SPM1140P

Four digit digital countdown timer

for big display

Datasheet

SPM1140P
24.12.2016 ©StefPro™

StefPro™
Software development for processors

Table of Contents

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

The IC SPM110X ... is a digital mono-flop IC with display and buttons for setup.It has a buzzer output for Sound notification that the time has expired and an output forswitching a load via relay, transistor, etc..

The IC is a programmed microcontroller of the AVR family by Atmel.The circuit can be used for different purposes, because the target file is free for download, thecircuit can be arbitrarily Modified.

This IC is suitable for big displays and has a SPI interface for Shift registers or LED driver.

Functions

- Adjustable digital timer ranges from 1 second to 99 minutes and 59 seconds.
  - The set time is stored in the internal EEPROM
  - Easy to start, with just one button press
  - Pause function interrupts the countdown
  - Signal sounds after the time, for a preset time or upto press the button start-stop.
  - An output for switching loads, relays, solid relays or similar. After inverting transistor BC547C 100mA output load (or similar type).
- This IC has the Classic Screen display and the new default view, the differences are seen to www.stefpro.biz as gif video.
- Extra menu button to easily change the settings or press the start / stop button for 1 second to operate with 3 buttons or rotary encoder.
- LED test, at power up all the LEDs turned on for 1 second in order to facilitate the quality control
- It requires no additional IC's without voltage regulator.
- Low power consumption. Requires a power below

Application

  - For second exact exposure of PCBs, screen printing templates ...
  - Precisely timed Baking of plastics
  - Timed bonding
  - Timed flow control

Functional states

The START button is to press for the state start and stop.

With button DOWN in state "Setting Wait" the time can be lowered in seconds. In state "Pause" the countdown can be stopped by this key.

With button UP in state "Setting Wait" the time can be increased in seconds. In state "start" and "pause" this key functions as start / pause button.

The functional states can be seen in Figure 1.
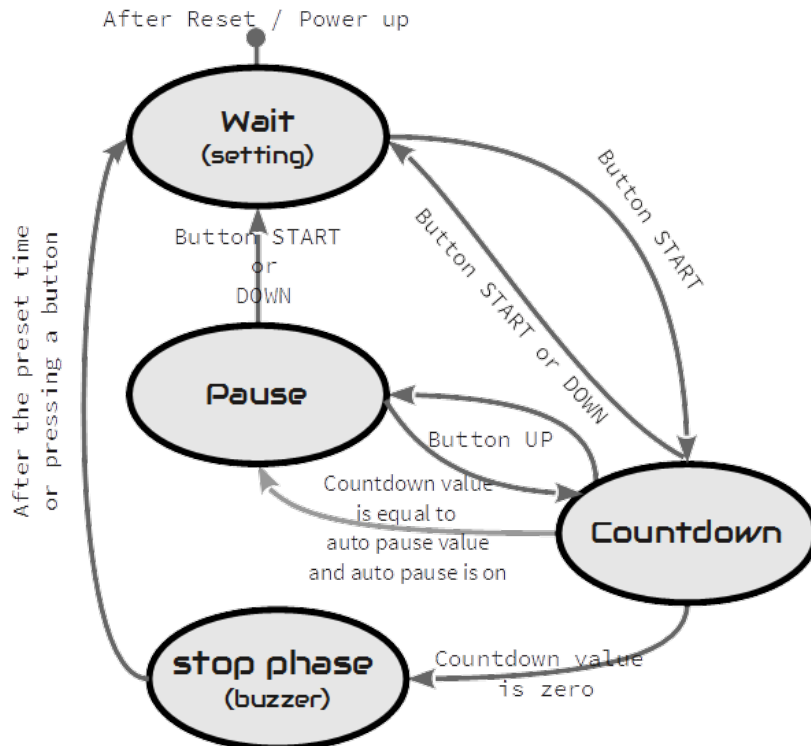
Abbildung 1: State diagram countdown mode

