32-kHz Clock CMOS IC with Self-Adaptive Pendulum Drive

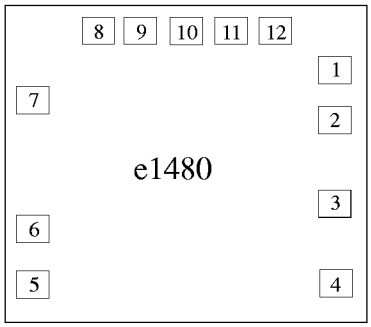
Description

The e1480 contains the complete electronic for driving a pendulum quartz clock. It also contains oscillator frequency dividers, output pulse formers and push-pull motor drivers. A frequency trimming is carried out by selecting on-chip oscillator capacitors via pad bonding. The pendulum drive function is optimized for the application.

Features

- 32-kHz crystal oscillator
- 1.1 V to 1.8 V operating-voltage range
- Integrated capacitors (mask selectable)
- Suitable for up to 12.5 pF quartz
- Low impedance output for bipolar stepping motor
- Self-adaptive pendulum drive function
- Single coil solution

Pad Configuration



Pad size: 88 µm × 88 µm
Chip size: 3.14 mm^2

14050

Figure 1.

Pin	Symbol	Function
2 or 8	V_{DD}	Positive supply voltage
7	V_{SS}	Negative supply voltage
1	OSCIN	Oscillator input
8 or 2	OSCOUT	Oscillator output
6 or 5	MOT 1	Motor drive output 1
4	MOT 2	Motor drive output 2
5 or 6	CAP	Reference input
3	COIL	Pendulum drive output
12 to 9	C1 ... C4	Trimming capacitors

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply voltage	V_{DD}	–0.3 to +5 V	V
Input voltage range, all inputs	V_{IN}	$(V_{SS} - 0.3\ V) \leqq V_{IN}, \leqq (V_{DD} + 0.3\ V)$	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_{sd}	260	°C

Absolute maximum ratings define parameter limits which, if exceeded, may permanently change or damage the device.

All inputs and outputs in TEMIC Semiconductors circuits are protected against electrostatic discharges. However, precautions to minimize the build-up of electrostatic charges during handling are recommended.

This circuit is protected against supply voltage reversal for typically 5 minutes.

Functional Description

The e1480 contains the complete electronic for driving a pendulum quartz clock. The only external components necessary are a crystal, an electrolytic capacitor of 20 µF to 50 µF and a single coil of typically 1.5 kΩ.

Oscillator

The clock section of the e1480 includes a regulated oscillator, similar to the e1467. For quartz trimming purposes, the 4 bondable capacitors of 4 pF, 5 pF, 6 pF and 7 pF are available (similar to the e1467) for bonding to the OSCIN pad.

Trimming Capacitors

Trimming Step	Capactitors Active	Trimming Step	Capactitors Active
1	C1	9	C2+C4
2	C2	10	C3+C4
3	C3	11	C1+C2+C3
4	C4	12	C1+C2+C4
5	C1+C2	13	C1+C3+C4
6	C1+C3	14	C2+C3+C4
7	C2+C3	15	C1+C2+C3+C4
8	C1+C4		

A frequency variation of typicaly 3 ppm for each tuning step is obtained by bonding the capacitor pads to OSCIN. Thus with none of these pads bonded, the IC will be in an untrimmed state. Figure 2 shows an example of trimming curve characteristic.

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

Motor Drive Output

The e1480 contains two push-pull output buffers for driving bipolar stepper motors. During a motor pulse, the n-channel device of one buffer and the p-channel device of the other buffer is activated. Between two pulses, the n-channel devices of both buffers are active. Motor period and motor pulse width are mask selectable.

Pendulum Drive

The pendulum is driven via the pads VDD and COIL (see figure 1). The induced voltages in the pendulum's coil are smoothed to a dynamic mean value via the electrolytic capacitor at the CAP pad. If the CAP voltage falls below an internal reference value, COIL pulses are generated every 15.6 ms. The pulse-width generated is dependend on the induced voltage sen at the COIL pad, which enables adaption to the application.

