## *Features and Benefits*

Flexible timer chip thanks to several configurations and options
Low cost – minimal external components
Low power consumption guarantees a long operation life on a low cost 1.5V button cell
COB (Chip-On-Board) package technology for compact and low cost implementation
Accurate timing based on low power crystal oscillator
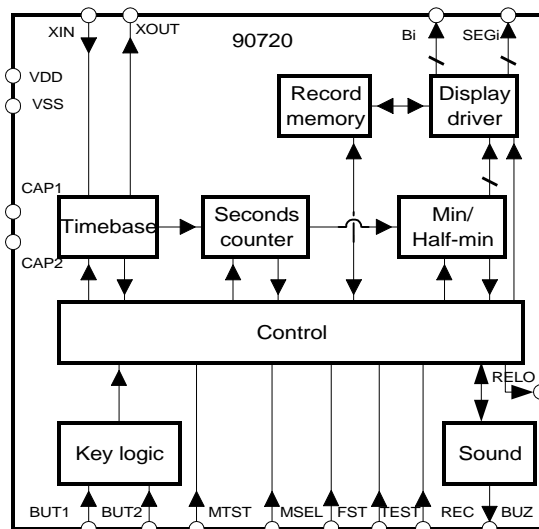Output for driving an external transistor
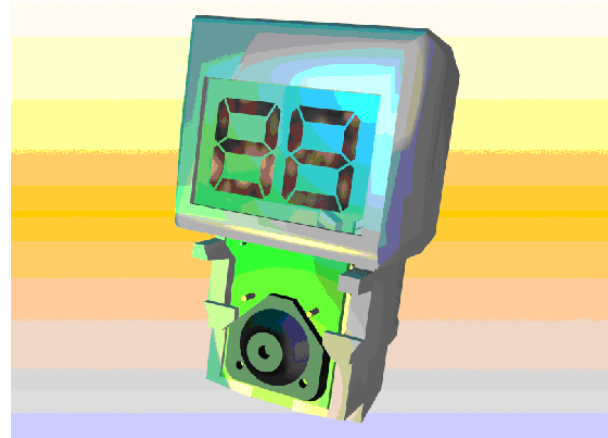
Applications

Autonomous kitchen timer
Parking timing reminder key ring

Ordering Information

Part No.	Temperature Suffix	Package	Temperature Range
MLX90720	S	die	0C to 85C

Functional Diagram

Description

The electronic timer device is powered by a 1.5V button cell, is programmable from 0 to 99 minutes, with 2 beep cycles at the end of countdown. The countdown mode is indicated with a blinking display. The timer is provided with an internal memory that allows the memorization of the last programmed time. The chip automatically enters sleep mode when not in use. The device can be used in several configurations and has several options, which are described below.

The chip is designed to be used with a dual backplane LCD.

The timer chip has an output (RELO) for driving an external low power NPN bipolar transistor. This transistor could be used for driving a switching element (relay). It can be connected directly (base to RELO) or through a resistor from 100 to 200 ohms.

General Description

The electronic timer is a self-powered device, programmable from 0 to 99 minutes, with ringing at the end of countdown. The timer has an internal memory which stores the last programmed time. An auto shut-off and a validation of the countdown (blinking display) are also provided.

The chip is designed to be used with a 2 backplanes LCD :
    Operation Voltage 3V
    Driving condition 1/2 Duty, 1/2 Bias

The timer chip has an output (RELO) for driving an external low power NPN bipolar transistor and a buzzer driver output.

RELO output

The timer chip has an output (RELO) for driving an external low power NPN bipolar transistor. This NPN transistor could be used for driving a switching element (relay). It can be connected directly (base to RELO) or through a resistor from 100 to 200 ohms.

Buzzer output

The chip has an output driver to drive a magnetic transducer. The frequency generated at this output is 2048 Hz.

Configurations

4 different configurations are possible and are defined according to the following table:

	MTST	MSEL
Configuration 1	0	0
Configuration 2	1	0
Configuration 3	0	1
Configuration 4	1	1

1: connected to Vdd.
0: connected to Vss.

Configuration 1: Minutes mode (a) : countdown in minutes and the last minute is displayed in seconds.
Configuration 2: Minutes mode (b): countdown in minutes and the last minute is **not** displayed in seconds.
Configuration 3: Minutes mode (c) : countdown in minutes with a 0.5 min. step from 10 min to 1 min and the last minute in seconds.

