SPDv2133.07

Six digit dcf clock

with 4x20mm + 2x14mm blue 7 segment LED displays
and temperature
and extera antenna

Handbook

Version: Firmware 1.79-145

Handbook Version 1.0.0 - Valid from 10.01.2018.

Table of Contents

Safety

Follow the manual

The device is only safe in operation if all instructions are read in this handbook.

General understanding of safety

By the device there are no hazard under normal use.

Intended Use

The module is designed for driving small to middle displays.
The power should come from a safe transformer (also protected transformer) or a corresponding low voltage power supply for the circuit.
Never use a higher voltage or direct mains voltage!

Concealed Hazards

DANGER

following hazards may arise in case of wrong construction of the circuit and wrong handling of device:

- With the direct connection to mains, it's a dangerous voltage on the module and other components, use a safety transformer!
- Reverse polarity and overloading the device may cause in smoke. This smoke possibly contains toxic substances which must not be inhaled! Ventilate the room.
- Reverse polarity or overload of the device can cause a hot surface on the IC or other component in the circuit.
    - There is a risk of burning when touching.
    - And flammable materials, for example Paper, can come in fire.
- Despite careful examination, the housing parts can still be sharp and sharp! Therefore, they can cause wounds if handled incorrectly.

Modifications of the example circuit

Check as appropriate all housing part and lines for damage. This applies in particular to parts of the directly (for example power cord and power supply) or indirectly come into contact with mains voltage.

Application and function description

Function description

This IC can analyze the DCF77 signal, which is received by a receiver and demodulated. Thereceived time and date can output directly to a 7-segment displays. The clock synchronizes itself automatically once a day. The hour of the synchronization can be set in the menu.

The time is displayed according to DIN 5008, which means a leading 0 at the hour. 8 a.m. looks like 08:00:00 and 8 p.m. 20:00:00

Due to the 6-digit display, the date is not shown according to DIN 5008. The 24 December 2020 looks on the display like 24.12.20.

The DCF77 signal is a low frequency radio signal which transferred the time and date. It will besent in Frankfurt am Main, derived of the local atomic clock and sent with the carrier frequencyof 77.5 kHz. Therefore, these watches are also known as radio clock.

The input for the DCF77 antenna can now automatically detect whether a pullup resistor isrequired and whether the input has to be inverted.

Even a simple alarm function is implemented.

This IC also has an adjustable brightness control for the display, thereby the display is easy toread during the day and at night it does not light out the entire room.

With this IC the **temperature** will be displayed alternately with the time and or date.

This IC has a bootloader, which allows you to update the IC firmware.This means that you will always remain at the current state of the Firmware for the IC, without further costs.

Technical data

- Operating voltage: 9 - 12 volts DC
- Current: 200mA
- Power: approximately 1.8 W (at 9 volts)
- Volume level of the buzzer: approx. 85 to 90 DB

Construction description

Installation of the device (Dimensions)

Figure 1:Installation (Dimensions) description for device SPH2305.0

Place the watch on a level and stable surface.

Connectors

Figure 1:Connector description for device SPH2305.0

Please use a plug-in power supply with a matching socket of 2.1mm, as well as suitable voltage and current specifications. Pin assignment see X-DC.

⚠️ Make sure that you have connected all signals correctly. There is no overload and polarity protection!

X-DC : <u>DC</u> Power input : DC plug 2,1mm, 2 pins

Pin	Name	Direction	Function	Maximum
Outer	GND	Power		
Inner	V+	Power	Power supply input of the module	9 - 12 volts DC, 200mA

Properties of the components

DCF module properties

- The module has to be able to work with an operating voltage of 5V (some modules have an operating voltage range of 1.2 to 15 volts, these are also usable)
- The output has to be able to drive a CMOS input with a input impedance of 10kO
- For DCF modules with open collector (open collector) or open drain output the input detected automatically by default whether a pull-up resistor is required. In menu a pull-up resistor can be connected or disconnected permanently.
- Polarity of the output:
    - The output has to be non inverting, the high ⎍⎍⎍ state has to be 100ms or 200ms
    - The output has to be inverting, the low ⎍⎍⎍ state has to be 100ms or 200ms
    - The receiving LED should at good reception signal flash every second for 100 ms and 200 ms. Does the receiving LED goes off every second for 100 ms and 200 ms, then the polarity is wrong. Unfortunately, you then connected a wrong module, this can't be analyzed with the microcontroller.
    - Whether the output is non inverting or inverting, is detected automatically by default or can be set in the menu.
    - The receiving LED should at good reception signal flash every second for 100 ms and 200 ms. Does the receiving LED goes off every second for 100 ms and 200 ms, then the polarity is wrong. To correct this, you has to be invert the setting for the inverting DCF input pin in the menu. (Instead of on → off → on or off)
- The DCF module can have a power on / off pin. Then the DCF module is automatically switched off when the DCF signals from the microcontroller are not analyzed. In the menu can be set if the DCF module is with low or high on.

