Handling Instructions

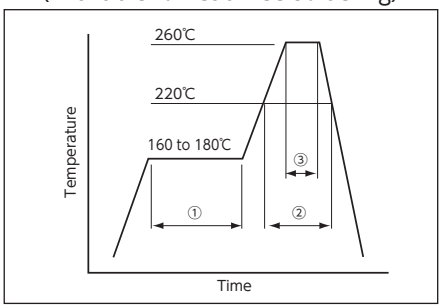
■ Soldering

Our products are designed so they may withstand the same standard reflow soldering temperatures as most other electronics components. However, if the reflow temperature is higher than our specification allows, the performance may be affected. Avoid soldering the product at temperatures higher than specified.
For the reflow temperature profile of SMD products, refer to the figure below.

①	Preheat	160 to 180℃	120sec.
②	Primary heat	220℃	60sec
③	Peak	260℃	10sec. max.

※ The reflow temperature profile may vary depending on the product model, specifications and frequency range. Refer to the individual product specifications for details.

Reflow Temperature Profile
(Available for lead free soldering)



■ Cleaning

◎General cleaning solutions or ultrasonic cleaning may be used to clean our crystal products, but verification tests are recommended prior to use.
◎Tuning fork crystals resonate at frequency bands that are close to the washing frequency of ultrasonic cleaning machines and this may cause resonance deterioration in the crystal. Therefore the use of ultrasonic cleaning machines to clean tuning fork crystals should be avoi-ded. After applying ultrasonic cleaning, the functionality of crystals should be verified by testing the performance of the end product.

■ Shock

Crystal products are designed to resist shock, but if the products receive excessive shocks or are dropped on the ground, be sure to check for any damages before using.

■ Mounting

〈SMD crystal products〉

Surface mount crystals are designed to be compatible with most automatic mounting processes, but some processes may exert excessive shock which may damage the crystal. Therefore test mounting of the crystal prior to mass production is necessary.
If there is a possibility that PCB may be warped, make sure the warping is not to such a degree that the crystal products' operating characteristics or soldering conditions will be negatively affected.
Avoid mounting and processing by Ultrasonic welding because this method has a possibility of an excessive vibration spreading inside the crystal products and becoming the cause of characteristic deterioration and not oscillating.

〈Lead type〉

When bending, forming, or mounting leaded crystal products be careful not to put too much pressure on the glassed part of the base, as it may crack and negatively affect the crystals' performance.

■ Storage

Storing crystal products at high temperatures or high humidity may deteriorate the soldering condition of pins. Do not store in direct sunlight or damp environments.

■ Others

〈Crystal Resonators〉

◎When excessive voltage is applied to crystal resonators, their performance may be affected or the crystal blank may be damaged. When handling the product, use the product within the specifications provided.
◎Negative resistance determines the tolerance margin of a circuit that oscillates the resonator. We recommend that the negative resistance be at least five times the standard series resistance for standard applications.

〈Crystal Oscillators〉

◎C-MOS is used for internal circuit of crystal oscillators. To prevent latch-up phenomena or static electricity, take careful note.
◎Some crystal oscillators do not have internally connected bypass capacitors. When using the product, use a capacitor with a good high frequency characteristic of 0.01μF between Vcc and GND (e.g. Ceramic chip capacitor) and connect it at the shortest pos-sible distance. For details, refer to the specifications of each individual product.

〈Monolithic Crystal Filters〉

◎Take care so that the input pin and the output pin do not close on the PCB.
◎If the floating capacity of a PCB (on which a crystal filter is to be mounted) is too large, circuit tuning may be required to cancel out the excess floating capacity.
◎When excessive voltage is applied to crystal filters, their performance may be affected or the crystal blank may be damaged. When handling the product, use at its input level equal to or less than -10dBm.

RoHS/ELV Compliant Lead-free and Halogen-free products from KDS.

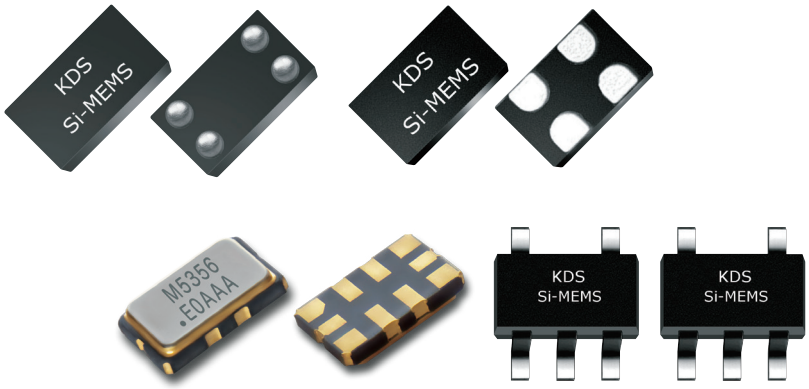
KDS is fully committed to environmental protection and has been proactively working to comply with the major environmental regulations such as RoHS Directive (Directive of the Restriction of the use of certain Hazardous Substances : 2011/65/EU and (EU) 2015/863), ELV Directive (End-of-Life Vehicles Directive : 2000/53/EC) and Halogen-free activities etc. The below spreadsheet provide the current status of the product compliance in each environmental regulations. Please visit our website for the latest information.(https://www.kds.info)

As of sept.30.2023

	Type	RoHS/ELV Compliant	Halogen-free	Pb-free	Materials of pin	Note
Crystal Resonators/ MHz Band Crystal Resonators	DX1008J SERIES	○	○	○	Ni/Au	
	DSX1210A	○	○	○	Ni/Au	
	DSX1612S	○	○	○	Ni/Au	
	DSX211S, DSX211SH	○	○	○	Ni/Au	
	DSX221SH	○	○	○	Ni/Au	
	DSX321SH	○	○	○	Ni/Au	
	DSX210GE	○	○	Pb in sealing-glass	Ni/Au	Pb in sealing-glass is exempted from RoHS/ELV Directive.(*)
	DSX320GE	○	○	Pb in sealing-glass	Ni/Au	Pb in sealing-glass is exempted from RoHS/ELV Directive.(*)
	DSX211G	○	○	Pb in sealing-glass	Ni/Au	Pb in sealing-glass is exempted from RoHS/ELV Directive.(*)
	DSX321G, DSX321GK	○	○	Pb in sealing-glass	Ni/Au	Pb in sealing-glass is exempted from RoHS/ELV Directive.(*)
	DSX530GA	○	○	Pb in sealing-glass	Ni/Au	Pb in sealing-glass is exempted from RoHS/ELV Directive.(*)
Tuning Fork Crystal Resonators/ kHz Band Crystal Resonators	DT-26, DT-261	○	○	○	Sn	
	DT-38, DT-381	○	○	○	Sn	
	DMX-26S	○	○	High temperature solder	Sn	High temperature solder used inside the product is exempted from RoHS/ELV Directive.(*)
	DST1210A	○	○	○	Ni/Au	
	DST1610A	○	○	○	Ni/Au	
	DST210AC	○	○	○	Ni/Au	
	DST310S	○	○	○	Ni/Au	
Crystal Resonators with dedicated temperature sensor/ MHz Band Crystal Resonators	DSR1210ATH	○	○	○	Ni/Au	
	DSR1612ATH	○	○	○	Ni/Au	
	DSR211STH	○	○	○	Ni/Au	
	DSR221STH	○	○	○	Ni/Au	
Temperature Compensated Crystal Oscillators (TCXO)	DSA/DSB1612 SERIES	○	○	○	Ni/Au	
	DSA/DSB211 SERIES	○	○	○	Ni/Au	
	DSA/DSB221 SERIES	○	○	○	Ni/Au	
	DSA/DSB321 SERIES	○	○	○	Ni/Au	
	DSA/DSB535 SERIES	○	○	○	Ni/Au	
	DSK1612ATD	○	○	○	Ni/Au	
	DSK321STD	○	○	○	Ni/Au	
Real Time Clock Module (RTC)	DD3225TS, DD3225TR	○	○	○	Ni/Au	
Simple Packaged Crystal Oscillators (SPXO)	DS1008J SERIES	○	○	○	Ni/Au	
	DSO1612AR	○	○	○	Ni/Au	
	DSO211S SERIES	○	○	○	Ni/Au	
	DSO221S SERIES	○	○	○	Ni/Au	
	DSO223S SERIES	○	○	○	Ni/Au	
	DSO321S SERIES	○	○	○	Ni/Au	
	DSO323S SERIES	○	○	○	Ni/Au	
	DSO531S SERIES	○	○	○	Ni/Au	
	DSO533 SERIES	○	○	○	Ni/Au	
	DLO555MBA	○	○	○	Sn	
	DSO751S SERIES	○	○	○	Ni/Au	
	DSO753S SERIES	○	○	○	Ni/Au	
Voltage Controlled Crystal Oscillators (VCXO)	DSV221SV	○	○	○	Ni/Au	
	DSV321S	○	○	○	Ni/Au	
Monolithic Crystal Filters	DSF334 SERIES	○	○	○	Ni/Au	
	DSF444 SERIES	○	○	○	Ni/Au	
	DSF633 SERIES	○	○	○	Ni/Au	
	DSF753 SERIES	○	○	○	Ni/Au	

* RoHS Directive and ELV Directive exemptions are granted for high temperature solder, lead content in low-melting glass of DSX-G Series.

