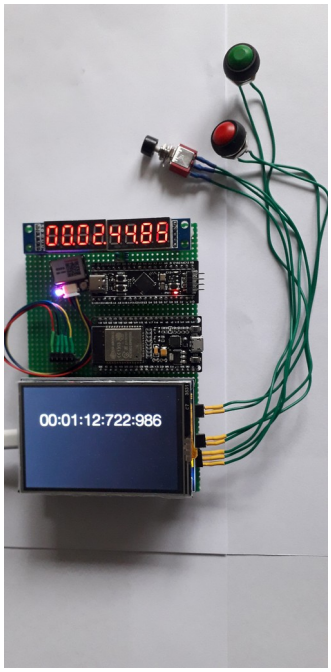
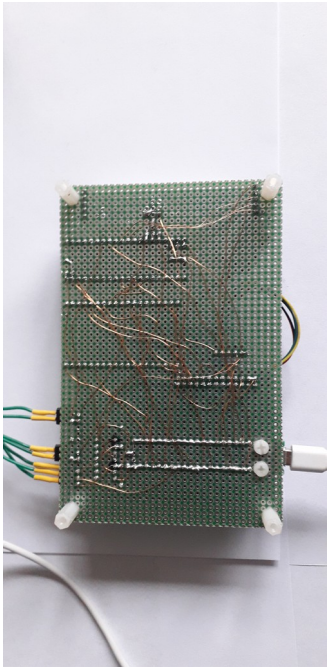
High precision chronometer

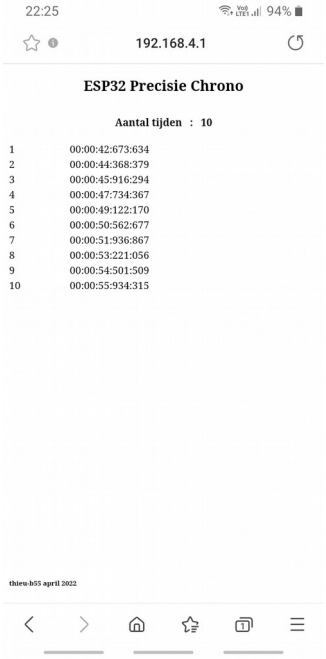
Specifications

from µsec up to 99u 59min 59sec 999msec 999µsec.

GPS module time base
STM32F411CEU used for timer and 8 digit LED display
ESP32 for LCD display, data keeping an web page with all the registered times.
maximum 500 time registrations
registered times are stored SPIFFS flash memory of ESP32
reset registered only possible at start-up
actual time visible on 8 digit led display
last registered time visible on LCD display
all registered times visible on web page







Useful adresses

ESP32 info
https://randomnerdtutorials.com/getting-started-with-esp32/

ESP32 arduino
https://randomnerdtutorials.com/installing-the-esp32-board-in-arduino-ide-windows-instructions/

STM32 TrueStudio software
https://www.st.com/en/development-tools/truestudio.html

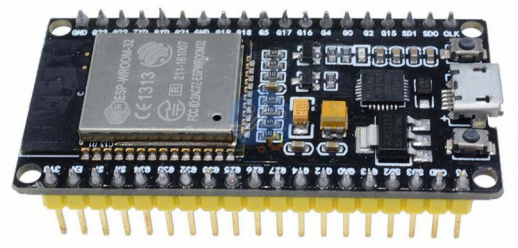
STM32 Cubeprogrammer
https://www.st.com/en/development-tools/stm32cubeprog.html

ublox evaluatie software
https://www.u-blox.com/en/product/u-center

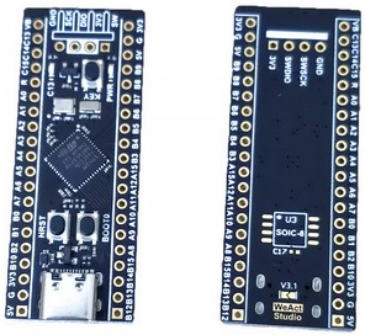
ublox NEO-M8
https://www.u-blox.com/en/product/neo-m8-series

