

# **Application Manual**

## **OCXO**

**Standard OCXO  
with HCMOS Output  
– up to 54 MHz**

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# OCXO

## Standard OCXO with HCMOS Output – up to 54 MHz

### 1. OVERVIEW

- Oven Controlled Oscillator with built-in oven and AT-cut crystal (OCXO), operating in fundamental mode
- Frequency stability versus operating temperature range: (values for high stability version (T),  $V_{DD} = 5.0\text{ V}$ )
  - $\pm 75\text{ ppb}$  at A = 0 to  $+60^\circ\text{C}$
  - $\pm 150\text{ ppb}$  at B =  $-20$  to  $+70^\circ\text{C}$
  - $\pm 250\text{ ppb}$  at C =  $-40$  to  $+85^\circ\text{C}$
  - $\pm 300\text{ ppb}$  at E =  $-55$  to  $+85^\circ\text{C}$
- Frequency long term aging (F < 40 MHz):
  - long term aging 10 years <  $\pm 3\text{ ppm}$
  - long term aging 1<sup>st</sup> year <  $\pm 0.5\text{ ppm}$
- Minimum frequency control range by  $V_C$  or R (F < 40 MHz):  $\geq \pm 3\text{ ppm}$
- Very fast start-up: typ. 1 ms at  $25^\circ\text{C}$
- Fast warm-up. Warm-up time within  $\pm 0.1\text{ ppm}$  at  $+25^\circ\text{C}$ :
  - $\leq 120\text{ s}$ ,  $V_{DD} = 3.3\text{ V}$
  - $\leq 60\text{ s}$ ,  $V_{DD} = 5.0\text{ V}$
- Output signal HCMOS compatible
- High shock and vibration resistance
- Operating voltage: 3.3 V or 5.0 V
- Power consumption at  $+25^\circ\text{C}$ :
  - $\leq 120\text{ mA}$ ,  $V_{DD} = 3.3\text{ V}$
  - $\leq 80\text{ mA}$ ,  $V_{DD} = 5.0\text{ V}$
- Operating temperature range:
  - A = 0 to  $+60^\circ\text{C}$
  - B =  $-20$  to  $+70^\circ\text{C}$
  - C =  $-40$  to  $+85^\circ\text{C}$
  - E =  $-55$  to  $+85^\circ\text{C}$  (only available at 5.0 V version (V))
  - X = Custom
- Low aging rate
- DIL-14 metal package (20.2 x 12.6 mm), RoHS-compliant

### 1.1. GENERAL DESCRIPTION

The OCXO combines an Oven Controlled HCMOS oscillator circuitry together with an AT-cut quartz crystal in a hermetically sealed DIL-14 / 4 pins metal package. No external components are required.

The frequency output – up to 54 MHz on  $F_{OUT}$  pin is always enabled. The frequency can be adjusted by varying the control voltage on  $V_C$  pin (version V3 or V5) or by varying the resistance  $R_C$  between  $V_C$  pin and GND (version R1).

## 1.2. APPLICATIONS

The OCXO oven controlled clock oscillator module combines outstanding performance and robustness in a standard metal package:

- OCXO oscillator module (embedded XTAL) in a standard 20.2 x 12.6 mm DIL-14 / 4 pins metal package
- High shock and vibration resistant

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

- Avionics / Aerospace: On-Board Computers and Instruments
- Instrumentation: Field and Laboratory Test Equipment
- Network Synchronization: Wireless Base Stations (3G, 4G and 5G) / SONET / SDH / OTN / SyncE / IEEE 1588 / VSAT / GNSS Time Synchronization
- Digital Broadcasting: DAB / DVB
- Battery Powered Monitoring Devices: Remote/Smart Metering Devices / Standalone Stations (Weather/Environment) / IoT

**1.3. ORDERING INFORMATION**

Example: OCXO W T – C V3 20.000 MHz D2 XXX

Code	Package Size
OCXO	20.2 x 12.6 mm

Code	Supply voltage
W	$V_{DD} = 3.3 \text{ V}$
V	$V_{DD} = 5.0 \text{ V}$

Code	Frequency stability
T	High stability
Blank	Standard

Code	Temperature range
A	0 to +60°C
B	-20 to +70°C
C	-40 to +85°C
E	-55 to +85°C *
X	Custom

Code	Frequency control
R1	$R = 0 \text{ to } 10 \text{ k}\Omega$
V3	$V_C = 0 \text{ to } 3.3 \text{ V}$
V5	$V_C = 0.5 \text{ to } 5.0 \text{ V}$
YA	Internal accuracy $\leq \pm 1.0 \text{ ppm}$
YB	Internal accuracy $\leq \pm 0.5 \text{ ppm}$
Y	Custom