Configuration 4: Seconds mode.

Options

In each configuration two options are possible: the restore memory option and the second fast increment option.

The *restore memory option* is available in one button version (OBT: One Button Timer) or two button version (TBT: Two Button Timer) (see functional description on following pages). With this option the last programmed time can be restored.
The chip operates in OBT mode with restore memory, if pin REC is connected to VDD and operates in TBT mode, if REC is connected to VSS and button 2 is bonded. When the restore function is not used, REC is connected to VSS and button 2 is not used.
The TBT also has more flexibility in programming mode, as the time can not only be increased but also decreased.

The *second fast increment option* can be chosen to have two increment speeds in programming mode to set the desired time. The chip operates in this mode if pin FST is connected to Vdd.

Modes

The timer has 6 modes of operation:
    Wake up mode
    Programming mode
    Count down mode
    Ringing mode
    Wait mode
    Power down mode
The timer is always in one of these modes.

Functional description

The following paragraph describes the functionality of the asic in configuration 1, but with different options.

Basic OBT

The basic One Button Timer has no second button, no restore memory and no second fast increment option.

Wake up:
The first press enables the wake up of the chip within two seconds (debouncing + startup of the oscillator). The value 00 is displayed (non-blinking) and the chip enters programming mode.

Programming mode:
The programming of the timer is implemented with one button. In this mode the display doesn't blink.

If the button is pressed and released (short press), the *single increment mode* is selected, in which the time value is incremented with one Least Significant Digit, which corresponds to 1 minute.

If the button is pressed for more then 1 second, the chip enters the *fast increment mode*, increasing the value of the programmed time with a speed of 4 LSD per second. If the button is released, the single increment mode is selected, in which the time value is incremented with one LSD on each cycle of press-release. The timer can switch back and forth between single and fast increment mode.
When exceeding 99 minutes the timer jumps to 00 minutes.

During the programming mode, reset is not available. If the button is released for more than 2 sec and the display is not at 00 the chip enters countdown mode. When 00 is displayed and no button has been pressed for more than 45 sec. the chip enters power down mode.

Countdown mode:
If the timer is in programming mode, and the loaded value is different from 00, when the button is released for more than 2 seconds, the countdown starts. The countdown mode is indicated with a blinking display with a cycle of one second (0.5 sec's on, 0.5 sec's off). The countdown of the last minute is diplayed in seconds: 1min, 59s, 58s,...0s.
At the end of the countdown, the chip enters ringing mode.

Reset is possible during countdown by pressing the button for more than 1 second. In this case the chip enters programming mode again, displaying 00.

Ringing mode:
At the end of countdown, a ringing is produced, which warns the user :
- 10 groups of 3 sounds, total duration 10 seconds
- a delay of 20 seconds
- 10 groups of 3 sounds, total duration 10 seconds

The second group of sounds starts 30 seconds after the end of countdown. In this way a time with a resolution of 30 seconds can be achieved.

At the end of the cycle, the timer value 00 is returned and programming mode is entered.
During the ringing mode, the display continues to blink. The ringing mode can be interrupted by pressing the button (short or long press). In this case the chip enters programming mode. The value 00 is shown.

Power down mode:
When the chip enters in this mode the oscillator and the display are disabled and the current consumption

is minimized.

Note that waiting mode is not available.

OBT with second fast increment

The basic One Button Timer can have the second fast increment option. This has only an influence during programming mode.

Wake up:
The first press enables the wake up of the chip within two seconds (debouncing + startup of the oscillator). The value 00 is displayed (non-blinking) and the chip enters programming mode.

Programming mode:
The programming of the timer is implemented with one button. In this mode the display doesn't blink.
If the button is pressed and released (short press), the *single increment mode* is selected, in which the time value is incremented with one Least Significant Digit, which corresponds to 1 minute.

If the button is pressed for more than 1 second, the chip enters the *fast increment mode*, increasing the value of the programmed time with a speed of 4 LSD per second. If the button is pressed for more then 5 seconds, the *second fast increment mode* is activated, increasing the time with 8 LSD per second. If the button is released, the single increment mode is selected, in which the time value is incremented with one LSD on each cycle of press-release. The timer can switch back and forth between single and fast increment mode.
When exceeding 99 minutes the timer jumps to 00 minutes.