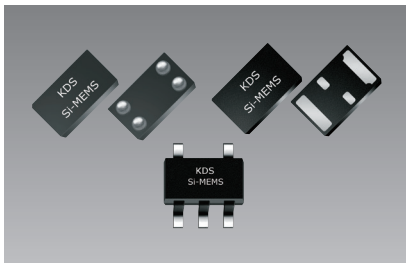
Silicon Timing Devices
MEMS oscillators



DAISHINKU CORP.

32 kHz MEMS Oscillators / 32 kHz TC-MO - µPower

MO1532/MO1552/MO1630/MO1566/MO1568



■Features

- Fixed 32.768 kHz
- Ultra-low power
- Internal filtering eliminates external Vdd bypass cap

■ Applications

- Mobile Phones, Tablets
- Health and wellness monitors, Fitness Watches
- Pulse-per- second timekeeping, RTC reference clock
- Battery Management Timekeeping

Pb-Free

RoHS Compliant

Model	Output Frequency (kHz)	Frequency Tolerance ($\times 10^{-6}$)	Supply Voltage (V)	Current Consumption (μA Typ.)	Size (mm)	Output
MO1532	32.768	±10 room; 75, 100 over temp.	+1.2 to +3.63	+0.90	1.5×0.8×0.6 (CSP)	NanoDrive™ LVCMOS
MO1552 TC-MO		±5, ±10, ±20 over temp.	+1.5 to +3.63	+0.99		
MO1566 Super TC-MO		±3, 5 all inclusive	+1.8	+4.5	1.5×0.8×0.6 (CSP)	LVCMOS
MO1568 Super TC-MO		±5 all inclusive After Overmold/Underfill				
MO1630 -40 to +105℃	16.384, 32.768	±20 room; ±75,100,150 over temp.	+1.5 to +3.63	+1.00	2.0×1.2×0.6 (QFN) 2.9×2.8×1.3 (SOT23-5)	LVCMOS

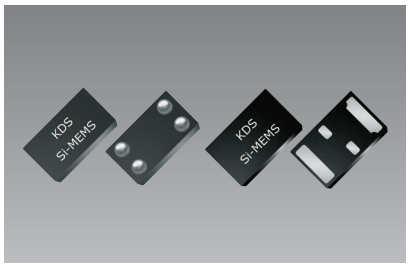
■ Standard Specification (MO1532)

Item	Legend	Min.	Typ.	Max.	Unit	Condition
Output Frequency Range	Fout		32.768		kHz	
Supply Voltage	Vdd	+1.2	-	+3.63	V	T_A = -10℃ to +70℃
		+1.5	-	+3.63		T_A = -40℃ to +85℃
Operating Temperature Range	T_use	-10 to +70 / -40 to +85			℃	
Frequency Stability [1]	F_stab	-	-	+75	$\times 10^{-6}$	T_A = -10℃ to +70℃, Vdd: +1.5V to +3.63V
		-	-	+100		T_A = -40℃ to +85℃, Vdd: +1.5V to +3.63V
		-	-	+250		T_A = -10℃ to +70℃, Vdd: +1.2V to +1.5V
Frequency Tolerance [2]	F_tol	-	-	+10	$\times 10^{-6}$	T_A = +25° C, post reflow, Vdd: +1.5V to +3.63V
		-	-	+20		T_A = +25° C, post reflow with board-level underfill, Vdd: +1.5V to +3.63V
First Year Aging	F_aging1	-1.0	-	+1.0	$\times 10^{-6}$	T_A = +25℃
Core Operating Current [3]	Idd	-	+0.9	-	µA	T_A = +25℃, Vdd: +1.8V. No load
		-	-	+1.3		T_A = -10℃ to +70℃, Vdd max: +3.63V. No load
		-	-	+1.4		T_A = -40℃ to +85℃, Vdd max: +3.63V. No load
Start-up Time [4]	T_start	-	180	300	ms	T_A = -40℃ ≦ T_A ≦ +50℃, valid output
		-	-	450		T_A = +50℃ < T_A ≦ +85℃, valid output
LVCMOS Output Option, TA = -40℃ to +85℃, typical values are at T_A = +25℃						
Duty Cycle	DC	48	-	52	%	
Output Low Voltage	V_{OL}	-	-	Vdd×0.1	V	Vdd: +1.5V to +3.63V, I_{OL} = +10 µA, 15 pF
Output High Voltage	V_{OH}	Vdd×0.9	-	-	V	Vdd: +1.5V to +3.63V, I_{OH} = -10 µA, 15 pF
Rise and Fall Time	Tr, Tf	-	100	200	ns	10 to 90% (Vdd), 15 pF load, Vdd = +1.5V to +3.63V
		-	-	50		10 to 90% (Vdd), 5 pF load, Vdd ≧ +1.62V
Packing Unit	1000pcs./reel (φ180) or 3000pcs./reel (φ180)					

[1]. Measured peak-to-peak. Inclusive of Initial Tolerance at +25° C, and variations over operating temperature, rated power supply voltage and load. Stability is specified for two operating voltage ranges. Stability progressively degrades with supply voltage below +1.5V.
[2]. Measured peak-to-peak. Tested with Keysight 53132A frequency counter. Due to the low operating frequency, the gate time must be ≥100 ms to ensure an accurate frequency measurement.
[3]. Core operating current does not include output driver operating current or load current. To derive total operating current (no load), add core operating current + (+0.065 µA/V)×(output voltage swing).
[4]. Measured from the time Vdd reaches +1.5V.

MEMS Oscillators / TC-MO - µPower

MO1534/MO1569/MO1576/MO8021



■Features

- Ultra-low power
- Internal filtering eliminates external Vdd bypass cap

■ Applications

- Tablets, Wearable, Portable audio
- Health and wellness monitors, Fitness bands
- IoT devices
- Input devices

Pb-Free

RoHS Compliant

Model	Output Frequency (kHz)	Frequency Tolerance ($\times 10^{-6}$)	Supply Voltage (V)	Current Consumption (μA Typ.)	Size (mm)	Output
MO1534	1 Hz to 32.768 kHz	±20 room; ±75,100,150 over temp	+1.2 to +3.63	+0.90	1.5×0.8×0.6 (CSP) 2.0×1.2×0.6 (QFN)	NanoDrive™ LVCMOS
MO1569	1 Hz to 462kHz	±50	+1.62 to +3.63	+2.0 (100 kHz)	1.5×0.8×0.6 (CSP)	LVCMOS
MO1576 Super TC-MO	1 Hz to 2 MHz	±5 all inclusive		+8.0 (100 kHz)		
MO8021	1 Hz to 26 MHz	±100	+1.62 to +1.98, +2.25 to +3.63	+6 to +340 (0.9 µA stby)		

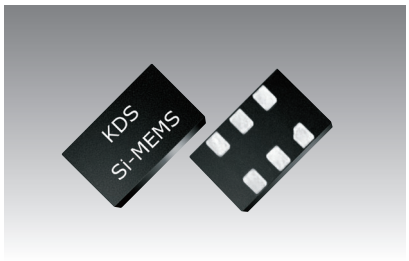
■ Standard Specification (MO8021)

