HT13R90
40-Bit Programmable Timer

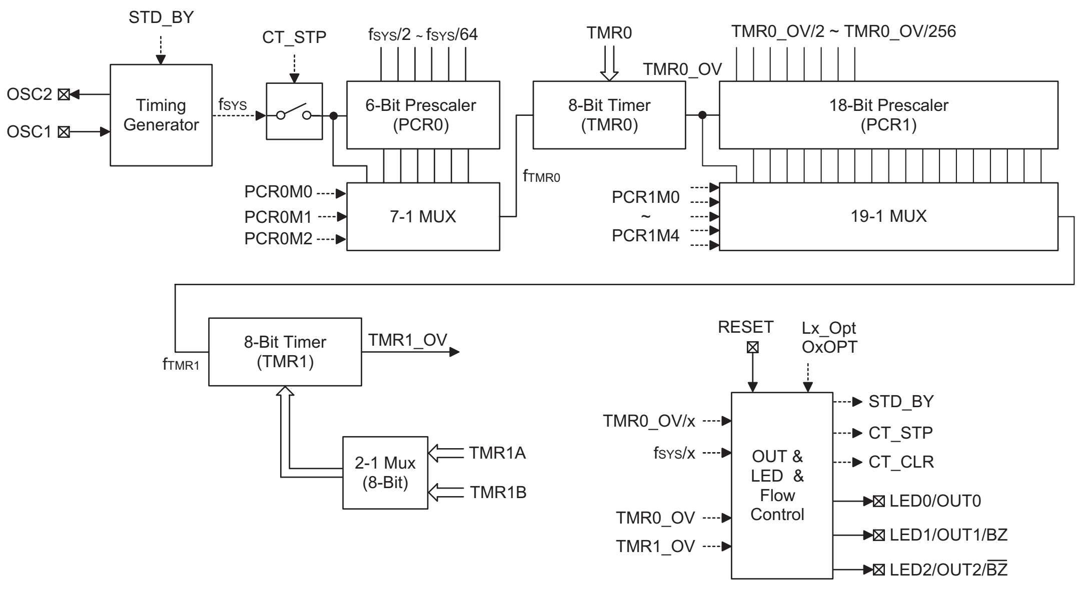
Features

- Operating voltage: 2.2V~5.5V
- Integrated 40-bit programmable timer provides a maximum time of over one year
- 3 operating modes: continuous mode, single period mode and single pulse mode)
- Single output
- Dual LED or Buzzer outputs for status indication
- Adjustable 5% internal RC or 32768Hz crystal oscillator with quick startup circuit.
- OTP configuration options of 22×4 bits for mode setting.
- 8-pin DIP/SOP package

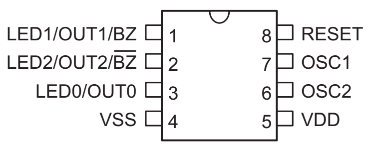
General Description

The HT13R90 is a programmable timer, whose timing is controlled by a 40bit counter. Providing a long bit counter enables long timer values of over one year to be programmed. When added to its other features, which include multi-preloadable values, varied output waveform combinations and OTP configuration option settings, give the device a flexibility making it suitable for a wide range of product timing applications.

Block Diagram



Pin Assignment



HT13R90
— 8 DIP-A/SOP-A

Pad Assignment

Pin Name	I/O	Mask Option	Description
LED0/OUT0	O	OMOD	Outputs a continuous duty cycle or pulse or single period duty cycle depending upon the OMOD configuration option.
LED1/OUT1/BZ	O	L1xx Option	Indicates the system operational status. The LED related options determine the LED or Buzzer output format.
LED2/OUT2/$\overline{BZ}$	O	L2xx Option	
RESET	I	—	Schmitt trigger reset input, active low.
OSC1 OSC2	I O	Crystal or IRC	The system oscillator can be external crystal oscillator or internal RC oscillator determined by a configuration option for the internal system clock. OSC, OSC2 are connected to an external crystal when the external crystal oscillator is selected.
VDD	—	—	Positive power supply
VSS	—	—	Negative power supply, ground

Absolute Maximum Ratings

Supply Voltage ....V_{SS}–0.3V to V_{SS}+6.0V
Input Voltage ....V_{SS}–0.3V to V_{DD}+0.3V
Storage Temperature ....–50°C to 125°C
Operating Temperature ....–40°C to 85°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

D.C. Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	f_{SYS}=32768Hz	2.2	—	5.5	V
I_{DD1}	Operating Current (Crystal OSC, RC OSC)	3V	No load, all output pins non-toggle*, f_{SYS}=32768Hz	—	—	3	μA
		5V		—	—	5	μA
I_{DD2}	Operating Current (RC OSC)	3V		—	—	2	μA
		5V		—	—	3	μA
I_{STB}	Standby Current (WDT Enabled and WDT RC OSC On)	—	No load, system HALT	—	—	1	μA
V_{IL}	Input Low Voltage ($\overline{RES}$)	—	—	0	—	$0.4V_{DD}$	V
V_{IH}	Input High Voltage ($\overline{RES}$)	—	—	$0.9V_{DD}$	—	V_{DD}	V
I_{OL}	I/O Port Sink Current	3V	$V_{OL}=0.1V_{DD}$	4	8	—	mA
		5V		10	20	—	mA
I_{OH}	I/O Port Source Current	3V	$V_{OH}=0.9V_{DD}$	–2	–4	—	mA
		5V		–5	–10	—	mA

Note: "*" LED1/2 has no carrier, level, and all options set to the lowest frequency. Measured in the non-toggle state.