After reset / power up: Entry point after the reset and initialization.
Wait (setting): Setting the time is available, the time displayed on the screen is used as the next count down time. The Pin TiRe has a 0 (GND) at the output.
Countdown: In this operation, the time counted down in seconds and the decimal point (/SEGDP) flashes every second. Pin the TiRe has a 1 at the output so VCC potential.
Pause: The countdown is interrupted and the whole display flashes. Pin TiRe has a 0 (GND) at the output.
Stop phase (buzzer): In this state, the TiRe pin is reset to 0 (GND) and the buzzer pin is up for 3 seconds (or set time) or upto pressing the button Start to 0 (GND).

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
- Accuracy of the timer: better uncalibrated [[ACCURACY_OF_TIME_UNCAL_EN]] %; calibrated better [[ACCURACY_OF_TIME_CAL_EN]] %
- Other properties, refer to the datasheet for Microchip® ATMega328 or ATmega328P

Construction description
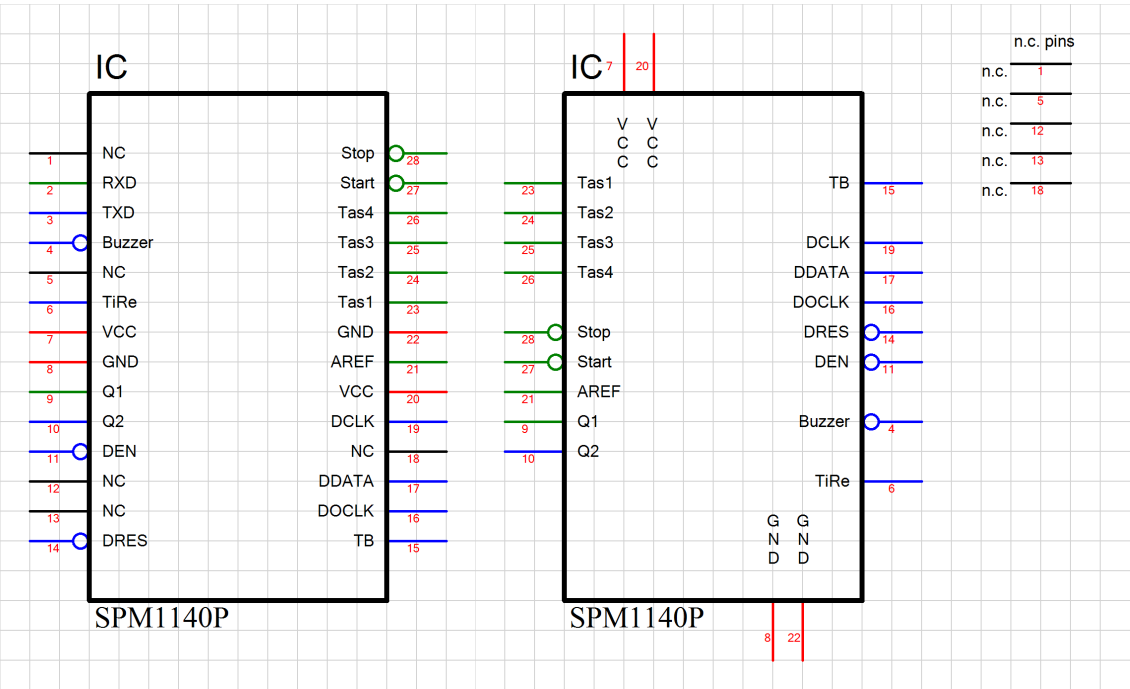
Pin assignment

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 ± 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 qaurtz

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!

Start

This pin starts the timer, by an extern signal.

Stop

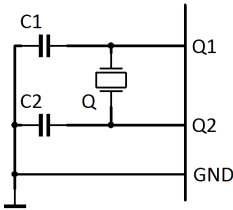This pin stops the timer, by an extern signal.

TiRe

Output for the time relay, it has to reinforce to switch a relay with a transistor (for example BC547C).

