //     Tiempo a nivel bajo de la señal de
start. (MCU -> Sensor)

                                      /** @CHANGE: 0.04*/

#define OW_RESET_ALTO                 0.02           //     Tiempo a nivel anto de la
señal de start. (MCU -> Sensor)

#define OW_RESPUESTA_BAJO             0.08           //     Señal respuesta del sensor a
nivel bajo.

#define OW_RESPUESTA_ALTO             0.08           //     Señal respuesta del sensor a
nivel alto.

                                      /** @CHANGE: 0.078*/
```

```
#define OW_MANDADO0                     0.076   //      Duración del tiempo de un bit = 0.
#define OW_MANDADO1                     0.120   //      Duración del tiempo de un bit = 1.

#define PERMISO_DIFERENCIAL             -0.005  //      Error que le permito tener al
sensor.
#define PERMISO_PROPORCIONAL    0.005   //      Error que le permito tener al sensor.

#define OW_PULL_UP                      0x0             //      Función de pull up.
#define OW_PULL_DOWN                    0x3             //      Función de pull down.
#define OW_CAPTURE_FUNC                 0x3             //      Función capture.
#define OW_CTCR_MASCARA                 0x0             //      Dejar TC contando.
#define OW_CCR_MASCARA_EN               0x30            //      Activo por flanco de bajada.
#define OW_CCR_MASCARA_DIS              0x20            //      Desactivo por flanco.
#define CAP11_IR                                0x00000020//   El IR de CAP1.1
#define MR0_IR                          0x00000001//   El IR de MR0.

#define OWDEEPSLEEP                     0
#define OWINICIO                                1
#define OWESPERANDO                     2
#define OWESPERANDO_BIT                 3
#define OWCHECKSUM                      4
#define OWGENERA                                5
#define OWESPERANDO_SEQ                 6

#define LIMITE_FALLOS                   5
#define BITOW                           19

#define US_AHORA                (LPC_TIM3->TC)
#define PIN_OWp         19
#define PIN_OW          (1      <<      19)
#define CONFIG_OUT      (LPC_GPIO1->FIODIR |= PIN_OW)
#define CONFIG_IN               (LPC_GPIO1->FIODIR &= ~(PIN_OW))
#define CLEAR_PIN               (LPC_GPIO1->FIOCLR = PIN_OW)
#define SET_PIN         (LPC_GPIO1->FIOSET = PIN_OW)
#define ENTRADA         ((LPC_GPIO1->FIOPIN >> PIN_OWp) & 1)
/**--------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                //
```

```
//            @funcdef              Estas son las funciones correspondientes al
protocolo OneWire.                                        //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/

void    __configuraOW__(      void    );      //      Configuración del protocolo OneWire.

void    mideTemperatura(      void    );      //      Código de medición de temperatura.

void    activaMedidaOW (      void    );      //      Lanza el activador del one wire.


void    StateChartOneWire     (      uint32_t       DeltaCap       );

void OWSetPin         (      uint8_t Nivel)  ;

void OWConfiguraEntrada       (      void    )              ;

void OWConfiguraSalida(       void    )              ;

void    ErrorRx               (      void    )              ;

void ErrorTx                  (      void    )              ;

void InvalidChecksum  (       void    )              ;

/**-----------------------------------------------------------------------------------
--------------------------------//

//

       //

                                                                        //

//            @end          ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/




/**-----------------------------------------------------------------------------------
--------------------------------//

//            @filename             PWM.h
                                                                                  //

//            @version              0.00

       //

//            @author       Alberto Palomo Alonso
                                                                        //

//

       //
```

```
//            @brief         Este es el programa donde están definidas las funciones a
utilizar en el módulo                        //
//                                  PWM dedicado al proyecto de Sistemas electrónicos
digitales avanzados (UAH - EPS).                  //
//
       //
//
       //
//            @category            Opcional.
       //
//
       //
//            @map                 @include
       //
//                                 @private
       //
//                                 @funcdef
       //
//                                 @end
       //
//
       //
//
       //
//            |---|  |             |      |\      /|
                                                                                    //
//            |   |   |         |   | \  / |
                                                                              //
//            |---|    |       |          |  \/  |
                                                                                    //
//            |                |   | |           |        |
       //
//            |                 | |       |        |
                                                                                    //
//
       //
//----------------------------------------------------------------------------------
---------------------------------//
//
       //
                                                                                    //
```

```
//             @include              Estos son los archivos utilizados con el código
PWM.                                                                    //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/

#ifndef LPC17XX

#define LPC17XX

#include "LPC17XX.H"

#endif


#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include "Systemsymbols.h"

#endif

/**-----------------------------------------------------------------------------------
--------------------------------//

//

       //


                                                                                //

//             @private              Estos son los símbolos correspondientes al módulo
PWM.                                                                    //

//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/

#define        Fpwm                  50                          // Velocidad de 20Hz.

#define        Tpwm                  0.02                        // Periodo de 20ms.


#define        TCR_MASK              0x9                         // Activo el contador
y el PWM.

#define        MCR_MASK              0x4                         // Para el set del
PWM.

#define        MCR_MASK_RESET 0x5                          // Para resetear el MCR.

#define        PCONP_MASK     0x1 << 6                     // Para encender el PWM.


#define        MODO_CICLO     1                            // Para la función
modificaPulso().

#define        MODO_SERVO     0                            // Para la función
modificaPulso().


#define        PWM1                  1
```

```
#define        PWM2                    2

#define        PWM3                    3

#define        PWM4                    4

#define        PWM5                    5

#define        PWM6                    6


#define        OPEN_DRAIN      0x2

#define        PULL_UP         0x0

#define        PULL_DOWN               0x3

#define        UNUSED          0x1


#define KMX                            1.3                             //      Constante de
corrección máxima.

#define KMN                            0.6                             //      Constante de
corrección mínima.

#define MINIMO_SERVO           0.001

#define        MAXIMO_SERVO            0.002


#define TEMP_MAX                       32                              //      Visionado de
temperatura.

#define TEMP_MIN                       17                              //      Visionado de
temperatura.

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                       //

//             @funcdef               Estas son las funciones correspondientes al módulo
PWM.                                                   //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

void    __configuraPWM__       (       float   FrecuenciaPWM          ,       uint16_t
       CualesPWM      );      //      Default = 0x3F3F -> Todo activado.

void    modificaPulso          (       uint32_t       PWMn                            ,
       uint8_t Modo           ,       uint8_t Ciclo          ,       uint8_t Grados ,
       float Minimo   ,       float Maximo   );

void softMod                   (       uint8_t GradosObjetivo         ,       uint8_t
       GradosActuales,        float Minimo   ,       float   Maximo ,       uint32_t
       PWMn);

/**-------------------------------------------------------------------------------------
---------------------------------//

//
```

```
       //

                                                                    //
//             @end           ENDFILE.
       //
//
       //
//-------------------------------------------------------------------------------------
--------------------------------**/




/**-------------------------------------------------------------------------------------
--------------------------------//
//             @filename              DAC.h
                                                                                  //
//             @version
       //
//             @author        Alberto Palomo Alonso
                                                                    //
//
       //
//             @brief         Cabecera para el código de DAC.c
                                                                    //
//
       //
//             @category              Periférico.
                                                                                  //
//
       //
//             @map                   @include
       //
//                                    @private
       //
//                                    @funcdef
       //
//                                    @end
       //
//
       //
```

```
//

	//

//-------------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                    //

//		@include		Estos son los archivos utilizados con el código de
configuración.                                          //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/

#ifndef LPC17xx

#define LPC17XX

#include	"LPC17XX.H"

#endif

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include	"Systemsymbols.h"

#endif

#ifndef LUT

#define LUT

#include	"LUT.h"

#endif

#ifndef TIMERS

#define TIMERS

#include	"Timers.h"

#endif

/**-----------------------------------------------------------------------------------
---------------------------------//

//

	//


                                                                                    //

//		@private		Estos son los símbolos correspondientes a la
configuración.                                                  //

//

	//

//-------------------------------------------------------------------------------------
---------------------------------**/
```

```
#define DAC_PIN        (28 - 16)                    //      Pin del DAC.
#define DAC_FUNC               0x2                          //      Función 2 del pin 28.
#define DAC_BIAS               (1 << 16)                    //      2.5 us de upstream.
#define BORRAR_DAC     (0x3FF << 6)          //      10 bits de DAC.

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                                              //

//             @funcdef               Estas son las funciones correspondientes a la
configuración.                                              //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void __configuraDAC__ (      void   );

void   activarDac             (      void   );

void desactivarDAC            (      void   );

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                        //

//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------------
---------------------------------**/
```

```
/**-------------------------------------------------------------------------------------------
---------------------------------//

//             @filename              LUT.g
                                                                                              //

//             @version               0.00

       //
```

```
//             @author        Alberto Palomo Alonso
                                                                    //
//
       //
//             @brief         Este es el programa donde se encuentra la cabecera de LUT.c
                                                                  //
//
       //
//             @category              Opcional.
       //
//
       //
//             @map                   @include
       //
//                                    @private
       //
//                                    @funcdef
       //
//                                    @end
       //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------//
//
       //

                                                                                    //
//             @include               Includes pertenecientes al módulo del anemómetro.
                                                                    //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------**/
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include       "Systemsymbols.h"
#endif
#ifndef LDR
#define LDR
#include       "LDR.h"
```

```
#endif

#ifndef DMA

#define DMA

#include       "DMA.h"

#endif

#ifndef MATH

#define MATH

#include       <math.h>

#endif


#define MUESTRAS_SENO          32

#define BRILLO_LDR             0

#define BRILLO2CICLO_LDR       1

#define INDICE_UVA             2

#define BRILLO_LDR_NOLUT       3


void goto_LUT( float dato , uint8_t LUTn , float * ret_f , uint8_t * ret_8 , uint16_t *
ret_16 , uint32_t * ret_32);

void crearSeno(       void    );

void ponTonoDMA(      void    );

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                          //

//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/









/**-------------------------------------------------------------------------------------
---------------------------------//

//             @filename             DMA.h
                                                                                  //
```

```
//              @version                0.00
        //
//              @author         Alberto Palomo Alonso
                                                                        //
//
        //
//              @brief          Cabecera del configurado del DMA.
                                                                        //
//
        //
//              @category               Opcional.
        //
//
        //
//              @map                    @include
        //
//                                      @private
        //
//                                      @funcdef
        //
//                                      @end
        //
//
        //
//
        //
//----------------------------------------------------------------------------------------
--------------------------------//
//
        //
                                                                                //
//              @include                Estos son los archivos utilizados con el código del
DMA.                                                            //
//
        //
//----------------------------------------------------------------------------------------
--------------------------------**/
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include       "Systemsymbols.h"
```

```
#endif

#ifndef LDR

#define LDR

#include       "LDR.h"

#endif

#ifndef LUT

#define LUT

#include       "LUT.h"

#endif

#include <LPC17xx.H>

#include <math.h>

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @private              Estos son los símbolos correspondientes al DMA.
                                                                                    //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

#define        N_samples_wave      32  // N° de muestras por ciclo

#define Ftono                  400

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @funcdef       Estas son las funciones que se usan en el DMA.
                                                                                    //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

void __configuraDMA__ (      void   );      //      Configurador del DMA.

void __configuraTono__(      void   );      //      Configurador del tono.

void __configuraAudio__      (      void   );      //      Configurador del audio.

/**-------------------------------------------------------------------------------------
---------------------------------//
```

```
//
       //
                                                                        //
//             @end           ENDFILE.
       //
//
       //
//-------------------------------------------------------------------------------------------
--------------------------------**/
```

```
/**-----------------------------------------------------------------------------------------
---------------------------------//
//             @filename              WDT.h
                                                                                  //
//             @version               0.00
       //
//             @author        Alberto Palomo Alonso
                                                                        //
//
       //
//             @brief         Cabecera del configurado del WDT.
                                                                        //
//
       //
//             @category              Opcional.
       //
//
       //
//             @map                   @include
       //
//                                    @private
       //
//                                    @funcdef
       //
```

```
//                                  @end

       //

//

       //

//

       //

//------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @include              Estos son los archivos utilizados con el código del
WDT.                                                        //

//

       //

//------------------------------------------------------------------------------------
---------------------------------**/

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include       "Systemsymbols.h"

#endif

/**----------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                  //

//             @private              Estos son los símbolos correspondientes al WDT.
                                                                  //

//

       //

//------------------------------------------------------------------------------------
---------------------------------**/

#define WATCHDOG_TIMEOUT      10                    //      En segundos.

#define Fwdt                          Fclk/(float)4  //      Reloj seleccionado del WDT.

#define WDMOD_MASK            0x03                  //      Se activa y resetea el
programa tras el timeout.

#define WDCLKSEL_MASK         0x01                  //      Se ha escogido el reloj Fclk.

#define WDT_CODIGO1           0xAA                  //      Primer código del WDT.

#define WDT_CODIGO2           0x55                  //      Segundo código del WDT.

/**----------------------------------------------------------------------------------
---------------------------------//
```

```
//

       //

                                                                                    //
//             @funcdef       Estas son las funciones que se usan en el WDT.
                                                                    //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

void    __configuraWDT__       (      void    );

void alimentaWDT               (      void    );

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //

                                                                    //

//             @end           ENDFILE.

       //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/
```

```
/**-------------------------------------------------------------------------------------
---------------------------------//

//             @filename              UART0.h
                                                                                    //

//             @version               0.00

       //

//             @author        Alberto Palomo Alonso
                                                                    //

//

       //

//             @brief         Este es el programa que recoge la transmisión por UART0.
                                                  //

//

       //
```

```
//             @category             Opcional.
       //
//
       //
//             @map                  @include
       //
//                                   @function
       //
//                                   @end
       //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------//
//
       //

                                                                                    //
//             @include              Includes pertenecientes a e la transmisión
asíncrona.                                                                          //
//
       //
//-------------------------------------------------------------------------------------
---------------------------------**/
#ifndef LPC17XX
#define LPC17XX
#include       "LPC17XX.H"
#endif
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include       "Systemsymbols.h"
#endif
#ifndef STDIO
#define STDIO
#include       <stdio.h>
#endif
#ifndef STRING
#define STRING
#include       <string.h>
#endif
```

```
#ifndef PWM

#define PWM

#include       "PWM.h"

#endif

#ifndef UART

#define UART

#include       "uart.h"

#endif

#ifndef MIGLOBAL

#define MIGLOBAL

#include       "miGlobal.h"

#endif

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @private              Estos son los símbolos correspondientes al
protocolo UART0.                                                                    //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

#define DLP                           7

#define UART0_MTX                     (1      <<      1)

#define UART0_MRX                     (1      <<      2)

#define RetornoDeCarro        13

#define CADMAX                120


#define COM10                 "GIVE SUGAR\r"

#define COM11                 "GIVE IP\r"

#define COM12                 "GIVE TEMPERATURA\r"

#define COM13                 "GIVE PRESION\r"

#define COM14                 "GIVE VIENTO\r"

#define COM15                 "GIVE LUGAR\r"

#define COM16                 "GIVE INDICEUV\r"

#define COM17                 "GIVE HORA\r"

#define COM18                 "GIVE HUMEDAD\r"

#define COM19                 "GIVE BRILLO\r"
```

```
#define COM20                   "SET BRILLO\r"
#define COM21                   "SET HORA\r"
#define COM22                   "SET MIN TEMP\r"
#define COM23                   "SET MAX TEMP\r"
#define COM24                   "SET MIN PRES\r"
#define COM25                   "SET MAX PRES\r"
#define COM26                   "SET TEMPERATURA\r"
#define COM27                   "SET PRESION\r"

#define COM3                            "KILL\r"

#define COM0                            "ABOUT\r"
#define COM4                            "HELP\r"
#define COM41                   "HELP GIVE\r"
#define COM42                   "HELP SET\r"

#define UART_TX                 0
#define UART_RX_BRILLO          1
#define UART_RX_MINT            2
#define UART_RX_MAXT            3
#define UART_RX_MINP            4
#define UART_RX_MAXP            5
#define UART_RX_HORA            6
#define UART_RX_VARM            7
/**-------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                //

//              @funcdef                Estas son las funciones correspondientes al
protocolo UART0.                                        //

//

        //

//-------------------------------------------------------------------------------------
---------------------------------**/

void    __configuraUART0__      (       void    );

uint8_t procesarComando(        char * );

/**-------------------------------------------------------------------------------------
---------------------------------//

//
```

```
       //

                                                                          //
//             @end           ENDFILE.
       //
//
       //
//-------------------------------------------------------------------------------------------
--------------------------------**/v
```

```
/*
 * uart_.h
 *
 *  Created on: 1-Oct-2011
 *  Author: J.M.V.C.
 */

#ifndef UART_H_
#define UART_H_

// Accepted Error baud rate value (in percent unit)
#define UART_ACCEPTED_BAUDRATE_ERROR    3

#define CHAR_8_BIT                      (3 << 0)
#define STOP_1_BIT                      (0 << 2)
#define PARITY_NONE                     (0 << 3)
#define DLAB_ENABLE                     (1 << 7)
#define FIFO_ENABLE                     (1 << 0)
#define RBR_IRQ_ENABLE                  (1 << 0)
#define THRE_IRQ_ENABLE                 (1 << 1)
#define UART_LSR_THRE                                       (1 << 5)
#define RDA_INTERRUPT                   (2 << 1)
#define CTI_INTERRUPT                   (6 << 1)
void uart0_init(int baudrate);
void tx_cadena_UART0(char *ptr);
unsigned char procesarComando (char* buff);
#endif /* UART_H_ */
```

```
/**-------------------------------------------------------------------------------------------
---------------------------------//
//              @filename               HTTP_SOURCE.h
                                                                                        //
//              @version                0.00
        //
//              @author         Alberto Palomo Alonso
                                                                        //
//
        //
//              @brief          Cabecera que configura la página WEB.
                                                                        //
//
        //
//              @category               Opcional.
        //
//
        //
//              @map                    @include
        //
//                                      @funcdef
        //
//                                      @end
        //
//
        //
//
        //
//-------------------------------------------------------------------------------------------
---------------------------------//
//
        //
                                                                                        //
//              @include                Estos son los archivos utilizados en el código de
configuración.                                          //
//
        //
```

```
//-------------------------------------------------------------------------------------------
-------------------------------**/

#ifndef NETCONFIG

#define NETCONFIG

#include       <Net_Config.h>

#endif

#ifndef STDIO

#define STDIO

#include       <stdio.h>

#endif

#ifndef LPC17XX

#define LPC17XX

#include <LPC17XX.H>

#endif

#ifndef RTL

#define RTL

#include <RTL.h>

#endif


void    __configuraWEB__       (       void    );

void            __mantenerTCP__        (       void    );



/**-----------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                        //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------------
-------------------------------**/







/**-----------------------------------------------------------------------------------------
---------------------------------//
```

```
//             @filename              HTTP_CGI.h
                                                                                    //
//             @version               0.00
       //
//             @author        Alberto Palomo Alonso
                                                                          //
//
       //
//             @brief         Cabecera que configura los callback la página WEB.
                                                                              //
//
       //
//             @category              Opcional.
       //
//
       //
//             @map                   @include
       //
//                                    @private
       //
//                                    @funcdef
       //
//                                    @end
       //
//
       //
//
       //
//----------------------------------------------------------------------------------------
---------------------------------//
//
       //

                                                                                    //
//             @include               Estos son los archivos utilizados en el código de
configuración.                                          //
//
       //
//----------------------------------------------------------------------------------------
---------------------------------**/
#ifndef NETCONFIG
```

```
#define NETCONFIG
#include       <Net_Config.h>
#endif
#ifndef STDIO
#define STDIO
#include       <stdio.h>
#endif
#ifndef STDLIB
#define STDLIB
#include <stdlib.h>
#endif
#ifndef STDINT
#define STDINT
#include <stdint.h>
#endif
#ifndef SYSTEMSYMBOLS
#define SYSTEMSYMBOLS
#include <Systemsymbols.h>
#endif
#ifndef LPC17XX
#define   LPC17XX
#include "LPC17XX.H"
#endif
/**-------------------------------------------------------------------------------------------
---------------------------------//
//
       //
                                                                                        //
//             @private              Estos son los símbolos correspondientes al cgi.
                                                                                //
//
       //
//-------------------------------------------------------------------------------------------
---------------------------------**/
#define TEMPERATURA    't'
#define VELOCIDAD             'v'
#define PRESION        'p'
#define HUMEDAD        'h'
#define INDICEUV              'i'
#define BRILLO         'b'
```

```
#define ALTITUD         'a'

#define LONGITUD                'x'

#define LATITUD         'y'

#define ANYO                    'A'

#define MES                     'M'

#define DIA                     'D'

#define HORAS           'H'

#define MINUTOS         'T'

#define SEGUNDOS                'S'

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @funcdef                Estas son las funciones correspondientes al cgi.
                                                                                //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void cgi_process_var  (       U8*     qs);    //              NO SE USA.

void cgi_process_data (       U8              tipo    ,       U8      *       qs      ,
        U16             longitud);      //      NO SE USA.