A.C. Characteristics

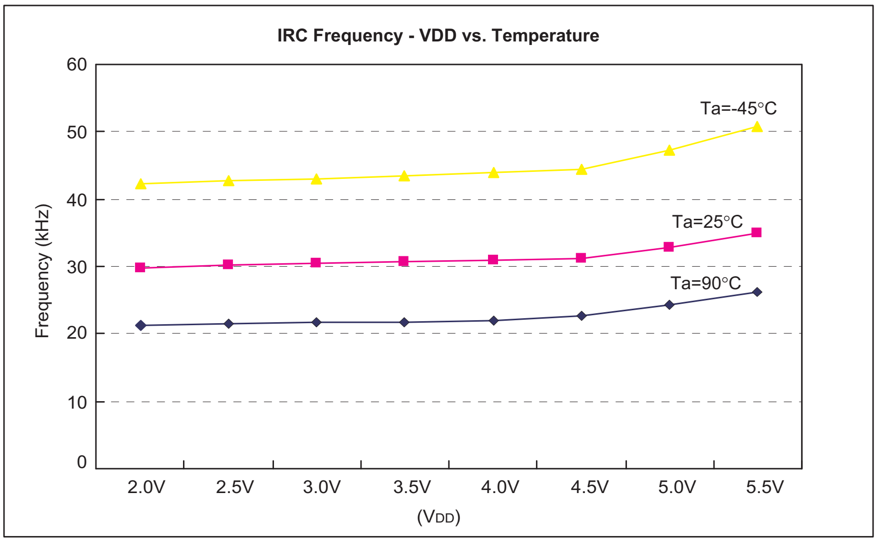
Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
f_{SYS}	System Clock (Crystal OSC, RC OSC)	—	—	—	32768	—	Hz
f_{IRC}	Internal RC Oscillator Deviation (5%)	5V	—	31129	32768	34407	Hz

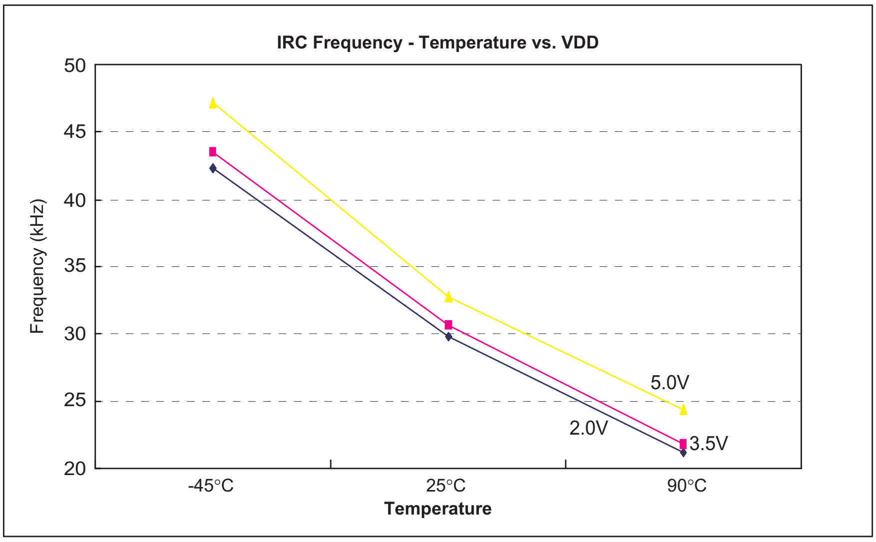
Note: $t_{SYS}=1/f_{SYS}$

IRC Characteristics Curves

IRC frequency - VDD vs. Temperature Characteristics Curve



IRC frequency - Temperature vs. VDD Characteristics Curve



Note: The graphs of the IRC characteristics curves provided above are a statistical summary based on a limited number of samples and are provided for reference only.

Functional Description

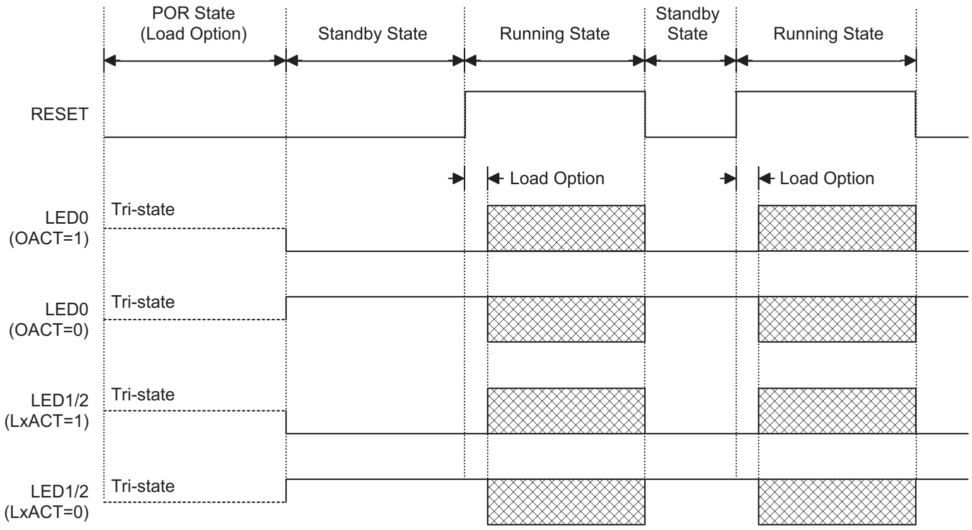
Power On & Reset

The HT13R90 has four different operating states, namely the POR state, the standby state, the running state and the wait state. The wait state can only be entered when the Operating Mode bits, known as OMOD, have a value of either 01 or 10. The POR state is the Power on state, during which the device internal clock will be used to load the configuration options. When the device is in the POR state, the output pins, LED0, LED1 and LED2, will remain in a tri-state condition.

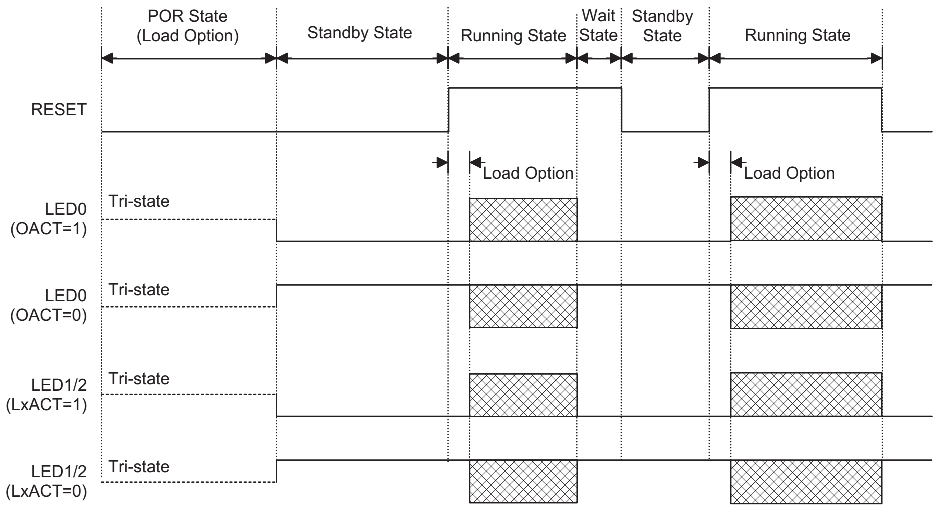
After the POR state has completed, if the RESET pin remains low, the device will then enter the standby state. In this state, the output pins will remain in an inactive state according to the configuration option settings. The accompanying timing diagram gives more details. For the general case, the oscillator will cease running to reduce power, however the configuration options can also be set to keep the oscillator running in the standby mode in order to reduce the oscillator startup time.

