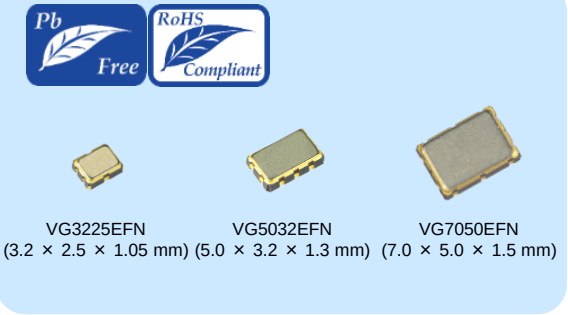
Low Phase Jitter VCXO: VG3225EFN/VG5032EFN/VG7050EFN

Features

- Voltage controlled crystal oscillator (VCXO)
- Frequency range (fo): 25 MHz to 500 MHz (VG3225EFN)
  25 MHz to 250 MHz (All other)
- Output: LVPECL
- Absolute pull range: ±50 / ±20 / ±10 × 10^{-6} Min.
- Supply voltage: 3.3 V Typ.
- Operating temperature: -40 °C to +85 °C / +105 °C
- Low phase jitter: 55 fs Typ. (fo = 122.88 MHz)
  22 fs Typ. (fo = 491.52 MHz)



Applications

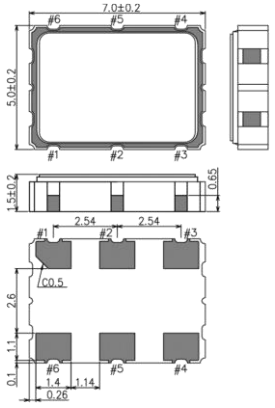
- 5G (5th Generation) Base Station, RRH
- Optical Transmission System (400ZR, 800ZR)
- Broadcast Equipment, Professional Video Equipment
- High Speed Converters like ADC and DAC

Description

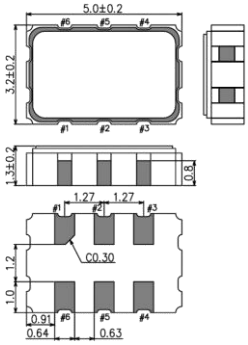
5G commercial service is being rapidly deployed worldwide from 2020. A 5G communication network needs to maintain high speed and high reliability, both of which need low noise. The F series VCXO described above uses a high frequency fundamental mode crystal oscillator (up to 500 MHz) which can provide a low phase noise reference clock resulting in reduction in system noise and enabling overall improvement in system throughput.

Outline Drawing and Terminal Assignment

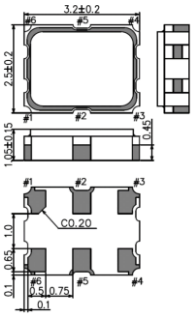
VG7050EFN



VG5032EFN



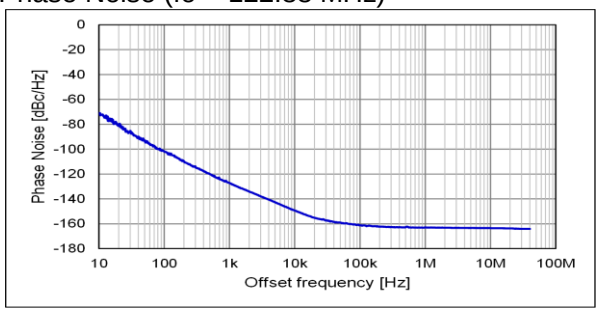
VG3225EFN



Pin	Connection
1	Vc
2	OE
3	GND
4	OUT
5	$\overline{OUT}$
6	V_{CC}

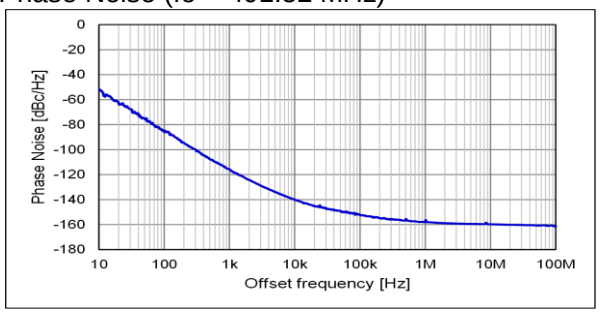
Typical Performance

Phase Noise (fo = 122.88 MHz)



Phase Jitter (12 kHz to 20 MHz): 55 fs Typ.

Phase Noise (fo = 491.52 MHz)



Phase Jitter (12 kHz to 20 MHz): 22 fs Typ.

[1] Product Number / Product Name

(1-1) Product Number

VG3225EFN: X1G005361xxxx00
VG5032EFN: X1G005471xxxx00
VG7050EFN: X1G005491xxxx00 (Please contact Epson for details)

(1-2) Product Name (Standard Form)

VG3225 E FN 122.880000MHz C J H H B A
① ② ③ ④⑤⑥⑦⑧⑨

①Model
②Output (E: LVPECL)
③Frequency
④Supply voltage
⑤Frequency tolerance
⑥Operating temperature
⑦OE function
⑧Absolute pull range
⑨Output standby type

④Supply voltage	
C	3.3 V Typ.

⑤Frequency tolerance	
J	±50 × 10^{-6} Max.

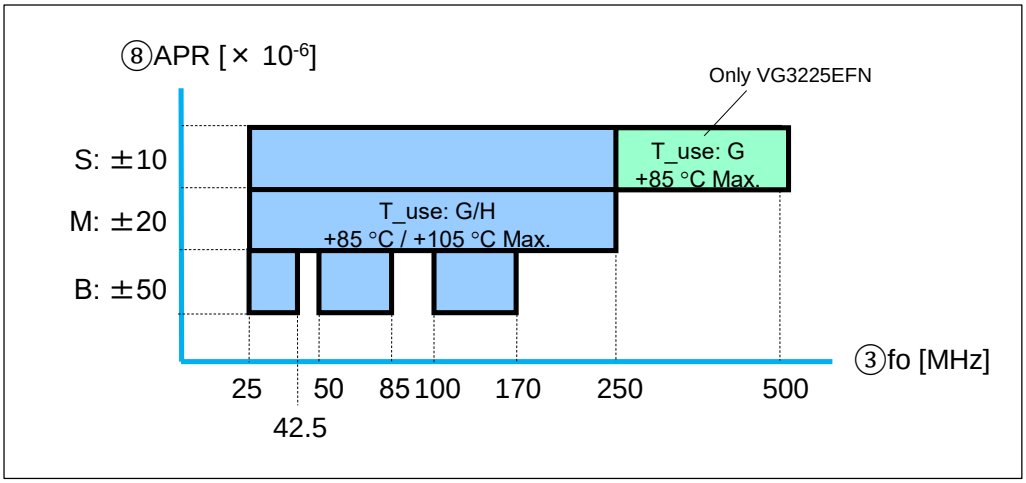
⑥Operating temperature	
G	-40 °C to +85 °C
H	-40 °C to +105 °C

⑦OE function	
H	Active High

⑧Absolute pull range	
B	±50 × 10^{6} Min.
M	±20 × 10^{6} Min.
S	±10 × 10^{6} Min.

⑨Output standby type	
A	High-Z

Available combinations of specifications



[2] Absolute Maximum Ratings

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Maximum supply voltage	V_{CC}	-0.5	-	+5.0	V	
Input voltage	Vin	-0.5	-	V_{CC} + 0.5	V	OE terminal
Storage temperature range	T_stg	-55	-	+125	°C	

[3] Operating Range

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Supply voltage	V_{CC}	3.135	3.3	3.465	V	Suffix: C
Supply voltage	GND	0.0	0.0	0.0	V	
Control voltage	Vc	0.0	1.65	3.3	V	
Operating temperature range	T_use	-40	+25	+85	°C	Suffix: G
		-40	+25	+105	°C	Suffix: H
ECL load condition	L_ECL	50			Ω	Terminated to V_{CC} - 2.0 V

* Power supply startup time (0 %V_{CC}→90 %V_{CC}) should be more than 150 µs
* A 0.01 µF and a 0.1 µF bypass capacitor should be connected between V_{CC} and GND pins located close to the device

[4] Frequency Characteristics

(Unless stated otherwise [3] Operating Range, Vc = 1.65 V)

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Output frequency *1	fo	25	-	500	MHz	VG3225EFN
		25	-	250	MHz	VG5032EFN, VG7050EFN
Frequency tolerance *2	f_tol	-50	-	+50	$\times 10^{-6}$	Suffix: J

*1 Please contact Epson for available frequencies.
*2 Frequency tolerance includes Initial frequency tolerance, Frequency / temperature characteristics, Frequency / voltage coefficient and aging (10 years, +25 °C).

[5] Frequency Control Characteristics

(Unless stated otherwise [3] Operating Range)

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Absolute pull range *1	APR	±50	-	-	$\times 10^{-6}$	Suffix: B 25 MHz ≤ fo ≤ 42.5 MHz, 50 MHz ≤ fo ≤ 85 MHz, 100 MHz ≤ fo ≤ 170 MHz
		±20	-	-	$\times 10^{-6}$	Suffix: M 25 MHz ≤ fo ≤ 250 MHz
		±10	-	-	$\times 10^{-6}$	Suffix: S 25 MHz ≤ fo ≤ 250 MHz
						250 MHz < fo ≤ 500 MHz, T_use: G (-40 °C to +85 °C)
Input impedance	Zin	10	-	-	MΩ	DC level
Linearity *2	F_{LIN}	-	±5	±10	%	
Modulation bandwidth	BW	10	15	-	kHz	±3 dB, 25 MHz ≤ fo ≤ 250 MHz
		7	10	-	kHz	±3 dB, 250 MHz < fo ≤ 500 MHz
Frequency change polarity	f_cp	Positive			-	

*1 Absolute pull range = Frequency control range - Frequency tolerance
*2 Deviation from best linear fit.