U16 cgi_func                    (       U8      *       env     ,       U8      *       buff
        ,       U16             bufflen ,       U32     *       pcgi);

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                //

//              @end            ENDFILE.

        //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/




/**-------------------------------------------------------------------------------------------
---------------------------------//
```

```
//             @filename              RTC.h
                                                                                    //
//             @version               0.00
       //
//             @author        Alberto Palomo Alonso
                                                                          //
//
       //
//             @brief         Cabecera del código RTC.
                                                                              //
//
       //
//             @category              Opcional.
       //
//
       //
//             @map                   @include
       //
//                                    @private
       //
//                                    @funcdef
       //
//                                    @end
       //
//
       //
//
       //
//----------------------------------------------------------------------------------------
---------------------------------//
//
       //

                                                                                    //
//             @include               Estos son los archivos utilizados con el código
fuente.                                                       //
//
       //
//----------------------------------------------------------------------------------------
---------------------------------**/
#ifndef SYSTEMSYMBOLS
```

```
#define SYSTEMSYMBOLS

#include "Systemsymbols.h"

#endif

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @private                Estos son los símbolos privados a RTC.
                                                                                    //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

#define MITIEMPO        (time_t *)(LPC_RTC_BASE)

#define RTCMASK                 1 << 9

#define CALIBRACION_RTC         (1 << 4) | (0x1 << 1)

#define CALIBRATION_VALUE       0x00

#define INT_SEGUNDOS            1 << 0

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                                        //

//              @funcdef                Funciones a definir en el RTC.
                                                                                    //

//

        //

//-------------------------------------------------------------------------------------------
---------------------------------**/

void __configuraRTC__(void    );

/**-------------------------------------------------------------------------------------------
---------------------------------//

//

        //


                                                                        //

//              @end            ENDFILE.

        //

//

        //
```

```
//-------------------------------------------------------------------------------------------
-------------------------------**/




/**-------------------------------------------------------------------------------------------
--------------------------------//
//             @filename             Timers.h

       //
//             @version              0.00

       //
//             @author        Alberto Palomo Alonso
                                                                    //
//

       //
//             @brief         Cabecera para configurar los timers.
                                                          //
//

       //
//             @category             Principal.
                                                                          //
//

       //
//             @map                  @include

       //
//                                   @funcdef

       //
//                                   @end

       //
//

       //
//

       //
//-------------------------------------------------------------------------------------------
--------------------------------//
//

       //

                                                                          //
//             @include              Estos son los archivos utilizados para los timers.
                                                          //
```

```
//

       //

//-------------------------------------------------------------------------------------
--------------------------------**/

#ifndef RTL

#define RTL

#include       "RTL.h"

#endif

#ifndef LPC17XX

#define LPC17XX

#include       "LPC17XX.H"

#endif

#ifndef SYSTEMSYMBOLS

#define SYSTEMSYMBOLS

#include       "Systemsymbols.h"

#endif

#ifndef ANEMOMETRO

#define ANEMOMETRO

#include       "Anemometro.h"

#endif

#ifndef LDR

#define LDR

#include       "LDR.h"

#endif

#ifndef DAC

#define DAC

#include       "DAC.h"

#endif

#ifndef PWM

#define PWM

#include       "PWM.h"

#endif

#ifndef UFONO

#define UFONO

#include       "uFono.h"

#endif

#ifndef ONEWIRE

#define ONEWIRE

#include       "OneWire.h"

#endif
```

```
#ifndef I2C

#define I2C

#include       "I2C.h"

#endif

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //


                                                                                    //

//             @private              Estos son los símbolos correspondientes a los
timers.                                                                  //

//

       //

//-------------------------------------------------------------------------------------
---------------------------------**/

#define FREQ_OVERFLOW_SYSTICK 10                                              //
       Frecuencia en Hz de overflow o fin de cuenta del SysTick. (Tsyst = 100ms)

#define ENABLEBIT_SYST                0x1

#define FCPUBIT_SYST                  0x4

#define ENABLEINTBIT_SYST             0x2

#define MASCARA_CTRL_SYSTICK   FCPUBIT_SYST | ENABLEBIT_SYST | ENABLEINTBIT_SYST

#define SYSTICK_COUNTFLAG             0x1 << 16

//     Para cada timer.

#define ACTIVAR_TIMER                 0x1

#define RESET_TIMER_TCR               0x2

#define TIMER0_BIT                    (0x1 << 1)

#define TIMER1_BIT                    (0x1 << 2)

#define TIMER2_BIT                    (0x1 << 22)

#define TIMER3_BIT                    (0x1 << 23)

#define TIMER0_MCR_MASK               0x3 << (0*3)                            //
       Activo la interrupción y reseteo el contador.

#define TIMER1_MCR_MASK               0x3 << (0*3)                            //
       No usado.

#define TIMER2_MCR_MASK               0x3 << (0*3)

#define TIMER3_MCR_MASK               0x1 << (0*3)


#define MODO_ENTRADA                  1

#define MODO_SALIDA                   0

/**-------------------------------------------------------------------------------------
---------------------------------//

//

       //
```

```
                                                                                //
//            @funcdef              Estas son las funciones correspondientes a los
timers.                                                 //
//
       //
//--------------------------------------------------------------------------------
--------------------------------**/
void __configuraSysTick__     (      void   );     //     TCP.
void __configuraTimer0__              (      void   );     //     Muestreo.
void __configuraTimer1__              (      void   );     //     ...
void __configuraTimer2__              (      void   );     //     Audio.
void __configuraTimer3__              (      void   );     //     ...
/**------------------------------------------------------------------------------
--------------------------------//
//
       //

                                                                        //
//            @end          ENDFILE.
       //
//
       //
//--------------------------------------------------------------------------------
--------------------------------**/
```

```
/*****************************************************************************//**
 * @file     core_cm3.h
 * @brief    CMSIS Cortex-M3 Core Peripheral Access Layer Header File
 * @version  V2.01
 * @date     06. December 2010
 *
 * @note
 * Copyright (C) 2009-2010 ARM Limited. All rights reserved.
 *
 * @par
 * ARM Limited (ARM) is supplying this software for use with Cortex-M
 * processor based microcontrollers.  This file can be freely distributed
 * within development tools that are supporting such ARM based processors.
```

```
 *
 * @par
 * THIS SOFTWARE IS PROVIDED "AS IS".  NO WARRANTIES, WHETHER EXPRESS, IMPLIED
 * OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, IMPLIED WARRANTIES OF
 * MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE APPLY TO THIS SOFTWARE.
 * ARM SHALL NOT, IN ANY CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL, OR
 * CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.
 *
 ******************************************************************************/
#if defined ( __ICCARM__ )
 #pragma system_include  /* treat file as system include file for MISRA check */
#endif

#ifdef __cplusplus
 extern "C" {
#endif

#ifndef __CORE_CM3_H_GENERIC
#define __CORE_CM3_H_GENERIC



/*******************************************************************************
 *                 CMSIS definitions
 ******************************************************************************/
/** @ingroup  CMSIS
 * @addtogroup CMSIS_core_definitions CMSIS Core Definitions
  This file defines all structures and symbols for CMSIS core:
   - CMSIS version number
   - Cortex-M core
   - Cortex-M core Revision Number
  @{
 */


/*  CMSIS CM3 definitions */
#define __CM3_CMSIS_VERSION_MAIN  (0x02)
/*!< [31:16] CMSIS HAL main version */
#define __CM3_CMSIS_VERSION_SUB   (0x00)
/*!< [15:0]  CMSIS HAL sub version  */
#define __CM3_CMSIS_VERSION       ((__CM3_CMSIS_VERSION_MAIN << 16) |
__CM3_CMSIS_VERSION_SUB) /*!< CMSIS HAL version number       */
```

```
#define __CORTEX_M                (0x03)
/*!< Cortex core                   */



#if defined ( __CC_ARM   )

  #define __ASM            __asm                                      /*!< asm keyword
for ARM Compiler          */

  #define __INLINE         __inline                                   /*!< inline
keyword for ARM Compiler       */


#elif defined ( __ICCARM__ )

  #define __ASM           __asm                                       /*!< asm keyword
for IAR Compiler          */

  #define __INLINE        inline                                      /*!< inline
keyword for IAR Compiler. Only avaiable in High optimization mode! */


#elif defined   (  __GNUC__  )

  #define __ASM            __asm                                      /*!< asm keyword
for GNU Compiler          */

  #define __INLINE         inline                                     /*!< inline
keyword for GNU Compiler       */


#elif defined   (  __TASKING__  )

  #define __ASM            __asm                                      /*!< asm keyword
for TASKING Compiler      */

  #define __INLINE         inline                                     /*!< inline
keyword for TASKING Compiler   */


#endif


#include <stdint.h>                       /*!< standard types definitions
*/

#include "core_cmInstr.h"                 /*!< Core Instruction Access
*/

#include "core_cmFunc.h"                  /*!< Core Function Access
*/


#endif /* __CORE_CM3_H_GENERIC */



#ifndef __CMSIS_GENERIC


#ifndef __CORE_CM3_H_DEPENDANT

#define __CORE_CM3_H_DEPENDANT
```

```
/* IO definitions (access restrictions to peripheral registers) */

#ifdef __cplusplus

  #define     __I     volatile           /*!< defines 'read only' permissions
*/

#else

  #define     __I     volatile const     /*!< defines 'read only' permissions
*/

#endif

#define     __O     volatile             /*!< defines 'write only' permissions
*/

#define     __IO    volatile             /*!< defines 'read / write' permissions
*/


/*@} end of group CMSIS_core_definitions */




/*******************************************************************************
 *                 Register Abstraction
 ******************************************************************************/


/** @ingroup  CMSIS
 * @addtogroup CMSIS_core_register CMSIS Core Register
  Core Register contain:
  - Core Register
  - Core NVIC Register
  - Core SCB Register
  - Core SysTick Register
  - Core Debug Register
  - Core MPU Register
*/


/** \ingroup  CMSIS_core_register
    \defgroup CMSIS_CORE CMSIS Core
  Type definitions for the Cortex-M Core Registers
  @{
 */


/** \brief  Union type to access the Application Program Status Register (APSR).
 */
typedef union
```

```
{
  struct
  {
#if (__CORTEX_M != 0x04)
    uint32_t _reserved0:27;              /*!< bit:  0..26  Reserved
*/
#else
    uint32_t _reserved0:16;              /*!< bit:  0..15  Reserved
*/
    uint32_t GE:4;                       /*!< bit: 16..19  Greater than or Equal flags
*/
    uint32_t _reserved1:7;               /*!< bit: 20..26  Reserved
*/
#endif
    uint32_t Q:1;                        /*!< bit:     27  Saturation condition flag
*/
    uint32_t V:1;                        /*!< bit:     28  Overflow condition code flag
*/
    uint32_t C:1;                        /*!< bit:     29  Carry condition code flag
*/
    uint32_t Z:1;                        /*!< bit:     30  Zero condition code flag
*/
    uint32_t N:1;                        /*!< bit:     31  Negative condition code flag
*/
  } b;                                   /*!< Structure used for bit  access
*/
  uint32_t w;                            /*!< Type      used for word access
*/
} APSR_Type;



/** \brief  Union type to access the Interrupt Program Status Register (IPSR).
 */
typedef union
{
  struct
  {
    uint32_t ISR:9;                      /*!< bit:  0.. 8  Exception number
*/
    uint32_t _reserved0:23;              /*!< bit:  9..31  Reserved
*/
  } b;                                   /*!< Structure used for bit  access
*/
  uint32_t w;                            /*!< Type      used for word access
*/
} IPSR_Type;
```

```
/** \brief  Union type to access the Special-Purpose Program Status Registers (xPSR).
 */
typedef union
{
  struct
  {
    uint32_t ISR:9;                     /*!< bit:  0.. 8  Exception number
*/
#if (__CORTEX_M != 0x04)
    uint32_t _reserved0:15;             /*!< bit:  9..23  Reserved
*/
#else
    uint32_t _reserved0:7;              /*!< bit:  9..15  Reserved
*/
    uint32_t GE:4;                      /*!< bit: 16..19  Greater than or Equal flags
*/
    uint32_t _reserved1:4;              /*!< bit: 20..23  Reserved
*/
#endif
    uint32_t T:1;                       /*!< bit:     24  Thumb bit        (read 0)
*/
    uint32_t IT:2;                      /*!< bit: 25..26  saved IT state   (read 0)
*/
    uint32_t Q:1;                       /*!< bit:     27  Saturation condition flag
*/
    uint32_t V:1;                       /*!< bit:     28  Overflow condition code flag
*/
    uint32_t C:1;                       /*!< bit:     29  Carry condition code flag
*/
    uint32_t Z:1;                       /*!< bit:     30  Zero condition code flag
*/
    uint32_t N:1;                       /*!< bit:     31  Negative condition code flag
*/
  } b;                                  /*!< Structure used for bit  access
*/
  uint32_t w;                           /*!< Type      used for word access
*/
} xPSR_Type;


/** \brief  Union type to access the Control Registers (CONTROL).
 */
typedef union
{
```

```
  struct

  {

    uint32_t nPRIV:1;                    /*!< bit:      0  Execution privilege in Thread
mode */

    uint32_t SPSEL:1;                    /*!< bit:      1  Stack to be used
*/

    uint32_t FPCA:1;                     /*!< bit:      2  FP extension active flag
*/

    uint32_t _reserved0:29;              /*!< bit:  3..31  Reserved
*/

  } b;                                   /*!< Structure used for bit  access
*/

  uint32_t w;                            /*!< Type      used for word access
*/

} CONTROL_Type;


/*@} end of group CMSIS_CORE */



/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_NVIC CMSIS NVIC

  Type definitions for the Cortex-M NVIC Registers

  @{

 */


/** \brief  Structure type to access the Nested Vectored Interrupt Controller (NVIC).

 */

typedef struct

{

  __IO uint32_t ISER[8];                /*!< Offset: 0x000 (R/W)  Interrupt Set Enable
Register           */

       uint32_t RESERVED0[24];

  __IO uint32_t ICER[8];                /*!< Offset: 0x080 (R/W)  Interrupt Clear
Enable Register         */

       uint32_t RSERVED1[24];

  __IO uint32_t ISPR[8];                /*!< Offset: 0x100 (R/W)  Interrupt Set Pending
Register          */

       uint32_t RESERVED2[24];

  __IO uint32_t ICPR[8];                /*!< Offset: 0x180 (R/W)  Interrupt Clear
Pending Register        */

       uint32_t RESERVED3[24];

  __IO uint32_t IABR[8];                /*!< Offset: 0x200 (R/W)  Interrupt Active bit
Register           */

       uint32_t RESERVED4[56];
```

```
  __IO uint8_t  IP[240];                /*!< Offset: 0x300 (R/W)  Interrupt Priority
Register (8Bit wide) */

       uint32_t RESERVED5[644];

  __O  uint32_t STIR;                   /*!< Offset: 0xE00 ( /W)  Software Trigger
Interrupt Register     */

}  NVIC_Type;


/*@} end of group CMSIS_NVIC */



/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_SCB CMSIS SCB

  Type definitions for the Cortex-M System Control Block Registers

  @{

 */


/** \brief  Structure type to access the System Control Block (SCB).

 */

typedef struct

{

  __I  uint32_t CPUID;                  /*!< Offset: 0x000 (R/ )  CPU ID Base Register
*/

  __IO uint32_t ICSR;                   /*!< Offset: 0x004 (R/W)  Interrupt Control
State Register                       */

  __IO uint32_t VTOR;                   /*!< Offset: 0x008 (R/W)  Vector Table Offset
Register                             */

  __IO uint32_t AIRCR;                  /*!< Offset: 0x00C (R/W)  Application Interrupt
/ Reset Control Register        */

  __IO uint32_t SCR;                    /*!< Offset: 0x010 (R/W)  System Control
Register                                */

  __IO uint32_t CCR;                    /*!< Offset: 0x014 (R/W)  Configuration Control
Register                            */

  __IO uint8_t  SHP[12];                /*!< Offset: 0x018 (R/W)  System Handlers
Priority Registers (4-7, 8-11, 12-15) */

  __IO uint32_t SHCSR;                  /*!< Offset: 0x024 (R/W)  System Handler
Control and State Register             */

  __IO uint32_t CFSR;                   /*!< Offset: 0x028 (R/W)  Configurable Fault
Status Register                      */

  __IO uint32_t HFSR;                   /*!< Offset: 0x02C (R/W)  Hard Fault Status
Register                              */

  __IO uint32_t DFSR;                   /*!< Offset: 0x030 (R/W)  Debug Fault Status
Register                             */

  __IO uint32_t MMFAR;                  /*!< Offset: 0x034 (R/W)  Mem Manage Address
Register                             */

  __IO uint32_t BFAR;                   /*!< Offset: 0x038 (R/W)  Bus Fault Address
Register                              */
```

```
  __IO uint32_t AFSR;                    /*!< Offset: 0x03C (R/W)  Auxiliary Fault
Status Register                        */

  __I  uint32_t PFR[2];                  /*!< Offset: 0x040 (R/ )  Processor Feature
Register                               */

  __I  uint32_t DFR;                     /*!< Offset: 0x048 (R/ )  Debug Feature
Register                              */

  __I  uint32_t ADR;                     /*!< Offset: 0x04C (R/ )  Auxiliary Feature
Register                               */

  __I  uint32_t MMFR[4];                 /*!< Offset: 0x050 (R/ )  Memory Model Feature
Register                            */

  __I  uint32_t ISAR[5];                 /*!< Offset: 0x060 (R/ )  ISA Feature Register
*/

} SCB_Type;


/* SCB CPUID Register Definitions */

#define SCB_CPUID_IMPLEMENTER_Pos          24
/*!< SCB CPUID: IMPLEMENTER Position */

#define SCB_CPUID_IMPLEMENTER_Msk          (0xFFUL << SCB_CPUID_IMPLEMENTER_Pos)
/*!< SCB CPUID: IMPLEMENTER Mask */


#define SCB_CPUID_VARIANT_Pos              20
/*!< SCB CPUID: VARIANT Position */

#define SCB_CPUID_VARIANT_Msk              (0xFUL << SCB_CPUID_VARIANT_Pos)
/*!< SCB CPUID: VARIANT Mask */


#define SCB_CPUID_PARTNO_Pos                4
/*!< SCB CPUID: PARTNO Position */

#define SCB_CPUID_PARTNO_Msk               (0xFFFUL << SCB_CPUID_PARTNO_Pos)
/*!< SCB CPUID: PARTNO Mask */


#define SCB_CPUID_REVISION_Pos              0
/*!< SCB CPUID: REVISION Position */

#define SCB_CPUID_REVISION_Msk             (0xFUL << SCB_CPUID_REVISION_Pos)
/*!< SCB CPUID: REVISION Mask */


/* SCB Interrupt Control State Register Definitions */

#define SCB_ICSR_NMIPENDSET_Pos            31
/*!< SCB ICSR: NMIPENDSET Position */

#define SCB_ICSR_NMIPENDSET_Msk            (1UL << SCB_ICSR_NMIPENDSET_Pos)
/*!< SCB ICSR: NMIPENDSET Mask */


#define SCB_ICSR_PENDSVSET_Pos             28
/*!< SCB ICSR: PENDSVSET Position */

#define SCB_ICSR_PENDSVSET_Msk             (1UL << SCB_ICSR_PENDSVSET_Pos)
/*!< SCB ICSR: PENDSVSET Mask */


#define SCB_ICSR_PENDSVCLR_Pos             27
/*!< SCB ICSR: PENDSVCLR Position */
```