In modes 01 and 10, after the counting ends, the device will enter the wait state, which is different from what will happen if the RESET line goes low. The wait state encompasses the same behavior as the standby state.

When the RESET line returns high, the device will enter the running state. At the beginning of this state, the configuration options will be loaded, which will initiate a reset, switch to the defined oscillator and start running.



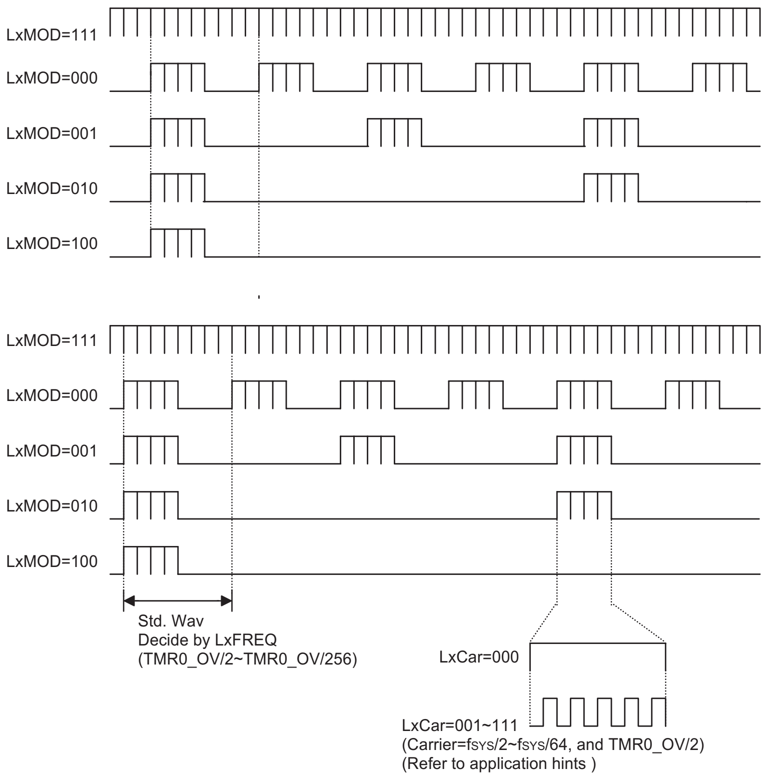
For all OMOD



For OMOD = 01 and 10

Operating Modes

The HT13R90 has 3 operating modes. MODE 0 is the continuous mode, MODE 1 is the single period mode and MODE 2 is the single pulse mode. The required mode is selected via the OMOD bits in the configuration options.



LED Waveform for Each Active State

Note: To ensure the carrier pulse is visible at the onset of every pulse on the LED1 and LED2 pins, the carrier frequency, which is selected by the LxCARR configuration option bits, should be set to a higher value than the TMR0 prescaler frequency, which is selected by the PCR0M configuration option bits.To ensure that the LED1 and LED2 output pulses are visible at the onset of every active state, the output pulse frequency, which is selected by the LxFREQ configuration option bits should be higher than the TMR1 prescaler frequency, which is selected by the PCR1M configuration option bits

