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| Icono  Descripción generada automáticamente | Universidad Nacional de La Matanza |
| DEPARTAMENTO DE INGENIERÍA E INVESTIGACIONES TECNOLÓGICAS |

**ELECTRÓNICA DE POTENCIA**

CONTROL DE ENERGÍA POR TIEMPOS DE OPERACIÓN

**MANUAL TÉCNICO**

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**Control de Energía por Tiempos de Operación - Manual Técnico**

# 1. Descripción

El dispositivo tiene como principal función la conexión y desconexión de forma automática de un artefacto o carga eléctrica monofásica siguiendo un programa semanal configurable, respetando los feriados según el calendario anual vigente. Este proyecto fue desarrollado a lo largo de la cursada de la asignatura “Electrónica de Potencia”, en el marco de impulsar una mejora en el consumo sustentable de la Universidad.

# 2. Hardware

El eje central del dispositivo es un microcontrolador ATMEGA328P, encargado de coordinar cada una de las tareas del proyecto. Lo rodean diferentes bloques/módulos que le brindan al equipo funcionalidades para cumplir con su objetivo. Estos bloques se irán definiendo en particular en la sección “Descripción de partes”.

## 2.1. Diagrama en bloques

Diagrama

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**Ilustración 1: Diagrama en bloques**

## 2.2. Descripción de partes

* *ATMEGA328P*

Es un microcontrolador que pertenece a la familia de los microcontroladores AVR de arquitectura RISC-8-bit. En formato DIP, es el que se utiliza en la tarjeta Arduino Uno R3. Posee características como:

* 32 KB de memoria FLASH
* 1 KB de memoria EEPROM
* 2 KB de SRAM
* 23 líneas de I/O de propósito general
* 32 registros de proceso general
* 3 temporizadores flexibles
* Interrupciones internas y externas (timers, adc, ext\_int, etc)
* Interfaces UART, I2C e SPI.
* Conversor A/D de 10 bits
* Frecuencia máxima de funcionamiento de 20MHz.
* Voltaje de alimentación de 3,3V a 5V DC.

Imagen en blanco y negro

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**Ilustración 2: ATMEGA238P**

* *Fuente Switching 220VAC – 5VDC*

Para la alimentación del dispositivo, dado que la mayoría de los bloques requerían una tensión constante de 5V, se utilizó una pequeña fuente switching modelo WX-DC12003. Esta permite una sencilla implementación, conectando la alimentación monofásica en su entrada y obteniendo una alimentación de 5V constantes en su salida, con una variación de una centésima de volt. Posee las siguientes características.

* Tensión de entrada: 50-270VAC
* Tensión de salida: 5V DC (±0.3 V)
* Corriente de salida: 700mA
* Potencia de salida: 3,5W
* Ripple: <40mV
* Protección contra cortocircuito/sobretensión/sobrecorriente
* Dimensiones: 23,5x18,15x13,5mm

Una caja de cartón

Descripción generada automáticamente con confianza baja

**Ilustración 3: Fuente Switching**

* *Pantalla LCD 16x2*

Para la visualización del menú, se colocó una pantalla LCD 16x2, la cual es comúnmente usada en proyectos de electrónica y su manejo es conocido. Junto con el encoder rotativo, integran la interfaz con el usuario del dispositivo. Permite un control del contraste, el cual es ajustado con un preset desde la placa principal. Como el proyecto consiste en un control de la energía, se agregó como funcionalidad del diseño el apagado del backlight de la pantalla cuando se cumple 1 minuto de inactividad. De esta manera el consumo del dispositivo se reduce (ver sección 3 del informe). La pantalla, de la marca DUAITEK, posee las siguientes características:

* Pantalla de 16 caracteres, 2 líneas
* Caracteres de 5x8 puntos, color blanco.
* Permite mostrar letras, números, caracteres especiales y hasta 8 caracteres personalizados por el usuario.
* Backlight color azul
* Interfaz paralela
* Alimentación 5V

Imagen que contiene reloj

Descripción generada automáticamente

**Ilustración 4: Pantalla LCD 16x2**

* *Encoder Rotativo*

La segunda parte que integra la interfaz con el usuario, es el encoder rotativo. Este dispositivo permite que usuario pueda ir atravesando las diferentes pantallas que se presentan y de esta manera realizar una correcta configuración del dispositivo. Se utilizó un encoder para simplificar y reducir la cantidad de partes del proyecto, ya que con este se puede generar movimientos hacia la derecha, izquierda y confirmaciones pulsando el switch que incluye. El modelo utilizado es el KY-040 y posee las siguientes características:

* Tipo encoder incremental
* Ciclos por resolución (CPR): 20
* Tensión de trabajo: 0-5V
* Peso: 10g
* Dimensiones: 32x19x30mm

Un circuito electrónico

Descripción generada automáticamente con confianza baja

**Ilustración 5: Encoder rotativo**

* *Módulo RTC (Real Time Clock)*

Para el proyecto era necesario tener como información la fecha y hora actual, así como también la posibilidad de configurarla la primera vez que se utilizaba. Para ello se utilizó un módulo DS3231, el cual es un reloj en tiempo real (RTC) extremadamente preciso y de bajo costo, con un oscilador de cristal con compensación de temperatura (TCXO) y un cristal integrados. Este dispositivo incorpora una entrada de batería, para cuando sea necesario desconectar la fuente de alimentación principal y continúa manteniendo un cronometraje preciso. El oscilador integrado mejora la precisión a largo plazo del dispositivo. RTC mantiene información de segundos, minutos, horas, día, fecha, mes y año. Menos de 31 días del mes, la fecha de finalización se ajustará automáticamente, incluidas las correcciones por año bisiesto. El reloj funciona en la indicación de 24 horas o de banda AM/PM del formato de 12 horas. Proporciona dos despertadores configurables y un calendario que se puede configurar en una salida de onda cuadrada. La dirección y los datos se transfieren en serie a través de un bus bidireccional I2C. A continuación, se enumeran algunas características:

* Tensión de Alimentación: 3,3V – 5V
* RTC de alta precisión DS3231 con oscilador interno
* Exactitud Reloj: 2ppm
* Dirección I2C del DS3132: Read (11010001) Write (11010000)
* Memoria EEPROM AT23C32 (4K\*8bit = 32Kbit = 4Kbyte)
* Interfaz I2C
* La batería puede mantener al RTC funcionando por 10 años.

Imagen que contiene electrónica, circuito

Descripción generada automáticamente

**Ilustración 6: Módulo RTC**

* *Módulo microSD*

El dispositivo necesita conocer la fecha de los días feriados, así como también la programación semanal con los rangos de trabajo por día. Esto puede configurarse de forma manual, pero teniendo en cuenta una posible reproducción e implementación de este prototipo, aparecía un problema a la hora de la programación de cada uno de los dispositivos, ya que debían ser configurados en forma individual utilizando el encoder rotativo. Esto podría llegar a resultar molesto, pero sobre todo demandaba mucho tiempo. Es por eso que se incluyó un módulo para tarjeta microSD, el cual se cargará con un archivo .txt que contiene los feriados anuales y la programación semanal.

El módulo utilizado cuenta con las siguientes características:

* Soporta tarjetas microSD, microSDHC
* Posee un conversor de nivel para utilizarlo con 3,3V o 5V
* Posee interfaz de comunicación SPI
* Tensión de Alimentación recomendada de 5V
* Dimensiones: 42x23x12mm

Un circuito electrónico

Descripción generada automáticamente con confianza media

**Ilustración 7: Módulo microSD**

* *Módulo Relay*

La conexión y desconexión del artefacto a controlar estará a cargo del módulo relay, el cual cuenta con transistores para permitir el comando del relay mediante un microcontrolador. Dispone de un contacto simple inversor y la placa presenta un LED indicador de alimentación general. Otras características son:

* Tensión de alimentación: 5V
* Consumo de relay: 50-60mA
* Capaz de manejar una carga de hasta 250VAC-10A/30VDC-10A
* Lógica TTL
* Posee un LED indicador de estado

Imagen que contiene electrónica, circuito

Descripción generada automáticamente

**Ilustración 8: Módulo relay**

* *Módulo Interlock*

La alimentación del prototipo será monofásica, para lo cual se empleó un módulo interlock que cuenta con fusible y llave incluidos. De esta manera, utilizando un cable interlock se puede realizar una conexión rápida y segura del equipo.

Una cámara de video

Descripción generada automáticamente con confianza baja

**Ilustración 9: Módulo interlock**

* *Tomacorriente*

El lugar para la conexión del artefacto a controlar será en el lateral del dispositivo, a un costado del módulo interlock. Se utilizó un tomacorriente normalizado de 220V-10A de color blanco, embutido en el equipo.

Imagen que contiene reloj

Descripción generada automáticamente

**Ilustración 10: Tomacorriente**

## 2.3. Circuito esquemático

El diseño del circuito esquemático fue realizado utilizando el software KiCad versión 7.0.

![Diagrama, Esquemático

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automáticamente](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAkACQAAD/4RD0RXhpZgAATU0AKgAAAAgABAE7AAIAAAAOAAAISodpAAQAAAABAAAIWJydAAEAAAAcAAAQ0OocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFNhbnRpYWdvIFJ1aXoAAAWQAwACAAAAFAAAEKaQBAACAAAAFAAAELqSkQACAAAAAzEwAACSkgACAAAAAzEwAADqHAAHAAAIDAAACJoAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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**Ilustración 11: Circuito esquemático**

## 2.4. Circuito impreso

El diseño del circuito impreso fue realizado utilizando el software KiCad versión 7.0.

![Imagen de la pantalla de un video juego

Descripción generada automáticamente con confianza media](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAkACQAAD/4RD0RXhpZgAATU0AKgAAAAgABAE7AAIAAAAOAAAISodpAAQAAAABAAAIWJydAAEAAAAcAAAQ0OocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFNhbnRpYWdvIFJ1aXoAAAWQAwACAAAAFAAAEKaQBAACAAAAFAAAELqSkQACAAAAAzAxAACSkgACAAAAAzAxAADqHAAHAAAIDAAACJoAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAyMDIzOjA3OjAyIDE1OjU4OjM3ADIwMjM6MDc6MDIgMTU6NTg6MzcAAABTAGEAbgB0AGkAYQBnAG8AIABSAHUAaQB6AAAA/+ELIGh0dHA6Ly9ucy5hZG9iZS5jb20veGFwLzEuMC8APD94cGFja2V0IGJlZ2luPSfvu78nIGlkPSdXNU0wTXBDZWhpSHpyZVN6TlRjemtjOWQnPz4NCjx4OnhtcG1ldGEgeG1sbnM6eD0iYWRvYmU6bnM6bWV0YS8iPjxyZGY6UkRGIHhtbG5zOnJkZj0iaHR0cDovL3d3dy53My5vcmcvMTk5OS8wMi8yMi1yZGYtc3ludGF4LW5zIyI+PHJkZjpEZXNjcmlwdGlvbiByZGY6YWJvdXQ9InV1aWQ6ZmFmNWJkZDUtYmEzZC0xMWRhLWFkMzEtZDMzZDc1MTgyZjFiIiB4bWxuczpkYz0iaHR0cDovL3B1cmwub3JnL2RjL2VsZW1lbnRzLzEuMS8iLz48cmRmOkRlc2NyaXB0aW9uIHJkZjphYm91dD0idXVpZDpmYWY1YmRkNS1iYTNkLTExZGEtYWQzMS1kMzNkNzUxODJmMWIiIHhtbG5zOnhtcD0iaHR0cDovL25zLmFkb2JlLmNvbS94YXAvMS4wLyI+PHhtcDpDcmVhdGVEYXRlPjIwMjMtMDctMDJUMTU6NTg6MzcuMDExPC94bXA6Q3JlYXRlRGF0ZT48L3JkZjpEZXNjcmlwdGlvbj48cmRmOkRlc2NyaXB0aW9uIHJkZjphYm91dD0idXVpZDpmYWY1YmRkNS1iYTNkLTExZGEtYWQzMS1kMzNkNzUxODJmMWIiIHhtbG5zOmRjPSJodHRwOi8vcHVybC5vcmcvZGMvZWxlbWVudHMvMS4xLyI+PGRjOmNyZWF0b3I+PHJkZjpTZXEgeG1sbnM6cmRmPSJodHRwOi8vd3d3LnczLm9yZy8xOTk5LzAyLzIyLXJkZi1zeW50YXgtbnMjIj48cmRmOmxpPlNhbnRpYWdvIFJ1aXo8L3JkZjpsaT48L3JkZjpTZXE+DQoJCQk8L2RjOmNyZWF0b3I+PC9yZGY6RGVzY3JpcHRpb24+PC9yZGY6UkRGPjwveDp4bXBtZXRhPg0KICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICA8P3hwYWNrZXQgZW5kPSd3Jz8+/9sAQwAHBQUGBQQHBgUGCAcHCAoRCwoJCQoVDxAMERgVGhkYFRgXGx4nIRsdJR0XGCIuIiUoKSssKxogLzMvKjInKisq/9sAQwEHCAgKCQoUCwsUKhwYHCoqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioqKioq/8AAEQgCggKFAwEiAAIRAQMRAf/EAB8AAAEFAQEBAQEBAAAAAAAAAAABAgMEBQYHCAkKC//EALUQAAIBAwMCBAMFBQQEAAABfQECAwAEEQUSITFBBhNRYQcicRQygZGhCCNCscEVUtHwJDNicoIJChYXGBkaJSYnKCkqNDU2Nz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f/ABz+VObxpYqU8rSpW2/eL3AG72Pyn9MUe0pdw5Z9jR/s2x/58rf/AL9L/hR/Ztj/AM+Vv/36X/CsweNbTP8AyCHX5t2RdZwPTBTGKdL41sdziLSZNpPyk3OCv/jp/XNHtKXcOWfY0f7Nsf8Anyt/+/S/4Uf2bY/8+Vv/AN+l/wAKzf8AhNrQn5tHYArg4uu/r9zr+ntT5PGuno6iDSpZUAwTJOFLfUBT+lHtKXf8A5anYv8A9m2P/Plb/wDfpf8ACj+zbH/nyt/+/S/4VmJ41tQU3aVIQp5/0kHI9PuUsnjSyDEQ6VKRuyGNyAcemNpGKPaUu4cs+xpf2bY/8+Vv/wB+l/wo/s2x/wCfK3/79L/hWYfGtmzNnR3UNj7t1936fJ/OnyeNrLe3l6Q7KVxk3AU59cBTg/p7Ue0pd/6+4OWfY0P7Nsf+fK3/AO/S/wCFH9m2P/Plb/8Afpf8Kz4/G1lvTzdIfaOGIuQSR9No/TFN/wCE1tFwBpLsFbIZrkAkeh+T/wCv70e0pd/wDln2NL+zbH/nyt/+/S/4Uf2bY/8APlb/APfpf8KzV8aWZbD6XKils5W5DFfYApz+NJJ41tC77NJkCt0/0ocf+OGj2lLuHLPsaf8AZtj/AM+Vv/36X/Cj+zbH/nyt/wDv0v8AhWcvjWyaQeZpEirjBK3OfxxtHP6Uh8a2YZcaQ7Be5usbvrhf5Ue0pd/6+4OWfY0v7Nsf+fK3/wC/S/4Uf2bY/wDPlb/9+l/wrOi8a2YKiTSZNoPLfaATj0xsH+PvSHxraDeE0lyCcqTcjK/+OfzzR7Sl3/AOWfY0v7Nsf+fK3/79L/hR/Ztj/wA+Vv8A9+l/wrPTxrYmR/M0mRFYcBbkHafb5R/OmN41tS2RpDj5cH/Shz7/AHOD9KPaUu4cs+xp/wBm2P8Az5W//fpf8KP7Nsf+fK3/AO/S/wCFZ0fjWxLL52kyAKDkrcg7vTPyj9P1pv8AwmtoFC/2Q7YbOTdYJHocJR7Sl3Dln2NP+zbH/nyt/wDv0v8AhR/Ztj/z5W//AH6X/Cs6PxpZEsJNKlUE5BW4DFfblen1zSHxtabnI0dsMMAfavu+4+Sj2lLv+Acs+xpf2bY/8+Vv/wB+l/wo/s2x/wCfK3/79L/hVGLxrp5ctPpUqjZgBJwwY+/yjH4flUX/AAmtr8n/ABKHO3qftQ+b6/J/Kj2lLv8AgHLU7Gn/AGbY/wDPlb/9+l/wo/s2x/58rf8A79L/AIVnJ40svLw+mShl5Ui4Bz7H5en4GmnxralWH9kP8xyD9q+79Pk/nmj2lLuHLPsaf9m2P/Plb/8Afpf8KP7Nsf8Anyt/+/S/4Vnr41sT5m/SZF3D5VW4zg/Xbkfr9KYPG1oGB/sdiAMEG74b3+5/Kjnpd/6+4OWfY0/7Nsf+fK3/AO/S/wCFH9m2P/Plb/8Afpf8Kz08a2OAZNKkBQcYuAd/sflGPqKYfGtqVwNIYHdkEXQ49vudKPaUu4cs+xtqqooVFCqOAAMAUtYw8a2LLJv0mRCcFdlwDg/iv+NM/wCE2tctnSGO4Y/4+hwfUfJ/9an7Wn3/ADFyT7G5RWNH41sQcyaTIMLgKLjIY+/yjH4UweNbUbP+JQ529c3X3vr8n8qPa0+/5hyT7G5RWL/wmliYTnSpVcNlcXAIx6ZK/wBDTW8bWrBgNHZdxyMXX3fp8n86Pa0+/wCYck+xuUVjf8JtYmNi2kyByMAC4GP97O3g/himL42tQwJ0hmAGCDdDn/xz+VHtaff8w5J9jcorFTxpZCMFtLlLqeB9oBDD3O3+lMPjW1xxpDg7sg/a+ntynSj2tPv+Yck+xu1X1wqfCd/jZuCJnghv9an4EfrWafGlgySE6VKrnG1VueB+O3+hqrqvi9NR0iaxj09oBKqjcZ9wGGDZxtHXHYgUpVafK1fp5jUJ3WhzNFaul/8ACP8A2Vv7a/tPz952/ZPL27cDGd3Oc5/SivNudljKoooqhBRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQB//9k=)