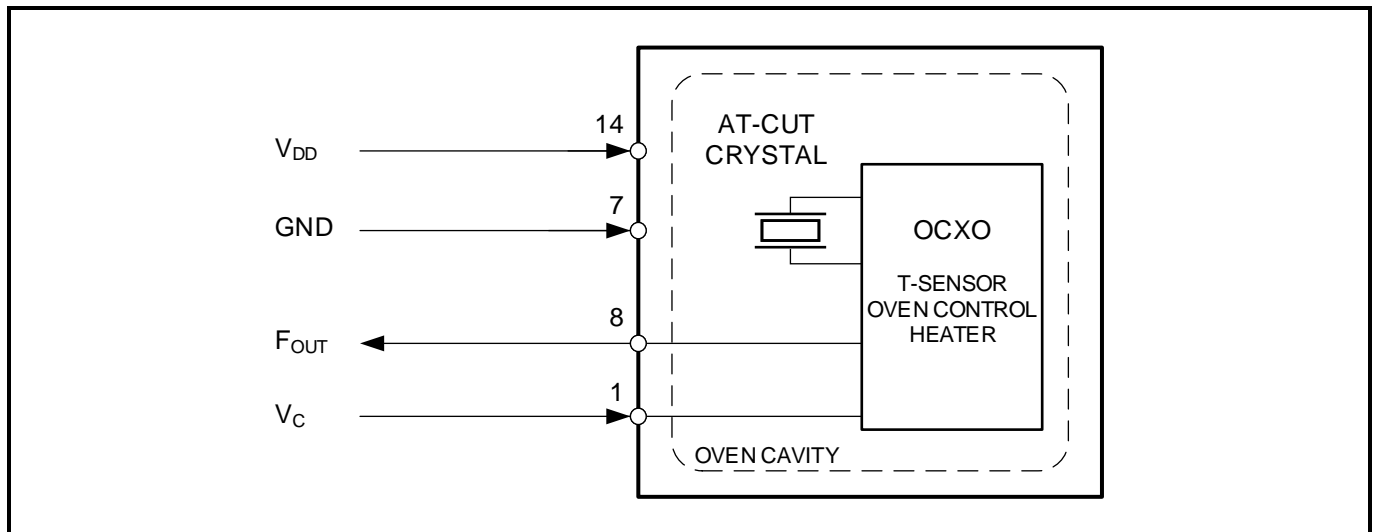
Code	Frequency
20.000 MHz	20.000 MHz

Code	Option 1
D2	SMD (formed leads)
Blank	THD (Standard)

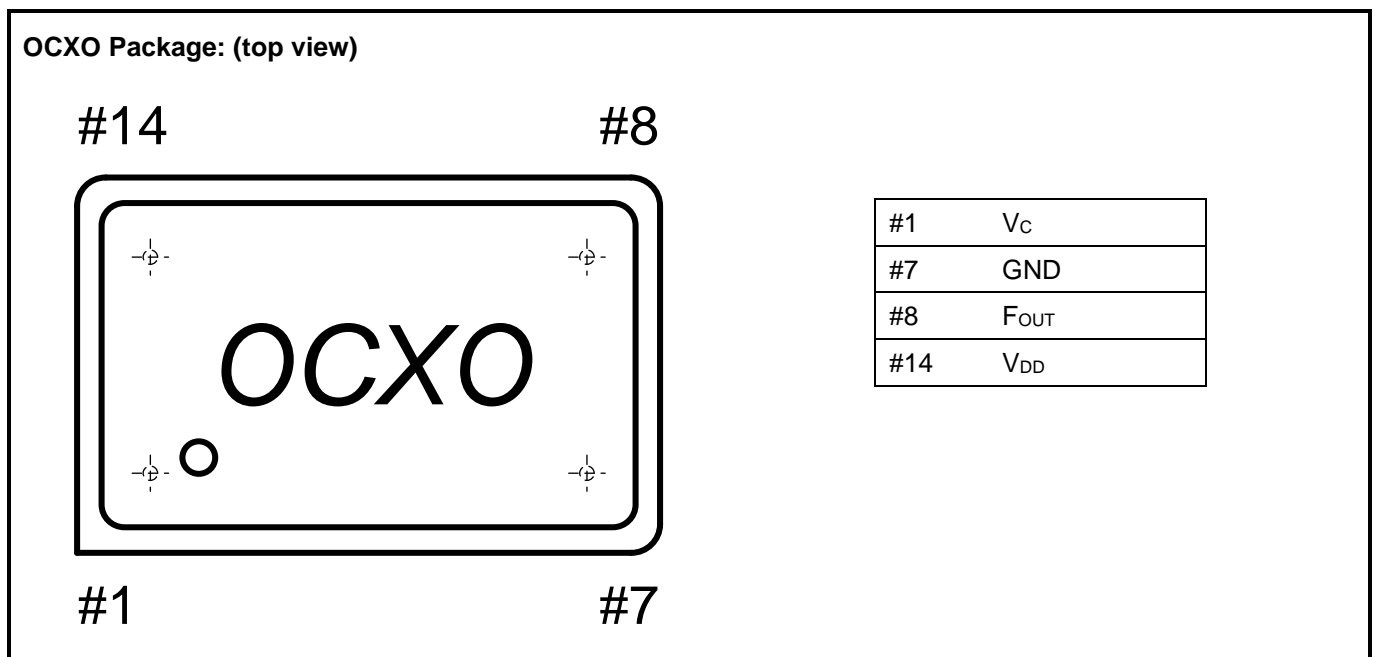
Code	Customer specification N°
XXX	XXX

\* E version is only available at 5.0 V version (V).

