32 kHz Clock CMOS IC with Electroset & Crescendo Alarm

Features

- 32 kHz crystal oscillator
- 1.1 - 1.8 V operating voltage range
- Integrated capacitors, mask-selectable
- Low impedance output for bipolar stepping motors
- Crescendo alarm with autostop function and snooze (for repeated alarm) with light
- Electroset
- Pin compatible to e1466D, e1467D
- Suitable for up to 12.5 pF quartz

Pad Configuration

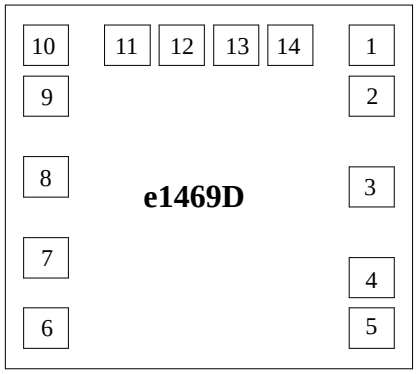

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Figure 1.

General Description

The e 1469D is an integrated circuit in CMOS Silicon Gate Technology for analog clocks. It consists of an oscillator, frequency divider, output pulse formers, push-pull motor drivers, electroset for electronic time setting and alarm output with volume modulation. Integrated capacitors are mask-selectable to accomodate the external quartz crystal. Additional capacitance can be selected through pad bonding, for trimming the oscillator frequency. This circuit is used mainly in applications using quartz-synchronized alarm clocks driven by a bipolar stepping motor. Here, the IC's low-power requirement, low operating voltage, increasing alarm volume and repeated snooze function (with light and the autostop facility) are used to an advantage.

Pin	Symbol	Function
2 or 10	V_{DD}	Positive supply voltage
0	V_{SS}	Negative supply voltage
1	OSCIN	Oscillator input
10 or 2	OSCOUT	Oscillator output
5 or 6 or 7	MOT1	Motor drive output 1
4	MOT2	Motor drive output 2
6 or 7	ALIN/ SNZ/ MTEST	Alarm activation and snooze or motor test
6 or 7	LIGHT	Light output driver
3	ALOUT	Alarm output driver
8	ESET/ TEST	Electroset or motor test input
14-11	SC1 to SC4	Trimming capacitor inputs

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply voltage	V_{SS}	–0.3 to +5 V	V
Input voltage range, all inputs	V_{IN}	$(V_{SS} - 0.3V) \leqq V_{IN} \leqq (V_{DD} + 0.3\ V)$	V
Output short circuit duration		Indefinite	
Power dissipation (DIL package)	P_{tot}	125 mW	mW
Operating ambient temperature range	T_{amb}	–20 to +70	°C
Storage temperature range	T_{stg}	–40 to +125	°C
Lead temperature during soldering at 2 mm distance, 10 seconds	T_{sld}	260	°C

Absolute maximum ratings define parameter limits which, if exceeded, may permanently change or damage the device. All inputs and outputs on TEMIC circuits are protected against electrostatic discharges. However, precautions to minimize the build-up of electrostatic charges during handling are recommended. The circuit is protected against supply voltage reversal for typically 5 minutes.

Functional Description

Oscillator

An oscillator inverter with feedback resistor is provided for generation of the 32768 Hz clock frequency. Values for the fixed capacitors at OSCIN and OSCOUT are mask-selectable (see note 3 of operating characteristics). Four capacitors switches SC1 to SC4 enable the addition of integrated trimming capacitors to OSCIN and OSCOUT, providing 15 tuning steps.

Trimming Capacitors

A frequency variation of typ. 3 ppm for each tuning step is obtained by bonding the capacitor switch pads to V_{DD}. As none of these pads are bonded, the IC is in an untrimmed state. Figure 4 shows the trimming curve characteristic.

Note: For applications which utilize this integrated trimming feature, TEMIC will determine optimum values for the integrated capacitors C_{OSCIN} and C_{OSCOUT}.