Tested modules

Module	GND	VCC	DCF input	PowerSave output	Comment
Conrad DCF Modul	1 (GND)	2 (Betriebs…)	3 (DCF Ausgang)	-	
ELV DCF Modul	3 (Masse)	1 (+ UB)	2 (Signal-Ausgang)	-	
Pollin DCF Modul	GND	VCC	DATA	PON	Caution An additional circuit is required for an operating voltage of more than 3.3V!

Our standard color coding for DCF signals

- GND: black
- VCC: rot
- DCF input: green
- PowerSave output: white (is not supported by each DCF receive module)

WARNING
Please check the pin assignments! It is not in our hands whether the manufacturers of the DCF receive modules change the pin assignments at a later date.

Power supply properties

Since the clock is usually to be operated on a 230 volt power supply, a power supply unit is required. This can be a normal transformer power supply or a switching power supply.

Transformer power supply:

- Pro:
    - Cheap
    - Little interference for DCF reception
- Contra:
    - Heavy
    - Depending on the power is it big
    - Poor efficiency
    - Even if the circuit requires little power, some power may be needed
    - Higher electricity costs

Switching Power Supply:

- Pro:
    - Light
    - Small
    - Good efficiency is possible
    - Standby possible with very low power requirements
    - Lower electricity costs than with the transformer power supply

- Contra:
    - Larger interference for DCF reception
    - Usually a little more expensive

Switching power supplies should be preferred, unfortunately they have the disadvantage that many can interfere with the DCF reception and the DCF clock is not synchronized.Switching power supplies with a PE feedthrough (PE is connected to ground) often have better interference behavior, but this cannot be generalized.The switching power supplies offered in our shop have been tested and only minimally interfere with DCF reception.

WARNING
Use only a power supply unit with electrical isolation!

Installation the DCF clock
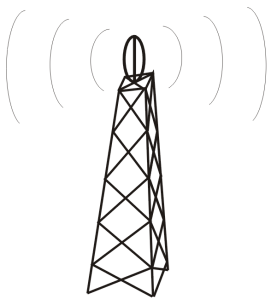
Sender in Frankfurt

DCF77-Antenne

Figure 2: Align the DCF antenna

The external antenna receives the DCF77 signal and should be directed to Frankfurt, as shown in Figure 2.
The antenna should be placed at least 1 meter away from a monitor, computer or other disturbing electronic devices .

Receive LED

During installation, the receiving LED can be used as an orientation to the quality of reception. The LED should flash at intervals of one second.If the antenna is properly aligned and the signal is strong enough, the display changes of „**no sig**nal„ (No impeccable DCF77 signal) in „**SEArCH**„ (search for the 59th second). Was the 59th second found so will the display shows „**rEAd60**„ (read the DCF time) henceforth. It still takes 60 seconds to display the correct time.If the clock is not synchronized to the DCF time, the receiver LED flashes DCF work cycle (power reserve is in operation), if the LED is enabled in the menu.Is the display not changed to „**SEArCH**„, the antenna is probably disturbed by a device or the antenna is too close to the display.Because the DCF antenna is so sensitive that it can disturb by the display in the near field, there is the possibility to reduce the brightness of the display during the synchronization, or to deactivate the display. This problem have all other DCF clocks with multiplexed LEDs displays also.By a darker display the DCF antenna can be mounted significantly closer to the display.

Synchronize with active display

This mode is active when in menu under "receive brightness" the brightness is set > 0.
Appearance of the text on the screen:

„**no sig**nal„ no signal.

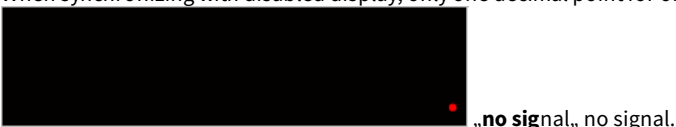„**SEArCH**„ Search the fifty-ninth second.

„**rEAdXX**„ read the dcf time.

Synchronize with deactivated display

This mode is active when in menu under "receive brightness" the brightness is set to 0.
When synchronizing with disabled display, only one decimal point for orientation appears.

„**no sig**nal„ no signal.

„**SEArCH**„ Search the fifty-ninth second.

„**rEAdXX**„ read the dcf time.