```
#define SCB_ICSR_PENDSVCLR_Msk            (1UL << SCB_ICSR_PENDSVCLR_Pos)
/*!< SCB ICSR: PENDSVCLR Mask */


#define SCB_ICSR_PENDSTSET_Pos            26
/*!< SCB ICSR: PENDSTSET Position */

#define SCB_ICSR_PENDSTSET_Msk            (1UL << SCB_ICSR_PENDSTSET_Pos)
/*!< SCB ICSR: PENDSTSET Mask */


#define SCB_ICSR_PENDSTCLR_Pos            25
/*!< SCB ICSR: PENDSTCLR Position */

#define SCB_ICSR_PENDSTCLR_Msk            (1UL << SCB_ICSR_PENDSTCLR_Pos)
/*!< SCB ICSR: PENDSTCLR Mask */


#define SCB_ICSR_ISRPREEMPT_Pos           23
/*!< SCB ICSR: ISRPREEMPT Position */

#define SCB_ICSR_ISRPREEMPT_Msk           (1UL << SCB_ICSR_ISRPREEMPT_Pos)
/*!< SCB ICSR: ISRPREEMPT Mask */


#define SCB_ICSR_ISRPENDING_Pos           22
/*!< SCB ICSR: ISRPENDING Position */

#define SCB_ICSR_ISRPENDING_Msk           (1UL << SCB_ICSR_ISRPENDING_Pos)
/*!< SCB ICSR: ISRPENDING Mask */


#define SCB_ICSR_VECTPENDING_Pos          12
/*!< SCB ICSR: VECTPENDING Position */

#define SCB_ICSR_VECTPENDING_Msk          (0x1FFUL << SCB_ICSR_VECTPENDING_Pos)
/*!< SCB ICSR: VECTPENDING Mask */


#define SCB_ICSR_RETTOBASE_Pos            11
/*!< SCB ICSR: RETTOBASE Position */

#define SCB_ICSR_RETTOBASE_Msk            (1UL << SCB_ICSR_RETTOBASE_Pos)
/*!< SCB ICSR: RETTOBASE Mask */


#define SCB_ICSR_VECTACTIVE_Pos            0
/*!< SCB ICSR: VECTACTIVE Position */

#define SCB_ICSR_VECTACTIVE_Msk           (0x1FFUL << SCB_ICSR_VECTACTIVE_Pos)
/*!< SCB ICSR: VECTACTIVE Mask */


/* SCB Interrupt Control State Register Definitions */

#define SCB_VTOR_TBLBASE_Pos              29
/*!< SCB VTOR: TBLBASE Position */

#define SCB_VTOR_TBLBASE_Msk              (1UL << SCB_VTOR_TBLBASE_Pos)
/*!< SCB VTOR: TBLBASE Mask */


#define SCB_VTOR_TBLOFF_Pos                7
/*!< SCB VTOR: TBLOFF Position */

#define SCB_VTOR_TBLOFF_Msk               (0x3FFFFFUL << SCB_VTOR_TBLOFF_Pos)
/*!< SCB VTOR: TBLOFF Mask */
```

```
/* SCB Application Interrupt and Reset Control Register Definitions */

#define SCB_AIRCR_VECTKEY_Pos              16
/*!< SCB AIRCR: VECTKEY Position */

#define SCB_AIRCR_VECTKEY_Msk              (0xFFFFUL << SCB_AIRCR_VECTKEY_Pos)
/*!< SCB AIRCR: VECTKEY Mask */


#define SCB_AIRCR_VECTKEYSTAT_Pos          16
/*!< SCB AIRCR: VECTKEYSTAT Position */

#define SCB_AIRCR_VECTKEYSTAT_Msk          (0xFFFFUL << SCB_AIRCR_VECTKEYSTAT_Pos)
/*!< SCB AIRCR: VECTKEYSTAT Mask */


#define SCB_AIRCR_ENDIANESS_Pos            15
/*!< SCB AIRCR: ENDIANESS Position */

#define SCB_AIRCR_ENDIANESS_Msk            (1UL << SCB_AIRCR_ENDIANESS_Pos)
/*!< SCB AIRCR: ENDIANESS Mask */


#define SCB_AIRCR_PRIGROUP_Pos              8
/*!< SCB AIRCR: PRIGROUP Position */

#define SCB_AIRCR_PRIGROUP_Msk             (7UL << SCB_AIRCR_PRIGROUP_Pos)
/*!< SCB AIRCR: PRIGROUP Mask */


#define SCB_AIRCR_SYSRESETREQ_Pos           2
/*!< SCB AIRCR: SYSRESETREQ Position */

#define SCB_AIRCR_SYSRESETREQ_Msk          (1UL << SCB_AIRCR_SYSRESETREQ_Pos)
/*!< SCB AIRCR: SYSRESETREQ Mask */


#define SCB_AIRCR_VECTCLRACTIVE_Pos         1
/*!< SCB AIRCR: VECTCLRACTIVE Position */

#define SCB_AIRCR_VECTCLRACTIVE_Msk        (1UL << SCB_AIRCR_VECTCLRACTIVE_Pos)
/*!< SCB AIRCR: VECTCLRACTIVE Mask */


#define SCB_AIRCR_VECTRESET_Pos             0
/*!< SCB AIRCR: VECTRESET Position */

#define SCB_AIRCR_VECTRESET_Msk            (1UL << SCB_AIRCR_VECTRESET_Pos)
/*!< SCB AIRCR: VECTRESET Mask */


/* SCB System Control Register Definitions */

#define SCB_SCR_SEVONPEND_Pos               4
/*!< SCB SCR: SEVONPEND Position */

#define SCB_SCR_SEVONPEND_Msk              (1UL << SCB_SCR_SEVONPEND_Pos)
/*!< SCB SCR: SEVONPEND Mask */


#define SCB_SCR_SLEEPDEEP_Pos               2
/*!< SCB SCR: SLEEPDEEP Position */

#define SCB_SCR_SLEEPDEEP_Msk              (1UL << SCB_SCR_SLEEPDEEP_Pos)
/*!< SCB SCR: SLEEPDEEP Mask */
```

```
#define SCB_SCR_SLEEPONEXIT_Pos             1
/*!< SCB SCR: SLEEPONEXIT Position */

#define SCB_SCR_SLEEPONEXIT_Msk            (1UL << SCB_SCR_SLEEPONEXIT_Pos)
/*!< SCB SCR: SLEEPONEXIT Mask */


/* SCB Configuration Control Register Definitions */

#define SCB_CCR_STKALIGN_Pos                9
/*!< SCB CCR: STKALIGN Position */

#define SCB_CCR_STKALIGN_Msk               (1UL << SCB_CCR_STKALIGN_Pos)
/*!< SCB CCR: STKALIGN Mask */


#define SCB_CCR_BFHFNMIGN_Pos               8
/*!< SCB CCR: BFHFNMIGN Position */

#define SCB_CCR_BFHFNMIGN_Msk              (1UL << SCB_CCR_BFHFNMIGN_Pos)
/*!< SCB CCR: BFHFNMIGN Mask */


#define SCB_CCR_DIV_0_TRP_Pos               4
/*!< SCB CCR: DIV_0_TRP Position */

#define SCB_CCR_DIV_0_TRP_Msk              (1UL << SCB_CCR_DIV_0_TRP_Pos)
/*!< SCB CCR: DIV_0_TRP Mask */


#define SCB_CCR_UNALIGN_TRP_Pos             3
/*!< SCB CCR: UNALIGN_TRP Position */

#define SCB_CCR_UNALIGN_TRP_Msk            (1UL << SCB_CCR_UNALIGN_TRP_Pos)
/*!< SCB CCR: UNALIGN_TRP Mask */


#define SCB_CCR_USERSETMPEND_Pos            1
/*!< SCB CCR: USERSETMPEND Position */

#define SCB_CCR_USERSETMPEND_Msk           (1UL << SCB_CCR_USERSETMPEND_Pos)
/*!< SCB CCR: USERSETMPEND Mask */


#define SCB_CCR_NONBASETHRDENA_Pos          0
/*!< SCB CCR: NONBASETHRDENA Position */

#define SCB_CCR_NONBASETHRDENA_Msk         (1UL << SCB_CCR_NONBASETHRDENA_Pos)
/*!< SCB CCR: NONBASETHRDENA Mask */


/* SCB System Handler Control and State Register Definitions */

#define SCB_SHCSR_USGFAULTENA_Pos          18
/*!< SCB SHCSR: USGFAULTENA Position */

#define SCB_SHCSR_USGFAULTENA_Msk          (1UL << SCB_SHCSR_USGFAULTENA_Pos)
/*!< SCB SHCSR: USGFAULTENA Mask */


#define SCB_SHCSR_BUSFAULTENA_Pos          17
/*!< SCB SHCSR: BUSFAULTENA Position */

#define SCB_SHCSR_BUSFAULTENA_Msk          (1UL << SCB_SHCSR_BUSFAULTENA_Pos)
/*!< SCB SHCSR: BUSFAULTENA Mask */
```

```
#define SCB_SHCSR_MEMFAULTENA_Pos          16
/*!< SCB SHCSR: MEMFAULTENA Position */

#define SCB_SHCSR_MEMFAULTENA_Msk          (1UL << SCB_SHCSR_MEMFAULTENA_Pos)
/*!< SCB SHCSR: MEMFAULTENA Mask */


#define SCB_SHCSR_SVCALLPENDED_Pos         15
/*!< SCB SHCSR: SVCALLPENDED Position */

#define SCB_SHCSR_SVCALLPENDED_Msk         (1UL << SCB_SHCSR_SVCALLPENDED_Pos)
/*!< SCB SHCSR: SVCALLPENDED Mask */


#define SCB_SHCSR_BUSFAULTPENDED_Pos       14
/*!< SCB SHCSR: BUSFAULTPENDED Position */

#define SCB_SHCSR_BUSFAULTPENDED_Msk       (1UL << SCB_SHCSR_BUSFAULTPENDED_Pos)
/*!< SCB SHCSR: BUSFAULTPENDED Mask */


#define SCB_SHCSR_MEMFAULTPENDED_Pos       13
/*!< SCB SHCSR: MEMFAULTPENDED Position */

#define SCB_SHCSR_MEMFAULTPENDED_Msk       (1UL << SCB_SHCSR_MEMFAULTPENDED_Pos)
/*!< SCB SHCSR: MEMFAULTPENDED Mask */


#define SCB_SHCSR_USGFAULTPENDED_Pos       12
/*!< SCB SHCSR: USGFAULTPENDED Position */

#define SCB_SHCSR_USGFAULTPENDED_Msk       (1UL << SCB_SHCSR_USGFAULTPENDED_Pos)
/*!< SCB SHCSR: USGFAULTPENDED Mask */


#define SCB_SHCSR_SYSTICKACT_Pos           11
/*!< SCB SHCSR: SYSTICKACT Position */

#define SCB_SHCSR_SYSTICKACT_Msk           (1UL << SCB_SHCSR_SYSTICKACT_Pos)
/*!< SCB SHCSR: SYSTICKACT Mask */


#define SCB_SHCSR_PENDSVACT_Pos            10
/*!< SCB SHCSR: PENDSVACT Position */

#define SCB_SHCSR_PENDSVACT_Msk            (1UL << SCB_SHCSR_PENDSVACT_Pos)
/*!< SCB SHCSR: PENDSVACT Mask */


#define SCB_SHCSR_MONITORACT_Pos            8
/*!< SCB SHCSR: MONITORACT Position */

#define SCB_SHCSR_MONITORACT_Msk           (1UL << SCB_SHCSR_MONITORACT_Pos)
/*!< SCB SHCSR: MONITORACT Mask */


#define SCB_SHCSR_SVCALLACT_Pos             7
/*!< SCB SHCSR: SVCALLACT Position */

#define SCB_SHCSR_SVCALLACT_Msk            (1UL << SCB_SHCSR_SVCALLACT_Pos)
/*!< SCB SHCSR: SVCALLACT Mask */


#define SCB_SHCSR_USGFAULTACT_Pos           3
/*!< SCB SHCSR: USGFAULTACT Position */
```

```
#define SCB_SHCSR_USGFAULTACT_Msk          (1UL << SCB_SHCSR_USGFAULTACT_Pos)
/*!< SCB SHCSR: USGFAULTACT Mask */


#define SCB_SHCSR_BUSFAULTACT_Pos           1
/*!< SCB SHCSR: BUSFAULTACT Position */

#define SCB_SHCSR_BUSFAULTACT_Msk          (1UL << SCB_SHCSR_BUSFAULTACT_Pos)
/*!< SCB SHCSR: BUSFAULTACT Mask */


#define SCB_SHCSR_MEMFAULTACT_Pos           0
/*!< SCB SHCSR: MEMFAULTACT Position */

#define SCB_SHCSR_MEMFAULTACT_Msk          (1UL << SCB_SHCSR_MEMFAULTACT_Pos)
/*!< SCB SHCSR: MEMFAULTACT Mask */


/* SCB Configurable Fault Status Registers Definitions */

#define SCB_CFSR_USGFAULTSR_Pos            16
/*!< SCB CFSR: Usage Fault Status Register Position */

#define SCB_CFSR_USGFAULTSR_Msk            (0xFFFFUL << SCB_CFSR_USGFAULTSR_Pos)
/*!< SCB CFSR: Usage Fault Status Register Mask */


#define SCB_CFSR_BUSFAULTSR_Pos             8
/*!< SCB CFSR: Bus Fault Status Register Position */

#define SCB_CFSR_BUSFAULTSR_Msk            (0xFFUL << SCB_CFSR_BUSFAULTSR_Pos)
/*!< SCB CFSR: Bus Fault Status Register Mask */


#define SCB_CFSR_MEMFAULTSR_Pos             0
/*!< SCB CFSR: Memory Manage Fault Status Register Position */

#define SCB_CFSR_MEMFAULTSR_Msk            (0xFFUL << SCB_CFSR_MEMFAULTSR_Pos)
/*!< SCB CFSR: Memory Manage Fault Status Register Mask */


/* SCB Hard Fault Status Registers Definitions */

#define SCB_HFSR_DEBUGEVT_Pos              31
/*!< SCB HFSR: DEBUGEVT Position */

#define SCB_HFSR_DEBUGEVT_Msk              (1UL << SCB_HFSR_DEBUGEVT_Pos)
/*!< SCB HFSR: DEBUGEVT Mask */


#define SCB_HFSR_FORCED_Pos                30
/*!< SCB HFSR: FORCED Position */

#define SCB_HFSR_FORCED_Msk                (1UL << SCB_HFSR_FORCED_Pos)
/*!< SCB HFSR: FORCED Mask */


#define SCB_HFSR_VECTTBL_Pos                1
/*!< SCB HFSR: VECTTBL Position */

#define SCB_HFSR_VECTTBL_Msk               (1UL << SCB_HFSR_VECTTBL_Pos)
/*!< SCB HFSR: VECTTBL Mask */


/* SCB Debug Fault Status Register Definitions */
```

```
#define SCB_DFSR_EXTERNAL_Pos               4
/*!< SCB DFSR: EXTERNAL Position */

#define SCB_DFSR_EXTERNAL_Msk              (1UL << SCB_DFSR_EXTERNAL_Pos)
/*!< SCB DFSR: EXTERNAL Mask */


#define SCB_DFSR_VCATCH_Pos                 3
/*!< SCB DFSR: VCATCH Position */

#define SCB_DFSR_VCATCH_Msk                (1UL << SCB_DFSR_VCATCH_Pos)
/*!< SCB DFSR: VCATCH Mask */


#define SCB_DFSR_DWTTRAP_Pos                2
/*!< SCB DFSR: DWTTRAP Position */

#define SCB_DFSR_DWTTRAP_Msk               (1UL << SCB_DFSR_DWTTRAP_Pos)
/*!< SCB DFSR: DWTTRAP Mask */


#define SCB_DFSR_BKPT_Pos                   1
/*!< SCB DFSR: BKPT Position */

#define SCB_DFSR_BKPT_Msk                  (1UL << SCB_DFSR_BKPT_Pos)
/*!< SCB DFSR: BKPT Mask */


#define SCB_DFSR_HALTED_Pos                 0
/*!< SCB DFSR: HALTED Position */

#define SCB_DFSR_HALTED_Msk                (1UL << SCB_DFSR_HALTED_Pos)
/*!< SCB DFSR: HALTED Mask */


/*@} end of group CMSIS_SCB */



/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_SysTick CMSIS SysTick

  Type definitions for the Cortex-M System Timer Registers

  @{

 */


/** \brief  Structure type to access the System Timer (SysTick).

 */

typedef struct

{

  __IO uint32_t CTRL;                    /*!< Offset: 0x000 (R/W)  SysTick Control and
Status Register */

  __IO uint32_t LOAD;                    /*!< Offset: 0x004 (R/W)  SysTick Reload Value
Register       */

  __IO uint32_t VAL;                     /*!< Offset: 0x008 (R/W)  SysTick Current Value
Register      */

  __I  uint32_t CALIB;                   /*!< Offset: 0x00C (R/ )  SysTick Calibration
Register        */
```

```
} SysTick_Type;


/* SysTick Control / Status Register Definitions */

#define SysTick_CTRL_COUNTFLAG_Pos         16
/*!< SysTick CTRL: COUNTFLAG Position */

#define SysTick_CTRL_COUNTFLAG_Msk         (1UL << SysTick_CTRL_COUNTFLAG_Pos)
/*!< SysTick CTRL: COUNTFLAG Mask */


#define SysTick_CTRL_CLKSOURCE_Pos          2
/*!< SysTick CTRL: CLKSOURCE Position */

#define SysTick_CTRL_CLKSOURCE_Msk         (1UL << SysTick_CTRL_CLKSOURCE_Pos)
/*!< SysTick CTRL: CLKSOURCE Mask */


#define SysTick_CTRL_TICKINT_Pos            1
/*!< SysTick CTRL: TICKINT Position */

#define SysTick_CTRL_TICKINT_Msk           (1UL << SysTick_CTRL_TICKINT_Pos)
/*!< SysTick CTRL: TICKINT Mask */


#define SysTick_CTRL_ENABLE_Pos             0
/*!< SysTick CTRL: ENABLE Position */

#define SysTick_CTRL_ENABLE_Msk            (1UL << SysTick_CTRL_ENABLE_Pos)
/*!< SysTick CTRL: ENABLE Mask */


/* SysTick Reload Register Definitions */

#define SysTick_LOAD_RELOAD_Pos             0
/*!< SysTick LOAD: RELOAD Position */

#define SysTick_LOAD_RELOAD_Msk            (0xFFFFFFUL << SysTick_LOAD_RELOAD_Pos)
/*!< SysTick LOAD: RELOAD Mask */


/* SysTick Current Register Definitions */

#define SysTick_VAL_CURRENT_Pos             0
/*!< SysTick VAL: CURRENT Position */

#define SysTick_VAL_CURRENT_Msk            (0xFFFFFFUL << SysTick_VAL_CURRENT_Pos)
/*!< SysTick VAL: CURRENT Mask */


/* SysTick Calibration Register Definitions */

#define SysTick_CALIB_NOREF_Pos            31
/*!< SysTick CALIB: NOREF Position */

#define SysTick_CALIB_NOREF_Msk            (1UL << SysTick_CALIB_NOREF_Pos)
/*!< SysTick CALIB: NOREF Mask */


#define SysTick_CALIB_SKEW_Pos             30
/*!< SysTick CALIB: SKEW Position */

#define SysTick_CALIB_SKEW_Msk             (1UL << SysTick_CALIB_SKEW_Pos)
/*!< SysTick CALIB: SKEW Mask */
```

```
#define SysTick_CALIB_TENMS_Pos             0
/*!< SysTick CALIB: TENMS Position */

#define SysTick_CALIB_TENMS_Msk            (0xFFFFFFUL << SysTick_VAL_CURRENT_Pos)
/*!< SysTick CALIB: TENMS Mask */


/*@} end of group CMSIS_SysTick */



/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_ITM CMSIS ITM

  Type definitions for the Cortex-M Instrumentation Trace Macrocell (ITM)

  @{

 */


/** \brief  Structure type to access the Instrumentation Trace Macrocell Register (ITM).