Item	Legend	Min.	Typ.	Max.	Unit	Condition
Output Frequency Range	f	1	–	26	MHz	
Operating Supply Voltage	Vdd	+1.62	+1.8	+1.98	V	
		+2.25	–	+3.63		Any voltage from +2.25 to +3.63V
Operating Temperature Range	T_use	-20	–	+70	℃	Extended Commercial
		-40	–	+85		Industrial
Frequency Stability	F_tol	-15	–	+15	$\times 10^{-6}$	Frequency offset at +25℃ post reflow
Frequency Tolerance	F_stab	-100	–	+100	$\times 10^{-6}$	Inclusive of initial tolerance, and variations over operating temperature, rated power supply voltage and output load.
First Year Aging	F_aging1	-3.0	–	+3.0	$\times 10^{-6}$	T_A = +25℃
Current Consumption [1]	Idd	–	+60	–	µA	f = 3.072 MHz, Vdd = +1.8V, no load
		–	+110	+130		f = 6.144 MHz, Vdd = +1.8V, no load
		–	+230	+270		f = 6.144 MHz, Vdd = +1.8V, 10 pF load
		–	+160	–		f = 12 MHz, Vdd = +1.8V, no load
		–	–	+160		f = 6.144 MHz, Vdd = +2.25V to +3.63V, no load
Standby Current	I_std	–	+0.7	+1.3	µA	Vdd = +1.8V, ST pin = HIGH, output is weakly pulled down
		–	–	+1.5		Vdd = +2.25V to +3.63V, ST pin = HIGH, output is weakly pulleddown
Duty Cycle	DC	45	–	55	%	
Output Low Voltage	V_{OL}	–	–	Vdd×0.1	V	I_{OL} = +0.5 mA
Output High Voltage	V_{OH}	Vdd×0.9	–	–	V	I_{OH} = -0.5 mA
Rise and Fall Time	Tr, Tf	–	+4.0	+8.0	ns	20% to 80%
Input Low Voltage	V_{IL}	–	–	Vdd×0.2	V	
Input High Voltage	V_{IH}	Vdd×0.8	–	–	V	
Start-up Time	T_start	–	75	150	ms	Measured from the time Vdd reaches 90% of its final value
Standby Time	T_stdby	–	–	20	µs	Measured from the time ST pin crosses 50% threshold
Resume Time	T_resume	–	2.0	3.0	ms	Measured from the time ST pin crosses 50% threshold
RMS Period Jitter	T_jitt	–	75	110	ps	f = 6.144 MHz, Vdd = +1.8V
		–	–	110		f = 6.144 MHz, Vdd = +2.25V to +3.63V
RMS Phase Jitter (random)	T_phj	–	0.8	2.5	ns	f = 6.144 MHz, Integration bandwidth = 100 Hz to 40 kHz
						Vdd = +1.8V, Note [2]
		–	–	2.5		f = 6.144 MHz, Integration bandwidth = 100 Hz ~ 40 kHz
						Vdd = +2.25V to +3.63V, Note [2]
Packing Unit	1000pcs./reel (φ180) or 3000pcs./reel (φ180)					

[1]. Supply current with load is a function of the output frequency and output load.
For any given output frequency, the capacitive loading will increase supply current equal to C_load × Vdd × f(MHz).
[2]. Max spec inclusive of +25 mV peak-to-peak sinusoidal noise on Vdd. Noise frequency 100 Hz to 20 MHz.

MEMS Oscillators - Super Low Jitter

MO9365/MO9366/MO9367



■Features

- Industry-Standard packages: 3.2×2.5 mm, 5.0×3.2 mm, 7.0×5.0 mm
- Output signaling types: LVPECL, LVDS, HCSL
- Frequency tolerance as low as ±10×10^{-6}
- 0.1 ps RMS phase jitter (random) for Ethernet applications

■ Applications

- 10/40GB Ethernet, SONET, SATA, SAS, Fibre Channel
- Telecom, networking, instrumentation, storage, servers

Pb-Free

RoHS Compliant

Model	Output Frequency (MHz)	Frequency Tolerance (×10^{-6})	Supply Voltage (V)	Current Consumption (mA Typ.)	Size (mm)	Output
MO9365	32 Standard Frequencies	±10, ±20, ±25, ±50	+2.25 to +3.63	+76 to +84	3.2×2.5×0.8, 5.0×3.2×0.8, 7.0×5.0×1.0 (QFN)	LVPECL LVDS HCSL
MO9366	1 to 220					
MO9367	220 to 725					

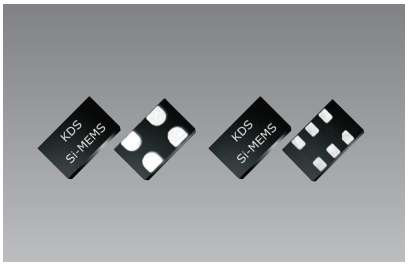
■ Standard Specification (MO9366)

Item	Legend	Min.	Typ.	Max.	Unit	Condition
Output Frequency Range	f	1	–	220	MHz	Accurate to 6 decimal places
Supply Voltage	Vdd	+2.25	+2.50	+2.75	V	
		+2.52	+2.80	+3.08		
		+2.70	+3.00	+3.30		
		+2.97	+3.30	+3.63		
Operating Temperature Range	T_use	-20	–	+70	℃	Extended Commercial
		-40	–	+85		Industrial
		-40	–	+95		
		-40	–	+105		Extended Industrial
Frequency Tolerance	F_stab	-10	–	+10	×10^{-6}	Inclusive of initial tolerance, and variations over operating temperature, rated power supply voltage and output load.
		-20	–	+20		
		-25	–	+25		
		-50	–	+50		
First Year Aging	F_aging1	–	±1	–	×10^{-6}	T_A = +25℃
Duty Cycle	DC	45	–	55	%	
OE Disable Supply Current	I_oe	–	–	+58	mA	OE = Low
Input Low Voltage	V_{IL}	–	–	Vdd×0.3	V	Pin 1, OE
Input High Voltage	V_{IH}	Vdd×0.7	–	–	V	Pin 1, OE
Start-up Time	T_start	–	–	3.0	ms	Measured from the time Vdd reaches its rated minimum value
Enable and Disable Time	T_oe	–	–	3.8	μs	f = 156.25 MHz
RMS Phase Jitter [1]	T_jitt	–	1	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 or 2.5 V
LVPECL output						
Current Consumption	Idd	–	–	+89	mA	Excluding Load Termination Current, Vdd = +3.3V or +2.5V
Output Low Voltage	V_{OL}	Vdd - 1.9	–	Vdd - 1.5	V	
Output High Voltage	V_{OH}	Vdd - 1.1	–	Vdd - 0.7	V	
Differential Output Voltage	V_Swing	1.2	1.6	2.0	V	
Rise and Fall Time	Tr, Tf	–	225	290	ps	20% to 80%
RMS Phase Jitter [random]	T_phj	–	0.225	0.275	ps	Note [2]
LVDS output						
Current Consumption	Idd	–	–	+79	mA	Excluding Load Termination Current, Vdd = +3.3V or +2.5V
Differential Output Voltage	V_{OD}	+250	–	+450	mV	
V_{OD} Magnitude Change	ΔV_{OD}	–	–	+50	mV	
Offset Voltage	V_{OS}	+1.125	–	+1.375	V	
V_{OS} Magnitude Change	ΔV_{OS}	–	–	+50	mV	
Rise and Fall Time	Tr, Tf	–	400	470	ps	Measured with 2 pF capacitive loading to GND, 20% to 80%
RMS Phase Jitter [random]	T_phj	–	0.235	0.275	ps	Note [2]
HCSL output						
Current Consumption	Idd	–	–	+89	mA	Excluding Load Termination Current, Vdd = +3.3V or +2.5V
Output Voltage Low	V_{OL}	-0.05	–	+0.08	V	
Output Voltage High	V_{OH}	0.6	–	+0.9	V	
Differential Output Voltage	V_Swing	1.0	1.4	1.8	V	
Rise and Fall Time	Tr, Tf	–	360	465	ps	Measured with 2 pF capacitive loading to GND, 20% to 80%
RMS Phase Jitter [random]	T_phj	–	0.225	0.275	ps	Note [2]
Packing Unit	1000pcs./reel (φ180) or 3000pcs./reel (φ180: 3225 package)					