[6] Electrical Characteristics (Unless stated otherwise [3] Operating Range)

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Start-up time	t_str	-	-	10	ms	t = 0 at 90 %V_{CC}
Current consumption	I_{CC}	-	-	60	mA	
Disable current	I_dis	-	-	25	mA	OE = GND
Rise time / Fall time	tr / tf	-	-	0.5	ns	20 % - 80 % (V_{OH} - V_{OL})
Symmetry	SYM	45	50	55	%	At output crossing point
Output voltage	V_{OH}	V_{CC} - 1.1	-	-	V	DC characteristics
	V_{OL}	-	-	V_{CC} - 1.5	V	
Differential swing	V_{SW}	800	-	2 000	mV	Differential output peek to peek voltage
Input voltage	V_{IH}	70 % V_{CC}	-	-	V	OE terminal
	V_{IL}	-	-	30 % V_{CC}	V	
Output disable time (OE)	tstp_oe	-	-	100	ns	OE terminal HIGH → LOW
Output enable time (OE)	tsta_oe	-	-	500	ns	OE terminal LOW → HIGH
Phase jitter (fo = 100 MHz)	t_{PJ}	-	-	160	fs	Offset frequency 12 kHz to 20 MHz
Phase jitter (fo = 122.88 MHz)	t_{PJ}	-	-	120	fs	
Phase jitter (fo = 153.6 MHz)	t_{PJ}	-	-	110	fs	
Phase jitter (fo = 245.76 MHz)	t_{PJ}	-	-	80	fs	
Phase jitter (fo = 307.2 MHz)	t_{PJ}	-	-	70	fs	
Phase jitter (fo = 350 MHz)	t_{PJ}	-	-	70	fs	
Phase jitter (fo = 450 MHz)	t_{PJ}	-	-	70	fs	
Phase jitter (fo = 491.52 MHz)	t_{PJ}	-	-	70	fs	
G-sensitivity	Gs	-	2	4	10^9/g	Vibration frequency 20 Hz to 200 Hz

[7] Thermal Resistance (For reference only)

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Junction temperature	Tj	-	-	140	°C	
Junction to case	θjc	-	97.9	-	°C/W	VG3225EFN
		-	102.6	-	°C/W	VG5032EFN
		-	42.6	-	°C/W	VG7050EFN
Junction to ambient	θja	-	155.4	-	°C/W	VG3225EFN
		-	150.1	-	°C/W	VG5032EFN
		-	75.2	-	°C/W	VG7050EFN

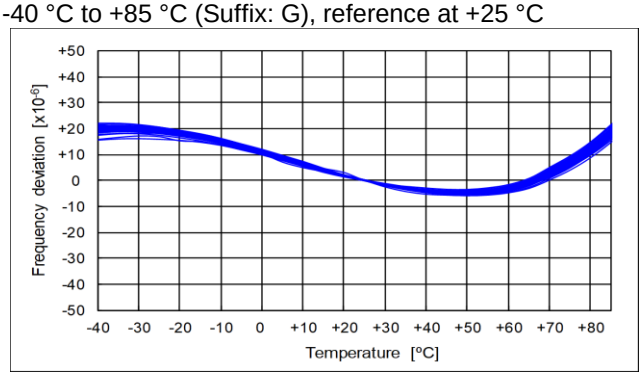
[8] Typical Performance Characteristics (For reference only)

The following data shows typical performance characteristics

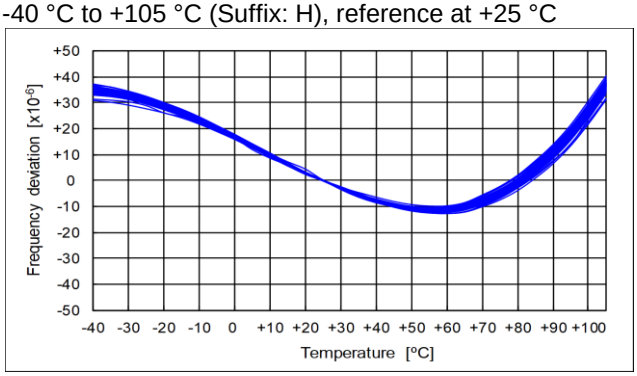
(8-1) Frequency / Temperature Characteristics

