Silicon Timing Devices
MEMS oscillators

KDS
DAISHINKU CORP.
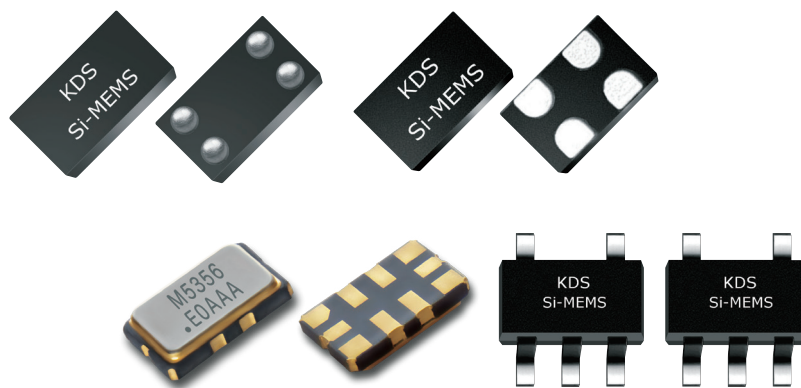
32 kHz MEMS Oscillators / 32 kHz TC-MO - µPower

MO1532/MO1552/MO1630/MO1566/MO1568
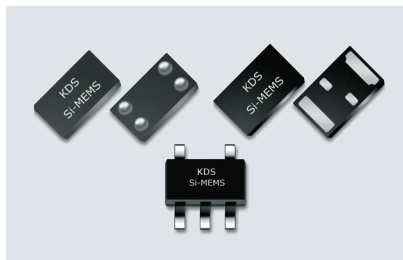
■ Features
- Fixed 32.768 kHz
- Ultra-low power
- Internal filtering eliminates external Vdd bypass cap

■ 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
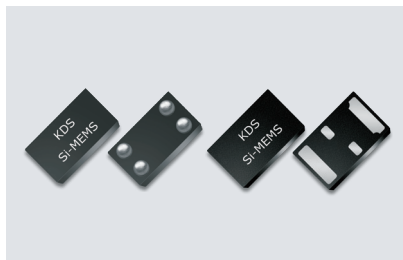
■ Features
● Ultra-low power
● Internal filtering eliminates external Vdd bypass cap

■ Applications
● Tablets, Wearable, Portable audio
● Health and wellness monitors, Fitness bands
● IoT devices
● Input devices

Model	Output Frequency (kHz)	Frequency Tolerance (×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 2.5 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	×10⁻⁶	Frequency offset at +25℃ post reflow
Frequency Tolerance	F_stab	–100	–	+100	×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	×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
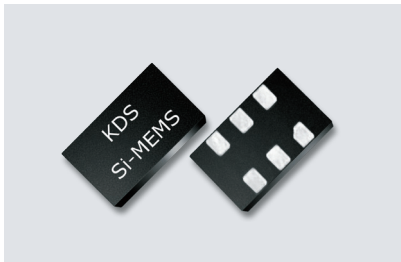
■ Features
● Industry-Standard packages: 3.2×2.5 mm, 5.0×3.2 mm, 7.0×5.0 mm
● Output signaling types: LVPECL, LVDS, HCSL
● Frequency tolerance as low as ±10×10^{-6}
● 0.1 ps RMS phase jitter (random) for Ethernet applications

■ 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	⊿V_{OD}	–	–	+50	mV	
Offset Voltage	V_{OS}	+1.125	–	+1.375	V	
V_{OS} Magnitude Change	⊿V_{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℃ and -40 to +85ºC

MEMS Oscillators - Low Jitter

MO9120/MO9121/MO9122/MO8208/MO8209
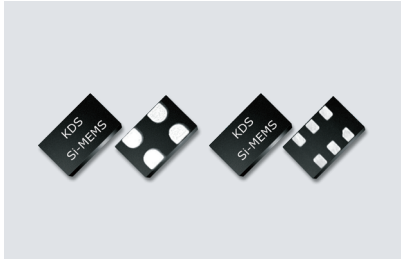
■ Features
- Frequency tolerance as low as $\pm 10 \times 10^{-6}$
- Ultra-Low phase Jitter

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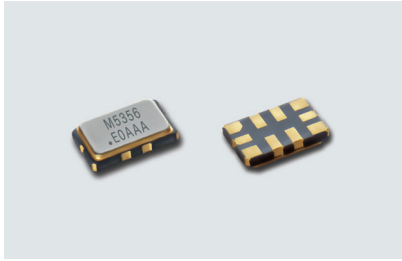- SATA, SAS, Ethernet, PCI Express, video, WiFi

