

Application Manual

MCSO2L

LVDS Clock Oscillator 40 MHz – 130 MHz

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MCSO2L

Clock Oscillator 40 MHz – 130 MHz

1. OVERVIEW

- Oscillator with built-in AT-cut crystal, operating in fundamental mode
- Overall frequency stability over temperature range: $\leq \pm 50$ ppm or $\leq \pm 100$ ppm
- Very fast start-up: typ. 1 ms at 25°C
- Low-Voltage Differential Signaling (LVDS) output (100 Ω differential load)
- High shock and vibration resistance
- Operating voltage: 2.5 V or 3.3 V
- Power consumption at $F \leq 100$ MHz:
 - < 10 mA at $V_{DD} = 2.5$ V
 - < 15 mA at $V_{DD} = 3.3$ V
- Operating temperature range:
 - A = 0 to +70°C
 - B = -40 to +85°C
 - C = -55 to +125°C
 - X = Custom
- Enable/Disable function (option 1):
 - Standby current $I_{DD} < 10$ μ A
- Low aging rate
- Ceramic SMD package (5.0 x 3.2 mm), RoHS-compliant and 100% lead-free

1.1. GENERAL DESCRIPTION

The MCSO2L combines a High Frequency HCMOS oscillator circuitry with LVDS output together with an AT-cut quartz crystal in a hermetically sealed ceramic package with ceramic or metal lid. The only external component required is a 100 Ω differential load.

The frequency output 40 MHz – 130 MHz on F_{OUT} / $\overline{F_{OUT}}$ pins can be enabled / disabled by the E/D pin (option 1). The F_{OUT} / $\overline{F_{OUT}}$ frequency is enabled when E/D pin is connected to V_{DD} or when it is left open (not connected). When the E/D pin is tied to GND the frequency is disabled and the pins F_{OUT} and $\overline{F_{OUT}}$ are in high impedance state (Hi-Z).

1.2. APPLICATIONS

The MCSO2L clock oscillator module combines outstanding performance and robustness in a standard ceramic package:

- Oscillator module (embedded XTAL) in a standard 5.0 x 3.2 mm lead-free ceramic package
- High shock and vibration resistant

The robust construction and high performances make this product perfectly suitable for many high reliability applications:

- Avionics / Aerospace: Airborne Equipment / Engine Control / Actuator Controller / Temperature Controller / Instrumentation / Navigation and Guidance Systems
- Instrumentation: Field Test Instrument / Automotive Test Equipment
- Communication: Optical Network / Wireless Communication System
- Security / Safety: Survival and Protection System / Railway Security System / Fire Fighter Equipment
- Industrial: Telemetry / A/C Controller / Hydraulic Sensor

1.3. ORDERING INFORMATION

Example: MCSO2L K V T – C 100.000 MHz E/D T3 XXX

Code	Package Size
MCSO2L	5.0 x 3.2 mm

Code	Lid
K	Kovar lid
Blank	Ceramic lid

Code	Supply voltage
W	$V_{DD} = 2.5 V$
V	$V_{DD} = 3.3 V$

Code	Frequency stability
T	± 50 ppm
Blank	± 100 ppm

Code	Temperature range
A	0 to +70°C
B	-40 to +85°C
C	-55 to +125°C
X	Custom

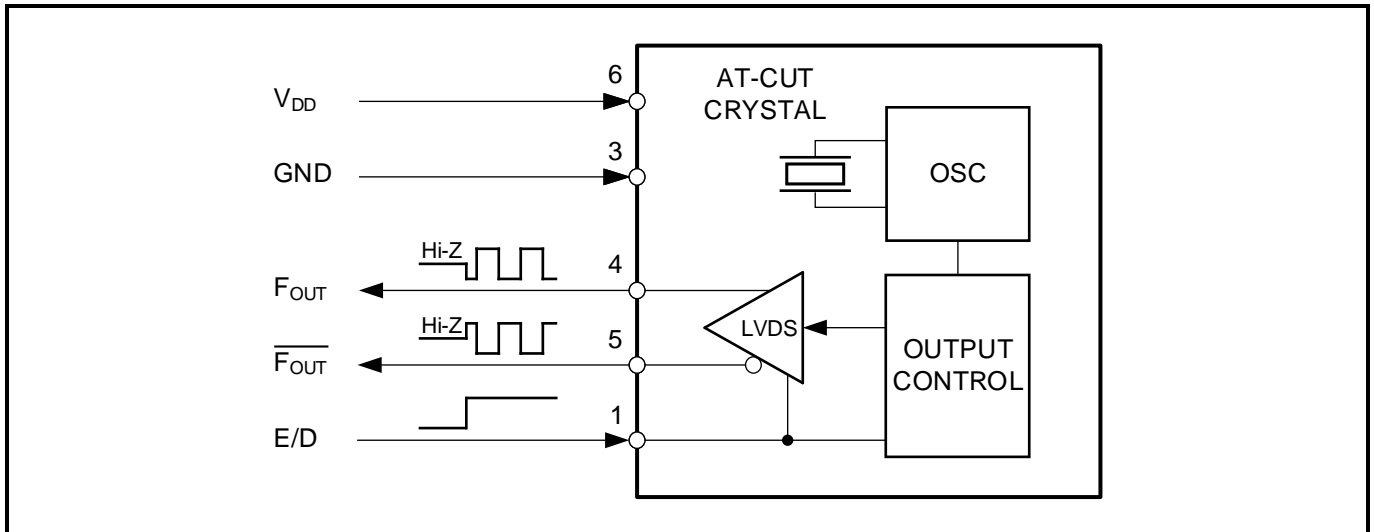
Code	Frequency
100.000 MHz	100.000 MHz

Code	Option 1
E/D	Enable/Disable
Blank	No function

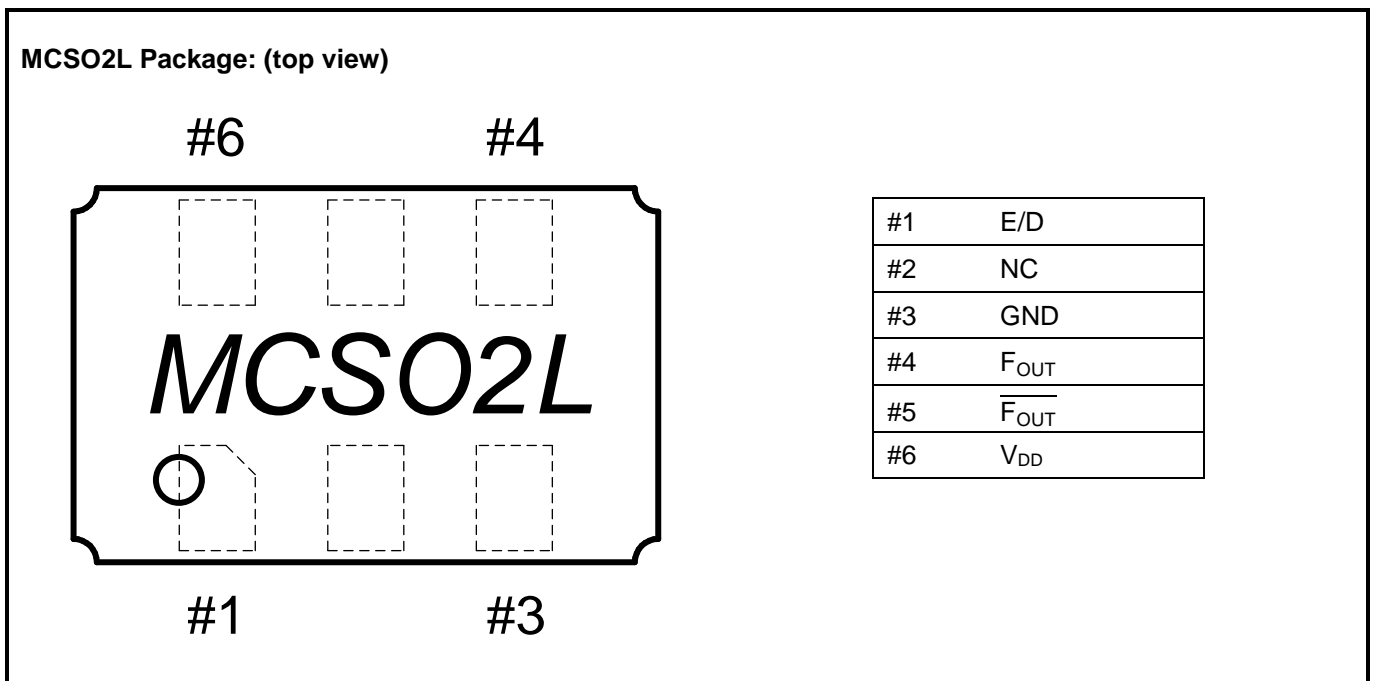
Code	Option 2
T3	SnAgCu solder dipped pads
Blank	Au flashed pads