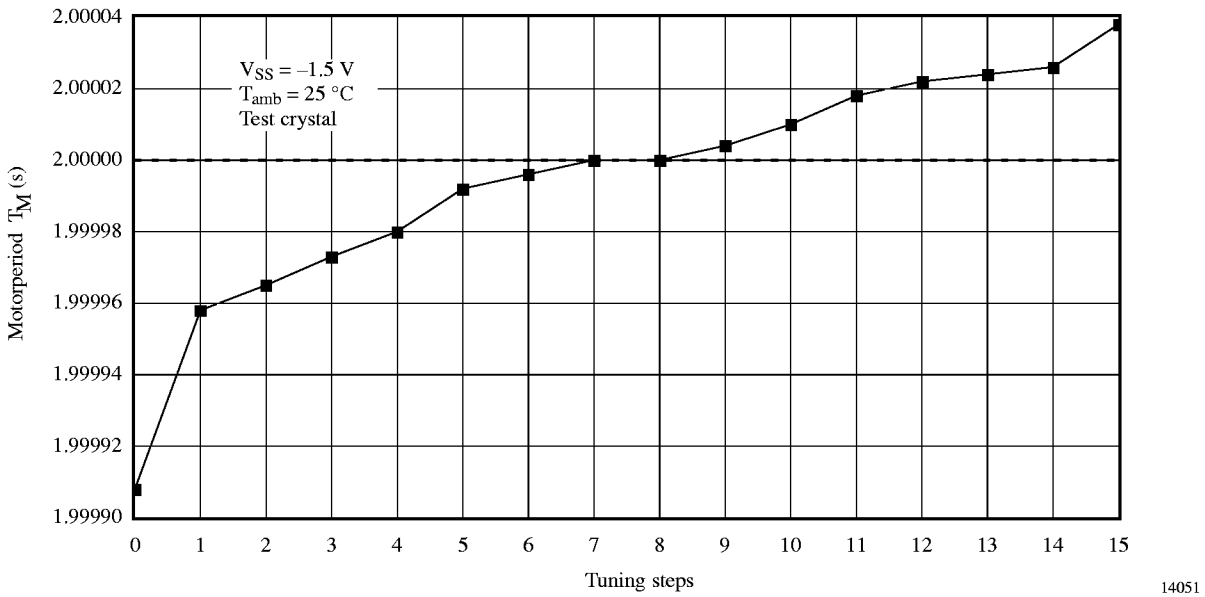


Figure 2. Typical trimming curve characteristic for T_M of 2 s

Operating Characteristics

V_{DD} = 0, V_{SS} = –1.5 V, 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	Functional test (figure 2)	V_{SS}	–1.1	–1.5	–1.8	V
Operating current	R_L = ∞ between motor pulses	I_{SS}		–2.5	–5	µA
Oerating temperature	Oscillator start-up at 25°C	T_{amb}	–10		+60	°C
Motor drive output						
Motor output current	R_L = 200 Ω, V_{SS} = –1.2 V	I_M	± 4.3			mA
Motor period	Note 2	t_M		Mask option		s
Motor period during test	Note 4	t_M		Mask option		ms
Motor pulse width	Note 3	t_{PW}		Mask option		ms
Oscillator						
Start-up voltage		V_{Start}	1.3			V
Start-up time	V_{SS} = –1.2 V	t_{Start}		0.5	2.0	s
Frequency stability	ΔV_{SS} = –1.2 V, V_{SS} = –1.1 V to –1.8V V	Δf/f		0.1		ppm
Integrated input capacitance	Note 1	C_{OSCIN}		Mask option		pF
Integrated output capacitance	Note 1	C_{OSCOUT}		Mask option		pF
Trimming capacitors	Includes on-chip stray capactance	C1 C2 C3 C4		4 5 6 7		pF pF pF pF
Coil drive output						
Output current	V_{SS} = –1.2 V, R_{COIL} = 1.5 kΩ pad COIL to V_{DD}	I_{COIL}	0.7			mA
Pulse period		T_{COIL}		15.6		ms
Pulse width	Note 5	t_{COIL}	0.98		10.7	ms

