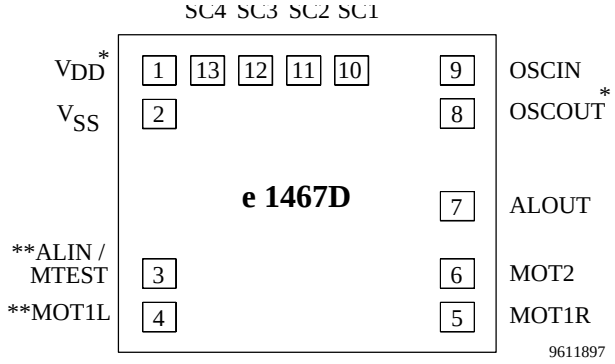
32-kHz Clock CMOS IC with Digital Trimming and Alarm

Features

- 32-kHz voltage regulated oscillator
- 1.1 V to 2.2 V operating-voltage range
- Integrated capacitors for digital trimming
- Suitable for up to 12.5 pF quartz
- Trimming inputs insensitive to stray capacitance
- Output pulse formers
- Mask options for motor period and pulse width
- Low resistance output for bipolar stepping motor
- Alarm function
- Motor-fast-test function

Pad Configuration



*) The pads for V_{DD} and OSCOUT are interchangeable per mask option

**) The pads for ALIN/-MTEST and MOT1L are interchangeable per mask-option

Figure 4. Pad configuration

General Description

The e1467D is an integrated circuit in CMOS Silicon Gate Technology for analog clocks. It consists of a 32-kHz oscillator, frequency divider, output pulse formers, push-pull motor drivers and alarm output. Integrated capacitors are mask-selectable to accomodate the external quartz crystal. Additional capacitance can be selected through pad bonding for trimming the oscillator frequency.

Absolute Maximum Ratings

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

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

All inputs and outputs in Atmel Wireless & Microcontrollers' 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

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 control inputs 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. 4 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 5 shows the trimming curve characteristic.

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

Motor Drive Output

The e1467D 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 will be activated. Both n-channel transistor 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, as listed below:

Available motor periods (T_M):
125, 250, 500 ms and 2, 16 s
Available max. pulse widths (t_M):
15, 6, 23.4, 31.25, 46.9 ms
Available motor periods for motor test (T_{MT}):
250, 500 ms and 1 s

Note: The following constraints for combination of motor period and pulse widths have to be considered: $T_M > 4 * t_M$, $T_{MT} > 4 * t_M$ or alternatively $T_M = 2 * t_M$, $T_{MT} = 2 * t_M$

Alarm Outputs

The alarm output driver consists of push-pull stage for driving a speaker via an external bipolar transistor. The output is configured for npn and pnp bipolar capability. The output is an alarm tone modulated by a low frequency. Tone frequencies, modulation frequencies, and on/off times are selectable via the metal mask option.

Alarm Input

A debounced alarm input is provided. Alarm activation is either to V_{DD} or V_{SS} by a mask option.

Test Functions

For test purposes the ALIN/MTEST pad is open. With a high resistance probe ($R \geq 10$ MΩ, $C \leq 20$ pF), a test frequency f_{TEST} of 128 Hz can be measured at the ALIN/MTEST pad. Connecting ALIN/MTEST (for at least 32 ms) to the opposite polarity for alarm activation changes the motor period from the selected value to T_{MT} (mask-selectable) while the pulse width remains unaffected. This feature can be used for testing the mechanical parts of the clock.