During the programming mode, reset is not available. If the button is released for more than 2 sec and the display is not at 00 the chip enters countdown mode. When 00 is displayed and no button has been pressed for more than 45 sec. the chip enters power down mode.

Countdown mode:
If the timer is in programming mode, and the loaded value is different from 00, when the button is released for more than 2 seconds, the countdown starts. The countdown mode is indicated with a blinking display with a cycle of one second (0.5 sec's on, 0.5 sec's off). The countdown of the last minute is diplayed in seconds: 1min, 59s, 58s,...0s.
At the end of the countdown, the chip enters ringing mode.
Reset is possible during countdown by pressing the button more than 1 second. In this case the chip enters programming mode again, displaying 00.

Ringing mode:
At the end of countdown, a ringing is produced, which warns the user :
- 10 groups of 3 sounds, total duration 10 seconds
- a delay of 20 seconds
- 10 groups of 3 sounds, total duration 10 seconds

The second group of sounds starts 30 seconds after the end of countdown. In this way a time with a resolution of 30 seconds can be achieved.

At the end of the cycle, the timer value 00 is returned and programming mode is entered.
During the ringing mode, the display continues to blink. The ringing mode can be interrupted by pressing the button (short or long press). In this case the chip enters programming mode. The value 00 is shown.

Power down mode:
When the chip enters in this mode the oscillator and the display are disabled and the current consumption is minimized.

Note that waiting mode is not available.

OBT with restore memory

The basic One Button Timer can have the restore memory option, which is operated with the same button.

Wake up:
In OBT configuration, the first press enables the wake up of the chip within two seconds (debouncing + startup oscillator).
If it is a short press, the value 00 is displayed (non-blinking), the chip enters programming mode.
If the button is pressed more than 1 sec., the restore function is activated and the last programmed time is displayed (non-blinking). During the first second, the value 00 is displayed (non blinking). The chip enters programming mode.

Programming mode:
The programming of the timer is implemented with one button. In this mode the display doesn't blink.
If the button is pressed and released (short press), the single increment mode is selected, in which the time value is incremented with one least significant digit (LSD), i.e. 1 minute.
If the button is pressed for more than 1 second, the chip enters the fast increment mode, increasing the value of the programmed time with a speed of 4 LSD per second. The timer can switch back and forth between single and fast increment mode.
When exceeding 99 minutes the timer jumps to 00 minutes.

During the programming mode, reset is not available.
If the button is released for more than 2 sec and the display is not at 00 the chip enters countdown mode.
If the button is not pressed during 45 seconds the chip enters power down mode.

Countdown mode:
If the timer is in programming mode, and the loaded value is different from 00, when the button is released more than 2 seconds, the countdown starts. The countdown mode is indicated with a blinking display with a cycle of one second (0.5 sec's on, 0.5 sec's off). The countdown of the last minute is displayed in seconds: 1min, 59s, 58s,...0s.

At the end of the countdown, the chip enters ringing mode.
Reset is possible during countdown by pressing the button for more than 1 second. In this case the chip enters waiting mode.

Ringing mode:
At the end of countdown, a ringing is produced, which warns the user :
- 10 groups of 3 sounds, total duration 10 seconds
- a delay of 20 seconds
- 10 groups of 3 sounds, total duration 10 seconds

The second group of sounds starts 30 seconds after the end of countdown. In this way a time with a resolution of 30 seconds can be achieved.

At the end of the cycle, the timer value 00 is returned and waiting mode is entered.
During the ringing mode, the display continues to blink. The ringing mode can be interrupted by pressing the button. A short press directly enters waiting mode. A press of longer then 2 seconds activates the restore function and programming mode is entered with the restored time.

Waiting mode:
In this mode the timer value 00 is displayed and the display is blinking. Pressing the button for more then 2 seconds activates the restore function and programming mode is entered with the restored time. A short press of the button enters programming mode at time 00.
If the button is not pressed during 45 sec the chip enters power down mode.

Power down mode:
When the chip enters this mode the oscillator and the display are disabled and current consumption is minimized.

TBT with restore memory

The second button (button 2) has two functions: it is used to restore the last programmed time and is used to decrement the timer value in programming mode. Whatever mode the chip is in, when button 2 is pressed (long press in programming mode and short press in the other modes) and button 1 is not pressed, the last programmed time is restored (not blinking) and the chip enters programming mode.

