

# SPM9542P

Four digit temperature display

## Datasheet

Version: Firmware 1.82-148



**StefPro UG (haftungsbeschränkt) & Co. KG**

Theilenmoorstr. 11  
26345 Bockhorn, Germany

Phone: +49-4452-709175  
Web: <https://www.stefpro.biz/>  
E-mail: [info@stefpro.biz](mailto:info@stefpro.biz)

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## Safety

### Follow the manual



The IC is only safe in operation if all instructions are read in this datasheet.

### General understanding of safety

By the IC there are no hazard under normal use.

### Intended Use

The IC is designed for driving big 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 IC:

-  With the direct connection to mains, it's a dangerous voltage on the IC and other components, use a safety transformer!
-  Reverse polarity and overloading the IC may cause in smoke. This smoke possibly contains toxic substances which must not be inhaled!  
Ventilate the room.
-   Reverse polarity or overload of the IC 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.
-  Spalling of parts on reverse polarity or overloading of the IC.
-  Wear during the initial commissioning eye protection.
-  The pins of a IC are very pointed and sharp! Therefore, this may cause in sores in case of incorrect handling.
-  Use always passing a ESD bracelet to avoid electric charges! The IC can be damaged if handling without an earthing tape and housing!

### Modifications of the example circuit

The successfully built circuit may be damaged. Therefore 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 is suitable for big displays and has a SPI interface for Shift registers or LED driver.

This IC also has an adjustable brightness control for the display, thereby the display is easy to read 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.

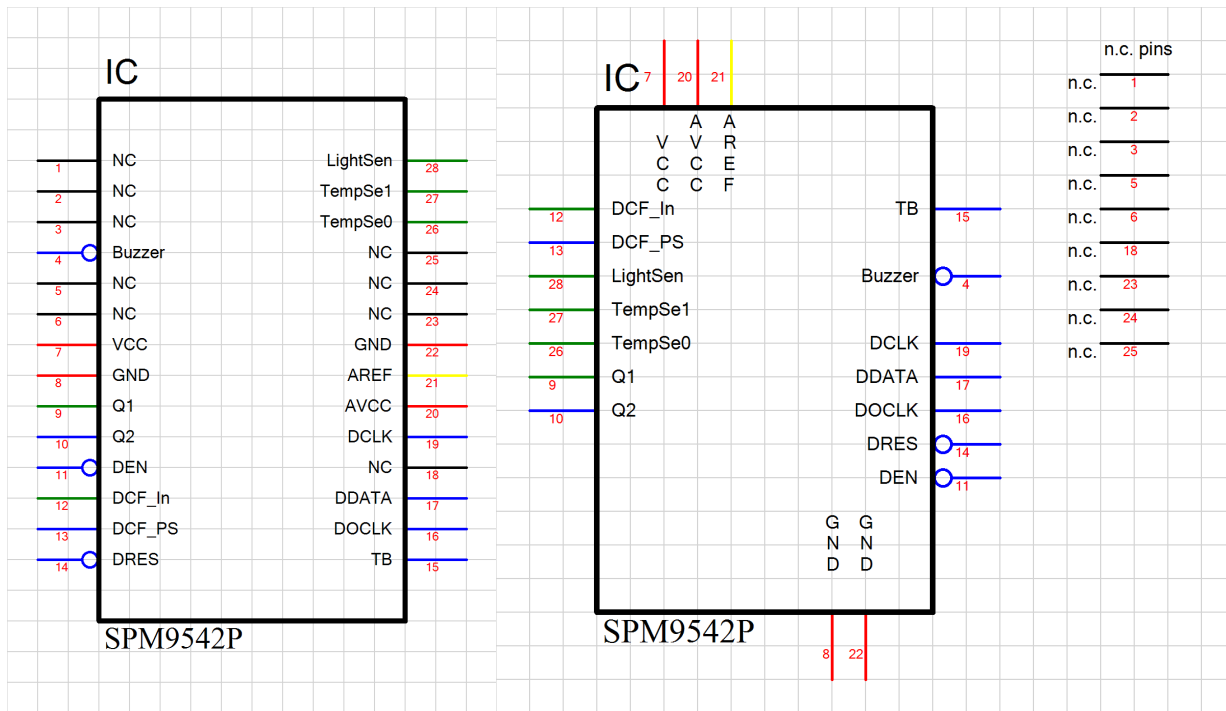
## Technical data

- Voltage (VCC): 3 V - 5 V
- Current: 20 mA (at 5 V)
- Power: approximately 100mW (at 5 volts)
- Number of Pins: 28
- Display Power: directly to the controller is the maximum LED current 40mA
- Clock frequency: 8MHz
- Temperature accuracy:
  - Worst inaccuracy:  $\pm 2.5$  °C
  - Typical:  $\pm 1$  °C
  - Calibrated:  $< \pm 1$  °C

The values apply when using the LM35, when calibrated, the value can also be reached for other sensors.

- Other properties, refer to the datasheet for Microchip® ATmega328 or ATmega328P

# Construction description



## Pin assignment

### Reset

Reset input to reset the microcontroller is normally not required. In case of higher EMC requirements a 100nF capacitor should be soldered to ground!