**Ilustración 12: Circuito impreso**

## 2.5. Gabinete Plástico

Para el diseño del gabinete plástico, se utilizó el software Fusion 360 de Autodesk. El gabinete consiste en dos partes, la base y una tapa. En la base se encuentra fija la placa principal, la fuente switching, el módulo relay, el tomacorriente y el módulo interlock. Mientras que, en la tapa, se encuentran el LCD, el encoder y el módulo de tarjeta microSD.

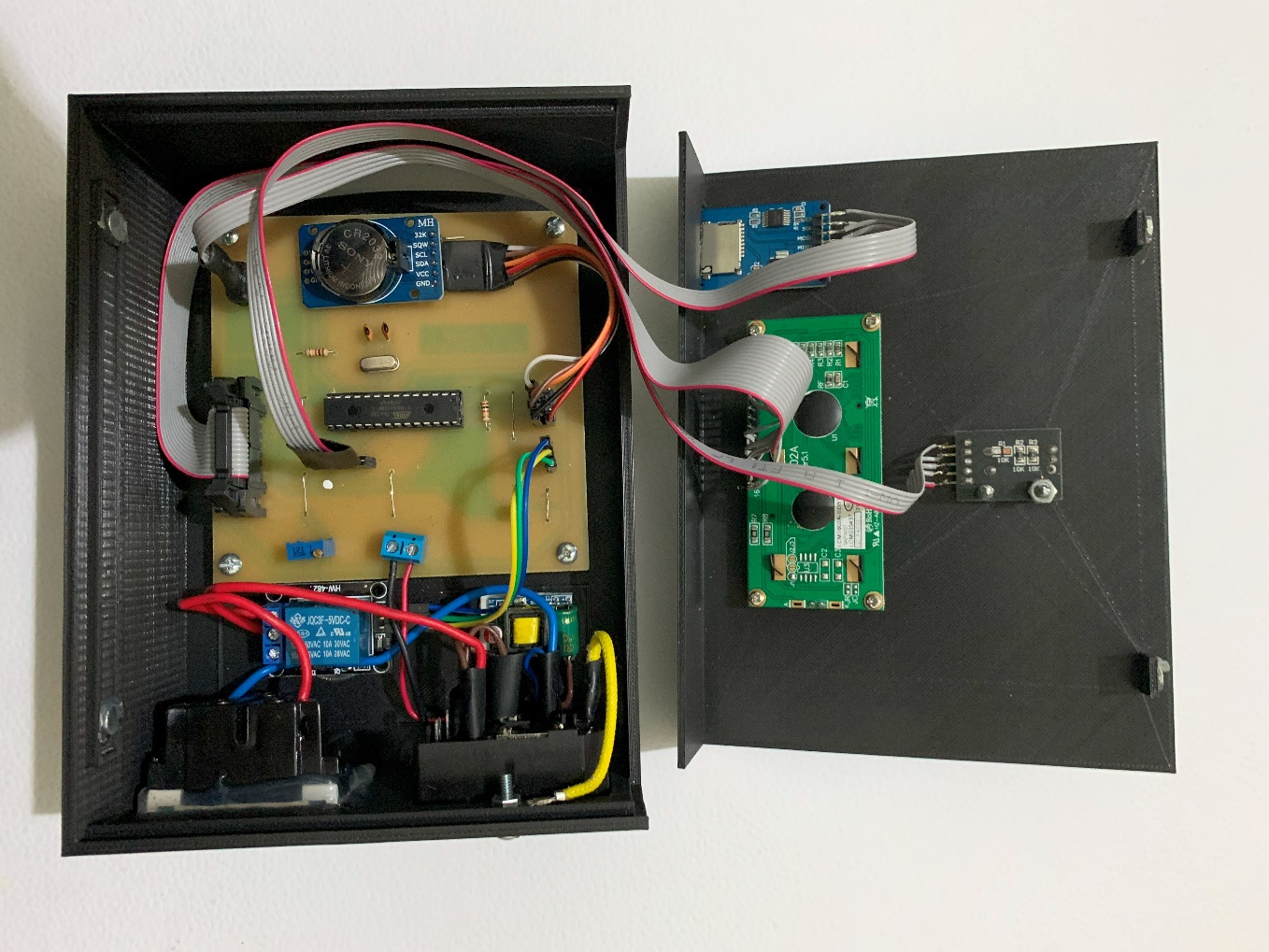
El gabinete posee unas guías sobre las cuales la tapa puede deslizarse libremente hasta cubrir la totalidad de la base. Además, se le incluyeron un juego de imanes de neodimio para el cierre de la tapa y evitar el uso de tornillos para el acoplamiento con la base.

Dibujo de ingeniería

Descripción generada automáticamente

**Ilustración 13: Diseño de Gabinete Plástico**

## 2.6. Montaje y ubicación de componentes



**TAPA**

**BASE**

**microSD**

**INTERLOCK**

**TOMACORRIENTE**

**FUENTE**

**RELAY**

**ENCODER**

**LCD 16X2**

**RTC**

**ATMEGA328P**

**Ilustración 14: Ubicación y montaje**

## 2.7. Costos

A continuación, se muestran los precios de todos los componentes que conforman al producto final, siendo los mismos registrados en junio de 2023.

|  |  |  |
| --- | --- | --- |
| **Componente** | **Precio** | |
| Fuente Switching 220 VAC 5 VDC 700 mA | AR$ | 1850,00 |
| ATMEGA328 con zócalo, cristal y capacitores | AR$ | 2829,00 |
| Display LCD 16x2 | AR$ | 1623,60 |
| Módulo Encoder Rotativo Ky-040 | AR$ | 565,50 |
| Módulo RTC DS3231 | AR$ | 1789,04 |
| Módulo Relay 5v 10A | AR$ | 798,94 |
| Módulo lector de memorias microSD | AR$ | 379,00 |
| Módulo Interlock con llave y fusible | AR$ | 2225,90 |
| Placa Pertinax 10cm x 10cm | AR$ | 408,27 |
| Transistor NPN BC548 | AR$ | 34,03 |
| Bornera azul de 2 contactos | AR$ | 126,42 |
| Conector hembra 1x40 | AR$ | 563,93 |
| Conector hembra 2x40 | AR$ | 781,96 |
| Conector hembra 2x7 | AR$ | 253,60 |
| Header macho 2x7 | AR$ | 157,08 |
| Resistencia 10K ohm 1/4 Watt | AR$ | 17,69 |
| Resistencia 1K ohm 1/4 Watt | AR$ | 17,69 |
| Preset Potenciómetro Multivuelta 10K ohm | AR$ | 419,00 |
| Cable plano de 14 conductores | AR$ | 607,93 |
| Plástico de base del gabinete | AR$ | 1900,00 |
| Plástico de tapa del gabinete | AR$ | 760,00 |
| **Total** | **AR$** | **18108,58** |

# 3. Consumos

A la hora de evaluar el consumo del dispositivo, era importante considerar que, si la carga a controlar era de hasta 10 A, limitada por el relay, el consumo del dispositivo debía ser mucho menor que este valor. Para este análisis, se plantearon 4 posibles condiciones de trabajo a las cuales puede estar sometido el equipo. Las mismas son:

* Que el backlight del LCD y el relay estén activados (**PEOR CONDICIÓN**)
* Que el backlight del LCD esté activado y el relay desactivado
* Que el backlight del LCD esté desactivado y el relay activado
* Que el backlight del LCD y el relay estén desactivados (**MEJOR CONDICIÓN**)

En función de lo planteado, se realizaron las mediciones correspondientes obteniendo los valores que se observan en la Ilustración 15.

Tabla

Descripción generada automáticamente

**Ilustración 15: Tabla de consumos**

De esta manera, se puede establecer que el equipo tiene un consumo que varía desde los 25mA hasta los 110mA aproximadamente, lo cual permite afirmar que el consumo del equipo no es representativo en comparación con el consumo del artefacto al cual busca controlar.

# 4. Firmware

## 4.1. Código

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Archivo: control\_de\_energia.ino*

*//*

*// Proyecto: CONTROL DE ENERGÍA POR TIEMPOS DE OPERACIÓN*

*//*

*// Materia: ELECTRÓNICA DE POTENCIA*

*//*

*// Fecha de creación: 1er CUATRIMESTRE 2023*

*//*

*// Profesores: Ing. Guillermo Luis Miquel*

*// Ing. Oscar Pugliese*

*//*

*// Autores: Nicolás Enrique Agostino*

*// Ignacio Luis Mehle*

*// Santiago Ruiz*

*// Federico Ladislao Sokolic*

*// Pablo Fabián Yujra Ventura*

*// Descripción:*

*// El dispositivo tiene como principal función la conexión y desconexión de*

*// forma automática de un artefacto o carga eléctrica monofásica siguiendo*

*// un programa semanal configurable, respetando los feriados según el*

*// calendario anual vigente. Este proyecto fue desarrollado a lo largo de*

*// la cursada de la asignatura “Electrónica de Potencia”, en el marco de*

*// impulsar una mejora en el consumo sustentable de la Universidad.*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

#include <LiquidCrystal.h>

#include <EEPROM.h>

#include <DS3231.h>

#include <Wire.h>

#include <SPI.h>

#include <SD.h>

#ifdef TIMER\_INTERNO

#include <TimerOne.h> *//Para simular el reloj del RTC*

#endif

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// ETIQUETAS*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*//Descomentar para habilitar el debug por puerto serie*

*//#define DEBUG\_SERIE*

*//Menu*

#define MENU\_PRINCIPAL 0

#define MENU\_AJUSTE\_FECHA\_HORA 1

#define MENU\_CONFIGURACION 2

#define MENU\_PROGRAMA\_SEMANAL 3

#define MENU\_FERIADOS 4

#define MENU\_CAMBIOS\_SD 5

*//Dias de la semana*

#define LUNES 1

#define MARTES 2

#define MIERCOLES 3

#define JUEVES 4

#define VIERNES 5

#define SABADO 6

#define DOMINGO 7

*//Rangos*

#define INICIO\_1 0

#define FIN\_1 1

#define INICIO\_2 2

#define FIN\_2 3

#define INICIO\_3 4

#define FIN\_3 5

#define INICIO\_4 6

#define FIN\_4 7

#define PRIMERA\_POSICION\_EVENTOS 0

#define ULTIMA\_POSICION\_EVENTOS PRIMERA\_POSICION\_EVENTOS+55

#define PRIMERA\_POSICION\_FERIADOS ULTIMA\_POSICION\_EVENTOS+1

#define ULTIMA\_POSICION\_FERIADOS PRIMERA\_POSICION\_FERIADOS+365

#define MAX\_VALOR\_HORARIOS 95 *//correspondiente a las 23:45*

#define CANT\_RANGOS 4

*//Encoder*

#define DERECHA 1

#define IZQUIERDA 2

#define ENTER 3

*//Para lectura de EEPROM*

#define HORA 0

#define MINUTOS 1

*//Para seteo de feriados*

#define ES\_FERIADO 1

#define NO\_ES\_FERIADO 0

#define TIEMPO\_PARA\_APAGAR\_LCD 60 *//en segundos*

*//Pin usado para disparar la interrupción, la salida SQW del RTC debe conectarse a el pin a usar*

#define CLINT 3

#define SSPin 10 *//CS de la uSD*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// VARIABLES*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**const** **int** Encoder\_OuputA PROGMEM = 9;

**const** **int** Encoder\_OuputB PROGMEM = 8;

**const** **int** Encoder\_Switch PROGMEM = 5;

**const** **int** Salida\_Rele PROGMEM = 0;

**const** **int** Salida\_Backlight PROGMEM = 4;

**int** Previous\_Output;

**int** diadelasemana=0;

**int** estado\_menu=0;

**int** estado\_menu\_anterior=0;

**int** estado\_ajuste=0;

**int** estado\_prog\_sem=0;

**int** estado\_prog\_rango=0;

**int** estado\_menu\_feriados=0;

**int** proximo\_menu=0;

**int** seg\_anterior=0;

**int** rango\_a\_programar=0;

**char** Rango\_num[CANT\_RANGOS\*2];

**char** Rangos\_hoy[CANT\_RANGOS\*2];

**char** codigo\_hora\_actual=0;

**char** codigo\_hora\_actual\_anterior=0;

**char** ultimo\_dia=0;

**bool** modificacion\_realizada=0;

**bool** cursor\_feriado=0;

**bool** feriado=0;

**int** tiempo\_sin\_pulsar=TIEMPO\_PARA\_APAGAR\_LCD;

*//ESTRUCTURA DE FECHA Y HORA*

**struct** RTC\_Time

{

*//Dia de la semana*

**char** DoW;

*//FECHA*

**char** dia; *//[1,31]*

**char** mes; *//[1,12]*

**char** anio; *//[0,255]*

*//HORA*

**char** seg; *//[0,59]*

**char** min; *//[0,59]*

**char** hora; *//[0,23]*

};

