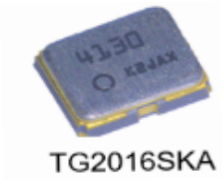
# TCXO for Automotive 105 ºC High temperature range AEC-Q100 compliant TG2016SKA: -40 ºC to +105 ºC




## Features

- ·Output frequency : 13 MHz to 55 MHz
- ·Supply voltage : 1.8 V Typ. / 2.8 V Typ. / 3.0 V Typ. / 3.3 V Typ.
- ·Operation temperature : -40 °C to +105 °C
- ·Frequency / temperature characteristics : ±0.5 × $10^{-6}$ Max.
- ·G-sensitivity : ±1.5 × $10^{-9}$ /G Max.
- ·Phase Jitter (12kHz to 5MHz) : 0.22 ps Typ. @ 26 MHz , 0.13 ps Typ. @ 38.4 MHz
- ·External dimensions : 2.0 × 1.6 × 0.7 mm Max.
- ·AEC-Q100 compliant, VC-TCXO / TCXO / TCXO-Standby function

## Description

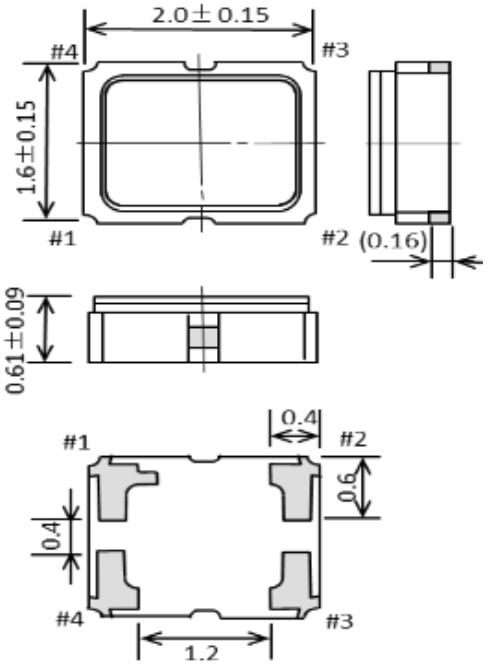
TG2016SKA are automotive grade AEC-Q100 compliant temperature-compensated crystal oscillators. Using an Epson-developed and fabricated IC and MHz fundamental crystal, it supports high temperatures up to 105 ºC, features a frequency slope and G sensitivity suitable for GNSS reception, and low jitter suitable for Wi-Fi used for V2X.

## Target Application

- GNSS for Automotive
- V2X (TCU, DSRC)*

* GNSS: Global Navigation Satellite System
V2X: Vehicle to Everything
TCU: Telematics control unit
DSRC: Dedicated Short Range Communication