 */

typedef struct

{

  __O  union

  {

    __O  uint8_t    u8;                 /*!< Offset: 0x000 ( /W)  ITM Stimulus Port 8-
bit                   */

    __O  uint16_t   u16;                /*!< Offset: 0x000 ( /W)  ITM Stimulus Port 16-
bit                  */

    __O  uint32_t   u32;                /*!< Offset: 0x000 ( /W)  ITM Stimulus Port 32-
bit                  */

  }  PORT [32];                         /*!< Offset: 0x000 ( /W)  ITM Stimulus Port
Registers               */

       uint32_t RESERVED0[864];

  __IO uint32_t TER;                    /*!< Offset:       (R/W)  ITM Trace Enable
Register                */

       uint32_t RESERVED1[15];

  __IO uint32_t TPR;                    /*!< Offset:       (R/W)  ITM Trace Privilege
Register              */

       uint32_t RESERVED2[15];

  __IO uint32_t TCR;                    /*!< Offset:       (R/W)  ITM Trace Control
Register               */

       uint32_t RESERVED3[29];

  __IO uint32_t IWR;                    /*!< Offset:       (R/W)  ITM Integration Write
Register            */

  __IO uint32_t IRR;                    /*!< Offset:       (R/W)  ITM Integration Read
Register             */

  __IO uint32_t IMCR;                   /*!< Offset:       (R/W)  ITM Integration Mode
Control Register     */

       uint32_t RESERVED4[43];
```

```
  __IO uint32_t LAR;                    /*!< Offset:       (R/W)  ITM Lock Access
Register                  */

  __IO uint32_t LSR;                    /*!< Offset:       (R/W)  ITM Lock Status
Register                  */

       uint32_t RESERVED5[6];

  __I  uint32_t PID4;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #4 */

  __I  uint32_t PID5;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #5 */

  __I  uint32_t PID6;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #6 */

  __I  uint32_t PID7;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #7 */

  __I  uint32_t PID0;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #0 */

  __I  uint32_t PID1;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #1 */

  __I  uint32_t PID2;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #2 */

  __I  uint32_t PID3;                   /*!< Offset:       (R/ )  ITM Peripheral
Identification Register #3 */

  __I  uint32_t CID0;                   /*!< Offset:       (R/ )  ITM Component
Identification Register #0 */

  __I  uint32_t CID1;                   /*!< Offset:       (R/ )  ITM Component
Identification Register #1 */

  __I  uint32_t CID2;                   /*!< Offset:       (R/ )  ITM Component
Identification Register #2 */

  __I  uint32_t CID3;                   /*!< Offset:       (R/ )  ITM Component
Identification Register #3 */

} ITM_Type;


/* ITM Trace Privilege Register Definitions */

#define ITM_TPR_PRIVMASK_Pos                0
/*!< ITM TPR: PRIVMASK Position */

#define ITM_TPR_PRIVMASK_Msk               (0xFUL << ITM_TPR_PRIVMASK_Pos)
/*!< ITM TPR: PRIVMASK Mask */


/* ITM Trace Control Register Definitions */

#define ITM_TCR_BUSY_Pos                   23
/*!< ITM TCR: BUSY Position */

#define ITM_TCR_BUSY_Msk                   (1UL << ITM_TCR_BUSY_Pos)
/*!< ITM TCR: BUSY Mask */


#define ITM_TCR_ATBID_Pos                  16
/*!< ITM TCR: ATBID Position */

#define ITM_TCR_ATBID_Msk                  (0x7FUL << ITM_TCR_ATBID_Pos)
/*!< ITM TCR: ATBID Mask */
```

```
#define ITM_TCR_TSPrescale_Pos              8
/*!< ITM TCR: TSPrescale Position */

#define ITM_TCR_TSPrescale_Msk             (3UL << ITM_TCR_TSPrescale_Pos)
/*!< ITM TCR: TSPrescale Mask */


#define ITM_TCR_SWOENA_Pos                  4
/*!< ITM TCR: SWOENA Position */

#define ITM_TCR_SWOENA_Msk                 (1UL << ITM_TCR_SWOENA_Pos)
/*!< ITM TCR: SWOENA Mask */


#define ITM_TCR_DWTENA_Pos                  3
/*!< ITM TCR: DWTENA Position */

#define ITM_TCR_DWTENA_Msk                 (1UL << ITM_TCR_DWTENA_Pos)
/*!< ITM TCR: DWTENA Mask */


#define ITM_TCR_SYNCENA_Pos                 2
/*!< ITM TCR: SYNCENA Position */

#define ITM_TCR_SYNCENA_Msk                (1UL << ITM_TCR_SYNCENA_Pos)
/*!< ITM TCR: SYNCENA Mask */


#define ITM_TCR_TSENA_Pos                   1
/*!< ITM TCR: TSENA Position */

#define ITM_TCR_TSENA_Msk                  (1UL << ITM_TCR_TSENA_Pos)
/*!< ITM TCR: TSENA Mask */


#define ITM_TCR_ITMENA_Pos                  0
/*!< ITM TCR: ITM Enable bit Position */

#define ITM_TCR_ITMENA_Msk                 (1UL << ITM_TCR_ITMENA_Pos)
/*!< ITM TCR: ITM Enable bit Mask */


/* ITM Integration Write Register Definitions */

#define ITM_IWR_ATVALIDM_Pos                0
/*!< ITM IWR: ATVALIDM Position */

#define ITM_IWR_ATVALIDM_Msk               (1UL << ITM_IWR_ATVALIDM_Pos)
/*!< ITM IWR: ATVALIDM Mask */


/* ITM Integration Read Register Definitions */

#define ITM_IRR_ATREADYM_Pos                0
/*!< ITM IRR: ATREADYM Position */

#define ITM_IRR_ATREADYM_Msk               (1UL << ITM_IRR_ATREADYM_Pos)
/*!< ITM IRR: ATREADYM Mask */


/* ITM Integration Mode Control Register Definitions */

#define ITM_IMCR_INTEGRATION_Pos            0
/*!< ITM IMCR: INTEGRATION Position */

#define ITM_IMCR_INTEGRATION_Msk           (1UL << ITM_IMCR_INTEGRATION_Pos)
/*!< ITM IMCR: INTEGRATION Mask */
```

```
/* ITM Lock Status Register Definitions */

#define ITM_LSR_ByteAcc_Pos                 2
/*!< ITM LSR: ByteAcc Position */

#define ITM_LSR_ByteAcc_Msk                (1UL << ITM_LSR_ByteAcc_Pos)
/*!< ITM LSR: ByteAcc Mask */


#define ITM_LSR_Access_Pos                  1
/*!< ITM LSR: Access Position */

#define ITM_LSR_Access_Msk                 (1UL << ITM_LSR_Access_Pos)
/*!< ITM LSR: Access Mask */


#define ITM_LSR_Present_Pos                 0
/*!< ITM LSR: Present Position */

#define ITM_LSR_Present_Msk                (1UL << ITM_LSR_Present_Pos)
/*!< ITM LSR: Present Mask */


/*@}*/ /* end of group CMSIS_ITM */



/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_InterruptType CMSIS Interrupt Type

  Type definitions for the Cortex-M Interrupt Type Register

  @{

 */


/** \brief  Structure type to access the Interrupt Type Register.

 */

typedef struct

{

       uint32_t RESERVED0;

  __I  uint32_t ICTR;                   /*!< Offset: 0x004 (R/ )  Interrupt Control
Type Register */

#if ((defined __CM3_REV) && (__CM3_REV >= 0x200))

  __IO uint32_t ACTLR;                  /*!< Offset: 0x008 (R/W)  Auxiliary Control
Register      */

#else

       uint32_t RESERVED1;

#endif

} InterruptType_Type;


/* Interrupt Controller Type Register Definitions */
```

```
#define IntType_ICTR_INTLINESNUM_Pos  0
/*!< InterruptType ICTR: INTLINESNUM Position */

#define IntType_ICTR_INTLINESNUM_Msk (0x1FUL << IntType_ICTR_INTLINESNUM_Pos)
/*!< InterruptType ICTR: INTLINESNUM Mask */


/* Auxiliary Control Register Definitions */

#define IntType_ACTLR_DISFOLD_Pos     2
/*!< InterruptType ACTLR: DISFOLD Position */

#define IntType_ACTLR_DISFOLD_Msk    (1UL << IntType_ACTLR_DISFOLD_Pos)
/*!< InterruptType ACTLR: DISFOLD Mask */


#define IntType_ACTLR_DISDEFWBUF_Pos  1
/*!< InterruptType ACTLR: DISDEFWBUF Position */

#define IntType_ACTLR_DISDEFWBUF_Msk (1UL << IntType_ACTLR_DISDEFWBUF_Pos)
/*!< InterruptType ACTLR: DISDEFWBUF Mask */


#define IntType_ACTLR_DISMCYCINT_Pos  0
/*!< InterruptType ACTLR: DISMCYCINT Position */

#define IntType_ACTLR_DISMCYCINT_Msk (1UL << IntType_ACTLR_DISMCYCINT_Pos)
/*!< InterruptType ACTLR: DISMCYCINT Mask */


/*@}*/ /* end of group CMSIS_InterruptType */




#if (__MPU_PRESENT == 1)

/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_MPU CMSIS MPU

  Type definitions for the Cortex-M Memory Protection Unit (MPU)

  @{

 */


/** \brief  Structure type to access the Memory Protection Unit (MPU).

 */

typedef struct

{

   __I  uint32_t TYPE;                   /*!< Offset: 0x000 (R/ )  MPU Type Register
*/

   __IO uint32_t CTRL;                   /*!< Offset: 0x004 (R/W)  MPU Control Register
*/

   __IO uint32_t RNR;                    /*!< Offset: 0x008 (R/W)  MPU Region RNRber
Register                      */

   __IO uint32_t RBAR;                   /*!< Offset: 0x00C (R/W)  MPU Region Base
Address Register               */

   __IO uint32_t RASR;                   /*!< Offset: 0x010 (R/W)  MPU Region Attribute
and Size Register         */
```

```
  __IO uint32_t RBAR_A1;                /*!< Offset: 0x014 (R/W)  MPU Alias 1 Region
Base Address Register       */

  __IO uint32_t RASR_A1;                /*!< Offset: 0x018 (R/W)  MPU Alias 1 Region
Attribute and Size Register */

  __IO uint32_t RBAR_A2;                /*!< Offset: 0x01C (R/W)  MPU Alias 2 Region
Base Address Register       */

  __IO uint32_t RASR_A2;                /*!< Offset: 0x020 (R/W)  MPU Alias 2 Region
Attribute and Size Register */

  __IO uint32_t RBAR_A3;                /*!< Offset: 0x024 (R/W)  MPU Alias 3 Region
Base Address Register       */

  __IO uint32_t RASR_A3;                /*!< Offset: 0x028 (R/W)  MPU Alias 3 Region
Attribute and Size Register */

} MPU_Type;


/* MPU Type Register */

#define MPU_TYPE_IREGION_Pos               16
/*!< MPU TYPE: IREGION Position */

#define MPU_TYPE_IREGION_Msk               (0xFFUL << MPU_TYPE_IREGION_Pos)
/*!< MPU TYPE: IREGION Mask */


#define MPU_TYPE_DREGION_Pos                8
/*!< MPU TYPE: DREGION Position */

#define MPU_TYPE_DREGION_Msk               (0xFFUL << MPU_TYPE_DREGION_Pos)
/*!< MPU TYPE: DREGION Mask */


#define MPU_TYPE_SEPARATE_Pos               0
/*!< MPU TYPE: SEPARATE Position */

#define MPU_TYPE_SEPARATE_Msk              (1UL << MPU_TYPE_SEPARATE_Pos)
/*!< MPU TYPE: SEPARATE Mask */


/* MPU Control Register */

#define MPU_CTRL_PRIVDEFENA_Pos             2
/*!< MPU CTRL: PRIVDEFENA Position */

#define MPU_CTRL_PRIVDEFENA_Msk            (1UL << MPU_CTRL_PRIVDEFENA_Pos)
/*!< MPU CTRL: PRIVDEFENA Mask */


#define MPU_CTRL_HFNMIENA_Pos               1
/*!< MPU CTRL: HFNMIENA Position */

#define MPU_CTRL_HFNMIENA_Msk              (1UL << MPU_CTRL_HFNMIENA_Pos)
/*!< MPU CTRL: HFNMIENA Mask */


#define MPU_CTRL_ENABLE_Pos                 0
/*!< MPU CTRL: ENABLE Position */

#define MPU_CTRL_ENABLE_Msk                (1UL << MPU_CTRL_ENABLE_Pos)
/*!< MPU CTRL: ENABLE Mask */


/* MPU Region Number Register */
```

```
#define MPU_RNR_REGION_Pos                 0
/*!< MPU RNR: REGION Position */

#define MPU_RNR_REGION_Msk                 (0xFFUL << MPU_RNR_REGION_Pos)
/*!< MPU RNR: REGION Mask */


/* MPU Region Base Address Register */

#define MPU_RBAR_ADDR_Pos                  5
/*!< MPU RBAR: ADDR Position */

#define MPU_RBAR_ADDR_Msk                  (0x7FFFFFFUL << MPU_RBAR_ADDR_Pos)
/*!< MPU RBAR: ADDR Mask */


#define MPU_RBAR_VALID_Pos                 4
/*!< MPU RBAR: VALID Position */

#define MPU_RBAR_VALID_Msk                 (1UL << MPU_RBAR_VALID_Pos)
/*!< MPU RBAR: VALID Mask */


#define MPU_RBAR_REGION_Pos                0
/*!< MPU RBAR: REGION Position */

#define MPU_RBAR_REGION_Msk                (0xFUL << MPU_RBAR_REGION_Pos)
/*!< MPU RBAR: REGION Mask */


/* MPU Region Attribute and Size Register */

#define MPU_RASR_XN_Pos                    28
/*!< MPU RASR: XN Position */

#define MPU_RASR_XN_Msk                    (1UL << MPU_RASR_XN_Pos)
/*!< MPU RASR: XN Mask */


#define MPU_RASR_AP_Pos                    24
/*!< MPU RASR: AP Position */

#define MPU_RASR_AP_Msk                    (7UL << MPU_RASR_AP_Pos)
/*!< MPU RASR: AP Mask */


#define MPU_RASR_TEX_Pos                   19
/*!< MPU RASR: TEX Position */

#define MPU_RASR_TEX_Msk                   (7UL << MPU_RASR_TEX_Pos)
/*!< MPU RASR: TEX Mask */


#define MPU_RASR_S_Pos                     18
/*!< MPU RASR: Shareable bit Position */

#define MPU_RASR_S_Msk                     (1UL << MPU_RASR_S_Pos)
/*!< MPU RASR: Shareable bit Mask */


#define MPU_RASR_C_Pos                     17
/*!< MPU RASR: Cacheable bit Position */

#define MPU_RASR_C_Msk                     (1UL << MPU_RASR_C_Pos)
/*!< MPU RASR: Cacheable bit Mask */
```

```
#define MPU_RASR_B_Pos                      16
/*!< MPU RASR: Bufferable bit Position */

#define MPU_RASR_B_Msk                      (1UL << MPU_RASR_B_Pos)
/*!< MPU RASR: Bufferable bit Mask */



#define MPU_RASR_SRD_Pos                     8
/*!< MPU RASR: Sub-Region Disable Position */

#define MPU_RASR_SRD_Msk                    (0xFFUL << MPU_RASR_SRD_Pos)
/*!< MPU RASR: Sub-Region Disable Mask */



#define MPU_RASR_SIZE_Pos                    1
/*!< MPU RASR: Region Size Field Position */

#define MPU_RASR_SIZE_Msk                   (0x1FUL << MPU_RASR_SIZE_Pos)
/*!< MPU RASR: Region Size Field Mask */



#define MPU_RASR_ENA_Pos                     0
/*!< MPU RASR: Region enable bit Position */

#define MPU_RASR_ENA_Msk                    (0x1UL << MPU_RASR_ENA_Pos)
/*!< MPU RASR: Region enable bit Disable Mask */



/*@} end of group CMSIS_MPU */

#endif




/** \ingroup  CMSIS_core_register

    \defgroup CMSIS_CoreDebug CMSIS Core Debug

  Type definitions for the Cortex-M Core Debug Registers

  @{

 */



/** \brief  Structure type to access the Core Debug Register (CoreDebug).

 */

typedef struct

{

  __IO uint32_t DHCSR;                  /*!< Offset: 0x000 (R/W)  Debug Halting Control
and Status Register    */

  __O  uint32_t DCRSR;                  /*!< Offset: 0x004 ( /W)  Debug Core Register
Selector Register        */

  __IO uint32_t DCRDR;                  /*!< Offset: 0x008 (R/W)  Debug Core Register
Data Register            */

  __IO uint32_t DEMCR;                  /*!< Offset: 0x00C (R/W)  Debug Exception and
Monitor Control Register */

} CoreDebug_Type;



/* Debug Halting Control and Status Register */
```

```
#define CoreDebug_DHCSR_DBGKEY_Pos         16
/*!< CoreDebug DHCSR: DBGKEY Position */

#define CoreDebug_DHCSR_DBGKEY_Msk         (0xFFFFUL << CoreDebug_DHCSR_DBGKEY_Pos)
/*!< CoreDebug DHCSR: DBGKEY Mask */


#define CoreDebug_DHCSR_S_RESET_ST_Pos     25
/*!< CoreDebug DHCSR: S_RESET_ST Position */

#define CoreDebug_DHCSR_S_RESET_ST_Msk     (1UL << CoreDebug_DHCSR_S_RESET_ST_Pos)
/*!< CoreDebug DHCSR: S_RESET_ST Mask */


#define CoreDebug_DHCSR_S_RETIRE_ST_Pos    24
/*!< CoreDebug DHCSR: S_RETIRE_ST Position */

#define CoreDebug_DHCSR_S_RETIRE_ST_Msk    (1UL << CoreDebug_DHCSR_S_RETIRE_ST_Pos)
/*!< CoreDebug DHCSR: S_RETIRE_ST Mask */


#define CoreDebug_DHCSR_S_LOCKUP_Pos       19
/*!< CoreDebug DHCSR: S_LOCKUP Position */

#define CoreDebug_DHCSR_S_LOCKUP_Msk       (1UL << CoreDebug_DHCSR_S_LOCKUP_Pos)
/*!< CoreDebug DHCSR: S_LOCKUP Mask */


#define CoreDebug_DHCSR_S_SLEEP_Pos        18
/*!< CoreDebug DHCSR: S_SLEEP Position */

#define CoreDebug_DHCSR_S_SLEEP_Msk        (1UL << CoreDebug_DHCSR_S_SLEEP_Pos)
/*!< CoreDebug DHCSR: S_SLEEP Mask */


#define CoreDebug_DHCSR_S_HALT_Pos         17
/*!< CoreDebug DHCSR: S_HALT Position */

#define CoreDebug_DHCSR_S_HALT_Msk         (1UL << CoreDebug_DHCSR_S_HALT_Pos)
/*!< CoreDebug DHCSR: S_HALT Mask */


#define CoreDebug_DHCSR_S_REGRDY_Pos       16
/*!< CoreDebug DHCSR: S_REGRDY Position */

#define CoreDebug_DHCSR_S_REGRDY_Msk       (1UL << CoreDebug_DHCSR_S_REGRDY_Pos)
/*!< CoreDebug DHCSR: S_REGRDY Mask */


#define CoreDebug_DHCSR_C_SNAPSTALL_Pos     5
/*!< CoreDebug DHCSR: C_SNAPSTALL Position */

#define CoreDebug_DHCSR_C_SNAPSTALL_Msk    (1UL << CoreDebug_DHCSR_C_SNAPSTALL_Pos)
/*!< CoreDebug DHCSR: C_SNAPSTALL Mask */


#define CoreDebug_DHCSR_C_MASKINTS_Pos      3
/*!< CoreDebug DHCSR: C_MASKINTS Position */

#define CoreDebug_DHCSR_C_MASKINTS_Msk     (1UL << CoreDebug_DHCSR_C_MASKINTS_Pos)
/*!< CoreDebug DHCSR: C_MASKINTS Mask */


#define CoreDebug_DHCSR_C_STEP_Pos          2
/*!< CoreDebug DHCSR: C_STEP Position */
```

```
#define CoreDebug_DHCSR_C_STEP_Msk         (1UL << CoreDebug_DHCSR_C_STEP_Pos)
/*!< CoreDebug DHCSR: C_STEP Mask */


#define CoreDebug_DHCSR_C_HALT_Pos          1
/*!< CoreDebug DHCSR: C_HALT Position */

#define CoreDebug_DHCSR_C_HALT_Msk         (1UL << CoreDebug_DHCSR_C_HALT_Pos)
/*!< CoreDebug DHCSR: C_HALT Mask */