Wake up:
Pressing button 1 or button 2 always wakes up the chip within two seconds (debouncing + startup oscillator):

If the chip is activated by pressing button 1, the time value 00 is displayed (not blinking).
If the chip is activated by pressing button 2, the last programmed time is restored (not blinking)
The chip always enters programming mode.

Programming mode:
In this mode the last programmed time can be displayed by pressing button 2.
Programming of the timer is done with button 1 and button 2.

When button 2 is not pressed:
If button 1 is pressed and released (short press), the single increment mode is selected, in which the time value is incremented with one least significant digit (LSD), i.e. with one minute.

If button 1 is pressed for more than 1 second, the chip enters the fast increment mode, increasing the value of the programmed time with a speed of 4 LSD per second. The timer can switch back and forth between single and fast increment mode.

While button 1 is pressed:
If button 2 is pressed for a short time, the chip enters decrement mode. Each short press on button 2 decrements the time with 1 LSD, and when pressing for more then 2 seconds, the chip enters fast decrement mode, decrementing the programmed time with a speed of 4 LSD per second.

If button 2 is not pressed for more then 1 second, the chip enters increment mode again.
If button 1 is released and button 2 still pressed, the last programmed time is restored.

In increment mode, when exceeding 99 minutes the timer jumps to 00 minutes.
In decrement mode, when passing 00 minutes the timer jumps to 99 minutes.

If no button is pressed for more than 2 seconds and the display is not at 00 the chip enters countdown mode.

When 00 is displayed and no button has been pressed for more than 45 sec. the chip enters power down mode.

Countdown mode:
In this mode the last programmed time can be restored by pressing button 2 for more than 1 second.
The countdown mode is indicated with a blinking display with a cycle of one second (0.5 sec's on, 0.5 sec's off). The countdown of the last minute is displayed in seconds: 1min, 59s, 58s,...0s.
At the end of the countdown, the chip enters ringing mode.

Reset is possible during the countdown by pressing button 1 or button 2 for more than 1 second. If a reset is generated with button 1, the value 00 is displayed and the chip enters programming mode. If a reset is generated with button 2, the restore function is activated and programming mode is entered.

Ringing mode:
In this mode the last programmed time can be restored by pressing button 2.

At the end of the countdown, a ringing is produced, which warns the user :

- 10 groups of 3 sounds = 10 sec.
- a delay of 20 seconds
- 10 groups of 3 sounds

The second group of sounds starts 30 seconds after the end of countdown. In this way a time with a resolution of 30 seconds can be achieved.
At the end of the cycle, the timer value 00 is returned and programming mode is entered.

During the ringing mode, the display continues to blink. This mode can be interrupted by pressing button1. In this case the value 00 is displayed (not blinking) and the chip enters programming mode. Ringing mode can also be interrupted by pressing button 2. In this case the last programmed time is restored and programming mode is entered.

Power down mode:
When the chip enters this mode the oscillator and the display are disabled, and current consumption is minimized.

Other configurations

In configuration 2, the countdown of the last minute is not displayed in seconds.

The restore memory option (in One Button Timer version or Two Button Timer version) and the second fast increment option can be selected. Thus, except for the display of the last minute countdown, the functional behavior remains the same as in configuration 1.

In configuration 3, the countdown of the last minute is displayed in seconds. The least significant digit is variable. For the first 10 minutes, the LSD is 0.5 minutes, above 10 minutes the LSD is 1 minute. This can also be displayed on the LCD with one additional character. This means that both programming, countdown and restore are done with a resolution of 0.5 minutes for the first 10 minutes.

Note: also the first minute is programmed in steps of 0.5 minutes, while during countdown it is displayed in seconds.

The restore memory option (in One Button Timer version or Two Button Timer version) and the second fast increment option can be selected.

All other details are as in configuration 1.

Configuration 4 has the same functionality as configuration 1, but is counting seconds instead of minutes. This means that the LCD is always displaying seconds, programming and countdown is always in steps of 1 second, and the maximum time that can be programmed is 99 seconds.