Operating mode	State	Comment
"Setting Wait"	0 (GND)	
"Countdown"	1 (VCC)	
"Pause"	0 (GND)	
"Stop phase"	0 (GND)	

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 [1]).

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 [1]).

DEN

DEN is an output. This turns on the outputs of the output buffers and off. This is used for brightness control. DEN needs to be connected all the shift registers (You may buffer this signal [1]).

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 DRES is used it must be connected to all shift register (You may buffer this signal [1]).

[1] 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, Tas4

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".

TB

Tap to verify the accuracy of the time base, min. 0,999 99 kHz and max. 1.000 01 kHz, the larger is the different from the 1 kHz the less accurate the IC. Production pin.

Basic circuit

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 SPM1140P, pin SERIN of IC1 have to connected to SEROUT of IC2, with more displays this continues like this. The shift register which is connected directly to DDATA of SPM1140P 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.
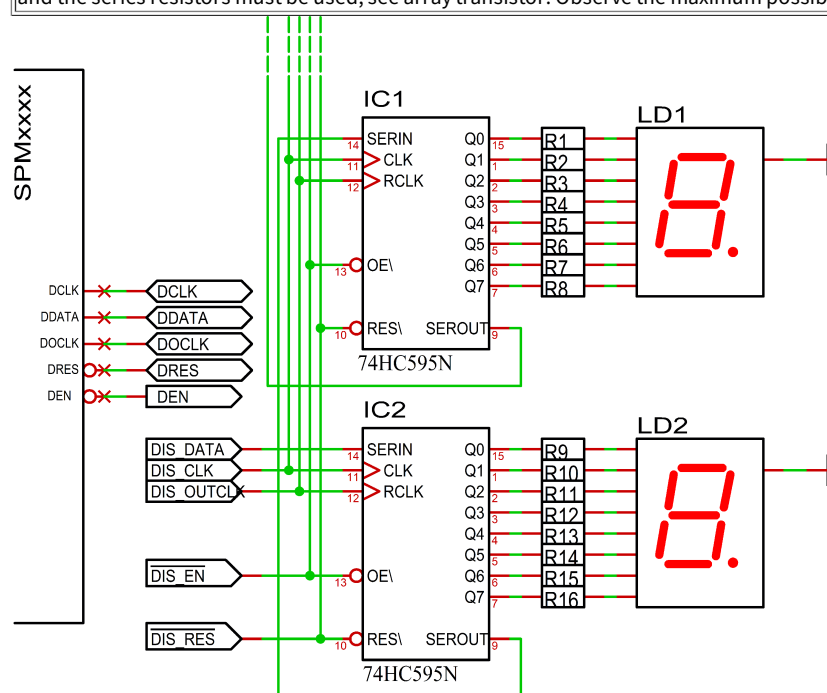
Output	Segment
Q0	Dezimalpunkt (DP) und Doppelpunkt an dem Display Zehnerminuten.
Q1	A
Q2	B
Q3	C
Q4	D
Q5	E
Q6	F
Q7	G

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!
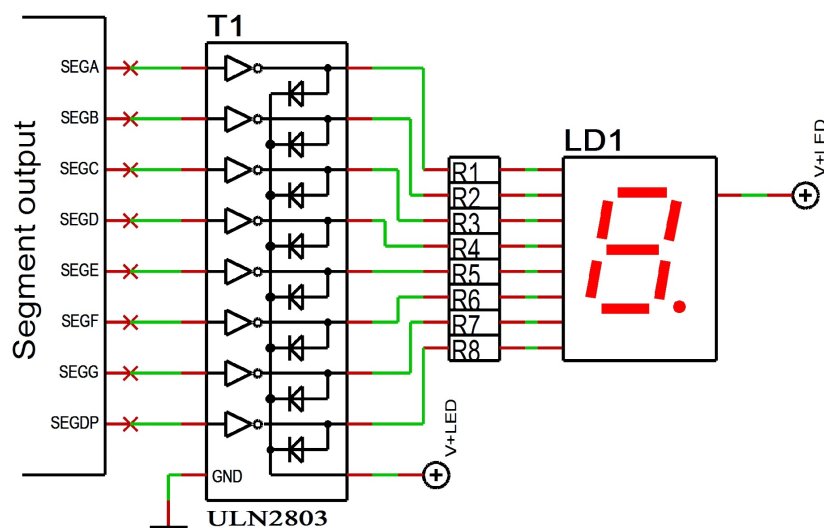
7 segment displays

