LCD PDF Data Logger

D/N: WAS-20B1EN

Introduction

The increasing usage of refrigerated transport has resulted in increasing use of data loggers. PDF data loggers are very suitable for refrigerated transport because of their security features. USB PDF data loggers can use different sensors and record sensor data over long periods of time. After being plugged into a USB port, a data logger is capable of internally generating PDF files, making them especially suitable for temperature and humidity data logging applications such as that used by refrigerated transport etc.

When using USB LCD PDF data loggers, it is possible to first understand recorded status using an LCD, which can show the maximum value, minimum value, average value, etc. This can immediately distinguish the goods status and obtain the detailed data from the PDF files after the goods arrive at their destination.

Aimed at the USB PDF data logger product area, Holtek has developed a dedicated MCU, the HT32F5828, which provides libraries for PDF file generation to assist designers with rapid product development. This document will introduce how to use the HT32F5828 to develop temperature and humidity data logger solutions.

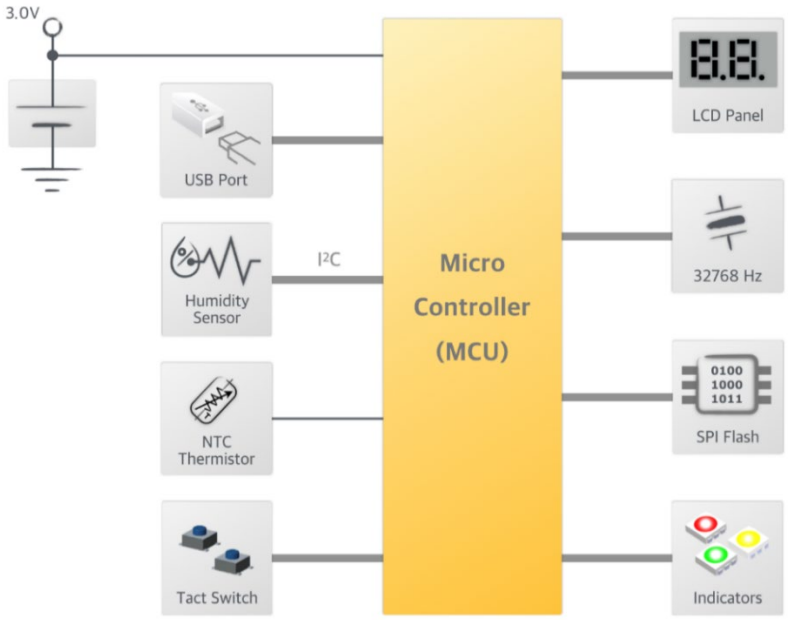


Figure 1. HT32F5828 USB PDF Data Logger Block Diagram

Application Areas

Refrigerated transport, temperature and humidity data logging etc.

Solution Features

1. Reduced component numbers: an MCU integrated LCD drive circuit will eliminate the need for an external LCD driver IC.

   The HT32F5828 contains an integrated LCD driver circuit with LCD pixels ranging from 37×4 to 33×8. It supports a wide application range without requiring an external LCD driver IC and reduces the number of required components resulting in reduced costs.

2. Rapid development: provides PDF generation libraries to generate PDF files which can be used to quickly develop a PDF generation function. Using the PDF generation library dedicated for the HT32F5828 and firmware usage descriptions, users can quickly start to generate PDF files without having to understand the PDF architecture. This solution supports multiple language encodings which allows for quick switching to different PDF languages.

3. Convenient operation: set by software or a HTML file.

   This solution provides software or a HTML file to set parameters which is different from a general method which only uses software. It also provides a variety of operating options.

4. Fast PDF generation: USB PDF data loggers can record mass data and generate a PDF file automatically. The HT32F5828 contains an operating frequency up to 60MHz to speed up PDF file operations. A single PDF page generation takes about 1 second in situations where each page records 576 points of raw data.

5. Easy to use: after plugging into a PC, a U disk will be generated which is easy to read and which can support multiple operating systems.

   This solution will generate a U disk with PDF files after being plugged into a PC, which makes user operation and use more convenient. Select FAT12, FAT16 or FAT32 based on disk capacity which can be used in Windows, Mac and Android systems.

Operating Principle

Data loggers are mainly used to record temperature and humidity data. In this solution the temperature data can be obtained using an NTC circuit or a BM25S2021-1 temperature and humidity module. For the NTC temperature measuring circuit, an NTC and voltage resistor divider along with an internal A/D Converter circuit will output a divided voltage. As the NTC impedance changes due to temperature changes, this will result in an output voltage change which can be measured by the ADC. If the BM25S2021-1 temperature and humidity module is selected, the temperature and humidity data provided by the module can be obtained directly through the I^2C interface. This temperature and humidity data will first be stored into the SPI Flash memory.

When plugged into a PC or a handheld device, the USB will serve as a mass storage device and a disk drive will be created. Then a FAT File System will also be created on the Flash memory. Based on the PDF file format in the File System, the Holtek PDF generate library can be used to generate a PDF File based on the SPI Flash data.

Functional Description

Solution Features

- Operating temperature range: -40℃~85℃.
- Operating voltage: 3.0V CR2032 battery.
- Test average power consumption.
  - Set measure interval to 10 seconds and then record the NTC temperature data.
  - Average current consumption

    (a) Average current is 10μA excluding the BM25S2021-1 temperature and humidity module, the LCD is off.

    (b) Average current is 11μA including the BM25S2021-1 temperature and humidity module, the LCD is off.
  - The above conditions use a CR2032 3V (240mA) battery. Based on 80% battery capacity, the product lifetime is estimated as:

    (a) The product lifetime is estimated at 2.2 years excluding the BM25S2021-1 temperature and humidity module and when the LCD is off.

    (b) The product lifetime is estimated at 2.0 years including the BM25S2021-1 temperature and humidity module and when the LCD is off.
  - It can enter the Power Down mode before starting use, average current is about 2.7μA

Solution Function

- Select an NTC or a temperature and humidity module to record temperature and humidity data using software or a configuration file in an HTML format.
- Set data logger parameters, such as data record intervals and start-up delay time, using software or a configuration file in an HTML format.
- Automatically determine whether the SPI Flash is added.
- Supports recorded points whether a BM25S2021-1 or an NTC is used.
  - Supports up to 7680 record points without an external Flash (NTC only, modify the program to increase or reduce points). After the external SPI Flash is added, the maximum number of record points can be defined by the user.
  - There is a disk capacity of 30K without an external Flash and a single page PDF file is generated. A list of all the temperature data will be generated after an external Flash is added.
  - If a CSV file is generated without an external Flash memory, the maximum number of points recorded will be reduced to 6000 points due to the disk capacity limits.
- After plugging into a PC, a disk drive will be created in the PC and a PDF file will also be generated automatically. A single PDF page generation takes about 1 second in situations where each page records 576 points of raw data.
- The CSV file is also generated at the same time.

- Select FAT, FAT16 or FAT32 based on disk capacity which can be used in Windows, Mac and Android systems.
- When there is a new record, a PDF file will be re-generated. When there is no new record, the original PDF file will be kept without destroying any original files on the disk.
- The LCD can display battery capacity, current temperature/humidity, maximum/minimum temperature and humidity, average temperature/humidity and temperature/humidity alarm upper and lower thresholds.
- Developed by Keil uVision V5.15.
- PDF generate library.
  - ♦ Supports multiple language encodings.
  - ♦ Up to three kinds of fonts can be used in a PDF file.
  - ♦ Supports a graphic logo.
  - ♦ Supports font size and colour settings.
  - ♦ Supports line width and colour settings.
  - ♦ Supports up to 160 pages.
  - ♦ Supports permissions setting and file encryption with RC4.

    ※ If the PDF file does not set access and encryption, it will conform to a PDF/A standard.