Code	Customer specification N°
XXX	XXX

2. BLOCK DIAGRAM



2.1. PINOUT



2.2. PIN DESCRIPTION

Symbol	Pin #	Description
E/D	1	Input to enable/disable the F_{OUT} / $\overline{F_{OUT}}$ pins (option 1). If E/D is HIGH or floating (V_{IH} or open), the F_{OUT} / $\overline{F_{OUT}}$ pins are in output mode. When E/D is tied to Ground (V_{IL}), the F_{OUT} and $\overline{F_{OUT}}$ pins are disabled (Hi-Z).
NC	2	Not connected.
GND	3	Ground.
F_{OUT}	4	LVDS Clock Output; three-state; controlled by E/D. Typically loaded with 100 Ω receiver termination resistor across differential pair. If E/D is HIGH (V_{DD}) or floating, the F_{OUT} / $\overline{F_{OUT}}$ pins drive the square wave of the frequency. When E/D is tied to Ground, the F_{OUT} pin is disabled (Hi-Z).
$\overline{F_{OUT}}$	5	Complementary LVDS Clock Output; three-state; controlled by E/D. Typically loaded with 100 Ω receiver termination resistor across differential pair. If E/D is HIGH (V_{DD}) or floating, the F_{OUT} / $\overline{F_{OUT}}$ pins drive the square wave of the frequency. When E/D is tied to Ground, the $\overline{F_{OUT}}$ pin is disabled (Hi-Z).
V_{DD}	6	Power Supply Voltage.

3. ELECTRICAL SPECIFICATIONS

3.1. ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings according to IEC 60134:

SYMBOL	PARAMETER	CONDITIONS	MIN	MAX	UNIT
V _{DD}	Power supply voltage	Nominal V _{DD} = 2.5 V	-0.3	3	V
		Nominal V _{DD} = 3.3 V	-0.3	3.8	
V _I	Input voltage		-0.3	V _{DD}	V
V _O	Output voltage		-0.3	V _{DD}	V
V _{ESD}	ESD voltage	HBM (1)		±2000	V
		MM (2)		±200	
T _A	Operating temperature range A		0	70	°C
T _B	Operating temperature range B		-40	85	°C
T _C	Operating temperature range C		-55	125	°C
T _{STO}	Storage temperature	Stored as bare product	-65	125	°C
T _{PEAK}	Maximum reflow condition	JEDEC J-STD-020C		265	°C

(1) HBM: Human Body Model, according to JESD22-A114.
(2) MM: Machine Model, according to JESD22-A115.

3.2. OPERATING PARAMETERS

For this Table, V_{DD} = nominal voltage; $GND = 0\text{ V}$; $T_A = 25\text{ °C}$; unless otherwise indicated.

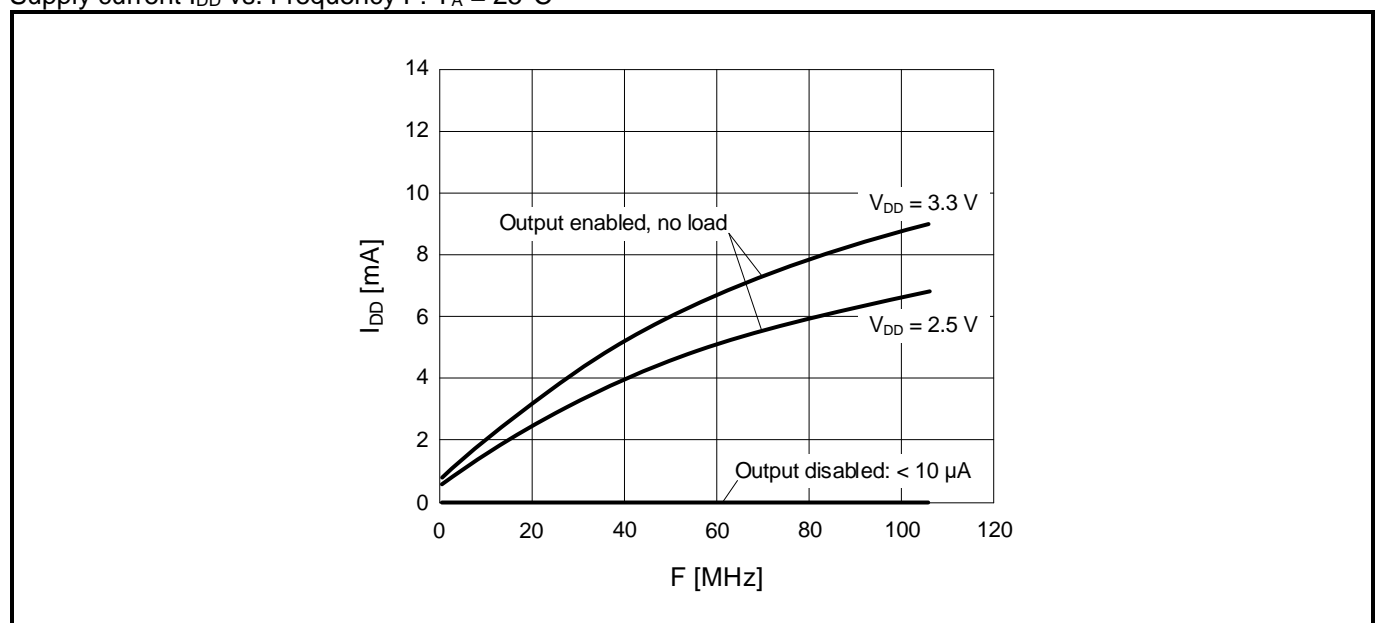
Operating Parameters:

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Supply						
V_{DD}	Power supply voltage (1)	Nominal $V_{DD} = 2.5\text{ V}$	2.375		2.625	V
		Nominal $V_{DD} = 3.3\text{ V}$	3.135		3.465	
I_{DD}	Input current. $V_{DD} = 2.5\text{ V}$, output enabled, no load	$F = 40\text{ MHz}$			5	mA
		$40\text{ MHz} < F \leq 100\text{ MHz}$			10	
		$100\text{ MHz} < F \leq 130\text{ MHz}$			20	
	Input current. $V_{DD} = 3.3\text{ V}$, output enabled, no load	$F = 40\text{ MHz}$			10	
		$40\text{ MHz} < F \leq 100\text{ MHz}$			15	
		$100\text{ MHz} < F \leq 130\text{ MHz}$			25	
I_{DDDD}	Standby current. Input current. Output disabled	$E/D \leq 0.3\text{ V}$			10	μA
Input E/D						
V_I	Input voltage		GND -0.3		$V_{DD} + 0.3$	V
V_{IL}	LOW level input voltage		GND		$0.3 V_{DD}$	V
V_{IH}	HIGH level input voltage		$0.7 V_{DD}$		V_{DD}	V
I_{IL}	LOW level input current	E/D pin, $V_{IL} = 0.0\text{ V}$		-10		μA
t	Reaction time				5	ms
Output $F_{OUT} / \overline{F_{OUT}}$ (LVDS)						
V_{OH}	HIGH level output voltage	$R_L = 100\ \Omega$, $E/D \geq (V_{DD} - 0.3\text{ V})$,		1.4	1.6	V
V_{OL}	LOW level output voltage	$F_{OUT} / \overline{F_{OUT}}$	0.9	1.1		V
V_{OD}	Differential voltage	$R_L = 100\ \Omega$, $E/D \geq (V_{DD} - 0.3\text{ V})$,	250	330	450	mV
ΔV_{OD}	Differential voltage deviation	$F_{OUT} / \overline{F_{OUT}}$ differential			50	mV
V_{OS}	Offset voltage	$R_L = 100\ \Omega$ (between $F_{OUT} / \overline{F_{OUT}}$	1.125	1.25	1.375	V
ΔV_{OS}	Offset voltage deviation	$\overline{F_{OUT}}$ to GND), $E/D = \text{open}$			50	mV
I_z	Output leakage current	$E/D \leq 0.3\text{ V}$, $F_{OUT} / \overline{F_{OUT}}$			10	μA
t_r / t_f	Rise & fall time	$0.2 V_{OPP}$ to $0.8 V_{OPP}$			1	ns

(1) A 47 nF decoupling capacitor has to be connected between V_{DD} and GND.

3.3. TYPICAL CHARACTERISTICS

Supply current I_{DD} vs. Frequency F : $T_A = 25\text{ °C}$



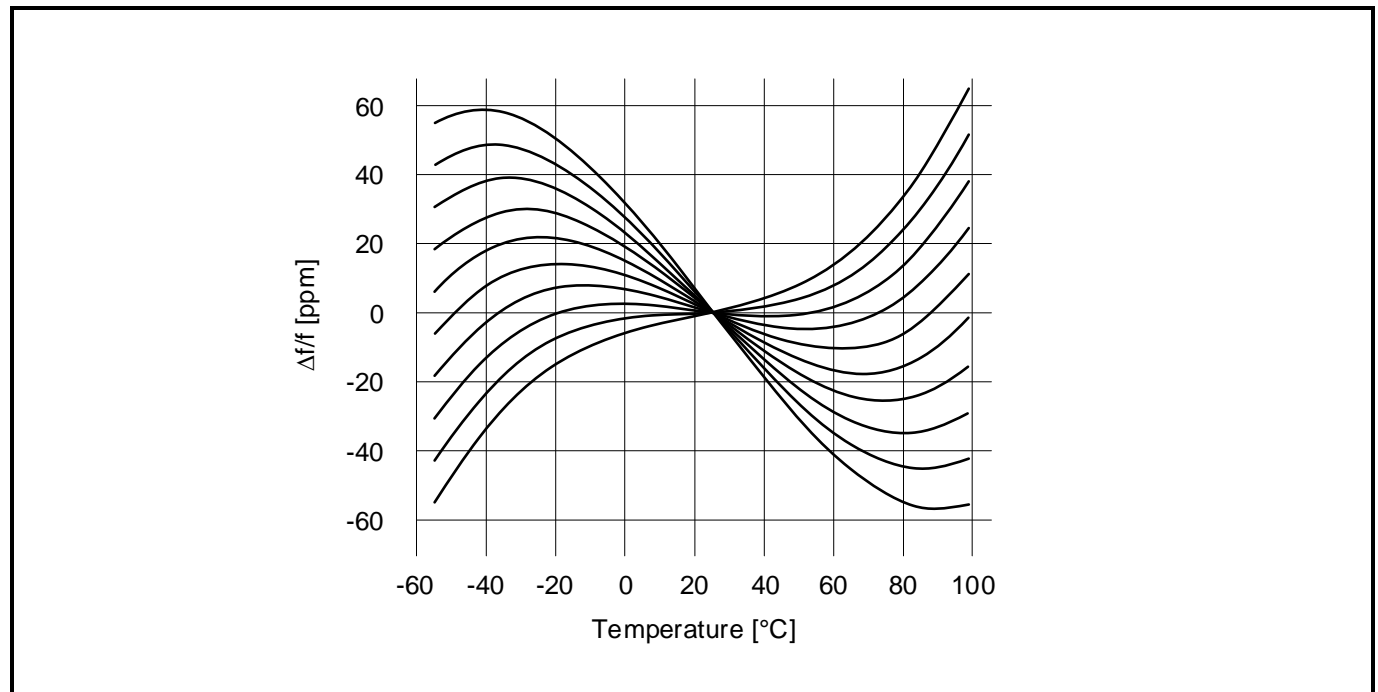
3.4. OSCILLATOR PARAMETERS

For this Table, V_{DD} = nominal voltage; $GND = 0\text{ V}$; $T_A = 25\text{ °C}$; unless otherwise indicated.

Oscillator Parameters:

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
General						
F	Frequency range		40		130	MHz
t_{START}	Oscillator start-up time			1	5	ms
δ_{OUT}	Output duty cycle @ $V_{OPP}/2$		45		55	%
V_{OPP}	Output swing (2 V_{OD})	$F_{OUT} / \overline{F_{OUT}}$ differential	0.5			V
Frequency Characteristics						
$\Delta F/F$	Overall frequency stability over temperature range (see ORDERING INFORMATION) Standard version (1) T version (2)	Including adjustment at +25°C and V_{DD} variations ±5%			±100 ±50	ppm
t_{RMS}	One-sigma jitter	BW = 1 kHz to 1 MHz			0.3	ps RMS
	Phase noise	Typical at 100 MHz, static conditions, BW = 1 Hz 10 Hz 100 Hz 1 kHz 10 kHz 100 kHz		-70 -100 -125 -145 -150		dBc/Hz
(1) Including long term aging 10 years.						
(2) Including long term aging 1 year.						