[1]. Measured according to JESD65B
[2]. 5.0×3.2 and 3.2×2.5 mm package, f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to +70°C and -40 to +85°C

MEMS Oscillators - Low Jitter

MO9120/MO9121/MO9122/MO8208/MO8209



■Features

- Frequency tolerance as low as ±10×10^{-6}
- Ultra-Low phase Jitter

■ Applications

- Computing, storage, networking
- Telecom, industrial control
- SATA, SAS, Ethernet, PCI Express, video, WiFi

Pb-Free

RoHS Compliant

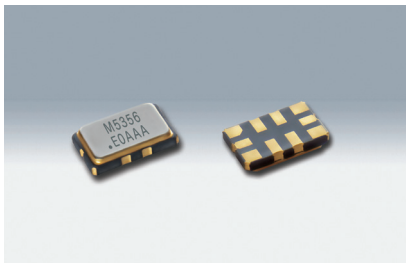
Model	Output Frequency (MHz)	Frequency Tolerance (×10^{-6})	Supply Voltage (V)	Current Consumption (mA Typ.)	Size (mm)	Output
MO9120	25 to 212.5	±10, ±20, ±25, ±50	+2.25 to +3.63	+54 to +69	3.2×2.5×0.8, 5.0×3.2×0.8, 7.0×5.0×1.0 (QFN)	LVPECL LVDS
MO9121	1 to 220					
MO9122	220 to 625					
MO8208	1 to 80			+29 to +36 (+10 µA stby)	2.7×2.4×0.8, 3.2×2.5×0.8, 5.0×3.2×0.8, 7.0×5.0×1.0 (QFN)	LVCMOS
MO8209	80 to 220					

■ Standard Specification (MO9121)

Item	Legend	Min.	Typ.	Max.	Unit	Condition
Output Frequency Range	f	1	–	220	MHz	Refer to datasheet for exact list of supported frequencies
Supply Voltage	Vdd	+2.97	+3.3	+3.63	V	
		+2.25	+2.5	+2.75		
		+2.25	–	+3.63		
Operating Temperature Range	T_use	–20	–	+70	℃	Extended Commercial
		–40	–	+85		Industrial
Frequency Tolerance	F_stab	–10	–	+10	×10^{-6}	Inclusive of initial tolerance, and variations over operating temperature, rated power supply voltage and output load.
		–20	–	+20		
		–25	–	+25		
		–50	–	+50		
First Year Aging	F_aging1	–2.0	–	+2.0	×10^{-6}	T_A = +25℃
10-year Aging	F_aging10	–5.0	–	+5.0		T_A = +25℃
Duty Cycle	DC	45	–	55	%	
Input Low Voltage	V_{IL}	–	–	Vdd×0.3	V	Pin 1, OE or $\overline{ST}$
Input High Voltage	V_{IH}	Vdd×0.7	–	–	V	Pin 1, OE or $\overline{ST}$
Start-up Time	T_start	–	6.0	10	ms	Measured from the time Vdd reaches its rated minimum value.
Resume Time	T_resume	–	6.0	10	ms	In Standby mode, measured from the time ST pin crosses 50% threshold.
LVPECL, DC and AC Characteristics						
Current Consumption	Idd	–	+61	+69	mA	Excluding Load Termination Current, Vdd = +3.3V or +2.5V
OE Disable Supply Current	I_oe	–	–	+35	mA	OE = Low
Standby Current	I_std	–	–	+100	µA	$\overline{ST}$ = Low, for all Vdds
Output Low Voltage	V_{OL}	Vdd - 1.9	–	Vdd - 1.5	V	
Output High Voltage	V_{OH}	Vdd - 1.1	–	Vdd - 0.7	V	
Rise and Fall Time	Tr, Tf	–	300	700	ps	20% to 80%
Enable and Disable Time	T_oe	–	–	115	ns	f = 212.5 MHz - For other frequencies, T_oe = 100ns + 3 period
RMS Period Jitter	T_jitt	–	1.2	1.7	ps	f = 100 MHz, Vdd = +3.3V or +2.5V
		–	1.2	1.7		f = 156.25 MHz, Vdd = +3.3V or +2.5V
		–	1.2	1.7		f = 212.5 MHz, Vdd = +3.3V or +2.5V
RMS Phase Jitter (random)	T_phj	–	0.6	0.85	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdds
LVDS, DC and AC Characteristics						
Current Consumption	Idd	–	+47	+55	mA	Excluding Load Termination Current, Vdd = +3.3V or +2.5V
OE Disable Supply Current	I_oe	–	–	+35	mA	OE = Low
Standby Current	I_std	–	–	+100	µA	$\overline{ST}$ = Low, for all Vdds
Rise and Fall Time	Tr,Tf	–	495	700	ps	20% to 80%
Differential Output Voltage	V_{OD}	+250	+350	+450	mV	
V_{OD} Magnitude Change	ΔV_{OD}	–	–	+50	mV	
Offset Voltage	V_{OS}	+1.125	+1.2	+1.375	V	
V_{OS} Magnitude Change	ΔV_{OS}	–	–	+50	mV	
Enable and Disable Time	T_oe	–	–	115	ns	f = 212.5 MHz - For other frequencies, T_oe = 100ns + 3 period
RMS Period Jitter	T_jitt	–	1.2	1.7	ps	f = 100 MHz, Vdd = +3.3V or +2.5V
		–	1.2	1.7		f = 156.25 MHz, Vdd = +3.3V or +2.5V
		–	1.2	1.7		f = 212.5 MHz, Vdd = +3.3V or +2.5V
RMS Phase Jitter (random)	T_phj	–	0.6	0.85	ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdds
Packing Unit	1000pcs./reel (φ180) or 3000pcs./reel (φ180: 3225 package)					

TC-MO / VC TC-MO - Super Low Jitter

MO5155/MO5156/MO5157/MO5356/MO5357/MO5358/MO5359



■Features

- 5.0×3.2 mm Ceramic package
- LVCMOS or Clipped Sinewave output

■ Applications

- Synchronous Ethernet
- Small cell
- Optical transport-SONET/SDH, OTN
- IEEE1588
- Test and measurement

Pb-Free

RoHS Compliant

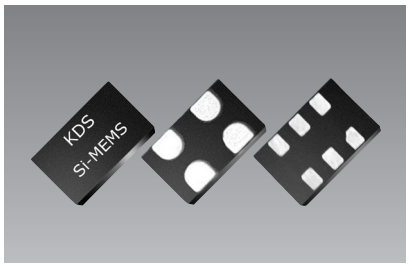
Model	Output Frequency (MHz)	Frequency Tolerance ($\times 10^{-6}$)	Supply Voltage (V)	Current Consumption (mA Typ.)	Size (mm)	Output
MO5155	10 std. GNSS Freq.	±0.5, ±1.0, ±2.5	+2.25 to +3.63	+40 to +50	5.0×3.2×0.95 (Ceramic)	Clipped Sinewave (1 to 60 MHz) LVCMOS
MO5156	1 to 60					
MO5157	60 to 220					
MO5356	1 to 60	±0.1, ±0.2, ±0.25				
MO5357	60 to 220					
MO5358	1.0 to 60	±0.05	+2.25 to +3.63			Clipped sinewave, LVCMOS
MO5359	60 to 189, 200 to 220					LVCMOS

■ Standard Specification (MO5356)