fo = 100 MHz n = 50 pcs

-40 °C to +85 °C (Suffix: G), reference at +25 °C

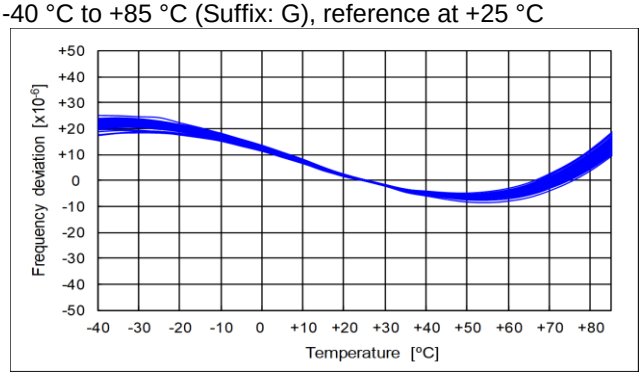


-40 °C to +105 °C (Suffix: H), reference at +25 °C

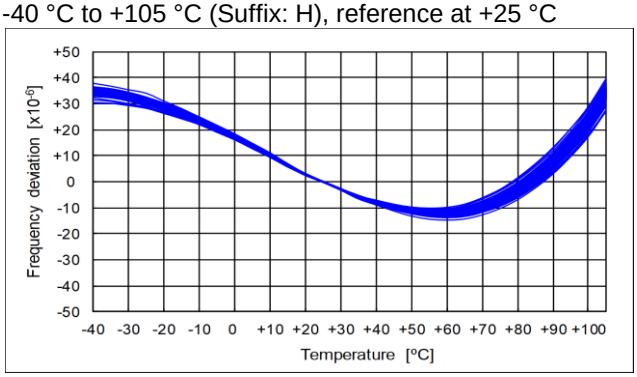


fo = 122.88 MHz n = 50 pcs

-40 °C to +85 °C (Suffix: G), reference at +25 °C

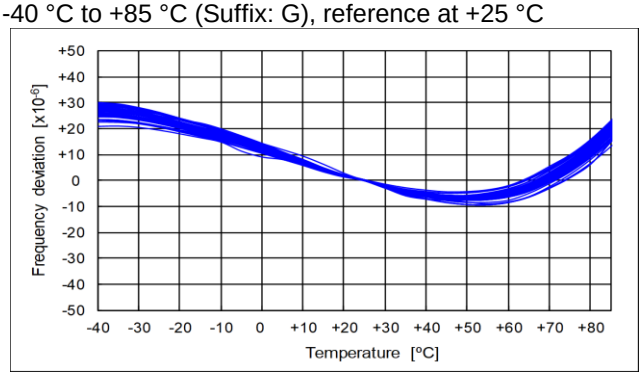


-40 °C to +105 °C (Suffix: H), reference at +25 °C

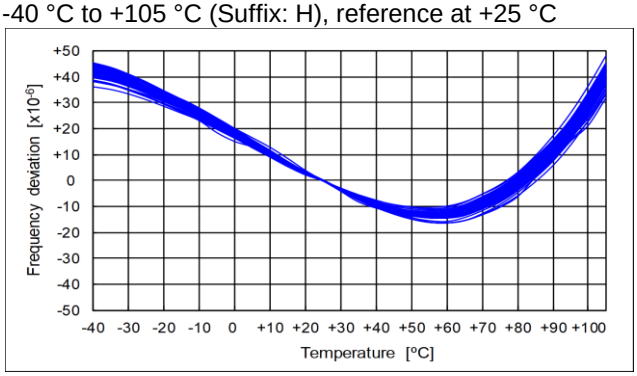


fo = 245.76 MHz n = 50 pcs

-40 °C to +85 °C (Suffix: G), reference at +25 °C

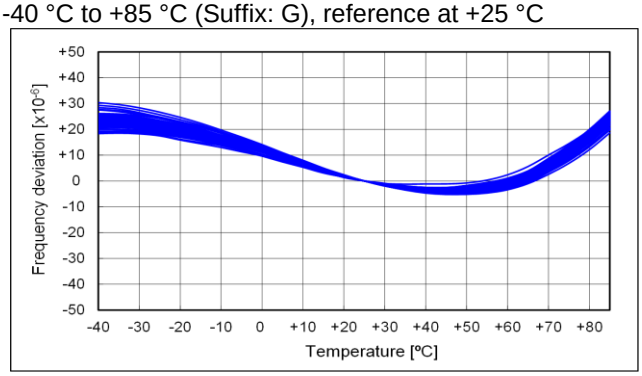


-40 °C to +105 °C (Suffix: H), reference at +25 °C

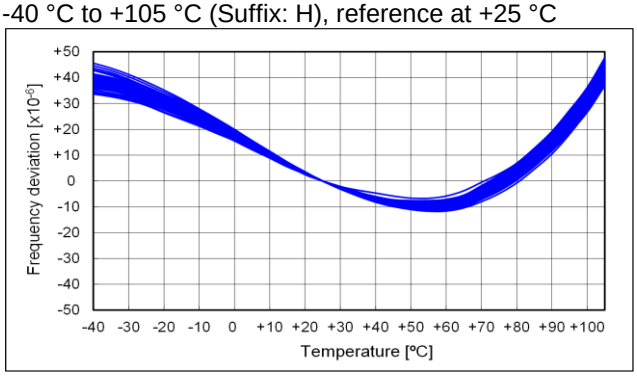


fo = 491.52 MHz n = 50 pcs

-40 °C to +85 °C (Suffix: G), reference at +25 °C

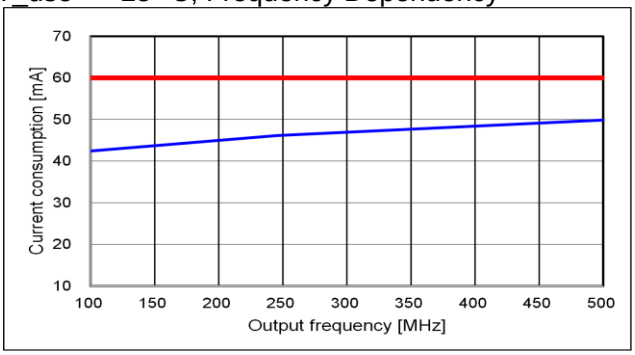


-40 °C to +105 °C (Suffix: H), reference at +25 °C

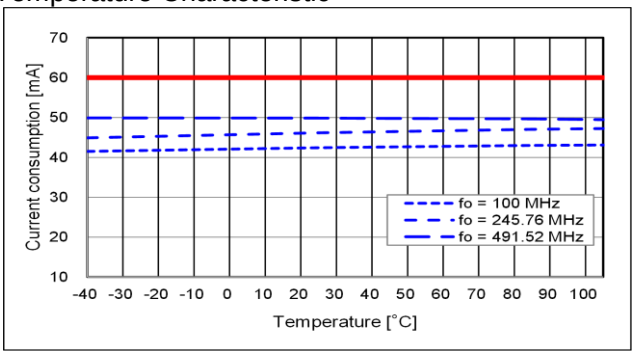


(8-2) Current Consumption

T_use = +25 °C, Frequency Dependency



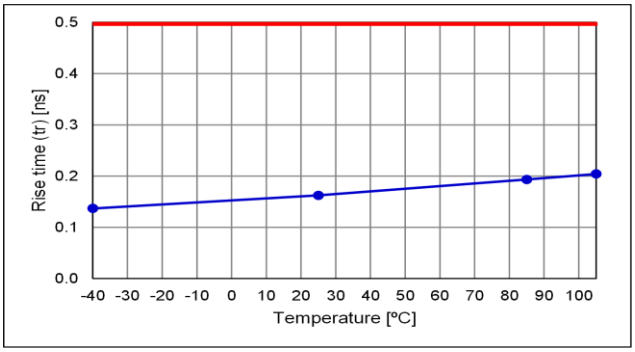
Temperature Characteristic



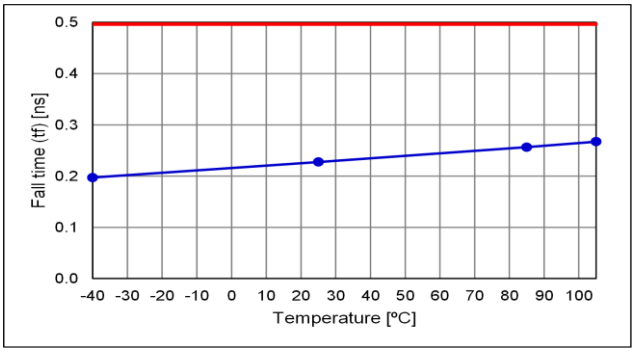
(8-3) Rise Time / Fall Time Temperature Characteristic

