



32 KHz Standard Watch CMOS IC

C1933 / C1933B

GENERAL DESCRIPTION

The C1933/C1933B is an integrated circuit fabricated in Polysilicon-Gate CMOS technology for application in bipolar stepping motor driven analog timepieces. It consists of a 32 KHz oscillator, frequency divider, voltage regulator and push-pull motor driver. A programmable oscillator output integrated capacitor is built-in so that only an external trimming capacitor and crystal are required by the oscillator. Low current consumption and high oscillator stability are achieved by an on-chip voltage regulator.

FEATURES

- Built-in 32768 Hz oscillator.
- Mask selectable integrated oscillator capacitors.
- 1.3 ~ 1.8V operating voltage range.
- Single battery operation and low current consumption achieved by built-in voltage regulator.
- Low resistance push-pull motor output drivers.
- Motor fast test function.
- Mask programmable motor cycle time, motor pulse width, motor test cycle time and pad designation.
- Low operating current.

FUNCTIONAL DESCRIPTION

Oscillator

An integrated oscillator with mask selectable capacitor in OSCOUT are provided so that only a 32768 Hz quartz crystal and a trimming capacitor is required to complete the oscillator circuit. If a trimmer capacitor is not used, another built-in capacitor at OSCIN can be mask programmed as an oscillator input capacitor. The capacitance of both built-in capacitors can be programmed in 2 pF step size with maximum total capacitance of 24 pF.

Voltage regulator

A well controlled reduced negative supply voltage is provided by a built-in integrated voltage regulator. It helps in improving the oscillator stability as well as reducing the power consumption.

Push-pull motor drivers

The C1933/C1933B has two push-pull output drivers. During a motor pulse the n-channel transistor of one driver and the p-channel transistor of the other driver are on. Between two consecutive motor pulses the n-channel transistors of both drivers are on (Figure 2). Cycle time and pulse width can be chosen from various options by the metal mask.

Reset

A debounced circuit with debounced time of 23.4 ms is provided for the RESET input. Connecting the RESET pad to V_{DD} longer than the debounced time would disable further motor pulses. Motor pulse in progress when RESET is applied will be completed. Disconnecting the RESET pad from V_{DD}, the next motor pulses would be output after half motor cycle time with polarity opposite to the previous one (Figure 3).

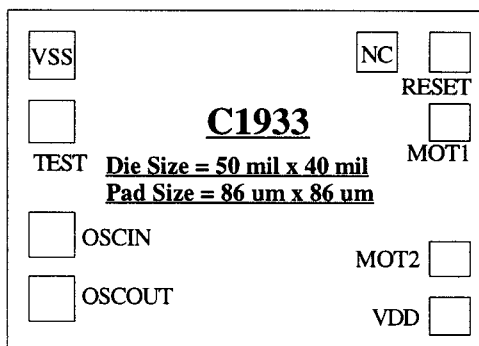
Test

The test pad can be used to monitor the oscillating frequency which is divided down to 512 Hz and can be measured with a high resistance probe. To enter the test mode, this pad should be pull to V_{DD} longer than the debounced time (3ms) and the motor cycle time would change from the selected value to the test cycle time (mask options), while the motor pulse width remains unchanged.

TABLE 1 : OPTION LIST FOR C1933/C1933B MOTOR OUTPUTS

Cycle time T _M	=	2, 4, 6, 8, 10, 12, 20, 24, 30, 40, 60, 120 s
Motor pulse width t _m	=	0.98ms X N (N= 1 to 15)
Motor test cycle time T _M T	=	250, 125, 62.5 ms

PAD CONFIGURATION



Note : Substrate should be either left open or connected to VDD.