### VCC

Operating voltage (3 V - 5 V)

### AVCC

Analog operating voltage ( $VCC \pm 0.3 V$ ), there should be a coil with about 10µH connected between VCC and AVCC.

### AREF

Internal analog reference voltage should be blocked with a 1 nF ceramic capacitor

### GND

Ground

### Q1, Q2

The connecting of the 8MHz quartz is shown in Figure 1

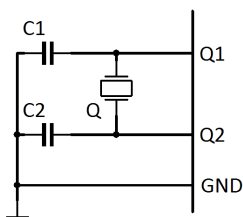


Figure 1: Connection of quartz

C1 and C2 are 20pF to 27pF ceramic capacitors (depending on the quartz) Q is an 8MHz quartz

**N.C.**

Do not connect, connect to no other signal!

**DDATA**

The serial display data output, this must be connected to the serial data input of the first shift register.

**DCLK**

Output for the clock of the serial display data output, it must be connected to the clock input of all shift register (You may buffer this signal <sup>1</sup>).

**DOCLK**

Output for the data transfer of the shift register to the output buffer, it must be connected to the storage clock input of all shift registers (You may buffer this signal <sup>1</sup>).

**DEN**

DEN is an output. This turns on the outputs of the output buffers and off. This is used for brightness control.  $\overline{\text{DEN}}$  needs to be connected all the shift registers (You may buffer this signal <sup>1</sup>).

**DRES**

DRES resets all the shift registers to a default value. This pin is not necessary, if the selected shift register hasn't this pin it can be used anyway. If  $\overline{\text{DRES}}$  is used it must be connected to all shift register (You may buffer this signal <sup>1</sup>).

<sup>1</sup>If too many inputs are connected to this output signal, this signal will be distorted too much and therefore the display may fault. You will need to check the datasheet of the shift register for the input current.

**Tas1, Tas2, Tas3**

Inputs for the keyboard.

**Buzzer**

On this connector a buzzer can be connected as an acoustic alarm optional. The plus pole must be connected to VCC pin of the buzzer, the minus pin must connected with "Summer".

**LightSen**

Analogue input for a light sensor.

**TempSen0**

Analogue input for a temperature sensor 0.

**TempSen1**

Analogue input for a temperature sensor 1.

# Properties of the components

## Shift register

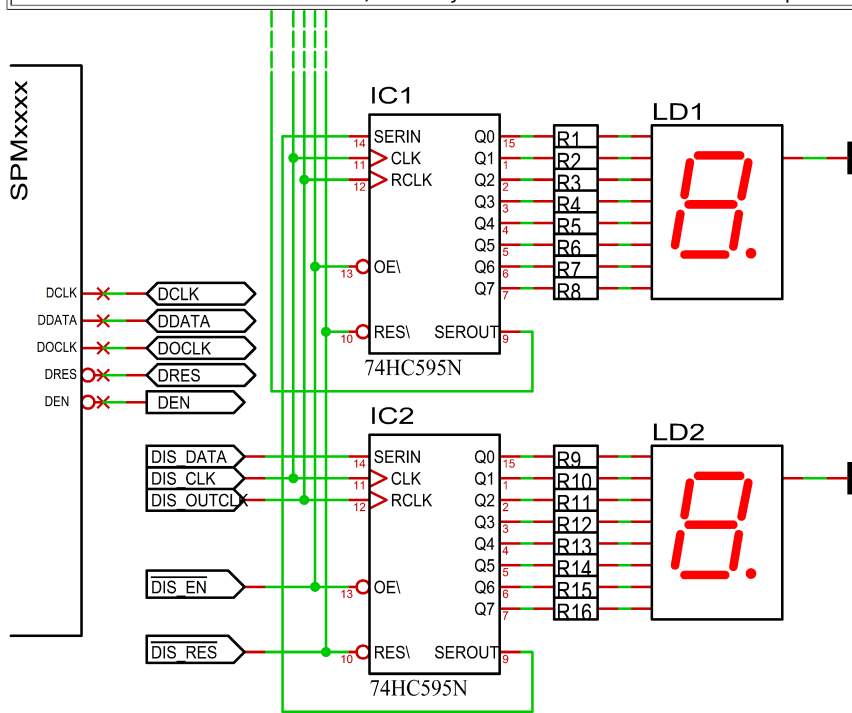
The shift register receives the data to be displayed serially and stores it in the output buffer. IC1 and IC2 are conventional 8-bit shift register of type 74HC595, the operating voltage and the blocking capacitors of IC1 and IC2 were not shown in the draw. The pin SERIN of IC2 have to be connected to pin DDATA of SPM9542P, pin SERIN of IC1 have to be connected to SEROUT of IC2, with more displays this continues like this. The shift register which is connected directly to DDATA of SPM9542P is the unit digit of the information. (yx = y: LD1, x: LD2) R1 to R16 are series resistor for the LED in the 7-segment displays.

**NOTICE**

It can be used other shift register, but only 74HC595 have been tested yet.

**NOTICE**

**Big displays**  
For larger displays which have larger current or higher voltage than the operating voltage of IC1 or IC2, a transistor buffer between the shift register and the series resistors must be used, see array transistor. Observe the maximum possible current which is in datasheet.