#define CoreDebug_DHCSR_C_DEBUGEN_Pos       0
/*!< CoreDebug DHCSR: C_DEBUGEN Position */

#define CoreDebug_DHCSR_C_DEBUGEN_Msk      (1UL << CoreDebug_DHCSR_C_DEBUGEN_Pos)
/*!< CoreDebug DHCSR: C_DEBUGEN Mask */


/* Debug Core Register Selector Register */

#define CoreDebug_DCRSR_REGWnR_Pos         16
/*!< CoreDebug DCRSR: REGWnR Position */

#define CoreDebug_DCRSR_REGWnR_Msk         (1UL << CoreDebug_DCRSR_REGWnR_Pos)
/*!< CoreDebug DCRSR: REGWnR Mask */


#define CoreDebug_DCRSR_REGSEL_Pos          0
/*!< CoreDebug DCRSR: REGSEL Position */

#define CoreDebug_DCRSR_REGSEL_Msk         (0x1FUL << CoreDebug_DCRSR_REGSEL_Pos)
/*!< CoreDebug DCRSR: REGSEL Mask */


/* Debug Exception and Monitor Control Register */

#define CoreDebug_DEMCR_TRCENA_Pos         24
/*!< CoreDebug DEMCR: TRCENA Position */

#define CoreDebug_DEMCR_TRCENA_Msk         (1UL << CoreDebug_DEMCR_TRCENA_Pos)
/*!< CoreDebug DEMCR: TRCENA Mask */


#define CoreDebug_DEMCR_MON_REQ_Pos        19
/*!< CoreDebug DEMCR: MON_REQ Position */

#define CoreDebug_DEMCR_MON_REQ_Msk        (1UL << CoreDebug_DEMCR_MON_REQ_Pos)
/*!< CoreDebug DEMCR: MON_REQ Mask */


#define CoreDebug_DEMCR_MON_STEP_Pos       18
/*!< CoreDebug DEMCR: MON_STEP Position */

#define CoreDebug_DEMCR_MON_STEP_Msk       (1UL << CoreDebug_DEMCR_MON_STEP_Pos)
/*!< CoreDebug DEMCR: MON_STEP Mask */


#define CoreDebug_DEMCR_MON_PEND_Pos       17
/*!< CoreDebug DEMCR: MON_PEND Position */

#define CoreDebug_DEMCR_MON_PEND_Msk       (1UL << CoreDebug_DEMCR_MON_PEND_Pos)
/*!< CoreDebug DEMCR: MON_PEND Mask */


#define CoreDebug_DEMCR_MON_EN_Pos         16
/*!< CoreDebug DEMCR: MON_EN Position */
```

```
#define CoreDebug_DEMCR_MON_EN_Msk         (1UL << CoreDebug_DEMCR_MON_EN_Pos)
/*!< CoreDebug DEMCR: MON_EN Mask */


#define CoreDebug_DEMCR_VC_HARDERR_Pos     10
/*!< CoreDebug DEMCR: VC_HARDERR Position */

#define CoreDebug_DEMCR_VC_HARDERR_Msk     (1UL << CoreDebug_DEMCR_VC_HARDERR_Pos)
/*!< CoreDebug DEMCR: VC_HARDERR Mask */


#define CoreDebug_DEMCR_VC_INTERR_Pos       9
/*!< CoreDebug DEMCR: VC_INTERR Position */

#define CoreDebug_DEMCR_VC_INTERR_Msk      (1UL << CoreDebug_DEMCR_VC_INTERR_Pos)
/*!< CoreDebug DEMCR: VC_INTERR Mask */


#define CoreDebug_DEMCR_VC_BUSERR_Pos       8
/*!< CoreDebug DEMCR: VC_BUSERR Position */

#define CoreDebug_DEMCR_VC_BUSERR_Msk      (1UL << CoreDebug_DEMCR_VC_BUSERR_Pos)
/*!< CoreDebug DEMCR: VC_BUSERR Mask */


#define CoreDebug_DEMCR_VC_STATERR_Pos      7
/*!< CoreDebug DEMCR: VC_STATERR Position */

#define CoreDebug_DEMCR_VC_STATERR_Msk     (1UL << CoreDebug_DEMCR_VC_STATERR_Pos)
/*!< CoreDebug DEMCR: VC_STATERR Mask */


#define CoreDebug_DEMCR_VC_CHKERR_Pos       6
/*!< CoreDebug DEMCR: VC_CHKERR Position */

#define CoreDebug_DEMCR_VC_CHKERR_Msk      (1UL << CoreDebug_DEMCR_VC_CHKERR_Pos)
/*!< CoreDebug DEMCR: VC_CHKERR Mask */


#define CoreDebug_DEMCR_VC_NOCPERR_Pos      5
/*!< CoreDebug DEMCR: VC_NOCPERR Position */

#define CoreDebug_DEMCR_VC_NOCPERR_Msk     (1UL << CoreDebug_DEMCR_VC_NOCPERR_Pos)
/*!< CoreDebug DEMCR: VC_NOCPERR Mask */


#define CoreDebug_DEMCR_VC_MMERR_Pos        4
/*!< CoreDebug DEMCR: VC_MMERR Position */

#define CoreDebug_DEMCR_VC_MMERR_Msk       (1UL << CoreDebug_DEMCR_VC_MMERR_Pos)
/*!< CoreDebug DEMCR: VC_MMERR Mask */


#define CoreDebug_DEMCR_VC_CORERESET_Pos    0
/*!< CoreDebug DEMCR: VC_CORERESET Position */

#define CoreDebug_DEMCR_VC_CORERESET_Msk   (1UL << CoreDebug_DEMCR_VC_CORERESET_Pos)
/*!< CoreDebug DEMCR: VC_CORERESET Mask */


/*@} end of group CMSIS_CoreDebug */



/** \ingroup  CMSIS_core_register
```

```
  @{
 */


/* Memory mapping of Cortex-M3 Hardware */
#define SCS_BASE            (0xE000E000UL)                            /*!< System
Control Space Base Address */
#define ITM_BASE            (0xE0000000UL)                            /*!< ITM Base
Address                  */
#define CoreDebug_BASE      (0xE000EDF0UL)                            /*!< Core Debug
Base Address           */
#define SysTick_BASE        (SCS_BASE +  0x0010UL)                    /*!< SysTick Base
Address              */
#define NVIC_BASE           (SCS_BASE +  0x0100UL)                    /*!< NVIC Base
Address                 */
#define SCB_BASE            (SCS_BASE +  0x0D00UL)                    /*!< System
Control Block Base Address */


#define InterruptType       ((InterruptType_Type *) SCS_BASE)         /*!< Interrupt
Type Register           */
#define SCB                 ((SCB_Type *)           SCB_BASE)         /*!< SCB
configuration struct          */
#define SysTick             ((SysTick_Type *)       SysTick_BASE)     /*!< SysTick
configuration struct      */
#define NVIC                ((NVIC_Type *)          NVIC_BASE)        /*!< NVIC
configuration struct         */
#define ITM                 ((ITM_Type *)           ITM_BASE)         /*!< ITM
configuration struct          */
#define CoreDebug           ((CoreDebug_Type *)     CoreDebug_BASE)   /*!< Core Debug
configuration struct   */


#if (__MPU_PRESENT == 1)
  #define MPU_BASE          (SCS_BASE +  0x0D90UL)                    /*!< Memory
Protection Unit            */
  #define MPU               ((MPU_Type*)            MPU_BASE)         /*!< Memory
Protection Unit            */
#endif


/*@} */




/*******************************************************************************
 *                Hardware Abstraction Layer
 ******************************************************************************/
/** \ingroup  CMSIS
  \addtogroup CMSIS_Core_FunctionInterface CMSIS Core Function Interface
```

```
  Core Function Interface contains:
  - Core NVIC Functions
  - Core SysTick Functions
  - Core Debug Functions
  - Core Register Access Functions
*/




/* ##########################   NVIC functions  #################################### */
/** \ingroup  CMSIS_Core_FunctionInterface
    \defgroup CMSIS_Core_NVICFunctions CMSIS Core NVIC Functions
  @{
 */
/** @addtogroup CMSIS_Core_NVICFunctions
 * @{
 */
/** \brief  Set Priority Grouping

  This function sets the priority grouping field using the required unlock sequence.
  The parameter PriorityGroup is assigned to the field SCB->AIRCR [10:8] PRIGROUP field.
  Only values from 0..7 are used.
  In case of a conflict between priority grouping and available
  priority bits (__NVIC_PRIO_BITS) the smallest possible priority group is set.

    \param [in]      PriorityGroup  Priority grouping field
 */
static __INLINE void NVIC_SetPriorityGrouping(uint32_t PriorityGroup)
{
  uint32_t reg_value;
  uint32_t PriorityGroupTmp = (PriorityGroup & 0x07);                          /* only
values 0..7 are used          */


  reg_value  =  SCB->AIRCR;                                                    /* read
old register configuration    */
  reg_value &= ~(SCB_AIRCR_VECTKEY_Msk | SCB_AIRCR_PRIGROUP_Msk);              /* clear
bits to change               */
  reg_value  =  (reg_value                        |
                (0x5FA << SCB_AIRCR_VECTKEY_Pos) |
                (PriorityGroupTmp << 8));                                      /* Insert
write key and priorty group */
```

```
  SCB->AIRCR =  reg_value;
}



/** \brief  Get Priority Grouping

  This function gets the priority grouping from NVIC Interrupt Controller.
  Priority grouping is SCB->AIRCR [10:8] PRIGROUP field.

    \return                Priority grouping field
 */
static __INLINE uint32_t NVIC_GetPriorityGrouping(void)
{
  return ((SCB->AIRCR & SCB_AIRCR_PRIGROUP_Msk) >> SCB_AIRCR_PRIGROUP_Pos);   /* read
priority grouping field */
}



/** \brief  Enable External Interrupt

    This function enables a device specific interupt in the NVIC interrupt controller.
    The interrupt number cannot be a negative value.

    \param [in]      IRQn  Number of the external interrupt to enable
 */
static __INLINE void NVIC_EnableIRQ(IRQn_Type IRQn)
{
  NVIC->ISER[((uint32_t)(IRQn) >> 5)] = (1 << ((uint32_t)(IRQn) & 0x1F)); /* enable
interrupt */
}



/** \brief  Disable External Interrupt

    This function disables a device specific interupt in the NVIC interrupt controller.
    The interrupt number cannot be a negative value.

    \param [in]      IRQn  Number of the external interrupt to disable
 */
static __INLINE void NVIC_DisableIRQ(IRQn_Type IRQn)
```

```
{
  NVIC->ICER[((uint32_t)(IRQn) >> 5)] = (1 << ((uint32_t)(IRQn) & 0x1F)); /* disable
interrupt */
}



/** \brief  Get Pending Interrupt

    This function reads the pending register in the NVIC and returns the pending bit
    for the specified interrupt.

    \param [in]      IRQn  Number of the interrupt for get pending
    \return             0  Interrupt status is not pending
    \return             1  Interrupt status is pending
 */
static __INLINE uint32_t NVIC_GetPendingIRQ(IRQn_Type IRQn)
{
  return((uint32_t) ((NVIC->ISPR[(uint32_t)(IRQn) >> 5] & (1 << ((uint32_t)(IRQn) &
0x1F)))?1:0)); /* Return 1 if pending else 0 */
}



/** \brief  Set Pending Interrupt

    This function sets the pending bit for the specified interrupt.
    The interrupt number cannot be a negative value.

    \param [in]      IRQn  Number of the interrupt for set pending
 */
static __INLINE void NVIC_SetPendingIRQ(IRQn_Type IRQn)
{
  NVIC->ISPR[((uint32_t)(IRQn) >> 5)] = (1 << ((uint32_t)(IRQn) & 0x1F)); /* set
interrupt pending */
}



/** \brief  Clear Pending Interrupt

    This function clears the pending bit for the specified interrupt.
    The interrupt number cannot be a negative value.
```

```
    \param [in]      IRQn  Number of the interrupt for clear pending
 */
static __INLINE void NVIC_ClearPendingIRQ(IRQn_Type IRQn)
{
  NVIC->ICPR[((uint32_t)(IRQn) >> 5)] = (1 << ((uint32_t)(IRQn) & 0x1F)); /* Clear
pending interrupt */
}



/** \brief  Get Active Interrupt

    This function reads the active register in NVIC and returns the active bit.
    \param [in]      IRQn  Number of the interrupt for get active
    \return             0  Interrupt status is not active
    \return             1  Interrupt status is active
 */
static __INLINE uint32_t NVIC_GetActive(IRQn_Type IRQn)
{
  return((uint32_t)((NVIC->IABR[(uint32_t)(IRQn) >> 5] & (1 << ((uint32_t)(IRQn) &
0x1F)))?1:0)); /* Return 1 if active else 0 */
}



/** \brief  Set Interrupt Priority

    This function sets the priority for the specified interrupt. The interrupt
    number can be positive to specify an external (device specific)
    interrupt, or negative to specify an internal (core) interrupt.

    Note: The priority cannot be set for every core interrupt.

    \param [in]      IRQn  Number of the interrupt for set priority
    \param [in]  priority  Priority to set
 */
static __INLINE void NVIC_SetPriority(IRQn_Type IRQn, uint32_t priority)
{
  if(IRQn < 0) {
    SCB->SHP[((uint32_t)(IRQn) & 0xF)-4] = ((priority << (8 - __NVIC_PRIO_BITS)) &
0xff); } /* set Priority for Cortex-M  System Interrupts */
  else {
```

```
    NVIC->IP[(uint32_t)(IRQn)] = ((priority << (8 - __NVIC_PRIO_BITS)) & 0xff);    }
/* set Priority for device specific Interrupts  */

}



/** \brief  Get Interrupt Priority

    This function reads the priority for the specified interrupt. The interrupt

    number can be positive to specify an external (device specific)

    interrupt, or negative to specify an internal (core) interrupt.

    The returned priority value is automatically aligned to the implemented

    priority bits of the microcontroller.

    \param [in]   IRQn  Number of the interrupt for get priority

    \return             Interrupt Priority

 */

static __INLINE uint32_t NVIC_GetPriority(IRQn_Type IRQn)

{


  if(IRQn < 0) {

    return((uint32_t)(SCB->SHP[((uint32_t)(IRQn) & 0xF)-4] >> (8 - __NVIC_PRIO_BITS)));
} /* get priority for Cortex-M  system interrupts */

  else {

    return((uint32_t)(NVIC->IP[(uint32_t)(IRQn)]           >> (8 - __NVIC_PRIO_BITS)));
} /* get priority for device specific interrupts  */

}



/** \brief  Encode Priority

    This function encodes the priority for an interrupt with the given priority group,

    preemptive priority value and sub priority value.

    In case of a conflict between priority grouping and available

    priority bits (__NVIC_PRIO_BITS) the samllest possible priority group is set.

    The returned priority value can be used for NVIC_SetPriority(...) function

    \param [in]     PriorityGroup  Used priority group

    \param [in]   PreemptPriority  Preemptive priority value (starting from 0)

    \param [in]       SubPriority  Sub priority value (starting from 0)
```

```
    \return                         Encoded priority for the interrupt
 */
static __INLINE uint32_t NVIC_EncodePriority (uint32_t PriorityGroup, uint32_t
PreemptPriority, uint32_t SubPriority)
{
  uint32_t PriorityGroupTmp = (PriorityGroup & 0x07);          /* only values 0..7 are
used          */
  uint32_t PreemptPriorityBits;
  uint32_t SubPriorityBits;

  PreemptPriorityBits = ((7 - PriorityGroupTmp) > __NVIC_PRIO_BITS) ? __NVIC_PRIO_BITS :
7 - PriorityGroupTmp;
  SubPriorityBits     = ((PriorityGroupTmp + __NVIC_PRIO_BITS) < 7) ? 0 :
PriorityGroupTmp - 7 + __NVIC_PRIO_BITS;

  return (
           ((PreemptPriority & ((1 << (PreemptPriorityBits)) - 1)) << SubPriorityBits) |
           ((SubPriority     & ((1 << (SubPriorityBits    )) - 1)))
         );
}

/** \brief  Decode Priority

    This function decodes an interrupt priority value with the given priority group to
    preemptive priority value and sub priority value.
    In case of a conflict between priority grouping and available
    priority bits (__NVIC_PRIO_BITS) the samllest possible priority group is set.

    The priority value can be retrieved with NVIC_GetPriority(...) function

    \param [in]         Priority   Priority value
    \param [in]     PriorityGroup  Used priority group
    \param [out] pPreemptPriority  Preemptive priority value (starting from 0)
    \param [out]     pSubPriority  Sub priority value (starting from 0)
 */
static __INLINE void NVIC_DecodePriority (uint32_t Priority, uint32_t PriorityGroup,
uint32_t* pPreemptPriority, uint32_t* pSubPriority)
{
  uint32_t PriorityGroupTmp = (PriorityGroup & 0x07);          /* only values 0..7 are
used          */
  uint32_t PreemptPriorityBits;
```

```
  uint32_t SubPriorityBits;


  PreemptPriorityBits = ((7 - PriorityGroupTmp) > __NVIC_PRIO_BITS) ? __NVIC_PRIO_BITS :
7 - PriorityGroupTmp;

  SubPriorityBits     = ((PriorityGroupTmp + __NVIC_PRIO_BITS) < 7) ? 0 :
PriorityGroupTmp - 7 + __NVIC_PRIO_BITS;


  *pPreemptPriority = (Priority >> SubPriorityBits) & ((1 << (PreemptPriorityBits)) -
1);

  *pSubPriority     = (Priority                   ) & ((1 << (SubPriorityBits    )) -
1);

}




/** \brief  System Reset


    This function initiate a system reset request to reset the MCU.

 */

static __INLINE void NVIC_SystemReset(void)

{

  __DSB();                                                          /* Ensure all outstanding
memory accesses included

                                                                       buffered write are
completed before reset */

  SCB->AIRCR  = ((0x5FA << SCB_AIRCR_VECTKEY_Pos)      |

                 (SCB->AIRCR & SCB_AIRCR_PRIGROUP_Msk) |

                 SCB_AIRCR_SYSRESETREQ_Msk);                    /* Keep priority group
unchanged */

  __DSB();                                                          /* Ensure completion of
memory access */

  while(1);                                                         /* wait until reset */

}


/*@} end of CMSIS_Core_NVICFunctions */




/**

 * @}

 */

/* ##################################    SysTick function
############################################ */

/** \ingroup  CMSIS_Core_FunctionInterface

    \defgroup CMSIS_Core_SysTickFunctions CMSIS Core SysTick Functions
```

```
  @{
 */
/** @addtogroup CMSIS_Core_SysTickFunctions
 * @{
 */
#if (__Vendor_SysTickConfig == 0)

/** \brief  System Tick Configuration

    This function initialises the system tick timer and its interrupt and start the
system tick timer.
    Counter is in free running mode to generate periodical interrupts.

    \param [in]  ticks  Number of ticks between two interrupts
    \return          0  Function succeeded
    \return          1  Function failed
 */
static __INLINE uint32_t SysTick_Config(uint32_t ticks)
{
  if (ticks > SysTick_LOAD_RELOAD_Msk)  return (1);            /* Reload value
impossible */

  SysTick->LOAD  = (ticks & SysTick_LOAD_RELOAD_Msk) - 1;      /* set reload register */
  NVIC_SetPriority (SysTick_IRQn, (1<<__NVIC_PRIO_BITS) - 1);  /* set Priority for
Cortex-M0 System Interrupts */
  SysTick->VAL   = 0;                                          /* Load the SysTick
Counter Value */
  SysTick->CTRL  = SysTick_CTRL_CLKSOURCE_Msk |
                   SysTick_CTRL_TICKINT_Msk   |
                   SysTick_CTRL_ENABLE_Msk;                    /* Enable SysTick IRQ and
SysTick Timer */
  return (0);                                                  /* Function successful */
}

#endif

/*@} end of CMSIS_Core_SysTickFunctions */

/**
 * @}
 */
```

```
/* ################################### Debug In/Output function
########################################### */

/** \ingroup  CMSIS_Core_FunctionInterface

    \defgroup CMSIS_core_DebugFunctions CMSIS Core Debug Functions

  @{

 */


extern volatile int32_t ITM_RxBuffer;                    /*!< external variable to
receive characters                    */

#define                 ITM_RXBUFFER_EMPTY    0x5AA55AA5 /*!< value identifying
ITM_RxBuffer is ready for next character */




/** \brief  ITM Send Character


    This function transmits a character via the ITM channel 0.