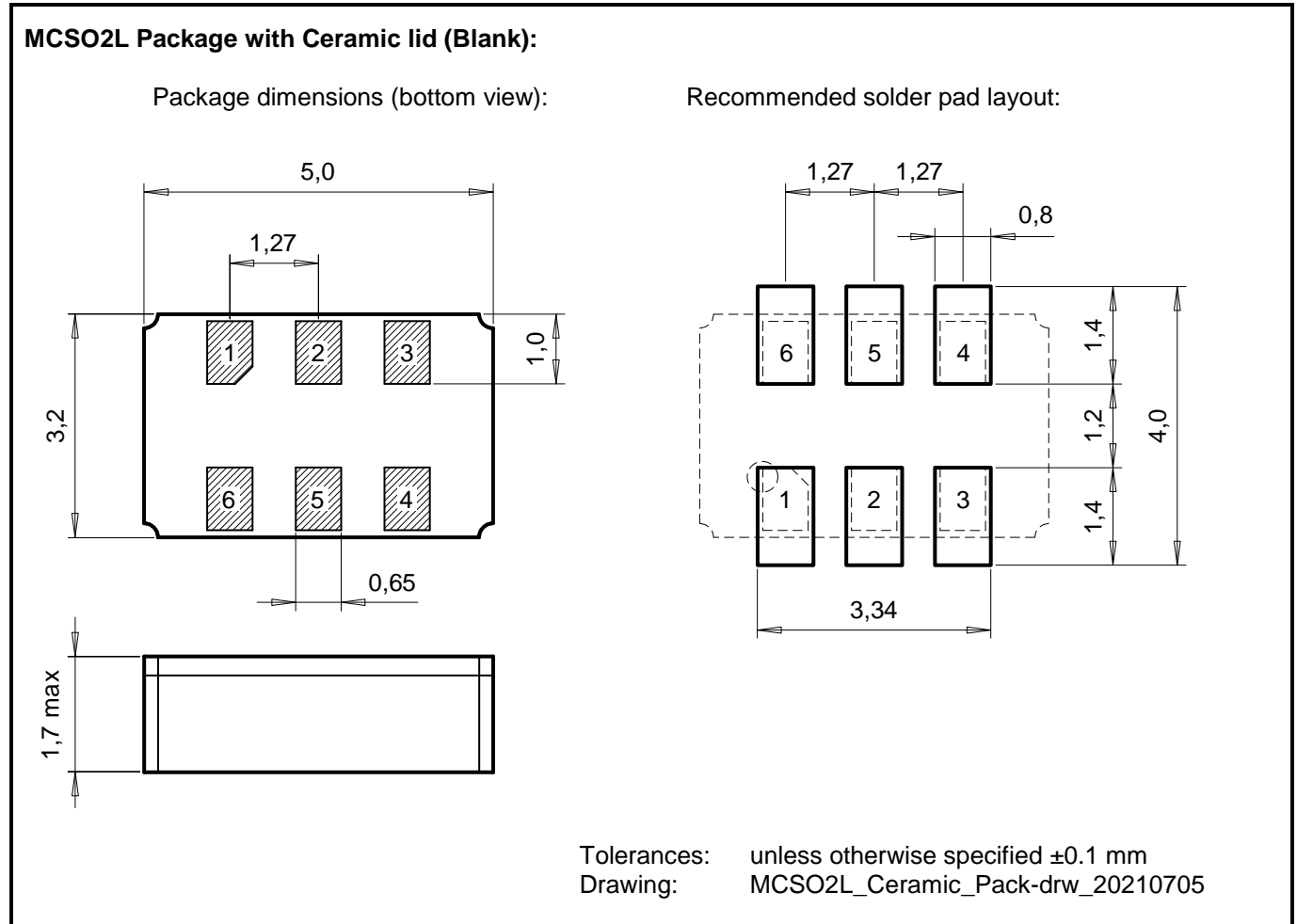
3.4.1.FREQUENCY VS. TEMPERATURE CHARACTERISTICS



4. PACKAGE

4.1. DIMENSIONS AND SOLDER PAD LAYOUT

4.1.1. PACKAGE WITH CERAMIC LID

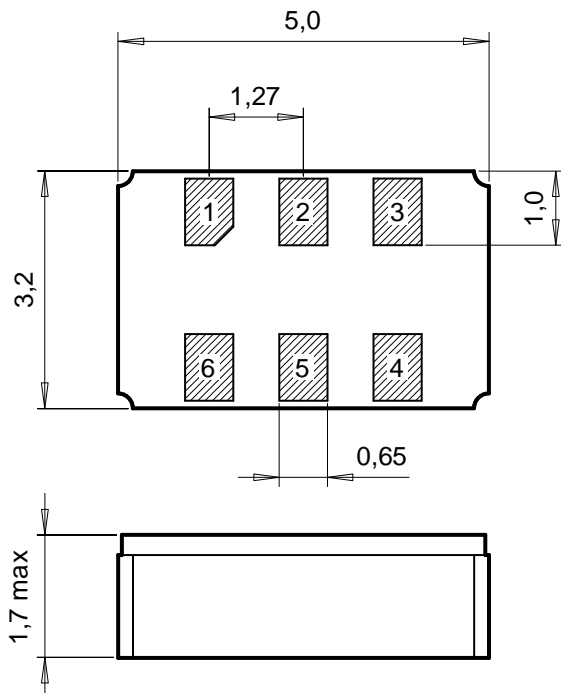


All dimensions in mm typical.

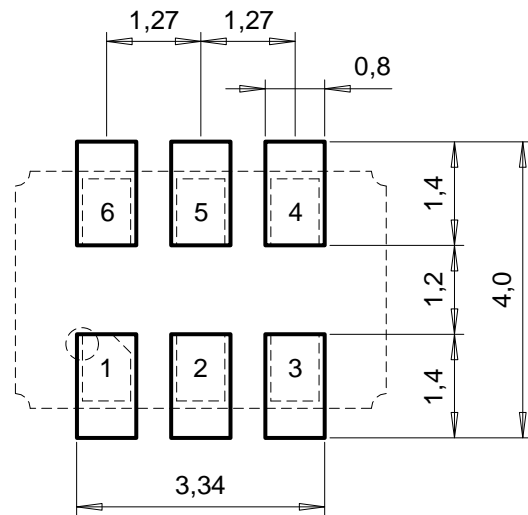
4.1.2. PACKAGE WITH METAL LID

MCSO2L Package with Metal lid (K):

Package dimensions (bottom view):