Output	Segment
Q0	Dezimalpunkt (DP) und Doppelpunkt an dem Display Zehnerminuten.
Q1	A
Q2	B
Q3	C
Q4	D
Q5	E
Q6	F
Q7	G

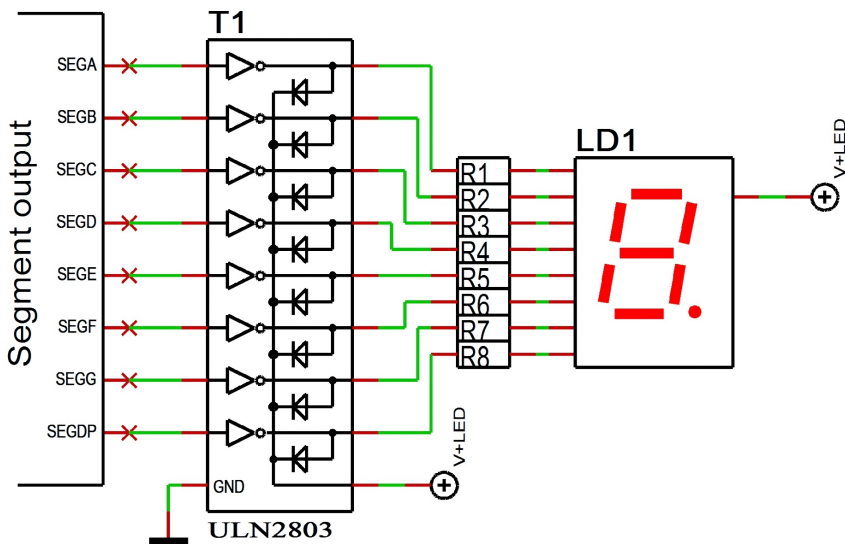
## Transistor array

For the sake of convenience, a transistor array is used for drive the cathode, in this case it is the ULN2803. The current and voltage amplifier for the LED's may also be constructed totally discrete and another transistor array may be used. If you using any other transistor arrays, the suitability for current and voltage load needs to be checked.

**NOTICE**

For smaller displays with just one LED per segment and low current, the transistor array T1 can be omitted if the driving IC can withstand the current. In this case the 7 segment display must be connected to VCC instead of V + LED!





## 7 segment displays

The seven-segment display LD1 and LD2 must have a common anode. Via R1 to R8 the brightness of the LEDs can be set.

### Checked displays

Manufacturer no. Hersteller-Nr.	Manufacturer Hersteller	Color Farbe	Brightness Helligkeit
<b>0.39 in - 10 mm</b>			
SA 39-11 SRWA	KINGBRIGHT	Red- Rot	—
SA 39-11 GN	KINGBRIGHT	Green- Grün	—
<b>0.52 in - 13,3 mm</b>			
SA52-11SRWA	KINGBRIGHT	Red- Rot	—
SA52-11LSRWA	KINGBRIGHT	Red- Rot	—
SA52-11EWA	KINGBRIGHT	Red- Rot	—
SA52-11YWA	KINGBRIGHT	Yellow- Gelb	—
SA52-11LYWA	KINGBRIGHT	Yellow- Gelb	—
SA52-11GWA	KINGBRIGHT	Green- Grün	—
SA52-11LGWA	KINGBRIGHT	Green- Grün	—
SA52-11QBWA-D	KINGBRIGHT	Blue- Blau	—
LTS-546AP	Lite-On	Red- Rot	—
TDSR5160	Vishay Semiconductors	Red- Rot	—
TDSG5150	Vishay Semiconductors	Green- Grün	—
<b>0.56 in - 14,2 mm</b>			
SA 56-11 EWA	KINGBRIGHT	Red- Rot	—
SA 56-11 GWA	KINGBRIGHT	Green- Grün	—
<b>0.8 in - 20,32 mm</b>			
SA08-11SRWA	KINGBRIGHT	Red- Rot	—
SA08-11EWA	KINGBRIGHT	Red- Rot	Testis still pending - Test steht noch aus
SA08-11YWA	KINGBRIGHT	Yellow- Gelb	—
SA08-11GWA	KINGBRIGHT	Green- Grün	—
SA08-11PBWA	KINGBRIGHT	Blue- Blau	—
HDSP-8601	Agilent	Green- Grün	—
<b>2.3 in - 56,9 mm</b>			
SA23-12SRWA	KINGBRIGHT	Red- Rot	✓
SA23-12EWA	KINGBRIGHT	Red- Rot	✓
SA23-12YWA	KINGBRIGHT	Yellow- Gelb	✓
SA23-12GWA	KINGBRIGHT	Green- Grün	✓
<b>4.0 in - 100 mm</b>			
SA40-19SRWA	KINGBRIGHT	Red- Rot	✓
SA40-19EWA	KINGBRIGHT	Red- Rot	✓
SA40-19YWA	KINGBRIGHT	Yellow- Gelb	✓
SA40-19GWA	KINGBRIGHT	Green- Grün	✓

- ✓ Works fine. The input voltage of the module may need to be adjusted, we will be happy to advise you. Please note that the ambient brightness can unfortunately reduce the impression of brightness somewhat.