RTC\_Time ActualTime;

RTC\_Time AuxTime;

*// Setup clock*

DS3231 RTC;

*//Estructura para el archivo de la uSD*

*//File myFile;*

**volatile** byte tick = 1;

byte alarmBits = 0b00001110; *// Cada un min*

**bool** Century = false;

**bool** h12=0;*//Modo 24HS*

**bool** PM ;

*//Cantidad de dias por mes, usado para calcular la posicion en memoria*

**const** **int** cant\_dias\_mes[] = {31, 29, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31};

*//Mention the pin number for LCD connection*

**const** **int** rs PROGMEM = 7;

**const** **int** en PROGMEM = 6;

**const** **int** d4 PROGMEM = 14;

**const** **int** d5 PROGMEM = 15;

**const** **int** d6 PROGMEM = 16;

**const** **int** d7 PROGMEM = 17;

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

**int** min\_ant,seg\_ant;

**bool** estado\_uSD=0;

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: setup*

*//*

*// Descripción: Configuración inicial del programa*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** setup()

{

*/\*\*\*Letras seleccionadas\*\*\*/*

byte L[8] = {

0b01111,

0b01111,

0b01111,

0b01111,

0b01111,

0b01111,

0b00000,

0b11111

};

byte M[8] = {

0b01110,

0b00100,

0b01010,

0b01010,

0b01110,

0b01110,

0b01110,

0b11111

};

byte a[8] = {

0b11111,

0b11111,

0b10001,

0b11110,

0b10000,

0b01110,

0b10000,

0b11111

};

byte i[8] = {

0b11011,

0b11111,

0b10011,

0b11011,

0b11011,

0b11011,

0b10001,

0b11111

};

byte J[8] = {

0b10000,

0b11101,

0b11101,

0b11101,

0b11101,

0b01101,

0b10011,

0b11111

};

byte V[8] = {

0b01110,

0b01110,

0b01110,

0b01110,

0b01110,

0b10101,

0b11011,

0b11111

};

byte S[8] = {

0b10001,

0b01110,

0b01111,

0b10001,

0b11110,

0b01110,

0b10001,

0b11111

};

byte D[8] = {

0b00011,

0b01101,

0b01110,

0b01110,

0b01110,

0b01101,

0b00011,

0b11111

};

*// Begin I2C communication*

Wire.begin();

*//Interrupción de RTC*

configuraInterrupcionRTC();

*// put your setup code here, to run once:*

lcd.begin(16, 2); *//Initialise 16\*2 LCD*

lcd.createChar(0,D);

lcd.createChar(1,L);

lcd.createChar(2,M);

lcd.createChar(3,a);

lcd.createChar(4,i);

lcd.createChar(5,J);

lcd.createChar(6,V);

lcd.createChar(7,S);

#ifdef DEBUG\_SERIE

Serial.begin(9600);

#endif

pinMode (Encoder\_OuputA, INPUT);

pinMode (Encoder\_OuputB, INPUT);

pinMode (Encoder\_Switch, INPUT);

Previous\_Output = digitalRead(Encoder\_OuputA); *//Read the inital value of Output A*

pinMode (Salida\_Rele, OUTPUT);

pinMode (Salida\_Backlight, OUTPUT);

Leer\_Fecha\_Hora\_RTC(ActualTime);

#ifdef TIMER\_INTERNO

*//Para tener un timer de 1seg*

Timer1.initialize(1000000);

Timer1.attachInterrupt(ISR\_Segundo);

#endif

Rango\_num[INICIO\_1]=Rango\_num[FIN\_1]='1';

Rango\_num[INICIO\_2]=Rango\_num[FIN\_2]='2';

Rango\_num[INICIO\_3]=Rango\_num[FIN\_3]='3';

Rango\_num[INICIO\_4]=Rango\_num[FIN\_4]='4';

*//Cargo los rangos del día de hoy*

Cargar\_Rangos();

ultimo\_dia=ActualTime.DoW;

tiempo\_sin\_pulsar=TIEMPO\_PARA\_APAGAR\_LCD;

*//Lee si hay feriados en la uSD para agregar*

leerFeriadosDeSd();

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: leerFeriadosDeSd*

*//*

*// Descripción: Lee los feriados y eventos de la uSD y los agrega en la EEPROM*

*//*

*// Parámetros: void*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** leerFeriadosDeSd(**void**)

{

#ifdef DEBUG\_SERIE

**char** BufferAux[25];

#endif

*//Estructura para el archivo de la uSD*

File myFile;

**int** feriado\_anterior=PRIMERA\_POSICION\_FERIADOS;

**bool** hubo\_cambio=0;

#ifdef DEBUG\_SERIE

Serial.print(F("Inicializando tarjeta...\n"));

delay(50);

#endif

**if** (!SD.begin(SSPin))

{

estado\_uSD=0;

#ifdef DEBUG\_SERIE

Serial.print(F("Falló la inicialización de la uSD\n"));

delay(50);

#endif

}

**else**

{

*//Si entra acá es porque está la uSD presente*

*//La leo solo si no la leí previamente desde que está colocada*

**if**(!estado\_uSD)

{

*//Abre el archivo de feriados*

myFile = SD.open("feriados.txt");

**if**(myFile)

{

String feriados;

String eventos;

estado\_uSD = 1;

#ifdef DEBUG\_SERIE

Serial.print(F("if TRUE\n"));

delay(50);

#endif

*// while (myFile.available())*

*// {*

*//Feriados*

feriados = myFile.readStringUntil('|');

**int** feriados\_len = feriados.length() + 1;

String evento = "";

**int** eventos\_len;

**char** char\_feriados[feriados\_len];

feriados.toCharArray(char\_feriados, feriados\_len);

String feriado = "";

**for** (**int** i = 0; i < feriados.length(); i++)

{

**if** (feriados[i] == ',')

{

**if**((feriado.toInt()>=PRIMERA\_POSICION\_FERIADOS)&&

(feriado.toInt()<=ULTIMA\_POSICION\_FERIADOS))

{

**if**(EEPROM.read(feriado.toInt())!=1)

{

EEPROM.write(feriado.toInt(), 1);

hubo\_cambio=1;

#ifdef DEBUG\_SERIE

Serial.print(F("Lo guardo!"));

#endif

}

#ifdef DEBUG\_SERIE

sprintf(BufferAux,"feriado: %d \n",feriado.toInt());

Serial.print(BufferAux);

#endif

*//Borro todas las posiciones que no estén en la microSD*

**for**(**int** j=feriado\_anterior;j<feriado.toInt();j++)

{

**if**(EEPROM.read(j)!=0)

{

EEPROM.write(j, 0);

hubo\_cambio=1;

#ifdef DEBUG\_SERIE

Serial.print(F("Lo borro!"));

#endif

}

}

feriado\_anterior = feriado.toInt()+1;

}

feriado = "";

}

**else**

{

feriado += feriados[i];

#ifdef DEBUG\_SERIE

Serial.print(feriado);

Serial.print(F("\n"));

#endif

}

}

**if**((feriado\_anterior>PRIMERA\_POSICION\_FERIADOS)&&(feriado\_anterior<=ULTIMA\_POSICION\_FERIADOS))

{

*//Borro todas las posiciones que faltan de la uSD*

**for**(**int** i=feriado\_anterior;i<=ULTIMA\_POSICION\_FERIADOS;i++)

{

**if**(EEPROM.read(i)!=0)

EEPROM.write(i, 0);

}

}

**while** (myFile.available())

{

eventos = "";

evento = "";

*//Eventos*

eventos = myFile.readStringUntil(',');

*//if (eventos[i] != '.')*

**if** (eventos[0] != '.')

{

eventos += ',';

eventos\_len = eventos.length() + 1;

#ifdef DEBUG\_SERIE

Serial.print(eventos);

delay(100);

sprintf(BufferAux,"\n eventos\_len: %d\n",eventos\_len);

Serial.print(BufferAux);

#endif

*//char char\_eventos[eventos\_len];*

*//eventos.toCharArray(char\_eventos, eventos\_len);*

**for** (**int** i = 0; i < eventos.length(); i++)

{

#ifdef DEBUG\_SERIE

sprintf(BufferAux,"eventos[%d]: %c\n",i,eventos[i]);

Serial.print(BufferAux);

#endif

**if** (eventos[i] != ',')

{

*//Mientras no llegue la coma, armo el string*

evento += eventos[i];

#ifdef DEBUG\_SERIE

Serial.print(evento);

Serial.print(F("\n"));

#endif

}

**else**

{

String posicionEnMemoriaEvento = evento.substring(0,2); *//Agarro la posicion (antes del ':')*

String valorAGuardarEnPosicion = evento.substring(3,5); *//Agarro el codigo a guardar (despues del ':')*

#ifdef DEBUG\_SERIE

sprintf(BufferAux,"posicionEnMemoriaEvento: %d\n",posicionEnMemoriaEvento.toInt());

Serial.print(BufferAux);

sprintf(BufferAux,"valorAGuardarEnPosicion: %d\n",valorAGuardarEnPosicion.toInt());

Serial.print(BufferAux);

#endif

**if**((posicionEnMemoriaEvento.toInt()>=PRIMERA\_POSICION\_EVENTOS)&&(posicionEnMemoriaEvento.toInt()<=ULTIMA\_POSICION\_EVENTOS)&&(valorAGuardarEnPosicion.toInt()<= MAX\_VALOR\_HORARIOS))

{

*//Si es valido, me fijo si es diferente a lo que ya está guardado*

**if**(EEPROM.read(posicionEnMemoriaEvento.toInt())!=valorAGuardarEnPosicion.toInt())

{

*//Si es diferente, lo guardo*

EEPROM.write(posicionEnMemoriaEvento.toInt(), valorAGuardarEnPosicion.toInt());

hubo\_cambio = 1;

#ifdef DEBUG\_SERIE

Serial.print(F("Lo guardo!"));

#endif

}

}

evento = "";

}

}

}

}

**if**(hubo\_cambio)

estado\_menu = MENU\_CAMBIOS\_SD;

*// Cerrar el archivo*

myFile.close();

}

**else**

{

estado\_uSD=0;

#ifdef DEBUG\_SERIE

Serial.print(F("Error leyendo feriados.txt"));

#endif

}

}

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Leer\_Fecha\_Hora\_RTC*

*//*

*// Descripción: Carga en la estructura la fecha y hora guardada en el RTC*

*//*

*// Parámetros: RTC\_Time Time (estructura a cargar)*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Leer\_Fecha\_Hora\_RTC(RTC\_Time& Time)

{

*//Leo los datos del RTC*

Time.DoW=RTC.getDoW();

*//FECHA*

Time.dia=RTC.getDate();

Time.mes=RTC.getMonth(Century);

Time.anio=RTC.getYear();

*//HORA*

Time.hora=RTC.getHour(h12, PM);

Time.min=RTC.getMinute();

Time.seg=RTC.getSecond();

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Cargar\_Rangos*

*//*

*// Descripción: Carga los rangos de encendido del día de hoy*

*//*

*// Parámetros: void*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Cargar\_Rangos(**void**)

{

#ifdef DEBUG\_SERIE

**char** BufferAux[50];

#endif

**for**(**int** i=0; i<CANT\_RANGOS\*2; i++)

{

Rangos\_hoy[i]=EEPROM.read((ActualTime.DoW-1)\*8+i);

#ifdef DEBUG\_SERIE

**if**(i%2==0)

Serial.print(F("Inicio "));

**else**

Serial.print(F("Fin "));

sprintf(BufferAux,"%c: %d\n",Rango\_num[i],Rangos\_hoy[i]);

Serial.print(BufferAux);

#endif

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Leer\_Encoder*

*//*

*// Descripción: Devuelve la dirección del enconder o si se apretó el*

*// pulsador, teniendo prioridad el pulsador*

*//*

*// Parámetros: void*

*// Valor devuelto: int IZQUIERDA(antihorario), DERECHA(horario) o ENTER*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**int** Leer\_Encoder(**void**)

{

**int** giro\_encoder=0;

**if** (digitalRead(Encoder\_OuputB) != Previous\_Output)

{

**if** (digitalRead(Encoder\_OuputA) != Previous\_Output)

{

giro\_encoder = DERECHA;

tiempo\_sin\_pulsar=TIEMPO\_PARA\_APAGAR\_LCD;

}

**else**

{

giro\_encoder = IZQUIERDA;

tiempo\_sin\_pulsar=TIEMPO\_PARA\_APAGAR\_LCD;

}

}

Previous\_Output = digitalRead(Encoder\_OuputB);

*//El ENTER tiene prioridad ante los giros*

**if**(digitalRead(Encoder\_Switch)==0)

{

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

**if**(tiempo\_sin\_pulsar>0) *//Si está el backlight apagado, no realiza ninguna acción el enter, solo prende el backlight*

**return**(ENTER);

tiempo\_sin\_pulsar=TIEMPO\_PARA\_APAGAR\_LCD;

}

**return**(giro\_encoder);

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Programacion\_Semanal*

*//*

*// Descripción: Se programan los rangos de encendido de cada día de la semana*

*//*

*// Parámetros: void*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Programacion\_Semanal(**void**)

{

**char** BufferAux[5];

**switch**(estado\_prog\_sem)

{

default:

estado\_prog\_sem=0;

**break**;

**case** 0:

lcd.setCursor(0, 0);

lcd.print(F("Seleccionar dia"));

lcd.setCursor(0, 1);

lcd.print(F("D L Ma Mi J V S"));

*//Selecciono DOMINGO*

*//lcd.setCursor(0, 1);*

*//lcd.write(byte(0));//D seleccionada*

*//diadelasemana=DOMINGO;*

*//delay(1000);*

diadelasemana=ActualTime.DoW;

estado\_prog\_sem++;

**break**;

**case** 1:

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** DERECHA:

diadelasemana ++;

**if**(diadelasemana > DOMINGO)

diadelasemana = LUNES;

#ifdef DEBUG\_SERIE

Serial.print(F("Variable: "));

Serial.print(diadelasemana);

Serial.print(F("\n"));

#endif

delay(50);

**break**;

**case** IZQUIERDA:

diadelasemana--;

**if**(diadelasemana < LUNES)

diadelasemana = DOMINGO;

#ifdef DEBUG\_SERIE

Serial.print(F("Variable: "));

Serial.print(diadelasemana);

Serial.print(F("\n"));

#endif

delay(50);

**break**;

**case** ENTER:

estado\_prog\_sem++;

**break**;

}

Seleccion\_dias();

delay(10);

**break**;

**case** 2:

*//Presento el día en pantalla*

lcd.clear();

lcd.setCursor(0, 0);

**switch**(diadelasemana)

{

default:

diadelasemana=DOMINGO;

lcd.print(F("DOMINGO"));

**break**;

**case** DOMINGO:

lcd.print(F("DOMINGO"));

**break**;

**case** LUNES:

lcd.print(F("LUNES"));

**break**;

**case** MARTES:

lcd.print(F("MARTES"));

**break**;

**case** MIERCOLES:

lcd.print(F("MIERCOLES"));

**break**;

**case** JUEVES:

lcd.print(F("JUEVES"));

**break**;

**case** VIERNES:

lcd.print(F("VIERNES"));

**break**;

**case** SABADO:

lcd.print(F("SABADO"));

**break**;

}

estado\_prog\_sem++;

rango\_a\_programar=0;

estado\_prog\_rango=0;