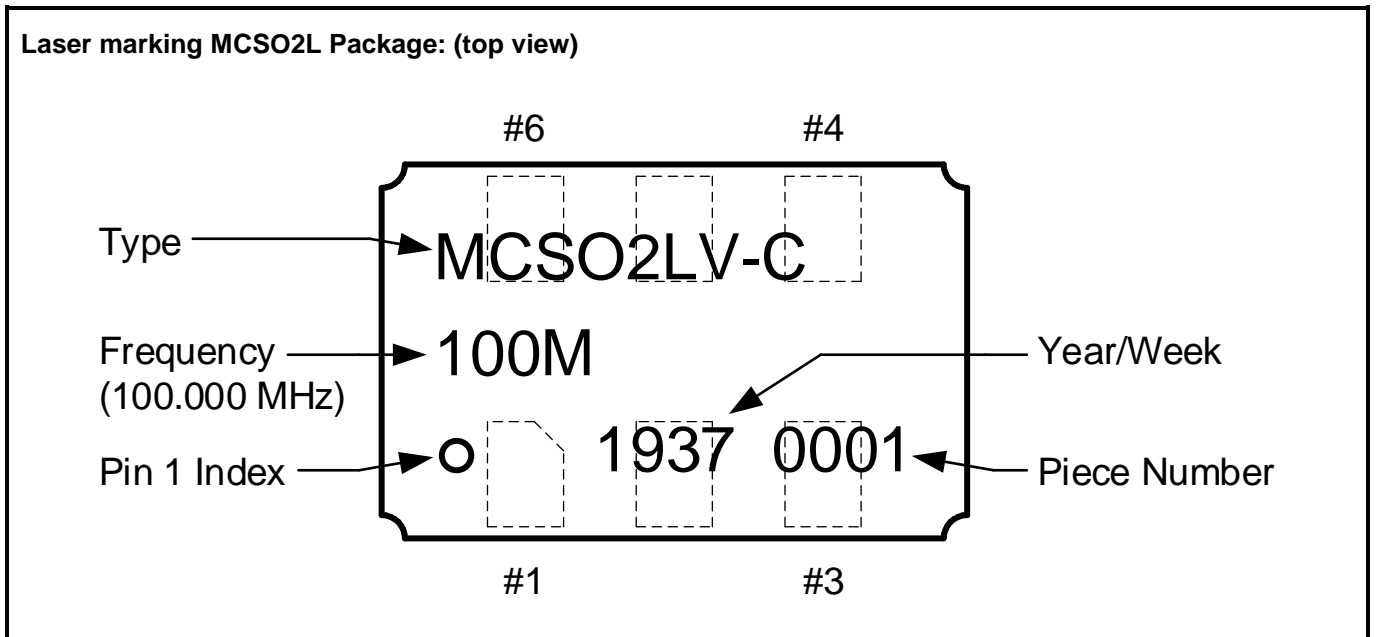
Recommended solder pad layout:



Tolerances: unless otherwise specified ± 0.1 mm
 Drawing: MCSO2L_Metal_Pack-drw_20210705

All dimensions in mm typical.

4.2. MARKING AND PIN #1 INDEX

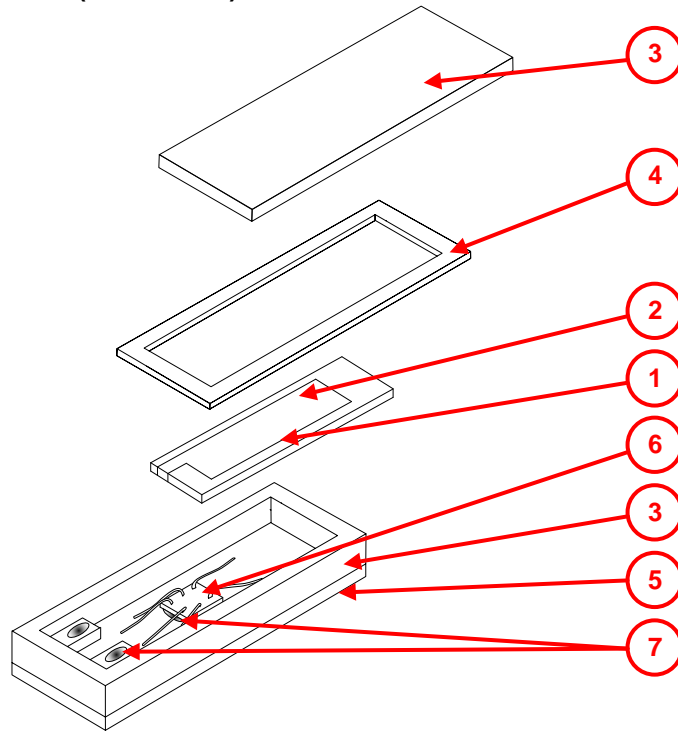


5. MATERIAL COMPOSITION DECLARATION & ENVIRONMENTAL INFORMATION

5.1. HOMOGENOUS MATERIAL COMPOSITION DECLARATION (CERAMIC LID)

Homogenous material information according to IPC-1752 standard

Material Composition MCSO2L (Ceramic lid):



(Symbolic drawing)



No.	Item Component Name	Sub Item Material Name	Material Weight		Substance Element	CAS Number	Comment
			(mg)	(%)			
1	Resonator	Quartz Crystal	3.7	100%	SiO ₂	14808-60-7	
2	Electrodes	Cr+Au	0.2	5%	Cr	Cr: 7440-47-3	
				95%	Au	Au: 7440-57-5	
3	Housing	Ceramic	63.1	100%	Al ₂ O ₃	1344-28-1	
4	Seal	Solder Preform	3.6	80%	Au80 / Sn20	Au: 7440-57-5	
				20%		Sn: 7440-31-5	
5	Terminations	Internal and external terminals	5.1	80%	W	W: 7440-33-7	Tungsten
				15%	Ni	Ni: 7440-02-0	Nickel plating
				5%	Au 0.2 micron	Au: 7440-57-5	Gold plating
6	HCMOS IC	Silicon	1.0	95%	Si	Si: 7440-21-3	
		Die pad plating		1%	Al	Al: 7429-90-5	
		Bonding wires		4%	Al	Al: 7429-90-5	
7	Conductive adhesive	Silver filled Epoxy	1.3	70%	Ag	Ag: 7440-22-4	
				30%	EP	129915-35-1	
		Unit weight typ. ±10%	78				

5.2. RECYCLING MATERIAL INFORMATION (CERAMIC LID)

Recycling material information according to IPC-1752 standard.

Element weight is accumulated and referenced to the unit weight of 78 mg.

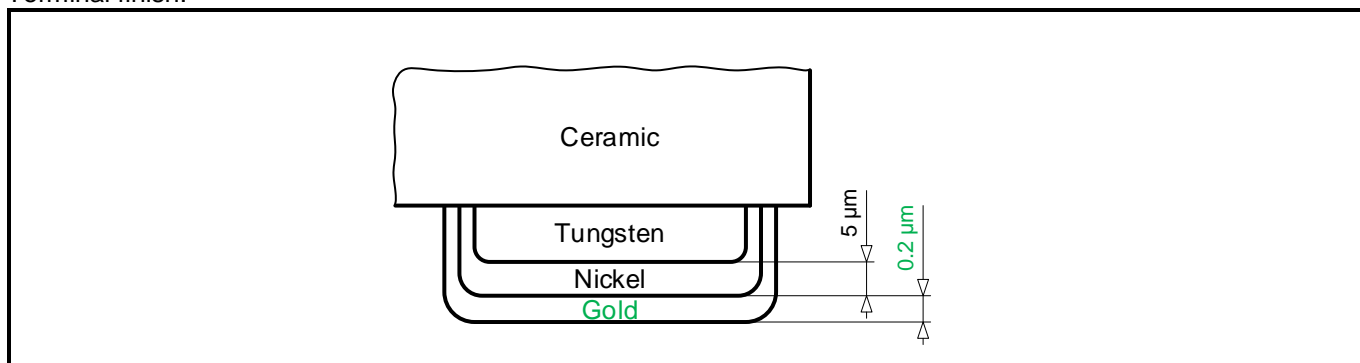
Item Material Name	No.	Item Component Name	Material Weight		Substance Element	CAS Number	Comment
			(mg)	(%)			
Quartz Crystal	1	Resonator	3.7	4.74	SiO ₂	14808-60-7	
Chromium	2	Electrodes	0.01	0.013	Cr	Cr: 7440-47-3	
Ceramic	3	Housing	63.1	80.9	Al ₂ O ₃	1344-28-1	
Gold	2	Electrodes	3.32	4.26	Au	Au: 7440-57-5	
	4	Seal					
	5	Terminations					
Tin	4	Seal	0.72	0.92	Sn	Sn: 7440-31-5	
Nickel	5	Terminations	0.77	0.98	Ni	Ni: 7440-02-0	
Tungsten	5	Terminations	4.08	5.23	W	W: 7440-33-7	
Silicon	6a	HCMOS IC	0.95	1.22	Si	Si: 7440-21-3	
Aluminum	6b	HCMOS IC	0.05	0.06	Al	Al: 7429-90-5	
	6c	HCMOS IC					
Silver	7a	Conductive adhesive	0.91	1.17	Ag	Ag: 7440-22-4	
Epoxy	7b	Conductive adhesive	0.39	0.50	EP	129915-35-1	
Unit weight (total) typ. ±10%			78	100			