## Outline dimensions

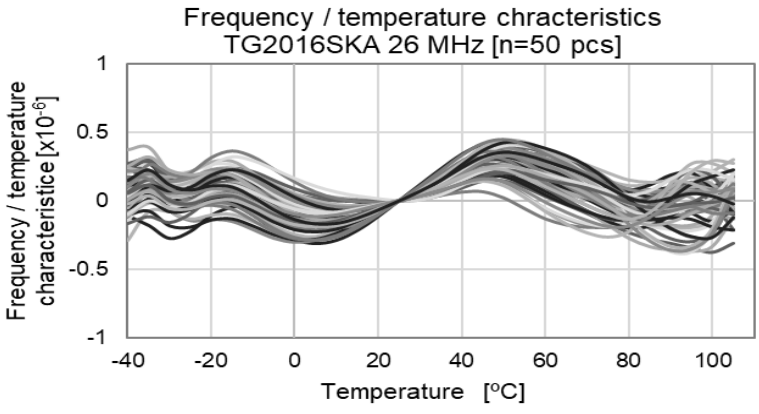



## Pin information

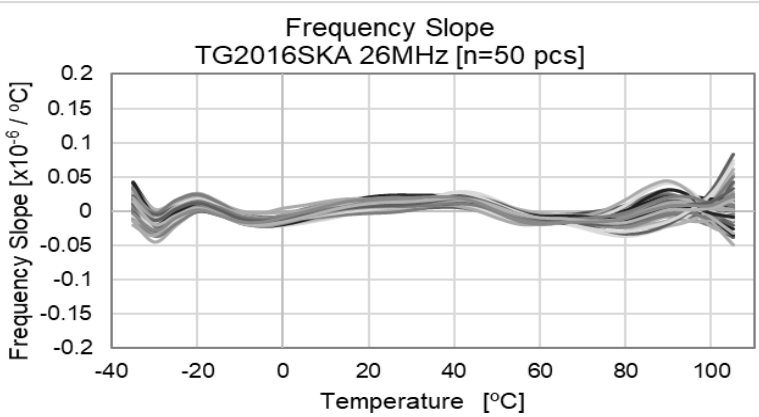
| Pin # | Connection | | |
|---|---|---|---|
| | VC-TCXO | TCXO | Standby |
| 1 | Vc | N.C. | $\overline{ST}$ |
| 2 | GND | | |
| 3 | OUT | | |
| 4 | Vcc | | |

## Characteristics

### Frequency / temperature characteristics




### Frequency slope




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## [ 1 ] Product Number / Product Name

### (1) Product Name (Standard Form)

TG2016 SKA 26.000000MHz E C H N N M
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

①Model (TG2016) ②Output (S: Clipped sine wave) ③Frequency ④Supply voltage (Refer to symbol table)
⑤Frequency / temperature characteristics (C: ±0.5 × $10^{-6}$ Max.) ⑥Operating temperature (H: -40 ºC to +105 ºC, G: -40 ºC to +85 ºC)
⑦Standby function (N: Non, S: Standby) ⑧$V_C$ function (Refer to symbol table, N: Non for TCXO, Standby) ⑨Internal identification code

| ④ Supply voltage [$V_{CC}$], ⑧ Vc function [Vc] (Symbol table) | | | | | |
|---|---|---|---|---|---|
| Voltage [V] | TCXO | VC-TCXO | | | |
| ④ $V_{CC}$ (Typ.) | E: 1.8 | E: 1.8 | B: 2.8 | A: 3.0 | C: 3.3 |
| ⑧ Vc (Typ.) | N: Non | B: 0.9 | C: 1.4 | D: 1.5 | E: 1.65 |

①

### (2) Product Number / Ordering Code

Please refer to the web site for the latest information

| Frequency [MHz] | TG2016SKA ( -40 ºC to +105 ºC) | |
|---|---|---|
| | Vcc = 1.8 V | Vcc = 3.3 V |
| 26 | X1G005371**020016**<br>Suffix: ECHNN**N** | X1G005371**030116**<br>Suffix: CCHNNM |
| 49.58 | X1G005371**020616**<br>Suffix: ECHNNM | X1G005371**030616**<br>Suffix: CCHNNM |

## [ 2 ] Absolute Maximum Ratings

| Parameter | Symbol | Specifications | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | $V_{CC}$-GND | -0.5 | - | +4.0 | V | |
| Frequency control voltage | Vc-GND | -0.3 | - | $V_{CC}$ + 0.3 | V | Vc Terminal |
| Input voltage | $V_{IN}$ | -0.3 | - | $V_{CC}$ + 0.3 | V | $\overline{ST}$ Terminal |
| Storage temperature range | T_stg | -55 | - | +125 | ºC | Storage as single product |