Button description

Overview of buttons

Buttons: Minus, Plus, Menu-, Menu+

Taster: Minus, Plus, Menu-, Menu+

Button functions

Menu+	Opens the menu, next setting
Menu-	Opens the menu, previus setting
Plus	Function key, in general + or on
Minus	Function key, in general - or off

To open the menu you have to press one the menu buttons.Use the menu+ button to navigate forward and the menu- button to navigate backward.
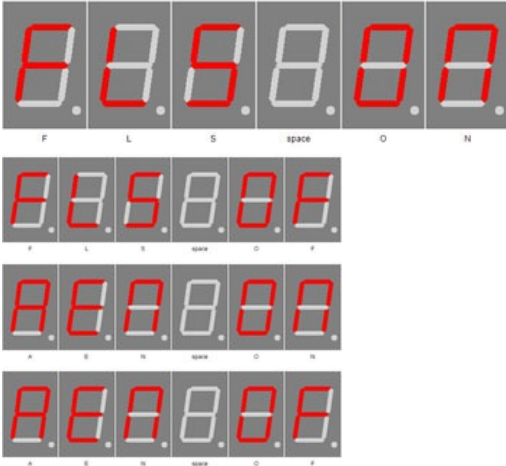
Menu

Level 1	Level 2
Normal⇓	
Display mode of clock⇓	
Show Temperature⇓	
Alarm⇓	Alarm enable ➡Alarm time hour ➡Alarm time minute ➡Alarm snooze time ➡Alarm sound wait time ➡Alarm maximum time ➡Alarm exit ↺
Brightness⇓	Brightness menu ➡Brightness max ➡Brightness min ➡Brightness automatically ➡Brightness speed ➡Brightness factor ➡Brightness offset ➡Activate standby ➡StandBy start hour ➡StandBy end hour ➡StandBy Brightness ➡Exit brightness settings ↺
DCF⇓	DCF active ➡Receiving brightness ➡Hour of synchronization ➡Receive state display ➡DCF input pull up ➡DCF input invert ➡Power save pin invert ➡DCF sensitivity ➡DCF exit ↺
Clock Settings⇓	Set hour ➡Set minute ➡Set year ➡Set month ➡Set day ➡Day of week ➡Set time ➡Calibrate quartz ➡Exit clock settings ↺
Info section⇓	
IC number⇓	
Firmware version⇓	

⇓: Next step in main menu.   ➡: Next step in sub menu.   ↺: The submenu starts again.
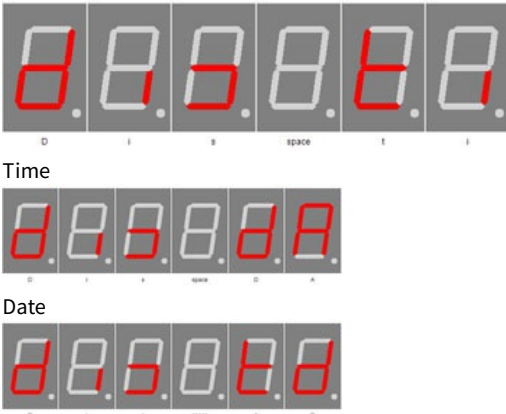
Normal

Normal mode, outside of the menu.

Here the + button has the function of the alarm temporary switch on or off.

The - button Switches the display to 100% (flashlight).

Display mode of clock

Time

Date

Time & Date

Sets the mode how to display time and date.

- OF: Does not display the time / date. When the temperature display is active, the temperature is displayed continuously. If no temperature display is possible or active, dashes (-) are shown in the display.
- ti: Shows only the time.
- dA: Shows only date.
- td: Shows time and date alternately.

Show Temperature
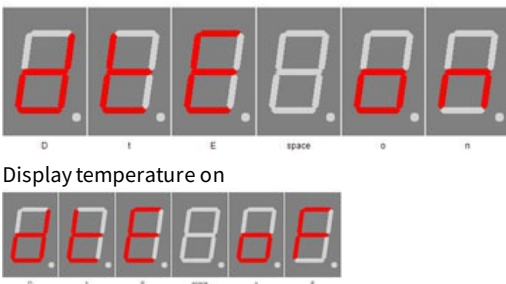
Display temperature on

Display temperature off

Enables the temperature display.

Long press + activates the calibration via temperature input, long press - activates the calibration via offset value. You can find more information in the chapter "Temperature sensor" - "Method of calibration ...".

Alarm

ALARM

With + you enter the sub-menu Alarm.