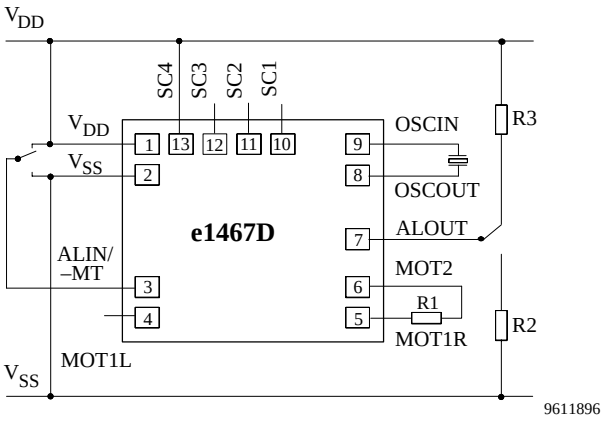


Figure 5. Functional test

Test Crystal Specification

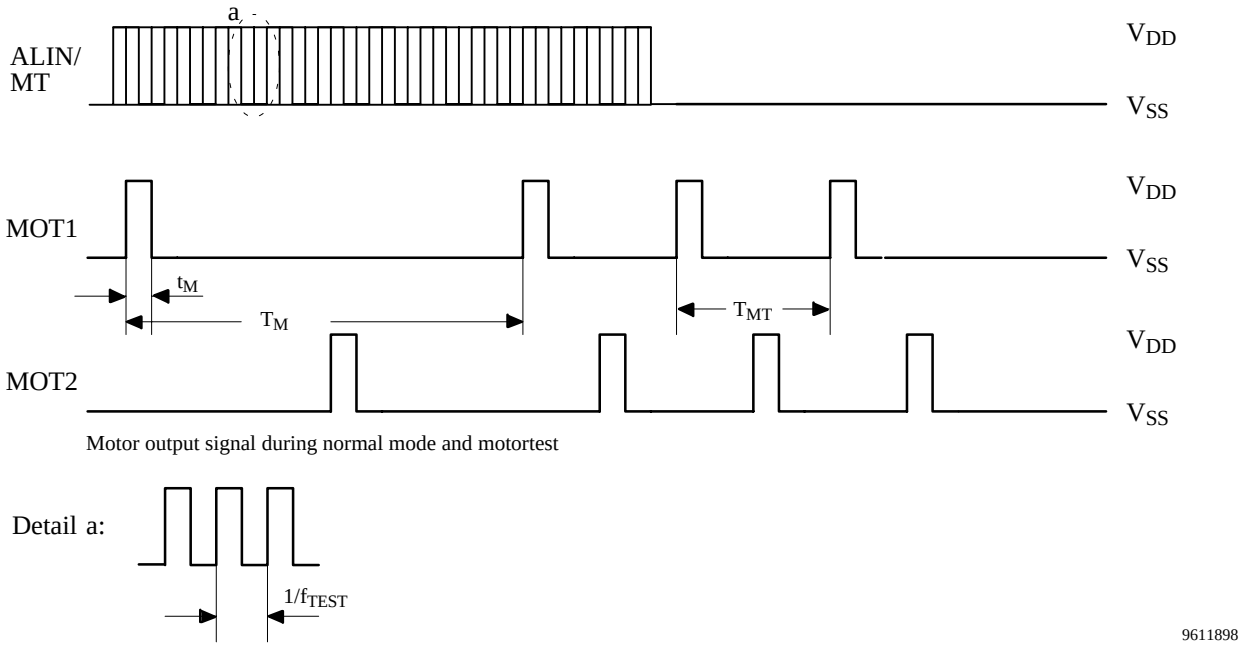
Oscillation frequency	f_{OSC} = 32768 Hz
Series resistance	R_S = 30 kΩ
Static capacitance	C_O = 1.5 pF
Dynamic capacitance	C_1 = 3.0 fF
Load capacitance	C_L optionally 10 or 12.5 pF