## [ 3 ] Recommended Operating Conditions

| Parameter | Symbol | Specifications | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Supply voltage | Vcc | 1.7 | 1.8 | 1.9 | V | $V_{CC}$ = 1.8 V ± 0.1 V |
| | | 2.66 | 2.8 | 2.94 | V | $V_{CC}$ = 2.8 V ± 5 % |
| | | 2.85 | 3.0 | 3.15 | V | $V_{CC}$ = 3.0 V ± 5 % |
| | | 3.135 | 3.3 | 3.465 | V | $V_{CC}$ = 3.3 V ± 5 % |
| | GND | 0 | - | 0 | V | |
| Frequency control voltage | Vc | 0.3 | 0.9 | 1.5 | V | $V_{CC}$ = 1.8 V |
| | | 0.4 | 1.4 | 2.4 | V | Vc ≤ $V_{CC}$ / 2 |
| | | 0.5 | 1.5 | 2.5 | V | |
| | | 0.65 | 1.65 | 2.65 | V | |
| Operating temperature range | T_use | -40 | +25 | +105 | ºC | TG2016SKA |
| Output load (Clipped sin wave) | Load_R | 9 | 10 | 11 | kΩ | |
| | Load_C | 9 | 10 | 11 | pF | |
| | Cc | 0.01 | - | - | µF | DC-cut capacitor * |

* DC-cut capacitor is not included in this TCXO. Please attach an external DC-cut capacitor to the out pin.

## [ 4 ] Frequency Characteristics

### 1 ) Frequency Characteristics

(Unless stated otherwise [ 3 ] Recommended operating conditions)

| Parameter | Symbol | Specifications | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Output Frequency | fo | 13 | - | 55 | MHz | |
| Frequency tolerance *1 | f_tol | -2.0 | - | +2.0 | $x10^{-6}$ | T_use = +25 ºC ± 2 ºC<br>After 3 reflows *2 |
| Frequency / temperature characteristics | fo-Tc | -0.5 | - | +0.5 | $x10^{-6}$ | T_use = -40 ºC to +105 ºC<br>(Reference to +25 ºC) |
| Frequency / load coefficient | fo-Load | -0.2 | - | +0.2 | $x10^{-6}$ | Load ± 10 % |
| Frequency / voltage coefficient | fo-$V_{CC}$ | -0.2 | - | +0.2 | $x10^{-6}$ | $V_{CC}$ ± 5 % |
| Frequency aging_1 year *3 | f_age | -1.0 | - | +1.0 | $x10^{-6}$ | 13 MHz ≤ fo ≤ 20 MHz<br>26 MHz ≤ fo ≤ 40 MHz |
| | | -1.5 | - | +1.5 | $x10^{-6}$ | 20 MHz < fo < 26 MHz<br>40 MHz < fo ≤ 55 MHz |
| Frequency aging_5 year *3 | f_age | -3.0 | - | +3.0 | $x10^{-6}$ | |
| Frequency aging_10 year *3 | f_age | -5.0 | - | +5.0 | $x10^{-6}$ | |
| G sensitivity | - | - | - | 1.5 | $x10^{-9}$ /G | 3 axes, 30 Hz to 3 000 Hz |

*1 Include initial frequency tolerance and frequency deviation after reflow cycles.
*2 Measured in the elapse of 24 hours after reflow soldering.
*3 Aging stability is estimated from environmental reliability tests; expected amount of the frequency variation.

### 2 ) Frequency Control Characteristics *VC-TCXO only

(Unless stated otherwise [ 3 ] Recommended operating conditions)

| Parameter | Symbol | Specifications | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Frequency control range | f_cont | -15 | - | -8 | $x10^{-6}$ | Vc = 0.9 V - 0.6 V at $V_{CC}$ = 1.8 V<br>Vc = 1.4 V - 1.0 V at $V_{CC}$ = 2.8 V<br>Vc = 1.5 V - 1.0 V at $V_{CC}$ = 3.0 V<br>Vc = 1.65 V - 1.0 V at $V_{CC}$ = 3.3 V |
| | | +8 | - | +15 | $x10^{-6}$ | Vc = 0.9 V + 0.6 V at $V_{CC}$ = 1.8 V<br>Vc = 1.4 V + 1.0 V at $V_{CC}$ = 2.8 V<br>Vc = 1.5 V + 1.0 V at $V_{CC}$ = 3.0 V<br>Vc = 1.65 V +1.0 V at $V_{CC}$ = 3.3 V |
| Input impedance | Zin | 500 | - | - | kΩ | Vc - GND (DC) |
| Frequency change polarity | - | Positive polarity | | | - | |