Funktioniert perfekt. Die Eingangsspannung des Moduls muss ggf. angepasst werden, wir beraten Sie gerne. Bitte beachten Sie, dass die Umgebungshelligkeit den Helligkeitseindruck leider etwas mindern kann.

- Works but not fine - Funktioniert, aber nicht zu empfehlen

- X Doesn't work - Funktioniert nicht
- X Not tested, would not work directly - Nicht getestet, da nicht direkt möglich.

### Effect of an acrylic glass

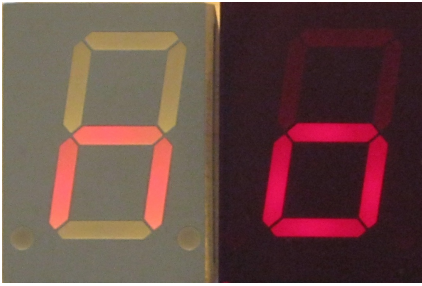


Figure 2: SA08-11SRWA left without and right with contrast pane with front light.

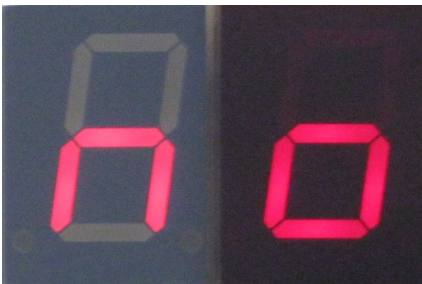


Figure 3: SA08-11SRWA left without and right with contrast pane without front light.

Below with and above without front light.

Because the display control is static, all 7 segment displays can be used. It can only be that, with reduced brightness setting, not all 7 segment displays lead to the desired result.

All segments with 4 LEDs were limited with a 220 ohm resistor. All segments with 2 LED (decimal point on SA23 and SA40) were limited with 390 ohm resistor.

This circuit is not optimised for minimum components and power. The displays are therefore easy to read when illuminated directly by lamps. The brightness of the display is also important for readability. A milky display such as the SA40 is not as easy to read as a display consisting of individual clear LEDs. Even in the shade there is still enough light, namely around 10,000 lux. At maximum current, however, the SA40-SRWA only measured approx. 3,000 lux with a Peaktech 3695.

It is recommended to place a contrast glass in the corresponding display colour in front of the displays, see figure 3 and 2.

Correct colour of the glass.

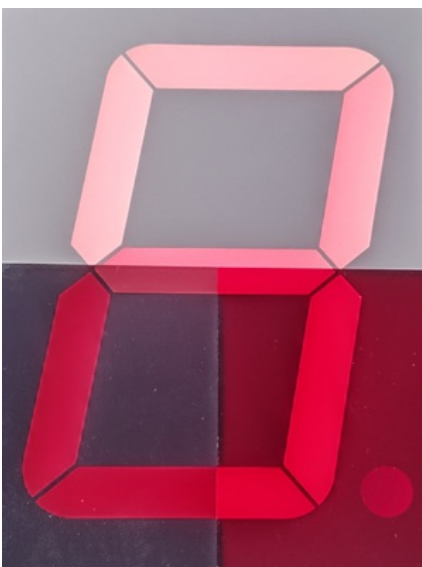


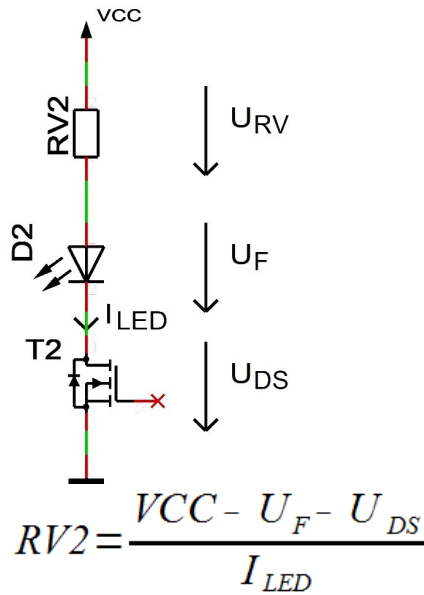
Figure 4: SA40-19SRWA top without, bottom left grey and right with red contrast lens with front light

SPI contrast without front light 2

Figure 5: SA40-19SRWA upper red and lower gray contrast pane with front light.

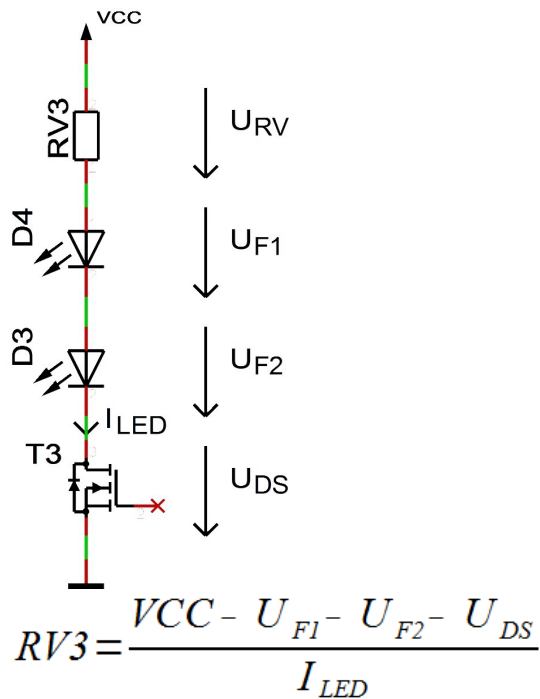
The colour of the disc also makes a difference, see 4 and 5 with 20,000 lux front light. Note: The menu is always displayed with 100% brightness.