## 2. BLOCK DIAGRAM



### 2.1. PINOUT



### 2.2. PIN DESCRIPTION

Symbol	Pin #	Description
V <sub>C</sub>	1	Control Voltage Input. The frequency on F <sub>OUT</sub> pin can be adjusted by varying the voltage applied to V <sub>C</sub> pin (version V3 or V5) or by varying the resistance R <sub>C</sub> between V <sub>C</sub> pin and GND (version R1). The slope polarity is positive (increasing voltage/resistance increases output frequency). If there is no frequency control (YA or YB), V <sub>C</sub> pin has to be connected to GND.
GND	7	Ground.
F <sub>OUT</sub>	8	Clock Output; always enabled. F <sub>OUT</sub> pin drives the square wave of the frequency. The frequency can be adjusted by varying the control voltage applied to the V <sub>C</sub> pin (version V3 or V5) or by varying the resistance R <sub>C</sub> between V <sub>C</sub> pin and GND (version R1). If there is no frequency control (YA or YB), V <sub>C</sub> pin has to be connected to GND.
V <sub>DD</sub>	14	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 <sub>DD</sub>	Power supply voltage	Nominal V <sub>DD</sub> = 3.3 V	-0.3	3.8	V
		Nominal V <sub>DD</sub> = 5.0 V	-0.3	5.5	
V <sub>I</sub>	Input voltage		-0.3	V <sub>DD</sub>	V
V <sub>O</sub>	Output voltage		-0.3	V <sub>DD</sub>	V
V <sub>ESD</sub>	ESD voltage	HBM (1)		±2000	V
		MM (2)		±200	
T <sub>A</sub>	Operating temperature range A		0	60	°C
T <sub>B</sub>	Operating temperature range B		-20	70	°C
T <sub>C</sub>	Operating temperature range C		-40	85	°C
T <sub>E</sub>	Operating temperature range E		-55	85	°C
T <sub>STO</sub>	Storage temperature	Stored as bare product	-55	125	°C
T <sub>PEAK</sub>	Maximum pins soldering temperature	10 seconds maximum		235	°C
		5 seconds maximum		260	

(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<sub>DD</sub> = nominal voltage; GND = 0 V; T<sub>A</sub> = +25°C; unless otherwise indicated.

Operating Parameters:

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
<b>Supply</b>						
V <sub>DD</sub>	Power supply voltage (1)	Nominal V <sub>DD</sub> = 3.3 V	3.15		3.45	V
		Nominal V <sub>DD</sub> = 5.0 V	4.8		5.2	
I <sub>DD</sub>	Input current. T <sub>A</sub> = +25 °C, C <sub>L</sub> = 15 pF	Nominal V <sub>DD</sub> = 3.3 V			120	mA
		Nominal V <sub>DD</sub> = 5.0 V			80	
	Input current. T <sub>A</sub> = -20 °C, C <sub>L</sub> = 15 pF	Nominal V <sub>DD</sub> = 3.3 V			170	
		Nominal V <sub>DD</sub> = 5.0 V			120	
Input current at start-up. T <sub>A</sub> = +25 °C, C <sub>L</sub> = 15 pF	Nominal V <sub>DD</sub> = 3.3 V, duration = 30 seconds			350		
	Nominal V <sub>DD</sub> = 5.0 V, duration = 10 seconds			300		
<b>Input pin 1 V<sub>C</sub> (Version V3 or V5)</b>						
V <sub>C</sub>	Control voltage range	Version V3	0		3.3	V
		Version V5	0.5		5.0	
	Slope polarity		Positive			
Z <sub>VC</sub>	V <sub>C</sub> input impedance		47			kΩ
<b>Input pin 1 V<sub>C</sub> (Version R1)</b>						
R <sub>C</sub>	Control resistor range (2)		0		10	kΩ
	Slope polarity		Positive			
Z <sub>VC</sub>	V <sub>C</sub> input impedance		-4.7			kΩ
<b>Input pin 1 V<sub>C</sub> (Version YA or YB)</b>						
	No frequency control		Pin V <sub>C</sub> has to be connected to GND			
<b>Output F<sub>OUT</sub> (HCMOS compatible)</b>						
V <sub>OH</sub>	HIGH level output voltage		V <sub>DD</sub> -0.5			V
V <sub>OL</sub>	LOW level output voltage				0.4	V
C <sub>L</sub>	Output load capacitance	HCMOS	3	15	47	pF
t <sub>r</sub> / t <sub>f</sub>	Rise & fall time	C <sub>L</sub> = 15 pF			7	ns