## [ 5 ] Electrical Characteristics

### 1) Electrical Characteristics

(Unless stated otherwise [ 3 ] Recommended operating conditions)

| Parameter | Symbol | Specifications | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Current consumption | $I_{CC}$ | - | - | 2.0<br>2.5 | mA | 13 MHz ≤ fo ≤ 40 MHz<br>40 MHz < fo ≤ 55 MHz |
| Output level | Vp-p | 0.8 | - | 1.5 | V | Peak to peak voltage |
| Start up time | t_sta | - | - | 2.0 | ms | Until output signal has been reached min 90 % of final amp. |
| | t_sta | - | - | 2.0 | ms | Until frequency has been reached within ±0.5 x $10^{-6}$ of final frequency. |
| Symmetry | SYM | 40 | 50 | 60 | % | GND level (DC-cut) |
| Harmonics | - | - | - | -10.0 | dBc | |
| Phase noise (fo = 26 MHz) * | L(f) | - | -61 | - | dBc/Hz | 1 Hz offset |
| | | - | -90 | - | | 10 Hz offset |
| | | - | -116 | - | | 100 Hz offset |
| | | - | -138 | - | | 1 kHz offset |
| | | - | -155 | - | | 10 kHz offset |
| | | - | -161 | - | | 100 kHz offset |
| | | - | -161 | - | | 1 MHz offset |
| Phase jitter (fo = 26 MHz) * | PJ | - | 0.22 | - | ps | 12 kHz to 5 MHz |

* For other frequencies, refer to Page 9 (6-11) Phase noise

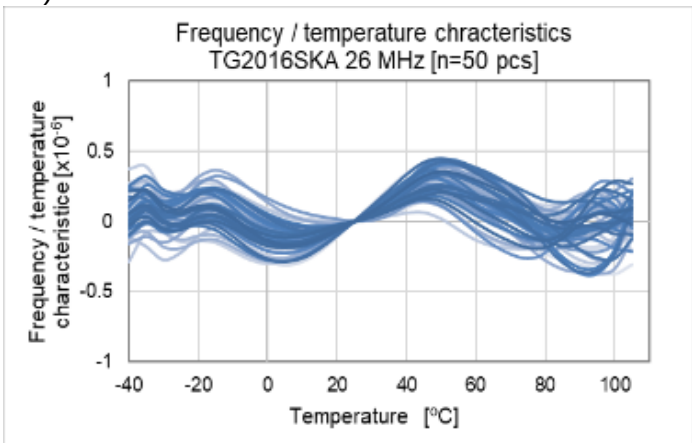
2) Standby Function * Standby-TCXO only (Unless stated otherwise [ 3 ] Recommended operating conditions)

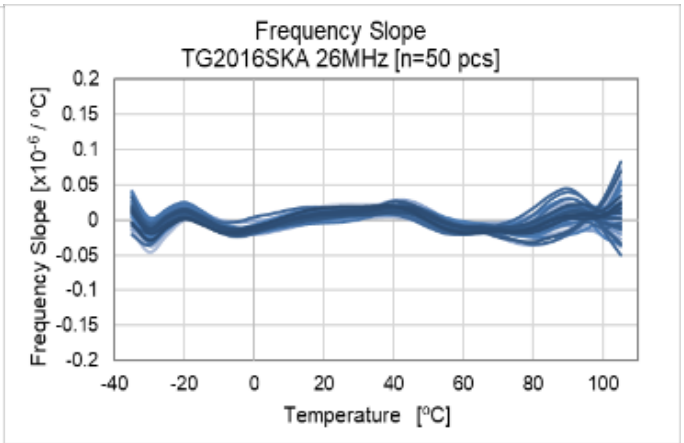
| Parameter | Symbol | Specifications | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Standby current | I_std | - | - | 10 | µA | $\overline{ST}$ = GND |
| Input voltage | $V_{IH}$ | 80 % $V_{CC}$ | - | - | V | $\overline{ST}$ terminal |
| Input voltage | $V_{IL}$ | - | - | 20 % $V_{CC}$ | V | $\overline{ST}$ terminal |
| Output disable time | t_stp | - | - | 150 | ns | $\overline{ST}$ terminal: High to Low |
| Output enable time | t_sta | - | - | 2 | ms | $\overline{ST}$ terminal: Low to High |