**Calculate the series resistor for one LED**



- $U_{DS} \approx 0$
- $I_{LED} < 35 \text{ mA}$

**Calculate the series resistor for two LED**

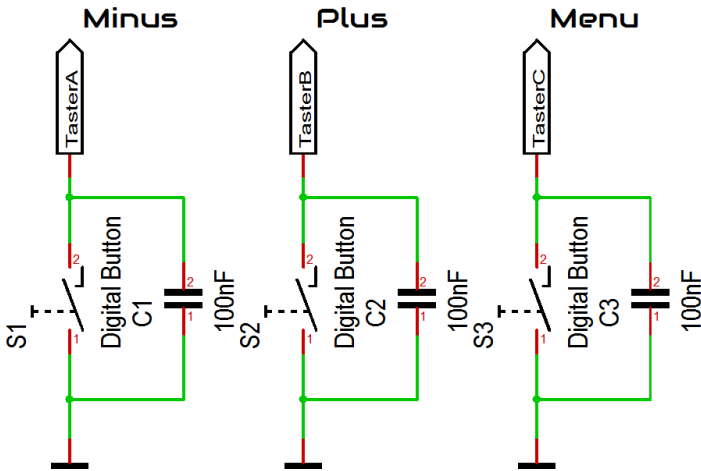


- $U_{DS} \approx 0$
- $I_{LED} < 35 \text{ mA}$

**Keyboard**

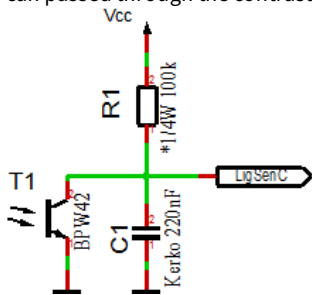
Inputs for the keyboard. The buttons must switch the pin to ground when it is pressed. It is expressly recommended to use digital compatible switches. A capacitor (C1) to suppress bouncing is an advantage.

The remote control of the controller is simply possible by parallel adding or replacing the button with NPN transistors.

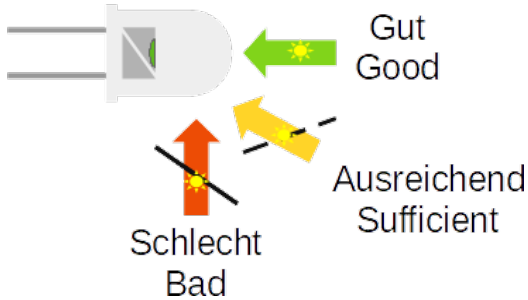


**Properties of light sensor with Phototransistor**

The light sensor is used to control the brightness of the display. As light sensors many phototransistors are suitable, in the example circuit a BPW42 is used. If another phototransistor is used, may you need to change the value of the pull-up resistor R1. The menu allows to adjust the calculation factor, offset and the control speed. If the sensor is mounted behind a contrast panel, it must be taken to ensure that the wavelength of the phototransistor can pass through the contrast screen.



In the case of the BPW42 and similar photo transistors in the LED diode housing, the incidence of light must take place as follows in order to achieve the best result:



⚠ **NOTICE**

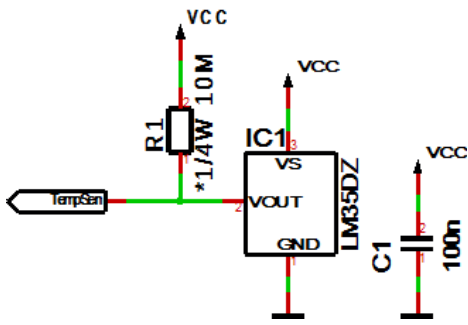
When using a different phototransistor or a different photodiode, it may be necessary to adapt R1 (top picture) and the settings in the menu!

**Temperature sensor**

The temperature sensor is used to display the temperature and it must be an analog sensor with 10mV / 1°C. This is to be connected to the temperature sensor input (TempSen).

From version 1.79-144 the temperature sensor can be calibrated and also display negative temperatures. The calibration is done with one decimal place, but the display is always an integer.

When installing the temperature sensor, make sure that it does not receive any foreign heating, installation directly on the circuit board can make a difference of several Å° C (Kelvin) under certain circumstances!



R1 is optional for the detection of whether a sensor is connected or not; this is not necessary with permanent wiring.

#### Method of calibration with a temperature value

You can carry out a calibration with a temperature value yourself with a suitable temperature measuring device.