    ※The PDF file encryption supports a V1R2 algorithm with 40-bit RC4.

Demo Board Description

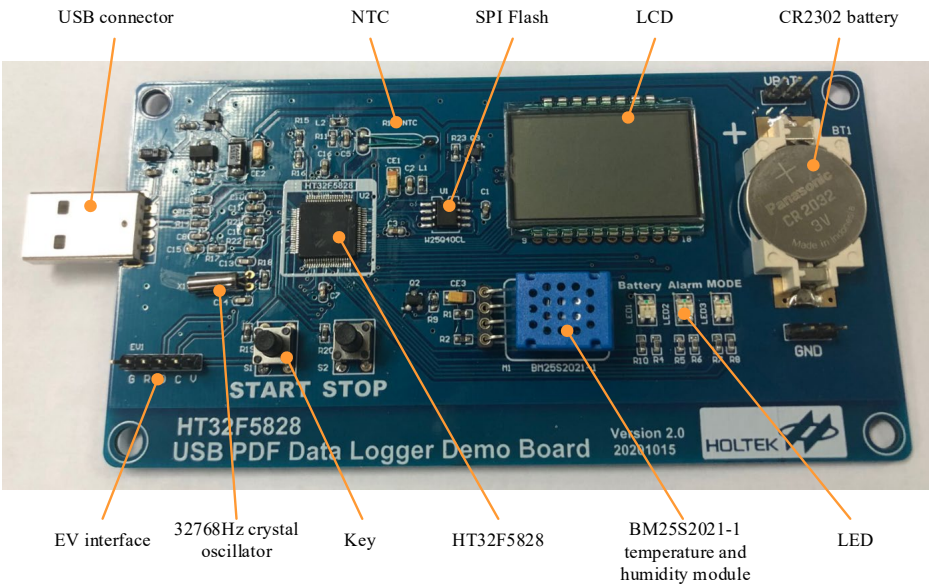


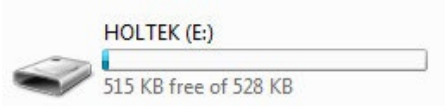
Figure 2. HT32F5828 USB PDF Data Logger Demo Board

- HT32F5828: main MCU.
- USB connector: used to connect to the PC USB port.
- LED: Mode/Low Battery/Alarm display.
- LCD: operating status, temperature and humidity, setting value display.
- Keys: used for start/stop control.

- 32768Hz Crystal: provides clock source for the RTC.
- SPI Flash: mainly used for storing PDF files.
- EV interface: used as an emulator interface in product development.
- BM25S2021-1 temperature and humidity module: the current temperature and humidity data can be obtained by the module.
- NTC: the current temperature data can be obtained by A/D conversion.

Operating Steps

Step 1: Plug the HT32F5828 Demo Board into the PC's USB port, after which a disk drive named Holtek will appear in the PC as shown below:



Step 2: Set data logger parameters using an AP or HTML file - refer to the Data Logger Setting section

Step 3: Refer to the Display and Keys Description Section for more information about the key functions and the LED/LCD display mode.

Step 4: The test will end if the user executes a STOP key long press on the Demo Board for 1 second or if the recorded space is completely filled.

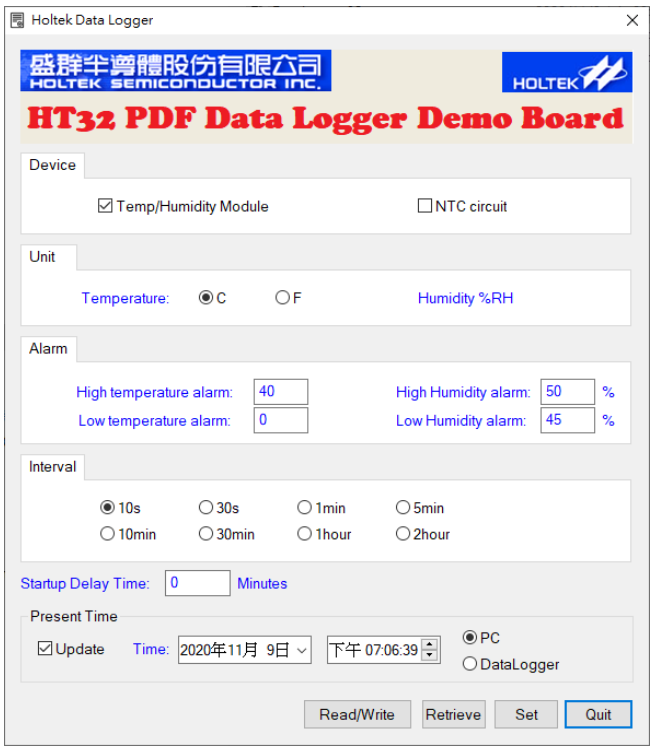
Step 5: Plug the HT32F5828 Demo Board into the PC's USB port and enter the HOLTEK disk drive. Then a file named HOLTEK.PDF can be found which is the PDF file generated by the HT32F5828 Demo Board.

Note: The data logger parameters are not required to be reconfigured after the completion of each test. After the START key is pressed, the present data logger parameters can be used for later testing. However, it must be noted that the start-up time will remain as the previous start testing time.

Data Logger Parameter Settings

The data logger parameters can be set in two ways, an AP or a HTML file.

- AP Setting Description: Plug a data logger into the USB port and execute the DataLogger32.exe file. Its AP operation interface is as follows.



  - ♦ Sensor Select: Either the temperature/humidity module and the NTC temperature measuring circuit or both can be used as sensor sources.
  - ♦ Unit Select: The temperature unit can select °C or °F. The humidity unit is %RH if the temperature/humidity module is selected as the sensor source.
  - ♦ Alarm Set: Set high/low temperature and high/low humidity alarm conditions.
  - ♦ Measure Interval: Select measure interval.
  - ♦ Start-up Delay Time: Set start-up delay time. When the test is initiated, the temperature/humidity test will be started after a user-defined delay time.
  - ♦ Time Setting

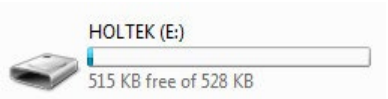
    Update: select whether to update the data logger time.

    PC: the time is obtained from the PC.

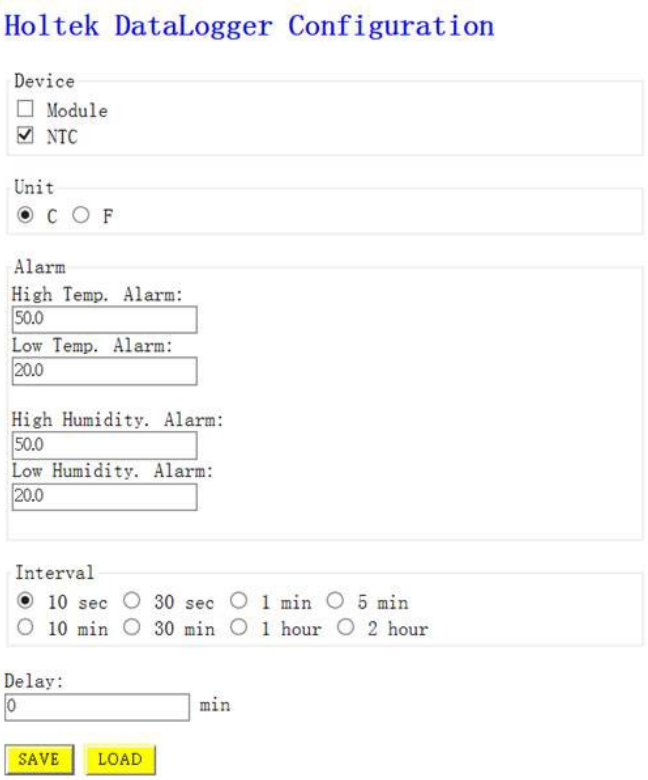
    Data Logger: the time is obtained from the internal data logger.
  - ♦ Retrieve button: Read the settings or options in the data logger for easy access to the original settings.
  - ♦ Set button: Write the user-defined settings or options to the data logger.
  - ♦ End button: Finish the test.
  - ♦ Read/Write button: Readable and writable memory data can be used by the user in product development.