Partslist

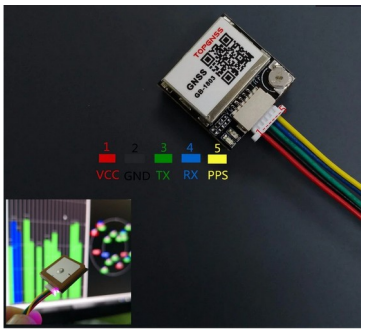
1 x ESP32-WROOM
https://www.aliexpress.com/item/1005001922031045.html?spm=a2g0o.store_pc_allProduct.8148356.8.3c357ac2VC21vm&pdp_npi=2%40dis%21EUR%21%E2%82%AC%207%2C14%21%E2%82%AC%204%2C43%21%21%21%21%21%40210318b816702302516377833eb65d%2112000020641291381%21sh



1 x STM32F411 BlackPill
https://www.aliexpress.com/item/1005001456186625.html?gps-id=pcStoreJustForYou&scm=1007.23125.137358.0&scm_id=1007.23125.137358.0&scm-url=1007.23125.137358.0&pvid=f07e86bf-8f17-45f8-8244-1e3d5f8562a3&_t=gps-id:pcStoreJustForYou,scm-url:1007.23125.137358.0,pvid:f07e86bf-8f17-45f8-8244-1e3d5f8562a3,tpp_buckets:668%232846%238109%231935&pdp_ext_f=%7B%22sku_id%22%3A%2212000030707522838%22%2C%22sceneId%22%3A%2213125%22%7D&pdp_npi=2%40dis%21EUR%217.57%216.43%21%21%21%21%21%40210323a416702304644014290e8587%2112000030707522838%21rec&spm=a2g0o.store_pc_home.smartJustForYou_2004270797050.0



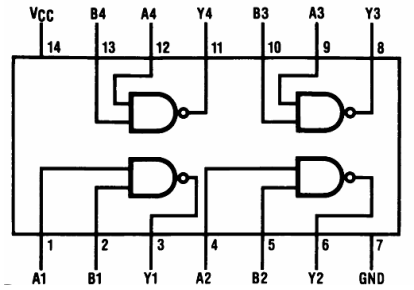
1 x GPS module ublox neo-m8n compatibel i.v.m. tijdsbasis programmatie door STM32F411
https://www.aliexpress.com/item/32852570526.html?spm=a2g0o.store_pc_allProduct.0.0.484f66caKko1RT&pdp_ext_f=%7B%22sku_id%22:%2265326712570%22,%22ship_from%22:%22%22%7D&gps-id=pcStoreJustForYou&scm=1007.23125.137358.0&scm_id=1007.23125.137358.0&scm-url=1007.23125.137358.0&pvid=04b50378-65ca-4e73-84c3-c2a2a246f1de



1 x LCD Display
https://www.aliexpress.com/item/32605410449.html?spm=a2g0o.store_pc_allProduct.8148356.1.5a6d67aak1sAxb&pdp_npi=2%40dis%21EUR%21%E2%82%AC%2014%2C44%21%E2%82%AC%2014%2C44%21%21%21%21%21%402100bdec16702303547062129efcf0%2159248080158%21sh

1 x 8 digit LED display
https://www.aliexpress.com/item/32815741807.html?spm=a2g0o.store_pc_allProduct.8148356.6.794315bfkrUnmN&pdp_npi=2%40dis%21EUR%21%E2%82%AC%201%2C28%21%E2%82%AC%201%2C17%21%21%21%21%21%402100bb4a16702308282726855e5738%2110000000865712045%21sh

1 x 74HC00



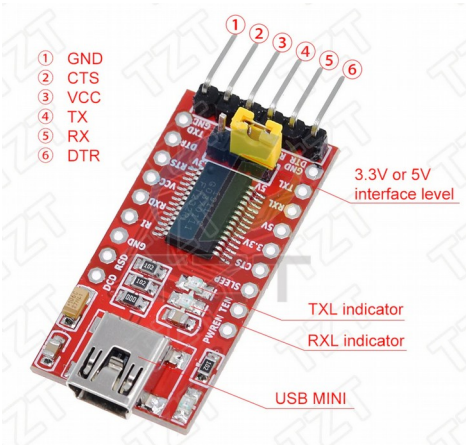
3 x pushbutton N.O.