LCD segment description

pin	SEG0	SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	B0	B1
BP0	D2	F2	A2	B2	F1	A1	B1	A0	BP0	-
BP1	D1	E2	G2	C2	E1	G1	C1	-	-	BP1
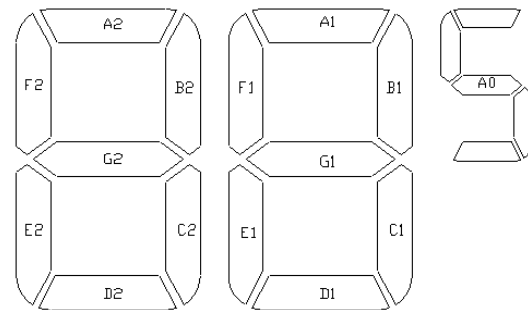
Pin description

Name	Type	Description
SEG0	output	LCD Segment 0 driver
SEG1	output	LCD Segment 1 driver
SEG2	output	LCD Segment 2 driver
SEG3	output	LCD Segment 3 driver
SEG4	output	LCD Segment 4 driver
SEG5	output	LCD Segment 5 driver
SEG6	output	LCD Segment 6 driver
SEG7	output	LCD Segment 7 driver
B0	output	LCD Backplane 0 driver
B1	output	LCD Backplane 1 driver
MTST	input	Configuration input 1
REC	input	One/two button selection
BUT1	input	Button 1 input

Name	Type	Description
FST	input	Second increment option
MSEL	input	Configuration input 2
VDD	supply	Power supply
REL0	output	Output driver
VSS	supply	ground
BUZ	output	Buzzer output
TST	input	Test pin
XOUT	output	Xtal oscillator output
XIN	input	Xtal oscillator input
BUT2	input	Button 2 input
CAP1	output	Charge pump cap. out
CAP2	input	Charge pump cap. in

MLX90720 Electrical Specifications

DC Operating Parameters T_A = 0°C to 85°C, V_{DD} = 1.2V to 1.7V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Standby current cons.	Isb	VDD = 1.5V			200	nA
Operating current cons.	Iop	VDD = 1.5V, buzzer output not loaded			3	uA

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Oscillator frequency	Fosc	VDD = 1.5V		32768		Hz

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Driver source current	Irelo	VDD = 1.2V		0.4		mA

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
timing tolerance for times < 2 minutes	tacc1		-1		1	sec
timing tolerance for times > 2 minutes	tacc2		-1		1	%

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Buzzer frequency	Fbuz			2048		Hz
Buzzer voltage	Vbuz			1.5		V