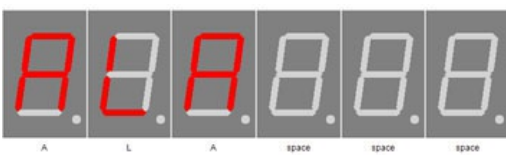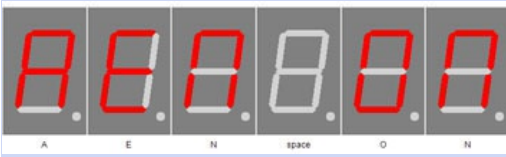|	
Alarm enable ALARM ON ALARM OFF	Enables the alarm.
Alarm time hour Alarm hour	Sets the hour for alarm.The number can be 0-23
Alarm time minute Alarm minute	Sets the minutes for alarm.The number can be 0-59
Alarm snooze time Alarm snooze time	Sets the minutes for the snooze function.The number can be 1-30 **NOTICE** If "alarm maximum time" is shorter than alarm snooze time, the snooze function is disabled!
Alarm sound wait time Alarm sound delay	Sets the maximum time in minutes for the alarm.The number can be 0 - 10. **NOTICE** If "Alarm sound delay" greater selected as maximum alarm time, then the display is only set to 100% brightness! No buzzer alarm!
Alarm maximum time Alarm after time	Sets the maximum time in minutes for the alarm.The number can be 2-60.
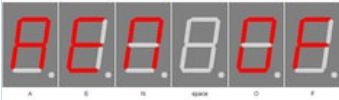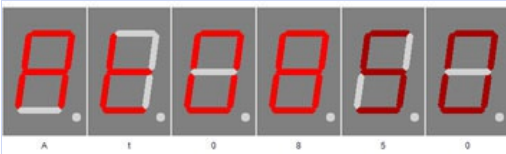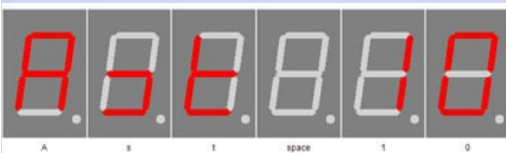
Alarm exit

A L A space space E
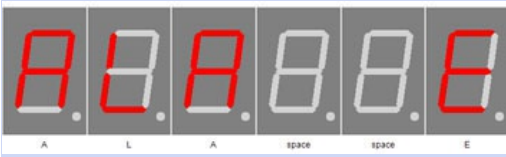
Alarm exit

With + you exit the sub-menu alarm.

Brightness

B r i space space space
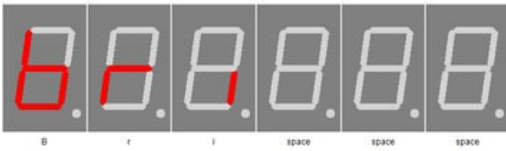
Brightness

With + you enter the sub-menu brightness.

Brightness menu

B U space space 2 5

Brightness

Sets the brightness of the menu.The number can be 10-25

Brightness max

B H space space 2 5

Brightness high

In this menu item, the maximum brightness of the display can be adjusted.

This is also used when auto brightness is disabled.

The number can be 0-25

Brightness min

B L space space 0 0

Brightness low

In this menu item, the minimum display brightness can be adjusted.

The number can be 0-25

Brightness automatically

B A space space O N

Brightness automatically on

B A space space O F

Brightness automatically off

This allows to turn on and off auto brightness.

Brightness speed
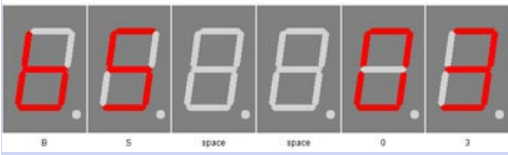
Brightness speed

This sets the speed of auto brightness.

The number can be 0-20. The maximum value may differ depending on the firmware.

Brightness factor

Brightness factor

This sets the calculation factor for auto brightness.

The number can be 1-99

Brightness offset

Brightness offset

Brightness offset -99

Brightness offset +99

This sets the calculation offset for auto brightness.

The number can be -99 - 99

Activate standby

StandBy (Powersave) Enable On

StandBy (Powersave) Enable Off

Activates standby mode, in which the display is switched off.The clock and alarm function are still available, the time, date or temperature are simply not displayed.

Through the flashlight function can this interrupted.

StandBy start hour

StandBy (Powersave) Start Hour

The standby operation starts from this hour. Only full hour can be set.

The range is from 0 (midnight) to 23 (11pm).

StandBy end hour

P	F	space	space	0	6

StandBy (Powersave) Finish Hour - Endstunde

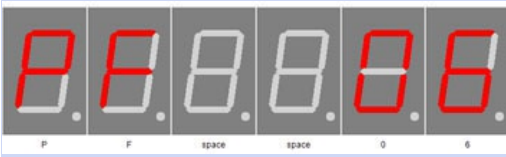From this hour on, standby operation ends. Only full hour can be set.
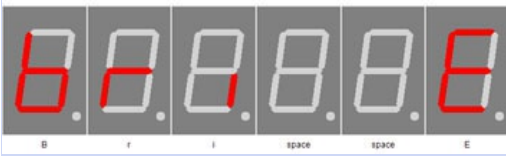
The range is from 0 (midnight) to 23 (11pm).

StandBy Brightness

P	B	space	space	0	1

StandBy (Powersave) Brightness level 1

This brightness is set in standby in the operation mode, 0 means off.

The range is 0 to 90, but 90 corresponds to 9 of the other brightness settings in this menu.