Item	Legend	Min.	Typ.	Max.	Unit	Condition
Output Frequency Range	f	1	-	60	MHz	
Supply Voltage	Vdd	+2.25	+2.50	+2.75	V	
		+2.52	+2.80	+3.08		
		+2.70	+3.00	+3.30		
		+2.97	+3.30	+3.63		
Operating Temperature Range	T_use	-20	-	+70	℃	Extended commercial
		-40	-	+85		Industrial
		-40	-	+105		Extended Industrial, ambient temperature
Initial Tolerance	F_init	-1.0	-	+1.0	$\times 10^{-6}$	Inclusive of solder-down shift at 48 hours after 2 reflows at +25℃
Frequency Stability over temperature	F_stab	-0.10	-	+0.10	$\times 10^{-6}$	Referenced to (fmas + fmin)/2 over the specified temperature range
		-0.20	-	+0.20		
		-0.25	-	+0.25		
First Year Aging	F_aging1	-	±1.0	-	$\times 10^{-6}$	T_A = +25℃
Pull Range	PR	±6.25			$\times 10^{-6}$	VC TC-MO mode. Contact KDS for ±12.5, ±25
		±6.25, ±10, ±12.5,±25, ±50, ±80, ±100, ±125, ±150, ±200, ±400, ±600, ±800, ±1200, ±1600, ±3200			$\times 10^{-6}$	DC TC-MO mode.
Upper Control Voltage	VC_U	Vdd×0.9	-	-	V	
Control Voltage Range	VC_L	-	-	Vdd×0.1	V	
Control Voltage Input Impedance	VC_z	8	-	-	MΩ	
Control Voltage Input Bandwidth	VC_c	-	10	-	kHz	
Frequency Change Polarity	-	Positive Slope			-	
Current Consumption	Idd	-	+44	+53	mA	No load condition, f = 19.2 MHz, TC-MO and DC TC-MO mode.
		-	+48	+57		No load condition, f = 19.2 MHz, VC TC-MO mode.
OE Disable Current	I_od	-	+43	+51	mA	OE = GND, output is weakly pull down, TC-MO and DC TC-MO mode.
		-	+47	+55		OE = GND, output is weakly pull down, VC TC-MO mode.
Input Low Voltage	V_{IL}	-	-	Vdd×0.3	V	For OE pin
Intput High Voltage	V_{IH}	Vdd×0.7	-	-	V	For OE pin
Start-up Time	T_start	-	2.5	3.5	ms	Time to first pulse, Measured from the time Vdd reaches its rated minimum value.
RMS Period Jitter	T_jitt	-	0.8	1.1	ps	f = 10 MHz
LVCMOS Output						
Duty Cycle	DC	45	-	55	%	
Output Low Voltage	V_{OL}	-	-	Vdd×0.1	V	I_{OL} = -3mA
Output High Voltage	V_{OH}	Vdd×0.9	-	-	V	I_{OH} = +3 mA
Rise and Fall Time	Tr, Tf	0.8	1.2	1.9	ns	10% to 90% Vdd.
RMS Phase Jitter (random)	T_phj	-	0.31	0.48	ps	f = 50 MHz, Integration bandwidth = 12 kHz to 20 MHz, -40 to +85 ℃
Clipped Sinewave Output						
Output Voltage Level	Vout	+0.8	-	+1.2	%	10kΩ || 10pF ± 10%
Rise and Fall Time	Tr, Tf	-	3.5	4.6	V	20% to 80% Vdd, 19.2MHz
RMS Phase Jitter (random)	T_phj	-	0.31	0.48	ps	f = 60 MHz, Integration bandwidth = 12 kHz to 20 MHz, -40 to +85 ℃
Packing Unit	1000pcs./reel (φ180)					

MEMS Oscillators with Spread Spectrum Function (SSCG)

MO9002/MO9003/MO9005



■Features

- Spread options
  Center Spread: ±0.5%, ±0.25%
  Down Spread: -1%, -0.5%
- Standby, output enable or spread disable mode
- <30 ps cycle-to-cycle jitter

■ Applications

- Printers
- Flat panel drivers
- PCI
- Microprocessors

Pb-Free

RoHS Compliant

Model	Output Frequency (MHz)	Frequency Tolerance ($\times 10^{-6}$)	Supply Voltage (V)	Current Consumption (mA Typ.)	Size (mm)	Output
MO9002	1 to 220	±25, ±50	+1.71 to +1.89, +2.25 to +3.63	+48 to +75	5.0×3.2×0.8, 7.0×5.0×1.0 (QFN)	LVPECL CML LVDS HCSL
MO9003	1 to 110	±50, ±100		+3.2 to +4.1 (+0.4 to +4.3 µA stby)	2.5×2.0×0.8, 3.2×2.5×0.8, 5.0×3.2×0.8, 7.0×5.0×1.0 (QFN)	LVCMOS
MO9005	1 to 141	±20, ±25, ±50	+1.62 to +1.98, +2.25 to +3.63	5.0 to 6.5 (0.4 to4.3 µA stby)	2.0×1.6×0.8, 2.5×2.0×0.8, 3.2×2.5×0.8 (QFN)	

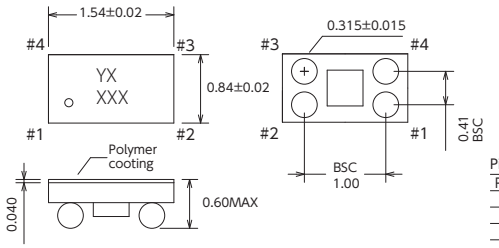
■ Standard Specification (MO9005)

Item	Legend	Min.	Typ.	Max.	Unit	Condition
Output Frequency Range	f	1	-	141	MHz	
Supply Voltage	Vdd	+1.62	+1.8	+1.98	V	
		+2.25	+2.5	+2.75		
		+2.52	+2.8	+3.08		
		+2.7	+3.0	+3.3		
		+2.97	+3.3	+3.63		
		+2.25	-	+3.63		
Operating Temperature Range	T_use	-20	-	+70	℃	Extended Commercial
		-40	-	+85		Industrial
Frequency Tolerance	F_tol	-20	-	+20	$\times 10^{-6}$	Inclusive of initial tolerance at +25℃, 1st year aging at +25℃, and variations over operating temperature, rated power supply voltage.
		-25	-	+25		
		-50	-	+50		
Current Consumption	Idd	-	+5.6	+6.5	mA	No load condition, f = 40 MHz, Vdd = +2.5V to +3.3V
		-	+5.0	+5.5		No load condition, f = 40 MHz, Vdd = +1.8V
Standby Current	I_std	-	+2.1	+4.3	µA	$\overline{ST}$ = GND, Vdd = +2.5V to +3.3V, Output is weakly pulled down
		-	+0.4	+1.5		$\overline{ST}$ = GND, Vdd = +1.8V, Output is weakly pulled down
Spread Spectrum	-	±0.125 to ±2.060			%	Center Spread
		-4.28 to -0.25				Down Spread
Duty Cycle	DC	45	-	55	%	
Output Low Voltage	V_{OL}	90%	-	-	Vdd	I_{OH} = -4 mA (Vdd = +3.0V or +3.3V) I_{OH} = -3 mA (Vdd = +2.8V and Vdd = +2.5V) I_{OH} = -2 mA (Vdd = +1.8V)
Output High Voltage	V_{OH}	-	-	10%	Vdd	I_{OL} = +4 mA (Vdd = +3.0V or +3.3V) I_{OL} = +3 mA (Vdd = +2.8V and Vdd = +2.5V) I_{OL} = +2 mA (Vdd = +1.8V)
Rise and Fall Time	Tr, Tf	-	1	2	ns	Vdd = +2.5V, +2.8V, +3.0V or +3.3V, 20% to 80%, default derive strength
		-	1.3	2.5		Vdd = +1.8V, 20% to 80%, default derive strength
		-	-	2.0		Vdd = +2.25V to +3.63V, 20% to 80%, default derive strength
Input Low Voltage	V_{IL}	-	-	Vdd×0.3	V	Pin 1, OE or $\overline{ST}$
Input High Voltage	V_{IH}	Vdd×0.7	-	-	V	Pin 1, OE or $\overline{ST}$
OE Disable Current	I_oe	-	+5.0	+6.5	mA	f = 40 MHz, Vdd = +2.5V to +3.3V, OE = GND, Output in high-Z state
		-	+4.6	+5.2		f = 40 MHz, Vdd = +1.8V, OE = GND, Output in high-Z state
Enable/Disable Time	T_oe	-	-	180	ns	f = 40 MHz - For other frequencies, T_oe = 100ns + 3 period
Packing Unit	1000pcs./reel(φ180)					