- HTML File Setting Description

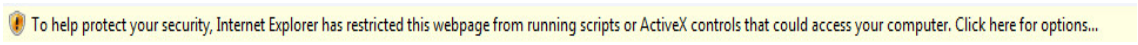
(1) Plug a data logger into the USB port after the battery is installed. First set the time and the default configuration setting values on the AP software, and copy the configuration.html file to the USB disk generated by the data logger.



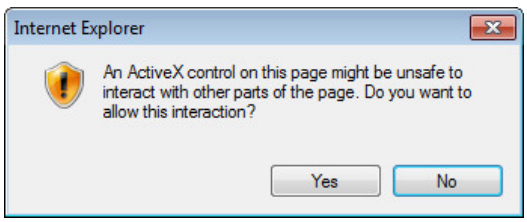
(2) Execute the Configuration.html file on USB disk, the setup screen is shown below. This Demo only supports Internet Explorer and does not support other browsers which do not support ActiveX.



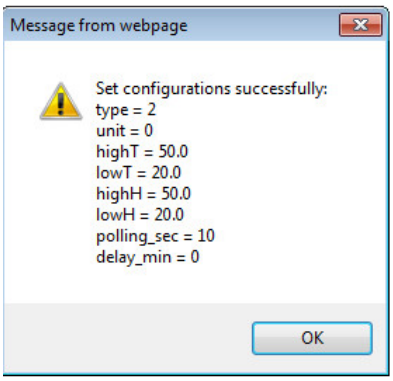
(3) When the HTML file is executed, the following screen will appear, then press the "Allow" button.



(4) When pressing the “SAVE” or “LOAD” button, the following screen will appear, then press the "Yes" button.



(5) When pressing the "SAVE" button, if the configurations have been set successfully, the following screen will appear and a setting.txt file will be generated on the USB disk.



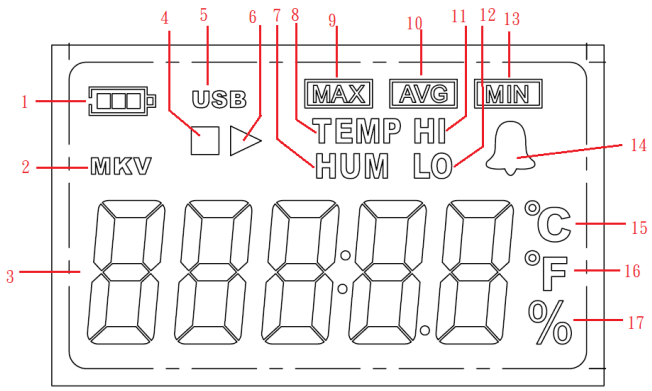
(6) If there is no Setting.txt file, use the default configuration, which is set by the software. To change the HTML file settings to AP settings, the setting.txt file needs to be deleted. Copy the Configuration.html file to the USB disk generated by the data logger after being powered on again.

Key Function and Display Description

To save power, the three R/G bicolour status indicator LEDs flash once every five seconds in the table below. If there is no action for 10 seconds, the data logger will enter the SLEEP mode, the LEDs will be off and wake up when any key is pressed.

Status	LED Colour
Alarm	
No alarm	Green
Alarm	Red
Battery Status (BAT)	
Full	Green
3/4	Green+Red
1/2 & 1/4	Red
Mode	
Waiting for measurement	Green+Red
Measurement in progress	Green
Stop measuring	Red

LCD Display Description



(1) Battery capacity:

Full: ; 3/4: ; 1/2: ; 1/4: 

(2) MKV (Mean Kinetic temperature Value) calculation

(3) Measured value

(4) Stop measuring

(5) Indicate that "Plug into the USB"

(6) Measurement in progress

(6-1) Measure delay time: 

(7) Humidity

(8) Temperature

(9) Measured maximum value

(10) Measured average value

(11) Set the upper limit

(12) Set the lower limit

(13) Measured minimum value

(14) Exceed a preset limit

(15)~(17) Units

Keys

There are two keys, START and STOP.

(A) When the setup has been completed and the LCD screen displays "waiting for measurement", the data logger will enter the SLEEP mode after 10 seconds. The LED/LCD will be off and it will be required to press START or STOP key to activate.

(B) When waiting for the measurement, long-press the START key for about 3 seconds to start the measurement.

-- Start measurement: the LED displays that the measurement is in progress and the LCD displays .

(C) When a measurement is in process or stopped and the "Record Points" is not zero, a short-press of the STOP key will result in the LCD displaying the switching order which is from Item 1 to Item 12. A short-press of the START key will result in the LCD displaying the switching order which is from Item 12 to Item 1.

Symbol	Display	The graphic to be displayed on LCD
1	The current temperature measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) ℃ / ℉ (According to the settings) (4) : Is there any alarm at the moment
2	The current relative humidity measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) % (4) : Is there any alarm at the moment
3	The current temperature average measured value. The symbol will be not displayed if	(1) : Display battery status (2) Measured values

Symbol	Display	The graphic to be displayed on LCD
	this option is not selected	(3) ℃ / ℉ (According to the settings) (4) AVG or MKV (According to the settings) (5) : Is there any alarm at the moment
4	The current humidity average measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) % (4) AVG or MKV (According to the settings) (5) : Is there any alarm at the moment
5	The current temperature maximum measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) ℃ / ℉ (According to the settings) (4) MAX (5) Is there any alarm at the moment
6	The current temperature minimum measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) ℃ / ℉ (According to the settings) (4) MIN (5) Is there any alarm at the moment
7	The current relative humidity maximum measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) % (4) MAX (5) Is there any alarm at the moment
8	The current relative humidity minimum measured value. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Measured values (3) % (4) MIN (5) Is there any alarm at the moment
9	Display temperature setting upper limit. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Temperature setting upper limit (3) TEMP HI (4) Is there any alarm at the moment
10	Display temperature setting lower limit. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Temperature setting lower limit (3) TEMP LO (4) Is there any alarm at the moment
11	Display humidity setting upper limit. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Humidity setting upper limit (3) HUM HI (4) Is there any alarm at the moment
12	Display humidity setting lower limit. The symbol will be not displayed if this option is not selected	(1) : Display battery status (2) Humidity setting lower limit (3) HUM LO (4) Is there any alarm at the moment

(D) During the measurement, a long-press of the STOP key for about 3 seconds will end the measurement. Plugging the data logger into the PC's USB port can also end the measurement. When the measurement has finished, the LED displays that the measurement has stopped and the LCD displays ■ ▷.

(E) After a long-press of the STOP and START keys for 3 seconds, the three LEDs will flash twice and then enter the Power Down mode. The LCD/LED will then be off. In the Power Down mode, press these two keys for 3 seconds at the same time to exit the Power Down mode.

Solution Design Description

This solution has developed the HT32F5828 as a USB PDF data logger dedicated MCU. The HT32F5828 MCU handles the functions of USB communication interface, ADC voltage value, I²C temperature and humidity module data reading, LCD/LED light effect display, SPI Flash reading and PDF generation. The HT32F5828 circuit is introduced in the following section.

Hardware Description

The HT32F5828 USB PDF data logger circuit is shown below.