Exit brightness settings

B	r	i	space	space	E

With + you exit the sub-menu brightness.

DCF

D	C	F	space	space	space
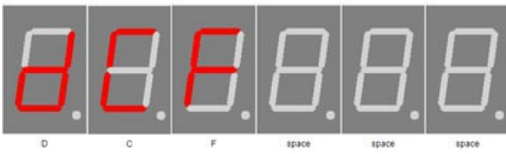
DCF

With + you enter the sub-menu DCF.

DCF active

D	A	C	space	O	N

DCF active on

D	A	C	space	O	F
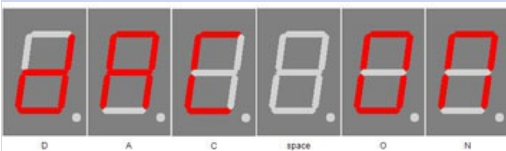
DCF active off

Sets whether or not DCF reception is active. If the DCF reception is deactivated, the clock only works with the built-in quartz clock.Note that in this case the time base must be set as well as possible.

Receiving brightness

r	B	r	space	2	5
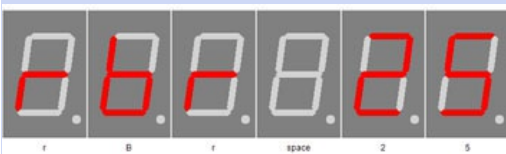
Receiving brightness

Sets the brightness during the DCF receiving. If 0, the display is turned off and the status of the synchronization is shown by decimal points.The number can be 0-25.

Hour of synchronization

DCF synchronize hour

DCF synchronize hour disabled

Sets the hour in which the DCF clock will synchronize. In this hour, the DCF signal will be analyzed until a synchronization has occurred or the hour changes.

The number can be 0-23.

If the display shows "--" instead of a number, the synchronization hour has been deactivated and the dcf receiver is constantly trying to synchronize. In this case, the receipt display can also be displayed permanently.

Receive state display

DCF status decimal point display

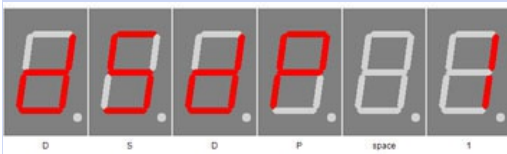Sets the mode for the receive LED, which shows the received signal. The number can be 0-2.

- 0: Only until the clock has been synchronized.
- 1: Shows the received signal when the clock is not synchronized with the DCF77 signal.
- 2: During the synchronization phase, the receive signal is always on the receive LED regardless of the DCF77 synchronization flag.

Only while the clock is trying to receive the DCF signal, see "Hour of synchronization".

DCF input pull up
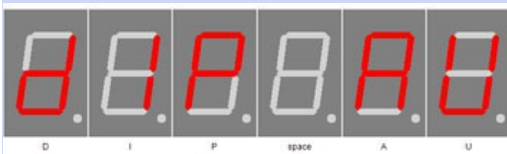
DCF input pull up auto

DCF input pull up on

DCF input pull up off

DCF77 input pin with pullup

- AU: Pull Up is automatically (default).
  AU is activated by pressing the + button.
- ON: Enables the pull-up resistor
- OFF: Disables the pull-up resistor
  ON and OFF is activated and toggled by the - button.

- Conrad DCF module = ON
- ELV DCF module = ON
- Pollin DCF module (3.3 V) = OFF

No guarantee for correctness of the information and changes of the manufacturer.

DCF input invert
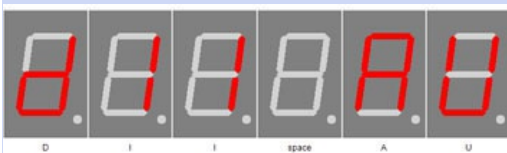
DCF input invert auto

DCF input invert on

DCF input invert off

DCF77 inverting the input pin

- AU: input is automatically inverted or not (default).
  AU is activated by pressing the + button.
- ON: Input inverts
- OFF: no input inverted *ON and OFF is activated and toggled by the - button.*

- Conrad DCF module = for PIN3 ON, PIN4 OFF
- ELV DCF module = ON
- Pollin DCF module (3.3 V) = OFF

No guarantee for correctness of the information and changes of the manufacturer.