Dimensions and Land Pattern

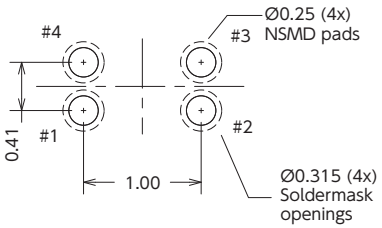
Package Size – Dimensions (unit:mm)	Recommended Land Pattern (unit:mm)

1.55 × 0.85 mm CSP



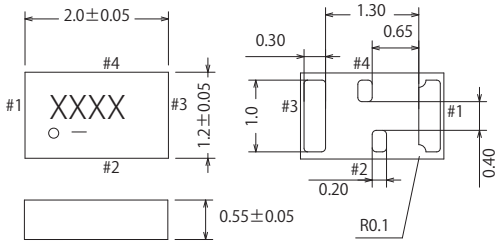
Pin Connections

Pin No.	Connection
#1	NC/ST/GND
#2	Output
#3	Vdd
#4	GND



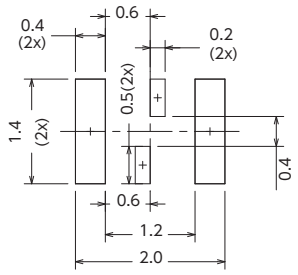
(soldermask openings shown with heavy dashed line)

2.0 × 1.2 mm QFN

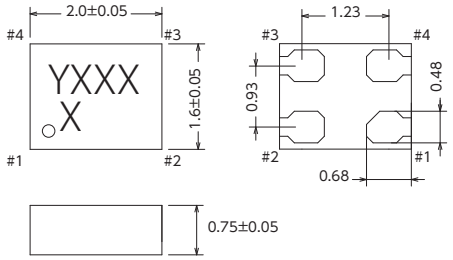


Pin Connections

Pin No.	Connection
#1	NC
#2	GND
#3	Output
#4	Vdd

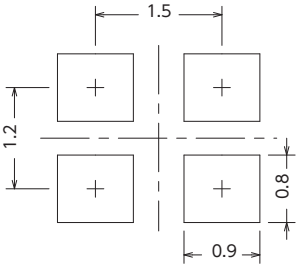


2.0 × 1.6 mm QFN

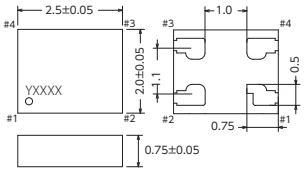


Pin Connections

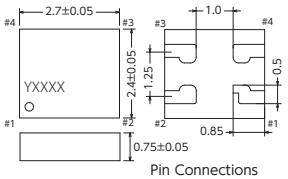
Pin No.	Connection
#1	OE/ST/NC/SD
#2	Output
#3	Vdd
#4	GND



2.5 × 2.0 mm QFN

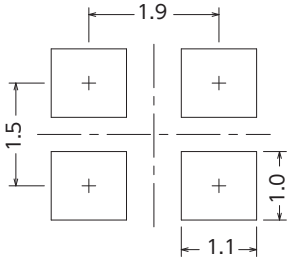


2.7 × 2.4 mm QFN

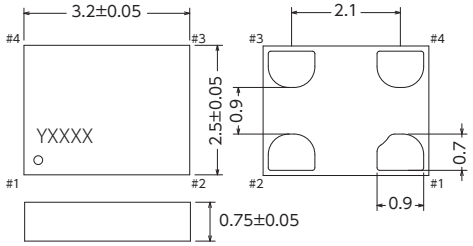


Pin Connections

Pin No.	Connection
#1	OE/ST/NC/VC/SD
#2	GND
#3	Output
#4	Vdd

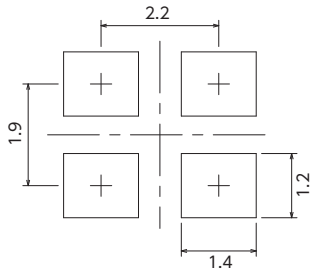


3.2 × 2.5 mm QFN (4-pin)

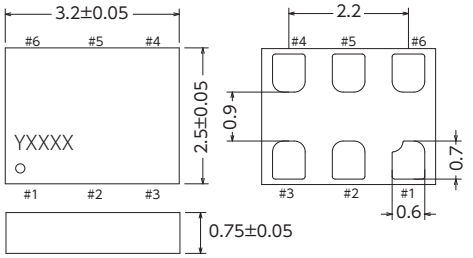


Pin Connections

Pin No.	Connection
#1	OE/ST/NC/VC/SD/DP
#2	GND
#3	Output
#4	Vdd

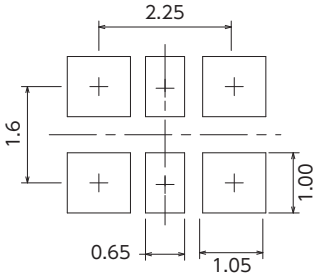


3.2 × 2.5 mm QFN (6-pin)



Pin Connections

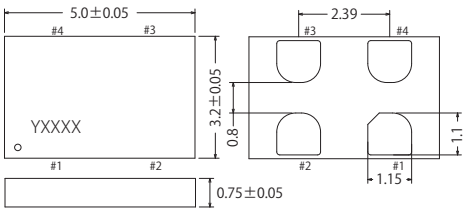
Pin No.	Connection
#1	OE/ST/NC/VC/SD/DP
#2	NC/OE
#3	GND
#4	Output+
#5	Output-
#6	Vdd



Dimensions and Land Pattern

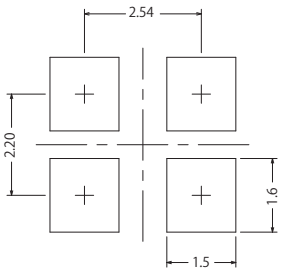
Package Size – Dimensions (unit:mm)	Recommended Land Pattern (unit:mm)

5.0 × 3.2 mm QFN (4-pin)

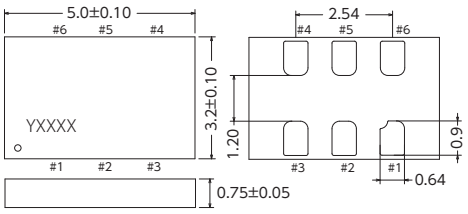


Pin Connections

Pin No.	Connection
#1	OE/ST/NC/SD
#2	GND
#3	Output
#4	Vdd

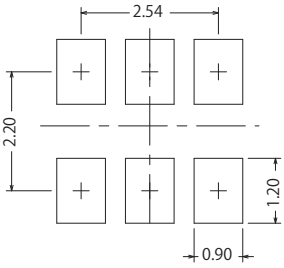


5.0 × 3.2 mm QFN (6-pin)

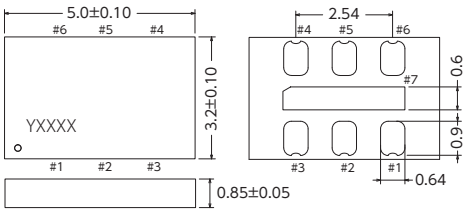


Pin Connections

Pin No.	Connection
#1	OE/ST/NC/VC/SD/DP
#2	NC/OE/ST
#3	GND
#4	Output+/Output
#5	Output-/NC-
#6	Vdd

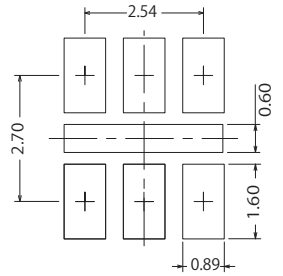


5.0 × 3.2 mm QFN (6-pin with center pad)

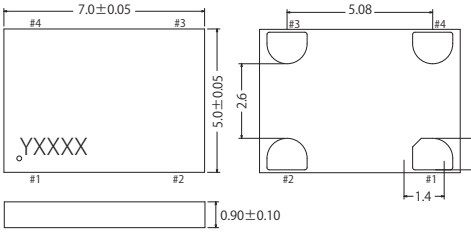


Pin Connections

Pin No.	Connection
#1	OE/NC/VC
#2	OE/NC
#3	GND
#4	Output+
#5	Output-
#6	Vdd
#7	GND