1. Use a temperature measuring device that is as accurate as possible to measure the temperature that the connected temperature sensor is exposed to; ideally, both sensors are thermally coupled.
2. Select Show temperature in the menu and press the + button for longer than a second, the currently measured temperature is displayed.
3. Set the temperature from the precise temperature measuring device and wait briefly until the display jumps back.
4. The correct temperature should now appear on the display. If this is not the case, repeat the process.

#### Procedure for calibration with an offset value

The calibration with offset value is intended if you buy a sensor with a previously measured offset value.

1. Select Display temperature in the menu and press the button for longer than one second, the current offset value is displayed.
2. Set the supplied offset value and wait briefly until the display jumps back.
3. The correct temperature should now appear on the display. If this is not the case, please contact us.

The calibration only refers to the offset, the linearity cannot be changed!

# Button description

## Button functions

### Button functions

- Menu Opens the menu, next setting
- Plus or + Function key, usually +, On or jump into and exit a submenu
- Minus or - Function key, in general - or off

Which button assignment to which pin, please refer to the example diagram.

To open the menu you have to press the menu or StartStop button for a long time. Use the menu button to navigate forward.

### General key functions

- A submenu is always opened with the "Plus" or "+" key and with menu display "... E" it can be exited again with "Plus" or "+".
- For numerical properties, the number is increased with the "Plus" or "+" key and decreased with the "Minus" or "-" key.
- If it is an On / Off property, then "Plus" or "+" sets On and "Minus" or "-" sets Off.
- With lists, the value is changed according to the order with the "Plus" or "+" button, with "Minus" or "-" this happens in the opposite way.
- In special cases, this is described in detail next to the images.

- Menu+ Opens the menu, next setting
- Menu- Opens the menu, previous setting
- Plus or + Function key, usually +, On or jump into and exit a submenu
- Minus or - Function key, in general - or off

Which button assignment to which pin, please refer to the example diagram.

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.

### General key functions

- A submenu is always opened with the "Plus" or "+" key and with menu display "... E" it can be exited again with "Plus" or "+".
- For numerical properties, the number is increased with the "Plus" or "+" key and decreased with the "Minus" or "-" key.
- If it is an On / Off property, then "Plus" or "+" sets On and "Minus" or "-" sets Off.
- With lists, the value is changed according to the order with the "Plus" or "+" button, with "Minus" or "-" this happens in the opposite way.
- In special cases, this is described in detail next to the images.

## Menu

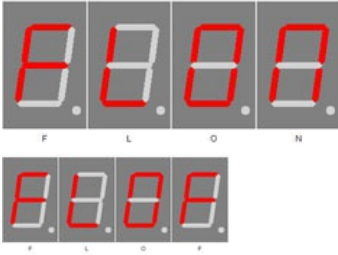
Level 1	Level 2
<b>Normal</b> ↓	
<b>Show Temperature channel 0</b> ↓	
<b>Show Temperature channel 1</b> ↓	
<b>Display mode</b> ↓	
<b>Change speed display</b> ↓	
<b>Brightness</b> ↓	Brightness menu → Brightness max → Brightness min → Brightness automatically → Brightness speed → Brightness factor → Brightness offset → Exit brightness settings ↻
<b>Info section</b> ↓	
<b>IC number</b> ↓	
<b>Firmware version</b> ↓	

⇓: Next step in main menu.

→: Next step in sub menu.

↺: The submenu starts again.

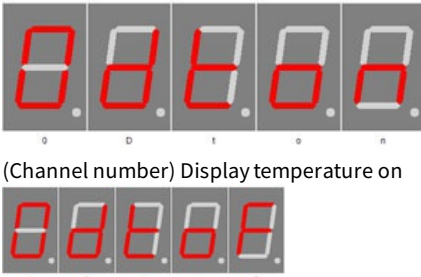
### Normal



Normal mode, outside of the menu.

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

### Show Temperature channel 0



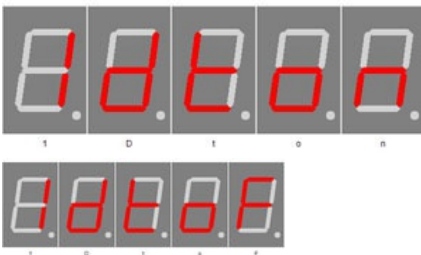
(Channel number) Display temperature on

(Channel number) Display temperature off

Enables the temperature display. Plus (+) enables the temperature display and minus (-) disables it.

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 ...".

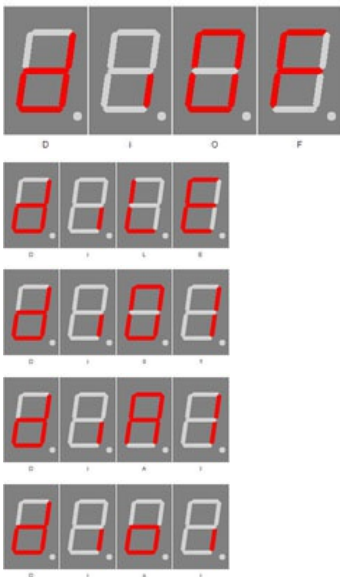
### Show Temperature channel 1



Enables the temperature display. Plus (+) enables the temperature display and minus (-) disables it.