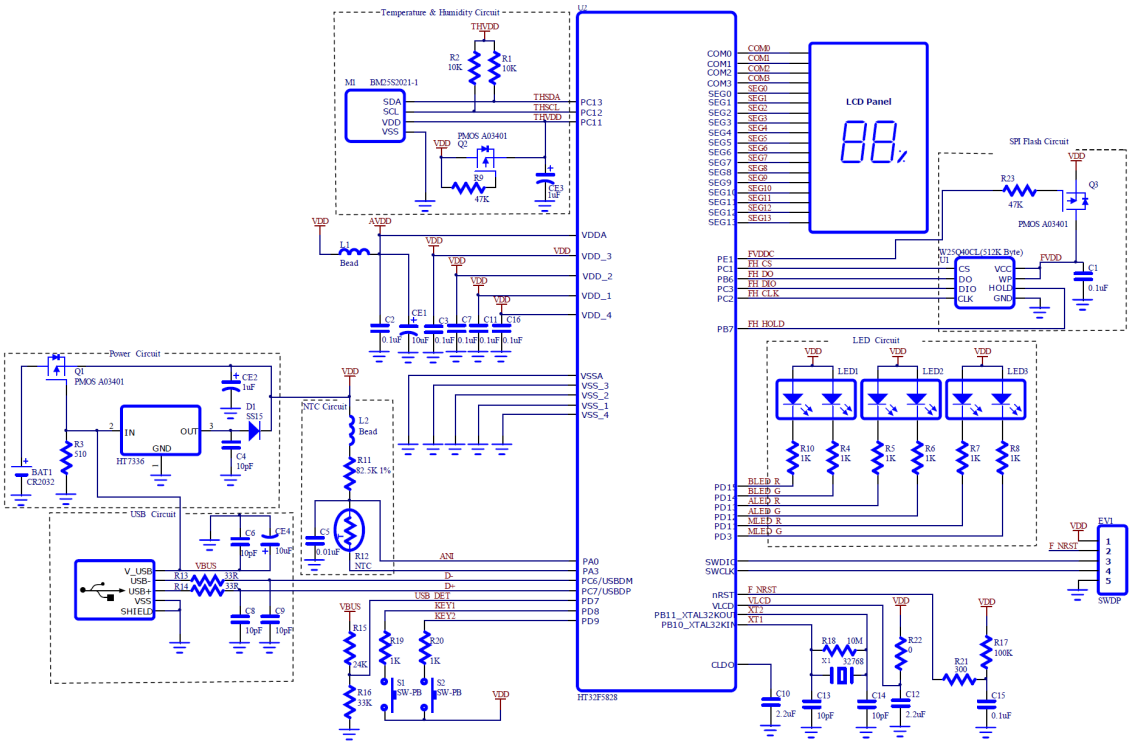
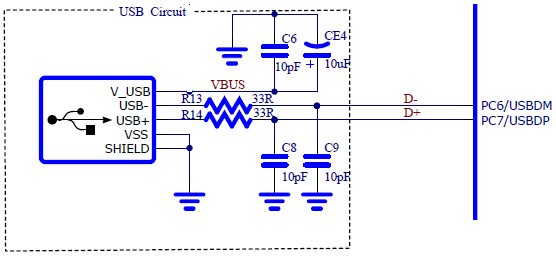


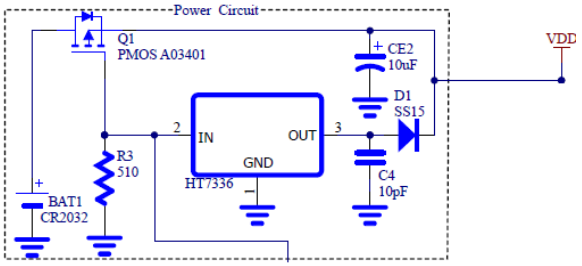
Figure 3. HT32F5828 USB PDF Data Logger Circuit Schematic Diagram

(1) USB Circuit



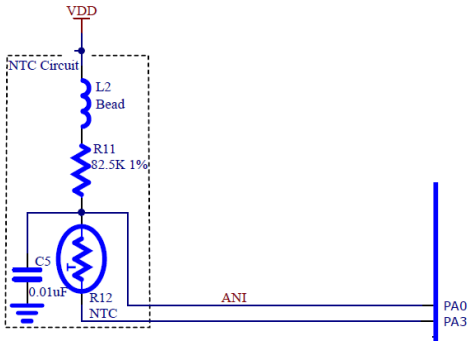
The HT32F5828 has two USB dedicated pins, USBDM/USBDP, which can be connected to a USB port after a USB signal match through the components R13/R14/C8/C9.

(2) LDO Circuit



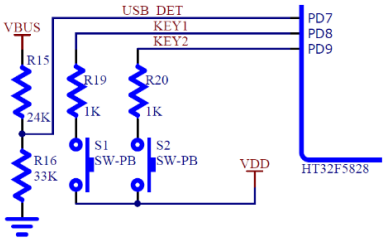
When the data logger is not connected to a USB Port and a CR2032 battery is being used, then Q1 will on and V_{DD} will be equal to the battery voltage. When the data logger has been connected to the USB Port, the voltage is converted, and V_{DD} will be about 3.3V after the USB power is transferred through the HT7336 and SS15.

(3) NTC Circuit



The NTC circuit is used to detect temperature. When the temperature changes, the NTC impedance will change and the divided voltage due to R11 will also change. After the voltage has been obtained by the internal ADC, the actual detected temperature can be obtained.

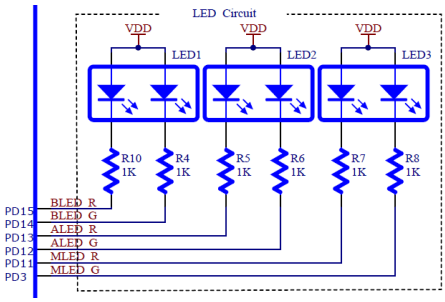
(4) USB Connection Detection and Key Circuit



If a USB port has been connected to R15 and R16, a divided voltage will be generated and the I/O input will be high, otherwise it will be low.

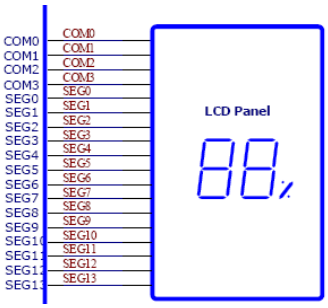
The START and STOP key states are determined by the I/O states. When the data logger is in the Power Down Mode, a rising edge will be triggered. When the key has been pressed, the I/O input is high.

(5) R/G LED Control Circuit



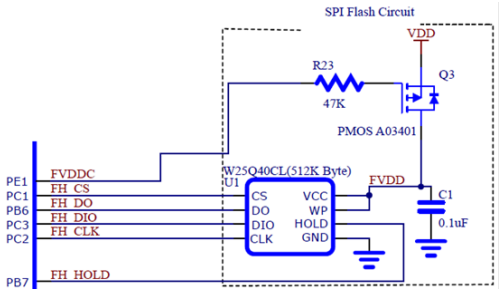
There is a total of 3 R/G bi-colour LEDs, which are directly driven by 6 I/O pins.

(6) LCD Control Circuit



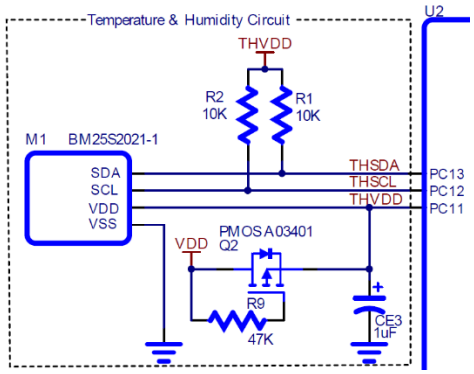
The HT32F5828 integrated LCD drive circuit can be up to 8×33 in size, the points number in this solution is 4×17.

(7) SPI Flash Control Circuit



The HT32F5828 provides an SPI interface for SPI Flash Memory access which is used to store raw data. An I/O pin is used to control the SPI Flash power which will turn off the power when the data logger enters the Power Down mode.