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

Manufactor no. Hersteller-Nr.	Manufactor Hersteller	Color Farbe	Brightness Helligkeit
0.39 in - 10 mm			
SA 39-11 SRWA	KINGBRIGHT	Red- Rot	✓
SA 39-11 GN	KINGBRIGHT	Green- Grün	✓
0.52 in - 13,3 mm			
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	✓
0.56 in - 14,2 mm			
SA 56-11 EWA	KINGBRIGHT	Red- Rot	✓
SA 56-11 GWA	KINGBRIGHT	Green- Grün	✓
0.8 in - 20,32 mm			
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	✓
2.3 in – 56,9 mm			
SA23-12SRWA	KINGBRIGHT	Red- Rot	✓
SA23-12EWA	KINGBRIGHT	Red- Rot	✓
SA23-12YWA	KINGBRIGHT	Yellow- Gelb	✓
SA23-12GWA	KINGBRIGHT	Green- Grün	✓
4.0 in – 100 mm			
SA40-19SRWA	KINGBRIGHT	Red- Rot	✓
SA40-19EWA	KINGBRIGHT	Red- Rot	✓
SA40-19YWA	KINGBRIGHT	Yellow- Gelb	✓
SA40-19GWA	KINGBRIGHT	Green- Grün	✓

- ✓ Works fine - Funktioniert perfekt
- — Works but not fine - Funktioniert, aber nicht zu empfehlen
- ✗ Doesn't work - Funktioniert nicht
- ✗ Not tested, would not work directly - Nicht getestet, da nicht direkt möglich.
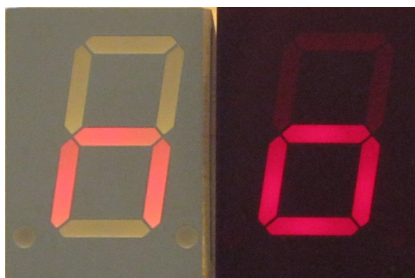
Effect of an acrylic glass

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

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

Below with and above without back 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.

Since this circuit is not optimized for minimal component and power requirements, the readability for direct exposure to headlights or sunlight is good even without a contrast panal.

It is recommended to place a contrast panel in front of the display, see figure 3 and 2.
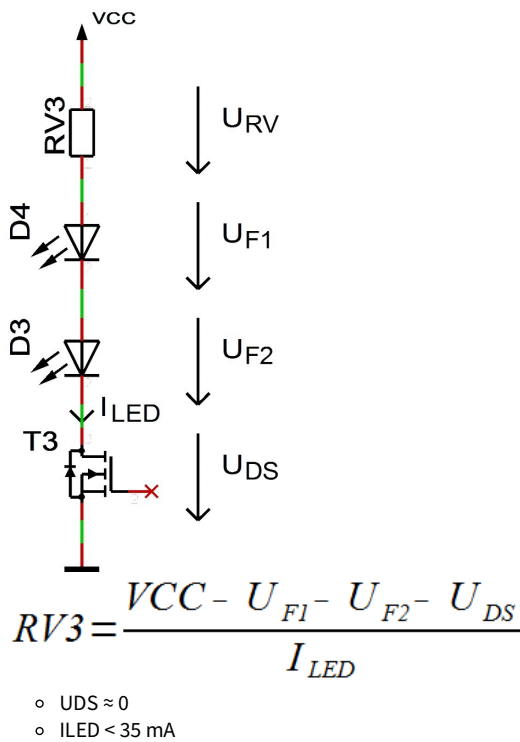
Note: The menu is always displayed with 100% brightness.