Signal	Description	Pads' Co-ordinates
VSS	Negative supply voltage	(-529.0, -198.5)
TEST	Test input / output	(-528.9, -368.6)
OSCIN / OSCOUT	Oscillator input / output	(-529.0, -666.2) / (-529.0, -872.7)
NC	For test internal VGG , cannot be used for bonding	(272.8, -187.5)
RESET	Reset input	(444.4, -198.5)
MOT1 / 2	Motor drive outputs	(442.9, -364.5) / (442.9, -729.0)
VDD	Positive supply voltage	(442.9, -903.1)

ABSOLUTE MAXIMUM RATINGS

Parameter	Value	Unit
Power supply voltage (VDD - Vss)	- 0.3 ~ + 3.0	V
Input voltage range, all inputs	(Vss - 0.3) ≤ V1 ≤ (VDD + 0.3)	V
Operating ambient temperature range	-20 ~ +70	°C
Storage temperature range	-40 ~ +125	°C

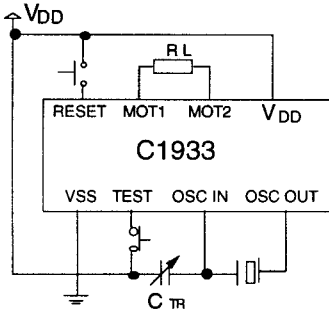
Note: Absolute maximum ratings state parameter limits exceeding which the device may be permanently changed or damaged.

ELECTRICAL CHARACTERISTICS

(VDD = 0V; Vss = -1.5V; Ta = +25°C; unless otherwise specified)
All voltage levels are measured with reference to VDD.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Operating voltage	Vss	-1.3	-	-1.8	V	Functional test (Fig.1)
Operating current	I _{SS}	-	-180	-300	nA	Coscout = 16 pF; RL = ∞
RESET input current	I _R	-	5	-	nA	RESET = VDD
Motor Outputs						
Motor output current	I _M	±0.7	-	-	mA	RL= 2KΩ, Vss = -1.55V
Cycle time	T _M	Mask option			s	-
Motor pulse width	t _m	Mask option			ms	-
Motor test cycle time	T _{MT}	Mask option			ms	-
Oscillator						
start-up voltage	V _{st}	-1.3	-	-	V	within 2 s
Integrated input capacitance	COSC IN	Mask option			-	Max. of (COSC IN + COSC OUT) = 38 pF
Integrated output capacitance	COSC OUT	Mask option			-	

Note 1 : Typical parameters represent the statistical mean values.



Test crystal specification

Frequency	$f = 32768 \text{ Hz}$
Series resistance	$R_s = 30 \text{ k}\Omega$
Static capacitance	$C_0 = 1.5 \text{ pF}$
Dynamic capacitance	$C_1 = 3 \text{ fF}$
Load capacitance	$C_l = 10 \text{ pF}$

Note: Substrate should be either left open or connected to V_{dd}.