1 x pushbutton changeover contact N.O. C N.C

5 x R 4K7

1 x ST-Link V2 for programming the STM32F411
https://www.aliexpress.com/item/1005003575620794.html?spm=a2g0o.productlist.0.0.5e8f763fErfgBt&algo_pvid=346e7784-949e-42b3-b33f-855091b51ce8&algo_exp_id=346e7784-949e-42b3-b33f-855091b51ce8-0&pdp_ext_f=%7B%22sku_id%22%3A%2212000026345111930%22%7D&pdp_npi=2%40dis%21EUR%212.25%211.98%21%21%21%21%21%402103255b16702309932973798e80e2%2112000026345111930%21sea&curPageLogUid=2HyAfOYlho7c

1 x FTDI only necessary if you want to use the U-blox evaluation software
https://www.aliexpress.com/item/32650148276.html?spm=a2g0o.productlist.0.0.32675c85KTDTNv&algo_pvid=5f83f7c0-d2bf-4e84-87ba-9ab743807e95&algo_exp_id=5f83f7c0-d2bf-4e84-87ba-9ab743807e95-1&pdp_ext_f=%7B%22sku_id%22%3A%2210000000738199659%22%7D&pdp_npi=2%40dis%21EUR%211.64%211.44%21%21%21%21%21%402103255a16702310382163471e9816%2110000000738199659%21sea&curPageLogUid=cbnlTkalQgDF



Please note:
GPS module has to be u-blox compatible, the frequency and on/off time of the output pulse is programmed by the STM32F411CEU. Frequency = 1MHz, 100 nSec on, 900nSec off

Connections

Power 5V

+ 5V	>>	5V in STM32F411CEU (2x)
	>>	5V ESP32-WROOM
	>>	5V 8 digit LED display
	>>	5V LCD display
GND	>>	GND STM32F411CEU (2x)
	>>	GND ESP32-WROOM (3x)
	>>	GND 8 digit LED Display
	>>	GND LCD display
	>>	GND GPS module

/*****/**

STM32F411CEU (BlackPill)

USART1 (115200)

PA9	USART1 TX	>>	ESP32-WROOM RX2	GPIO16
PA10	USART1 RX	>>	ESP32-WROOM TX2	GPIO17

USART2 (9600)

PA2	USART2 TX	>>	GPS module RX

SPI 1

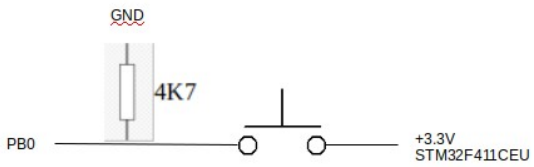
PA4	SPI1 /CS	>>	/CS 8 digit LED display
PA5	SPI1 SCK	>>	CLK 8 digit LED display
PA7	SPI1 MOSI	>>	DIN 8 digit LED display

1MHz puls van GPS module in

PA12	>>	pulse out from GPS module (parallel PB3) input Timer1
PB3	>>	pulse out from GPS module (parallel PA12) trigger used in the program

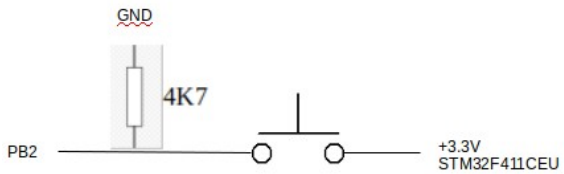
Start timer

PB0

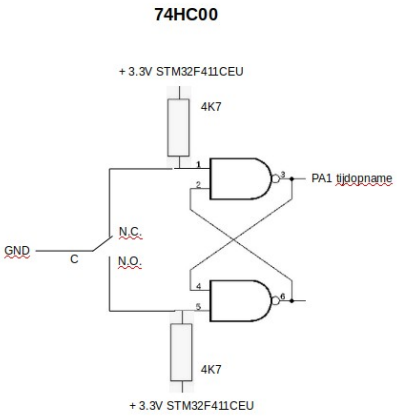


Stop and reset timer

PB2



Time registration
PA1



PIN 7 >> GND
PIN 14 >> +3.3V STM32F411CEU

3.3V from STM32F411CEU

>> VCC GPS module
>> 2 x 4K7 74HC00
>> C push-button start timer
>> C push-button stop/reset timer