Capacitor switches				Trimming Step
SC4	SC3	SC2	SC1	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

Motor Drive Output

The e1469D contains two push-pull output buffers for driving bipolar stepping motors. During a motor pulse, the n-channel device of one buffer and the p-channel device of the other buffer is activated. Both n-channel transistors are on and conducting, between output pulses. The outputs are protected against inductive voltage spikes with diodes to both supply pins. The motor output period and pulse width are mask programmable over a wide range of values, as listed below:

Available motor periods (T_M):
62.5, 125, 250, 500 ms
and 1, 2, 4, 6, 8, 10, 12, 16, 20, 24, 30, 40, 60, 120 s

Available pulse widths (t_M):
7.8, 11.7, 15.6, 23.4, 31.2, 46.9, 62.5, 117 and 125 ms

Available motors periods during electroset (T_{M2}): 0.125, 0.250, 0.500, 1.0, 2.0 s

Note: Restrictions prohibit combinations of certain motor pulse widths with motor periods.

Electroset

When electroset is activated, all the counters are reset and a single motor pulse is generated. If electroset is then held active for longer than 1 s or 500 ms (mask-selectable), the e1469D generates a constant series of accelerated motor pulses thus enabling the fast setting of the time. On releasing electroset all the counters are again reset. This avoids the risk of a natural pulse arising whilst waiting for a time standard. Fine tuning and synchronization can therefore be carried out by single stepping. When the electroset function is activated, any motor pulse in progress is be completed. A mask option also enables an electroset to be activated either by connection to V_{DD} or V_{SS}. The principle of electroset is illustrated in figure 3.

Alarm Output

The alarm output driver consists of a push-pull stage for driving a speaker via an external bipolar transistor. The output is configured for npn bipolar capability. The output is an alarm tone modulated by a low frequency. The crescendo alarm enables the output volume level to rise in two distinct crescendo steps. At the end of the second crescendo step, the highest level of the alarm volume is achieved and held. By using a metal mask option, the crescendo steps can be selected to be either in 4 seconds or 8 seconds. The mask option also enables a range of volume levels, tone frequencies, modulation frequencies, and the on/off times to be selected.

Alarm Input

Alarm activation is either to V_{DD} or V_{SS} by a mask option. By connecting the alarm input to V_{DD} (V_{SS}), the alarm is activated for the duration of the autostop time. Thereafter, it stops automatically. In order to restart the alarm after automatic stop, the alarm input must be momentarily disconnected from V_{DD} (V_{SS}) and then reconnected. The alarm can be stopped before the autostop time by disconnecting the alarm input from V_{SS} (V_{DD}). Connecting the alarm input to V_{SS} (V_{DD}) whilst the alarm is active stops the alarm for the duration of the snooze time. At the onset of this snooze time the LIGHT pad sinks the current (suitable for a pnp driver) for a duration of some seconds (optional 0.5 to 15.5 s in 0.5 s increments). Thereafter, the alarm becomes active again. Once snooze is activated, the snooze time cannot be extended by renewed connection to V_{SS} (V_{DD}). The snooze activation polarity is always opposite to alarm activation. The metal mask option enables the snooze and the autostop periods to be selected from a range of values.

Test Functions

For test purposes, the ALIN/SNZ/MTEST pad is open. With a high resistance probe, ($R \geq 10\ M\Omega$, $C \leq 20$ pF) a test frequency of 128 Hz can be measured at the ALIN/SNZ/MTEST pad. An additional test feature on the e1469D enables the fast testing of the device's alarm functions. It is activated by forcing both MOT1 and MOT2 pads to V_{DD}. This results in the alarm counters being accelerated by a factor of 64. They remain in this state as long as both MOT1 and MOT2 are held to V_{DD}. This test enables the e1469D's alarm modulation (on/off, autostop and snooze times) to be fast tested with the device clocked by the crystal. Releasing MOT1 and MOT2 returns the e1469D to normal operation.

Operating Characteristics

V_{DD} = 0, V_{SS} = –1.5, T_{amb} = +25°C; unless otherwise specified
All voltage levels are measured with reference to V_{DD}. Test crystal as specified below.