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 ...".

### Display mode



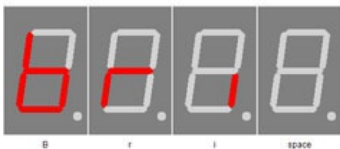
The mode for the channel display can be set with the plus (+) and minus (-) buttons:  
 OF: No channel display  
 LE: One LED (one segment A = 0 or B = 1 of display 5) is used.  
 01: The display 5 shows 0 or 1 for the channel.  
 AI: The display 5 shows A or I for the channel. A = channel 0 and I = channel 1.  
 oi: The display 5 shows O or I for the channel. o = channel 0 and i = channel 1.

### Change speed display



The change speed can be set in seconds with the plus (+) and minus (-) buttons, the range is 1 to 10 seconds.

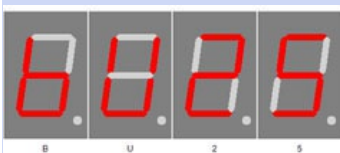
### Brightness



With plus (+) you enter the sub-menu brightness.

Brightness

#### Brightness menu



Brightness

Sets the brightness of the menu. The number can be between 10 and 25, with 10 being the darkest menu and 25 the lightest.

#### Brightness max



Brightness high

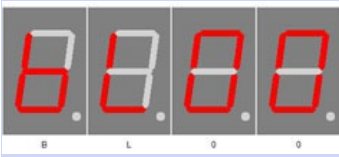
In this menu item, the maximum brightness plus (+) and minus (-) of the display can be adjusted.

This is also used when auto brightness is disabled.

The number can be between 0 and 25, with 0 being the darkest and 25 the lightest.



**Brightness min**



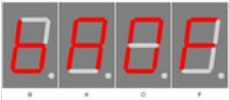
Brightness low

In this menu item, the minimum display brightness can be adjusted with plus (+) und minus (-).  
The number can be between 0 and 25, with 0 being the darkest and 25 the lightest.

**Brightness automatically**



Brightness automatically on



Brightness automatically off

This allows to turn on with plus (+) and off with minus (-) the auto brightness.

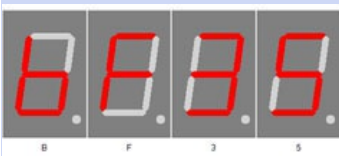
**Brightness speed**



Brightness speed

Use plus (+) and minus (-) to set the speed of auto brightness.  
The number can be between 0 and 20 and delays the brightness calculation by approx. 100 ms. With the setting 20, the brightness is therefore recalculated every 2 seconds. The maximum value may differ depending on the firmware.

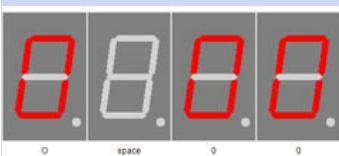
**Brightness factor**



Brightness factor

Use plus (+) and minus (-) to set the calculation factor for auto brightness.  
The number can be 1-99. There is no unit for this, as it cannot be defined due to component tolerances.

**Brightness offset**



Brightness offset



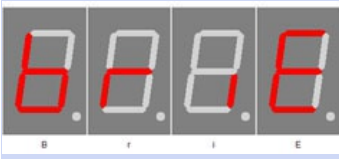
Brightness offset -99



Brightness offset +99

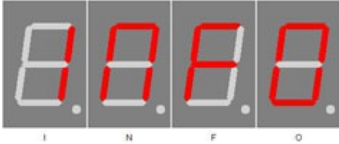
Use plus (+) and minus (-) to set the calculation offset for auto brightness.  
The number can be between -99 and 99. There is no unit for this, as it cannot be defined due to component tolerances.

**Exit brightness settings**



With plus (+) you exit the sub-menu brightness.

**Info section**



This indicates the start the information area

**IC number**



IC / device type

Chip number

**Firmware version**

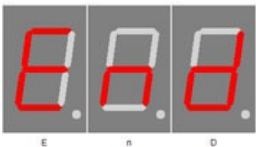


Firmware version

Example, it might be something else at this point.

Firmware version

**Menu end**



End of the menu, hide automatically after 2 seconds.

End

# 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).  
"RXD" → UART adapter TXD and "TXD" → 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.