(1) A 3.3 μF buffer and a 47 nF decoupling capacitor have to be connected between V<sub>DD</sub> and GND close to the device.  
(2) Resistor R<sub>C</sub> between pin V<sub>C</sub> and GND

### 3.3. OSCILLATOR PARAMETERS

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

Oscillator Parameters:

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
<b>General</b>						
F	Frequency range		0.01		54	MHz
$t_{START}$	Oscillator start-up time			1	5	ms
$\delta_{FOUT}$	$F_{OUT}$ duty cycle @ $V_{DD}/2$		40		60	%
<b>Frequency Characteristics</b>						
$\Delta F/F$	Frequency versus temperature (without air flow)  (see ORDERING INFORMATION)	$V_{DD} = 3.3 V \pm 0.15 V$ , Standard stability (blank) A = 0 to +60°C B = -20 to +70°C C = -40 to +85°C			$\pm 200$ $\pm 300$ $\pm 500$	ppb
		$V_{DD} = 3.3 V \pm 0.15 V$ , High stability version (T) A = 0 to +60°C B = -20 to +70°C C = -40 to +85°C			$\pm 75$ $\pm 150$ $\pm 250$	
		$V_{DD} = 5.0 V \pm 0.2 V$ , Standard stability (blank) A = 0 to +60°C B = -20 to +70°C C = -40 to +85°C E = -55 to +85°C			$\pm 200$ $\pm 300$ $\pm 500$ $\pm 700$	
		$V_{DD} = 5.0 V \pm 0.2 V$ , High stability version (T) A = 0 to +60°C B = -20 to +70°C C = -40 to +85°C E = -55 to +85°C			$\pm 75$ $\pm 150$ $\pm 250$ $\pm 300$	
$\Delta F/F$	Frequency long term aging  (1)	< 40 MHz long term aging 10 years long term aging 1 <sup>st</sup> year			< $\pm 3$ $\pm 0.5$	ppm
		$\geq 40$ MHz long term aging 10 years long term aging 1 <sup>st</sup> year			< $\pm 4$ $\pm 1$	
$\Delta F/F$	Minimum frequency control range by $V_C$ or $R_C$ , (see input pin 1 $V_C$ in section OPERATING PARAMETERS)	< 40 MHz	$\pm 3$			ppm
		$\geq 40$ MHz	$\pm 4$			
$\Delta F/F$	Frequency stability versus load change of $\pm 10\%$	< 40 MHz			$\pm 10$	ppb
		$\geq 40$ MHz			$\pm 30$	
t	Warm-up time within $\pm 0.1$ ppm at +25°C	Nominal $V_{DD} = 3.3 V$			120	s
		Nominal $V_{DD} = 5.0 V$			60	
$\Delta F/F$	Stability versus $V_{DD}$				< $\pm 0.1$	ppm
$\sigma$	Short term stability (Allan deviation) at T = 0.1 to 30 s				< 0.5	ppb
	Typical short term stability (Allan deviation) at T = 1 s			0.05		
L	Phase noise	Typical at 10 MHz: Static conditions, BW = 1 Hz	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz		-100 -130 -140 -145 -145	dBc/Hz

(1) After 30 days operating.



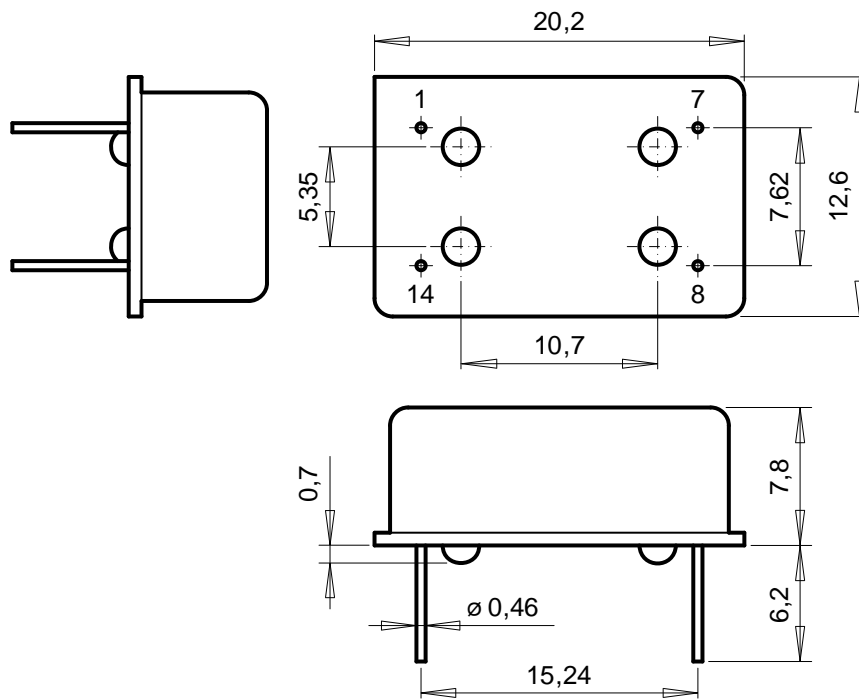
## 4. PACKAGE

### 4.1. DIMENSIONS

#### 4.1.1. THD PACKAGE (STANDARD)

OCXO THD standard package (Option 1 = Blank):