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Operating voltage		V_{SS}	–1.1	–1.5	–1.8	V
Operating temperature		T_{amb}	–20		+70	°C
Operating current	SC1 to SC4 = V_{DD}, R_L = ∞	I_{SS}		–0.8	–3	µA
Motor drive output						
Motor output current	V_{SS} = –1.2 V, R_L = 200 Ω	I_M	± 4.3			mA
Motor period		T_M	Mask option			
Motor period during electroset		T_{M2}	Mask option			
Motor pulse width		t_M	Mask option			
Oscillator						
Startup voltage	Within 2 s	V_{START}	–1.2		–1.8	V
Frequency stability	ΔV_{SS} = 100 mV V_{SS} = –1.3 to –1.8	Δf/f		0.2	0.6	ppm
Integrated input capacitance	Note 3	C_{OSCIN}	Mask option			
Integrated output capacitance	Note 3	C_{OSCOUT}	Mask option			µA
Input current SC1 to SC4	V_{IN} = –1.0 V V_{IN} = V_{DD}, peak current	I_{SCINL} I_{SCINH}	1 0.2	5 0.6	25 2.0	µA µA
Alarm/ light output						
Output current for driving npn-transistor n-channel	V_{SS} = –1.2 V R_3 = 100 kΩ	I_{ANn}	1	3	10	µA
p-channel	R_2 = 1 k, note 2	I_{ANp}	–0.5	–1		mA
Output current for driving pnp-transistor n-channel	V_{SS} = –1.2 V R_3 = 1 kΩ	I_{APn}	0.5	1		mA
p-channel	R_2 = 100 kΩ, note 2	I_{APp}	–1	–3	–10	µA
Alarm options						
Tone frequency		f_A	Mask option			Hz
Crescendo duties		D_{CRES}				
Crescendo times		t_{CRES}				s
Modulation frequency		f_{MOD}				Hz
On/ Off time	Note 4	$t_{ON/OFF}$				s
Autostop time		t_{ASTOP}				s
Snooze time		t_{SNZ}				s
Light option						
On-time		t_{LIGHT}	Mask option			s
Alarm input/ motor test input/ snooze input						
Input current	ALIN = V_{DD}	I_{AINavg}	1	3	10	µA
Input current	ALIN = V_{SS}, peak current	I_{AINL}	–1	–3	–10	µA
Input debounce delay			23.4		31.2	ms
Snooze debounce time	Optional Optional	t_{SNZd}	23.4 7.8		31.2 15.6	ms ms

Note 1: Typical parameters represent the statistical mean value
Note 2: See test circuit
Note 3: Values can be selected in 1 pF steps. A total capacitance (C_{OSCIN} + C_{OSCOUT}) of 38.5 pF is available
Note 4: On/Off or continuous alarm signal in 3rd stage

Test Crystal Specification

Oscillation frequency	f_{OSC} = 32768 Hz
Series resistance	R_S = 30 kΩ
Static capacitance	C_O = 1.5 pF
Dynamic capacitance	C_1 = 3.0 fF
Load capacitance	C_L = 10 pF