## [ 6 ] Characteristic Data

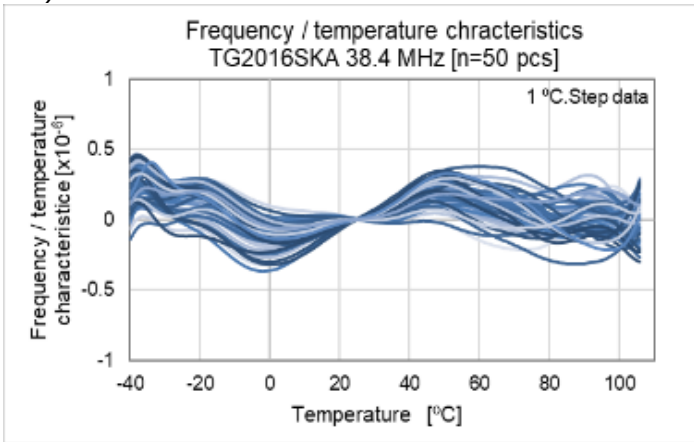
### (6-1) Frequency / Temperature Characteristics & Frequency Slope

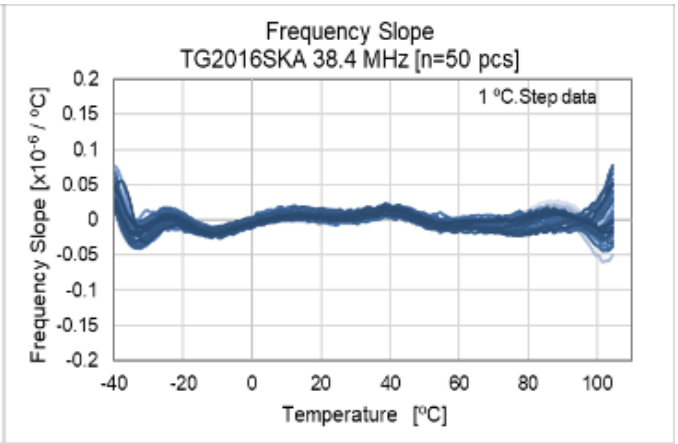
1) fo = 26 MHz



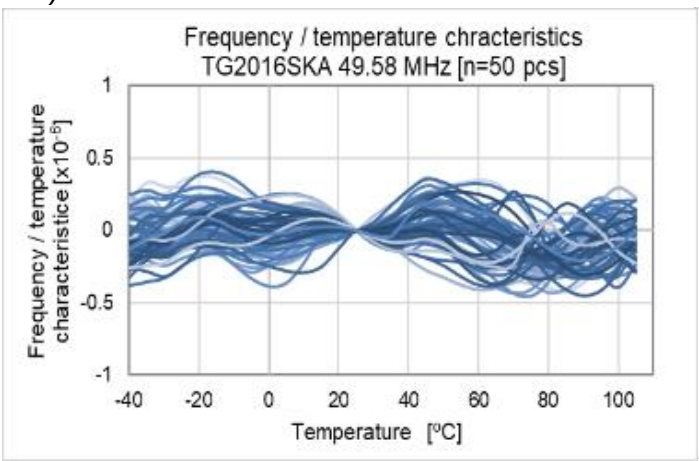



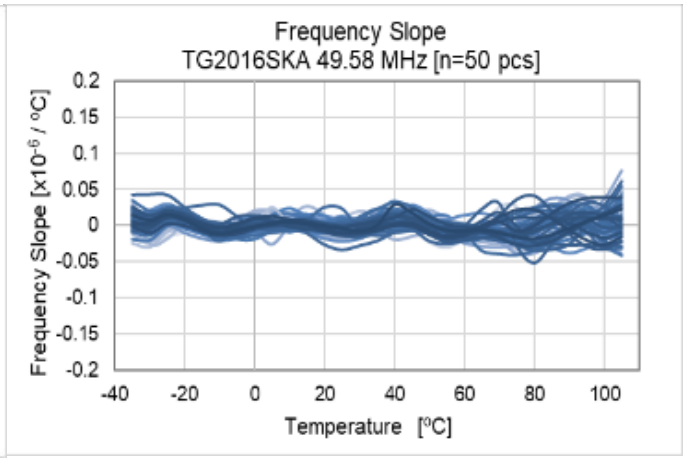