Package dimensions (bottom view):



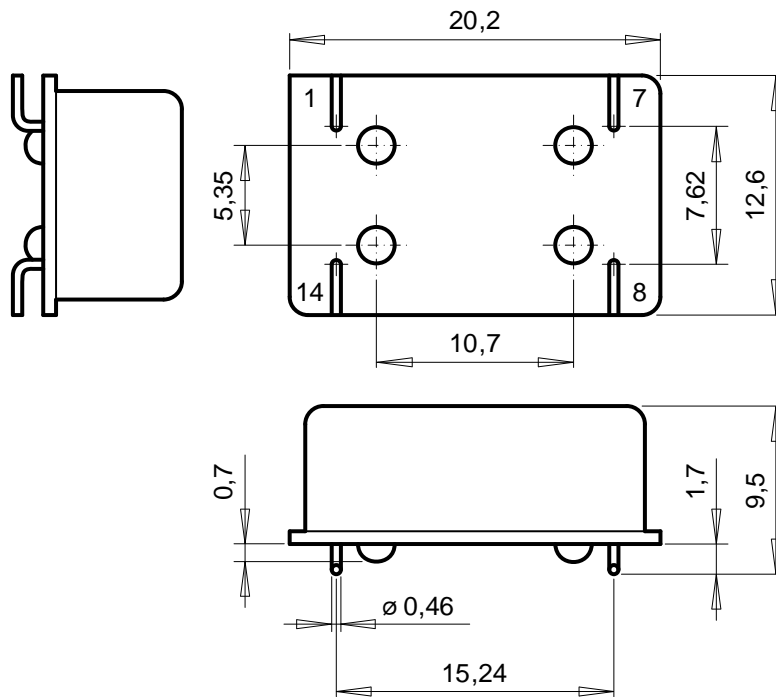
Case is connected to GND (pin 7)

Dimensions: in mm  
 Tolerances: unless otherwise specified  $\pm 0.1$  mm  
 Drawing: OCXO\_THD\_Pack-drw\_20211015

4.1.2.SMD PACKAGE

OCXO SMD formed leads package (Option 1 = D2):

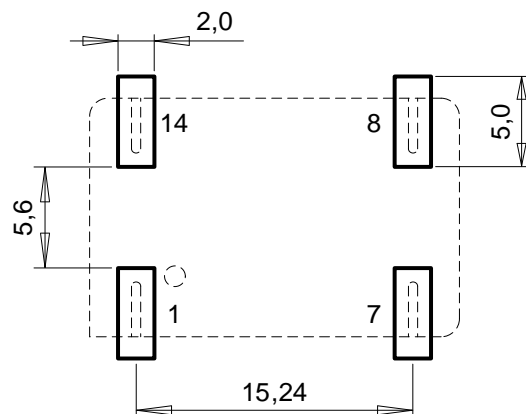
Package dimensions (bottom view):



Case is connected to GND (pin 7)

Dimensions: in mm  
 Tolerances: unless otherwise specified  $\pm 0.1$  mm  
 Drawing: OCXO\_SMD\_Pack-drw\_20211015

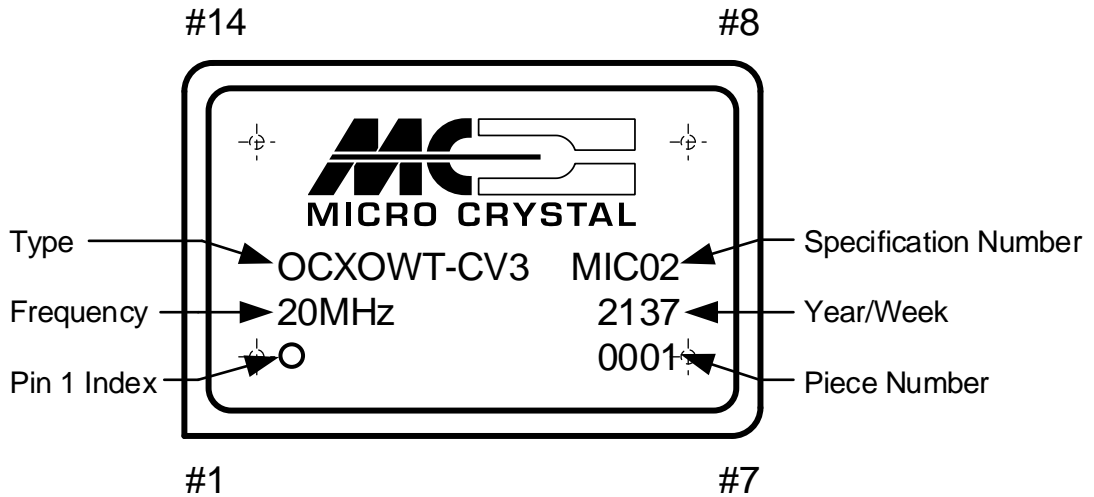
4.1.3.RECOMMENDED SOLDER PAD LAYOUT FOR SMD PACKAGE



Dimensions: in mm

4.2. MARKING AND PIN #1 INDEX



Laser marking OCXO Package: (top view)