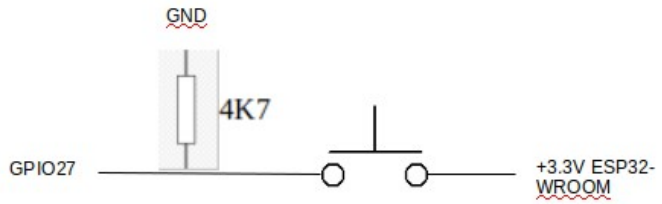
/*****/**

ESP32-WROOM

Serial2

GPIO16	RXD2	<< PA9 USART1 TX STM32F411CEU
GPIO17	TXD2	>> PA10 USART1 RX STM32F411CEU

Clear registered times in SPIFFS Flash memory
GPIO27



LCD screen

GPIO19 >> LCD_SI/TP_SI LCD screen
GPIO23 >> TP_SO LCD screen
GPIO18 >> LCD_SCK/TP_SCK LCD screen
GPIO15 >> LCD_CS LCD screen
GPIO2 >> LCD-RS LCD screen
GPIO4 >> RST LCD screen

/*****/**

GPS module

VCC << +3.3V from STM32F411CEU
GND << GND
RX << PA2 USART2 STM32F411CEU baudrate = 9600
Timing puls >> PA12 STM32F411CEU
>> PB3 STM32F411CEU

/*****/**

8 digit LED display

VCC << +5V power supply
GND << GND
IN << PA7 MOSI STM32F411CEU
/CS << PA4 STM32F411CEU
CLK << PA5 SCK STM32F411CEU

/*****/**

LCD Display

Discription	Connected Pin	Silk	Pin		Silk	Connected Pin	Discription
VCC	5V	5V	2	1	3v3		
		5V	4	3	SDA		
GND	GND	GND	6	5	SCL		
		TX	8	7	P7		
		RX	10	9	GND		
		P1	12	11	P0	TP-IRQ	Interrupt of the touch panel. If the touch panel is tapped, it's low level
		GND	14	13	P2		
		P4	16	15	P3		
Choose the command/data register (Register Select)	LCD-RS	P5	18	17	3V3		
		GND	20	19	MO	LCD-SI/TP_SI	LCD display/ SPI data input of the touch panel
Reset	RST	P6	22	21	MI	TP_SO	SPI data output of the touch panel
chip select signal; select LCD when it's low level.	LCD_CS LCD	CE0	24	23	SCK	LCD_SCK/TP_SCK	LCD display/ SPI clock signal of the touch panel
Touch panel chip select signal; select touch panel when it's low level	TP_CS	CE1	26	25	GND		

bottom view connector LCD screen

5V << +5V power supply
GND << GND
LCD_SI/TP_SI << GPIO19 ESP32-WROOM
TP_SO << GPIO23 ESP32-WROOM
RST << GPIO4 ESP32-WROOM
LCD_SCK/TP_SCK << GPIO18 ESP32-WROOM
LCD_CS LCD << GPIO15 ESP32-WROOM

/*****/**

74HC00
see schematic PA1 STM32F411CEU

Github files

chrono.hex
compiled program for STM32F411CEU can be programmed in STM32F411CEU with ST-Link and STM32Cubeprogrammer .

ST-LINK		SWDIO connector STM32F411CEU
GND	>>	GND
SWDIO	>>	SWDIO
SWCLK	>>	SWCLK

when STM32F411CEU has no external power supply
3.3V >> 3.3V

Plug ST-Link in USB computer port
Open STM32Cubeprogrammer
ST-LINK <Connect>
In left vertical bar choose download
Browse and choose chrono.hex
Verify Programming

<Start Programming>

Chrono.zip
after unzip these files can be opened with Atollic TrueSTUDIO
After compiling you find the chrono.hex file in the Debug folder.

chrono_esp32.ino
Can be programmed in the ESP32-WROOM with the Arduino IDE
Before programming find in the Arduino libraries folder the TFT-eSPI folder and change the following files according to these screenprints.

User_Setup.h

```
// Display type -  only define if RPi display
//#define RPI_DISPLAY_TYPE // 20MHz maximum SPI

// Only define one driver, the other ones must be commented out
//#define ILI9341_DRIVER       // Generic driver for common displays
//#define ILI9341_2_DRIVER     // Alternative ILI9341 driver, see https://github.com/Bodmer/TFT_eSPI/issues/1172
//#define ST7735_DRIVER      // Define additional parameters below for this display
//#define ILI9163_DRIVER     // Define additional parameters below for this display
//#define S6D02A1_DRIVER
//#define RPI_ILI9486_DRIVER // 20MHz maximum SPI
//#define HX8357D_DRIVER
//#define ILI9481_DRIVER
//#define ILI9486_DRIVER
//#define ILI9488_DRIVER     // WARNING: Do not connect ILI9488 display SDO to MISO if other devices share the SPI bus (TFT SDO does NOT tri
//#define ST7789_DRIVER      // Full configuration option, define additional parameters below for this display
//#define ST7789_2_DRIVER    // Minimal configuration option, define additional parameters below for this display
//#define R61581_DRIVER
//#define RM68140_DRIVER
//#define ST7796_DRIVER
//#define SSD1351_DRIVER
//#define SSD1963_480_DRIVER
//#define SSD1963_800_DRIVER
//#define SSD1963_800ALT_DRIVER
//#define ILI9225_DRIVER
//#define GC9A01_DRIVER
```