    It just returns when no debugger is connected that has booked the output.

    It is blocking when a debugger is connected, but the previous character send is not
transmitted.


    \param [in]     ch  Character to transmit

    \return             Character to transmit

 */

static __INLINE uint32_t ITM_SendChar (uint32_t ch)

{

  if ((CoreDebug->DEMCR & CoreDebug_DEMCR_TRCENA_Msk)  &&      /* Trace enabled */

      (ITM->TCR & ITM_TCR_ITMENA_Msk)                  &&      /* ITM enabled */

      (ITM->TER & (1UL << 0)        )                    )     /* ITM Port #0 enabled */

  {

    while (ITM->PORT[0].u32 == 0);

    ITM->PORT[0].u8 = (uint8_t) ch;

  }

  return (ch);

}



/** \brief  ITM Receive Character


    This function inputs a character via external variable ITM_RxBuffer.

    It just returns when no debugger is connected that has booked the output.
```

```
    It is blocking when a debugger is connected, but the previous character send is not
transmitted.

    \return             Received character
    \return         -1  No character received
 */
static __INLINE int32_t ITM_ReceiveChar (void) {
  int32_t ch = -1;                           /* no character available */

  if (ITM_RxBuffer != ITM_RXBUFFER_EMPTY) {
    ch = ITM_RxBuffer;
    ITM_RxBuffer = ITM_RXBUFFER_EMPTY;       /* ready for next character */
  }

  return (ch);
}


/** \brief  ITM Check Character

    This function checks external variable ITM_RxBuffer whether a character is available
or not.
    It returns '1' if a character is available and '0' if no character is available.

    \return          0  No character available
    \return          1  Character available
 */
static __INLINE int32_t ITM_CheckChar (void) {

  if (ITM_RxBuffer == ITM_RXBUFFER_EMPTY) {
    return (0);                                 /* no character available */
  } else {
    return (1);                                 /*    character available */
  }
}

/*@} end of CMSIS_core_DebugFunctions */
/**
 * @}
 */
```

```
#endif /* __CORE_CM3_H_DEPENDANT */

#endif /* __CMSIS_GENERIC */

#ifdef __cplusplus
}
#endif

/*lint -restore */


/**************************************************************************//**
 * @file     LPC17xx.h
 * @brief    CMSIS Cortex-M3 Core Peripheral Access Layer Header File for
 *           NXP LPC17xx Device Series
 * @version: V1.09
 * @date:    25. July. 2011
 *
 * @note
 * Copyright (C) 2009 ARM Limited. All rights reserved.
 *
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 *
 ******************************************************************************/


#ifndef __LPC17xx_H__
#define __LPC17xx_H__
```

```
/*
 * ==========================================================================
 * ---------- Interrupt Number Definition -----------------------------------
 * ==========================================================================
 */

/** @addtogroup LPC17xx_System
 * @{
 */

/** @brief IRQ interrupt source definition */
typedef enum IRQn
{
/******  Cortex-M3 Processor Exceptions Numbers
***********************************************/
  NonMaskableInt_IRQn           = -14,      /*!< 2 Non Maskable Interrupt
*/
  MemoryManagement_IRQn         = -12,      /*!< 4 Cortex-M3 Memory Management Interrupt
*/
  BusFault_IRQn                 = -11,      /*!< 5 Cortex-M3 Bus Fault Interrupt
*/
  UsageFault_IRQn               = -10,      /*!< 6 Cortex-M3 Usage Fault Interrupt
*/
  SVCall_IRQn                   = -5,       /*!< 11 Cortex-M3 SV Call Interrupt
*/
  DebugMonitor_IRQn             = -4,       /*!< 12 Cortex-M3 Debug Monitor Interrupt
*/
  PendSV_IRQn                   = -2,       /*!< 14 Cortex-M3 Pend SV Interrupt
*/
  SysTick_IRQn                  = -1,       /*!< 15 Cortex-M3 System Tick Interrupt
*/

/******  LPC17xx Specific Interrupt Numbers
***********************************************/
  WDT_IRQn                      = 0,        /*!< Watchdog Timer Interrupt
*/
  TIMER0_IRQn                   = 1,        /*!< Timer0 Interrupt
*/
  TIMER1_IRQn                   = 2,        /*!< Timer1 Interrupt
*/
  TIMER2_IRQn                   = 3,        /*!< Timer2 Interrupt
*/
  TIMER3_IRQn                   = 4,        /*!< Timer3 Interrupt
*/
  UART0_IRQn                    = 5,        /*!< UART0 Interrupt
*/
```

```
  UART1_IRQn                    = 6,        /*!< UART1 Interrupt
*/

  UART2_IRQn                    = 7,        /*!< UART2 Interrupt
*/

  UART3_IRQn                    = 8,        /*!< UART3 Interrupt
*/

  PWM1_IRQn                     = 9,        /*!< PWM1 Interrupt
*/

  I2C0_IRQn                     = 10,       /*!< I2C0 Interrupt
*/

  I2C1_IRQn                     = 11,       /*!< I2C1 Interrupt
*/

  I2C2_IRQn                     = 12,       /*!< I2C2 Interrupt
*/

  SPI_IRQn                      = 13,       /*!< SPI Interrupt
*/

  SSP0_IRQn                     = 14,       /*!< SSP0 Interrupt
*/

  SSP1_IRQn                     = 15,       /*!< SSP1 Interrupt
*/

  PLL0_IRQn                     = 16,       /*!< PLL0 Lock (Main PLL) Interrupt
*/

  RTC_IRQn                      = 17,       /*!< Real Time Clock Interrupt
*/

  EINT0_IRQn                    = 18,       /*!< External Interrupt 0 Interrupt
*/

  EINT1_IRQn                    = 19,       /*!< External Interrupt 1 Interrupt
*/

  EINT2_IRQn                    = 20,       /*!< External Interrupt 2 Interrupt
*/

  EINT3_IRQn                    = 21,       /*!< External Interrupt 3 Interrupt
*/

  ADC_IRQn                      = 22,       /*!< A/D Converter Interrupt
*/

  BOD_IRQn                      = 23,       /*!< Brown-Out Detect Interrupt
*/

  USB_IRQn                      = 24,       /*!< USB Interrupt
*/

  CAN_IRQn                      = 25,       /*!< CAN Interrupt
*/

  DMA_IRQn                      = 26,       /*!< General Purpose DMA Interrupt
*/

  I2S_IRQn                      = 27,       /*!< I2S Interrupt
*/

  ENET_IRQn                     = 28,       /*!< Ethernet Interrupt
*/

  RIT_IRQn                      = 29,       /*!< Repetitive Interrupt Timer Interrupt
*/

  MCPWM_IRQn                    = 30,       /*!< Motor Control PWM Interrupt
*/
```

```
  QEI_IRQn                      = 31,       /*!< Quadrature Encoder Interface Interrupt
*/
  PLL1_IRQn                     = 32,       /*!< PLL1 Lock (USB PLL) Interrupt
*/
  USBActivity_IRQn                          = 33,          /*!< USB Activity Interrupt
                                */
  CANActivity_IRQn                          = 34           /*!< CAN Activity Interrupt
                                */
} IRQn_Type;



/*
 * ==========================================================================
 * ----------- Processor and Core Peripheral Section ------------------------
 * ==========================================================================
 */


/* Configuration of the Cortex-M3 Processor and Core Peripherals */
#define __MPU_PRESENT             1         /*!< MPU present or not
*/
#define __NVIC_PRIO_BITS          5         /*!< Number of Bits used for Priority Levels
*/
#define __Vendor_SysTickConfig    0         /*!< Set to 1 if different SysTick Config is
used     */



#include "core_cm3.h"                       /* Cortex-M3 processor and core peripherals
*/
#include "system_LPC17xx.h"                 /* System Header
*/



/******************************************************************************/
/*                Device Specific Peripheral registers structures             */
/******************************************************************************/


#if defined ( __CC_ARM   )
#pragma anon_unions
#endif


/*------------- System Control (SC) ------------------------------------------*/
/** @brief System Control (SC) register structure definition */
typedef struct
```

```
{
  __IO uint32_t FLASHCFG;               /* Flash Accelerator Module           */
       uint32_t RESERVED0[31];
  __IO uint32_t PLL0CON;                /* Clocking and Power Control         */
  __IO uint32_t PLL0CFG;
  __I  uint32_t PLL0STAT;
  __O  uint32_t PLL0FEED;
       uint32_t RESERVED1[4];
  __IO uint32_t PLL1CON;
  __IO uint32_t PLL1CFG;
  __I  uint32_t PLL1STAT;
  __O  uint32_t PLL1FEED;
       uint32_t RESERVED2[4];
  __IO uint32_t PCON;
  __IO uint32_t PCONP;
       uint32_t RESERVED3[15];
  __IO uint32_t CCLKCFG;
  __IO uint32_t USBCLKCFG;
  __IO uint32_t CLKSRCSEL;
  __IO uint32_t       CANSLEEPCLR;
  __IO uint32_t       CANWAKEFLAGS;
       uint32_t RESERVED4[10];
  __IO uint32_t EXTINT;                 /* External Interrupts                */
       uint32_t RESERVED5;
  __IO uint32_t EXTMODE;
  __IO uint32_t EXTPOLAR;
       uint32_t RESERVED6[12];
  __IO uint32_t RSID;                   /* Reset                              */
       uint32_t RESERVED7[7];
  __IO uint32_t SCS;                    /* Syscon Miscellaneous Registers     */
  __IO uint32_t IRCTRIM;                /* Clock Dividers                     */
  __IO uint32_t PCLKSEL0;
  __IO uint32_t PCLKSEL1;
       uint32_t RESERVED8[4];
  __IO uint32_t USBIntSt;               /* USB Device/OTG Interrupt Register  */
  __IO uint32_t DMAREQSEL;
  __IO uint32_t CLKOUTCFG;              /* Clock Output Configuration         */
} LPC_SC_TypeDef;
```

```
/*------------- Pin Connect Block (PINCON) -----------------------------------*/
/** @brief Pin Connect Block (PINCON) register structure definition */
typedef struct
{
  __IO uint32_t PINSEL0;
  __IO uint32_t PINSEL1;
  __IO uint32_t PINSEL2;
  __IO uint32_t PINSEL3;
  __IO uint32_t PINSEL4;
  __IO uint32_t PINSEL5;
  __IO uint32_t PINSEL6;
  __IO uint32_t PINSEL7;
  __IO uint32_t PINSEL8;
  __IO uint32_t PINSEL9;
  __IO uint32_t PINSEL10;
       uint32_t RESERVED0[5];
  __IO uint32_t PINMODE0;
  __IO uint32_t PINMODE1;
  __IO uint32_t PINMODE2;
  __IO uint32_t PINMODE3;
  __IO uint32_t PINMODE4;
  __IO uint32_t PINMODE5;
  __IO uint32_t PINMODE6;
  __IO uint32_t PINMODE7;
  __IO uint32_t PINMODE8;
  __IO uint32_t PINMODE9;
  __IO uint32_t PINMODE_OD0;
  __IO uint32_t PINMODE_OD1;
  __IO uint32_t PINMODE_OD2;
  __IO uint32_t PINMODE_OD3;
  __IO uint32_t PINMODE_OD4;
  __IO uint32_t I2CPADCFG;
} LPC_PINCON_TypeDef;

/*------------- General Purpose Input/Output (GPIO) --------------------------*/
/** @brief General Purpose Input/Output (GPIO) register structure definition */
typedef struct
{
  union {
```

```
    __IO uint32_t FIODIR;
    struct {
      __IO uint16_t FIODIRL;
      __IO uint16_t FIODIRH;
    };
    struct {
      __IO uint8_t  FIODIR0;
      __IO uint8_t  FIODIR1;
      __IO uint8_t  FIODIR2;
      __IO uint8_t  FIODIR3;
    };
  };
  uint32_t RESERVED0[3];
  union {
    __IO uint32_t FIOMASK;
    struct {
      __IO uint16_t FIOMASKL;
      __IO uint16_t FIOMASKH;
    };
    struct {
      __IO uint8_t  FIOMASK0;
      __IO uint8_t  FIOMASK1;
      __IO uint8_t  FIOMASK2;
      __IO uint8_t  FIOMASK3;
    };
  };
  union {
    __IO uint32_t FIOPIN;
    struct {
      __IO uint16_t FIOPINL;
      __IO uint16_t FIOPINH;
    };
    struct {
      __IO uint8_t  FIOPIN0;
      __IO uint8_t  FIOPIN1;
      __IO uint8_t  FIOPIN2;
      __IO uint8_t  FIOPIN3;
    };
  };
```

```
  union {
    __IO uint32_t FIOSET;
    struct {
      __IO uint16_t FIOSETL;
      __IO uint16_t FIOSETH;
    };
    struct {
      __IO uint8_t  FIOSET0;
      __IO uint8_t  FIOSET1;
      __IO uint8_t  FIOSET2;
      __IO uint8_t  FIOSET3;
    };
  };
  union {
    __O  uint32_t FIOCLR;
    struct {
      __O  uint16_t FIOCLRL;
      __O  uint16_t FIOCLRH;
    };
    struct {
      __O  uint8_t  FIOCLR0;
      __O  uint8_t  FIOCLR1;
      __O  uint8_t  FIOCLR2;
      __O  uint8_t  FIOCLR3;
    };
  };
} LPC_GPIO_TypeDef;


/** @brief General Purpose Input/Output interrupt (GPIOINT) register structure
definition */
typedef struct
{
  __I  uint32_t IntStatus;
  __I  uint32_t IO0IntStatR;
  __I  uint32_t IO0IntStatF;
  __O  uint32_t IO0IntClr;
  __IO uint32_t IO0IntEnR;
  __IO uint32_t IO0IntEnF;
       uint32_t RESERVED0[3];
  __I  uint32_t IO2IntStatR;
```

```
  __I  uint32_t IO2IntStatF;
  __O  uint32_t IO2IntClr;
  __IO uint32_t IO2IntEnR;
  __IO uint32_t IO2IntEnF;
} LPC_GPIOINT_TypeDef;

/*------------- Timer (TIM) ----------------------------------------------------*/
/** @brief Timer (TIM) register structure definition */
typedef struct
{
  __IO uint32_t IR;
  __IO uint32_t TCR;
  __IO uint32_t TC;
  __IO uint32_t PR;
  __IO uint32_t PC;
  __IO uint32_t MCR;
  __IO uint32_t MR0;
  __IO uint32_t MR1;
  __IO uint32_t MR2;
  __IO uint32_t MR3;
  __IO uint32_t CCR;
  __I  uint32_t CR0;
  __I  uint32_t CR1;
       uint32_t RESERVED0[2];
  __IO uint32_t EMR;
       uint32_t RESERVED1[12];
  __IO uint32_t CTCR;
} LPC_TIM_TypeDef;

/*------------- Pulse-Width Modulation (PWM) -----------------------------------*/
/** @brief Pulse-Width Modulation (PWM) register structure definition */
typedef struct
{
  __IO uint32_t IR;
  __IO uint32_t TCR;
  __IO uint32_t TC;
  __IO uint32_t PR;
  __IO uint32_t PC;
  __IO uint32_t MCR;
```

```
  __IO uint32_t MR0;
  __IO uint32_t MR1;
  __IO uint32_t MR2;
  __IO uint32_t MR3;
  __IO uint32_t CCR;
  __I  uint32_t CR0;
  __I  uint32_t CR1;
  __I  uint32_t CR2;
  __I  uint32_t CR3;
       uint32_t RESERVED0;
  __IO uint32_t MR4;
  __IO uint32_t MR5;
  __IO uint32_t MR6;
  __IO uint32_t PCR;
  __IO uint32_t LER;
       uint32_t RESERVED1[7];
  __IO uint32_t CTCR;
} LPC_PWM_TypeDef;


/*------------- Universal Asynchronous Receiver Transmitter (UART) -----------*/
/** @brief  Universal Asynchronous Receiver Transmitter (UART) register structure
definition */
typedef struct
{
  union {
  __I  uint8_t  RBR;
  __O  uint8_t  THR;
  __IO uint8_t  DLL;
       uint32_t RESERVED0;
  };
  union {
  __IO uint8_t  DLM;
  __IO uint32_t IER;
  };
  union {
  __I  uint32_t IIR;
  __O  uint8_t  FCR;
  };
  __IO uint8_t  LCR;
       uint8_t  RESERVED1[7];
```

```
  __I  uint8_t  LSR;
       uint8_t  RESERVED2[7];
  __IO uint8_t  SCR;
       uint8_t  RESERVED3[3];
  __IO uint32_t ACR;
  __IO uint8_t  ICR;
       uint8_t  RESERVED4[3];
  __IO uint8_t  FDR;
       uint8_t  RESERVED5[7];
  __IO uint8_t  TER;
       uint8_t  RESERVED6[39];
  __I  uint8_t  FIFOLVL;
} LPC_UART_TypeDef;


/** @brief  Universal Asynchronous Receiver Transmitter 0 (UART0) register structure
definition */
typedef struct
{
  union {
  __I  uint8_t  RBR;
  __O  uint8_t  THR;
  __IO uint8_t  DLL;
       uint32_t RESERVED0;
  };
  union {
  __IO uint8_t  DLM;
  __IO uint32_t IER;
  };
  union {
  __I  uint32_t IIR;
  __O  uint8_t  FCR;
  };
  __IO uint8_t  LCR;
       uint8_t  RESERVED1[7];
  __I  uint8_t  LSR;
       uint8_t  RESERVED2[7];
  __IO uint8_t  SCR;
       uint8_t  RESERVED3[3];
  __IO uint32_t ACR;
  __IO uint8_t  ICR;
```

```
       uint8_t  RESERVED4[3];
  __IO uint8_t  FDR;
       uint8_t  RESERVED5[7];
  __IO uint8_t  TER;
       uint8_t  RESERVED6[39];
  __I  uint8_t  FIFOLVL;
} LPC_UART0_TypeDef;


/** @brief  Universal Asynchronous Receiver Transmitter 1 (UART1) register structure
definition */
typedef struct
{
  union {
  __I  uint8_t  RBR;
  __O  uint8_t  THR;
  __IO uint8_t  DLL;
       uint32_t RESERVED0;
  };
  union {
  __IO uint8_t  DLM;
  __IO uint32_t IER;
  };
  union {
  __I  uint32_t IIR;
  __O  uint8_t  FCR;
  };
  __IO uint8_t  LCR;
       uint8_t  RESERVED1[3];
  __IO uint8_t  MCR;
       uint8_t  RESERVED2[3];
  __I  uint8_t  LSR;
       uint8_t  RESERVED3[3];
  __I  uint8_t  MSR;
       uint8_t  RESERVED4[3];
  __IO uint8_t  SCR;
       uint8_t  RESERVED5[3];
  __IO uint32_t ACR;
       uint32_t RESERVED6;
  __IO uint32_t FDR;
       uint32_t RESERVED7;
```

```
  __IO uint8_t  TER;
       uint8_t  RESERVED8[27];
  __IO uint8_t  RS485CTRL;
       uint8_t  RESERVED9[3];
  __IO uint8_t  ADRMATCH;
       uint8_t  RESERVED10[3];
  __IO uint8_t  RS485DLY;
       uint8_t  RESERVED11[3];
  __I  uint8_t  FIFOLVL;
} LPC_UART1_TypeDef;

/*------------- Serial Peripheral Interface (SPI) ----------------------------*/
/** @brief  Serial Peripheral Interface (SPI) register structure definition */
typedef struct
{
  __IO uint32_t SPCR;
  __I  uint32_t SPSR;
  __IO uint32_t SPDR;
  __IO uint32_t SPCCR;
       uint32_t RESERVED0[3];
  __IO uint32_t SPINT;
} LPC_SPI_TypeDef;

/*------------- Synchronous Serial Communication (SSP) -----------------------*/
/** @brief  Synchronous Serial Communication (SSP) register structure definition */
typedef struct
{
  __IO uint32_t CR0;
  __IO uint32_t CR1;
  __IO uint32_t DR;
  __I  uint32_t SR;
  __IO uint32_t CPSR;
  __IO uint32_t IMSC;
  __IO uint32_t RIS;
  __IO uint32_t MIS;
  __IO uint32_t ICR;
  __IO uint32_t DMACR;
} LPC_SSP_TypeDef;
```