## 5. MATERIAL COMPOSITION DECLARATION & ENVIRONMENTAL INFORMATION

### 5.1. HOMOGENOUS MATERIAL COMPOSITION DECLARATION

Homogenous material information according to IPC-1752 standard

Material Composition OCXO:								
No.	Item Component Name	Sub Item Material Name	Material Weight		Substance Element	CAS Number	Comment	
			(mg)	(%)				
1	Resonator	Quartz Crystal	9	100%	SiO <sub>2</sub>	14808-60-7		
2	Electrodes	Cr+Au	1	5%	Cr	Cr: 7440-47-3		
				95%	Au	Au: 7440-57-5		
3	Resonator Housing	Ceramic Terminations	125	90%	Al <sub>2</sub> O <sub>3</sub>	1344-28-1		
				7%	W	W: 7440-33-7	Tungsten	
				2%	Ni	Ni: 7440-02-0	Nickel plating	
				1%	Au	Au: 7440-57-5	Gold plating	
4	Resonator Lid	Kovar Lid	65	90%	Fe53Ni29Co18	Fe: 7439-89-6	Metal Lid (Kovar)	
						Ni: 7440-02-0		
		Ni-plating Au-plating		9%	Ni	Ni: 7440-02-0	Nickel plating	
				1%	Au	Au: 7440-57-5	Gold plating	
5	Resonator Seal	Solder Preform	10	80%	Au80 / Sn20	Au: 7440-57-5		
20%	Sn: 7440-31-5							
6	Resistors	Ceramic body Terminations	60	90%	Al <sub>2</sub> O <sub>3</sub>	1344-28-1		
				1%	Cu	Cu: 7440-50-8		
				1%	Ni	Ni: 7440-02-0		
				8%	Sn	Sn: 7440-31-5		
7	Solder connections	Solder	50	100%	Sn97Ag2Cu1	Sn: 7440-31-5 Ag: 7440-22-4 Cu: 7440-50-8		
8	PCB	Substrate Plating	780	80%	Fiberglass Epoxy			
				14%	Cu	Cu: 7440-50-8		
				3%	Ni	Ni: 7440-02-0		
				3%	Au	Au: 7440-57-5		
9	Custom IC	Silicon Die pad plating Bonding wires	120	90%	Si	Si: 7440-21-3		
				1%	Al	Al: 7429-90-5		
				9%	Au	Au: 7440-57-5		
10	Base	CRS1010 Steel Kovar Pins	2350	94%	Fe	Fe: 7439-89-6	Metal Pins (Kovar)	
				3%	Fe53Ni29Co18	Fe: 7439-89-6 Ni: 7440-02-0 Co: 7440-48-4		
		Glass		3%		65997-17-3		
11	Cap	SPCD Steel	1250	100%	Fe	Fe: 7439-89-6		
12	Capacitors	Ceramic body Terminations	120	90%	Al <sub>2</sub> O <sub>3</sub>	1344-28-1		
				1%	Cu	Cu: 7440-50-8		
				1%	Ni	Ni: 7440-02-0		
				8%	Sn	Sn: 7440-31-5		
13	Conductive adhesive	Silver filled Epoxy	60	70%	Ag	Ag: 7440-22-4		
				30%	EP	129915-35-1		
Unit weight typ. ±20%			5000					

## 5.2. RECYCLING MATERIAL INFORMATION

Recycling material information according to IPC-1752 standard.

Element weight is accumulated and referenced to the unit weight of 5000 mg.