(8) BM25S2021-1 Temperature and Humidity Module Circuit



The HT32F5828 provides an I^2C interface to control the BM25S2021-1 to read temperature and humidity data. An I/O pin is used to control its power which will turn off the power when the data logger enters the Power Down mode.

Layout and Hardware Considerations

The following figure shows the front and back view of the PCB layout.

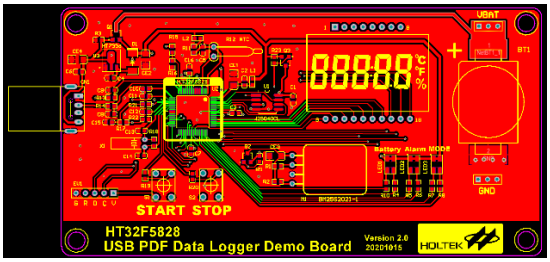


Figure 4. PCB Top Side

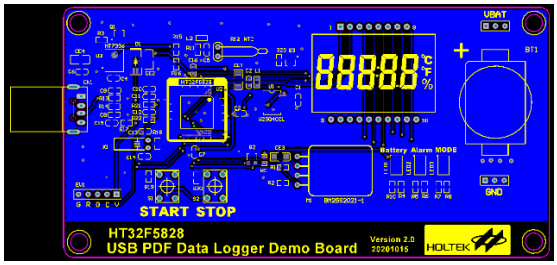


Figure 5. PCB Bottom Side

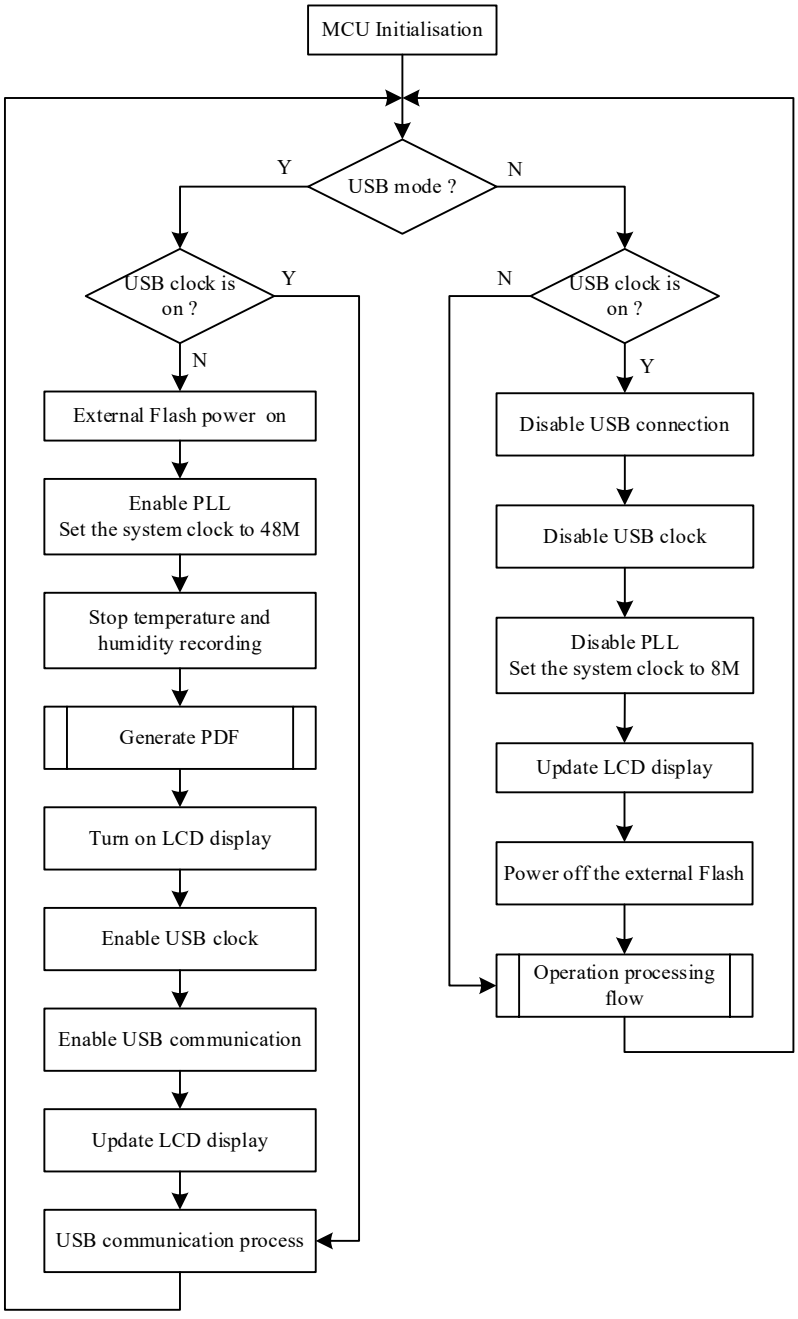
PCB BOM Table

HT32F5828 USB PDF Data Logger BOM

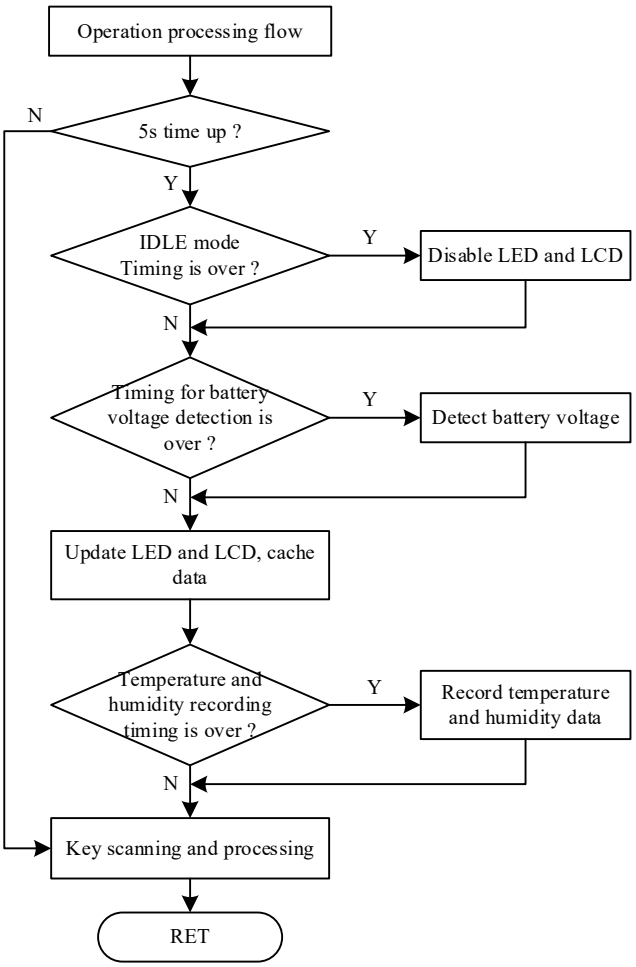
Comment	Description	Designator	Footprint	LibRef	Quantity
LCD	LCD		LCD	LCD	1
CR2032	Battery	BT1	BAT/2032-X4_2	BATT	1
0.1uF	Capacitor	C1, C2, C3, C4, C6, C7, C11, C15, C16	C0603-2	CAP	9
0.01uF	Capacitor	C5	C0603-2	CAP	1
10pF	Capacitor	C8, C9, C13, C14	C0603-2	CAP	4
2.2uF	Capacitor	C10, C12	C0603-2	CAP	2
10uF	Electrolytic Capacitor	CE1, CE2, CE3	C_CASE_A	CAP1_POLARITY	3
1uF	Electrolytic Capacitor	CE3, CE4	C_CASE_A	CAP1_POLARITY	1
Comment	USB Connector	CN1	USB_A_R	USB_5P	1
SS15		D1	DIODE4001_SMD	DIODE	1
Bead		L1, L2	L0603	INDUCTOR_2	2
LED1_DUAL_2	R/G LED	LED1, LED2, LED3	LED_SMD_RGB1	LED1_DUAL_2	3
BM25S2021-1		M1	DHT10	HT6M6121	2
PMOS AO3401		Q1, Q2,Q3	SOT-23	MOSFET-P	3
10K		R1, R2	R0603-2	R_1/4W	2
510		R3	R0603-2	R_1/4W	1
1K		R4, R5, R6, R7, R8, R10, R19, R20	R0603-2	R_1/4W	8
47K		R9, R23	R0603-2	R_1/4W	2
82.5K 1%		R11	R0603-2	R_1/4W	1
NTC	NTC Resistor	R12	NTC1	RT	1
33R		R13, R14	R0603-2	R_1/4W	2
24K		R15	R0603-2	R_1/4W	1
33K		R16	R0603-2	R_1/4W	1
100K		R17	R0603-2	R_1/4W	1
10M		R18	R0603-2	R_1/4W	1
300		R21	R0603-2	R_1/4W	1
0		R22	R0603-2	R_1/4W	1
SW-PB	Switch	S1, S2	SW_SMALLBTN_2	SW-PB	2
W25Q40CL(512Kbyte)	SPI Flash	U1	SOP8-150	W25X40	1
HT32F5828_LQFP80	MCU	U2	LQFP80	HT32F57352_LQFP80	1
HT7336	LDO	U3	SOT89	LDO	1
32768	Crystal	X1	XYAL_F	CRYSTAL	1