If the receive LED is off every second, the setting must be inverted.
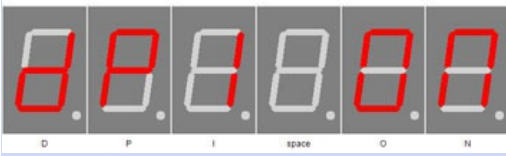
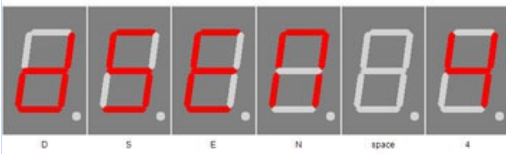|	
Power save pin invert	Inverts DCF77 power On / Off output
	• ON: Power ON / OFF output is inverted (module ON at GND)
	• OFF: power on / off output is not inverted. (module ON at VCC)
DCF powersave invert on	• Conrad DCF module = No power on / off input pin available
	• ELV DCF module = No power on / off input pin available
	• Pollin DCF module (3.3 V) = ON
DCF powersave invert off	No guarantee for correctness of the information and changes of the manufacturer.
	Read the instructions of the receiver module for the power on / off pin of the DCF module to set this setting correctly. Many modules do not have this pin, then this setting can be ignored.
DCF sensitivity	Sets the DCF Sensitivity. 1 has a very low tolerance and 6 has the highest tolerance for reception. The Sensitivity should be set as small as possible to avoid incorrect receiving.The number can be 1-6
DCF sensitivity	
DCF exit	With + you exit the sub-menu DCF
DCF Exit	
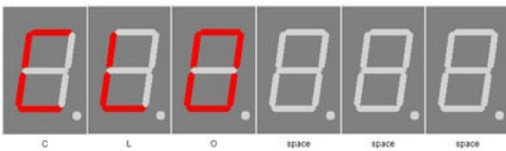
Clock Settings

clock

With + you enter the sub-menu clock.

Set hour	Set the hour.
	The number can be 0-23.
change time	
Set minute	Set the minute.
	The number can be 0-59.
change time	

Set year
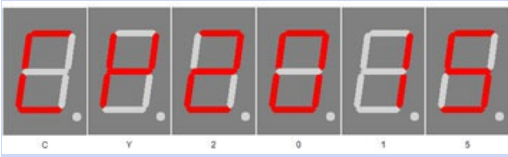
change year

Sets the year.
The number can be 2000-2099.

Set month

change month

Sets the month.
The number can be 1-12.

Set day
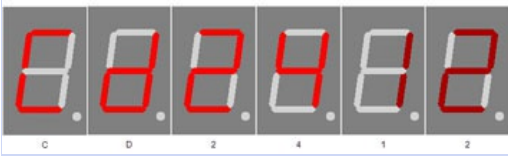
change day

Set the day, limit by month.
The number can be 1- 28, 29, 30, 31.

Day of week

Monday - Montag

Tuesday - Dienstag

Wednesday - Mittwoch

Thursday - Donnerstag

Friday - Freitag

Saturday - Samstag

Displays the day of the week from the set date.

Set time
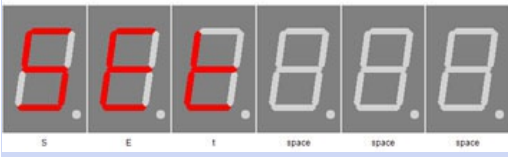
Set settings

Sets the time, while looking for DCF time, otherwise the time will be provided directly.

Calibrate quartz
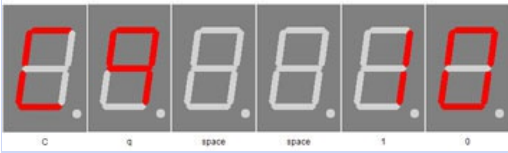
Calibrate quartz +10

Calibrate quartz -10

With this setting the quartz can be calibrated, a positive value increases the period time and a negative value reduces it.The period should also be set as precisely as possible to 1ms or 1kHz (for frequency measurement). The measurement must be carried out on pin TB.Further information can be found in the chapter Quartz properties - Accuracy of the time".

Exit clock settings


Clock end

With + you exit the sub-menu clock. Until here the clock, without DCF synchronization, will be taken and used until the next scheduled synchronization.

Info section
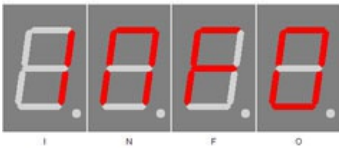
This indicates the start the information area

IC number
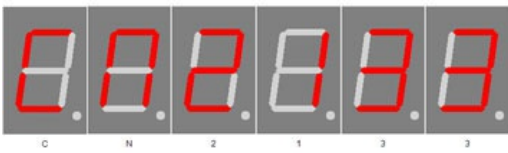
Chip number

IC / device type

Firmware version

Firmware version

Firmware version

Example, it might be something else at this point.

Menu end
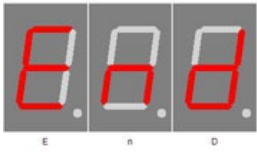
End

End of the menu, hide automatically after 2 seconds.