Figure 1 : Functional test

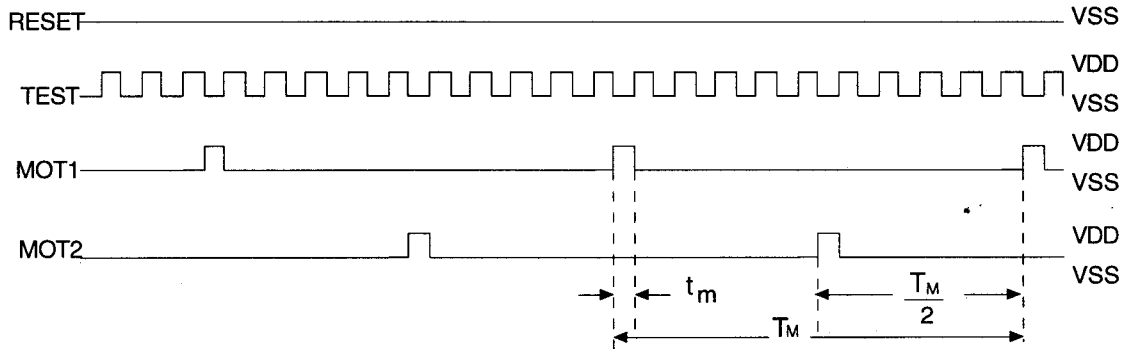


Figure 2 : Motor drive output in normal mode

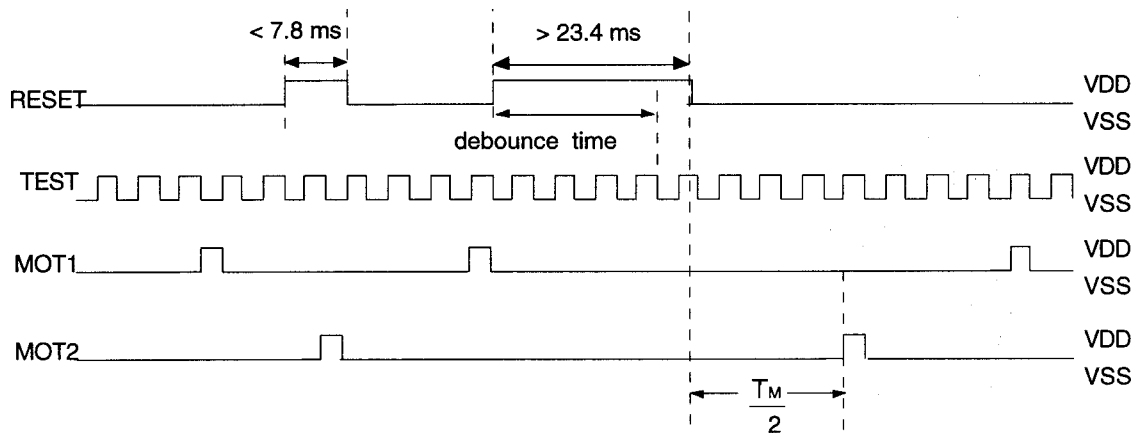


Figure 3 : Motor drive output and RESET

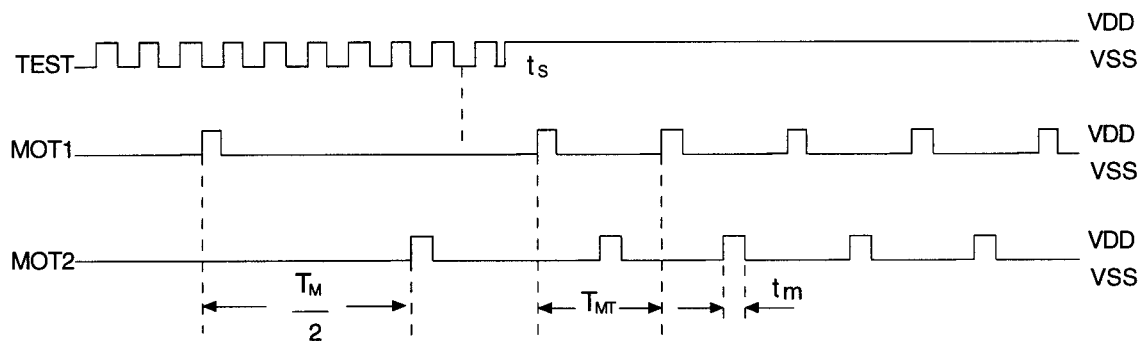


Figure 4 : TEST mode : V_{dd} applied to TEST at time $t = t_s$

OPTION LIST OF C1933/C1933B

Option	Motor Output			IC Cap **		P A D D E S I G N A T I O N								
	Cycle time	Pulse width	Test cycle time	OSC IN	OSC OUT	Pad1	Pad2	Pad3	Pad4	Pad5	Pad6	Pad7	Pad8	Pad9
	s	ms	ms	FF	FF									
C1933 -1	2	5.9	125	2	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933 -2	2	4.9	125	20	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933 -3	2	5.9	125	20	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933 -5	2	3.9	62.5	20	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933 -6	2	3.9	62.5	2	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933 -7	2	4.9	125	14	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933 -8	2	3.9	62.5	2	14	VSS	TEST	OSCOUT	OSCIN	VDD	MOT2	MOT1	RESET	___
C1933B -3	2	5.9	125	20	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___
C1933B -9	2	5.9	125	14	14	VSS	TEST	OSCIN	OSCOUT	VDD	MOT2	MOT1	RESET	___

** on-chip stray capacitance included