Software Description

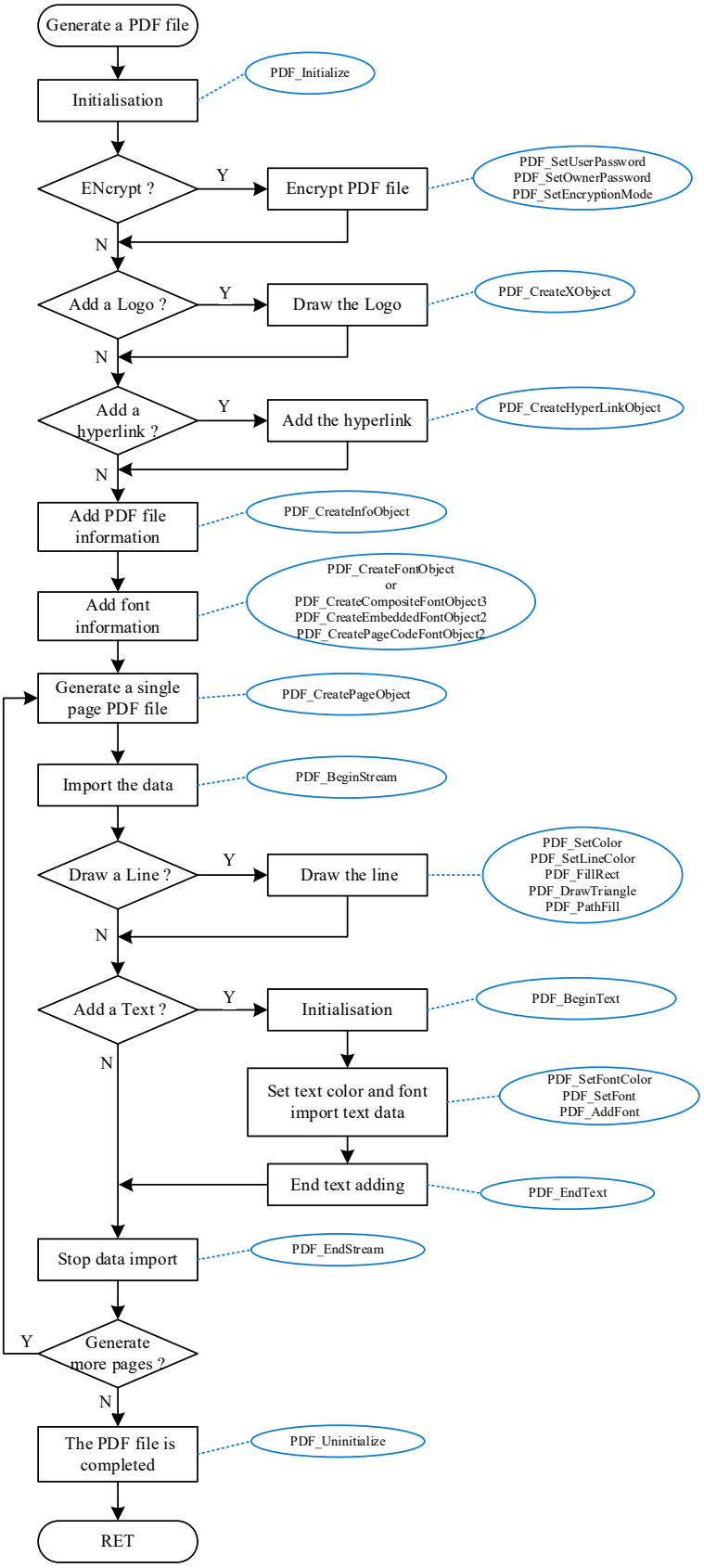
Main Flow Chart



Operation Processing Flow Chart



PDF Generation Simple Flow Chart



Directory Structure

This project did not package the whole Holtek HT32F5XXXX series library together, but a large number of Library functions were used in the program. Download the latest HT32F5XXXX (M0+) Standard Peripheral Firmware Library and unpack the project to the application\DataLogger folder of the library. Do not arbitrarily change the relative position of the project directory in order to ensure correct compilation.

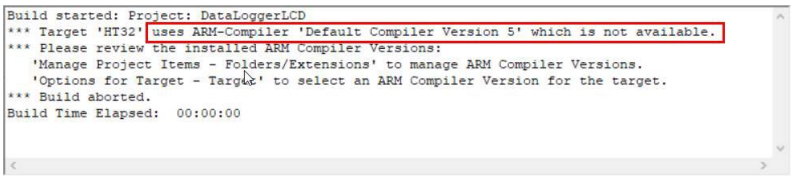
The following description is only for the DataLoggerLCD related files. For more information about the MCU and library, download the relevant files from the Holtek website.

HT32_STD_5xxxx_FWLib_v017_5074
--[application]
--[DataLogger]
--[DataLoggerLCD]
--[MDK_ARMv5] – Project the directory (Note 1)
--[ff12c]
--adc
--flash_disk
--gpio
--holtek
--htk_util
--i2c
--lcd
--main
--pdf
--pdf_data.h
--pdf_lib90.h
--rtc
--spi_flash
--var
--ht32f5xxxx_01_it
--usb_bulk_only_transport
--usb_scsi.h
--usb_scsi_block_command
--var
--HoltekPDF32_V90.lib
-- DLUtility.exe – Software for converting JP2 to C and ASM and calculating the FAT12 filename checksum (Note 2)

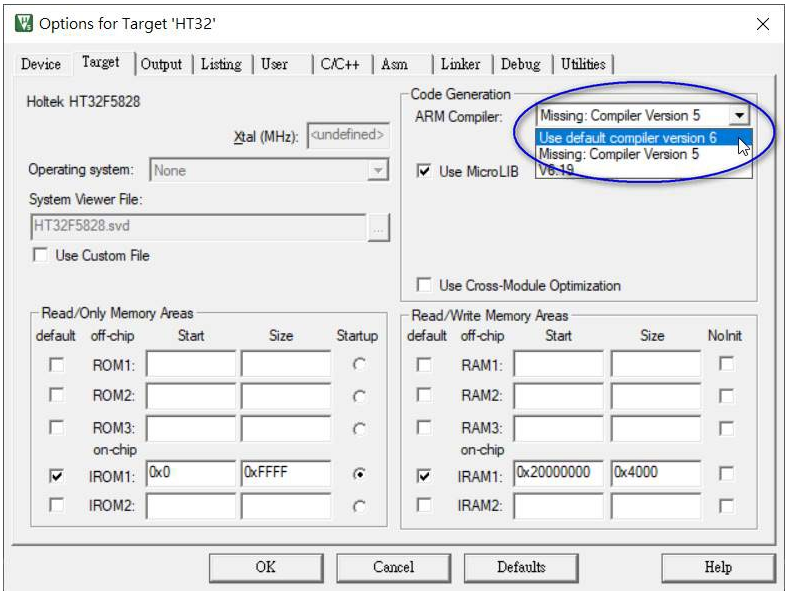
Note: 1. This Keil project uses Arm® Compiler 5 to compile, the Keil latest version has been upgrated to Arm® Compiler 6. If the following figure error occurs during compilation, please modify the compiler and optimization options.