```
/*------------- Inter-Integrated Circuit (I2C) --------------------------------*/
/** @brief  Inter-Integrated Circuit (I2C) register structure definition */
typedef struct
{
  __IO uint32_t I2CONSET;
  __I  uint32_t I2STAT;
  __IO uint32_t I2DAT;
  __IO uint32_t I2ADR0;
  __IO uint32_t I2SCLH;
  __IO uint32_t I2SCLL;
  __O  uint32_t I2CONCLR;
  __IO uint32_t MMCTRL;
  __IO uint32_t I2ADR1;
  __IO uint32_t I2ADR2;
  __IO uint32_t I2ADR3;
  __I  uint32_t I2DATA_BUFFER;
  __IO uint32_t I2MASK0;
  __IO uint32_t I2MASK1;
  __IO uint32_t I2MASK2;
  __IO uint32_t I2MASK3;
} LPC_I2C_TypeDef;

/*------------- Inter IC Sound (I2S) ------------------------------------------*/
/** @brief  Inter IC Sound (I2S) register structure definition */
typedef struct
{
  __IO uint32_t I2SDAO;
  __IO uint32_t I2SDAI;
  __O  uint32_t I2STXFIFO;
  __I  uint32_t I2SRXFIFO;
  __I  uint32_t I2SSTATE;
  __IO uint32_t I2SDMA1;
  __IO uint32_t I2SDMA2;
  __IO uint32_t I2SIRQ;
  __IO uint32_t I2STXRATE;
  __IO uint32_t I2SRXRATE;
  __IO uint32_t I2STXBITRATE;
  __IO uint32_t I2SRXBITRATE;
  __IO uint32_t I2STXMODE;
```

```
  __IO uint32_t I2SRXMODE;
} LPC_I2S_TypeDef;

/*------------- Repetitive Interrupt Timer (RIT) -----------------------------*/
/** @brief  Repetitive Interrupt Timer (RIT) register structure definition */
typedef struct
{
  __IO uint32_t RICOMPVAL;
  __IO uint32_t RIMASK;
  __IO uint8_t  RICTRL;
       uint8_t  RESERVED0[3];
  __IO uint32_t RICOUNTER;
} LPC_RIT_TypeDef;

/*------------- Real-Time Clock (RTC) ----------------------------------------*/
/** @brief  Real-Time Clock (RTC) register structure definition */
typedef struct
{
  __IO uint8_t  ILR;
       uint8_t  RESERVED0[7];
  __IO uint8_t  CCR;
       uint8_t  RESERVED1[3];
  __IO uint8_t  CIIR;
       uint8_t  RESERVED2[3];
  __IO uint8_t  AMR;
       uint8_t  RESERVED3[3];
  __I  uint32_t CTIME0;
  __I  uint32_t CTIME1;
  __I  uint32_t CTIME2;
  __IO uint8_t  SEC;
       uint8_t  RESERVED4[3];
  __IO uint8_t  MIN;
       uint8_t  RESERVED5[3];
  __IO uint8_t  HOUR;
       uint8_t  RESERVED6[3];
  __IO uint8_t  DOM;
       uint8_t  RESERVED7[3];
  __IO uint8_t  DOW;
       uint8_t  RESERVED8[3];
```

```
  __IO uint16_t DOY;
       uint16_t RESERVED9;
  __IO uint8_t  MONTH;
       uint8_t  RESERVED10[3];
  __IO uint16_t YEAR;
       uint16_t RESERVED11;
  __IO uint32_t CALIBRATION;
  __IO uint32_t GPREG0;
  __IO uint32_t GPREG1;
  __IO uint32_t GPREG2;
  __IO uint32_t GPREG3;
  __IO uint32_t GPREG4;
  __IO uint8_t  RTC_AUXEN;
       uint8_t  RESERVED12[3];
  __IO uint8_t  RTC_AUX;
       uint8_t  RESERVED13[3];
  __IO uint8_t  ALSEC;
       uint8_t  RESERVED14[3];
  __IO uint8_t  ALMIN;
       uint8_t  RESERVED15[3];
  __IO uint8_t  ALHOUR;
       uint8_t  RESERVED16[3];
  __IO uint8_t  ALDOM;
       uint8_t  RESERVED17[3];
  __IO uint8_t  ALDOW;
       uint8_t  RESERVED18[3];
  __IO uint16_t ALDOY;
       uint16_t RESERVED19;
  __IO uint8_t  ALMON;
       uint8_t  RESERVED20[3];
  __IO uint16_t ALYEAR;
       uint16_t RESERVED21;
} LPC_RTC_TypeDef;

/*------------- Watchdog Timer (WDT) -----------------------------------------*/
/** @brief  Watchdog Timer (WDT) register structure definition */
typedef struct
{
  __IO uint8_t  WDMOD;
```

```
       uint8_t  RESERVED0[3];
  __IO uint32_t WDTC;
  __O  uint8_t  WDFEED;
       uint8_t  RESERVED1[3];
  __I  uint32_t WDTV;
  __IO uint32_t WDCLKSEL;
} LPC_WDT_TypeDef;


/*------------- Analog-to-Digital Converter (ADC) -----------------------------*/
/** @brief  Analog-to-Digital Converter (ADC) register structure definition */
typedef struct
{
  __IO uint32_t ADCR;
  __IO uint32_t ADGDR;
       uint32_t RESERVED0;
  __IO uint32_t ADINTEN;
  __I  uint32_t ADDR0;
  __I  uint32_t ADDR1;
  __I  uint32_t ADDR2;
  __I  uint32_t ADDR3;
  __I  uint32_t ADDR4;
  __I  uint32_t ADDR5;
  __I  uint32_t ADDR6;
  __I  uint32_t ADDR7;
  __I  uint32_t ADSTAT;
  __IO uint32_t ADTRM;
} LPC_ADC_TypeDef;


/*------------- Digital-to-Analog Converter (DAC) -----------------------------*/
/** @brief  Digital-to-Analog Converter (DAC) register structure definition */
typedef struct
{
  __IO uint32_t DACR;
  __IO uint32_t DACCTRL;
  __IO uint16_t DACCNTVAL;
} LPC_DAC_TypeDef;


/*------------- Motor Control Pulse-Width Modulation (MCPWM) ------------------*/
/** @brief  Motor Control Pulse-Width Modulation (MCPWM) register structure definition
*/
```

```
typedef struct
{
  __I  uint32_t MCCON;
  __O  uint32_t MCCON_SET;
  __O  uint32_t MCCON_CLR;
  __I  uint32_t MCCAPCON;
  __O  uint32_t MCCAPCON_SET;
  __O  uint32_t MCCAPCON_CLR;
  __IO uint32_t MCTIM0;
  __IO uint32_t MCTIM1;
  __IO uint32_t MCTIM2;
  __IO uint32_t MCPER0;
  __IO uint32_t MCPER1;
  __IO uint32_t MCPER2;
  __IO uint32_t MCPW0;
  __IO uint32_t MCPW1;
  __IO uint32_t MCPW2;
  __IO uint32_t MCDEADTIME;
  __IO uint32_t MCCCP;
  __IO uint32_t MCCR0;
  __IO uint32_t MCCR1;
  __IO uint32_t MCCR2;
  __I  uint32_t MCINTEN;
  __O  uint32_t MCINTEN_SET;
  __O  uint32_t MCINTEN_CLR;
  __I  uint32_t MCCNTCON;
  __O  uint32_t MCCNTCON_SET;
  __O  uint32_t MCCNTCON_CLR;
  __I  uint32_t MCINTFLAG;
  __O  uint32_t MCINTFLAG_SET;
  __O  uint32_t MCINTFLAG_CLR;
  __O  uint32_t MCCAP_CLR;
} LPC_MCPWM_TypeDef;

/*------------- Quadrature Encoder Interface (QEI) ----------------------------*/
/** @brief  Quadrature Encoder Interface (QEI) register structure definition */
typedef struct
{
  __O  uint32_t QEICON;
```

```
  __I  uint32_t QEISTAT;
  __IO uint32_t QEICONF;
  __I  uint32_t QEIPOS;
  __IO uint32_t QEIMAXPOS;
  __IO uint32_t CMPOS0;
  __IO uint32_t CMPOS1;
  __IO uint32_t CMPOS2;
  __I  uint32_t INXCNT;
  __IO uint32_t INXCMP;
  __IO uint32_t QEILOAD;
  __I  uint32_t QEITIME;
  __I  uint32_t QEIVEL;
  __I  uint32_t QEICAP;
  __IO uint32_t VELCOMP;
  __IO uint32_t FILTER;
       uint32_t RESERVED0[998];
  __O  uint32_t QEIIEC;
  __O  uint32_t QEIIES;
  __I  uint32_t QEIINTSTAT;
  __I  uint32_t QEIIE;
  __O  uint32_t QEICLR;
  __O  uint32_t QEISET;
} LPC_QEI_TypeDef;


/*------------- Controller Area Network (CAN) -----------------------------*/
/** @brief  Controller Area Network Acceptance Filter RAM (CANAF_RAM)structure
definition */
typedef struct
{
  __IO uint32_t mask[512];             /* ID Masks                          */
} LPC_CANAF_RAM_TypeDef;


/** @brief  Controller Area Network Acceptance Filter(CANAF) register structure
definition */
typedef struct                         /* Acceptance Filter Registers       */
{
  __IO uint32_t AFMR;
  __IO uint32_t SFF_sa;
  __IO uint32_t SFF_GRP_sa;
  __IO uint32_t EFF_sa;
```

```
  __IO uint32_t EFF_GRP_sa;
  __IO uint32_t ENDofTable;
  __I  uint32_t LUTerrAd;
  __I  uint32_t LUTerr;
  __IO uint32_t FCANIE;
  __IO uint32_t FCANIC0;
  __IO uint32_t FCANIC1;
} LPC_CANAF_TypeDef;

/** @brief  Controller Area Network Central (CANCR) register structure definition */
typedef struct                          /* Central Registers                    */
{
  __I  uint32_t CANTxSR;
  __I  uint32_t CANRxSR;
  __I  uint32_t CANMSR;
} LPC_CANCR_TypeDef;

/** @brief  Controller Area Network Controller (CAN) register structure definition */
typedef struct                          /* Controller Registers                 */
{
  __IO uint32_t MOD;
  __O  uint32_t CMR;
  __IO uint32_t GSR;
  __I  uint32_t ICR;
  __IO uint32_t IER;
  __IO uint32_t BTR;
  __IO uint32_t EWL;
  __I  uint32_t SR;
  __IO uint32_t RFS;
  __IO uint32_t RID;
  __IO uint32_t RDA;
  __IO uint32_t RDB;
  __IO uint32_t TFI1;
  __IO uint32_t TID1;
  __IO uint32_t TDA1;
  __IO uint32_t TDB1;
  __IO uint32_t TFI2;
  __IO uint32_t TID2;
  __IO uint32_t TDA2;
```

```
  __IO uint32_t TDB2;
  __IO uint32_t TFI3;
  __IO uint32_t TID3;
  __IO uint32_t TDA3;
  __IO uint32_t TDB3;
} LPC_CAN_TypeDef;


/*------------- General Purpose Direct Memory Access (GPDMA) -----------------*/
/** @brief  General Purpose Direct Memory Access (GPDMA) register structure definition
*/
typedef struct                          /* Common Registers                    */
{
  __I  uint32_t DMACIntStat;
  __I  uint32_t DMACIntTCStat;
  __O  uint32_t DMACIntTCClear;
  __I  uint32_t DMACIntErrStat;
  __O  uint32_t DMACIntErrClr;
  __I  uint32_t DMACRawIntTCStat;
  __I  uint32_t DMACRawIntErrStat;
  __I  uint32_t DMACEnbldChns;
  __IO uint32_t DMACSoftBReq;
  __IO uint32_t DMACSoftSReq;
  __IO uint32_t DMACSoftLBReq;
  __IO uint32_t DMACSoftLSReq;
  __IO uint32_t DMACConfig;
  __IO uint32_t DMACSync;
} LPC_GPDMA_TypeDef;


/** @brief  General Purpose Direct Memory Access Channel (GPDMACH) register structure
definition */
typedef struct                          /* Channel Registers                   */
{
  __IO uint32_t DMACCSrcAddr;
  __IO uint32_t DMACCDestAddr;
  __IO uint32_t DMACCLLI;
  __IO uint32_t DMACCControl;
  __IO uint32_t DMACCConfig;
} LPC_GPDMACH_TypeDef;


/*------------- Universal Serial Bus (USB) -----------------------------------*/
```

```
/** @brief  Universal Serial Bus (USB) register structure definition */
typedef struct
{
  __I  uint32_t HcRevision;             /* USB Host Registers                */
  __IO uint32_t HcControl;
  __IO uint32_t HcCommandStatus;
  __IO uint32_t HcInterruptStatus;
  __IO uint32_t HcInterruptEnable;
  __IO uint32_t HcInterruptDisable;
  __IO uint32_t HcHCCA;
  __I  uint32_t HcPeriodCurrentED;
  __IO uint32_t HcControlHeadED;
  __IO uint32_t HcControlCurrentED;
  __IO uint32_t HcBulkHeadED;
  __IO uint32_t HcBulkCurrentED;
  __I  uint32_t HcDoneHead;
  __IO uint32_t HcFmInterval;
  __I  uint32_t HcFmRemaining;
  __I  uint32_t HcFmNumber;
  __IO uint32_t HcPeriodicStart;
  __IO uint32_t HcLSTreshold;
  __IO uint32_t HcRhDescriptorA;
  __IO uint32_t HcRhDescriptorB;
  __IO uint32_t HcRhStatus;
  __IO uint32_t HcRhPortStatus1;
  __IO uint32_t HcRhPortStatus2;
       uint32_t RESERVED0[40];
  __I  uint32_t Module_ID;

  __I  uint32_t OTGIntSt;               /* USB On-The-Go Registers           */
  __IO uint32_t OTGIntEn;
  __O  uint32_t OTGIntSet;
  __O  uint32_t OTGIntClr;
  __IO uint32_t OTGStCtrl;
  __IO uint32_t OTGTmr;
       uint32_t RESERVED1[58];

  __I  uint32_t USBDevIntSt;            /* USB Device Interrupt Registers    */
  __IO uint32_t USBDevIntEn;
```

```
  __O  uint32_t USBDevIntClr;
  __O  uint32_t USBDevIntSet;

  __O  uint32_t USBCmdCode;            /* USB Device SIE Command Registers   */
  __I  uint32_t USBCmdData;

  __I  uint32_t USBRxData;             /* USB Device Transfer Registers      */
  __O  uint32_t USBTxData;
  __I  uint32_t USBRxPLen;
  __O  uint32_t USBTxPLen;
  __IO uint32_t USBCtrl;
  __O  uint32_t USBDevIntPri;

  __I  uint32_t USBEpIntSt;            /* USB Device Endpoint Interrupt Regs */
  __IO uint32_t USBEpIntEn;
  __O  uint32_t USBEpIntClr;
  __O  uint32_t USBEpIntSet;
  __O  uint32_t USBEpIntPri;

  __IO uint32_t USBReEp;               /* USB Device Endpoint Realization Reg*/
  __O  uint32_t USBEpInd;
  __IO uint32_t USBMaxPSize;

  __I  uint32_t USBDMARSt;             /* USB Device DMA Registers           */
  __O  uint32_t USBDMARClr;
  __O  uint32_t USBDMARSet;
       uint32_t RESERVED2[9];
  __IO uint32_t USBUDCAH;
  __I  uint32_t USBEpDMASt;
  __O  uint32_t USBEpDMAEn;
  __O  uint32_t USBEpDMADis;
  __I  uint32_t USBDMAIntSt;
  __IO uint32_t USBDMAIntEn;
       uint32_t RESERVED3[2];
  __I  uint32_t USBEoTIntSt;
  __O  uint32_t USBEoTIntClr;
  __O  uint32_t USBEoTIntSet;
  __I  uint32_t USBNDDRIntSt;
  __O  uint32_t USBNDDRIntClr;
```

```
  __O  uint32_t USBNDDRIntSet;
  __I  uint32_t USBSysErrIntSt;
  __O  uint32_t USBSysErrIntClr;
  __O  uint32_t USBSysErrIntSet;
       uint32_t RESERVED4[15];

  union {
  __I  uint32_t I2C_RX;                /* USB OTG I2C Registers             */
  __O  uint32_t I2C_TX;
  };
  __I  uint32_t I2C_STS;
  __IO uint32_t I2C_CTL;
  __IO uint32_t I2C_CLKHI;
  __O  uint32_t I2C_CLKLO;
       uint32_t RESERVED5[824];

  union {
  __IO uint32_t USBClkCtrl;            /* USB Clock Control Registers       */
  __IO uint32_t OTGClkCtrl;
  };
  union {
  __I  uint32_t USBClkSt;
  __I  uint32_t OTGClkSt;
  };
} LPC_USB_TypeDef;

/*------------- Ethernet Media Access Controller (EMAC) ----------------------*/
/** @brief  Ethernet Media Access Controller (EMAC) register structure definition */
typedef struct
{
  __IO uint32_t MAC1;                  /* MAC Registers                     */
  __IO uint32_t MAC2;
  __IO uint32_t IPGT;
  __IO uint32_t IPGR;
  __IO uint32_t CLRT;
  __IO uint32_t MAXF;
  __IO uint32_t SUPP;
  __IO uint32_t TEST;
  __IO uint32_t MCFG;
```

```
  __IO uint32_t MCMD;
  __IO uint32_t MADR;
  __O  uint32_t MWTD;
  __I  uint32_t MRDD;
  __I  uint32_t MIND;
       uint32_t RESERVED0[2];
  __IO uint32_t SA0;
  __IO uint32_t SA1;
  __IO uint32_t SA2;
       uint32_t RESERVED1[45];
  __IO uint32_t Command;                /* Control Registers                  */
  __I  uint32_t Status;
  __IO uint32_t RxDescriptor;
  __IO uint32_t RxStatus;
  __IO uint32_t RxDescriptorNumber;
  __I  uint32_t RxProduceIndex;
  __IO uint32_t RxConsumeIndex;
  __IO uint32_t TxDescriptor;
  __IO uint32_t TxStatus;
  __IO uint32_t TxDescriptorNumber;
  __IO uint32_t TxProduceIndex;
  __I  uint32_t TxConsumeIndex;
       uint32_t RESERVED2[10];
  __I  uint32_t TSV0;
  __I  uint32_t TSV1;
  __I  uint32_t RSV;
       uint32_t RESERVED3[3];
  __IO uint32_t FlowControlCounter;
  __I  uint32_t FlowControlStatus;
       uint32_t RESERVED4[34];
  __IO uint32_t RxFilterCtrl;           /* Rx Filter Registers                */
  __IO uint32_t RxFilterWoLStatus;
  __IO uint32_t RxFilterWoLClear;
       uint32_t RESERVED5;
  __IO uint32_t HashFilterL;
  __IO uint32_t HashFilterH;
       uint32_t RESERVED6[882];
  __I  uint32_t IntStatus;              /* Module Control Registers           */
  __IO uint32_t IntEnable;
```

```
  __O  uint32_t IntClear;
  __O  uint32_t IntSet;
       uint32_t RESERVED7;
  __IO uint32_t PowerDown;
       uint32_t RESERVED8;
  __IO uint32_t Module_ID;
} LPC_EMAC_TypeDef;


#if defined ( __CC_ARM   )
#pragma no_anon_unions
#endif


/*****************************************************************************/
/*                         Peripheral memory map                             */
/*****************************************************************************/
/* Base addresses                                                            */
#define LPC_FLASH_BASE        (0x00000000UL)
#define LPC_RAM_BASE          (0x10000000UL)
#ifdef __LPC17XX_REV00
#define LPC_AHBRAM0_BASE      (0x20000000UL)
#define LPC_AHBRAM1_BASE      (0x20004000UL)
#else
#define LPC_AHBRAM0_BASE      (0x2007C000UL)
#define LPC_AHBRAM1_BASE      (0x20080000UL)
#endif
#define LPC_GPIO_BASE         (0x2009C000UL)
#define LPC_APB0_BASE         (0x40000000UL)
#define LPC_APB1_BASE         (0x40080000UL)
#define LPC_AHB_BASE          (0x50000000UL)
#define LPC_CM3_BASE          (0xE0000000UL)