Attachment

Bootloader handling

Start the IC/module/device in bootloader mode

1. Switch off the IC/module/device.
2. Connect the UART adapter (USB → 3.3 volts or 5 volts UART or RS232 → 3.3 volts or 5 volts UART).
   "DCF in" → UART adapter TXD and "DCF ps" → UART adapter RXD.
3. Press the button S1, power up the IC/module/device with voltage and do not release this button until you hear a short BEEP. The display is off.
4. Now you can connect to the firmware upload tool.

⚠️🔥 WARNING
Wrong UART level
If an incorrect voltage level (for example directly RS232, ± 12 Volt) is used, the UART adapter or the IC/module/device can be damaged or destroyed. In the worst case, overheating and fire may occur!

NOTICE
Defect firmware
Defect firmware can be detected as follows: Every second a short BEEP.

Use the Firmware Upload Tool to upload an update

1. Download the latest upload tool from www.stefpro.biz: [SP Firmware UP](#)
2. Start the tool
3. Select the COM port.
4. Press the "Load" button and select a firmware which you have previously downloaded from SP Firmware UP
5. Now press the "Connect" button, the data from the IC / Module / device will be read and the compatibility of the new firmware with the IC / module / device will be checked
6. If an upload is possible, you can now press the "Upload Firmware" button. The upload starts and should not be interrupted.

NOTICE
Firmware upload interruption
If the firmware upload is interrupted or uploaded an inappropriate firmware, so there is a broken firmware, the IC can be operated only in bootloader mode.

7 segment characters

The symbolism of each character:

0	1	2	3	4	5	6	7
8	9	A	B	C	D	E	F
g	G	h	H	i	I	J	L
n	N	o	O	P	q	r	s
S	t	u	U	Y	-	_	space
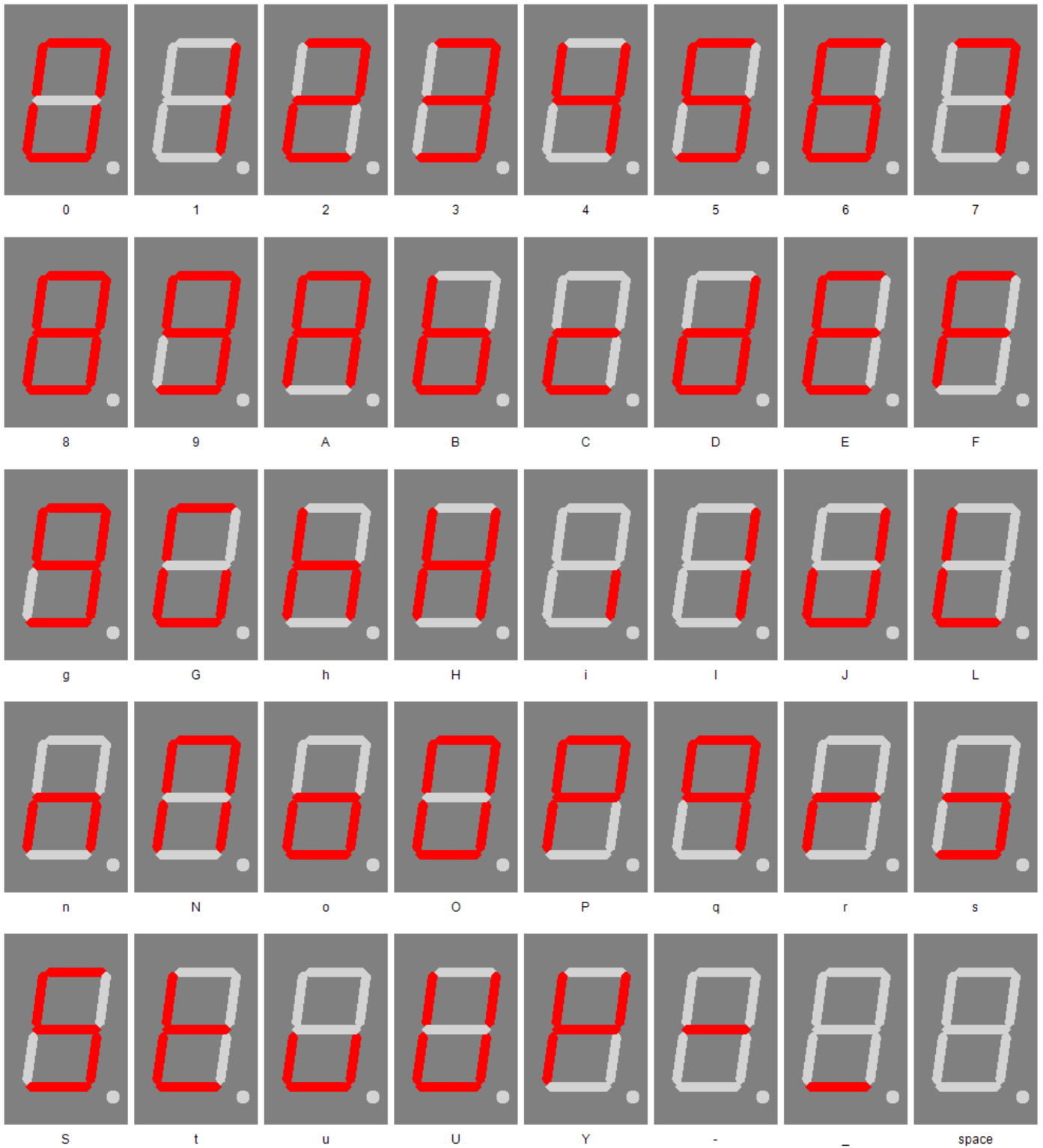
Change log