Pb-Free

RoHS Compliant

Model	Output Frequency (MHz)	Frequency Tolerance ($\times 10^{-6}$)	Supply Voltage (V)	Current Consumption (mA Typ.)	Size (mm)	Output
MO9120	25 to 212.5				$3.2 \times 2.5 \times 0.8$, $5.0 \times 3.2 \times 0.8$, $7.0 \times 5.0 \times 1.0$ (QFN)	LVPECL LVDS
MO9121	1 to 220	$\pm 10, \pm 20, \pm 25, \pm 50$	+2.25 to +3.63	+54 to +69		
MO9122	220 to 625					
MO8208	1 to 80			+29 to +36 ($+10\,\mu A$ stby)	$2.7 \times 2.4 \times 0.8$, $3.2 \times 2.5 \times 0.8$, $5.0 \times 3.2 \times 0.8$, $7.0 \times 5.0 \times 1.0$ (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	V_{dd}	+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	$\times 10^{-6}$	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	$\times 10^{-6}$	$T_A = +25$℃
10-year Aging	F_aging10	–5.0	–	+5.0		$T_A = +25$℃
Duty Cycle	DC	45	–	55	%	
Input Low Voltage	V_{IL}	–	–	$V_{dd} \times 0.3$	V	Pin 1, OE or $\overline{ST}$
Input High Voltage	V_{IH}	$V_{dd} \times 0.7$	–	–	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	$\varDelta V_{OD}$	–	–	+50	mV	
Offset Voltage	V_{OS}	+1.125	+1.2	+1.375	V	
V_{OS} Magnitude Change	$\varDelta V_{OS}$	–	–	+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)

MO9005
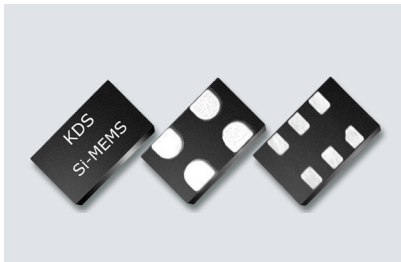
■ Features
- Spread options
  Center Spread: ±0.5%, ±0.25%
  Down Spread: –1%, –0.5%
- Standby, output enable or spread disable mode
- <30 ps cycle-to-cycle jitter

■ Applications
- Printers
- Flat panel drivers
- PCI
- Microprocessors

Output Frequency (MHz)	Frequency Tolerance ($\times 10^{-6}$)	Supply Voltage (V)	Current Consumption (mA Typ.)	Size (mm)	Output
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)	LVCMOS

■ Standard Specification

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

1.54±0.02
0.84±0.02
YX XXX
Polymer cooting
0.040
0.60MAX
0.315±0.015
0.41 BSC
BSC 1.00

Pin Connections

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

Ø0.25 (4x)
#3 NSMD pads
0.41
1.00
Ø0.315 (4x)
Soldermask openings
(soldermask openings shown with heavy dashed line)

2.0 × 1.2 mm QFN

2.0±0.05
1.2±0.05
XXXX
1.30
0.30
0.65
1.0
0.40
0.20
R0.1
0.55±0.05

Pin Connections

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

0.4 (2x)
0.6
0.2 (2x)
1.4 (2x)
0.5(2x)
0.4
0.6
1.2
2.0

2.0 × 1.6 mm QFN

2.0±0.05
1.6±0.05
YXXX X
1.23
0.93
0.48
0.68
0.75±0.05

Pin Connections

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

1.5
1.2
0.8
0.9

2.5 × 2.0 mm QFN   2.7 × 2.4 mm QFN

2.5±0.05
2.0±0.05
YXXXX
1.0
1.1
0.5
0.75
0.75±0.05

2.7±0.05
2.4±0.05
YXXXX
1.0
1.25
0.5
0.85
0.75±0.05

Pin Connections

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

1.9
1.5
1.0
1.1

3.2 × 2.5 mm QFN (4-pin)

3.2±0.05
2.5±0.05
YXXXX
2.1
0.9
0.7
0.9
0.75±0.05

Pin Connections

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

2.2
1.9
1.2
1.4

3.2 × 2.5 mm QFN (6-pin)

3.2±0.05
2.5±0.05
YXXXX
2.2
0.9
0.7
0.6
0.75±0.05

Pin Connections

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

2.25
1.6
1.00
0.65
1.05

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/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＞

Unit：mm

＜Reel＞

Access Hole at Slot Location Ø40 Min.