Item Material Name	No.	Item Component Name	Material Weight		Substance Element	CAS Number	Comment
			(mg)	(%)			
Quartz Crystal	1	Resonator	9.0	0.18	SiO <sub>2</sub>	14808-60-7	
Chromium	2	Electrodes	0.05	0.001	Cr	Cr: 7440-47-3	
Ceramic	3a 6a 12a	Resonator Housing Resistors Capacitors	274.5	5.49	Al <sub>2</sub> O <sub>3</sub>	1344-28-1	
Gold	2 3d 4c 5 8d 9c	Electrodes Resonator Housing Resonator Lid Resonator Seal PCB Custom IC	45.0	0.90	Au	Au: 7440-57-5	
Tin	5 6d 12d	Resonator Seal Resistors Capacitors	16.4	0.33	Sn	Sn: 7440-31-5	
Nickel	3c 4b 6c 8c 12c	Resonator Housing Resonator Lid Resistors PCB Capacitors	33.6	0.67	Ni	Ni: 7440-02-0	
Tungsten	3b	Resonator Housing	8.75	0.175	W	W: 7440-33-7	
Kovar	4a 10b	Resonator Lid Base	129.0	2.58	Fe53Ni29Co18	Fe: 7439-89-6 Ni: 7440-02-0 Co: 7440-48-4	
Iron	10a 11	Base Cap	3459.0	69.18	Fe	Fe: 7439-89-6	
Glass	10c	Base	70.5	1.41		65997-17-3	
Copper	6b 8b 12b	Resistors PCB Capacitors	111.0	2.22	Cu	Cu: 7440-50-8	
Silicon	9a	Custom IC	108.0	2.16	Si	Si: 7440-21-3	
Aluminum	9b	Custom IC	1.2	0.024	Al	Al: 7429-90-5	
Silver	13	Conductive adhesive	42.0	0.84	Ag	Ag: 7440-22-4	
Epoxy	13	Conductive adhesive	18.0	0.36	EP	129915-35-1	
Substrate	8a	PCB	624.0	12.48	Fiberglass Epoxy		
Solder	7	Solder connections	50.0	1.0	Sn97Ag2Cu1	Sn: 7440-31-5 Ag: 7440-22-4 Cu: 7440-50-8	
Unit weight (total) typ. ±20%			5000	100			

**5.3. ENVIRONMENTAL PROPERTIES & ABSOLUTE MAXIMUM RATINGS**

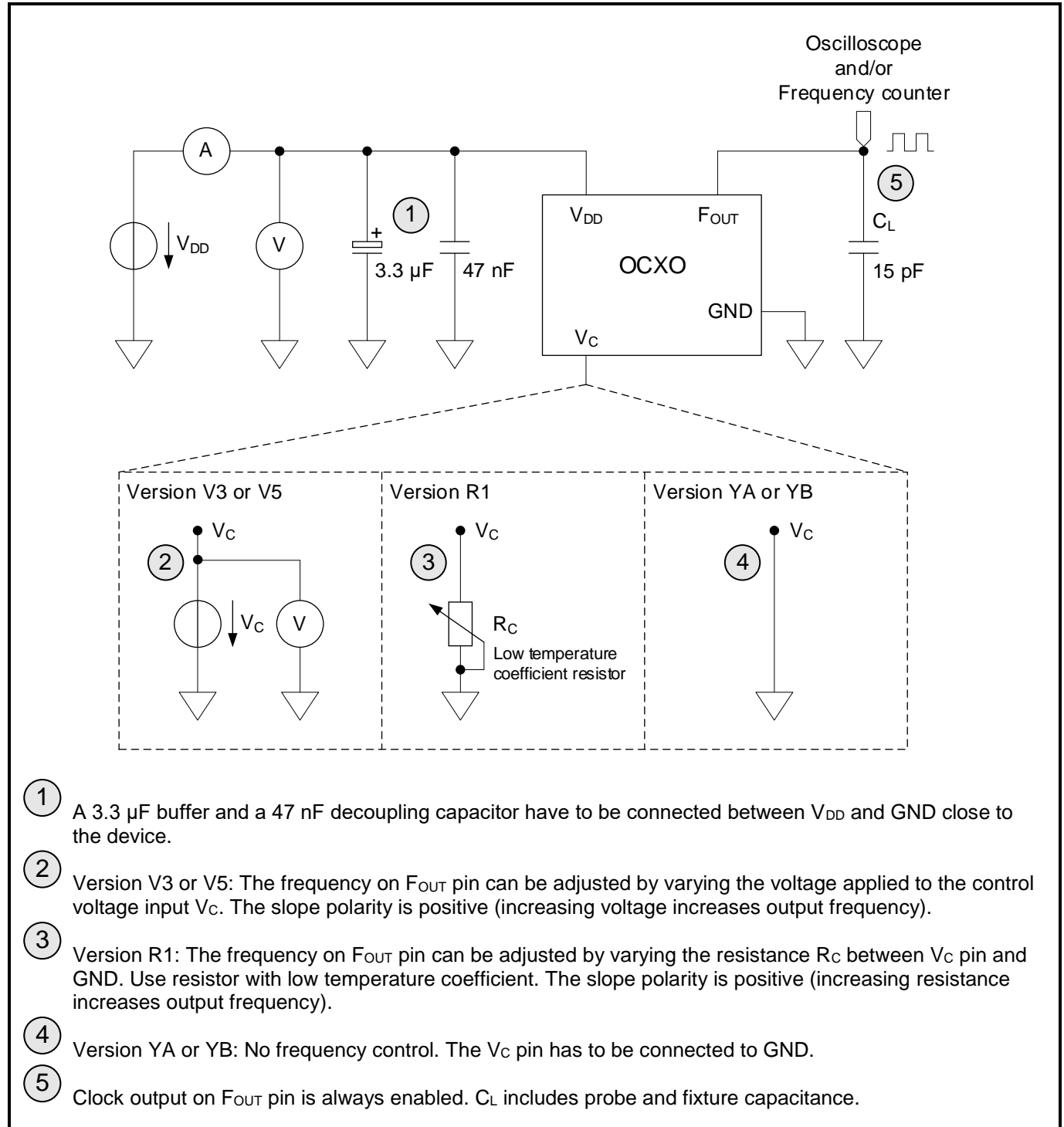
Package	Description
DIL-14 / 4 pins metal package	Dual In-Line (DIL), hermetically sealed metal package.