fo = 100 MHz

Rise Time

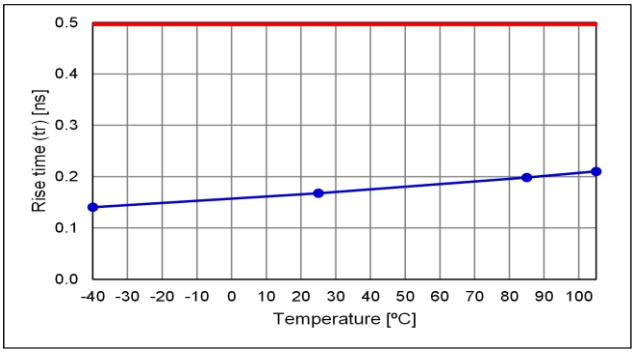


Fall Time

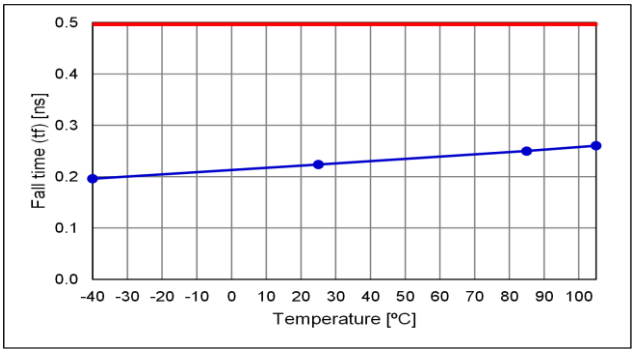


fo = 245.76 MHz

Rise Time

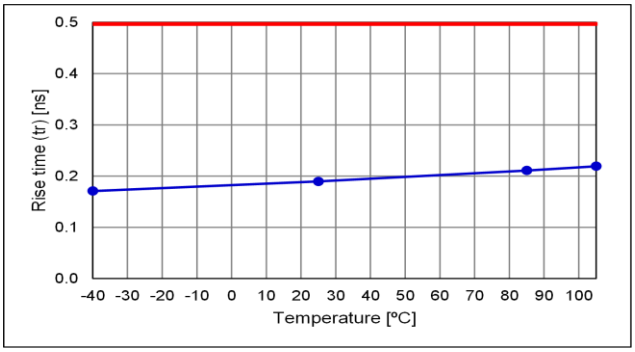


Fall Time

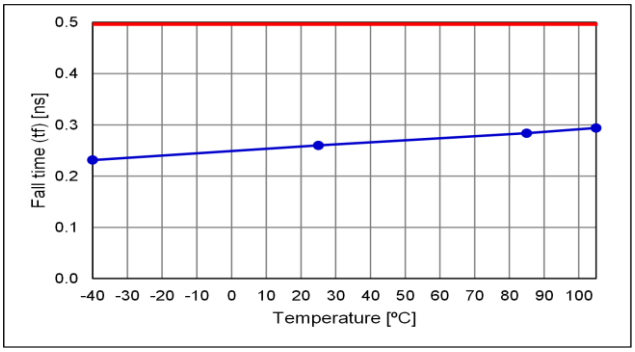


fo = 491.52 MHz

Rise Time

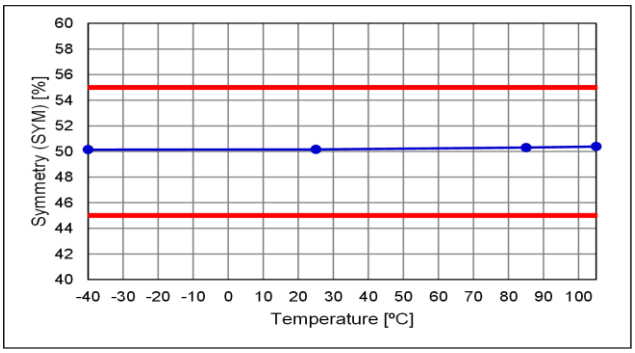


Fall Time

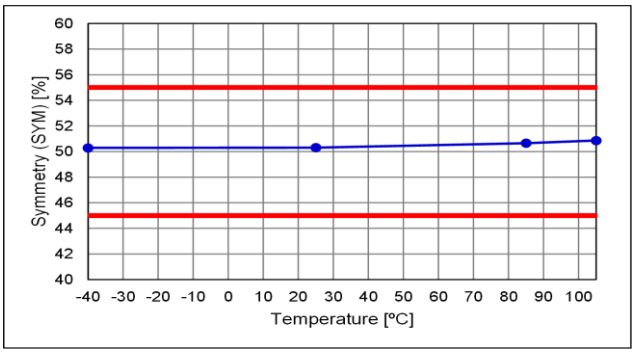


(8-4) Symmetry Temperature Characteristic

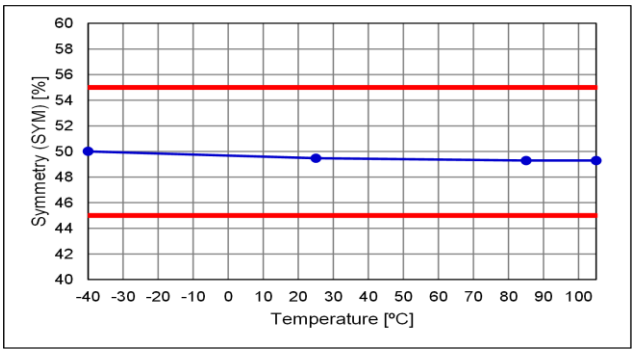
fo = 100 MHz



fo = 245.76 MHz

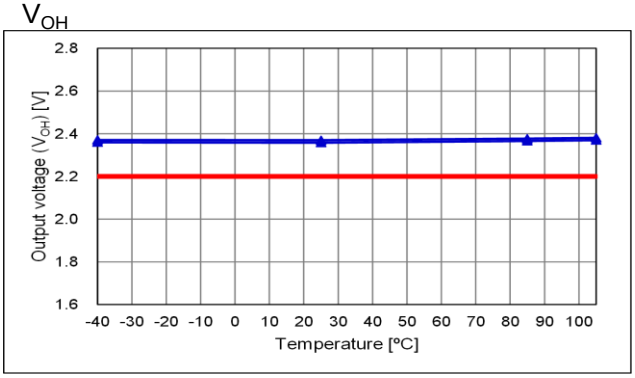


fo = 491.52 MHz

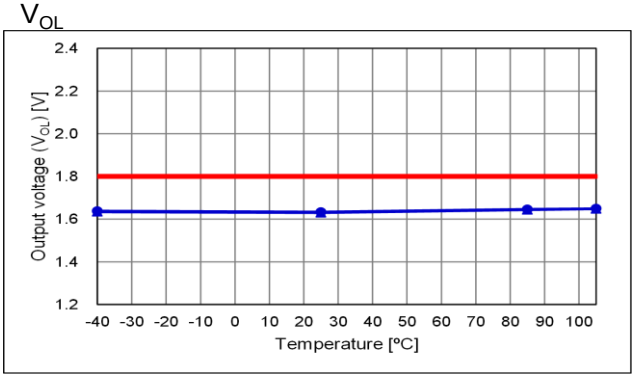


(8-5) Output Voltage Temperature Characteristic

V_{OH}

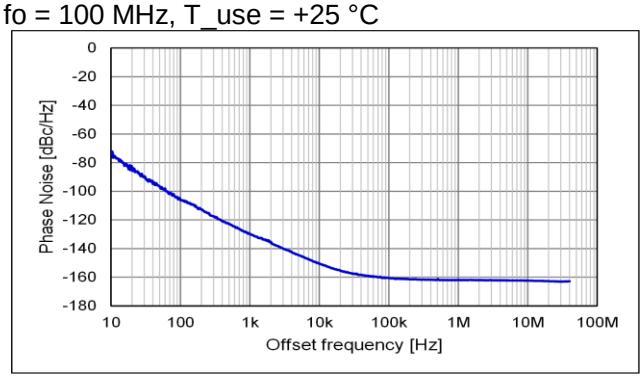


V_{OL}



(8-6) Phase Noise and Phase Jitter

fo = 100 MHz, T_use = +25 °C



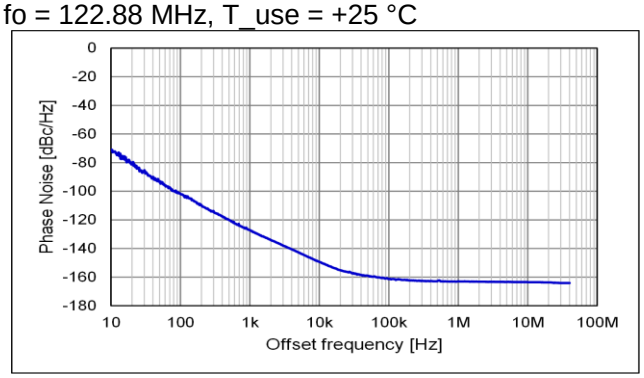
[Units: dBc/Hz]

100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-106.2	-129.8	-150.5	-160.5	-161.8	-162.4

Phase jitter: 76 fs

* Offset frequency: 12 kHz to 20 MHz

fo = 122.88 MHz, T_use = +25 °C



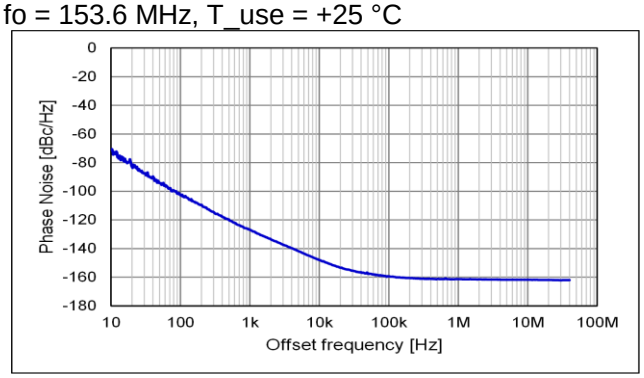
[Units: dBc/Hz]

100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-101.8	-127.2	-149.4	-161.3	-162.9	-163.5

Phase jitter: 55 fs

* Offset frequency: 12 kHz to 20 MHz

fo = 153.6 MHz, T_use = +25 °C



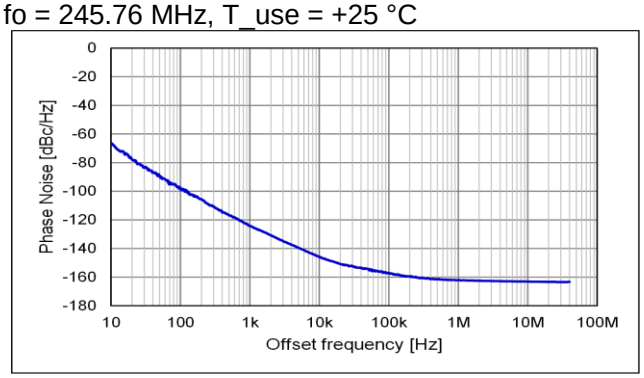
[Units: dBc/Hz]

100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-102.8	-126.9	-148.1	-159.4	-161.4	-161.8

Phase jitter: 53 fs

* Offset frequency: 12 kHz to 20 MHz

fo = 245.76 MHz, T_use = +25 °C



[Units: dBc/Hz]

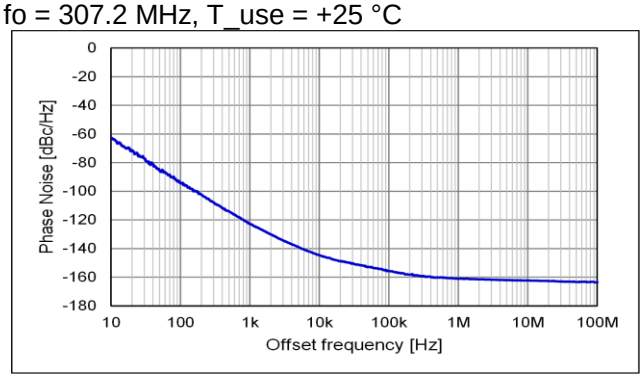
100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-98	-124.2	-145.8	-157	-162.1	-163.1

Phase jitter: 30 fs

* Offset frequency: 12 kHz to 20 MHz

(8-6) Phase Noise and Phase Jitter [cont'd]

fo = 307.2 MHz, T_use = +25 °C



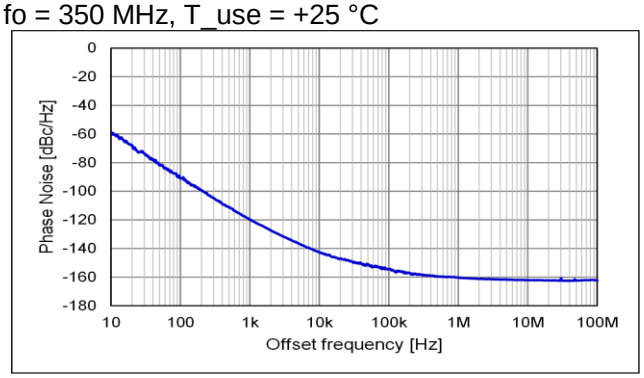
[Units: dBc/Hz]

100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-94.4	-122.9	-144.7	-155.8	-161.1	-162.3

Phase jitter: 26 fs

* Offset frequency: 12 kHz to 20 MHz

fo = 350 MHz, T_use = +25 °C



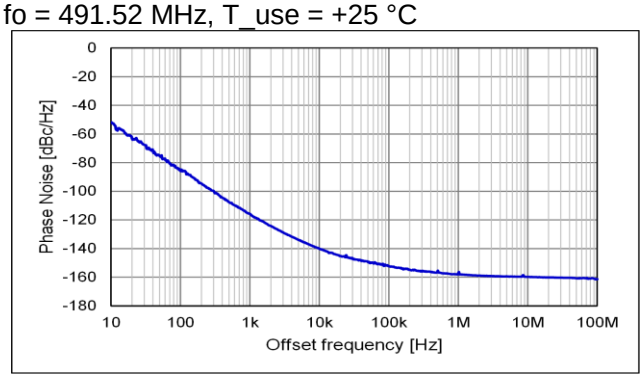
[Units: dBc/Hz]

100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-91	-119.9	-142.6	-154.4	-160.4	-162.1

Phase jitter: 24 fs

* Offset frequency: 12 kHz to 20 MHz

fo = 491.52 MHz, T_use = +25 °C



[Units: dBc/Hz]

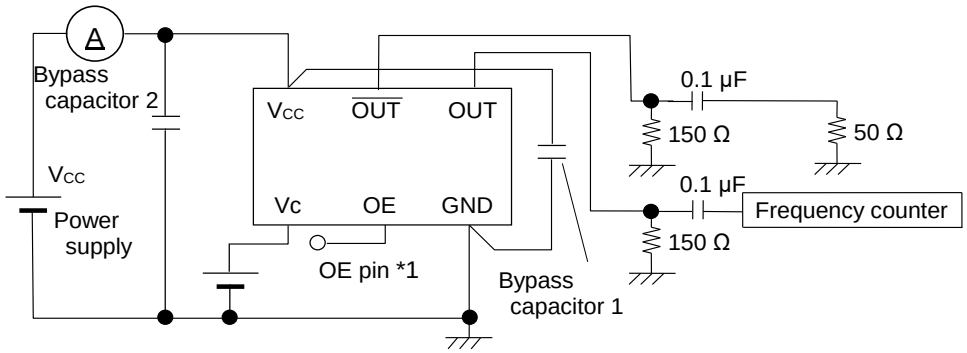
100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
-85.9	-115.8	-140.2	-152.2	-157.4	-159.8