**break**;

**case** 3:

**if**(Programar\_Rango(rango\_a\_programar)==1)

rango\_a\_programar++;

**if**(rango\_a\_programar >= (CANT\_RANGOS\*2))

estado\_prog\_sem++;

**break**;

**case** 4:

*//Trato de guardar los cambios si hay uSD*

Guardar\_Cambios\_uSD();

lcd.setCursor(0, 0);

lcd.print(F("Config guardada "));

lcd.setCursor(0, 1);

lcd.print(F(" con exito "));

delay(3000);

estado\_menu=MENU\_PRINCIPAL;

estado\_prog\_sem=0;

diadelasemana=0;

Cargar\_Rangos();

modificacion\_realizada=1;

**break**;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Programar\_Rango*

*//*

*// Descripción: Se programan las horas y minutos de cada rango*

*//*

*// Parámetros: int rango: INICIO1,FIN1,INICIO2,FIN2...etc*

*// Valor devuelto: bool: devuelve un 1 cuando ya se programó ese rango, sino 0*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**bool** Programar\_Rango(**int** rango)

{

*//Por cada rango a programar va a entrar acá*

**char** BufferAux[5];

**switch**(estado\_prog\_rango)

{

default:

estado\_prog\_rango=0;

**break**;

**case** 0:

lcd.setCursor(10, 0);

lcd.print(F("Rango"));

lcd.setCursor(15, 0);

lcd.print(Rango\_num[rango]);

**if**(rango%2==0)

{

lcd.setCursor(0, 1);

lcd.print(F("Encendido:"));*//Rangos pares son encedido*

}

**else**

{

lcd.setCursor(0, 1);

lcd.print(F("Apagado: "));*//Rangos impares son apagado*

}

AuxTime.hora = Leer\_Rangos\_EEPROM(diadelasemana, rango, HORA);

AuxTime.min = Leer\_Rangos\_EEPROM(diadelasemana, rango, MINUTOS);

lcd.setCursor(11, 1);

**if**((AuxTime.hora<0 || AuxTime.hora>23)||(AuxTime.min<0 || AuxTime.min>45))

{

AuxTime.hora = 0;

AuxTime.min = 0;

}

**else**

{

sprintf(BufferAux,"%02d:%02d",AuxTime.hora,AuxTime.min);

lcd.print(BufferAux);

}

estado\_prog\_rango++;

**break**;

**case** 1:

*//Programo la hora*

lcd.setCursor(11, 1);

sprintf(BufferAux,"%02d:%02d",AuxTime.hora,AuxTime.min);

lcd.print(BufferAux);

Efecto\_Titilar(11,1,2,100);

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** IZQUIERDA:

AuxTime.hora--;

**if**(AuxTime.hora<0)

AuxTime.hora=23;

**break**;

**case** DERECHA:

AuxTime.hora++;

**if**(AuxTime.hora>23)

AuxTime.hora=0;

**break**;

**case** ENTER:

estado\_prog\_rango++;

**break**;

}

**break**;

**case** 2:

*//Programo los minutos*

lcd.setCursor(11, 1);

sprintf(BufferAux,"%02d:%02d",AuxTime.hora,AuxTime.min);

lcd.print(BufferAux);

Efecto\_Titilar(14,1,2,100);

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** IZQUIERDA:

AuxTime.min=AuxTime.min-15;

**if**(AuxTime.min<0)

AuxTime.min=45;

**break**;

**case** DERECHA:

AuxTime.min=AuxTime.min+15;

**if**(AuxTime.min>45)

AuxTime.min=0;

**break**;

**case** ENTER:

estado\_prog\_rango++;

**break**;

}

**break**;

**case** 3:

*//Guardo el rango en EEPROM*

#warning "Habria que hacer una logica que se fije que el inicio sea antes del fin en cada rango, y que no se superpongan"

Escribir\_Rangos\_EEPROM(diadelasemana,rango,AuxTime.hora,AuxTime.min);

estado\_prog\_rango=0;

**return**(1);

**break**;

}

**return**(0);

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Leer\_Rangos\_EEPROM*

*//*

*// Descripción: Se leen las horas o minutos (según se solicite) guardado*

*// en la EEPROM del día solicitado en el rango solicitado.*

*//*

*// Parámetros: int dia (LUNES, MARTES... etc)*

*// int rango (INICIO1, FIN1, INICIO2... etc)*

*// Valor devuelto: bool hora\_min: aclaras si queres recibir la hora o los mins*

*// (HORA o MINUTOS)*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**char** Leer\_Rangos\_EEPROM(**int** dia, **int** rango, **bool** hora\_min)

{

**char** codigo\_hora=0;

**int** direccion\_eeprom=0;

*//Leo la hora y fecha programada*

direccion\_eeprom= (dia-1)\*8+rango;

codigo\_hora = EEPROM.read(direccion\_eeprom);

**if**(hora\_min == HORA)

**return**(codigo\_hora/4);

**else** *//if(hora\_min == MINUTOS)*

{

codigo\_hora=codigo\_hora%4; *//Agarro el resto (de 0 a 3)*

codigo\_hora=codigo\_hora\*15;*//Lo multiplico por 15*

**return**(codigo\_hora);

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Escribir\_Rangos\_EEPROM*

*//*

*// Descripción: Se escribe en la EEPROM el código generado por las horas y*

*// minutos en la dirección generada por el día y rango indicados*

*//*

*// Parámetros: int dia (LUNES, MARTES... etc)*

*// int rango (INICIO1, FIN1, INICIO2... etc)*

*// int hora*

*// int min (múltiplo de 15 preferentemente)*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Escribir\_Rangos\_EEPROM(**int** dia, **int** rango, **int** hora, **int** min)

{

**char** codigo\_hora=0;

**int** direccion\_eeprom=0;

direccion\_eeprom= (dia-1)\*8+rango;

codigo\_hora=((hora\*4)+(min/15));

EEPROM.write(direccion\_eeprom,codigo\_hora);

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Seleccion\_dias*

*//*

*// Descripción: Se utiliza el encoder para seleccionar el día de la semana*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Seleccion\_dias(**void**)

{

**switch**(diadelasemana)

{

default:

diadelasemana=DOMINGO;

**break**;

**case** DOMINGO:

*//Selecciono DOMINGO*

lcd.setCursor(0, 1);

lcd.write(byte(0));*//D seleccionada*

*//Deselecciono resto de dias*

*//Deselecciono SABADO*

lcd.setCursor(14, 1);

lcd.print(F("S"));

*//Deseleccionar\_dias(diadelasemana);*

*//Deselecciono LUNES*

lcd.setCursor(2, 1);

lcd.print(F("L"));

**break**;

**case** LUNES:

*//Selecciono LUNES*

lcd.setCursor(2, 1);

lcd.write(byte(1));*//L seleccionada*

*//Deselecciono DOMINGO*

lcd.setCursor(0, 1);

lcd.print(F("D"));

*//Deselecciono MARTES*

lcd.setCursor(4, 1);

lcd.print(F("Ma"));

**break**;

**case** MARTES:

*//Selecciono MARTES*

lcd.setCursor(4, 1);

lcd.write(byte(2));*//M seleccionada*

lcd.write(byte(3));*//a seleccionada*

*//Deselecciono LUNES*

lcd.setCursor(2, 1);

lcd.print(F("L"));

*//Deselecciono MIERCOLES*

lcd.setCursor(7, 1);

lcd.print(F("Mi"));

**break**;

**case** MIERCOLES:

*//Selecciono MIERCOLES*

lcd.setCursor(7, 1);

lcd.write(byte(2));*//M seleccionada*

lcd.write(byte(4));*//i seleccionada*

*//Deselecciono MARTES*

lcd.setCursor(4, 1);

lcd.print(F("Ma"));

*//Deselecciono JUEVES*

lcd.setCursor(10, 1);

lcd.print(F("J"));

**break**;

**case** JUEVES:

*//Selecciono JUEVES*

lcd.setCursor(10, 1);

lcd.write(byte(5));*//J seleccionada*

*//Deselecciono MIERCOLES*

lcd.setCursor(7, 1);

lcd.print(F("Mi"));

*//Deselecciono VIERNES*

lcd.setCursor(12, 1);

lcd.print(F("V"));

**break**;

**case** VIERNES:

*//Selecciono VIERNES*

lcd.setCursor(12, 1);

lcd.write(byte(6));*//V seleccionada*

*//Deselecciono JUEVES*

lcd.setCursor(10, 1);

lcd.print(F("J"));

*//Deselecciono SABADO*

lcd.setCursor(14, 1);

lcd.print(F("S"));

**break**;

**case** SABADO:

*//Selecciono SABADO*

lcd.setCursor(14, 1);

lcd.write(byte(7));*//S seleccionada*

*//Deselecciono VIERNES*

lcd.setCursor(12, 1);

lcd.print(F("V"));

*//Deselecciono DOMINGO*

lcd.setCursor(0, 1);

lcd.print(F("D"));

**break**;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Menu\_Principal*

*//*

*// Descripción: Muestra la fecha y la hora y utiliza el encoder para elegir*

*// ajustar la hora/fecha o configurar la programación*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Menu\_Principal(**void**)

{

**char** BufferAux[16];

*//Muestro la fecha y hora actual*

lcd.setCursor(0, 0);

**switch**(ActualTime.DoW)

{

default:

*//Distingo si me trae basura*

lcd.print(F("?"));

**break**;

**case** DOMINGO:

lcd.print(F("D"));

**break**;

**case** LUNES:

lcd.print(F("L"));

**break**;

**case** MARTES:

lcd.print(F("M"));

**break**;

**case** MIERCOLES:

lcd.print(F("X"));

**break**;

**case** JUEVES:

lcd.print(F("J"));

**break**;

**case** VIERNES:

lcd.print(F("V"));

**break**;

**case** SABADO:

lcd.print(F("S"));

**break**;

}

lcd.setCursor(1, 0);

sprintf(BufferAux," %02d/%02d/%02d %02d:%02d",ActualTime.dia,ActualTime.mes,ActualTime.anio,ActualTime.hora,ActualTime.min);

lcd.print(BufferAux);

lcd.setCursor(1, 1);

lcd.print(F("Reloj"));

lcd.setCursor(10, 1);

lcd.print(F("Config"));

*//Para la primera vez que entra aca*

*//if((proximo\_menu != MENU\_CONFIGURACION)&&(proximo\_menu != MENU\_AJUSTE\_FECHA\_HORA))*

**if**(proximo\_menu != MENU\_CONFIGURACION)

{

proximo\_menu = MENU\_AJUSTE\_FECHA\_HORA;

lcd.setCursor(0, 1);

*//lcd.write(byte(8));//Flecha señalando Reloj*

lcd.print(F(">"));

}

*/\**

*#ifdef DEBUG\_SERIE*

*Serial.print(F("proximo\_menu:"));*

*Serial.println(proximo\_menu);*

*#endif*

*\*/*

Seleccion\_Principal();

*//Hago titilar el ':' para que se vea que está vivo*

Efecto\_Titilar(13,0,1,50);

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Seleccion\_Principal*

*//*

*// Descripción: Dibuja una flecha en el menú seleccionado dentro del*

*// principal. Si se presiona ENTER, entra a ese menú.*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Seleccion\_Principal(**void**)

{

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** DERECHA:

lcd.setCursor(0, 1);

lcd.print(F(" "));

lcd.setCursor(9, 1);

*//lcd.write(byte(8));//Flecha señalando Config*

lcd.print(F(">"));

proximo\_menu = MENU\_CONFIGURACION;

delay(250);

**break**;

**case** IZQUIERDA:

lcd.setCursor(0, 1);

*//lcd.write(byte(8));//Flecha señalando Reloj*

lcd.print(F(">"));

lcd.setCursor(9, 1);

lcd.print(F(" "));

proximo\_menu = MENU\_AJUSTE\_FECHA\_HORA;

delay(250);

**break**;

**case** ENTER:

estado\_menu = proximo\_menu;

**break**;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Seleccion\_Configuracion*

*//*

*// Descripción: Muestra el menú Configuración y dibuja una flecha en el menu*

*// seleccionado. Si se presiona ENTER, entra a ese menu.*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Seleccion\_Configuracion(**void**)

{

lcd.setCursor(1, 0);

lcd.print(F("Prog. semanal"));

lcd.setCursor(1, 1);

lcd.print(F("Feriados"));

*//Para la primera vez que entra aca*

**if**((proximo\_menu != MENU\_PROGRAMA\_SEMANAL)&&(proximo\_menu != MENU\_FERIADOS))

{

lcd.setCursor(0, 0);

*//lcd.write(byte(8));//Flecha señalando Prog Semanal*

lcd.print(F(">"));

lcd.setCursor(0, 1);

lcd.print(F(" "));

proximo\_menu = MENU\_PROGRAMA\_SEMANAL;

delay(1000);

}

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** IZQUIERDA:

lcd.setCursor(0, 0);

*//lcd.write(byte(8));//Flecha señalando Prog Semanal*

lcd.print(F(">"));

lcd.setCursor(0, 1);

lcd.print(F(" "));

proximo\_menu = MENU\_PROGRAMA\_SEMANAL;

delay(250);

**break**;

**case** DERECHA:

lcd.setCursor(0, 0);

lcd.print(F(" "));

lcd.setCursor(0, 1);

*//lcd.write(byte(8));//Flecha señalando Feriados*

lcd.print(F(">"));

proximo\_menu = MENU\_FERIADOS;

delay(250);

**break**;

**case** ENTER:

estado\_menu = proximo\_menu;

**break**;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Reloj*

*//*

*// Descripción: Reloj en base al timer de 1seg para simular el RTC*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*/\**

*void Reloj(void){*

*if(ActualTime.seg >59)*

*{*

*ActualTime.seg=0;*

*ActualTime.min++;*

*if(ActualTime.min >59)*

*{*

*ActualTime.min=0;*

*ActualTime.hora++;*

*if(ActualTime.hora>23)*

*ActualTime.hora=0; //Faltaría cambiar de día*

*}*

*}*

*}*

*\*/*

#ifdef TIMER\_INTERNO

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: ISR\_Segundo*

*//*

*// Descripción: Timer de 1seg*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** ISR\_Segundo(**void**){

ActualTime.seg++;

**if**(tiempo\_sin\_pulsar>0)

tiempo\_sin\_pulsar--;

}

#endif

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Ajuste\_Reloj*

*//*

*// Descripción: Menú para modificar la hora y fecha actual usando el encoder*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Ajuste\_Reloj(**void**)

{

**char** BufferAux[16];

**switch**(estado\_ajuste)

{

default:

estado\_ajuste=0;

**break**;

**case** 0:

lcd.setCursor(0, 0);

lcd.print(F("Seleccione hora "));

lcd.setCursor(0, 1);

lcd.print(F("y fecha actual "));

delay(3000);

estado\_ajuste++;

**break**;

**case** 1:

*//Muestro la fecha y hora actual*

lcd.setCursor(0, 0);

lcd.print(F("Dia: "));

**switch**(ActualTime.DoW)

{

default:

*//Distingo si me trae basura*

lcd.print(F("?? "));

**break**;

**case** DOMINGO:

lcd.print(F("Do "));

**break**;

**case** LUNES:

lcd.print(F("Lu "));

**break**;

**case** MARTES:

lcd.print(F("Ma "));

**break**;

**case** MIERCOLES:

lcd.print(F("Mi "));

**break**;

**case** JUEVES:

lcd.print(F("Ju "));

**break**;

**case** VIERNES:

lcd.print(F("Vi "));

**break**;

**case** SABADO:

lcd.print(F("Sa "));