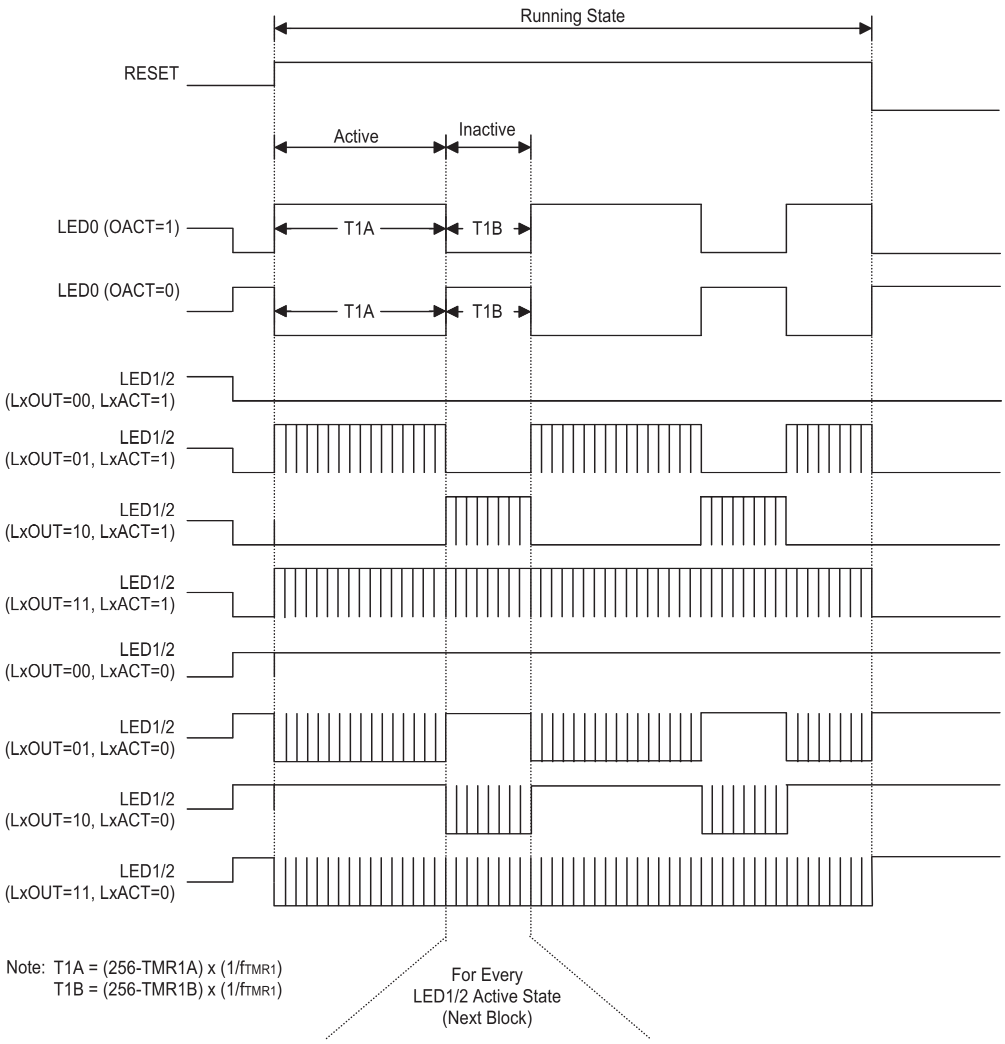
- Mode 0 – OMOD option bits set to 00

  At power on, after the power on procedure has completed, the device will keep running continuously as long as the RESET line remains at a high level. If the RESET line should go low, the oscillator will stop and the LED0 pad will change to an inactive state. The device will then enter the standby state. Any time the RESET line goes low, the device will enter the standby state until the RESET line again goes high.

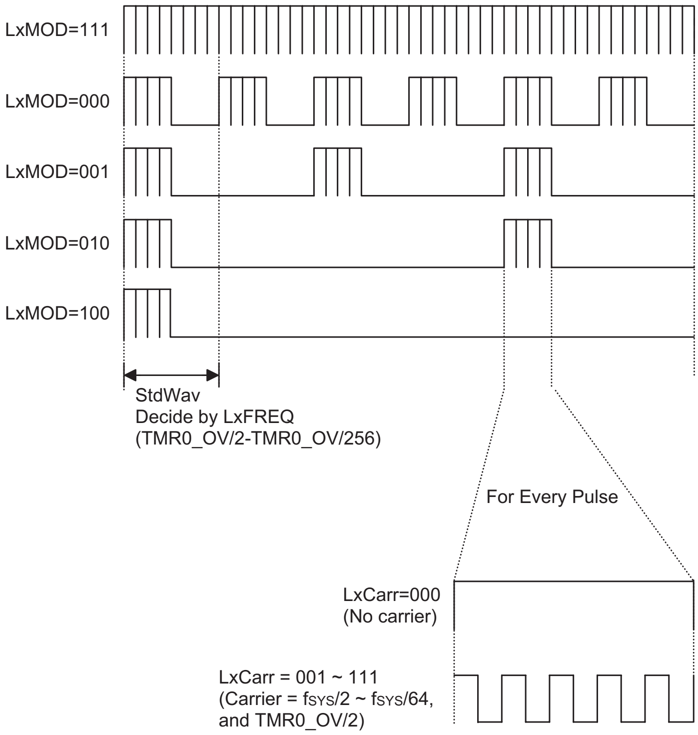
  This mode is usually used for periodic turn on and turn off time setting applications.

  The LED0 pad output signal timing and state machine is shown below.

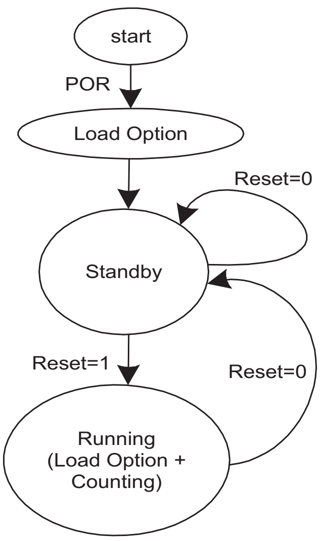
  Output Timing Diagram for OMOD = 0,0



Note: T1A = (256-TMR1A) x (1/f_{TMR1})
T1B = (256-TMR1B) x (1/f_{TMR1})



LxMOD=111
LxMOD=000
LxMOD=001
LxMOD=010
LxMOD=100
StdWav
Decide by LxFREQ
(TMR0_OV/2-TMR0_OV/256)
For Every Pulse
LxCarr=000
(No carrier)
LxCarr = 001 ~ 111
(Carrier = fSYS/2 ~ fSYS/64,
and TMR0_OV/2)



start
POR
Load Option
Reset=0
Standby
Reset=1
Reset=0
Running
(Load Option +
Counting)