2. The software used for ASM files and FAT12 filename checksum are only used in the Holtek 8-bit MCU data logger.

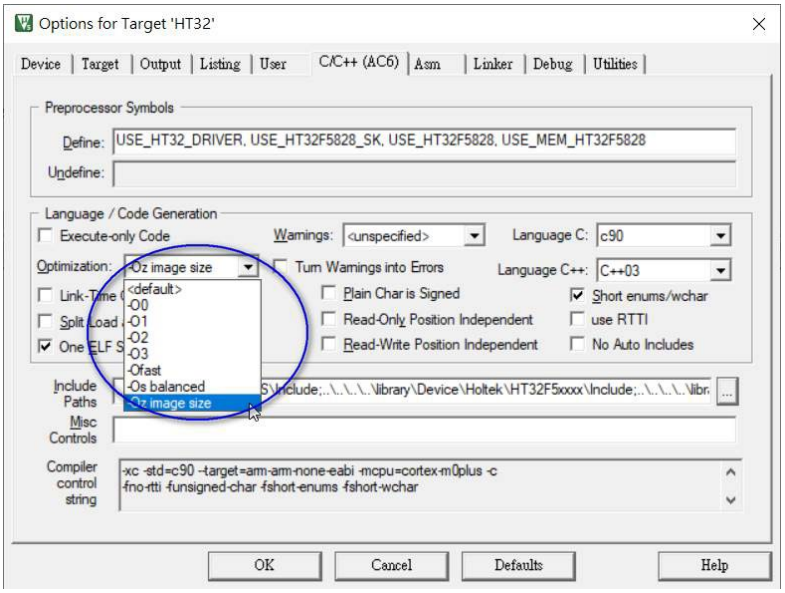
- "Compiler not available" message



- Compiler settings



- Optimization settings



File Description

HoltekPDF32_V90.lib	Function library related to PDF generation
--main.c	Main program for LED display / temperature logging / time calculation
--var.c	Variable declaration
--holtek.c	Logo image file
--adc.c	NTC temperature records
--i2c.c	Temperature and humidity module related functions
--lcd.c	LCD display related functions
--gpio.c	LED related functions
--rtc.c	RTC initialisation
--spi_flash.c	SPI Flash access related functions
--flash_disk.c	Internal Flash access related functions
--htk_util.c	Calendar related functions
--PDF.c	PDF text output related functions
--PDF_Data.h	PDF text position related information
--PDF_Lib.h	PDF Library header file
--ht32f5xxxx_01_it.c	Interrupt vector related function
--ht32_usbd_class.c	USB enumeration class command related functions
--ht32_usbd_descriptor.c	USB enumeration information
--usb_bulk_only_transport.c	Mass Storage Class command related functions
--usb_scsi_block_command.c	Mass Storage Class command related functions

PDF Generate Library

Function Summary Table

API	Functional Specifications
PDF_Initialize	Initialisation, which is the first step of PDF generation
PDF_SetUserPassword	Set User password, which is used to open PDF file
PDF_SetOwnerPassword	Set Owner password, which is used to set PDF file permissions
PDF_SetEncryptionMode	Set PDF permissions
PDF_CreateLinkObject	Create hyperlink
PDF_CreateXObject	Create graphic Logo
PDF_CreateInfoObject	Create PDF information
PDF_CreateFontObject	Create English font
PDF_CreateChiFontObject3	Create Chinese font
PDF_CreatePageObject	Create PDF page
PDF_BeginStream	Begin to create page stream content
PDF_EndStream	Finish creating page stream content
PDF_BeginText	Begin to create page text
PDF_EndText	Finish creating page text
PDF_Uninitialize	Finish PDF file
PDF_DrawRect	Draw rectangular
PDF_FillRect	Draw a rectangular filled inside

API	Functional Specifications
PDF_DrawTriangle	Draw triangle
PDF_MoveTo	Move to the specified coordinate
PDF_LineTo	Set line coordinate
PDF_LineStroke	Draw the coordinate that have been set
PDF_DawLine	Draw line
PDF_PathFill	Fill the space covered by the path
PDF_SetFont	Set font type and size for text
PDF_SetFontColor	Set font colour for Text
PDF_SetLineColor	Set line colour
PDF_SetColor	Set colour for fill action
PDF_SetLineWidth	Set line width
PDF_SetDashLine	Set dash line mode
PDF_AddText	Display text on the specified coordinate
PDF_CreateEmbeddedFontObject2	Embed font file into a PDF file
PDF_CreateCodePageFontObject2	Create language encodings

Function Name	**u8 PDF_Initialize(char *filename,u8 page_x, u8 page_y, u16 page_w, u16 page_h, u8 bEncrypt);**	
Function	Initialisation, which is the first step of PDF generation	
Enter	filename	PDF file name
	page_x/page_y	page start coordinate, which generally is (0,0)
	page_w/page_h	page width/height
	bEncrypt	Whether to encrypt the created PDF file and set a permission password. When the bEncrypt is 0, the created PDF file conforms to the PDF/A standard. When the bEncrypt is 1, use V1R2 algorithm to encrypt the PDF file.
Return	0: PDF initialisation failed Not 0: PDF initialisation is successful	

Function Name	**void PDF_SetUserPassword(const u8 *pUser);**	
Function	Set User password, which is used to open the PDF file	
Enter	pUser	PDF file open password. If an empty string is entered, this represents that no password will be set.
Return	Null	
Note	The entered password must be a ROM address or a global variable. The library only records the address of the input parameter.	

Function Name	**void PDF_SetOwnerPassword(const u8 *pOwer);**	
Function	Set Owner password, which is used to set PDF file permissions	
Enter	pOwner	PDF file permission password. To execute any file editing/printing, enter the Owner password correctly to obtain full permissions for the file. If an empty string is entered, this represents that no password will be set.
Return	Null	
Note	The entered password must be a ROM address or a global variable. The Library only records the address of the input parameter.	