Safety

20.03.2017 - 1.0.3 - ADD
Add ESD note

DCF module properties

21.11.2016 - 1.0.1 - ADD
Add list of tested modules
20.03.2017 - 1.0.3 - ADD
Update list of tested modules, add standard pin assingment

Power supply properties

21.12.2019 - 1.0.5 - ADD
Add SNT description

Temperature sensor

22.03.2021 - 2.0.1 - ADD
Add add temperatur sensor and calibration description

Set day

23.04.2017 - 1.0.4 - ERROR
Bugfix wrong title, this sets the day not the month.

Liability, *warranty* and copyright notice

Definitions

- "Device": A product that can be operated by simple connection via a power supply to the home power net. The power adapter does not have to be included.

Liability

- Although the information contained in this document has been checked very carefully for accuracy and completeness, for errors and omissions can not be held liable. StefPro reserves the right to any time change any portion of the described hardware and software features.

- There is no liability for damages incurred directly by or in the application of the "module", as well as for damage caused by chemical or electrochemical effects of water or generally from abnormal environmental conditions.

- "Device" by StefPro should not be used in critical areas."

    These include:

    - medical devices for implanting or life obtained.

    - Critical equipment for space, aerospace and traffic.

    - Other important life components or systems, where an error is fatal.

Safety Notes

- Since the built device is operated with an electrical voltage, the valid VDE regulations are complied with.
- This device is not in the hands of children!
- The device complies with the requirements of protection class III.
- The "device" may NOT directly to line voltage (or voltage > maximum operating voltage) in any case! It can be fatal!
    - Whenever it is that safe operation is no longer possible, the device must be taken out of service and secured against inadvertent operation. This assumption is justified,
    - when the device has visible damage,
    - when the device has loose parts
    - when the device no longer works
    - after prolonged storage under unfavorable conditions (eg outdoors or in moist environments)

Watch for correct voltage and connection of the device voltage and / or connection mistakes are beyond our control. Thus we can not assume any liability for damages arising out of it.

Intended operation

- The used electrical parts and components are designed for a temperature between 0 °C ... +45 °C, so the device may only be operated and stored in this temperature range. During transport, the temperature may be between -10 °C ... + 50 °C.
- If condensation has formed during transport or storage, the modules must be acclimatized for approx. 2 hours before commissioning.
- It must not be operated in an increased dust, high humidity, explosion risk or aggressive chemical exposure.
- Ensure proper operation and connection. Operating and/or connection errors are outside our area. Unfortunately, we can not accept any liability for damages resulting of this.
- The improper operation of this module may result in damage of this module, personal injury or property damage.
- The safety instructions must be observed!
- The manufacturer is not responsible for all personal injury and property damage caused by improper operation.

Warranty

- StefPro only warrants the device and its firmware. The warranty is limited to the exchange of the device within the warranty period in case of obviousdefects of the hardware, as well as faulty programming.

- Warranty does not extend the warranty period or starts a new period again.

- Additional or deviating claims are excluded, especially claims for damages arising out of the product for damage. This will not affect claims based on inalienable rules under the product liability law.

Copyright notice

The circuitry and firmware on the device from StefPro is protected by copyright. Unauthorized reproduction or distribution of Modules with this program or any portion of it. This is pursued bothcriminal and civil law, and may result in severe penalties and compensation for damages.

Status of the information 10.01.2018.

Disposal information

Do not dispose devices in household garbage!
This modules or devices comply with the EU directive on electronic and electrical equipment (WEEE regulation)and therefore may not be disposed of with household waste. Dispose of the device over your local collection center for electronic equipment!

WEEE-Reg.-Nr.:

DE 58929072 (StefPro UG (haftungsbeschränkt) & Co. KG)

DE 78089358 (StefPro Einzellunternehmen bis zum 01.01.2015)

Impress

StefPro™ UG (haftungsbeschränkt) & Co. KG
- Softwareentwicklung für Prozessoren

Dipl. Ing. (FH) Stefan Nannen

Theilenmoorstr. 11

26345 Bockhorn – Germany

Phone: +49-4452-709175

Web:http://www.stefpro.biz/

E-mail: info@stefpro.biz