Applications Example: One button timer in configuration 1
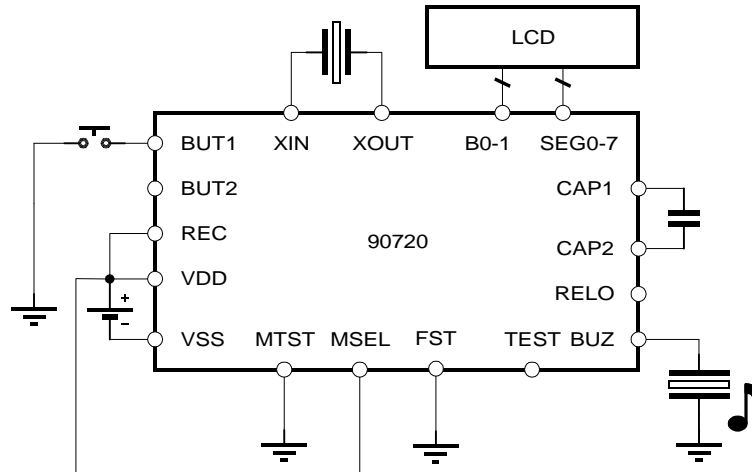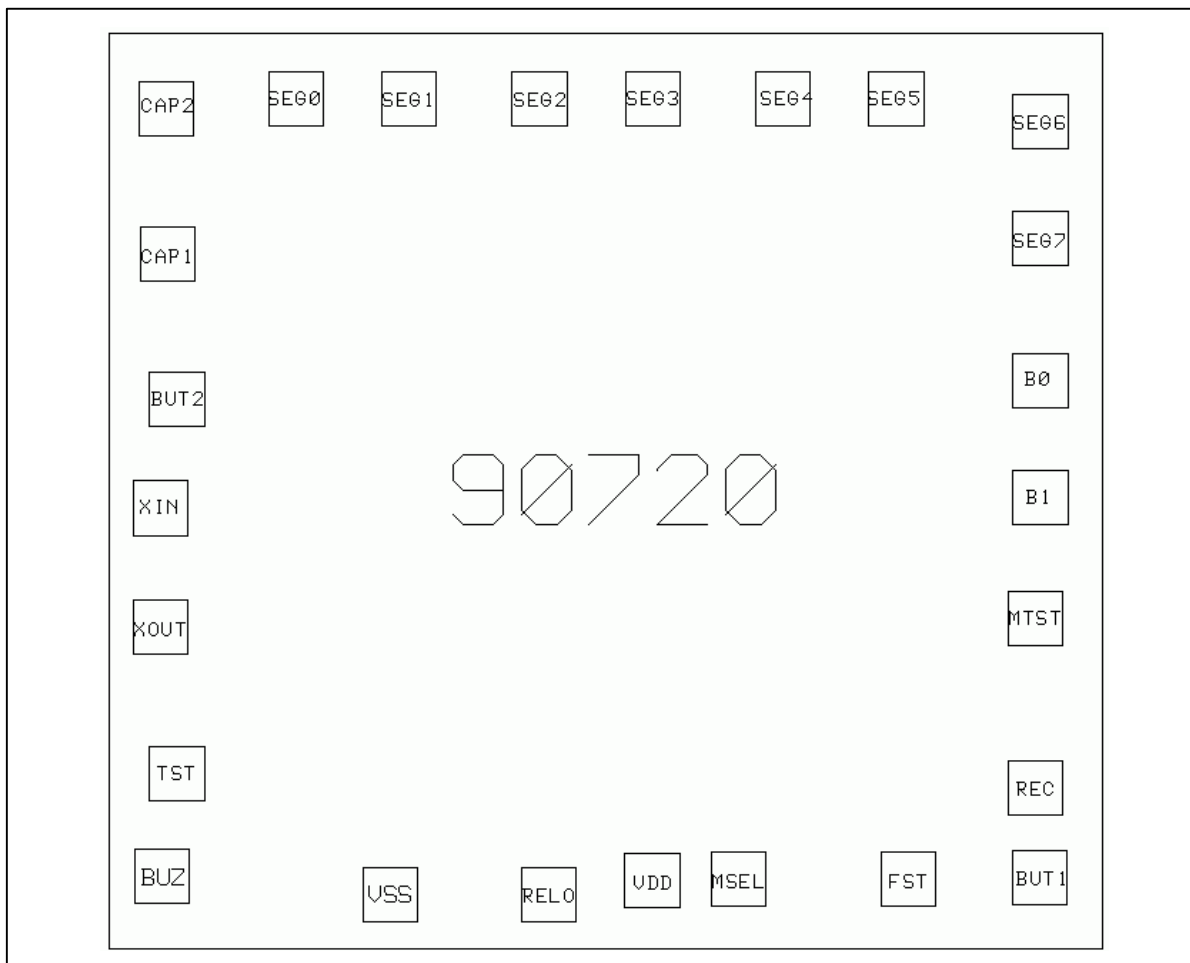

restore function active
second fast increment not active

Applications Example: Two button timer in configuration 3
with output driver
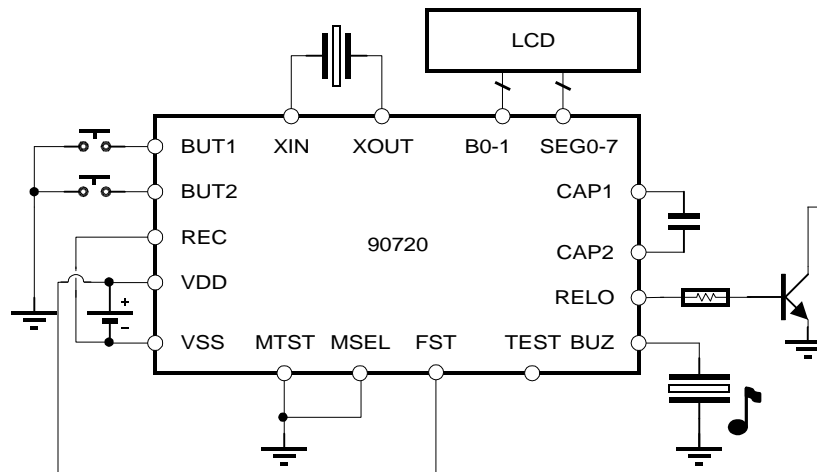
second fast increment active

MLX90720 bondpad placement

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