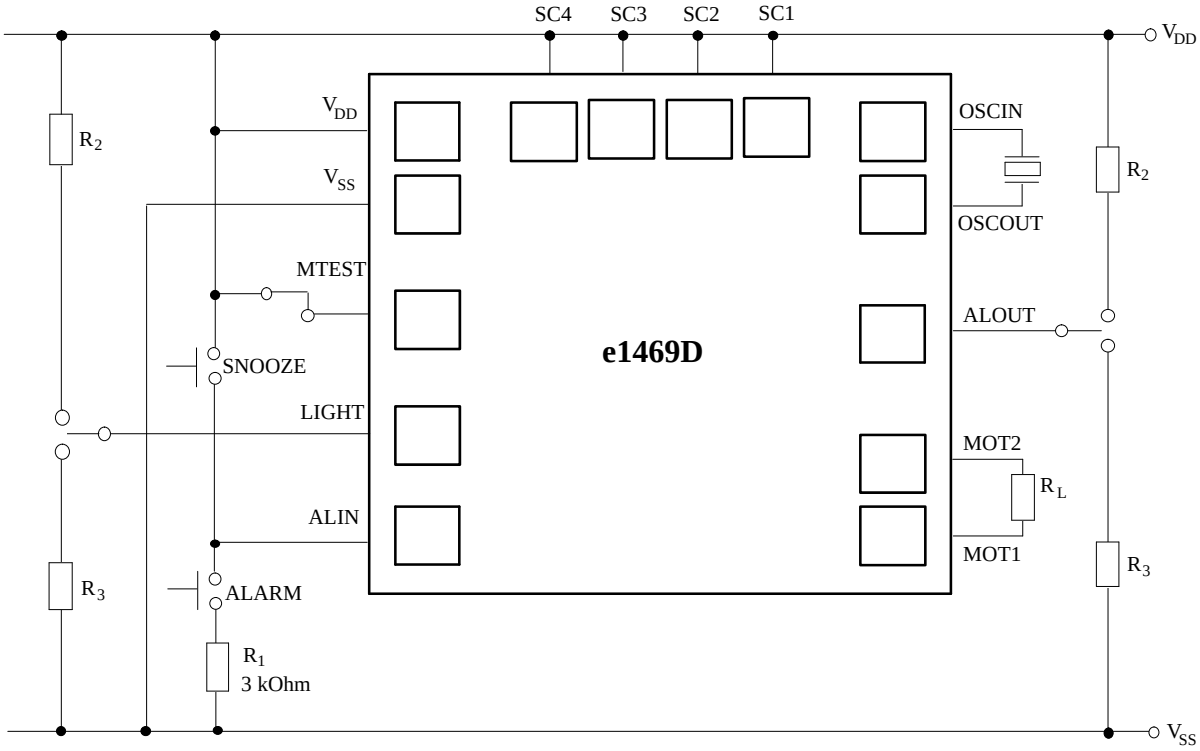

Figure 1. Functional test

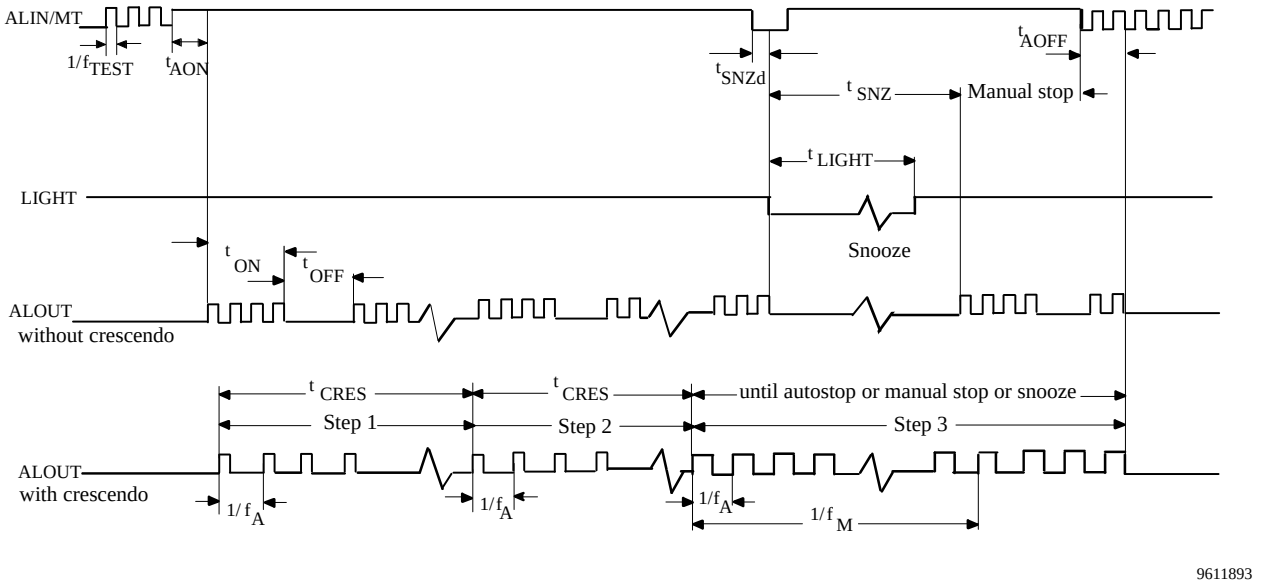

Figure 2. Timing diagram for alarm function

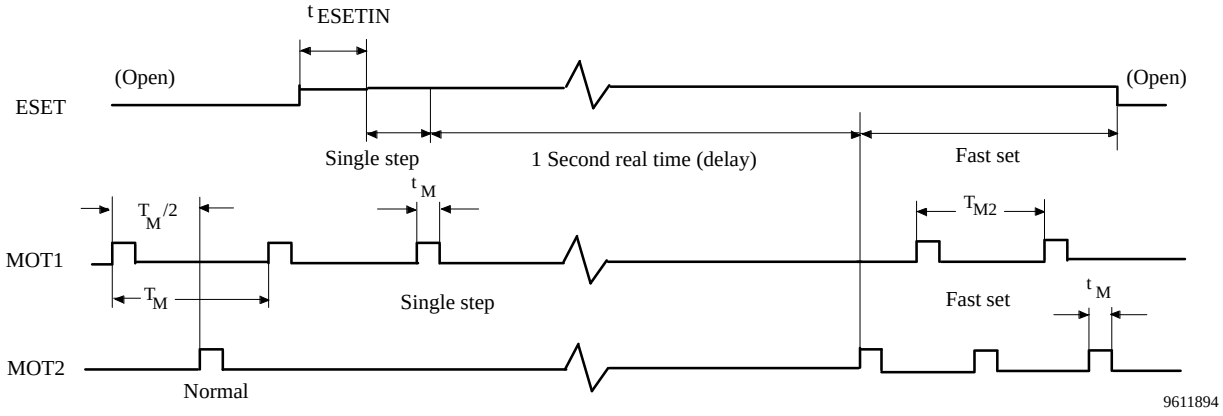

Figure 3. Electroset

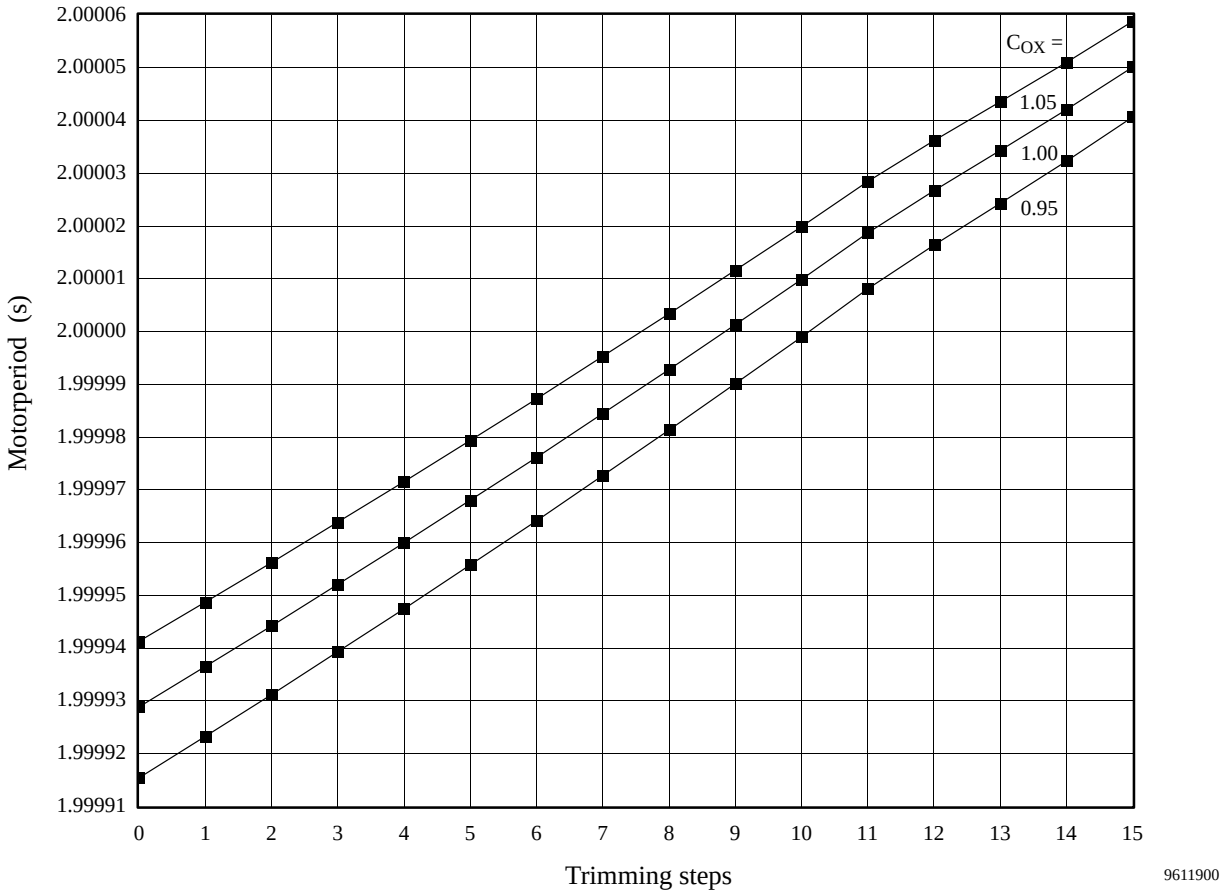

Figure 4. Typical trimming curve characteristic for T_M of 2 secs

C_{OX} means frequency deviation due to production process variations.

Trimming inputs SC1 ... SC4 are binary weighted, i.e., SC1 ... SC4 = 0 corresponds to trimming step 0
SC1 ... SC4 = 1 corresponds to trimming step 15

LSB = SC1

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