Note 1: These are mask selectable fixed oscillator input and output load capacitances. The fixed values are selectable in 1-pF steps from the minimum to the maximum values. Due to parasitics, 2 pF are assumed as stray for pad and bond at OSCIN and 5 pF at OSCOUT. For oscillator start-up test CAP must be held to V_{SS}. A 64-Hz signal is then output to the COIL pad via a pul-up resistor.

	Minimum	Maximum	
C_{OSCIN}	2 pF	15 pF	(includes 2 pF stray)
C_{OSCOUT}	5 pF	29 pF	(includes 5 pF stray)

Note 2: Motor period T_M: 0.5, 1, 2 s

Note 3: Motor pulse width t_M: 11.7, 15.6, 23.2, 31.2, 46.8, 62.5 ms

Note 4: For fast mode activation the COIL pad must be connected to V_{SS} for 250 ms
Motor test peiod T_{MT}: 62.5, 125, 250, 500, 1000 ms

Note 5: Self-adaptive pulse width to be defined by TEMIC Semiconductors

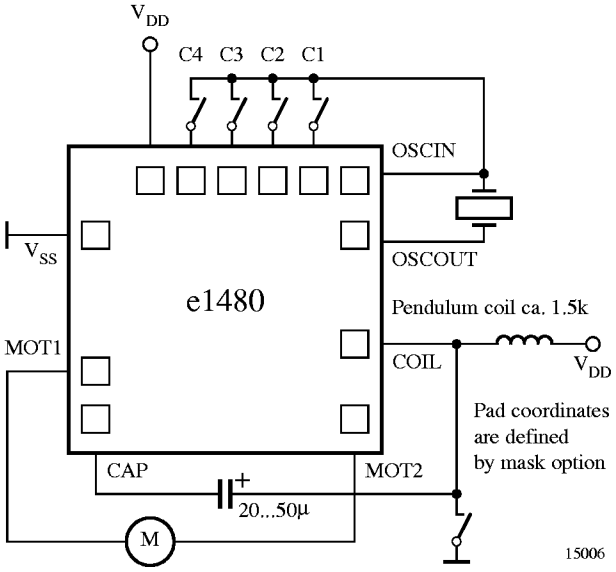


Figure 3. Functional test

Test-Crystal Specification

Frequency	f = 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 = depending on mask option (max. 12.5 pF)

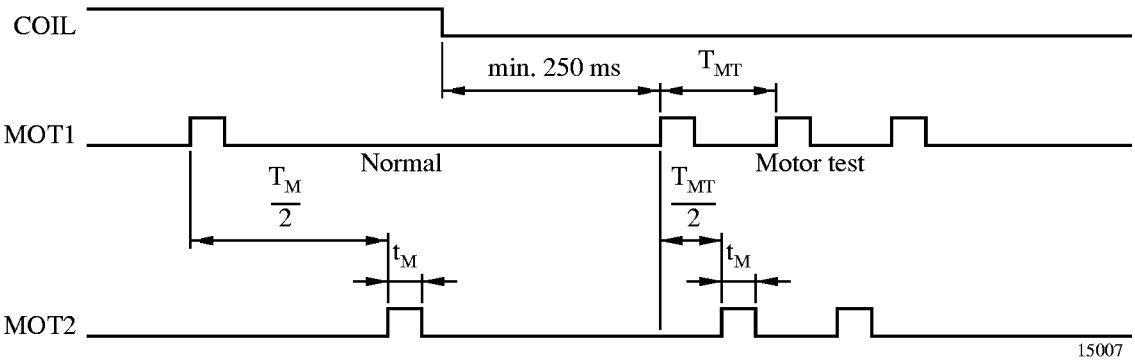


Figure 4. Timing diagram for test mode

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