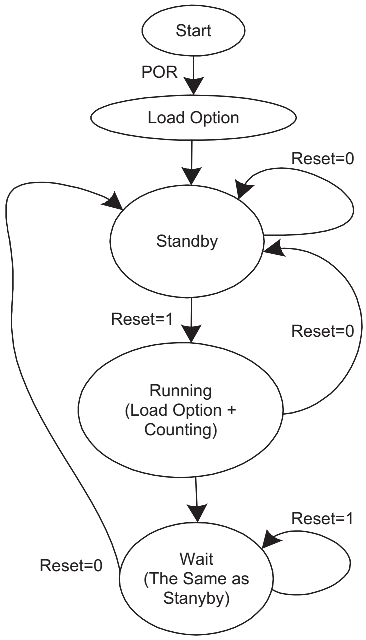
- Mode 1 – OMOD option bits set to 01

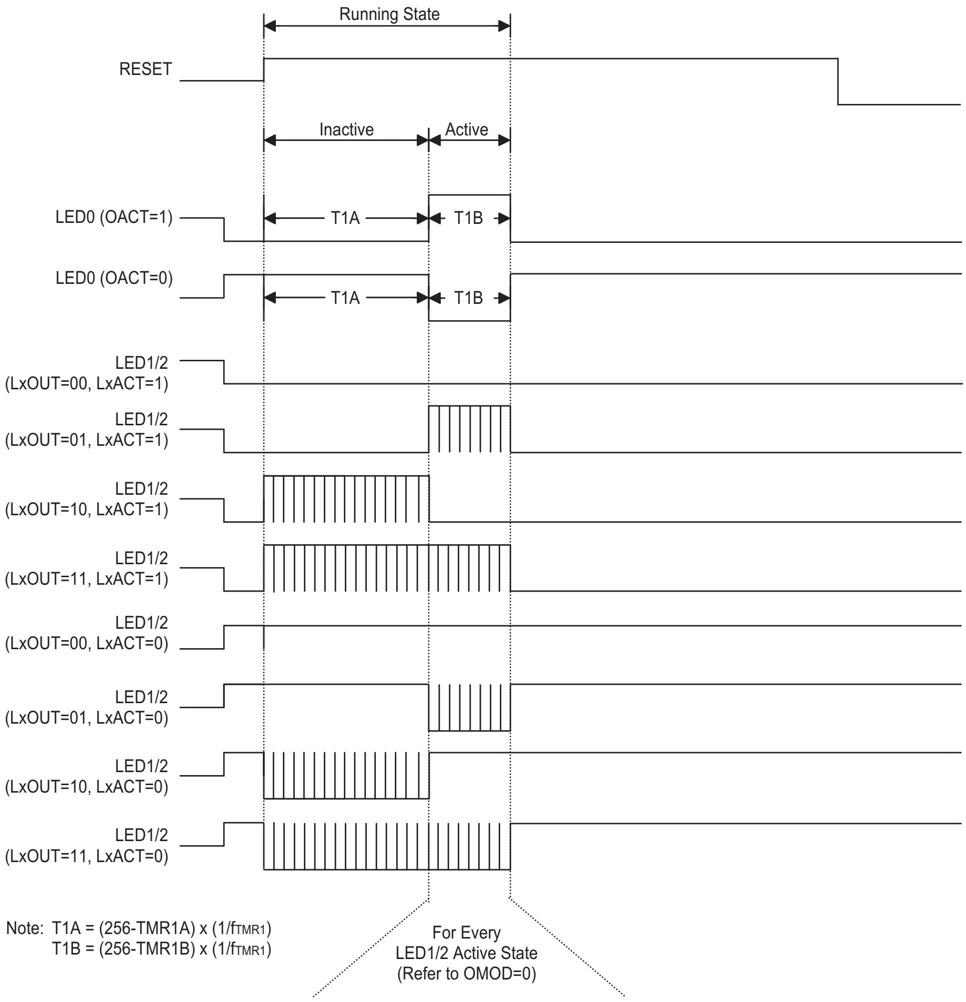
  At power on, after the power on procedure has completed, the device will start running. When the device is running, if the RESET line should go low, the device will enter the standby state until the RESET line returns to a high level. When the RESET line returns to a high level, the device will reload the configuration options and restart counting. If the RESET line does not change before the count has finished, it will automatically enter the standby state. When in the standby state, if the RESET line experiences a low to high edge, then the counting will restart.

  This mode can be used in practical applications to set a certain turn-on and turn-off time.

  The LED0 pad output signal timing and state machine is shown below.

  Output Timing Diagram for OMOD = 0,1





Note: T1A = (256-TMR1A) x (1/f_{TMR1})
T1B = (256-TMR1B) x (1/f_{TMR1})

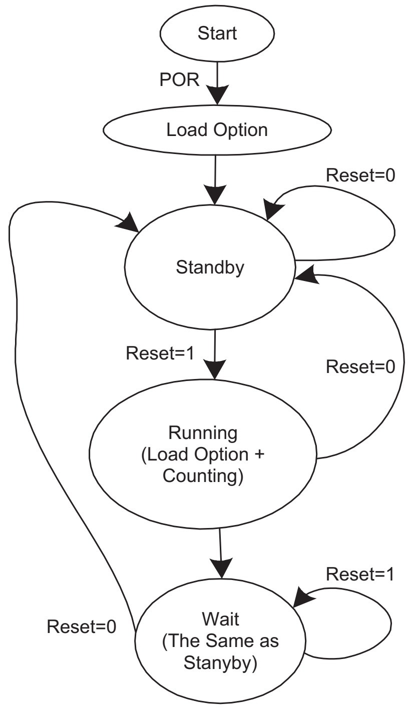
- Mode 2 – OMOD option bits set to 10

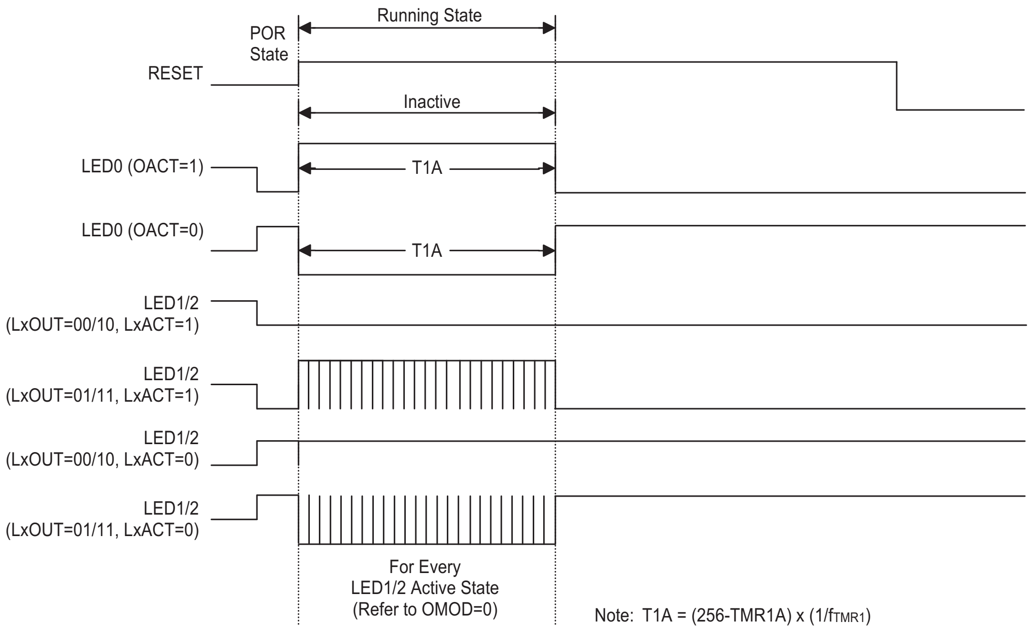
  In this mode, the TMR1B register is unused. At power on, after the power on procedure has completed, the device will start running. During the running state, if the RESET line goes low, the device will enter the standby state until the RESET line returns to a high level. When the RESET line is high, the device will reload the configuration options and restart counting. If the RESET line does not change state before counting has finished, the device will automatically enter the standby state. During the standby state, if the RESET line experiences a low to high edge, then counting can be restarted.