/* APB0 peripherals                                                          */
#define LPC_WDT_BASE          (LPC_APB0_BASE + 0x00000)
#define LPC_TIM0_BASE         (LPC_APB0_BASE + 0x04000)
#define LPC_TIM1_BASE         (LPC_APB0_BASE + 0x08000)
#define LPC_UART0_BASE        (LPC_APB0_BASE + 0x0C000)
#define LPC_UART1_BASE        (LPC_APB0_BASE + 0x10000)
```

```
#define LPC_PWM1_BASE         (LPC_APB0_BASE + 0x18000)
#define LPC_I2C0_BASE         (LPC_APB0_BASE + 0x1C000)
#define LPC_SPI_BASE          (LPC_APB0_BASE + 0x20000)
#define LPC_RTC_BASE          (LPC_APB0_BASE + 0x24000)
#define LPC_GPIOINT_BASE      (LPC_APB0_BASE + 0x28080)
#define LPC_PINCON_BASE       (LPC_APB0_BASE + 0x2C000)
#define LPC_SSP1_BASE         (LPC_APB0_BASE + 0x30000)
#define LPC_ADC_BASE          (LPC_APB0_BASE + 0x34000)
#define LPC_CANAF_RAM_BASE    (LPC_APB0_BASE + 0x38000)
#define LPC_CANAF_BASE        (LPC_APB0_BASE + 0x3C000)
#define LPC_CANCR_BASE        (LPC_APB0_BASE + 0x40000)
#define LPC_CAN1_BASE         (LPC_APB0_BASE + 0x44000)
#define LPC_CAN2_BASE         (LPC_APB0_BASE + 0x48000)
#define LPC_I2C1_BASE         (LPC_APB0_BASE + 0x5C000)

/* APB1 peripherals                                                   */
#define LPC_SSP0_BASE         (LPC_APB1_BASE + 0x08000)
#define LPC_DAC_BASE          (LPC_APB1_BASE + 0x0C000)
#define LPC_TIM2_BASE         (LPC_APB1_BASE + 0x10000)
#define LPC_TIM3_BASE         (LPC_APB1_BASE + 0x14000)
#define LPC_UART2_BASE        (LPC_APB1_BASE + 0x18000)
#define LPC_UART3_BASE        (LPC_APB1_BASE + 0x1C000)
#define LPC_I2C2_BASE         (LPC_APB1_BASE + 0x20000)
#define LPC_I2S_BASE          (LPC_APB1_BASE + 0x28000)
#define LPC_RIT_BASE          (LPC_APB1_BASE + 0x30000)
#define LPC_MCPWM_BASE        (LPC_APB1_BASE + 0x38000)
#define LPC_QEI_BASE          (LPC_APB1_BASE + 0x3C000)
#define LPC_SC_BASE           (LPC_APB1_BASE + 0x7C000)

/* AHB peripherals                                                    */
#define LPC_EMAC_BASE         (LPC_AHB_BASE  + 0x00000)
#define LPC_GPDMA_BASE        (LPC_AHB_BASE  + 0x04000)
#define LPC_GPDMACH0_BASE     (LPC_AHB_BASE  + 0x04100)
#define LPC_GPDMACH1_BASE     (LPC_AHB_BASE  + 0x04120)
#define LPC_GPDMACH2_BASE     (LPC_AHB_BASE  + 0x04140)
#define LPC_GPDMACH3_BASE     (LPC_AHB_BASE  + 0x04160)
#define LPC_GPDMACH4_BASE     (LPC_AHB_BASE  + 0x04180)
#define LPC_GPDMACH5_BASE     (LPC_AHB_BASE  + 0x041A0)
#define LPC_GPDMACH6_BASE     (LPC_AHB_BASE  + 0x041C0)
```

```
#define LPC_GPDMACH7_BASE     (LPC_AHB_BASE  + 0x041E0)
#define LPC_USB_BASE          (LPC_AHB_BASE  + 0x0C000)

/* GPIOs                                                                    */
#define LPC_GPIO0_BASE        (LPC_GPIO_BASE + 0x00000)
#define LPC_GPIO1_BASE        (LPC_GPIO_BASE + 0x00020)
#define LPC_GPIO2_BASE        (LPC_GPIO_BASE + 0x00040)
#define LPC_GPIO3_BASE        (LPC_GPIO_BASE + 0x00060)
#define LPC_GPIO4_BASE        (LPC_GPIO_BASE + 0x00080)

/*****************************************************************************/
/*                         Peripheral declaration                            */
/*****************************************************************************/
#define LPC_SC                ((LPC_SC_TypeDef        *) LPC_SC_BASE       )
#define LPC_GPIO0             ((LPC_GPIO_TypeDef      *) LPC_GPIO0_BASE    )
#define LPC_GPIO1             ((LPC_GPIO_TypeDef      *) LPC_GPIO1_BASE    )
#define LPC_GPIO2             ((LPC_GPIO_TypeDef      *) LPC_GPIO2_BASE    )
#define LPC_GPIO3             ((LPC_GPIO_TypeDef      *) LPC_GPIO3_BASE    )
#define LPC_GPIO4             ((LPC_GPIO_TypeDef      *) LPC_GPIO4_BASE    )
#define LPC_WDT               ((LPC_WDT_TypeDef       *) LPC_WDT_BASE      )
#define LPC_TIM0              ((LPC_TIM_TypeDef       *) LPC_TIM0_BASE     )
#define LPC_TIM1              ((LPC_TIM_TypeDef       *) LPC_TIM1_BASE     )
#define LPC_TIM2              ((LPC_TIM_TypeDef       *) LPC_TIM2_BASE     )
#define LPC_TIM3              ((LPC_TIM_TypeDef       *) LPC_TIM3_BASE     )
#define LPC_RIT               ((LPC_RIT_TypeDef       *) LPC_RIT_BASE      )
#define LPC_UART0             ((LPC_UART_TypeDef      *) LPC_UART0_BASE    )
#define LPC_UART1             ((LPC_UART1_TypeDef     *) LPC_UART1_BASE    )
#define LPC_UART2             ((LPC_UART_TypeDef      *) LPC_UART2_BASE    )
#define LPC_UART3             ((LPC_UART_TypeDef      *) LPC_UART3_BASE    )
#define LPC_PWM1              ((LPC_PWM_TypeDef       *) LPC_PWM1_BASE     )
#define LPC_I2C0              ((LPC_I2C_TypeDef       *) LPC_I2C0_BASE     )
#define LPC_I2C1              ((LPC_I2C_TypeDef       *) LPC_I2C1_BASE     )
#define LPC_I2C2              ((LPC_I2C_TypeDef       *) LPC_I2C2_BASE     )
#define LPC_I2S               ((LPC_I2S_TypeDef       *) LPC_I2S_BASE      )
#define LPC_SPI               ((LPC_SPI_TypeDef       *) LPC_SPI_BASE      )
#define LPC_RTC               ((LPC_RTC_TypeDef       *) LPC_RTC_BASE      )
#define LPC_GPIOINT           ((LPC_GPIOINT_TypeDef   *) LPC_GPIOINT_BASE  )
#define LPC_PINCON            ((LPC_PINCON_TypeDef    *) LPC_PINCON_BASE   )
#define LPC_SSP0              ((LPC_SSP_TypeDef       *) LPC_SSP0_BASE     )
```

```
#define LPC_SSP1              ((LPC_SSP_TypeDef       *) LPC_SSP1_BASE     )
#define LPC_ADC               ((LPC_ADC_TypeDef       *) LPC_ADC_BASE      )
#define LPC_DAC               ((LPC_DAC_TypeDef       *) LPC_DAC_BASE      )
#define LPC_CANAF_RAM         ((LPC_CANAF_RAM_TypeDef *) LPC_CANAF_RAM_BASE)
#define LPC_CANAF             ((LPC_CANAF_TypeDef     *) LPC_CANAF_BASE    )
#define LPC_CANCR             ((LPC_CANCR_TypeDef     *) LPC_CANCR_BASE    )
#define LPC_CAN1              ((LPC_CAN_TypeDef       *) LPC_CAN1_BASE     )
#define LPC_CAN2              ((LPC_CAN_TypeDef       *) LPC_CAN2_BASE     )
#define LPC_MCPWM             ((LPC_MCPWM_TypeDef     *) LPC_MCPWM_BASE    )
#define LPC_QEI               ((LPC_QEI_TypeDef       *) LPC_QEI_BASE      )
#define LPC_EMAC              ((LPC_EMAC_TypeDef      *) LPC_EMAC_BASE     )
#define LPC_GPDMA             ((LPC_GPDMA_TypeDef     *) LPC_GPDMA_BASE    )
#define LPC_GPDMACH0          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH0_BASE )
#define LPC_GPDMACH1          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH1_BASE )
#define LPC_GPDMACH2          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH2_BASE )
#define LPC_GPDMACH3          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH3_BASE )
#define LPC_GPDMACH4          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH4_BASE )
#define LPC_GPDMACH5          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH5_BASE )
#define LPC_GPDMACH6          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH6_BASE )
#define LPC_GPDMACH7          ((LPC_GPDMACH_TypeDef   *) LPC_GPDMACH7_BASE )
#define LPC_USB               ((LPC_USB_TypeDef       *) LPC_USB_BASE      )


/**
 * @}
 */


#endif  // __LPC17xx_H__


/**-------------------------------------------------------------------------------------
---------------------------------//
//             @filename             Systemsymbols.h
                                                                                    //
//             @version              0.00
       //
//             @author        Alberto Palomo Alonso
                                                                  //
//
       //
//             @brief         Este es el archivo donde son guardados los símbolos del
sistema utilizados para los                 //
```

```
//                                  diferentes archivos que necesiten una llamada a
este tipo de definiciones.                                  //
//
        //
//              @category           Esencial.
        //
//
        //
//              @map                @none
                                                                                    //
//                                  @types
                                                                                    //
//                                  @end
        //
//-------------------------------------------------------------------------------------
--------------------------------**/
#ifndef LPC17XX
#define LPC17XX
#include        "LPC17XX.H"
#endif
//      Acopladores de código.
#ifndef                 null
#define         null                            0
#endif
#ifndef         NULL
#define         NULL                            0
#endif
#define         none                            0
#define         NONE                            0
#define         VOID                            void
//      Símbolos prácticos de valores instantáneos.
#define         TODO_1_8                        0xFFFF
#define         TODO_1_16                       0xFFFFFFFF
#define         TODO_1_32                       0xFFFFFFFFFFFFFFFF
//      Símbolos correspondientes a definiciones propias para facilitar lectura de
código.
#define         SUBIDA                          1
#define         BAJADA                          0
#define         ALTO                                    1
#define         BAJO                                    0
#define         FLANCO                          1
```

```
#define        NIVEL                        0
#define        INICIALMENTE_ACTIVO   1
#define        INICIALMENTE_INACTIVO 0
#define        FUNC0                        0x0
#define        FUNC1                        0x1
#define        FUNC2                        0x2
#define        FUNC3                        0x3
#define               NOPIN                        0x00000000
#define               PIN_00                       0x00000001
#define               PIN_01                       0x00000002
#define               PIN_02                       0x00000004
#define               PIN_03                       0x00000008
#define               PIN_04                       0x00000010
#define               PIN_05                       0x00000020
#define               PIN_06                       0x00000040
#define               PIN_07                       0x00000080
#define               PIN_08                       0x00000100
#define               PIN_09                       0x00000200
#define               PIN_10                       0x00000400
#define               PIN_11                       0x00000800
#define               PIN_12                       0x00001000
#define               PIN_13                       0x00002000
#define               PIN_14                       0x00004000
#define               PIN_15                       0x00008000
#define               PIN_16                       0x00010000
#define               PIN_17                       0x00020000
#define               PIN_18                       0x00040000
#define               PIN_19                       0x00080000
#define               PIN_20                       0x00100000
#define               PIN_21                       0x00200000
#define               PIN_22                       0x00400000
#define               PIN_23                       0x00800000
#define               PIN_24                       0x01000000
#define               PIN_25                       0x02000000
#define               PIN_26                       0x04000000
#define               PIN_27                       0x08000000
#define               PIN_28                       0x10000000
#define               PIN_29                       0x20000000
#define               PIN_30                       0x40000000
```

```
#define               PIN_31                        0x80000000

//      Símbolos correspondientes a relojes del sistema.

#define         Fcpu                            100000000
        //      100MHz velocidad de la cpu.

#define         APBvalue                        4
        //      Valor del primer prescaler, 4 afer-reset.

#define         Prescaler                       0
        //      Valor del prescaler, 0 after-reset.

#define         Fclk                            (float)Fcpu/(float)APBvalue          //
        Valor del reloj prescalado por APB.

#define         Ftick                 Fclk/(float)(Prescaler+1)            //      Valor
del reloj asociado a los contadores.


#define         Ts0                             0.5
        //      Tiempo de muestreo en segundos sin prescaler. (Muestras)

#define         Fs0                             (float)1/(float)Ts0
        //      Frecuencia de muestreo en Hz. (Muestras)

#define         CsADC                 Fs0
        //      Frecuencia de muestreo del LDR.

#define         CsCAP                 10*Fs0                                       //
        Frecuencia de muestreo del UVA.


#define         FsAudio               8000
        //      3kHz de audio, Nyquist *= 2,  Yo *= 8khz.

#define         TsAudio               (float)1/(float)FsAudio                      //
        Periodo de muestreo del audio.

#define         DURACION_AUDIO        2
        //      2 segundos de audio.

#define         MUESTRAS_AUDIO        DURACION_AUDIO*FsAudio               //
        Muestras en los 2 segundos de audio.

#define         MUESTRAS_SENO         32

#define         LECTURA_AUDIO         25                    //     Pin que señaliza
lectura de audio.

#define         ESCRITURA_AUDIO       26                    //     Pin que señaliza
escritura de audio.


#define MAX_PRES              MODIFICABLES.Max_servo_p

#define MAX_TEMP              MODIFICABLES.Max_servo_t

#define MIN_PRES              MODIFICABLES.Min_servo_p

#define MIN_TEMP              MODIFICABLES.Min_servo_t


//      Constantes universales.

#define         PI                              3.141592

/**-------------------------------------------------------------------------------------
--------------------------------//

//
```

```
	//
                                                                        //
//		@types		Tipos utilizados para el programa.
                                                                        //
//
	//
//-------------------------------------------------------------------------------------
--------------------------------**/
typedef signed char                         int8_t;
typedef signed short int             int16_t;
typedef signed int                          int32_t;
typedef signed long long             int64_t;

typedef unsigned char                uint8_t;
typedef unsigned short int           uint16_t;
typedef unsigned       int           uint32_t;
typedef unsigned long long           uint64_t;

typedef        struct {                     //     Contadores de 8, 16 y 32 bits.
	__IO    uint8_t i;
	__IO    uint8_t j;
	__IO    uint16_t       k;
	__IO    uint32_t       Audio;
	__IO uint32_t  Segundos;
	__IO    uint32_t       RITicks;
}Counters_t;

typedef struct {
	uint8_t CHART;
}State_t;

typedef struct {
		float   Longitud;
		float   Latitud;
		float   Altura;
}locat_t;

typedef struct {
		float   Temperatura;   //     En grados celsius.
		float   Presion;             //     En pascales.
```

```
		float	Humedad;		//	En	%.
		float	IndiceUV;		//	En	UVs.
	locat_t Lugar;		//	Sitio donde el GPS nos posiciona.
		float	VelViento;	//	En	m/s.
		float	Brillo;		//	En	LUX.
}misDatos_t;

typedef struct {
	__IO uint8_t	Anemometro:1;
	__IO uint8_t	AnemometroRev:1;
	__IO uint8_t	LDR:1;
	__IO	uint8_t LDRrev:1;
	__IO	uint8_t UVA:1;
	__IO	uint8_t UVArev:1;
	__IO	uint8_t Audio:1;
	__IO	uint8_t Audiorev:1;
	__IO uint8_t	TempRev:1;
}actualizador_t;

typedef struct {
  uint32_t  source;		// Start of source area
  uint32_t  destination;// Start of destination area
  uint32_t  next;	// Address of next strLLI in chain
  uint32_t  control;	// DMACCxControl register
} DMA_t;

typedef struct {
	float	Max_servo_t;		//	Done
	float	Min_servo_t;		//	Done
	float	Max_servo_p;		//	Done
	float	Min_servo_p;		//	Done

	uint8_t Var_medida;		//	Done
	uint32_t	TiempoBrillo;		//	Done
}modificables_t;

/**-------------------------------------------------------------------------------------
---------------------------------//
//
	//
```

```
                                                                        //
//             @end           ENDFILE.
       //
//
       //
//-------------------------------------------------------------------------------------------
--------------------------------**/
```

Archivos extensión CGI.

```
t <!DOCTYPE html>
t  <html>
t   <head>
t    <meta content="text/html; charset=UTF-8" http-equiv="content-type">
#              ----------------------------------------------------------------------
------->       OJO QUE HAY QUE PONER LA URL CORRECTA:
t     <meta http-equiv="refresh" content="20; url=http://192.168.1.120/index.cgi">
t      <title>ESTACION METEOROLOGICA</title>
t       </head>
t        <body style="background-color:rgb(200,200,200);">
t          <h1 align="center">Estacion meteorologica</h1>
t           <br />
t           <table align="center" border="1">
t             <caption>Datos medios actuales:</caption>
t               <tr>
t                 <td>Temperatura:</td>
t                 <td>
c t               " %f
t                 </td>
t                 <td>Velocidad del viento:</td>
t                 <td>
c v               " %f
t                 </td>
t               </tr>
t               <tr>
t                 <td>Humedad:</td>
t                 <td>
c h               " %f
t                 </td>
t                 <td>Indice UV:</td>
t                 <td>
c i               " %f
t                 </td>
t               </tr>
t               <tr>
```

```
t                <td>Presion:</td>
t                <td>
c p              " %f
t                </td>
t                <td>Brillo:</td>
t                <td>
c b              " %f
t                </td>
t               </tr>
t           </table>
t           <table align="center" border="1">
t            <tr>
t            <td>Altitud:</td>
t            <td>
c a          " %f
t            </td>
t            <td>Longitud:</td>
t            <td>
c x          " %f
t            </td>
t            <td>Latitud:</td>
t            <td>
c y          " %f
t            </td>
t            </tr>
t           </table>
t           <br></br>
t           <table align="center" border="1">
t            <caption>Hora de la ultima muestra:</caption>
t            <tr>
t             <td>Anyo:</td>
t             <td>
c A           " %d
t             </td>
t             <td>Mes:</td>
t             <td>
c M           " %d
t             </td>
t             <td>Dia:</td>
```

```
t             <td>
c D           " %d
t             </td>
t            <tr>
t             <td>Hora:</td>
t             <td>
c H           " %d
t             </td>
t             <td>Minuto:</td>
t             <td>
c T           " %d
t             </td>
t             <td>Segundos:</td>
t             <td>
c S           " %d
t             </td>
t            </tr>
t           </table>
t           <br></br>
t           <br></br>
t           <table stile="width: 100%" border="1" align="center">
t            <tbody>
t             <tr>
t              <td>
t               <h1 style=" text-align: center;"> Magnitudes modificables: </h1>
t               <form method="GET" action="index.cgi">
t                <br> Temperatura min. :
t                <input size="10" value="-10" name="tmin" type="text">
t                <br> Temperatura max. :
t                <input size="10" value="50" name="tmax" type="text">
t                <br> Presion min. :
t                <input size="10" value="500" name="pmin" type="text">
t                <br> Presion max. :
t                <input size="10" value="1500" name="pmax" type="text">
t                <br> Segundos encendido :
t                <input size="10" value="10" name="bsec" type="text">
t                <br> <input value="si" type="radio" name="vart"> Temperatura<br>
t                <input value="si" type="radio" name="varp"> Presion<br>
t                <br> <input value="Enviar" type="submit">
```

```
t               </form>
t              </td>
t             </tr>
t            </tbody>
t           </table>
t           <br></br>
t           <br></br>
t           <br></br>
t           <br></br>
t           <table align="center">
t            <tr>
t             <td>Autor:     Alberto Palomo Alonso.</td>
t             <td>Sistemas Electronicos Digitales Avanzados.</td>
t             <td>Universidad de Alcala - Escuela politecnica superior.</td>
t            </tr>
t           </table>
t       </body>
t   </html>
.
```

Anexo III –Hojas de datos.