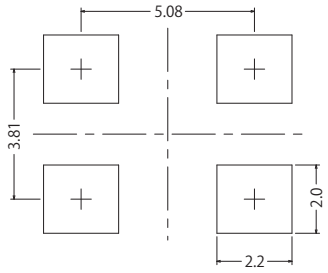


7.0 × 5.0 mm QFN (4-pin)

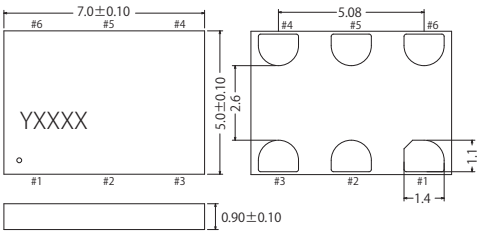


Pin Connections

Pin No.	Connection
#1	OE/ST/NC/SD
#2	GND
#3	Output
#4	Vdd

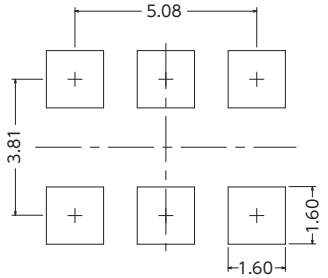


7.0 × 5.0 mm QFN (6-pin)

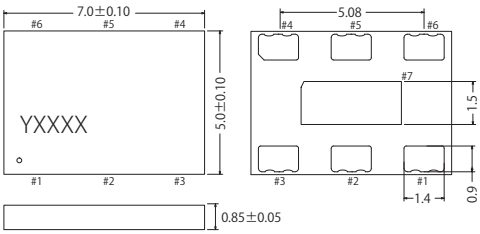


Pin Connections

Pin No.	Connection
#1	OE/ST/NC/VC/SD/DP
#2	NC/OE/ST
#3	GND
#4	Output+/Output
#5	Output-/NC
#6	Vdd

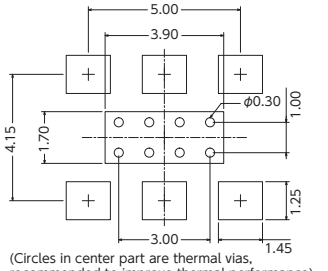


7.0 × 5.0 mm QFN (6-pin with center pad)



Pin Connections

Pin No.	Connection
#1	OE/NC/VC
#2	OE/NC
#3	GND
#4	Output+
#5	Output-
#6	Vdd
#7	GND

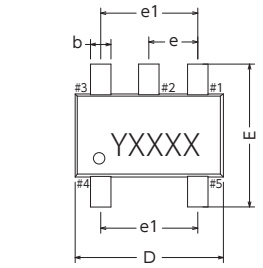


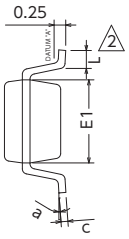
(Circles in center part are thermal vias, recommended to improve thermal performance)

Dimensions and Land Pattern

Package Size – Dimensions (unit:mm)	Recommended Land Pattern (unit:mm)

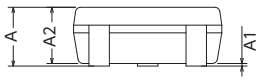
2.9 × 2.8 mm (SOT23-5)



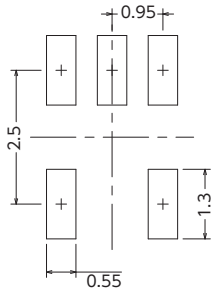


Pin Connections

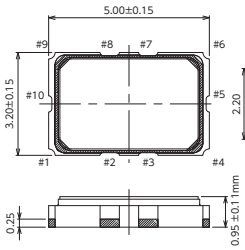
Pin No.	Connection
#1	GND
#2	NC
#3	OE/NC/ST
#4	Vdd
#5	Output

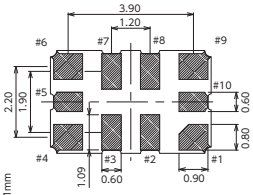


Symbol	Min.	Nom.	Max.
A	0.9	1.25	1.45
A1	0	0.05	0.15
A2	0.9	1.1	1.3
b	0.35	0.4	0.5
c	0.08	0.15	0.2
D	2.8	2.9	3
E	2.6	2.8	3
E1	1.5	1.625	1.75
L	0.35	0.45	0.6
L1	0.60 REF		
e	0.95 BSC.		
e1	1.90 BSC.		
α	0°	2.5°	8°



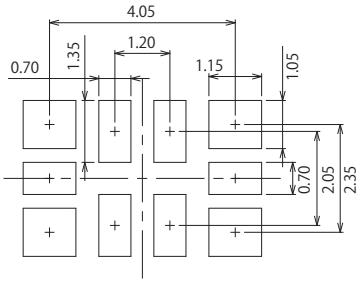
5.0 × 3.2 mm (Ceramic)



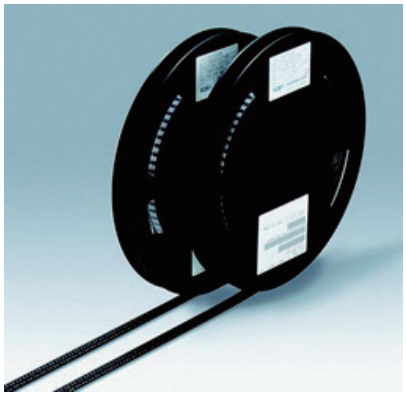


Pin Connections

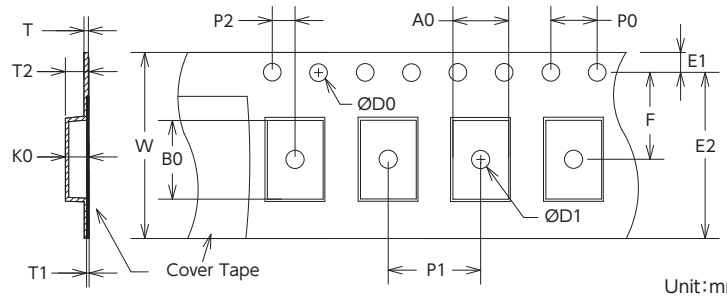
Pin No.	Connection
#1	OE/NC/VC
#2	NC
#3	NC
#4	GND
#5	NC
#6	#6 Output
#7	NC
#8	NC
#9	Vdd
#10	NC



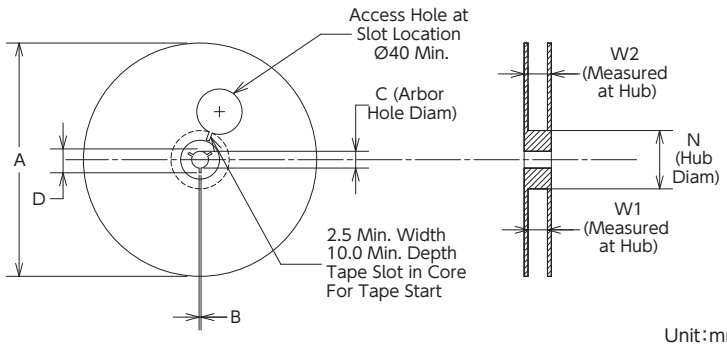
Emboss Carrier Tape (MEMS Oscillators)



<Tape>



<Reel>



■ Reel Standard Specification

Tape Size	A Max.	B Min.	C	D Min.	N	W1	W2 Max.
8	180	1.5	13.0 +0.6/-0.2	20.2	60 +0.5/-0.5	8.4 +1.5/-0	14.4
8	330	1.5	13.0 +0.2/-0.2	20.2	100 +0.5/-0.5	8.4 +1.5/-0	14.4
12	330	1.5	13.0 +0.2/-0.2	20.2	100 +0.5/-0.5	12.4 +2.0/-0	18.4
12	180	1.5	13.0 +0.2/-0.2	20.2	60 +0.5/-0.5	12.4 +2.0/-0	18.4
16	330	1.5	13.0 +0.2/-0.2	20.2	100 +0.5/-0.5	16.4 +2.0/-0	22.4
16	180	1.5	13.0 +0.2/-0.2	20.2	60 +0.5/-0.5	16.4 +2.0/-0	22.4