  This mode can be used in practical applications to set a certain turn-on time.

  The LED0 pad output signal timing and state machine is shown below:

  Output Timing Diagram for OMOD = 1,0





LED2 Complementary Function

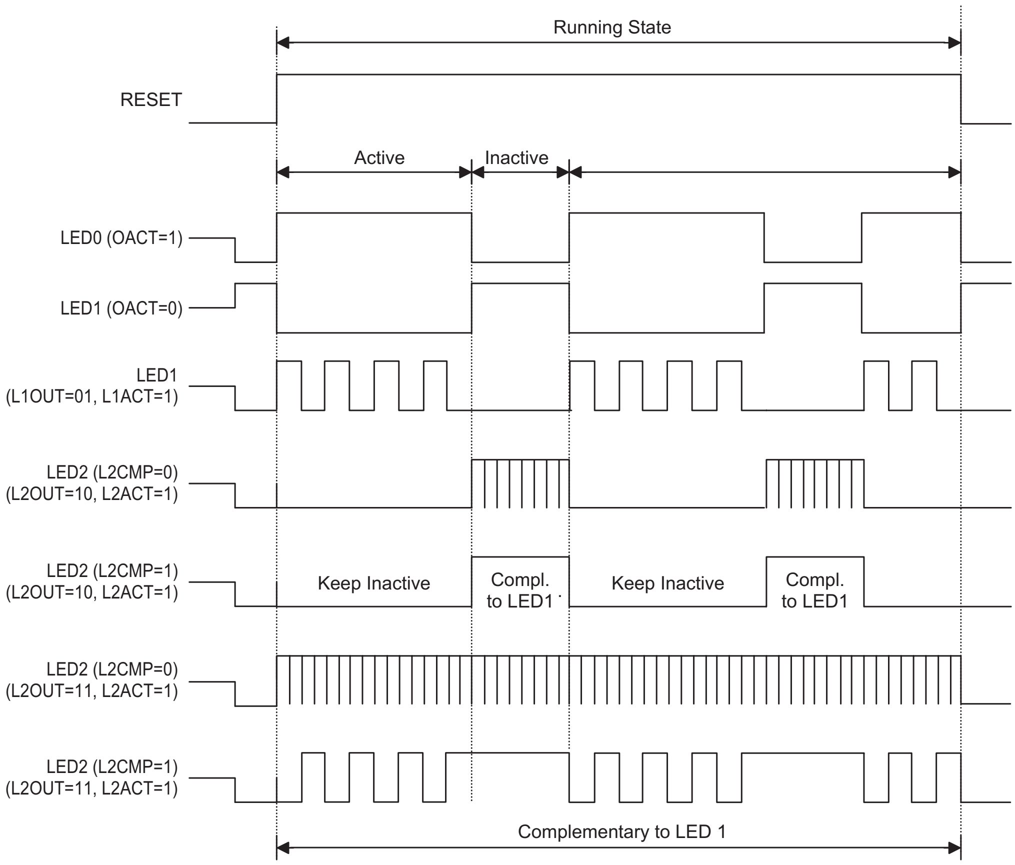
The LED2 output condition can be the same as the LED1 output, but can also be setup to be the complement of the LED1 output. There is a configuration option named L2CMP related to this setting.

If L2CMP is set to zero, the LED2 output will be the same as the LED1 output. By utilising the other options which have either an L2 or L1 header, both LED2 and LED1 can be individually controlled.

If L2CMP is set to one, the LED2 output will be the complement of the LED1 output. In this situation, only L2ACT and L2OUT will have an effect on the LED2 output. All other options with an L2 header will be ignored.

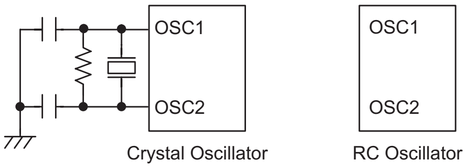
In the complement situation, when the LED2 output is in its active state, then it will output the complementary waveform. If LED2 is in its inactive state, then it will keep its inactive state depending upon the L2ACT setting and the condition of the LED1 waveform.

LED2 Complementary Timing Diagram for OMOD = 0,0



Oscillator Configuration

There are 2 oscillator circuits within the device.



Both circuits are designed for system clocks, namely the Internal RC oscillator (IRC) and the external Crystal oscillator (ECRY), the choice of which is determined by a configuration option. When in the standby state, the system oscillator stops running and all external signals are ignored to reduce power.

The Internal RC oscillator provides the most cost effective method of clock implementation, however, when compared with the crystal oscillator, the frequency of oscillation may vary with VDD, temperature and process variations. It is therefore not suitable for timing sensitive operations where an accurate oscillator frequency is desired.

If the Crystal oscillator is selected, a crystal connected between OSC1 and OSC2 is needed to provide the feedback and phase shift required for the oscillator. No other external components are required. Instead of a crystal, a resonator can also be connected between OSC1 and OSC2 to obtain the desired frequency reference, but two external capacitors between OSC1, OSC2 and ground are required.

Note: The 32768Hz Oscillator has a quick start up design. This quick start function should automatically turn off after the clock has stabilised to reduce power consumption.

The IRC circuit will provide the clock during the power-on option-loading stage. This is necessary as the choice of crystal or IRC is determined by the oscillator configuration option in the OTP memory.

The IRC oscillator contains an adjustment configuration option, to enable the IRC frequency to be adjusted during device programming. This option has a total of 7 bits (128 sections).