User_Select_Setup.h

```
#ifndef USER_SETUP_LOADED //  Lets PlatformIO users define settings in
                          //  platformio.ini, see notes in "Tools" folder.

// Only ONE line below should be uncommented.  Add extra lines and files as needed.

#include <User_Setup.h>           // Default setup is root library folder

//#include <User_Setups/Setup1_ILI9341.h>  // Setup file for ESP8266 configured for my ILI9341
//#include <User_Setups/Setup2_ST7735.h>   // Setup file for ESP8266 configured for my ST7735
//#include <User_Setups/Setup3_ILI9163.h>  // Setup file for ESP8266 configured for my ILI9163
//#include <User_Setups/Setup4_S6D02A1.h>  // Setup file for ESP8266 configured for my S6D02A1
//#include <User_Setups/Setup5_RPi_ILI9486.h>        // Setup file for ESP8266 configured for my stock RPi TFT
//#include <User_Setups/Setup6_RPi_Wr_ILI9486.h>     // Setup file for ESP8266 configured for my modified RPi TFT
//#include <User_Setups/Setup7_ST7735_128x128.h>     // Setup file for ESP8266 configured for my ST7735 128x128 display
//#include <User_Setups/Setup8_ILI9163_128x128.h>    // Setup file for ESP8266 configured for my ILI9163 128x128 display
//#include <User_Setups/Setup9_ST7735_Overlap.h>     // Setup file for ESP8266 configured for my ST7735
//#include <User_Setups/Setup10_RPi_touch_ILI9486.h> // Setup file for ESP8266 configured for ESP8266 and RPi TFT with touch

#include <User_Setups/Setup11_RPi_touch_ILI9486.h> // Setup file configured for ESP32 and RPi TFT with touch
//#include <User_Setups/Setup12_M5Stack_Basic_Core.h>// Setup file for the ESP32 based M5Stack (Basic Core only)
//#include <User_Setups/Setup13_ILI9481_Parallel.h>  // Setup file for the ESP32 with parallel bus TFT
//#include <User_Setups/Setup14_ILI9341_Parallel.h>  // Setup file for the ESP32 with parallel bus TFT
//#include <User_Setups/Setup15_HX8357D.h>           // Setup file for ESP8266 configured for HX8357D
//#include <User_Setups/Setup16_ILI9488_Parallel.h>  // Setup file for the ESP32 with parallel bus TFT
//#include <User_Setups/Setup17_ePaper.h>            // Setup file for ESP8266 and any Waveshare ePaper display
//#include <User_Setups/Setup18_ST7789.h>            // Setup file for ESP8266 configured for ST7789
```

Program the STM32-WROOM.

If all connections are made and the program should be running

How does it work

After start-up the GPS module is prograamed by the STM32F411CEU

8 digit LED display shows 00000000

LCD screen shows a red screen with the text
<Opgeslagen tijden worden gekopieerd naar buffer>
English Stored times are copied to the buffer

After copying the following text is shown
<TIJDEN NIET GEWIST>
English Stored Times are not cleared
Storing new times is not possible

The already stored times are available on the web page.
Connect to
Network : ESP32Chrono
Password : ESP32pswd
Page: 192.168.4.1

Clearing registered times.
Push push-button connected to GPIO27 from ESP32-WROOM at start-up.
LCD screen shows
<SPIFFS wordt geformatteerd>
English SPIFFS is being formatted
After formatting the screen is cleared and the chronometer is ready to use.

Timer is started with push-button connected with PB0 from STM32F411CEU

Timer stop and reset with push-button connected with PB2 from STM32F411CEU

Register a time with push-button connected with PA1 from STM32F411CEU.

The last registered time is shown on the LCD screen.
All registered times with a maximum of 500 a visible on the web-page.
Connect to
Network : ESP32Chrono
Password : ESP32pswd
Page: 192.168.4.1

that’s all, have fun and sorry for my english

groeten,
thieu-b55