Operating Characteristics

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

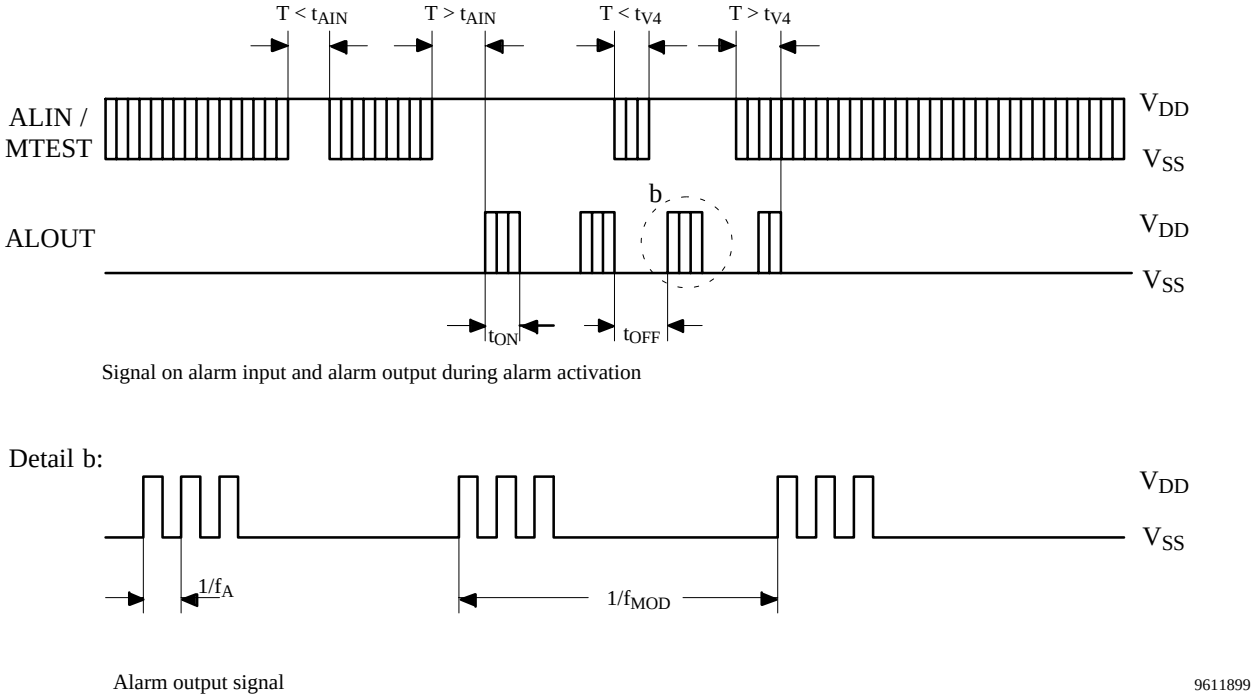
Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Operating voltage		V_{DD}	1.1	1.5	2.2	V
Operating temperature		T_{amb}	–20		+70	°C
Operating current	R_1 = ∞, note 2	I_{DD}		1	3	µA
Motor drive output						
Motor output current	V_{DD} = 1.2 V, R_1 = 200 Ω	I_M	± 4.3			mA
Motor period		T_M	See option list			s
Motor period during motor test		T_{MT}	See option list			ms
Motor pulse width		t_M	See option list			ms
Oscillator						
Startup voltage	Within 2 s	V_{START}	1.2		2.2	V
Frequency stability	ΔV_{DD} = 100 mV V_{DD} = 1.1 to 2.2 V	Δf/f		0.1	0.2	ppm
Integrated input capacitance	Note 3	C_{OSCIN}	See option list			pF
Integrated output capacitance		C_{OSCOUT}	See option list			pF
Input current SC1 to SC4	V_{IN} = 0.2 V V_{IN} = V_{DD}, note 5	I_{SCINL} I_{SCINH}	1 0.05	5 0.15	25 0.5	µA µA
Alarm/output						
Output current for driving npn-transistor	V_{DD} = 1.2 V					
n-channel	R_3 = 100 kΩ	I_{ANn}	1	3	10	µA
p-channel	R_2 = 1 kΩ, note 2, note 4	I_{ANp}	–0.5	–1		mA
Output current for driving pnp-transistor	V_{DD} = 1.2 V					
n-channel	R_3 = 1 kΩ	I_{APn}	0.5	1		mA
p-channel	R_2 = 100 kΩ, note 2, note 4	I_{APp}	–1	–2	–10	µA
Alarm options						
Tone frequency		f_A	See option list			Hz
Modulation frequency		f_{MOD}	See option list			Hz
On/Off time		t_{ON}/t_{OFF}	See option list			s
Alarm input/motor test						
Input current	ALIN = V_{DD}, peak current	I_{AINH}	0.6	3	10	µA
Input current	ALIN = V_{SS}, peak current	I_{AINL}	–0.6	–3	–10	µA
Input debounce delay		t_{AIN}	23.4		31.2	ms

Note 1: Typical parameters represent the statistical mean values
Note 2: See test circuit
Note 3: Values can be selected in 1 pF steps. A total capacitance (C_{OSCIN} + C_{OSCOUT}) of 38 pF is available
Note 4: npn or pnp driving transistors defined by mask options
Note 5: I_{SCINH} is the peak current of a pulsed current with duty cycle 1:63. Average current is always smaller than 10 nA