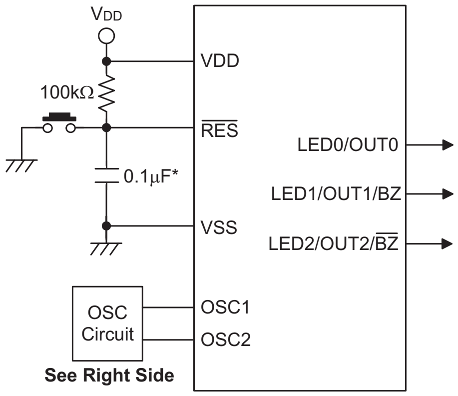
Configuration Options

The following table shows the full range of Timer configuration options. All of the options must be defined to ensure proper system functioning.

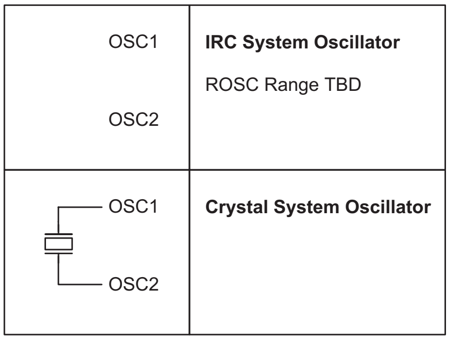
Name	Description	Function
OSC	Oscillator type definition	0 = 32768Hz oscillator 1 = Internal RC oscillator
OSCON	Oscillator on/off control in standby mode	Oscillator switched off Oscillator remains on
PCR0M	TMR0 prescaler PCR0 - Output Clock Selection	f_{SYS} $f_{SYS}/2$ $f_{SYS}/4$ $f_{SYS}/8$ $f_{SYS}/16$ $f_{SYS}/32$ $f_{SYS}/64$
PCR1M	TMR1 prescaler PCR1 - output clock selection	TMR0_OV TMR0_OV/2 ~ TMR0_OV/(2^{18})
OMOD	Operating mode selection	MODE 0 – continuous mode MODE 1 – single period mode MODE 2 – single pulse mode
OACT	Setup LED0 pin active high or active low	Active low Active high
LxACT	LEDx where x = 1 or 2 active high/low setting	Active low – low driving LED Active high – high driving LED
LxOUT	LEDx Output state where x = 1 or 2	None – no output When active – output when the LED0 pin is in an active state When inactive – output when the LED0 pin is in an inactive state Both Active and Inactive – output when the LED0 pin is in both states

Name	Description	Function
L2CMP	LED2 complement output setting	LED1 and LED2 identical outputs LED2 output is the complement of LED1 in its active state Note: ignore L2 Options except for L2ACT, L2OUT
LxMOD	LEDx output mode setting where x = 1 or 2	Normal – output the LxFREQ defined waveform 2-Combo – output logical AND of LxFREQ and LxFREQ/2 3-Combo – output logical AND of LxFREQ, LxFREQ/2, LxFREQ/4 Single shot – output a single cycle LxFREQ defined waveform Level – ignore the LxFREQ setting
LxFREQ	LEDx output square waveform where x = 1 or 2	TMR0_OV/2 TMR0_OV/4 TMR0_OV/8 TMR0_OV/16 TMR0_OV/32 TMR0_OV/64 TMR0_OV/128 TMR0_OV/256
LxCARR	LEDx carrier waveform definition where x = 1 or 2	No carrier $f_{SYS}/2$ $f_{SYS}/4$ $f_{SYS}/8$ $f_{SYS}/16$ $f_{SYS}/32$ $f_{SYS}/64$ TMR0_OV/2
TMR0	TMR0 count register preload value	Valid value range from 0 to 255 Count no = 256-TMR0
TMR1A	TMR1 first count register preload value	Valid value range from 0 to 255 Count no = 256-TMR1A
TMR1B	TMR1 second count register preload value	Valid value range from 0 to 255 Count no = 256-TMR1B

Application Circuit

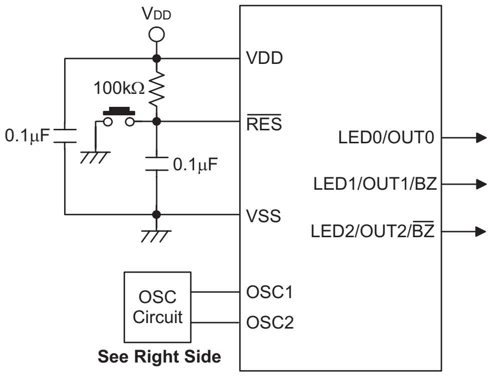


HT13R90

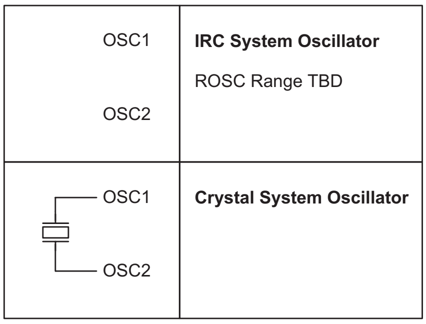


OSC Circuit

Note: "*" If the power-up ramp is sharp enough, the capacitor can be removed.

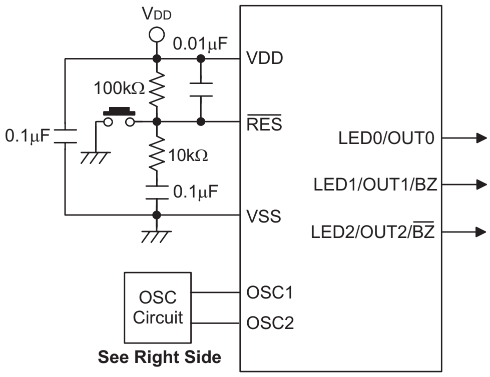


HT13R90

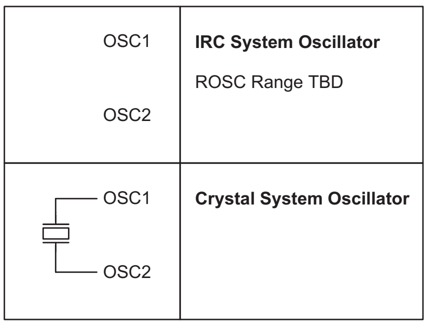


OSC Circuit

Note: If the device is used in low noise environment, the application circuit shown above is suggested.