Phase jitter: 22 fs

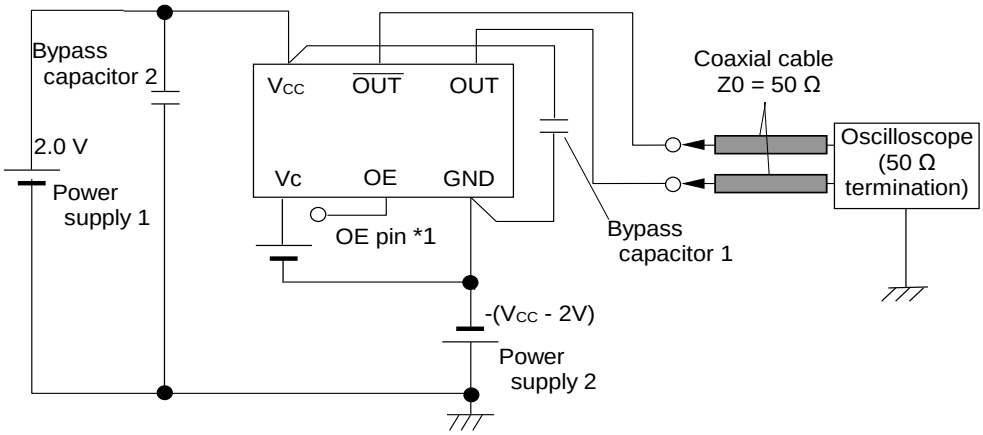
* Offset frequency: 12 kHz to 20 MHz

[9] Test Circuit

(9-1) Output Frequency and Current Consumption Test Setup



(9-2) Waveform Observation Test Setup



* Each output trace should be same length

* To measure Disable Current, OE terminal is connected to GND

(9-3) Conditions

(1) Oscilloscope

The bandwidth should be a minimum of 5 times wider than the measurement frequency

(2) A 0.1 µF and a 10 µF bypass capacitor should be connected between V_{CC} and GND pins located close to the device

(3) Use a current meter with a low internal impedance

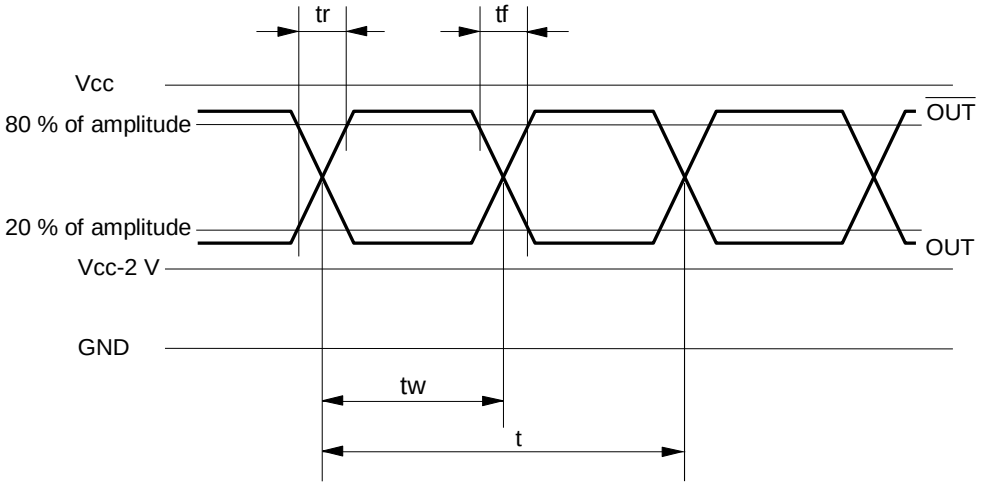
(4) Power Supply

Power supply startup time (0 %V_{CC}→90 %V_{CC}) should be more than 150 µs

Power supply impedance should be as low as possible

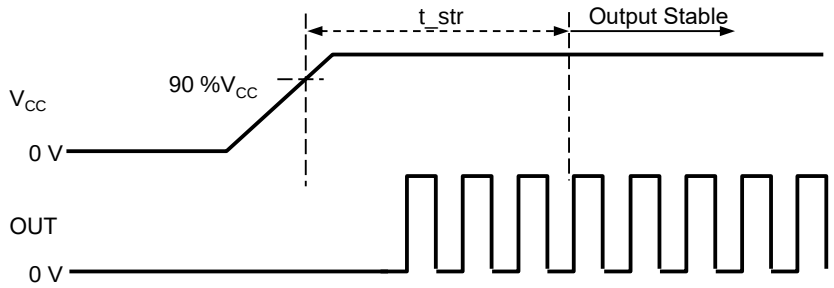
(9-4) Timing Chart

(1) Output Waveform and Level



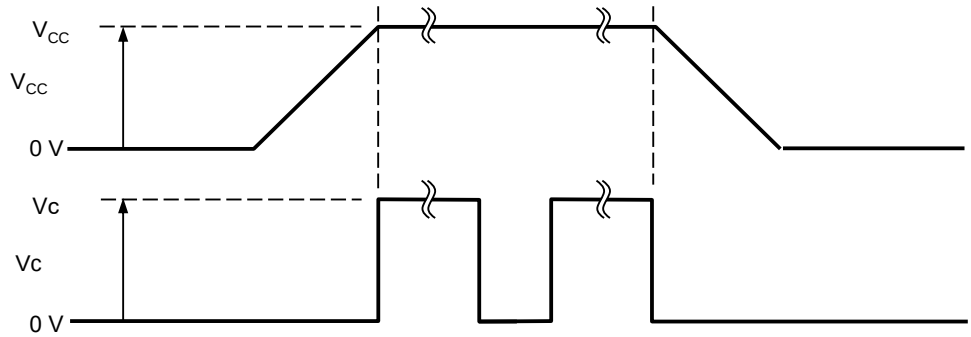
SYM = tw / t× 100 [%]

(2) Output Frequency Timing



(3) Control Voltage (Vc) Timing

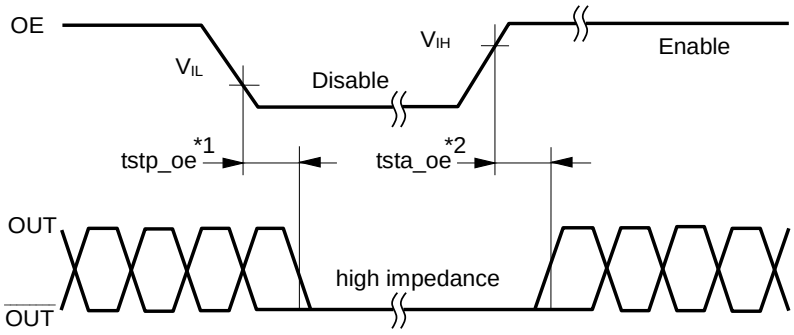
* Please apply the control voltage (Vc) after the startup of the supply voltage (V_{CC}).



(9-4) Timing Chart [cont'd]

(4) OE Function and Timing

OE Terminal	Osc. Circuit	Output status
"H" or OPEN	Oscillation	Specified frequency is output: Enable
"L"	Oscillation	Output becomes high impedance: Disable



*1 The period from OE = V_{IL} to OUT = High impedance (Disable)

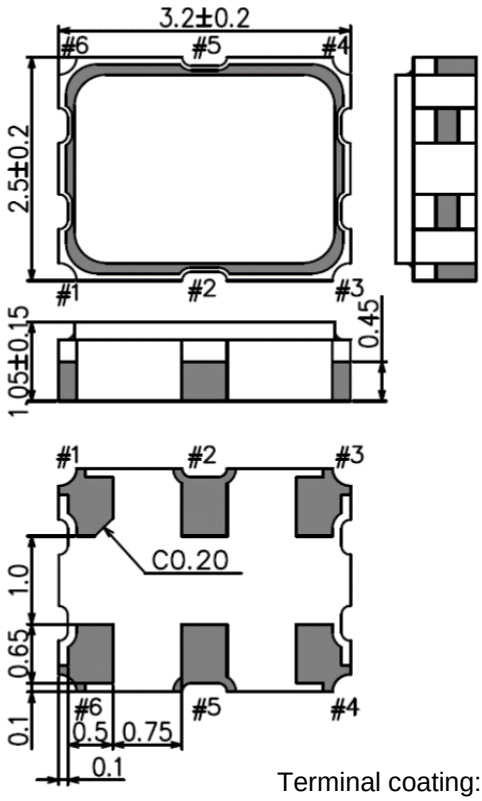
*2 The period from OE = V_{IH} to OUT = Enable

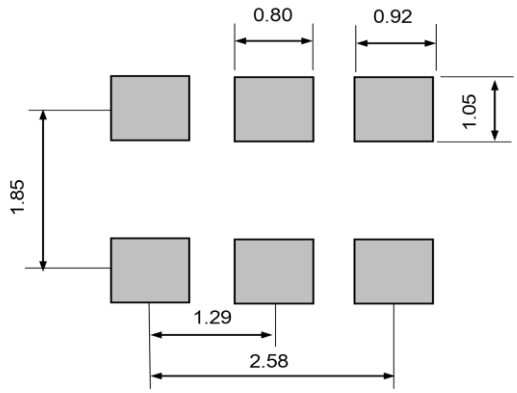
* OE terminal voltage level should not exceed supply voltage when using OE function.
Please note that OE rise time should not exceed supply voltage rise time at the start-up.

[10] Outline Drawing and Recommended Footprint

(10-1) VG3225EFN

Units: mm





For stable operation, it is recommended that 0.1 µF and 10 µF bypass capacitors should be connected between V_{CC} and GND and placed as close to the V_{CC} pin as possible.