Motor output signal during normal mode and motortest

Figure 6. Motor output signal during normal operation and during motor test



Signal on alarm input and alarm output during alarm activation

Alarm output signal

Figure 7. Alarm operation

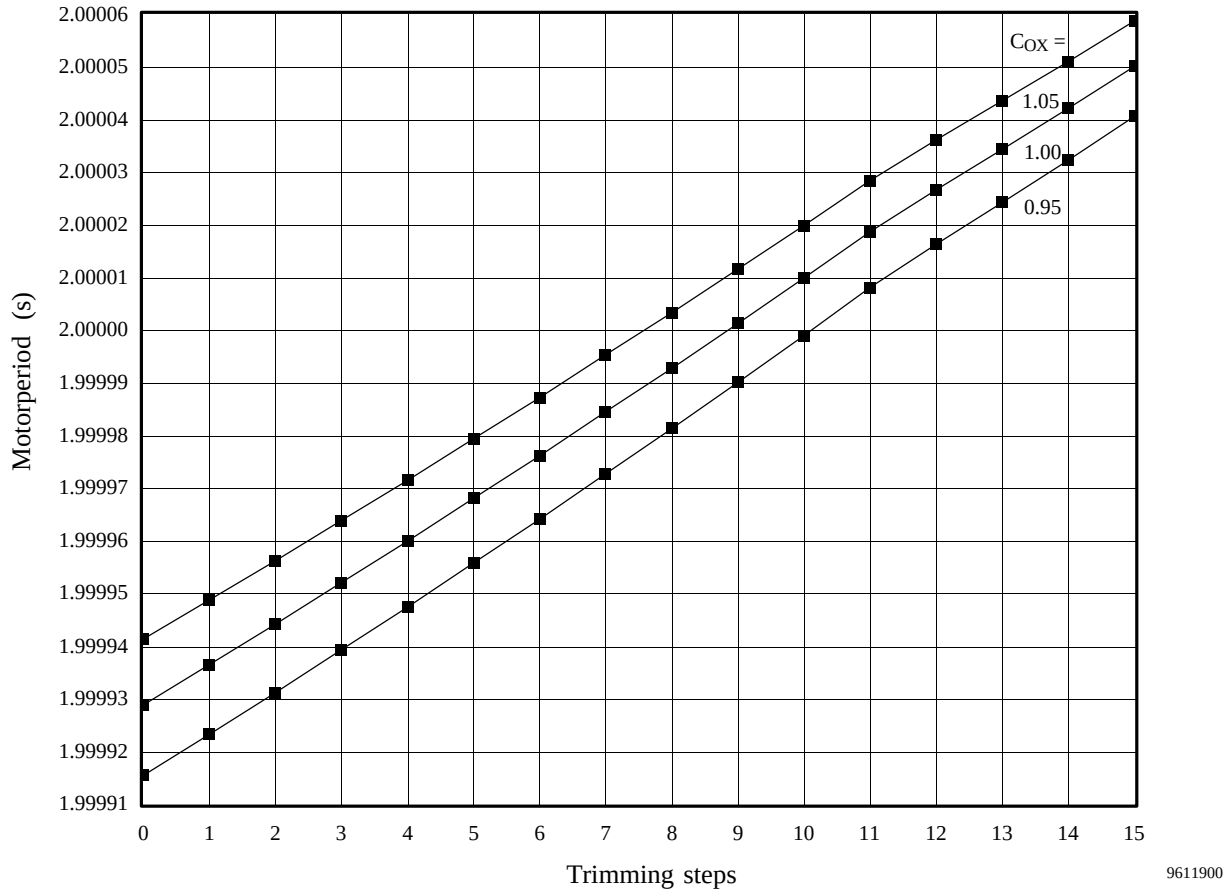


Figure 8. Typical trimming curve characteristic for T_M of 2 s

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

Ordering Information

Table 4. Option list e1267D–

Option	Motor			Alarm					Load Cap.	Integrated Capacitance	
	Cycle (T_M) s	Pulse (t_M) ms	Test (T_{MT}) ms	Frequency Hz	Modulation Frequency Hz	On/ Off Time s	Driver Type	Activation Polarity	pF	C_{OSCIN} *) pF	C_{OSCOUT} *) pF
–B	2	23.4	250	2048	8	0.5/ 0.5	NPN	V_{SS}	10	17	12
–D	2	31.25	250	2048	8	0.5/ 0.5	NPN	V_{DD}	10	17	12
–V2	0.5	23.4	250	2048	8	0.5/ 0.5	NPN	V_{SS}	12.5	20	16
E2	2	46.9	250	2048	8	1/ 3	NPN	V_{SS}	12.5	20	16

*) on-chip stray capacitance included

Option	Pad Designation												
	Pad 1	Pad 2	Pad 3	Pad 4	Pad 5	Pad 6	Pad 7	Pad 8	Pad 9	Pad 10	Pad 11	Pad 12	Pad 13
–B	OSCIN	V_{DD}	ALOUT	MOT2	MOT1	MOT1	ALIN/ MTEST	V_{SS}	OSC-OUT	SC4	SC3	SC2	SC1
–D	OSCIN	OSC-OUT	ALOUT	MOT2	MOT1	MOT1	ALIN/ MTEST	V_{SS}	V_{DD}	SC4	SC3	SC2	SC1
–V2	OSCIN	V_{DD}	ALOUT	MOT2	MOT1	MOT1	ALIN/ MTEST	V_{SS}	OSC-OUT	SC4	SC3	SC2	SC1
–D	OSCIN	OSC-OUT	ALOUT	MOT2	MOT1	ALIN/ TEST	MOT1	V_{SS}	V_{DD}	SC4	SC3	SC2	SC1

Data sheets can also be retrieved from the Internet: http://www.atmel–wm.com

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