Calculate the series resistor for one LED

$$RV2 = \frac{VCC - U_F - U_{DS}}{I_{LED}}$$
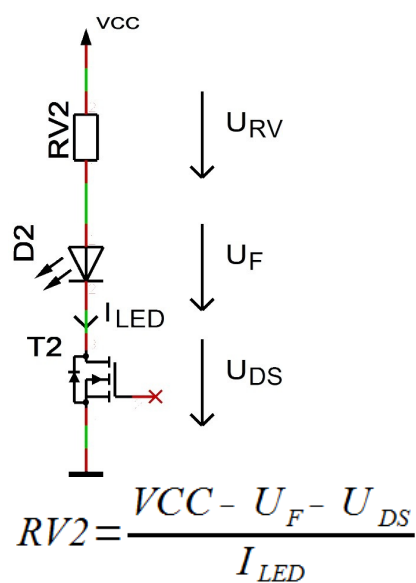
- UDS ≈ 0
- ILED < 35 mA

Calculate the series resistor for two LED

$$RV3 = \frac{VCC - U_{F1} - U_{F2} - U_{DS}}{I_{LED}}$$

- UDS ≈ 0
- ILED < 35 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.
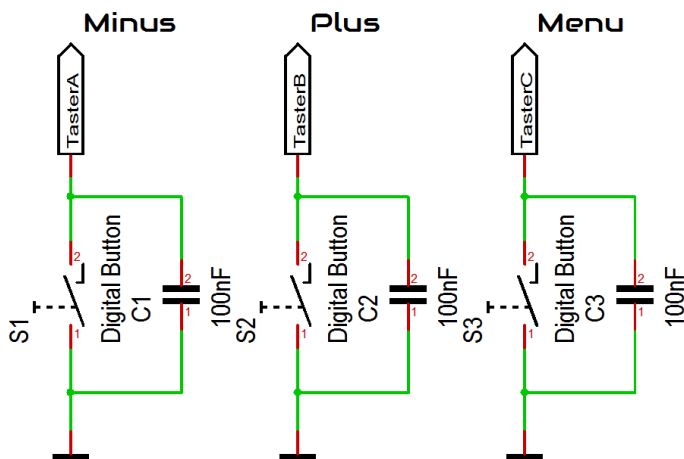

Relais

In the basic circuit is shown how a relay or something like that can be connected. T1 used R5 as a series resistor, T1 is operated as an amplifier and also as an inverter. For T1 and R5, other components may be used. A direct connection of a coil or a load with more than 20 mA is not recommended direct with the SPM1100 - SPM1102. D6 is idle, the diode when operating with coils. If the controller frequently triggers a reset or has other mistakes, instead of a transistor a optocoupler should be used.

Buzzer properties

The buzzer B1 must be self-producing and have a minimum voltage of VCC. Does the buzzer have not VCC, a series resistor have to be installed. The buzzer may further maximum of 40mA directly from the IC SPM1140P. The plus pole of the buzzer have to be applied to VCC and the minus pin of the buzzer have to connected to the IC. D1 is the idle diode when operating with coils.

VCC

D1
1N4148

B1

Buzzer TDB 05
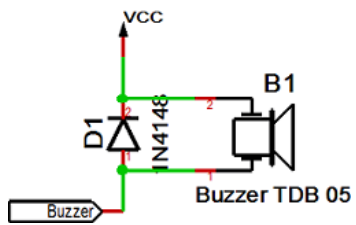
Buzzer

Button description

Menu

Level 1	Level 2
Using the Countdown Timer - Outside of menu⇓	
Buzzer setting⇓	
Auto pause⇓	Enable auto pause ➡Set auto pause ➡Exit auto pause ↻
Count direction⇓	
Display mode setting⇓	
Info section⇓	
IC number⇓	
Firmware version⇓	

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

## Using the Countdown Timer - Outside of menu

The countdown timer is operated by 3 buttons.