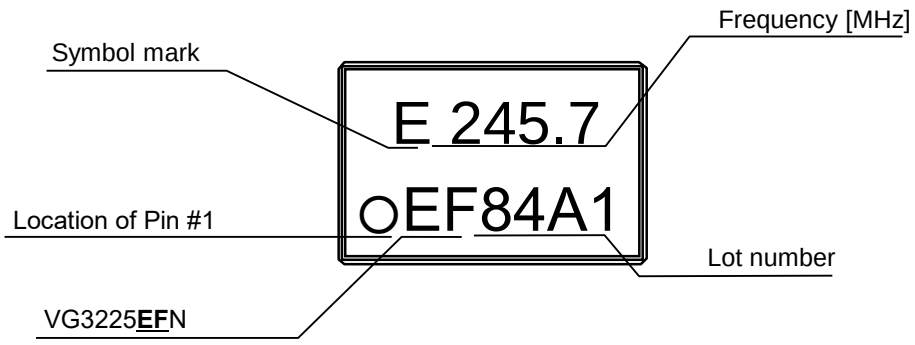
Terminal coating: Au plating

Reference Weight Typ.: 26 mg

Terminal Assignment

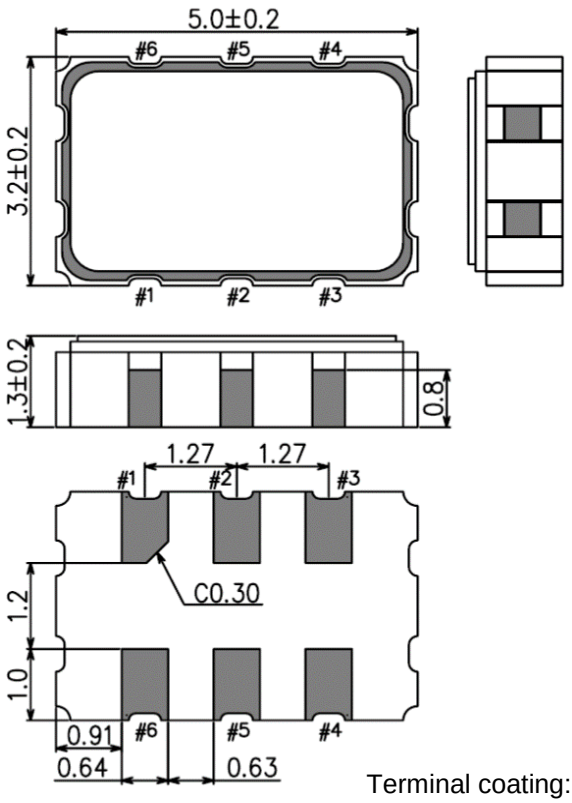
Pin #	Connection	Function		
#1	Vc	Vc terminal		
#2	OE	OE terminal / active high		
		OE function	Osc. circuit	Output
		"H" or OPEN	Oscillation	Specified frequency: Enable
		"L"	Oscillation	High impedance: Disable
#3	GND	GND terminal		
#4	OUT	Output terminal (Positive)		
#5	$\overline{OUT}$	Output terminal (Negative)		
#6	V_{CC}	V_{CC} terminal		

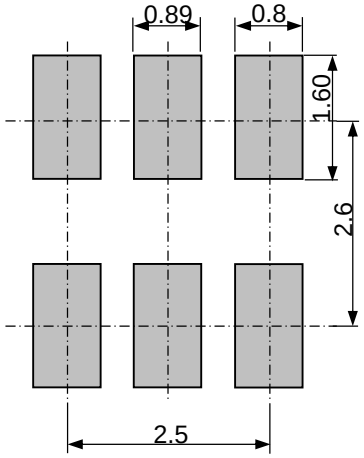
Marking



(10-2) VG5032EFN

Units: mm





For stable operation, it is recommended that 0.1 µF and 10 µF bypass capacitors should be connected between V_{CC} and GND and placed as close to the V_{CC} pin as possible.

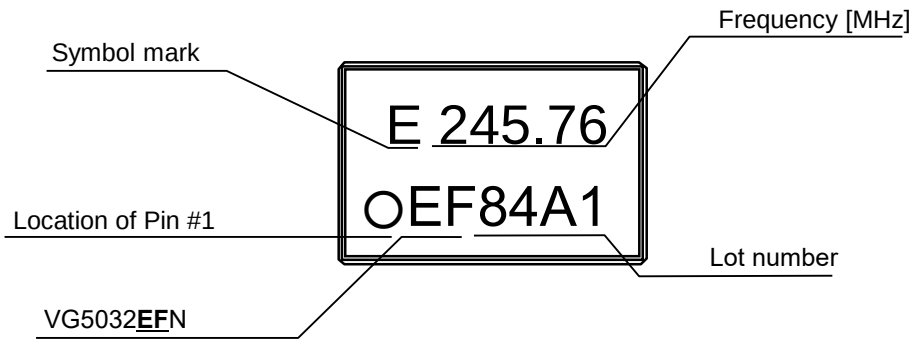
Terminal coating: Au plating

Reference Weight Typ.: 66 mg

Terminal Assignment

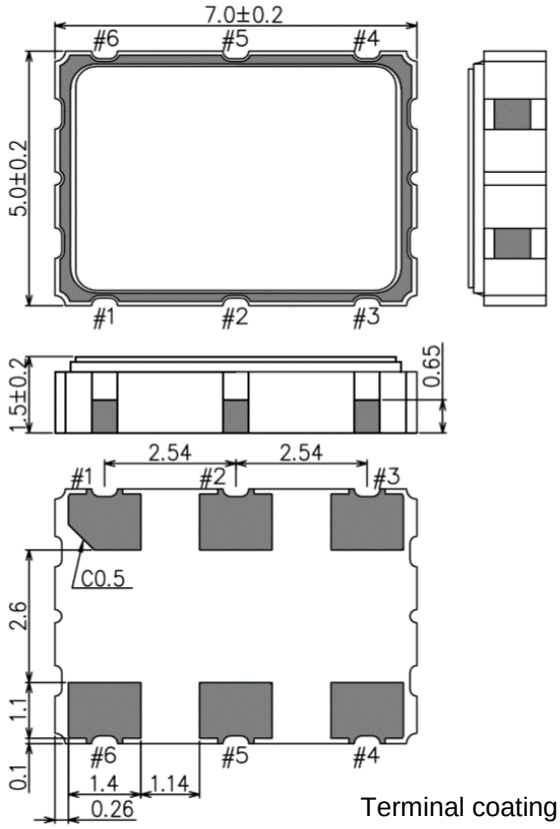
Pin #	Connection	Function		
#1	Vc	Vc terminal		
#2	OE	OE terminal / active high		
		OE function	Osc. circuit	Output
		"H" or OPEN	Oscillation	Specified frequency: Enable
		"L"	Oscillation	High impedance: Disable
#3	GND	GND terminal		
#4	OUT	Output terminal (Positive)		
#5	$\overline{OUT}$	Output terminal (Negative)		
#6	V_{CC}	V_{CC} terminal		

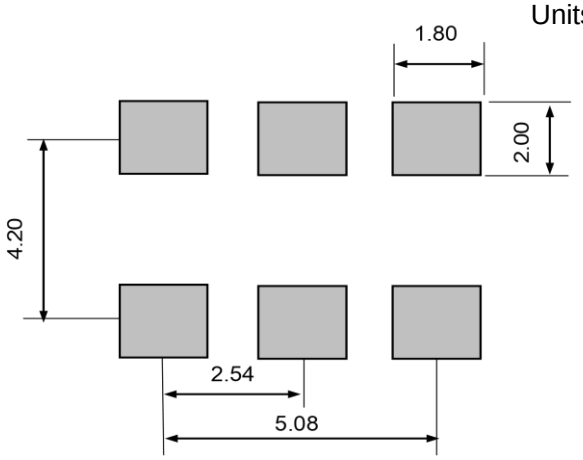
Marking



(10-3) VG7050EFN

Units: mm





For stable operation, it is recommended that 0.1 µF and 10 µF bypass capacitors should be connected between V_{CC} and GND and placed as close to the V_{CC} pin as possible.

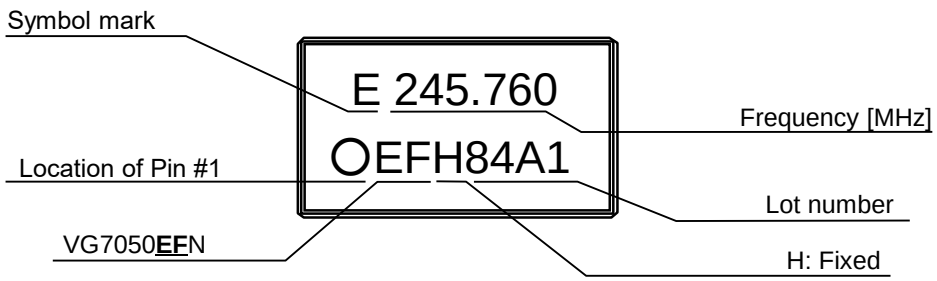
Terminal coating: Au plating

Reference Weight Typ.: 172 mg

Terminal Assignment

Pin #	Connection	Function		
#1	Vc	Vc terminal		
#2	OE	OE terminal / active high		
		OE function	Osc. circuit	Output
		"H" or OPEN	Oscillation	Specified frequency: Enable
		"L"	Oscillation	High impedance: Disable
#3	GND	GND terminal		
#4	OUT	Output terminal (Positive)		
#5	$\overline{OUT}$	Output terminal (Negative)		
#6	V_{CC}	V_{CC} terminal		

Marking



[11] Moisture Sensitivity Level and Electro-Static Discharge Ratings

(11-1) Moisture Sensitivity Level (MSL)

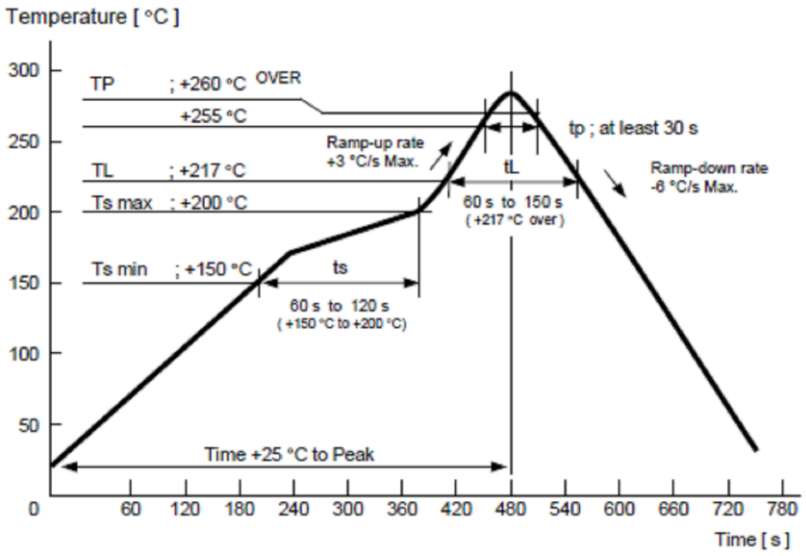
Parameter	Specification	Conditions
MSL	LEVEL 1	IPC/JEDEC J-STD-020D.1

(11-2) Electro-Static Discharge (ESD)

Parameter	Specification	Conditions
HBM	2 000 V Min.	IEC 60749-26 Ed. 2.0:2006 (b), 100 pF, 1.5 kΩ, 3 times
MM	200 V Min.	IEC 60749-27 Ed. 2.0:2006 (b), 200 pF, 0 Ω, 1 time

[12] Reflow Profile

IPC/JEDEC J-STD-020D.1



[13] Packing Information

(13-1) VG3225EFN

(1) Packing Quantity

The last two digits of the Product Number (X1G005361xxxx**xx**) are a code that defines the packing quantity. The standard is "00" for a 2 000 pcs/Reel.