5.3. ENVIRONMENTAL PROPERTIES & ABSOLUTE MAXIMUM RATINGS (CERAMIC LID)

Package	Description
DFN-6 ceramic package	Dual Flat No Leads (DFN), hermetically sealed ceramic package with ceramic lid.

Parameter	Directive	Conditions	Value
Product weight (total)			78 mg
Storage temperature		Store as bare product	-65 to +125°C
Moisture sensitivity level (MSL)	IPC/JEDEC J-STD-020D		MSL1
MTTF			> 100 years

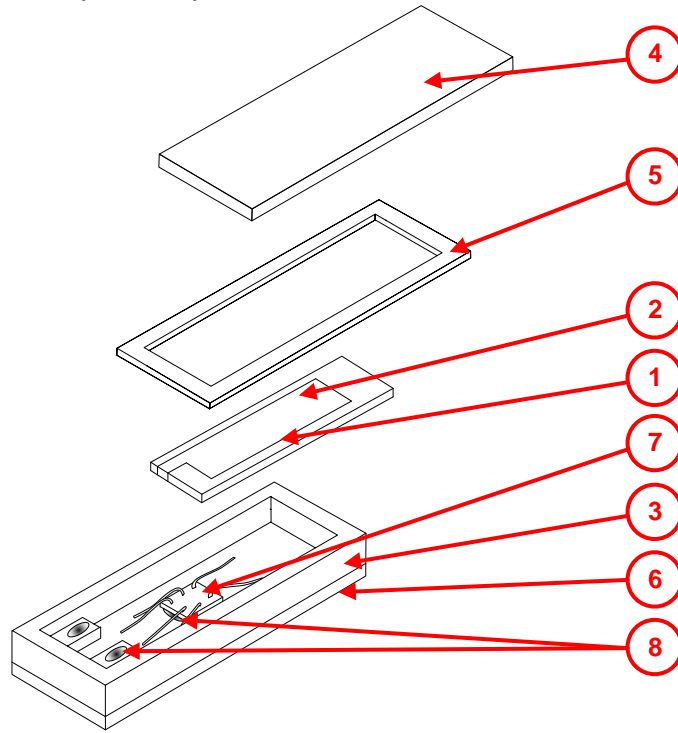
Terminal finish:



5.4. HOMOGENOUS MATERIAL COMPOSITION DECLARATION (METAL LID)

Homogenous material information according to IPC-1752 standard

Material Composition MCSO2L (Metal lid):



(Symbolic drawing)



No.	Item Component Name	Sub Item Material Name	Material Weight		Substance Element	CAS Number	Comment
			(mg)	(%)			
1	Resonator	Quartz Crystal	3.7	100%	SiO ₂	14808-60-7	
2	Electrodes	Cr+Au	0.2	5%	Cr	Cr: 7440-47-3	
				95%	Au	Au: 7440-57-5	
3	Housing	Ceramic	48.7	100%	Al ₂ O ₃	1344-28-1	
4	Metal Lid	Kovar Lid	32.0	90%	Fe53Ni29Co18	Fe: 7439-89-6 Ni: 7440-02-0 Co: 7440-48-4	
				9%	Ni	Ni: 7440-02-0	Nickel plating
				1%	Au	Au: 7440-57-5	Gold plating
5	Seal	Solder Preform	3.6	80% 20%	Au80 / Sn20	Au: 7440-57-5 Sn: 7440-31-5	
6	Terminations	Internal and external terminals	3.5	80%	W	W: 7440-33-7	Tungsten
				15%	Ni	Ni: 7440-02-0	Nickel plating
				5%	Au 0.2 micron	Au: 7440-57-5	Gold plating
7	HCMOS IC	Silicon Die pad plating Bonding wires	1.0	95%	Si	Si: 7440-21-3	
				1%	Al	Al: 7429-90-5	
				4%	Al	Al: 7429-90-5	
8	Conductive adhesive	Silver filled Epoxy	1.3	70%	Ag	Ag: 7440-22-4	
				30%	EP	129915-35-1	
		Unit weight typ. ±10%	94				

5.5. RECYCLING MATERIAL INFORMATION (METAL LID)

Recycling material information according to IPC-1752 standard.

Element weight is accumulated and referenced to the unit weight of 94 mg.

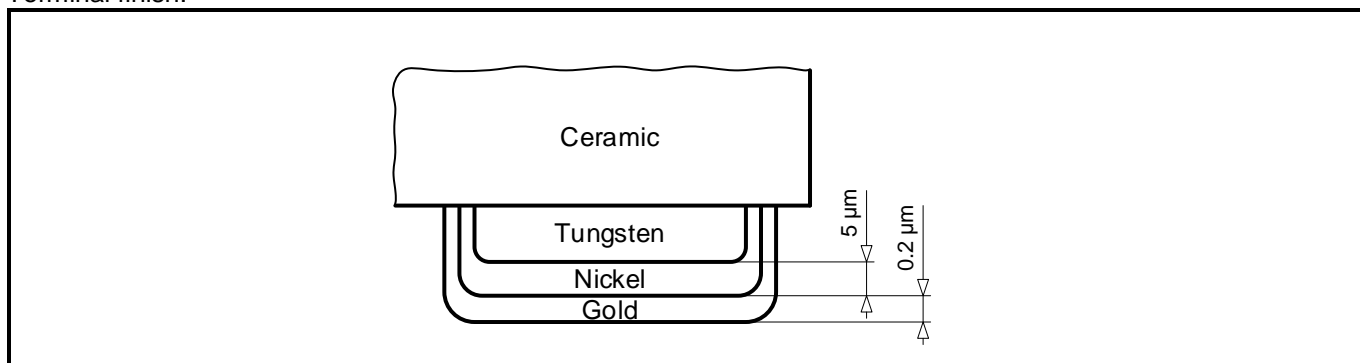
Item Material Name	No.	Item Component Name	Material Weight		Substance Element	CAS Number	Comment
			(mg)	(%)			
Quartz Crystal	1	Resonator	3.7	3.94	SiO ₂	14808-60-7	
Chromium	2	Electrodes	0.01	0.011	Cr	Cr: 7440-47-3	
Ceramic	3	Housing	48.7	51.8	Al ₂ O ₃	1344-28-1	
Gold	2	Electrodes	3.56	3.79	Au	Au: 7440-57-5	
	4	Metal Lid					
	5	Seal					
	6	Terminations					
Tin	5	Seal	0.72	0.77	Sn	Sn: 7440-31-5	
Nickel	4	Metal Lid (Plating)	3.41	3.62	Ni	Ni: 7440-02-0	
	6	Terminations					
Tungsten	6	Terminations	2.80	2.98	W	W: 7440-33-7	
Kovar	4	Metal Lid	28.8	30.6	Fe53Ni29Co18	Fe: 7439-89-6	
						Ni: 7440-02-0	
						Co: 7440-48-4	
Silicon	7a	HCMOS IC	0.95	1.01	Si	Si: 7440-21-3	
Aluminum	7b	HCMOS IC	0.05	0.05	Al	Al: 7429-90-5	
	7c	HCMOS IC					
Silver	8a	Conductive adhesive	0.91	0.97	Ag	Ag: 7440-22-4	
Epoxy	8b	Conductive adhesive	0.39	0.41	EP	129915-35-1	
Unit weight (total) typ. ±10%			94	100			