HT13R90

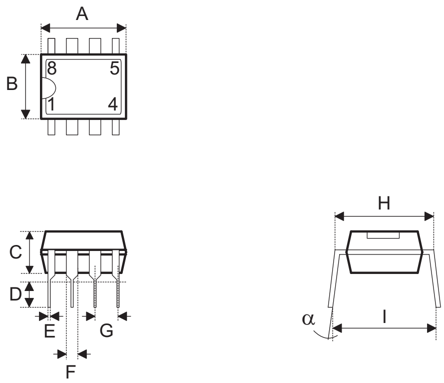


OSC Circuit

Note: If the device is used in high noise environment, the application circuit shown above is suggested.

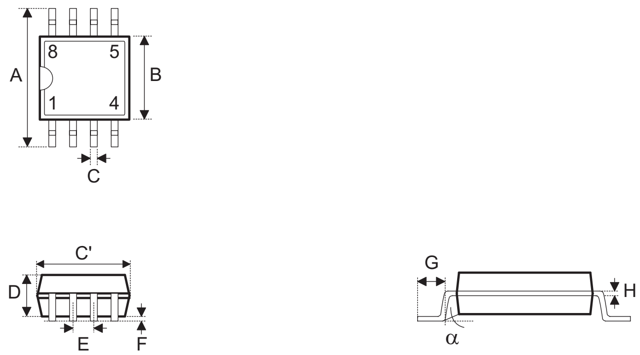
Package Information

8-pin DIP (300mil) Outline Dimensions



Symbol	Dimensions in mil		
	Min.	**Nom.**	**Max.**
A	355	—	375
B	240	—	260
C	125	—	135
D	125	—	145
E	16	—	20
F	50	—	70
G	—	100	—
H	295	—	315
I	335	—	375
α	0°	—	15°

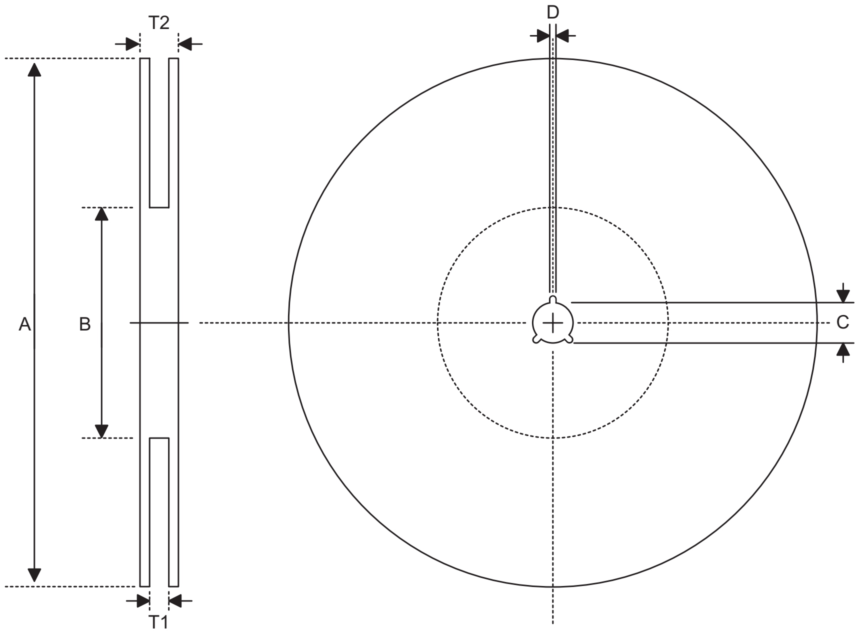
8-pin SOP (150mil) Outline Dimensions



Symbol	Dimensions in mil		
	Min.	**Nom.**	**Max.**
A	228	—	244
B	149	—	157
C	14	—	20
C′	189	—	197
D	53	—	69
E	—	50	—
F	4	—	10
G	22	—	28
H	4	—	12
α	0°	—	10°

Product Tape and Reel Specifications

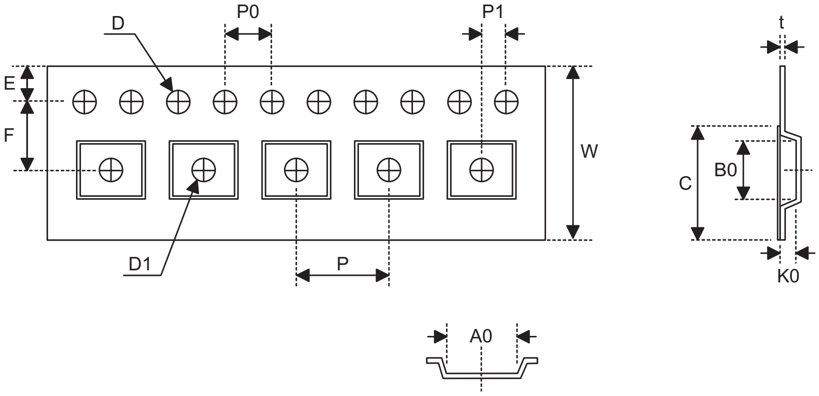
Reel Dimensions



SOP 8N

Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	330±1.0
B	Reel Inner Diameter	62±1.5
C	Spindle Hole Diameter	13.0+0.5 −0.2
D	Key Slit Width	2.0±0.15
T1	Space Between Flange	12.8+0.3 −0.2
T2	Reel Thickness	18.2±0.2

Carrier Tape Dimensions



SOP 8N

Symbol	Description	Dimensions in mm
W	Carrier Tape Width	12.0+0.3 −0.1
P	Cavity Pitch	8.0±0.1
E	Perforation Position	1.75±0.1
F	Cavity to Perforation (Width Direction)	5.5±0.1
D	Perforation Diameter	1.55±0.1
D1	Cavity Hole Diameter	1.5+0.25
P0	Perforation Pitch	4.0±0.1
P1	Cavity to Perforation (Length Direction)	2.0±0.1
A0	Cavity Length	6.4±0.1
B0	Cavity Width	5.20±0.1
K0	Cavity Depth	2.1±0.1
t	Carrier Tape Thickness	0.3±0.05
C	Cover Tape Width	9.3

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