Function Name	**void PDF_SetEncryptionMode(TimeStamp *ts,u32 permission);**	
Function	Set PDF permissions	
Enter	ts	Entered time as the encryption parameter to improve security
	permission	Set PDF permissions, including PDF_READ/PDF_EDIT/PDF_PRINT/PDF_COPY
Return	Null	
Note	This function must be called after PDF_SetUserPassword/PDF_SetOwnerPassword	

Function Name	void PDF_CreateLinkObject(u16 x1, u16 y1, u16 x2, u16 y2, char *link);	
Function	If each page is required to support a hyper link click-link function in a fixed place, call this function before calling CreatePageObject. This function only is used to create the link function. To display the link name, call PDF_AddText to display it at position x1 and y1.	
Enter	x1/y1/x2/y2	Rectangular coordinate for the hyper link valid range
	link	The hyper link website address
Return	Null	

Function Name	void PDF_CreateXObject(const char *jp2,u16 jp2_len,u8 jpg_width, u8 jpg_height,u16 x, u16 y, u8 w, u8 h);	
Function	If the graphic logo is required, call this function before CreatePageObject. The library only supports JP2 format at present.	
Enter	jp2	Graphic data pointer
	jp2_len	Image data length
	jp2_width	Image width (pixel)
	jp2_height	Image height (pixel)
	x/y	Image located coordinate (x,y)
	w/h	Actual image width and height
Return	Null	
Note	The operation method will be described in the following example “How to modify the logo”	

Function Name	void PDF_CreateInfoObject(TimeStamp datetime,char *author, char *title, char *subject);	
Function	Create PDF information.	
Enter	datetime	PDF created time
	author	PDF author
	title	PDF title
	subject	PDF subject
Return	Null	

Function Name	void PDF_CreateFontObject(char* font);	
Function	Create English font. This function must be called before CreatePageObject.	
Enter	Font	Font name
Return	Null	

Function Name	void PDF_CreateChiFontObject3(char *font,_Bool bTrad);	
Function	Create Chinese font. This function must be called before CreatePageObject.	
Enter	Font	Font name
Enter	bTrad	1: Traditional Chinese 0: Simplified Chinese
Return	Null	

Function Name	void PDF_CreatePageObject(u8 page);	
Function	Create PDF page	
Enter	Page	Page code
Return	Null	

Function Name	void PDF_BeginStream();
Function	Begin to create page stream content.
Enter	Null
Return	Null

Function Name	void PDF_EndStream();	
Function	Finish creating page stream content.	
Enter	Null	
Return	Null	

Function Name	void PDF_BeginText();	
Function	Begin to create page text.	
Enter	Null	
Return	Null	

Function Name	void PDF_EndText();	
Function	Finish creating page text.	
Enter	Null	
Return	Null	

Function Name	u32 PDF_Uninitialize();	
Function	Finish PDF file.	
Enter	Null	
Return	PDF file size	

Function Name	void PDF_DrawRect(u16 x,u16 y,u16 w, u16 h);	
Function	Draw rectangle.	
Enter	x/y	Rectangle start coordinate
	w/h	Rectangle width and height
Return	Null	
Note	The bottom left corner of PDF page is (0,0)	

Function Name	void PDF_FillRect(u16 x,u16 y,u16 w, u16 h);	
Function	Draw a rectangle filled inside. PDF_SetLineColor is used to set the outline colour PDF_SetColor is used to set the filled colour	
Enter	x/y	Rectangular start coordinate
Enter	w/h	Rectangular width and height
Return	Null	
Note	The bottom left corner of the PDF page is (0,0)	

Function Name	void PDF_DrawTriangle(Triangle *tr);	
Function	Draw triangle. To draw a triangle filled with colour, call PDF_PathFill later PDF_SetLineColor is used to set the outline colour PDF_SetColor is used to set the filled colour	
Enter	tr	Specify the three coordinates of the triangle in Triangle data structure
Return	Null	

Function Name	void PDF_MoveTo(u16 x,u16 y);	
Function	Move to the coordinate (x,y) to prepare for drawing a line	
Enter	x/y	Target coordinate
Return	Null	

Function Name	void PDF_LineTo(u16 x,u16 y);	
Function	Draw line from the MoveTo setting coordinate to (x,y)	
Enter	x/y	Target coordinate
Return	Null	
Note	The combination of MoveTo and LineTo is used to setup a drawing path. The drawing operation will be executed after LineStroke is called.	

Function Name	void PDF_LineStroke();
Function	Refer to the PDF_LineTo description
Enter	Null
Return	Null
Note	MoveTo(x1,y1); LineTo(x2,y2) LineTo(x3,y3) LineStroke() That is drawing a line from (x1,y1) to (x2,y2) to (x3,y3)

Function Name	void PDF_DrawLine(u16 x1,u16 y1,u16 x2,u16 y2);	
Function	Draw line	
Enter	X1/y1	Start coordinates of the line
	X2/y2	End coordinates of the line
Return	Null	
Note	That is the combination of MoveTo(x1,y1)+LineTo(x2,y2)+LineStroke()	

Function Name	void PDF_PathFill();
Function	Fill the space surrounded by functions such as Line/Rect/Triangle The filled colour is set using PDF_SetColor
Enter	Null
Return	Null

Function Name	void PDF_SetFont(u8 idx,u8 size);	
Function	Set font type and size for PDF file text	
Enter	idx	Font index. When either of CreateFontObject and CreateChiFontObject3 is called, the font index will be generated. The index value starts from 1.
Enter	size	Font size
Return	Null	

Function Name	void PDF_SetFontColor(float r,float g,float b);	
Function	Set font colour for PDF file text	
Enter	r/g/b	Red, green and blue values (0~1)
Return	Null	
Note	(R,G,B)=(0,0,0) indicates black (R,G,B)=(1,1,1) indicates white, true colour (255,255,255) (R,G,B)=(0.5,0.5,0.5) indicates grey, true colour (128,128,128)	

Function Name	void PDF_SetLineColor(float r,float g,float b);	
Function	Set line colour for drawing	
Enter	r/g/b	Red, green and blue values (0~1)
Return	Null	

Function Name	void PDF_SetColor(float r,float g,float b);	
Function	Set colour for fill action	
Enter	r/g/b	Red, green and blue values (0~1)
Return	Null	

Function Name	void PDF_SetLineWidth(float w);	
Function	Set line width for drawing	
Enter	w	Line width
Return	Null	

Function Name	void PDF_SetDashLine(u8 on, u8 off);	
Function	Set dash line mode	
Enter	On/off	On stands for drawing, off stands for no drawing, (on,off)=(3,2) stands for drawing 3 units and spacing 2 units
Return	Null	
Note	(on,off) = (0,0) stands for drawing solid lines	

Function Name	void PDF_AddText(int x, int y, char *text, u8 hex);	
Function	Display text on the coordinates (x,y)	
Enter	x/y	The coordinates to display text
	Text	The displayed text
	hex	0: displayed in the ASCII 1: the text will be encoded into hexadecimal and displayed. This can enhance the unreadability of PDF raw data and improve its security.
Return	Null	

Function Name	void PDF_CreateEmbeddedFontObject2(u32 addr);	
Function	Embed font file into a PDF file	
Enter	addr	External Flash address to store the font file
Return	Null	
Note	Refer to the Embedded Font for the Holtek PDF generate library for the detailed operation method	

Function Name	void PDF_CreateCodePageFontObject2(u32 addr, char *font);	
Function	Create language encodings	
Enter	addr	External Flash address to store language encodings
	font	Font name
Return	Null	
Note	Refer to the Embedded Font for the Holtek PDF generate library for the detailed operation method	

FATFs File System

This solution uses FATFS open source code for parsing configuration files and generating PDF files.

※Refer to the PDF Generate Library User Manual for the PDF generate library operating instructions.

Test Data

Test Project	Measured Value
Operating current	Set the measure interval to 10 seconds and then record the NTC temperature data. Average current is 10μA excluding the BM25S2021-1 temperature and humidity module, the LCD is off.
Current in the Power Down Mode	2.7μA without RTC operating

Conclusion

The HT32F5828 has a dedicated PDF generate library, a USB full-speed transceiver and an integrated LCD driver. It ensures that USB PDF data loggers achieve the dual advantages of fast development and low cost and provides a simple and convenient solution for such applications.

Reference File

Reference file: HT32F5828, BM25S2021-1 Datasheet.

For more information, consult the Holtek official website: www.holtek.com.

Revision and Modification Information

Date	Author	Issue	Modification Information
2023.05.29	王冠中	V1.10	Modify the directory structure content of the software description due to the demo code optimization.
2020.12.23	王冠中	V1.00	First version

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