5.6. ENVIRONMENTAL PROPERTIES & ABSOLUTE MAXIMUM RATINGS (METAL LID)

Package	Description
DFN-6 ceramic package	Dual Flat No Leads (DFN), hermetically sealed ceramic package with metal lid.

Parameter	Directive	Conditions	Value
Product weight (total)			94 mg
Storage temperature		Store as bare product	-65 to +125°C
Moisture sensitivity level (MSL)	IPC/JEDEC J-STD-020D		MSL1
MTTF			> 100 years

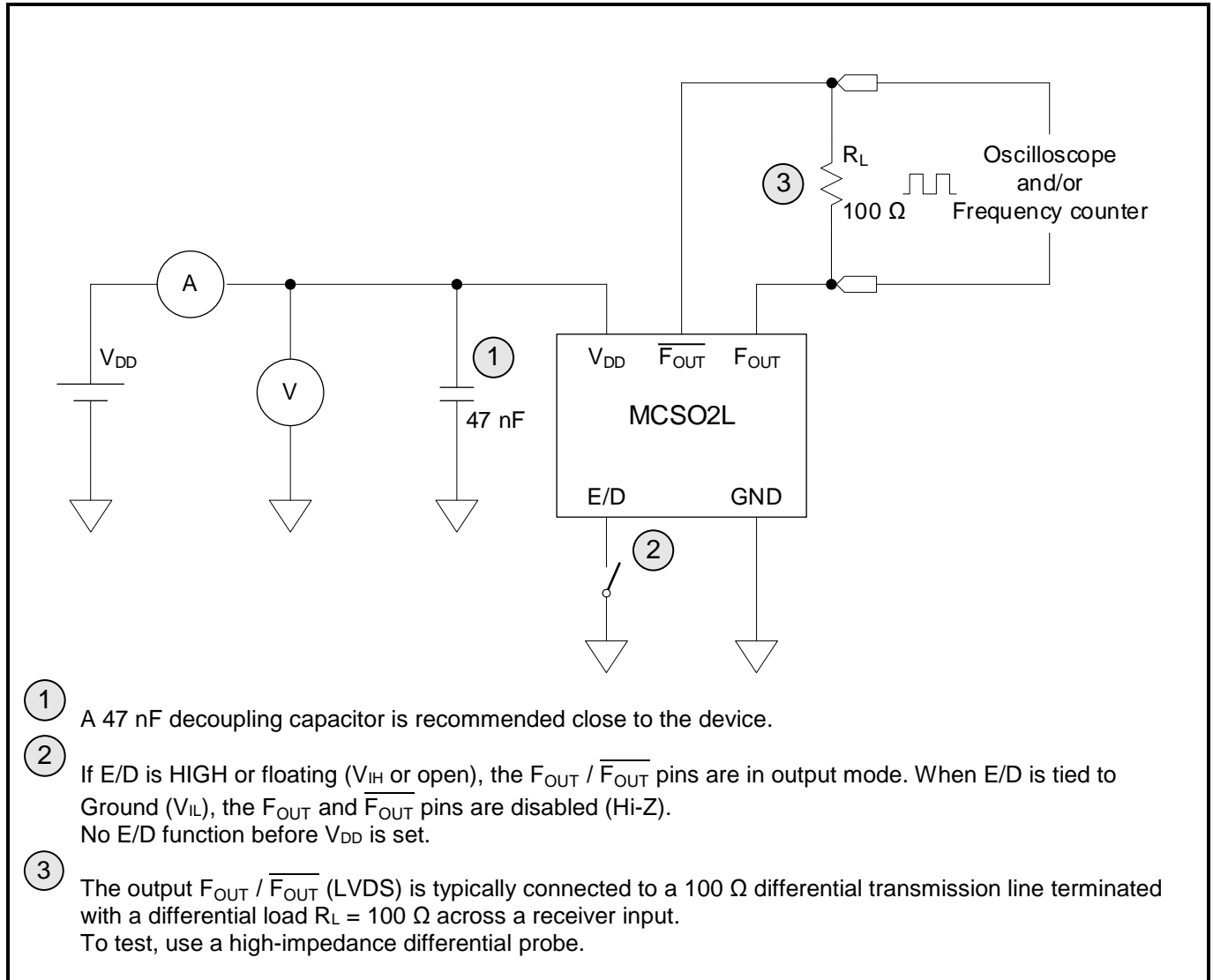
Terminal finish:



6. APPLICATION INFORMATION

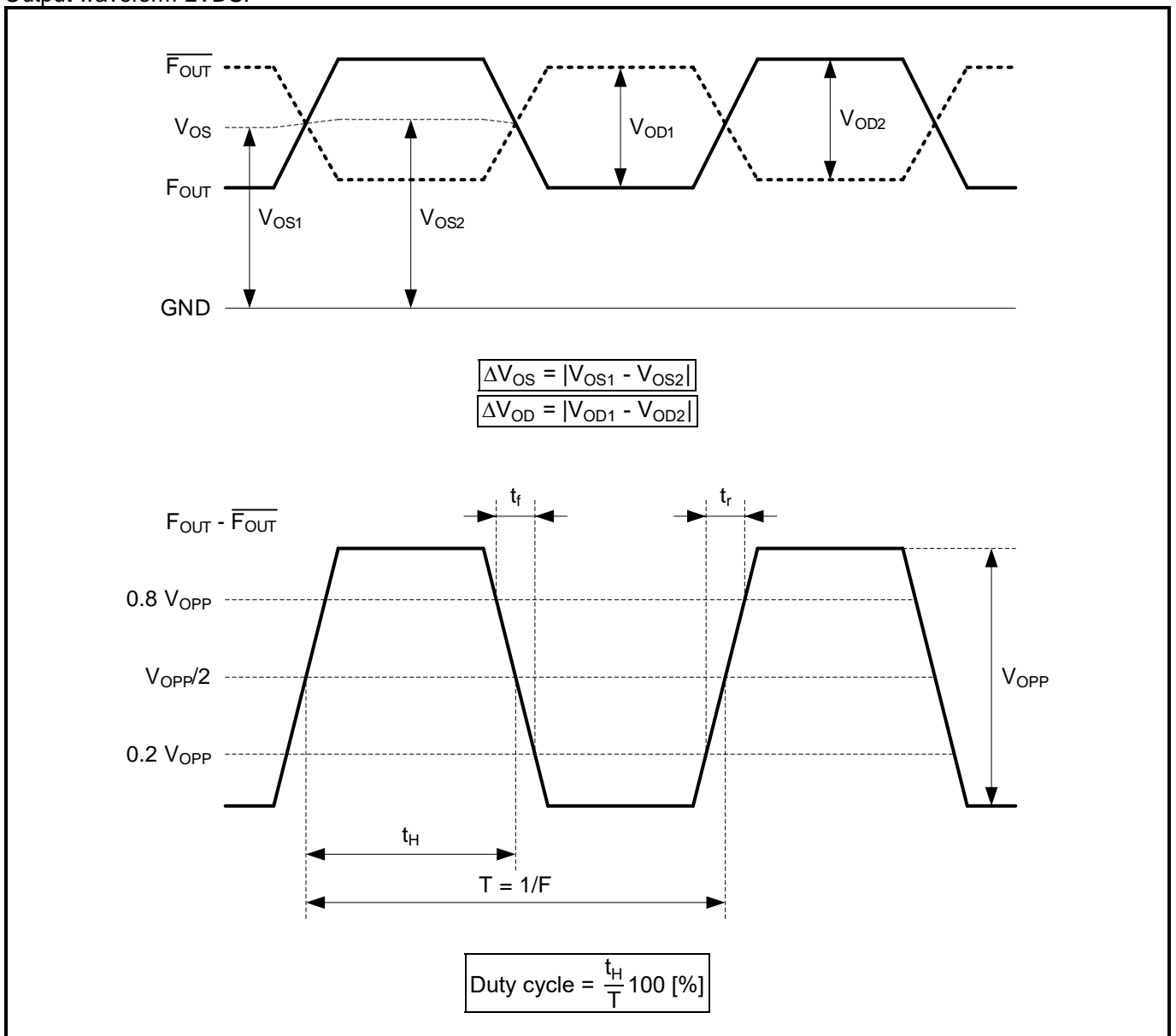
6.1. TEST CIRCUIT

Test circuit LVDS:



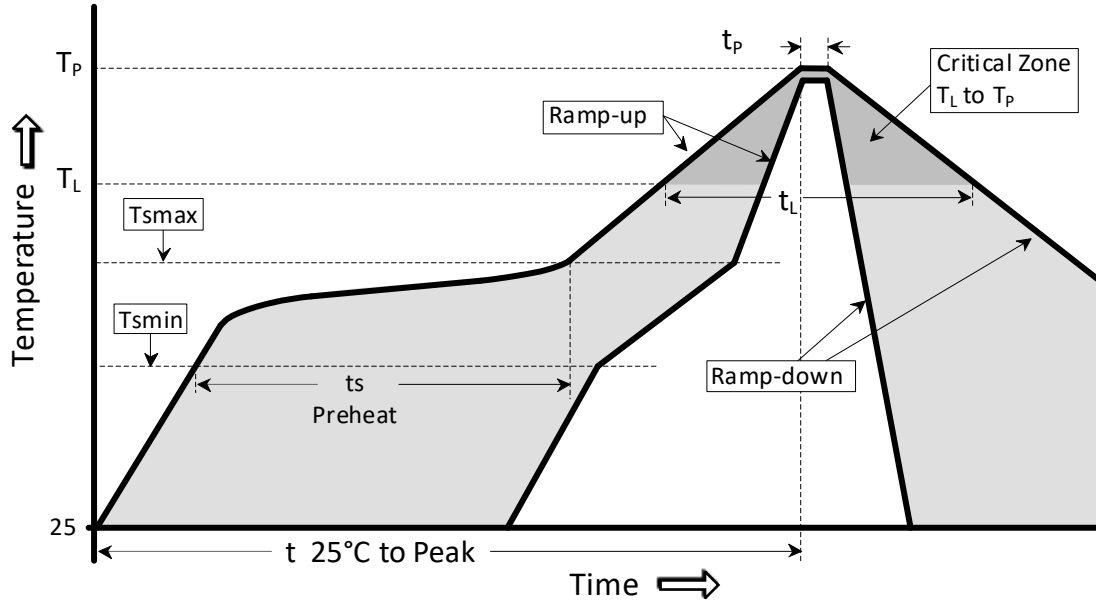
6.2. OUTPUT WAVEFORM

Output waveform LVDS:



6.3. SOLDERING INFORMATION

Maximum Reflow Conditions in accordance with IPC/JEDEC J-STD-020C “Pb-free”



Temperature Profile	Symbol	Condition	Unit
Average ramp-up rate	(T_{smax} to T_p)	3°C / second max	°C / s
Ramp down Rate	T_{cool}	6°C / second max	°C / s
Time 25°C to Peak Temperature	$T_{to-peak}$	8 minutes max	min
Preheat			
Temperature min	T_{smin}	150	°C
Temperature max	T_{smax}	200	°C
Time T_{smin} to T_{smax}	t_s	60 – 180	sec
Soldering above liquidus			
Temperature liquidus	T_L	217	°C
Time above liquidus	t_L	60 – 150	sec
Peak temperature			
Peak Temperature	T_p	260	°C
Time within 5°C of peak temperature	t_p	20 – 40	sec

6.4. HANDLING PRECAUTIONS FOR MODULES WITH EMBEDDED CRYSTALS

The built-in AT-cut crystal consists of pure Silicon Dioxide in crystalline form. The cavity inside the package is evacuated and hermetically sealed in order for the crystal blank to function undisturbed from air molecules, humidity and other influences.

Shock and vibration:

Keep the crystal / module from being exposed to **excessive mechanical shock and vibration**. Micro Crystal guarantees that the crystal / module will bear a mechanical shock of 5000 g / 0.3 ms.

The following special situations may generate either shock or vibration:

Multiple PCB panels - Usually at the end of the pick & place process the single PCBs are cut out with a router. These machines sometimes generate vibrations on the PCB that have a fundamental or harmonic frequency close to the resonance frequency of the crystal unit. This might cause breakage of crystal blanks due to resonance. Router speed should be adjusted to avoid resonant vibration.

Ultrasonic cleaning - Avoid cleaning processes using ultrasonic energy. These processes can damage the crystals due to the mechanical resonance frequencies of the crystal blank.

Overheating, rework high temperature exposure:

Avoid overheating the package. The package is sealed with a seal ring consisting of 80% Gold and 20% Tin. The eutectic melting temperature of this alloy is at 280°C. Heating the seal ring up to >280°C will cause melting of the metal seal which then, due to the vacuum, is sucked into the cavity forming an air duct. This happens when using hot-air-gun set at temperatures >280°C.

Use the following methods for rework:

- Use a hot-air-gun set at 270°C.
- Use 2 temperature controlled soldering irons, set at 270°C, with special-tips to contact all solder-joints from both sides of the package at the same time, remove part with tweezers when pad solder is liquid.

7. COMPLIANCE INFORMATION

Micro Crystal confirms that the standard product Clock Oscillator MCSO2L is compliant with “EU RoHS Directive” and “EU REACH Directives”.

Please find the actual Certificate of Conformance for Environmental Regulations on our website:

[CoC Environment MCSO-Series.pdf](#)

8. DOCUMENT REVISION HISTORY

Date	Revision #	Revision Details
September 2016	2.0	Previous version
August 2021	3.0	New extended version

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