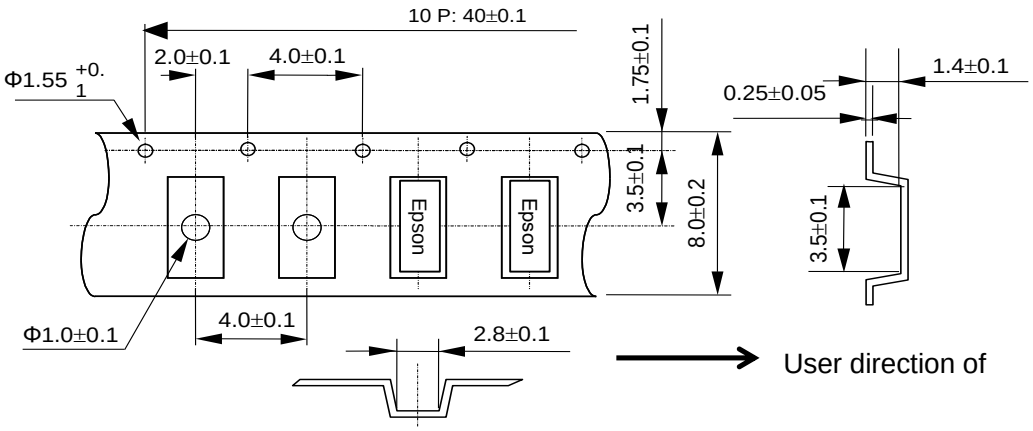
(2) Taping Specification

Subject to EIA-481, IEC-60286 and JIS C0806

1) Tape Dimensions

Carrier Tape Material: PS (Polystyrene)

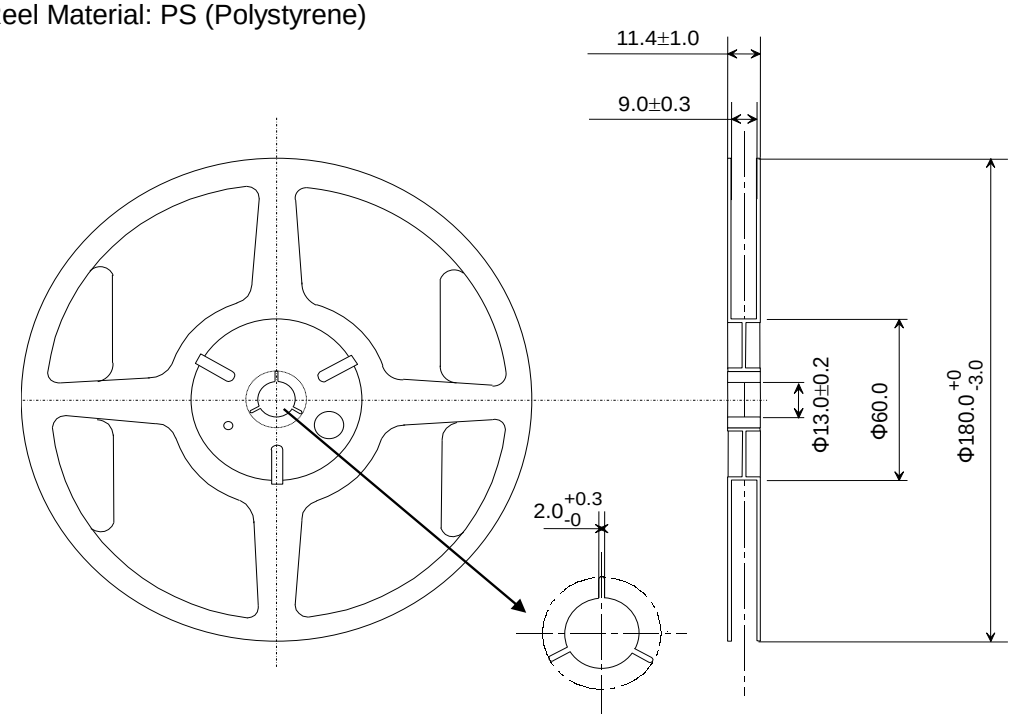
Top Tape Material: PET (Polyethylene Terephthalate) + PE (Polyethylene) Units: mm



2) Reel Dimensions

Center Material: PS (Polystyrene)

Reel Material: PS (Polystyrene) Units: mm



3) Storage Environment

We recommend to keep at normal temperature and normal humidity in a packed condition.

(13-2) VG5032EFN

(1) Packing Quantity

The last two digits of the Product Number (X1G005471xxxx**xx**) are a code that defines the packing quantity. The standard is "00" for a 1 000 pcs/Reel.

(2) Taping Specification

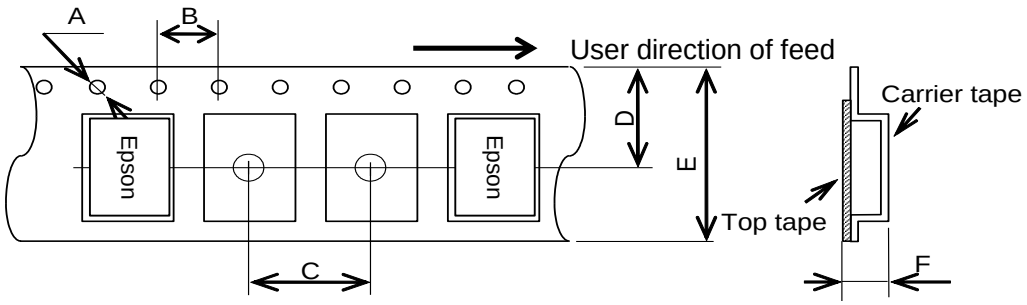
Subject to EIA-481, IEC-60286 and JIS C0806

1) Tape Dimensions

Carrier Tape Material: PS (Polystyrene)

Top Tape Material: PET (Polyethylene Terephthalate)

Units: mm



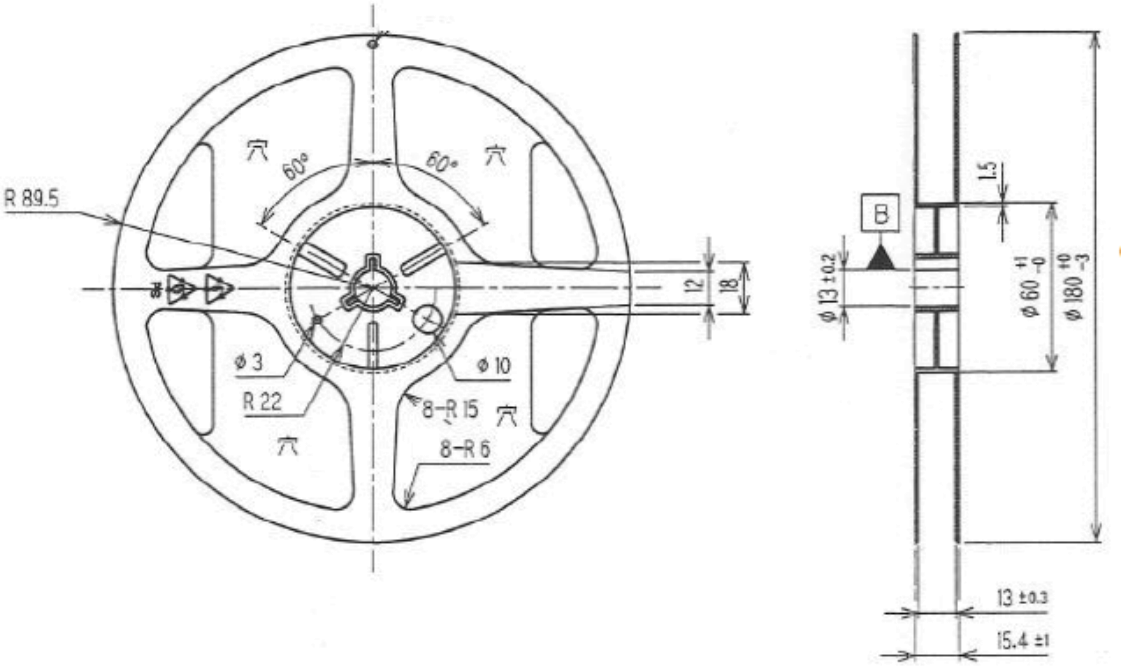
Symbol	A	B	C	D	E	F	G	H
Dimension	Φ1.5	4.0	8.0	7.25	12.0	1.7	3.5	5.4

2) Reel Dimensions

Center Material: PS (Polystyrene)

Reel Material: PS (Polystyrene)

単位: mm



3) Storage Environment

We recommend to keep at normal temperature and normal humidity in a packed condition.

(13-3) VG7050EFN

(1) Packing Quantity

The last two digits of the Product Number (X1G005491xxxx**xx**) are a code that defines the packing quantity. The standard is "00" for a 1 000 pcs/Reel.