- S1 is the start and stop button. If the countdown timer in the pause mode, the timer can be restart with this button.
- S3 is the plus key, it increments the time. If the countdown timer is running, this button paused the countdown.
- S4 is the minus key, it decrements the time. If the countdown timer is running, this button stops the countdown.
    These buttons are available only when the menu is not open, otherwise the keys are used by the menu.

Buzzer setting
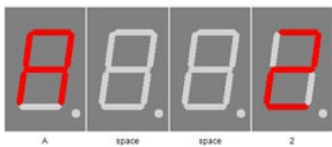
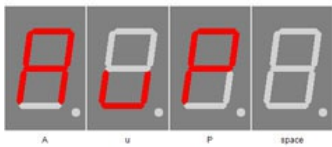With the button plus and minus the buzzer settings can be select.0: No tone
1: 3 seconds after the counter ends
2: 9 seconds after the counter ends
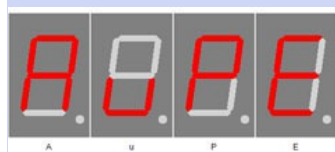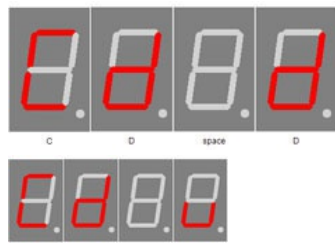3: infinitely until keystroke after the counter ends

Auto pause

With + you enter the sub-menu auto pause.

Auto pause

Enable auto pause	
	Enables the auto pause function.
Set auto pause	
	Sets the time for auto pause.

Exit auto pause

With + you exit the sub-menu auto pause.

Count direction

With plus key is counted up and with minus key down.
The direction does not change if the timer is already started, this take over until a restart.

Display mode setting

With keys plus and minus display mode setting Select
- C: Classic, buzzer beeps continuously
- S: Standard, the buzzer beeps with interruptions

Display Classic

Display Standard

Info section
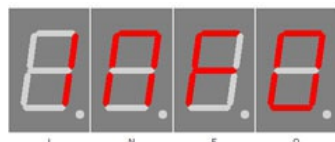
This indicates the start the information area

IC number

IC / device type

Chip number

Firmware version

Firmware version

Example, it might be something else at this point.

Firmware version

Menu end
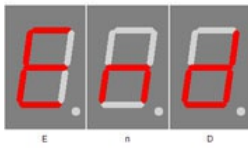
End

End of the menu, hide automatically after 2 seconds.

Attachment

Troubleshooting

This is a general listing of possible errors and error codes associated with the SPM1xxx series.

The following errors can occur

- IC gets hot
    - power supply not okay: measure VCC power supply, eventl. too big.
    - IC is plugged in reverse polarity.
- display remains dark and buzzer remains idle
    - Power supply not okay, re-measure VCC power supply.
    - Quartz does not vibrate: Quartz defect or quartz capacitors are defective or too large.
    - Reset pin is grounded or too small Capacitor is connected.
- The display stays dark and at the beginning there is only a short beep*
    - Bootloader button is pressed at power on
    - Bootloader button is shorted and defective.
- The display stays dark and at the beginning there is only one beep*
    - Firmware was not updated correctly during the last firmware update, try firmware update again.
    - firmware is broken for another reason, replace IC.

*Note: If no buzzer is available or planned, an LED or a multimeter on the PIN 4 can be used to check whether the bootloader is active or the firmware is defective.

The following error messages may occur

With this firmware there is no active display of error messages.