C (Arbor Hole Diam)

2.5 Min. Width 10.0 Min. Depth Tape Slot in Core For Tape Start

W2 (Measured at Hub)

N (Hub Diam)

W1 (Measured at Hub)

Unit：mm
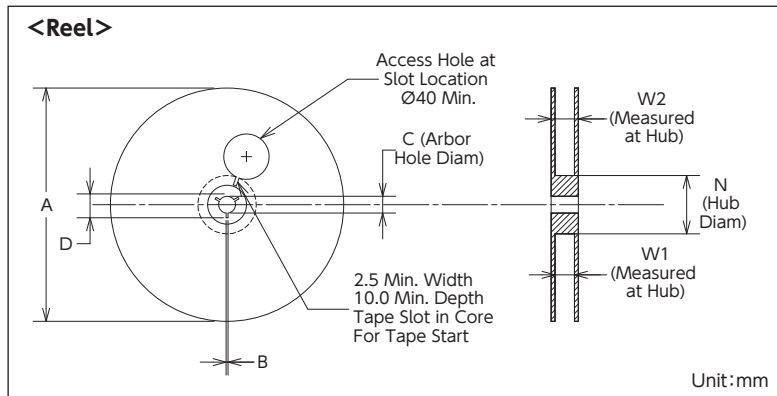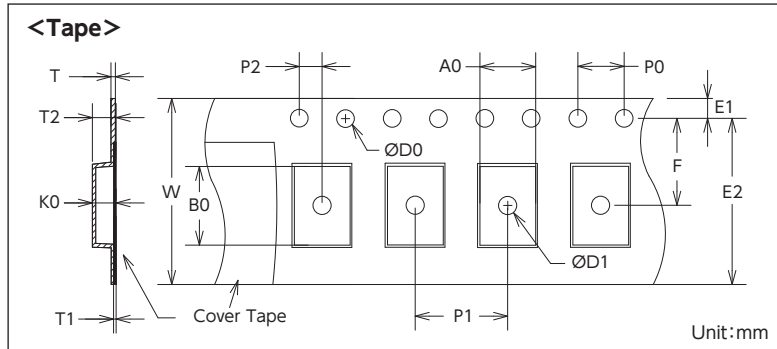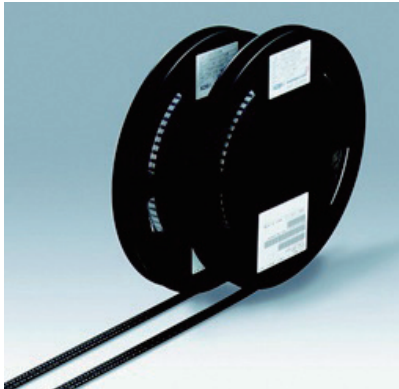
■ Reel Standard Specification

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 ±0.05	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

Power Supply

$0.01\mu F$

VDD OUT

OE/ST/NC GND

"H"
"OPEN"
"L"

T.P.

L_CMOS

L_CMOS : Total Fixture and Probe Capacitance

CMOS (VCMO)

Power Supply

$0.01\mu F$

VDD NC OUT+

VIN OE/ST GND

"H"
"OPEN"
"L"

VIN

T.P.

L_CMOS

L_CMOS : Total Fixture and Probe Capacitance

LVPECL

Power Supply

$0.01\mu F$

VDD OUT- OUT+

OE/ST NC GND

"H"
"OPEN"
"L"

50Ω

50Ω

$0.01\mu F$

T.P.2

T.P.1

VDD-2V

LVDS

Power Supply

$0.01\mu F$

VDD OUT- OUT+

OE/ST NC GND

"H"
"OPEN"
"L"

100Ω

T.P.2

T.P.1

HCSL

Power Supply

$0.01\mu F$

VDD OUT- OUT+

OE/ST/SD NC GND

"H"
"OPEN"
"L"

50Ω 50Ω

T.P.2

T.P.1

CML

Power Supply

$0.01\mu F$

VDD OUT- OUT+

OE/ST/SD NC GND

"H"
"OPEN"
"L"

50Ω

50Ω

$0.01\mu F$

T.P.2

T.P.1

VDD<Vt<3.63V

2.9 × 2.8 mm (SOT23-5)

T.P.

L_CMOS

OUT VDD

GND NC OE/ST/NC

"H"
"OPEN"
"L"

$0.01\mu F$

Power Supply

L_CMOS : Total Fixture and Probe Capacitance

5.0 × 3.2 mm (Ceramic) - Clipped Sine

Power Supply

$0.1\mu F$ $10\mu F$

VDD OUT

⑨ ⑧ ⑦ ⑥
⑩ ⑤
① ② ③ ④

GND

NC/VC/OE

T.P.

Load_L Load_C

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

5.0 × 3.2 mm (Ceramic) - CMOS

Power Supply

$0.1\mu F$ $10\mu F$

VDD OUT

⑨ ⑧ ⑦ ⑥
⑩ ⑤
① ② ③ ④

GND

NC/VC/OE

T.P.

L_CMOS

L_CMOS : Total Fixture and Probe Capacitance