Parameter	Directive	Conditions	Value
Product weight (total)			5000 mg
Storage temperature		Store as bare product	-55 to +125°C
Moisture sensitivity level (MSL)	IPC/JEDEC J-STD-020D		MSL1

## 6. APPLICATION INFORMATION

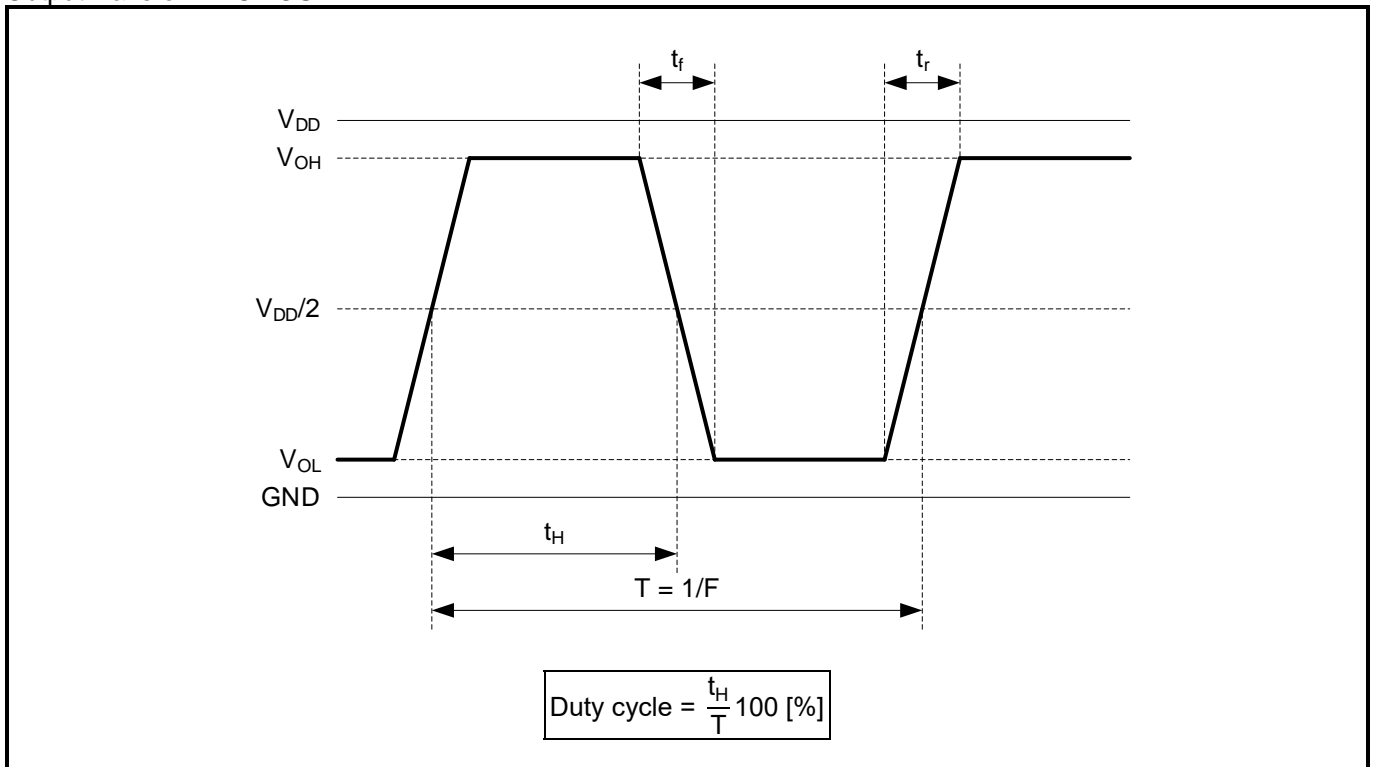
### 6.1. TEST CIRCUIT

Test circuit HCMOS:



## 6.2. OUTPUT WAVEFORM

Output waveform HCMOS:



## 6.3. SOLDERING INFORMATION

Hand solder only – not reflow compatible. See ABSOLUTE MAXIMUM RATINGS.



#### 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 in the built-in crystal 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 built-in crystal 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.

## 7. COMPLIANCE INFORMATION

Micro Crystal confirms that the standard product Oven Controlled Oscillator OCXO 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 OCXO-Series.pdf](#)

## 8. DOCUMENT REVISION HISTORY

Date	Revision #	Revision Details
November 2012	9.0	Initial version
February 2022	10.0	New extended version

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