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
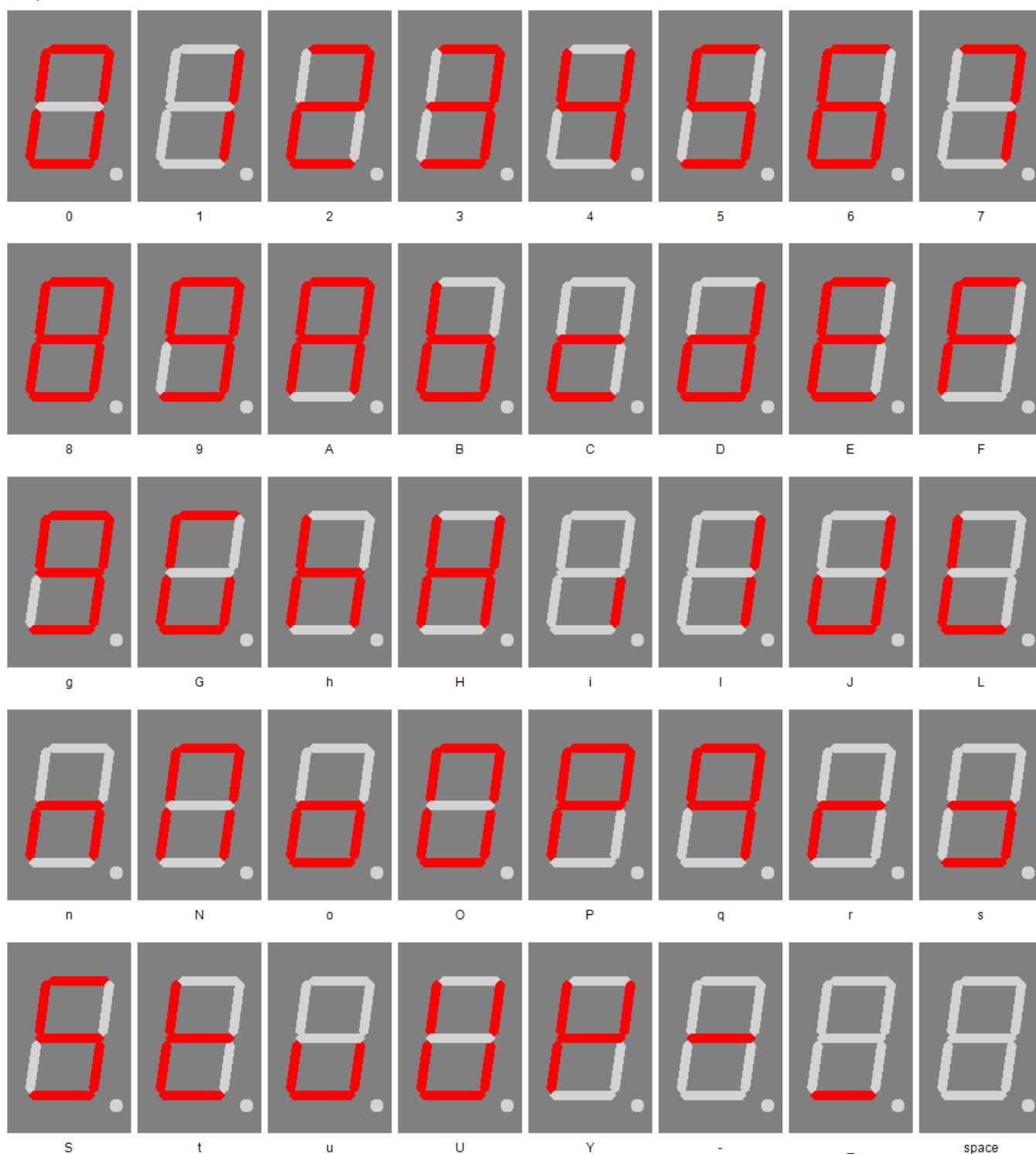
Change log

Safety

20.03.2017 - 1.0.3 - ADD
Add ESD note

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.

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- 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 <u>example circuit</u>, 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."

    Theseinclude:

    - 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.

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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

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- Softwareentwicklung für Prozessoren

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