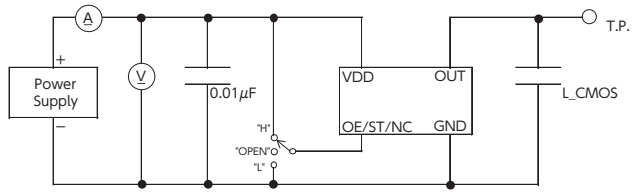
■ Carrier Tape Standard Specification

Package Outline Drawing	Package Size	Tape Size	D0	D1 Min.	E1	E2 Min.	F	P0	P1	P2	T	T1 Max.	T2 Max.	W Max.	A0	B0	K0
POD-1	2.5×2.0×0.75	12	1.5 +0.1/-0.0	1.5	1.75 ±0.1	10.25	5.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.6	0.1	1.65	12.3	2.3 ±0.10	2.8 ±0.10	1.10 ±0.10
POD-1	2.5×2.0×0.75	8	1.55 ±0.05	1.0	1.75 ±0.1	5.85	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.3 ±0.05	0.1	1.65	8.3	2.25 ±0.05	2.8 ±0.05	1.10 ±0.10
POD-23	2.7×2.4×0.75	12	1.55 ±0.05	1.0	1.75 ±0.1	9.85	5.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.3 ±0.05	0.1	1.55	12.3	2.65 ±0.10	2.95 ±0.10	1.00 ±0.10
POD-23	2.7×2.4×0.75	8	1.55 ±0.05	1.0	1.75 ±0.1	5.85	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.3 ±0.05	0.1	1.55	8.3	2.65 ±0.10	2.95 ±0.10	1.00 ±0.10
POD-2	3.2×2.5×0.75	12	1.5 +0.1/-0.0	1.5	1.75 ±0.1	10.25	5.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.6	0.1	1.65	12.3	2.8 ±0.10	3.5 ±0.10	1.10 ±0.10
POD-2	3.2×2.5×0.75	8	1.5 +0.1/-0.0	1.0	1.75 ±0.1	5.95	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.2 ±0.05	0.1	1.65	8.2	2.7 ±0.10	3.4 ±0.10	1.15 ±0.10
POD-3	5.0×3.2×0.75	12	1.5 +0.1/-0.0	1.5	1.75 ±0.1	10.25	5.5 ±0.05	4.0 ±0.1	8.0 ±0.1	2.0 ±0.05	0.6	0.1	1.65	12.3	3.5 ±0.10	5.3 ±0.10	1.10 ±0.10
POD-4	7.0×5.0×0.90	16	1.5 +0.1/-0.0	1.5	1.75 ±0.1	14.25	7.5 ±0.10	4.0 ±0.1	8.0 ±0.1	2.0 ±0.10	0.6	0.1	1.80	16.3	5.4 ±0.10	7.4 ±0.10	1.3 ±0.10
POD-9	3.5×3.0×0.30	12	1.5 +0.1/-0.0	1.5	1.75 ±0.1	10.25	5.5 ±0.05	4.0 ±0.1	8.0 ±0.1	2.0 ±0.05	0.6	0.1	1.65	12.3	3.3 ±0.10	3.8 ±0.10	0.65 ±0.10
POD-26	2.0×1.6×0.75	8	1.55 ±0.05	0.9	1.75 ±0.1	6.05	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.3 ±0.05	0.1	1.55	8.3	1.9 ±0.05	2.3 ±0.05	1.00 ±0.10
POD-29	2.0×1.2×0.60	8	1.55 ±0.05	1.0	1.75 ±0.1	6.05	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.25 ±0.05	0.1	1.55	8.3	1.9 ±0.05	2.3 ±0.05	1.00 ±0.10
POD-32	1.5×0.8×0.60	8	1.55 ±0.05	0.18	1.75 ±0.1	6.05	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.2 ±0.02	0.1	1.55	8.3	0.96 ±0.03	1.66 ±0.03	0.63 ±0.03
SOT-23	2.8×1.6×1.45	8	1.55 ±0.05	1.0	1.75 ±0.1	6.05	3.5 ±0.05	4.0 ±0.1	4.0 ±0.1	2.0 ±0.05	0.25 ±0.02	0.1	1.62	8.3	3.23 ±0.10	3.17 ±0.10	1.37 ±0.10

Refer to datasheet for details of emboss carrier tape specifications.

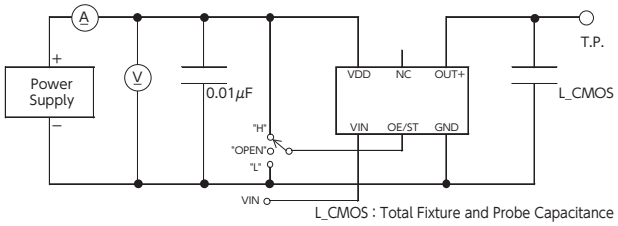
Measurement Circuit (MEMS Oscillators)

CMOS



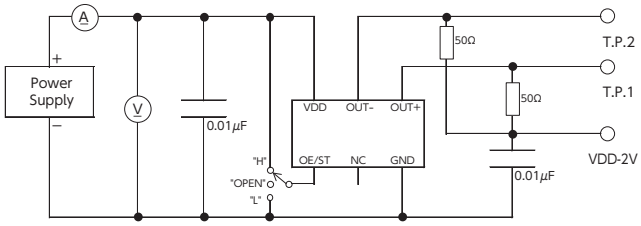
L_CMOS: Total Fixture and Probe Capacitance

CMOS (VCMO)

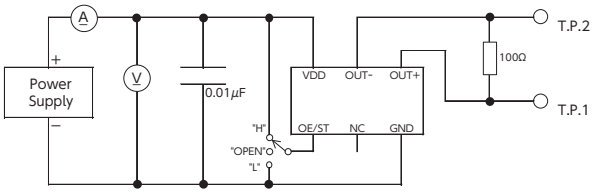


L_CMOS : Total Fixture and Probe Capacitance

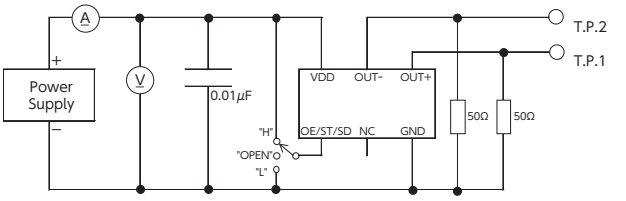
LVPECL



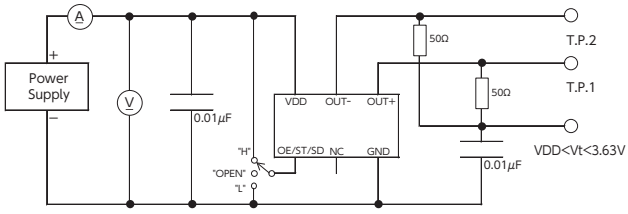
LVDS



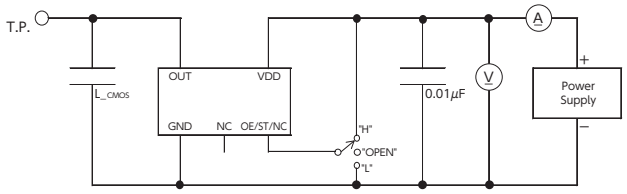
HCSL



CML

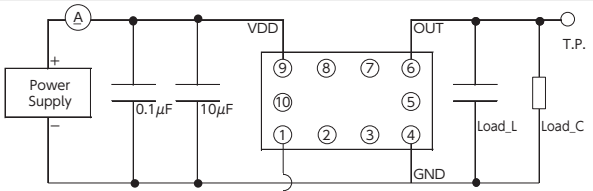


2.9 × 2.8 mm (SOT23-5)



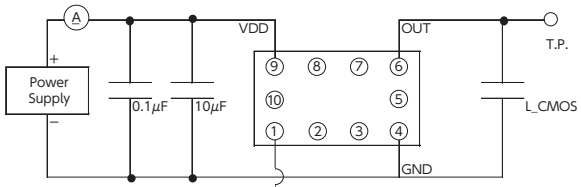
L_CMOS : Total Fixture and Probe Capacitance

5.0 × 3.2 mm (Ceramic) - Clipped Sine



Load_L : Total Fixture and Probe Capacitance
Load_C : Total Fixture and Probe Resistance

5.0 × 3.2 mm (Ceramic) - CMOS



L_CMOS : Total Fixture and Probe Capacitance