(2) Taping Specification

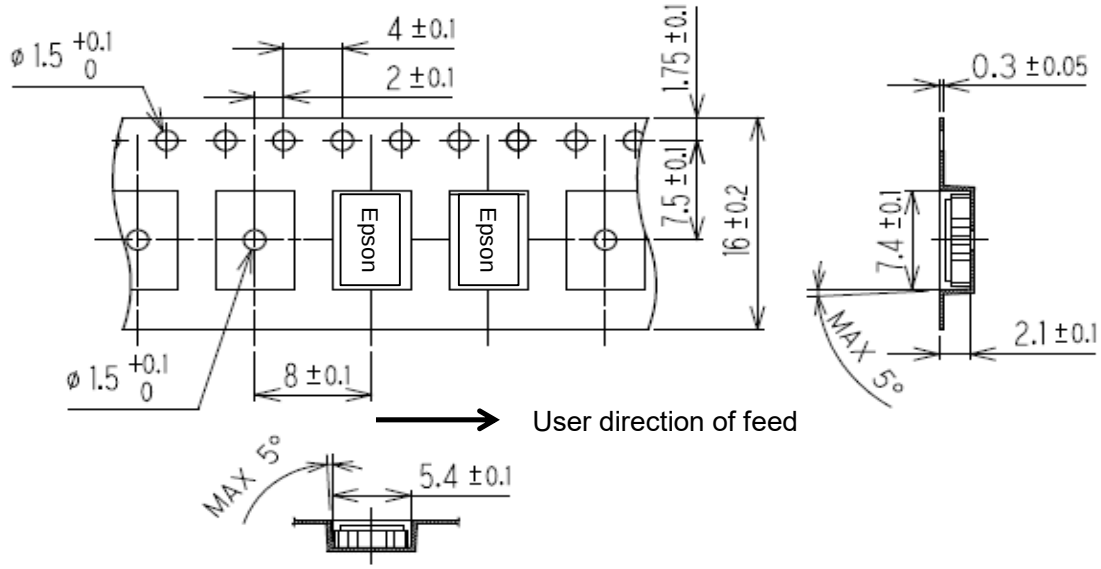
Subject to EIA-481, IEC-60286 and JIS C0806

1) Tape Dimensions

Carrier Tape Material: PS (Polystyrene)

Top Tape Material: PET (Polyethylene Terephthalate)

Units: mm

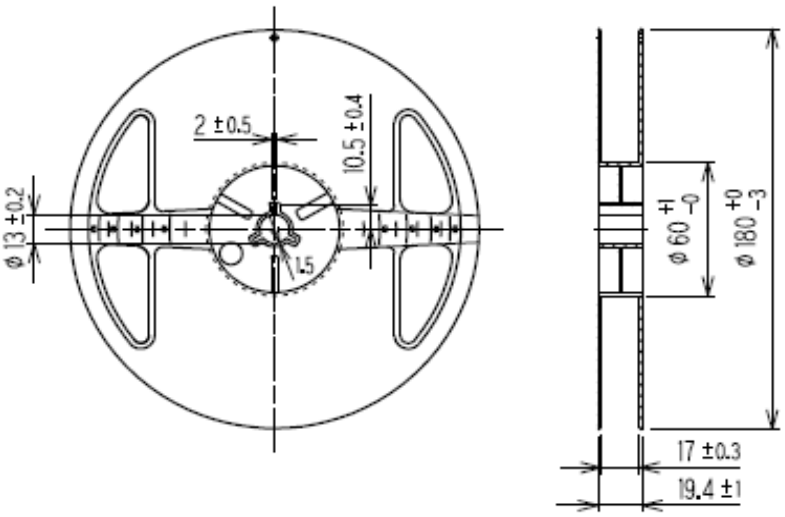


2) Reel Dimensions

Center Material: PS (Polystyrene)

Reel Material: PS (Polystyrene)

Units: mm



3) Storage Environment

We recommend to keep at normal temperature and normal humidity in a packed condition.

[14] Handling Precautions

Prior to using this product, please carefully read the section entitled “Precautions” on our Web site (https://www5.epsondevice.com/en/information/#precaution) for instructions on how to handle and use the product properly to ensure optimal performance of the product in your equipment.
Before using the product under any conditions other than those specified therein, please consult with us to verify and confirm that the performance of the product will not be negatively affected by use under such conditions.
In addition to the foregoing precautions, in order to avoid the deteriorating performance of the product, we strongly recommend that you DO NOT use the product under ANY of the following conditions:

(1) Do not expose this product to excessive mechanical shock or vibration.
(2) This product can be damaged by mechanical shock during the soldering process depending on the equipment used, process conditions, and any impact forces experienced. Always follow appropriate procedures, particularly when changing the assembly process in any way and be sure to follow applicable process qualification standards before starting production.
(3) These devices are sensitive to ESD, use appropriate precautions during handling, assembly, test, shipment, and installation.
(4) The use of ultrasonic technology for cleaning, bonding, etc. can damage the Xtal unit inside this product. Please carefully check for this consideration before using ultrasonic equipment for volume production with this product.
(5) Noise and ripple on the power supply may have undesirable affects on operation and cause degradation of phase noise characteristics. Evaluate the operation of this device with appropriate power supplies carefully before use.
(6) When applying power, ensure that the supply voltage increases monotonically for proper operation. On power down, do not reapply power until the supplies, bypass capacitors, and any bulk capacitors are completely discharged since that may cause the unit to malfunction.
(7) Aging specifications are estimated from environmental reliability tests and expected frequency variation over time. They do not provide a guarantee of aging over the product lifecycle.
(8) The metal cap on top of the device is directly connected to the GND terminal (pin #2). Take necessary precautions to prevent any conductor not at ground potential from contacting the cap as that could cause a short circuit to GND.
(9) Do not route any signal lines, supply voltage lines, or GND lines underneath the area where the oscillators are mounted including any internal layers and on the opposite side of the PCB. To avoid any issues due to interference of other signal lines, please take care not to place signal lines near the product as this may have an adverse affect on the performance of the product.
(10) A bypass capacitor of the recommended value(s) must be connected between the V_{CC} and GND terminals of the product. Whenever possible, mount the capacitor(s) on the same side of the PCB and as close to the product as possible to keep the routing traces short.
(11) Power supply connections to V_{CC} and GND pins should be routed as thick as possible while keeping the high frequency impedance low in order to get the best performance.
(12) The use of a filter or similar element in series with the power supply connections to protect from electromagnetic radiation noise may increase the high frequency impedance of the power supply line and may cause the oscillator to not operate properly. Please verify the design to ensure sufficient operational margin prior to use.
(13) Keep PCB routing from the output terminal(s) to the load as short as possible for best performance.
(14) The Enable (OE or $\overline{ST}$) input terminal is high impedance and so susceptible to noise. Connect it to a low impedance source when used and when not used it is recommended to connect it to Vcc for active high inputs and GND for active low inputs.
(15) Do not short the output to GND as that will damage the product. Always use with an appropriate load resistor connected.
(16) This product should be reflowed no more than 3 times. If rework is needed after reflow, please correct it with a soldering iron with the tip set for a temperature of +350 °C or less and only contact each terminal once and for no more than 5 seconds. If this product is mounted on the bottom of the board during a reflow please check that it soldered down properly afterwards.

[Availability of mounting conditions]

Reflow on the board	Available
Reflow under the board	The parts may fall. Please judge whether it is possible to implement.
Soldering pot/bath (Dip soldering system, Flow soldering system)	**Not Available**
Soldering iron	Available

(17) Product failures during the warranty period only apply when the product is used according to the recommended operating conditions described in the specifications. Products that have been opened for analysis or damaged will not be covered. It is recommended to store and use in normal temperature and humidity environments described in the specifications to ensure frequency accuracy and prevent moisture condensation. If the product is stored for more than one year, please confirm the pin solderability prior to use.
(18) If the oscillation circuit is exposed to condensation, the frequency may change or oscillation may stop. Do not use in any conditions where condensation occurs.
(19) Do not store or use the product in an environment where it can be exposed to chemical substances that are corrosive to metal or plastics such as salt water, organic solvents, chemical gasses, etc. Do not use the product when it is exposed to sunlight, dust, corrosive gasses, or other materials for long periods of time.
(20) When using water-soluble solder flux make sure to completely remove the flux residue after soldering. Pay particular attention when the residues contain active halogens which will negatively affect the product and its performance.
(21) Terminals on the side of the product are internally connected to the IC, be careful not to cause short-circuits or reduce the insulation resistance of them in any way.
(22) Should any customer use the product in any manner contrary to the precautions and/or advice herein, such use shall be done at the customer’s own risk.

PROMOTION OF ENVIRONMENTAL MANAGEMENT SYSTEM CONFORMING TO INTERNATIONAL STANDARDS

At Seiko Epson, all environmental initiatives operate under the Plan-Do-Check-Action (PDCA) cycle designed to achieve continuous improvements. The environmental management system (EMS) operates under the ISO 14001 environmental management standard.

All of our major manufacturing and non-manufacturing sites, in Japan and overseas, completed the acquisition of ISO 14001 certification.

ISO 14000 is an international standard for environmental management that was established by the International Standards Organization in 1996 against the background of growing concern regarding global warming, destruction of the ozone layer, and global deforestation.

WORKING FOR HIGH QUALITY

In order provide high quality and reliable products and services than meet customer needs, Seiko Epson made early efforts towards obtaining ISO9000 series certification and has acquired ISO9001 for all business establishments in Japan and abroad. We have also acquired IATF 16949 certification that is requested strongly by major manufacturers as standard.

IATF 16949 is the international standard that added the sector-specific supplemental requirements for automotive industry based on ISO9001.

■ Explanation of marks used in this datasheet

Pb Free	●**Pb free.**
RoHS Compliant	●**Complies with EU RoHS directive.** *About the products without the Pb-free mark. Contains Pb in products exempted by EU RoHS directive (Contains Pb in sealing glass, high melting temperature type solder or other)

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