**break**;

}

sprintf(BufferAux,"%02d/%02d/%02d",ActualTime.dia,ActualTime.mes,ActualTime.anio);

lcd.print(BufferAux);

lcd.setCursor(0, 1);

sprintf(BufferAux,"Hora: %02d:%02d ",ActualTime.hora,ActualTime.min);

lcd.print(BufferAux);

AuxTime = ActualTime;*//Copio la estructura para modificarla*

estado\_ajuste++;

**break**;

**case** 2:

*//Modifico el día de la semana*

lcd.setCursor(5, 0);

**switch**(AuxTime.DoW)

{

default:

*//Distingo si me trae basura*

lcd.print(F("?? "));

**break**;

**case** DOMINGO:

lcd.print(F("Do "));

**break**;

**case** LUNES:

lcd.print(F("Lu "));

**break**;

**case** MARTES:

lcd.print(F("Ma "));

**break**;

**case** MIERCOLES:

lcd.print(F("Mi "));

**break**;

**case** JUEVES:

lcd.print(F("Ju "));

**break**;

**case** VIERNES:

lcd.print(F("Vi "));

**break**;

**case** SABADO:

lcd.print(F("Sa "));

**break**;

}

**if**(digitalRead(Encoder\_Switch)==0)*//ENTER*

{

estado\_ajuste++;

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

}

**else**

{

AuxTime.DoW=Modificar\_Variable(AuxTime.DoW,1,7);

Efecto\_Titilar(5,0,2,100);

}

**break**;

**case** 3:

*//Modifico el día*

lcd.setCursor(8, 0);

sprintf(BufferAux,"%02d",AuxTime.dia);

lcd.print(BufferAux);

**if**(digitalRead(Encoder\_Switch)==0)*//ENTER*

{

estado\_ajuste++;

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

}

**else**

{

AuxTime.dia=Modificar\_Variable(AuxTime.dia,1,31);

Efecto\_Titilar(8,0,2,100);

}

**break**;

**case** 4:

*//Modifico el mes*

lcd.setCursor(11, 0);

sprintf(BufferAux,"%02d",AuxTime.mes);

lcd.print(BufferAux);

**if**(digitalRead(Encoder\_Switch)==0)*//ENTER*

{

**if**(Validar\_Fecha(AuxTime.dia,AuxTime.mes)==false)

{

lcd.setCursor(0, 0);

lcd.print(F("La fecha elegida"));

lcd.setCursor(0, 1);

lcd.print(F(" no existe "));

delay(3000);

estado\_ajuste=0;

estado\_menu=MENU\_PRINCIPAL;

}

**else**

estado\_ajuste++;

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

}

**else**

{

AuxTime.mes=Modificar\_Variable(AuxTime.mes,1,12);

Efecto\_Titilar(11,0,2,100);

}

**break**;

**case** 5:

*//Modifico el año*

lcd.setCursor(14, 0);

sprintf(BufferAux,"%02d",AuxTime.anio);

lcd.print(BufferAux);

**if**(digitalRead(Encoder\_Switch)==0)*//ENTER*

{

**if**((AuxTime.dia==29)&&(AuxTime.mes==2)&&(AuxTime.anio%4!=0))

{

lcd.setCursor(0, 0);

lcd.print(F("La fecha elegida"));

lcd.setCursor(0, 1);

lcd.print(F(" no existe "));

delay(3000);

estado\_ajuste=0;

estado\_menu=MENU\_PRINCIPAL;

}

**else**

estado\_ajuste++;

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

}

**else**

{

AuxTime.anio=Modificar\_Variable(AuxTime.anio,0,99);*//De 2023 a 2099*

Efecto\_Titilar(14,0,2,100);

}

**break**;

**case** 6:

*//Modifico la hora*

lcd.setCursor(8, 1);

sprintf(BufferAux,"%02d",AuxTime.hora);

lcd.print(BufferAux);

**if**(digitalRead(Encoder\_Switch)==0)*//ENTER*

{

estado\_ajuste++;

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

}

**else**

{

AuxTime.hora=Modificar\_Variable(AuxTime.hora,0,23);

Efecto\_Titilar(8,1,2,100);

}

**break**;

**case** 7:

*//Modifico los minutos*

lcd.setCursor(11, 1);

sprintf(BufferAux,"%02d",AuxTime.min);

lcd.print(BufferAux);

**if**(digitalRead(Encoder\_Switch)==0)*//ENTER*

{

estado\_ajuste++;

**while**(digitalRead(Encoder\_Switch)==0)

{

*//Espero a que suelte el pulsador*

};

}

**else**

{

AuxTime.min=Modificar\_Variable(AuxTime.min,0,59);

Efecto\_Titilar(11,1,2,100);

}

**break**;

**case** 8:

lcd.setCursor(0, 0);

lcd.print(F(" Modificacion "));

lcd.setCursor(0, 1);

lcd.print(F(" exitosa "));

*//Copio la hora seleccionada en la actual*

AuxTime.seg = 0;

ActualTime = AuxTime;

*//Como la fecha es válida guardo fecha y hora en el RTC*

RTC.setSecond(0);

RTC.setMinute(ActualTime.min);

RTC.setHour(ActualTime.hora);

RTC.setDoW(ActualTime.DoW);

RTC.setDate(ActualTime.dia);

RTC.setMonth(ActualTime.mes);

RTC.setYear(ActualTime.anio);

RTC.setClockMode(h12);

delay(3000);

estado\_ajuste=0;

estado\_menu=MENU\_PRINCIPAL;

modificacion\_realizada=1;

**break**;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Validar\_Fecha*

*//*

*// Descripción: Verifica que la combinación dia/mes exista*

*//*

*// Parámetros: dia y mes*

*//*

*// Valor devuelto: bool: true (fecha valida) false (fecha inexistente)*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**bool** Validar\_Fecha(**int** dia,**int** mes)

{

**if**(dia>cant\_dias\_mes[mes-1])

{

#ifdef DEBUG\_SERIE

Serial.print("cant dias del mes:");

Serial.print(cant\_dias\_mes[mes-1]);

#endif

**return** false;

}

**else**

**return** true;

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Efecto\_Titilar*

*//*

*// Descripción: Efecto que hace titilar los digitos de pantalla cada 1 seg*

*//*

*// Parámetros: int col (columna inicial)*

*// int fila (fila inicial)*

*// int digitos (digitos a hacer titilar)*

*// int delay\_ms (para ajustar el tiempo en off)*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Efecto\_Titilar(**int** col,**int** fila,**int** digitos,**int** delay\_ms)

{

**if**(ActualTime.seg != seg\_anterior)

{

lcd.setCursor(col,fila);

**for**(**int** i=0; i<digitos;i++)

lcd.print(F(" "));

delay(delay\_ms);

seg\_anterior=ActualTime.seg;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Modificar\_Variable*

*//*

*// Descripción: Permite modificar una variable con el encoder entre un*

*// mínimo y un máximo*

*//*

*// Parámetros: int variable\_a\_modificar*

*// int minimo*

*// int maximo*

*//*

*// Valor devuelto: int: devuelve la variable modificada*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**int** Modificar\_Variable(**int** variable\_a\_modificar, **int** minimo, **int** maximo)

{

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** DERECHA:

variable\_a\_modificar++;

**if**(variable\_a\_modificar > maximo)

variable\_a\_modificar=minimo;

**break**;

**case** IZQUIERDA:

variable\_a\_modificar--;

**if**(variable\_a\_modificar < minimo)

variable\_a\_modificar=maximo;

**break**;

}

**return**(variable\_a\_modificar);

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Menu\_Feriados*

*//*

*// Descripción: Muestra los feriados y permite agregar o quitar.*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Menu\_Feriados(**void**)

{

**char** BufferAux[30];

**switch**(estado\_menu\_feriados)

{

default:

estado\_menu\_feriados=0;

**break**;

**case** 0:

*//Parto desde la hora actual*

AuxTime = ActualTime;

estado\_menu\_feriados++;

**break**;

**case** 1:

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** DERECHA:

AuxTime.dia++;

**if**(AuxTime.dia > cant\_dias\_mes[AuxTime.mes-1])

{

AuxTime.dia=1;

AuxTime.mes++;

**if**(AuxTime.mes>12)

AuxTime.mes=1;

}

**break**;

**case** IZQUIERDA:

AuxTime.dia--;

**if**(AuxTime.dia < 1)

{

AuxTime.mes--;

**if**(AuxTime.mes<1)

AuxTime.mes=12;

AuxTime.dia=cant\_dias\_mes[AuxTime.mes-1];

}

**break**;

**case** ENTER:

estado\_menu\_feriados++;

lcd.setCursor(0, 1);

lcd.print(F(">"));

lcd.setCursor(0, 0);

sprintf(BufferAux,"%02d/%02d",AuxTime.dia,AuxTime.mes);

lcd.print(BufferAux);

**return**;

**break**;

}

lcd.setCursor(0, 0);

sprintf(BufferAux,"%02d/%02d",AuxTime.dia,AuxTime.mes);

lcd.print(BufferAux);

lcd.setCursor(6, 0);

**if**(verificaFeriado(AuxTime.dia,AuxTime.mes) == true)

{

lcd.print(F("es feriado"));

lcd.setCursor(1, 1);

lcd.print(F("Eliminar"));

feriado = ES\_FERIADO;

}

**else**

{

lcd.print(F(" "));

lcd.setCursor(1, 1);

lcd.print(F("Agregar "));

feriado = NO\_ES\_FERIADO;

}

cursor\_feriado=0;

lcd.setCursor(11, 1);

lcd.print(F("Salir"));

*//Hago titilar a los números*

Efecto\_Titilar(0,0,5,100);

lcd.setCursor(2, 0);

lcd.print(F("/"));

**break**;

**case** 2:

*//Elijo entre Agregar/Eliminar o Salir*

**switch**(Leer\_Encoder())

{

default:

**break**;

**case** DERECHA:

cursor\_feriado=1;

lcd.setCursor(0, 1);

lcd.print(F(" "));

lcd.setCursor(10, 1);

lcd.print(F(">"));

**break**;

**case** IZQUIERDA:

cursor\_feriado=0;

lcd.setCursor(0, 1);

lcd.print(F(">"));

lcd.setCursor(10, 1);

lcd.print(F(" "));

**break**;

**case** ENTER:

estado\_menu\_feriados++;

**break**;

}

**break**;

**case** 3:

**if**(cursor\_feriado == 0)

{

modificacion\_realizada=true;

lcd.setCursor(0, 0);

*// Modifico el estado actual*

**if**(feriado== ES\_FERIADO)

{

seteaFeriado(AuxTime.dia, AuxTime.mes, NO\_ES\_FERIADO);

sprintf(BufferAux,"%02d/%02d se quita ",AuxTime.dia,AuxTime.mes);

lcd.print(BufferAux);

lcd.setCursor(0, 1);

lcd.print(F("de los feriados "));

}

**else**

{

seteaFeriado(AuxTime.dia, AuxTime.mes, ES\_FERIADO);

sprintf(BufferAux,"%02d/%02d se agrega ",AuxTime.dia,AuxTime.mes);

lcd.print(BufferAux);

lcd.setCursor(0, 1);

lcd.print(F("a los feriados "));

}

delay(3000);

*//Me permite seguir eligiendo feriados*

estado\_menu\_feriados=1;

lcd.clear();

}

**else**

{

*//Presionó Salir*

estado\_menu\_feriados=0;

estado\_menu=MENU\_PRINCIPAL;

}

**break**;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: verificaFeriado*

*//*

*// Descripción: Chequea en la EEPROM si hoy es feriado*

*//*

*// Parámetros: int dia, int mes*

*//*

*// Valor devuelto: bool: true (es feriado), false (no es feriado)*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**bool** verificaFeriado(**int** dia, **int** mes)

{

*//Obtenemos el dia del año en formato "M|D"*

**int** indexMonthEeprom = mes - 1;

**int** daysAccum = 0;

**for**(**int** i = 0; i < indexMonthEeprom; i++)

{

daysAccum += cant\_dias\_mes[i];

}

daysAccum += ULTIMA\_POSICION\_EVENTOS + dia;

**if**(EEPROM.read(daysAccum) == ES\_FERIADO)

{

#ifdef DEBUG\_SERIE

Serial.print(F("Feriado detectado\n"));

#endif

**return** true;

}

**else**

{

**return** false;

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: seteaFeriado*

*//*

*// Descripción: Setea como feriado el conjunto dia/mes recibido guardandolo*

*// en EEPROM*

*//*

*// Parámetros: int dia, int mes, bool feriado (para indicar si es o no es)*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** seteaFeriado(**int** dia, **int** mes, **bool** feriado)

{

**int** indexMonthEeprom = mes - 1;

**int** daysAccum = 0;

**char** buff\_aux[4];

**for**(**int** i = 0; i < indexMonthEeprom; i++)

{

daysAccum += cant\_dias\_mes[i];

}

daysAccum += ULTIMA\_POSICION\_EVENTOS + dia;

EEPROM.write(daysAccum, feriado);

*//Trato de guardar los cambios si hay uSD*

Guardar\_Cambios\_uSD();

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: Guardar\_Cambios\_uSD*

*//*

*// Descripción: Si está colocada la microSD, guarda las modificaciones*

*// ya sea de feriados o de eventos*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** Guardar\_Cambios\_uSD(**void**)

{

**char** buff\_feriado[4];

**char** buff\_eventos[6];

**int** valor;

*//Estructura para el archivo de la uSD*

File myFile;

*//Borro el archivo actual para crear uno nuevo*

SD.remove("feriados.txt");

myFile = SD.open("feriados.txt",FILE\_WRITE);

**if**(myFile)

{

*//Guardo los feriados*

**for**(**int** i=PRIMERA\_POSICION\_FERIADOS; i<=ULTIMA\_POSICION\_FERIADOS;i++)

{

**if**(EEPROM.read(i)==1)

{

sprintf(buff\_feriado,"%d,",i);

myFile.print(buff\_feriado);

#ifdef DEBUG\_SERIE

Serial.print(buff\_feriado);

#endif

}

}

*//Ya terminé con los feriados*

myFile.print('|');

*//Guardo los eventos*

**for**(**int** i=PRIMERA\_POSICION\_EVENTOS; i<=ULTIMA\_POSICION\_EVENTOS;i++)

{

*//Guardo posicion:valor, asegurandome que tanto posicion como valor ocupen 2 dígitos*

valor = EEPROM.read(i);

**if**(valor > MAX\_VALOR\_HORARIOS)

valor=0;

sprintf(buff\_eventos, "%02d:%02d,", i, valor);

myFile.print(buff\_eventos);

#ifdef DEBUG\_SERIE

Serial.print(buff\_eventos);

#endif

}

*//Ya terminé con los eventos*

myFile.print('.');

myFile.close();

}

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: configuraInterrupcionRTC*

*//*

*// Descripción: Configura la Interrupción del RTC*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** configuraInterrupcionRTC (**void**)

{

*// Set alarm 1 to fire at one-second intervals*

RTC.turnOffAlarm(1);

RTC.setA1Time(0, 0, 0, 0, alarmBits, false, false, false);

*// enable Alarm 1 interrupts*

RTC.turnOnAlarm(1);

*// clear Alarm 1 flag*

RTC.checkIfAlarm(1);

pinMode(CLINT, INPUT\_PULLUP);

attachInterrupt(digitalPinToInterrupt(CLINT), isr\_TickTock, FALLING);