**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

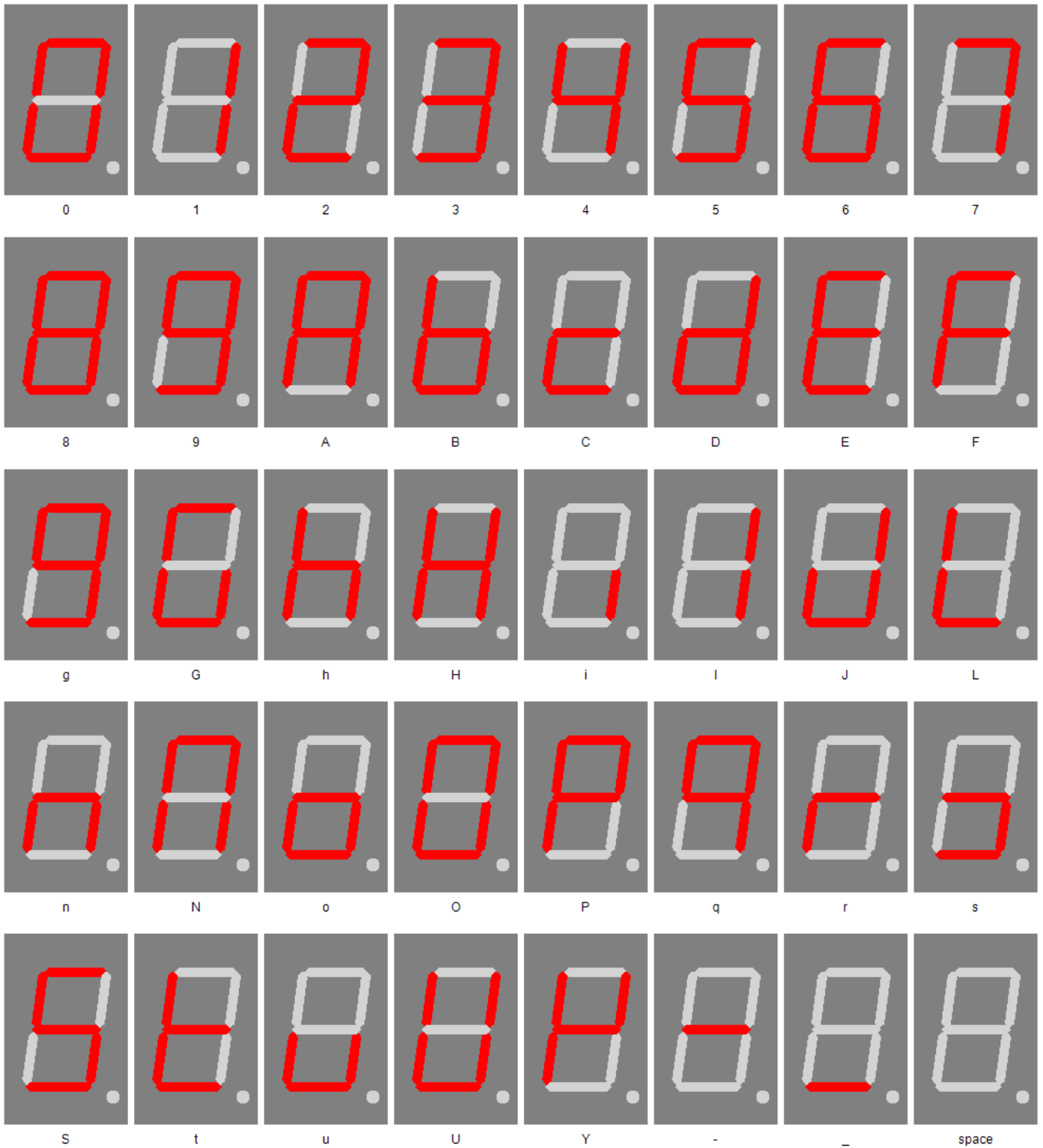
1. Download the latest upload tool from www.stefpro.biz: [SP Firmware UP](#)
2. Start the tool
3. Select the COM port.
4. Press the "Load" button and select a firmware which you have previously downloaded from SP Firmware UP
5. Now press the "Connect" button, the data from the IC / Module / device will 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:



## Change log

### Safety

20.03.2017 - 1.0.3 - ADD  
Add ESD note

### Temperature sensor

22.03.2021 - 2.0.1 - ADD

Add add temperatur sensor and calibration description

# Liability, warranty and copyright notice

## Definitions

- "Programmed IC": IC which was developed by StefPro and can only used with a minimum basic circuit.
- "Manufacturer of the whole device": The manufacturer of the whole device, the natural or legal person is mounted a device which can be made to function without special knowledge. E.G. Simple connection to the network via a euro, safety plug or by connecting to a power supply.

## 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.
- StefPro delivers only the "programmed IC", a basic circuit and possibly an [example circuit](#), but these are not tested for CE and EMC. The "Manufacturer of the whole device" requires the valid VDE, CE and EMC is comply with regulations.
- There is no liability for damages incurred directly by or in the application of the "programmed IC", as well as for damage caused by chemical or electrochemical effects of water or generally from abnormal environmental conditions.
- "Programmed IC's" by StefPro may not be used in critical equipment. At disregard exclusively the responsibility of "Manufacturer of the whole device."

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.
- All developed with a "programmed IC" by StefPro modules and devices must be the responsibility of the "Manufacturer of the whole device" sufficiently tested to detect any defects.

## Warranty

- StefPro warranty only for the programmed IC and their firmware. The warranty is exclusively limited for the replacement of the IC within the warranty period for obvious defects in the hardware, and programming error.
- 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 from StefPro is protected by copyright.. Unauthorized reproduction or distribution of programmed IC's with this program or any portion of it. This is pursued both criminal and civil law, and may result in severe penalties and compensation for damages.

## 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 Einzelunternehmen 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 (please note our [business hours](#))

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

E-mail: [info@stefpro.biz](mailto:info@stefpro.biz)