*// Use builtin LED to blink*

*//pinMode(LED\_BUILTIN, OUTPUT);*

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: isr\_TickTock*

*//*

*// Descripción: Interrupción del RTC*

*//*

*// Parámetros: void*

*//*

*// Valor devuelto: void*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** isr\_TickTock(**void**) {

*// interrupt signals to loop*

tick = 1;

**return**;

}

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

*// Función: loop*

*//*

*// Descripción: Bucle principal del programa*

*//*

*//\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\**

**void** loop(){

#ifdef DEBUG\_SERIE

**char** BufferAux[50];

#endif

**int** min\_aux, seg\_aux;

*//Reloj();*

**if**(estado\_menu != estado\_menu\_anterior)

{

lcd.clear();

*//proximo\_menu = 0;*

estado\_menu\_anterior = estado\_menu;

delay(300);

}

**switch**(estado\_menu)

{

default:

**case** MENU\_PRINCIPAL:

Menu\_Principal();

**break**;

**case** MENU\_AJUSTE\_FECHA\_HORA:

Ajuste\_Reloj();

**break**;

**case** MENU\_CONFIGURACION:

Seleccion\_Configuracion();

**break**;

**case** MENU\_PROGRAMA\_SEMANAL:

Programacion\_Semanal();

**break**;

**case** MENU\_FERIADOS:

Menu\_Feriados();

**break**;

**case** MENU\_CAMBIOS\_SD:

lcd.clear();

digitalWrite(Salida\_Backlight,0);*//se enciende el backlight*

tiempo\_sin\_pulsar=TIEMPO\_PARA\_APAGAR\_LCD;

lcd.setCursor(0, 0);

lcd.print(F("Leyendo memoria"));

delay(2000);*//2seg*

lcd.setCursor(0, 0);

lcd.print(F(" Modificaciones "));

lcd.setCursor(0, 1);

lcd.print(F(" realizadas "));

delay(4000);*//4seg*

modificacion\_realizada=1;

estado\_menu = MENU\_PRINCIPAL;

**break**;

}

min\_aux=RTC.getMinute();

seg\_aux=RTC.getSecond();

*//El tick no lo estamos utilizando*

**if**(seg\_aux != seg\_ant)

{

*//Aca entra cada 1seg*

ActualTime.seg++;

*//Cada 5 segundos me fijo si metieron una uSD para cargar los feriados*

**if**(ActualTime.seg%10==0)

leerFeriadosDeSd();

**if**(tiempo\_sin\_pulsar>0)

tiempo\_sin\_pulsar--;

**if**((min\_aux != min\_ant)||(modificacion\_realizada))

{

*//Aca entra cada un minuto o cuando se haga una modificación en el Reloj o en los Rangos*

Leer\_Fecha\_Hora\_RTC(ActualTime);

*//Si cambia el día, leo los rangos permitidos*

**if**((ultimo\_dia != ActualTime.DoW)||(modificacion\_realizada))

{

Cargar\_Rangos();

ultimo\_dia=ActualTime.DoW;

}

modificacion\_realizada=0;

codigo\_hora\_actual = (ActualTime.hora\*4)+(ActualTime.min/15);

**if**(codigo\_hora\_actual != codigo\_hora\_actual\_anterior)

{

#ifdef DEBUG\_SERIE

sprintf(BufferAux,"Codigo actual: %d\n",codigo\_hora\_actual);

Serial.print(BufferAux);

#endif

codigo\_hora\_actual\_anterior=codigo\_hora\_actual;

}

*//Sólo con esto manejo la salida*

**if**((((codigo\_hora\_actual>=Rangos\_hoy[INICIO\_1])&&(codigo\_hora\_actual<Rangos\_hoy[FIN\_1]))|| ((codigo\_hora\_actual>=Rangos\_hoy[INICIO\_2])&&(codigo\_hora\_actual<Rangos\_hoy[FIN\_2]))||

((codigo\_hora\_actual>=Rangos\_hoy[INICIO\_3])&&(codigo\_hora\_actual<Rangos\_hoy[FIN\_3]))|| ((codigo\_hora\_actual>=Rangos\_hoy[INICIO\_4])&&(codigo\_hora\_actual<Rangos\_hoy[FIN\_4])))&& (!verificaFeriado(ActualTime.dia,ActualTime.mes)))

{

*//Si no es feriado y se encuentra dentro de alguno de los rangos programados, alimento la carga*

digitalWrite(Salida\_Rele,1);

}

**else**

{

*//Si se encuentra fuera de los rangos dejo de alimentar la carga*

digitalWrite(Salida\_Rele,0);

}

*// Clear Alarm 1 flag*

RTC.checkIfAlarm(1);

}

}

min\_ant = min\_aux;

seg\_ant = seg\_aux;

*//Controlo el backlight del lcd*

**if**(!tiempo\_sin\_pulsar)

digitalWrite(Salida\_Backlight,1);*//Si pasa cierto tiempo en el que no se tocó el encoder, se apaga el display*

**else**

digitalWrite(Salida\_Backlight,0);*//Si se toca el encoder, se enciende*

}

## 

## 4.2. Guardado de datos en memoria

Para guardar los datos relacionados a la programación del equipo se ha utilizado la memoria EEPROM interna del ATMEGA328P (1 KB de memoria). Las primeras 56 posiciones (0 a 55) se utilizaron para la programación de los eventos semanales, mientras que las siguientes 365 posiciones se utilizaron para indicar los días feriados.

* *Eventos*

Se establecieron los siguientes parámetros:

|  |  |
| --- | --- |
| LUNES | 0 |
| MARTES | 1 |
| MIÉRCOLES | 2 |
| JUEVES | 3 |
| VIERNES | 4 |
| SÁBADO | 5 |
| DOMINGO | 6 |
|  |  |
| ENCENDIDO\_1 | 0 |
| APAGADO\_1 | 1 |
| ENCENDIDO\_2 | 2 |
| APAGADO\_2 | 3 |
| ENCENDIDO\_3 | 4 |
| APAGADO\_3 | 5 |
| ENCDENDIDO\_4 | 6 |
| APAGADO\_4 | 7 |

La posición de memoria que representa cada combinación se obtiene con la siguiente fórmula:

Además, para cada horario del día se genera un código, el cual se guarda en esa posición de memoria. Este código puede ser un valor entre 0 y 95, y se obtiene de la siguiente fórmula:

Hay que recordar que los lapsos de horarios son cada 15 minutos.

**Ejemplo:**

Si se quiere guardar que el tercer encendido del jueves ocurra a las 19:45, el código realizará lo siguiente:

Se obtiene en la EEPROM:

|  |  |
| --- | --- |
| **Posición** | **Dato** |
| 28 [0x1C] | 79 [0x4F] |

* *Feriados*

Cada día del año, incluyendo al 29 de febrero, tiene asignada una posición de memoria, comenzando desde el 01/01 (posición 56 [0x38]) hasta el 31/12 (posición 421 [0x1A5]).

Si el día es considerado feriado, guardará un 1 en su respectiva posición. En cambio, si no lo es, guardará un 0.

* *Archivo “feriados.txt”*

El archivo “feriados.txt” es un archivo de texto que puede ser interpretado y escrito, tanto por el dispositivo como por el software desarrollado.

Para la correcta interpretación de los datos generados, se debe tener en cuenta que el formato en el que se guardan los datos es el siguiente:

*posicion\_feriado\_1,posicion\_feriado\_2,…,posicion\_feriado\_N,|posicion\_rango\_1:codigo\_horario\_rango1, posicion\_rango\_2: codigo\_horario \_rango2,…, posicion\_rango\_N: codigo\_horario \_rango\_N,.*

Será fundamental que se respete el orden y los símbolos separadores para la correcta interpretación de los datos.

Se interpretará como feriado a todos los días cuya posición se encuentre en el archivo, mientras que las posiciones que no aparezcan, se las tomará como días no feriados. Para su correcta interpretación, estas posiciones deben estar ordenadas de menor a mayor.

En cuanto a los rangos de eventos, se cargarán en el dispositivo los rangos que aparezcan en el archivo siempre y cuando tengan un código horario valido. Si algún rango de eventos no aparece en el archivo, mantiene el valor previo sin ninguna modificación.

A continuación, se muestra el contenido del archivo Default. El mismo contiene todos los feriados del año 2023, y tiene como rangos de encendido los horarios en los que la facultad permanece abierta.

56,106,107,139,148,153,177,201,202,224,226,227,246,289,342,345,380,398,415,|00:32,01:48,02:56,03:72,04:76,05:92,06:00,07:00, 08:32,09:48,10:56,11:72,12:76,13:92,14:00,15:00, 16:32,17:48,18:56,19:72,20:76,21:92,22:00,23:00, 24:32,25:48,26:56,27:72,28:76,29:92,30:00,31:00, 32:32,33:48,34:56,35:72,36:76,37:92,38:00,39:00, 40:32,41:48,42:56,43:72,44:00,45:00,46:00,47:00, 48:00,49:00,50:00,51:00,52:00,53:00,54:00,55:00,.

# 5. Software

A continuación, se documenta el software para la creación del archivo *feriados.txt*, al cual se le puede cargar feriados y rangos para luego ser leídos por el dispositivo.

El Proyecto en Java 8 se compone de una clase ProyectoPotencia.java que contiene la clase **main** y se crean 3 clases (Dia, Evento y Mes) para crear instancias de estas y usarlas en la clase principal.

Para ejecutar el programa se requiere tener instalado java 8 o una versión superior y ejecutar en consola el comando:  
  
*java -jar Proyecto\_Potencia\_2023.jar*

Se adjunta el detalle de las clases descritas anteriormente:

**Clase ProyectoPotencia.java**

package proyecto**.**potencia**;**

**import** java**.**util**.**ArrayList**;**

**import** java**.**util**.**List**;**

**import** java**.**util**.**OptionalInt**;**

**import** java**.**util**.**Scanner**;**

**import** java**.**util**.**stream**.**Collectors**;**

**import** java**.**util**.**stream**.**IntStream**;**

**import** java**.**io**.**File**;**

**import** java**.**io**.**FileWriter**;**

**import** java**.**io**.**IOException**;**

**import** java**.**util**.**Collections**;**

**import** java**.**util**.**HashMap**;**

/\*\*

\*

\* **@author** ELECTRONICA DE POTENCIA - SOFTWARE PARA CARGA DE FERIADOS Y RANGOS EN

\* SD

\*

\* Clase ProyectoPotencia con metodo Main

\*

\*/

public class ProyectoPotencia **{**

//Listado de Meses

private static List**<**Mes**>** meses **=** **new** ArrayList**<>();**

//Se inicializan los meses con un id

private static Mes enero **=** **new** Mes**(**1**,** "Enero"**);**

private static Mes febrero **=** **new** Mes**(**2**,** "Febrero"**);**

private static Mes marzo **=** **new** Mes**(**3**,** "Marzo"**);**

private static Mes abril **=** **new** Mes**(**4**,** "Abril"**);**

private static Mes mayo **=** **new** Mes**(**5**,** "Mayo"**);**

private static Mes junio **=** **new** Mes**(**6**,** "Junio"**);**

private static Mes julio **=** **new** Mes**(**7**,** "Julio"**);**

private static Mes agosto **=** **new** Mes**(**8**,** "Agosto"**);**

private static Mes septiembre **=** **new** Mes**(**9**,** "Septiembre"**);**

private static Mes octubre **=** **new** Mes**(**10**,** "Octubre"**);**

private static Mes noviembre **=** **new** Mes**(**11**,** "Noviembre"**);**

private static Mes diciembre **=** **new** Mes**(**12**,** "Diciembre"**);**

//Listado de dias de la semana

private static List**<**Dia**>** dias **=** **new** ArrayList**<>();**

//Se inicializan los dias de la semana con un id

private static Dia lunes **=** **new** Dia**(**1**,** "Lunes"**);**

private static Dia martes **=** **new** Dia**(**2**,** "Martes"**);**

private static Dia miercoles **=** **new** Dia**(**3**,** "Miercoles"**);**

private static Dia jueves **=** **new** Dia**(**4**,** "Jueves"**);**

private static Dia viernes **=** **new** Dia**(**5**,** "Viernes"**);**

private static Dia sabado **=** **new** Dia**(**6**,** "Sábado"**);**

private static Dia domingo **=** **new** Dia**(**0**,** "Domingo"**);**

private static HashMap**<**Integer**,** Integer**>** decoMeses **=** **new** HashMap**<>();**

private static HashMap**<**Integer**,** Integer**>** decoDias **=** **new** HashMap**<>();**

public static void main**(**String**[]** args**)** **{**

String logo **=** " \n"

**+** " \n"

**+** " \n"

**+** " ..:::^^^^^^:::.. \n"

**+** " .:^~!77777?????????7777!~^:. \n"

**+** " .^!77??JJY55PPPPPPP55YJJ??77???77!^. \n"

**+** " :~77???JY555PPPPGGBB#&@@@@@&#GPY?777??77~: \n"

**+** " .^!???777777777777777777??J5PB&@@@@&#PY?77???7^. \n"

**+** " .~7??77?JY5PGB######BBGP5J?77777?JP#@@@@@&GJ777??7~. \n"

**+** " .~7????Y5PPGPPPPPPGBB#&@@@@@&#G5J77777JP&@@@@@BY777??7~. \n"

**+** " :7??77????7777777777777?JYPB&@@@@@#5?7777?5#@@@@@BJ777??7: \n"

**+** " ~??777777?JY5PGGGGP55J?777777?5B&@@@@&G?7777?5&@@@@@57777??~ \n"

**+** " ~??777?YPB&@@@@@@@@@@@@&#GY?77777JG&@@@@&577777?B@@@@@G7777??~ \n"

**+** " ~??77?P#@@@@@@@@@@@@@@@@@@@@&PJ77777JB@@@@@B?77777P@@@@@G77777?~ \n"

**+** " ^??7?P&@@@@@@@@@@@@@@@@@@@@@@@@&P?77777P@@@@@B?77777G@@@@@57777??^ \n"

**+** " .7?7J#@@@@@@@@@@@@@@@@@@@@@@@@@@@@B?77777P@@@@@G77777?&@@@@&?7777?7. \n"

**+** " ~?7?#@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@B?7777?#@@@@@J77777G@@@@@577777?~ \n"

**+** " 7?7G@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@5777775@@@@@P777775@@@@@G77777?7. \n"

**+** " .77J@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@#77777J@@@@@B77777J@@@@@B77777?7. \n"

**+** " :?7JGGGP#@@@@@@@@@@@@@@@@@GGGGGG@@@@@&PPPP5P@@@@@#55555G@@@@@&555PJ7?: \n"

**+** " .7?77777P@@@@@@@@@@@@@@@@&?7777?&@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@Y7?: \n"

**+** " .7?77777Y@@@@@@@@@@@@@@@@@Y77777P@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@B??7. \n"

**+** " ~?77777?#@@@@@@@@@@@@@@@@B77777?B@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@&J7?! \n"

**+** " :7?77777Y@@@@@@@@@@@@@@@@@577777?G@@@@@@@@@@@@@@@@@@@@@@@@@@@@#J7??: \n"

**+** " ~?777777P@@@@@@@@@@@@@@@@@Y777777Y#@@@@@@@@@@@@@@@@@@@@@@@@&P?77?~ \n"

**+** " !?777777P@@@@@@@@@@@@@@@@@P?777777YB&@@@@@@@@@@@@@@@@@@@#P?777?!. \n"

**+** " .!??777775&@@@@@@@@@@@@@@@@#Y?777777?YG#&@@@@@@@@@@@&BPJ?7777?!. \n"

**+** " ~??77777JB@@@@@@@@@@@@@@@@@#5J77777777?JY55PPP55YJ?777777??!. \n"

**+** " ^7??77777Y#@@@@@@@@@@@@@@@@@&BPY?77777777777777777??77??7^ \n"

**+** " .!???77777YB&@@@@@@@@@@@@@@@@@@&#BP5YJJJJJJJYY5GG5?7??!. \n"

**+** " :!???77777?5B&@@@@@@@@@@@@@@@@@@@@@@@@@@@@@&#PJ7??!: \n"

**+** " :~7???77777?YPB&@@@@@@@@@@@@@@@@@@@@@&BGY?7??7~: \n"

**+** " .^!7????77777?JYPGBB##&&&&&&##BGPYJ?77??7!^. \n"

**+** " .:~!7?????7777777?????????7777???7!~:. \n"

**+** " .:^~!77????????????????77!~^:. \n"

**+** " .::^^^~~~~~~^^^::. \n"

**+** " \n"

**+** " ------------------------------------------------------------------------------------------------ \n"

**+** " UNLAM - Electronica de Potencia - 1° Cuatrimestre 2023 \n"

**+** " ------------------------------------------------------------------------------------------------ \n"

**+** " "**;**

System**.**out**.**println**(**logo**);**

System**.**out**.**println**(**"MENU: "**);**

System**.**out**.**println**(**""**);**

//INICIALIZACIONES

meses**.**add**(**enero**);**

meses**.**add**(**febrero**);**

meses**.**add**(**marzo**);**

meses**.**add**(**abril**);**

meses**.**add**(**mayo**);**

meses**.**add**(**junio**);**

meses**.**add**(**julio**);**

meses**.**add**(**agosto**);**

meses**.**add**(**septiembre**);**

meses**.**add**(**octubre**);**

meses**.**add**(**noviembre**);**

meses**.**add**(**diciembre**);**

decoMeses**.**put**(**1**,** 31**);**

decoMeses**.**put**(**2**,** 29**);**

decoMeses**.**put**(**3**,** 31**);**

decoMeses**.**put**(**4**,** 30**);**

decoMeses**.**put**(**5**,** 31**);**

decoMeses**.**put**(**6**,** 30**);**

decoMeses**.**put**(**7**,** 31**);**

decoMeses**.**put**(**8**,** 31**);**

decoMeses**.**put**(**9**,** 30**);**

decoMeses**.**put**(**10**,** 31**);**

decoMeses**.**put**(**11**,** 30**);**

decoMeses**.**put**(**12**,** 31**);**

dias**.**add**(**lunes**);**

dias**.**add**(**martes**);**

dias**.**add**(**miercoles**);**

dias**.**add**(**jueves**);**

dias**.**add**(**viernes**);**

dias**.**add**(**sabado**);**

dias**.**add**(**domingo**);**

decoDias**.**put**(**0**,** 0**);**

decoDias**.**put**(**1**,** 8**);**

decoDias**.**put**(**2**,** 16**);**

decoDias**.**put**(**3**,** 24**);**

decoDias**.**put**(**4**,** 32**);**

decoDias**.**put**(**5**,** 40**);**

decoDias**.**put**(**6**,** 48**);**

//Se cargan en una lista los items del menu

List**<**String**>** lista **=** **new** ArrayList**<>();**

lista**.**add**(**"Cargar Feriados"**);**

lista**.**add**(**"Ver Feriados Cargados"**);**

lista**.**add**(**"Eliminar todos los feriados"**);**

lista**.**add**(**"Eliminar un Feriado"**);**

lista**.**add**(**"Cargar Rangos"**);**

lista**.**add**(**"Ver Rangos Cargados"**);**

lista**.**add**(**"Eliminar todos los rangos"**);**

lista**.**add**(**"Eliminar un Rango"**);**

lista**.**add**(**"Guardar Feriados en SD y Dias"**);**

lista**.**add**(**"Leer SD"**);**

lista**.**add**(**"Salir"**);**

Scanner scanner **=** **new** Scanner**(**System**.**in**);**

//Se despliega el menu en consola

**while** **(true)** **{**

System**.**out**.**println**(**"Selecciona un elemento de la lista (ingresa el índice):"**);**

**for** **(**int i **=** 0**;** i **<** lista**.**size**();** i**++)** **{**

System**.**out**.**println**(**i **+** ": " **+** lista**.**get**(**i**));**

**}**

int indiceSeleccionado **=** scanner**.**nextInt**();**

**if** **(**indiceSeleccionado **>=** 0 **&&** indiceSeleccionado **<** lista**.**size**())** **{**

**switch** **(**indiceSeleccionado**)** **{**

**case** 0**:**

cargarFeriados**(**scanner**);**

**break;**

**case** 1**:**

verFeriadosCargados**();**

**break;**

**case** 2**:**

eliminarTodoLosFeriados**();**

**break;**

**case** 3**:**

eliminarUnFeriado**(**scanner**);**

**break;**

**case** 4**:**

cargarEventos**(**scanner**);**

**break;**

**case** 5**:**

verEentosCargados**();**

**break;**

**case** 6**:**

eliminarTodoLosEventos**();**

**break;**

**case** 7**:**

eliminarUnEvento**(**scanner**);**

**break;**

**case** 8**:**

guardarCalendarioEnSD**(**scanner**);**

**break;**

**case** 9**:**

leersd**(**scanner**);**

**break;**

**case** 10**:**

System**.**exit**(**0**);**

**}**

**}** **else** **{**

System**.**out**.**println**(**"Índice inválido. No se seleccionó ningún elemento."**);**

**}**

**}**

**}**

//Este Metodo permite cargar feriados en el formato especificado

private static void cargarFeriados**(**Scanner scanner**)** **{**

**while** **(true)** **{**

clearScreen**();**

System**.**out**.**println**(**"Escriba el feriado en formato dd/mm: "**);**

String feriado **=** scanner**.**next**();**

int mes **=** Integer**.**parseInt**(**feriado**.**split**(**"/"**)[**1**]);**

int dia **=** Integer**.**parseInt**(**feriado**.**split**(**"/"**)[**0**]);**

//Busco el mes en el array

Mes mesBuscado **=** meses**.**stream**()**

**.**filter**(**m **->** m**.**indice **==** mes**)**

**.**collect**(**Collectors**.**toList**()).**get**(**0**);**

//Cargo el feriado al array de dias en el mes

mesBuscado**.**feriados**.**add**(**dia**);**

//Obtengo el indice del mes del array

OptionalInt indexMeses **=** IntStream**.**range**(**0**,** meses**.**size**())**

**.**filter**(**i **->** mes **==** meses**.**get**(**i**).**indice**)**

**.**findFirst**();**

meses**.**set**(**indexMeses**.**getAsInt**(),** mesBuscado**);**

System**.**out**.**println**(**"Se agregó el feriado: " **+** dia **+** " de " **+** mesBuscado**.**name**);**

System**.**out**.**println**(**"¿Desea agregar otro feriado? (s/n)"**);**

String agregarOtroferiado **=** scanner**.**next**();**

**if** **(!**agregarOtroferiado**.**equalsIgnoreCase**(**"s"**))** **{**

**break;**

**}**

**}**

**}**

//Permite visualizar el listado de feriados

private static void verFeriadosCargados**()** **{**

clearScreen**();**

List**<**String**>** listadoFeriados **=** **new** ArrayList**<>();**

meses**.**stream**().**filter**((**mes**)** **->** **(!**mes**.**feriados**.**isEmpty**())).**forEachOrdered**((**mes**)** **->** **{**

mes**.**feriados**.**forEach**((**feriado**)** **->** **{**

listadoFeriados**.**add**(**feriado **+** "/" **+** mes**.**indice**);**

**});**

**});**

System**.**out**.**println**(**"Feriados Cargados:"**);**

listadoFeriados**.**forEach**((**feriado**)** **->** **{**

System**.**out**.**println**(**feriado**);**

**});**

System**.**out**.**println**(**""**);**

**}**

//Permite vizualisar los rangos cargados en formato de lista

private static void verEentosCargados**()** **{**

clearScreen**();**

dias**.**stream**().**filter**((**dia**)** **->** **(!**dia**.**eventos**.**isEmpty**())).**forEachOrdered**((**dia**)** **->** **{**

System**.**out**.**println**(**"[" **+** dia**.**name **+** "]"**);**

System**.**out**.**println**(**"|"**);**

dia**.**eventos**.**forEach**((**evento**)** **->** **{**

System**.**out**.**println**(**"|-> Inicio: " **+** evento**.**horaInicio **+** " Fin: " **+** evento**.**horaFin**);**

**});**

System**.**out**.**println**(**""**);**

**});**

System**.**out**.**println**(**""**);**

**}**

//Elimina todos los feriados de la variable meses

private static void eliminarTodoLosFeriados**()** **{**

System**.**out**.**print**(**"\033[H\033[2J"**);**

System**.**out**.**flush**();**

**for** **(**int i **=** 0**;** i **<** meses**.**size**();** i**++)** **{**

meses**.**get**(**i**).**feriados**.**clear**();**

**}**

System**.**out**.**println**(**"Se eliminaron todos los feriados."**);**

System**.**out**.**println**(**""**);**

System**.**out**.**println**(**""**);**

**}**

//Elimina todos los Rangos de la variable dias

private static void eliminarTodoLosEventos**()** **{**

System**.**out**.**print**(**"\033[H\033[2J"**);**

System**.**out**.**flush**();**

**for** **(**int i **=** 0**;** i **<** dias**.**size**();** i**++)** **{**

dias**.**get**(**i**).**eventos**.**clear**();**

**}**

System**.**out**.**println**(**"Se eliminaron todos los rangos."**);**

System**.**out**.**println**(**""**);**

System**.**out**.**println**(**""**);**

**}**

//Permite eliminar un feriado en especifico de la variable meses

private static void eliminarUnFeriado**(**Scanner scanner**)** **{**

clearScreen**();**

System**.**out**.**println**(**"Escriba el feriado a eliminar en formato dd/mm: "**);**

String feriado **=** scanner**.**next**();**

int mes **=** Integer**.**parseInt**(**feriado**.**split**(**"/"**)[**1**]);**

int dia **=** Integer**.**parseInt**(**feriado**.**split**(**"/"**)[**0**]);**

//Obtengo el indice del mes del array

OptionalInt indexMeses **=** IntStream**.**range**(**0**,** meses**.**size**())**

**.**filter**(**i **->** mes **==** meses**.**get**(**i**).**indice**)**

**.**findFirst**();**

//Obtengo el indice del mes del array

OptionalInt indexDia **=** IntStream**.**range**(**0**,** meses**.**get**(**indexMeses**.**getAsInt**()).**feriados**.**size**())**

**.**filter**(**i **->** dia **==** meses**.**get**(**indexMeses**.**getAsInt**()).**feriados**.**get**(**i**))**

**.**findFirst**();**

meses**.**get**(**indexMeses**.**getAsInt**()).**feriados**.**remove**(**indexDia**.**getAsInt**());**

System**.**out**.**println**(**"Se eliminó el feriado " **+** dia **+** "/" **+** mes**);**

System**.**out**.**println**(**""**);**

System**.**out**.**println**(**""**);**

**}**

//Metodo eliminar un rango en especifico de la variable dias

private static void eliminarUnEvento**(**Scanner scanner**)** **{**

clearScreen**();**

System**.**out**.**println**(**"Seleccione el dia del rango que desea eliminar: "**);**

System**.**out**.**println**(**"0: Lunes"**);**

System**.**out**.**println**(**"1: Martes"**);**

System**.**out**.**println**(**"2: Miercoles"**);**

System**.**out**.**println**(**"3: Jueves"**);**

System**.**out**.**println**(**"4: Viernes"**);**

System**.**out**.**println**(**"5: Sabado"**);**

System**.**out**.**println**(**"6: Domingo"**);**

String diaDelEvento **=** scanner**.**next**();**

int diaDelEventoInt **=** Integer**.**parseInt**(**diaDelEvento**);**

//Busco el dia en el array

Dia diabuscado **=** dias**.**stream**()**

**.**filter**(**d **->** d**.**indice **==** diaDelEventoInt**)**

**.**collect**(**Collectors**.**toList**()).**get**(**0**);**

//Obtengo el indice del mes del array

OptionalInt indexDia **=** IntStream**.**range**(**0**,** dias**.**size**())**

**.**filter**(**i **->** diaDelEventoInt **==** dias**.**get**(**i**).**indice**)**

**.**findFirst**();**

dias**.**get**(**indexDia**.**getAsInt**()).**eventos**.**remove**(**indexDia**.**getAsInt**());**

System**.**out**.**println**(**"Se eliminó el Rango del dia " **+** diabuscado**.**name**);**

System**.**out**.**println**(**""**);**

System**.**out**.**println**(**""**);**

**}**

//Metodo que permite cargar rangos y los almacena en la variable dias

private static void cargarEventos**(**Scanner scanner**)** **{**

**while** **(true)** **{**

clearScreen**();**

System**.**out**.**println**(**"Seleccione un día de la semana: "**);**

System**.**out**.**println**(**"0: Domingo"**);**

System**.**out**.**println**(**"1: Lunes"**);**

System**.**out**.**println**(**"2: Martes"**);**

System**.**out**.**println**(**"3: Miercoles"**);**

System**.**out**.**println**(**"4: Jueves"**);**

System**.**out**.**println**(**"5: Viernes"**);**

System**.**out**.**println**(**"6: Sabado"**);**

String diaDelEvento **=** scanner**.**next**();**

int diaDelEventoInt **=** Integer**.**parseInt**(**diaDelEvento**);**

//Busco el dia en el array

Dia diabuscado **=** dias**.**stream**()**

**.**filter**(**d **->** d**.**indice **==** diaDelEventoInt**)**

**.**collect**(**Collectors**.**toList**()).**get**(**0**);**

int eventoInt **=** **-**1**;**

**if** **(**diabuscado**.**eventos**.**size**()** **==** 4**)** **{**

System**.**out**.**println**(**"Los Eventos de este día estan completos, por favor seleccione un rango a sobrescribir:"**);**

System**.**out**.**println**(**"0: Rango 1"**);**

System**.**out**.**println**(**"1: Rango 2"**);**

System**.**out**.**println**(**"2: Rango 3"**);**

System**.**out**.**println**(**"3: Rango 4"**);**

String eventoSeleccionado **=** scanner**.**next**();**

eventoInt **=** Integer**.**parseInt**(**eventoSeleccionado**);**

**}**

System**.**out**.**println**(**"Seleccione el horario inicial del rango en formato hh:mm"**);**

System**.**out**.**println**(**"(Los minutos deben ser múltiplo de 15)"**);**

String horarioInicial **=** scanner**.**next**();**

System**.**out**.**println**(**"Seleccione el horario final del rango en formato hh:mm"**);**

System**.**out**.**println**(**"(Los minutos deben ser múltiplo de 15)"**);**

String horarioFinal **=** scanner**.**next**();**

Evento evento **=** **new** Evento**(**horarioInicial**,** horarioFinal**);**

**if** **(**eventoInt **<** 0**)** **{**

diabuscado**.**eventos**.**add**(**evento**);**

**}** **else** **{**

diabuscado**.**eventos**.**get**(**eventoInt**).**horaInicio **=** evento**.**horaInicio**;**

diabuscado**.**eventos**.**get**(**eventoInt**).**horaFin **=** evento**.**horaFin**;**

diabuscado**.**eventos**.**get**(**eventoInt**).**valorCalculadoInicio **=** evento**.**valorCalculadoInicio**;**

diabuscado**.**eventos**.**get**(**eventoInt**).**valorCalculadoFinal **=** evento**.**valorCalculadoFinal**;**

**}**

//Obtengo el indice del mes del array

OptionalInt indexDias **=** IntStream**.**range**(**0**,** dias**.**size**())**

**.**filter**(**i **->** diaDelEventoInt **==** dias**.**get**(**i**).**indice**)**

**.**findFirst**();**

dias**.**set**(**indexDias**.**getAsInt**(),** diabuscado**);**

System**.**out**.**println**(**"Se agregó el rango al día " **+** diabuscado**.**name **+** " [Hora Inicial: " **+** horarioInicial **+** " | Hora Final: " **+** horarioFinal **+** "]"**);**

System**.**out**.**println**(**"¿Desea agregar otro rango? (s/n)"**);**

String agregarOtroferiado **=** scanner**.**next**();**

**if** **(!**agregarOtroferiado**.**equalsIgnoreCase**(**"s"**))** **{**

**break;**

**}**

**}**

**}**

//Hace una lectura de los feriados y los rangos cargados en la SD y los mergea con los preexistentes

//durante la ejecución del programa

private static void leersd**(**Scanner scanner**)** **{**

clearScreen**();**

List**<**String**>** lista **=** **new** ArrayList**<>();**

**for** **(**File sysDrive **:** File**.**listRoots**())** **{**

lista**.**add**(**sysDrive**.**toString**());**

**}**

System**.**out**.**println**(**"Seleccione la unidad donde se encuentra la SD (ingresa el índice):"**);**

**for** **(**int i **=** 0**;** i **<** lista**.**size**();** i**++)** **{**

System**.**out**.**println**(**i **+** ": " **+** lista**.**get**(**i**));**

**}**

int indiceSeleccionado **=** scanner**.**nextInt**();**

String elementoSeleccionado **=** lista**.**get**(**indiceSeleccionado**);**

/\*

GUARDA EN SD

\*/

String nombreArchivo **=** "feriados.txt"**;**

// Tarjeta SD accesible

File directorioSD **=** **new** File**(**elementoSeleccionado**);**

**if** **(!**directorioSD**.**exists**()** **||** **!**directorioSD**.**isDirectory**())** **{**

System**.**out**.**println**(**"La tarjeta SD no está disponible."**);**

**return;**

**}**

int mes**;**

int dia**;**

**try** **{**

File archivo **=** **new** File**(**directorioSD**,** nombreArchivo**);**

Scanner myReader **=** **new** Scanner**(**archivo**);**

String data **=** ""**;**

**while** **(**myReader**.**hasNextLine**())** **{**

data **=** myReader**.**nextLine**();**

**}**

myReader**.**close**();**

//Carga de feriados

String feriadosLeidos **=** data**.**split**(**"\\|"**)[**0**];**

String eventosLeidos **=** data**.**split**(**"\\|"**)[**1**];**

String**[]** feriadosLeidosArray **=** feriadosLeidos**.**split**(**","**);**

String**[]** eventosLeidosArray **=** eventosLeidos**.**split**(**"[.]"**)[**0**].**substring**(**0**,** eventosLeidos**.**length**()** **-** 1**).**split**(**","**);**

//Obtengo Feriados Leidos Array

**for** **(**int i **=** 0**;** i **<** feriadosLeidos**.**split**(**","**).**length**;** i**++)** **{**

int accum **=** 55**;**

mes **=** 0**;**

dia **=** 0**;**

**for** **(**int j **=** 1**;** j **<=** decoMeses**.**size**();** j**++)** **{**

accum **=** accum **+** decoMeses**.**get**(**j**);**

**if** **(**Integer**.**parseInt**(**feriadosLeidosArray**[**i**])** **<** accum**)** **{**

mes **=** j**;**

dia **=** **(**accum **-** decoMeses**.**get**(**j**)** **-** Integer**.**parseInt**(**feriadosLeidosArray**[**i**]))** **\*** **-**1**;**

**break;**

**}**

**}**

cargarFeriadosForSdMethod**(**mes**,** dia**);**

**}**

//Carga de Eventos

ArrayList**<**ArrayList**<**Integer**>>** eventosHorarios **=** **new** ArrayList**<>();**

**for** **(**String posicionHorario **:** eventosLeidosArray**)** **{**

ArrayList**<**Integer**>** e **=** **new** ArrayList**();**

e**.**add**(**Integer**.**parseInt**(**posicionHorario**.**split**(**":"**)[**0**]));**

e**.**add**(**Integer**.**parseInt**(**posicionHorario**.**split**(**":"**)[**1**]));**

eventosHorarios**.**add**(**e**);**

**}**

Collections**.**sort**(**eventosHorarios**,** **(**ArrayList**<**Integer**>** o1**,** ArrayList**<**Integer**>** o2**)** **->** o1**.**get**(**0**).**compareTo**(**o2**.**get**(**0**)));**

//Eventos ordenados

**for** **(**int i **=** 0**;** i **<** eventosHorarios**.**size**();** i **=** i **+** 2**)** **{**

ArrayList**<**Integer**>** ev **=** **new** ArrayList**<>();**

ArrayList**<**Integer**>** evSiguiente **=** **new** ArrayList**<>();**

ev **=** eventosHorarios**.**get**(**i**);**

evSiguiente **=** eventosHorarios**.**get**(**i **+** 1**);**

//determina dia

int diaEvento **=** 0**;**

**for** **(**int j **=** 0**;** j **<** decoDias**.**size**();** j**++)** **{**

**if** **(**decoDias**.**get**(**j**)** **>** ev**.**get**(**0**))** **{**

diaEvento **=** j**;**

**break;**

**}**

**}**

**for** **(**int z **=** 0**;** z **<** decoDias**.**size**();** z**++)** **{**

**if** **(**decoDias**.**get**(**z**)** **>** ev**.**get**(**0**))** **{**

diaEvento **=** z **-** 1**;**

**break;**

**}**

**}**

Dia diabuscado **=** diaBuscado**(**diaEvento**);**

int eventoAOcupar **=** diabuscado**.**eventos**.**size**();**

**if** **(**eventoAOcupar **<=** 4**)** **{**

//Determina Horario Inicial y Final

String horarioInicial **=** formatNumber**(**ev**.**get**(**1**)** **/** 4**)** **+** ":" **+** formatNumber**((**ev**.**get**(**1**)** **%** 4**)** **\*** 15**);**

String horarioFinal **=** formatNumber**(**evSiguiente**.**get**(**1**)** **/** 4**)** **+** ":" **+** formatNumber**((**evSiguiente**.**get**(**1**)** **%** 4**)** **\*** 15**);**

Evento evento **=** **new** Evento**(**horarioInicial**,** horarioFinal**);**

diabuscado**.**eventos**.**add**(**evento**);**

//Obtengo el indice del mes del array

OptionalInt indexDias **=** indexDias**(**diaEvento**);**

dias**.**set**(**indexDias**.**getAsInt**(),** diabuscado**);**

System**.**out**.**println**(**"Feriados y Rangos Leidos correctamente de SD"**);**

**}** **else** **{**

System**.**out**.**println**(**"Todos los rangos estan ocupados para el dia " **+** diabuscado**.**name**);**

**}**

**}**

**}** **catch** **(**IOException e**)** **{**

e**.**printStackTrace**();**

System**.**out**.**println**(**"Error al leer el archivo en la tarjeta SD."**);**

**}**

System**.**out**.**println**(**"Feriados y Rangos Leidos correctamente de SD"**);**

**}**

/\*

Este Metodo guarda los feriados y los rangos en la SD:

Codifica los feriados a la posición de memoria correspondiente a la EEPROM del

Atmega328, luego el firmware del dispositivo se encarga de setear un 1 en

dichas posiciones de memoria indicando que corresponde un feriado para esas fechas.

Para los Rangos se utiliza el formato XX:YY, siendo XX la posición de memoria

de dentro de la EEPROM e YY el horario a alamacenenar en dicha posicion de memoria.

Los feriados y los rangos estan separados por un PIPE (|) para facilitar el parseo

y se detecta el fin de trama con un punto.

\*/

private static void guardarCalendarioEnSD**(**Scanner scanner**)** **{**

clearScreen**();**

List**<**String**>** lista **=** **new** ArrayList**<>();**

**for** **(**File sysDrive **:** File**.**listRoots**())** **{**

lista**.**add**(**sysDrive**.**toString**());**

**}**

System**.**out**.**println**(**"Seleccione la unidad donde se encuentra la SD (ingresa el índice):"**);**

**for** **(**int i **=** 0**;** i **<** lista**.**size**();** i**++)** **{**

System**.**out**.**println**(**i **+** ": " **+** lista**.**get**(**i**));**

**}**

int indiceSeleccionado **=** scanner**.**nextInt**();**

String elementoSeleccionado **=** lista**.**get**(**indiceSeleccionado**);**

/\*

GUARDA EN SD

\*/

String nombreArchivo **=** "feriados.txt"**;**

// Tarjeta SD accesible

File directorioSD **=** **new** File**(**elementoSeleccionado**);**

**if** **(!**directorioSD**.**exists**()** **||** **!**directorioSD**.**isDirectory**())** **{**

System**.**out**.**println**(**"La tarjeta SD no está disponible."**);**

**return;**

**}**

File archivo **=** **new** File**(**directorioSD**,** nombreArchivo**);**

**try** **{**

String fileToSd **=** ""**;**

**for** **(**Mes mes **:** meses**)** **{**

**if** **(!**mes**.**feriados**.**isEmpty**())** **{**

**for** **(**Integer feriado **:** mes**.**feriados**)** **{**

Integer posicionEnMemoria **=** 55 **+** feriado**;**

**for** **(**int i **=** 1**;** i **<** mes**.**indice**;** i**++)** **{**

posicionEnMemoria **=** posicionEnMemoria **+** decoMeses**.**get**(**i**);**

**}**

fileToSd **+=** posicionEnMemoria **+** ","**;**

**}**

**}**

**}**

fileToSd **+=** "|"**;**

//Dias

**for** **(**Dia dia **:** dias**)** **{**

**if** **(!**dia**.**eventos**.**isEmpty**())** **{**

int posicionInicial **=** decoDias**.**get**(**dia**.**indice**);**

**for** **(**int i **=** 0**;** i **<** dia**.**eventos**.**size**();** i**++)** **{**

fileToSd **+=** formatNumber**(**posicionInicial**)** **+** ":" **+** formatNumber**(**dia**.**eventos**.**get**(**i**).**valorCalculadoInicio**)** **+** ","**;**

posicionInicial **=** posicionInicial **+** 1**;**

fileToSd **+=** formatNumber**(**posicionInicial**)** **+** ":" **+** formatNumber**(**dia**.**eventos**.**get**(**i**).**valorCalculadoFinal**)** **+** ","**;**

posicionInicial **=** posicionInicial **+** 1**;**

**}**

**}**

**}**

fileToSd **+=** "."**;**

// Escribir el contenido en el archivo

FileWriter escritor **=** **new** FileWriter**(**archivo**);**

escritor**.**write**(**fileToSd**);**

escritor**.**close**();**

System**.**out**.**println**(**"Los feriados se guardaron correctamente en la tarjeta SD."**);**

**}** **catch** **(**IOException e**)** **{**

e**.**printStackTrace**();**

System**.**out**.**println**(**"Error al guardar el archivo en la tarjeta SD."**);**

**}**

**}**

//Metodo para obtener el Objeto Dia por un indice

private static Dia diaBuscado**(**int diaEvento**)** **{**

**return** dias**.**stream**()**

**.**filter**(**d **->** d**.**indice **==** diaEvento**)**

**.**collect**(**Collectors**.**toList**()).**get**(**0**);**

**}**

//Metodo para obtener indice en la variable dias

private static OptionalInt indexDias**(**int diaEvento**)** **{**

**return** IntStream**.**range**(**0**,** dias**.**size**())**

**.**filter**(**d **->** diaEvento **==** dias**.**get**(**d**).**indice**)**

**.**findFirst**();**

**}**

//Metodo para cargar feriados dentro de la variable meses

private static void cargarFeriadosForSdMethod**(**int mes**,** int dia**)** **{**

//Busco el mes en el array

Mes mesBuscado **=** meses**.**stream**()**

**.**filter**(**m **->** m**.**indice **==** mes**)**

**.**collect**(**Collectors**.**toList**()).**get**(**0**);**

//Cargo el feriado al array de dias en el mes

mesBuscado**.**feriados**.**add**(**dia**);**

//Obtengo el indice del mes del array

OptionalInt indexMeses **=** IntStream**.**range**(**0**,** meses**.**size**())**

**.**filter**(**i **->** mes **==** meses**.**get**(**i**).**indice**)**

**.**findFirst**();**

meses**.**set**(**indexMeses**.**getAsInt**(),** mesBuscado**);**

**}**

//Metodo para borrar pantalla

private static void clearScreen**()** **{**

System**.**out**.**print**(**"\033[H\033[2J"**);**

System**.**out**.**flush**();**

**}**

//Formatea numero en string para siempre manejar 2 decimales

private static String formatNumber**(**int valor**)** **{**

**if** **(**valor **<** 10**)** **{**

**return** "0" **+** valor**;**

**}** **else** **{**

**return** "" **+** valor**;**

**}**

**}**

**}**

**Clase Dia.java**

package proyecto**.**potencia**;**

**import** java**.**util**.**ArrayList**;**

**import** java**.**util**.**List**;**

public class Dia **{**

public Dia**(**int indice**,** String name**)** **{**

**this.**indice **=** indice**;**

**this.**name **=** name**;**

**}**

int indice**;**

String name**;**

List**<**Evento**>** eventos **=** **new** ArrayList**<>();**

**}**

**Clase Evento.java**

package proyecto**.**potencia**;**

public class Evento **{**

String horaInicio**;**

String horaFin**;**

int valorCalculadoInicio**;**

int valorCalculadoFinal**;**

public Evento**(**String horaInicio**,** String horaFin**)** **{**

**this.**horaInicio **=** horaInicio**;**

**this.**horaFin **=** horaFin**;**

**this.**valorCalculadoInicio **=** **(**Integer**.**parseInt**(**horaInicio**.**split**(**":"**)[**0**])** **\*** 4**)** **+** **(**Integer**.**parseInt**(**horaInicio**.**split**(**":"**)[**1**])** **/** 15**);**

**this.**valorCalculadoFinal **=** **(**Integer**.**parseInt**(**horaFin**.**split**(**":"**)[**0**])** **\*** 4**)** **+** **(**Integer**.**parseInt**(**horaFin**.**split**(**":"**)[**1**])** **/** 15**);**

**}**

**}**

**Clase Mes.java**

package proyecto**.**potencia**;**

**import** java**.**util**.**ArrayList**;**

**import** java**.**util**.**List**;**

public class Mes **{**

public Mes**(**int indice**,** String name**)** **{**

**this.**indice **=** indice**;**

**this.**name **=** name**;**

**}**

int indice**;**

String name**;**

List**<**Integer**>** feriados **=** **new** ArrayList**<>();**

**}**

# 6. Foto producto

Una bolsa de papel

Descripción generada automáticamente con confianza baja

**Ilustración 16: Vista superior del equipo**

Imagen que contiene tabla, cámara

Descripción generada automáticamente

**Ilustración 17: Vista Lateral del equipo**

# 7. Video de Funcionamiento

A continuación, encontrarás el enlace al video donde podrás observar el dispositivo en pleno funcionamiento.

<https://www.youtube.com/watch?v=BYdCcWpDvu8>