2) fo = 38.4 MHz



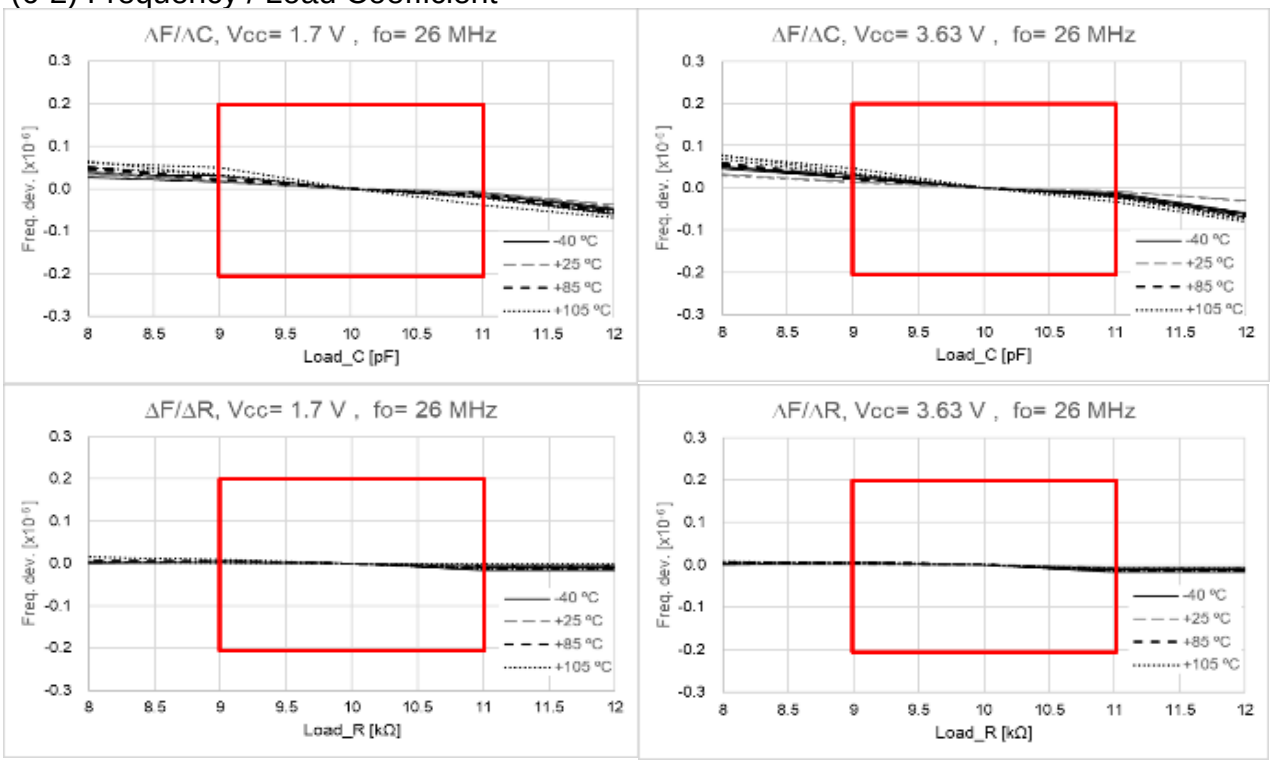




3) fo = 49.58 MHz

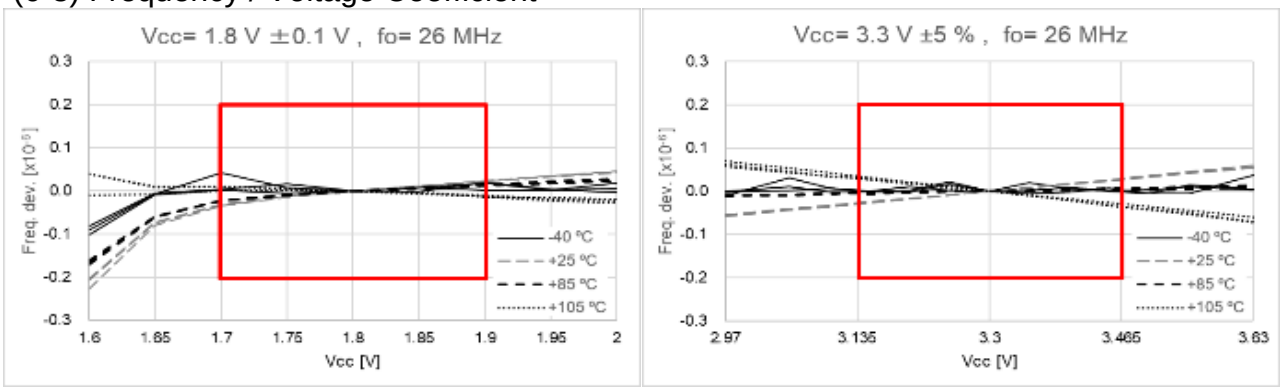


## (6-2) Frequency / Load Coefficient

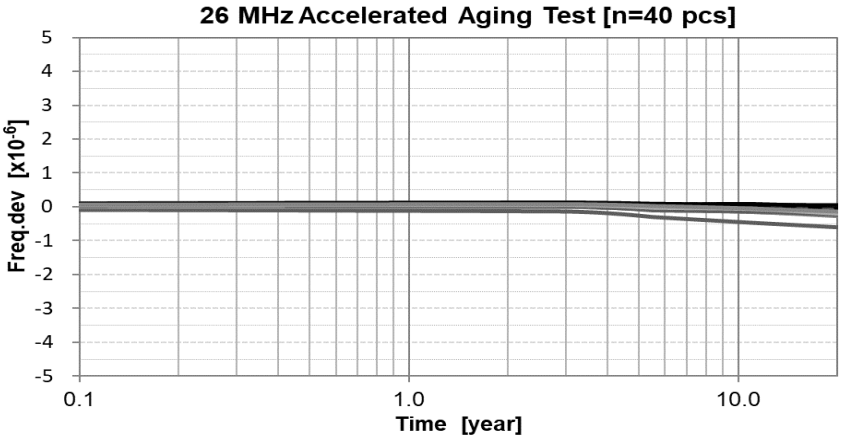



## (6-3) Frequency / Voltage Coefficient

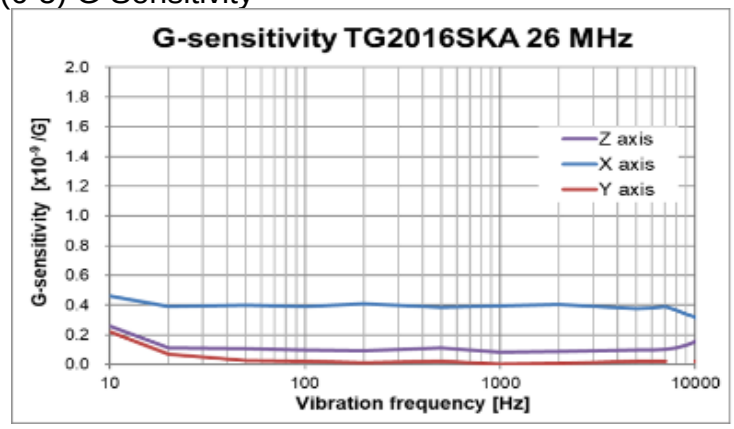


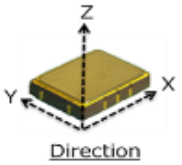

## (6-4) Frequency Aging Conversion

*Aging stability is estimated from environmental reliability tests; expected amount of the frequency variation.
It is not intended as a guarantee of performance over the product-life cycle.

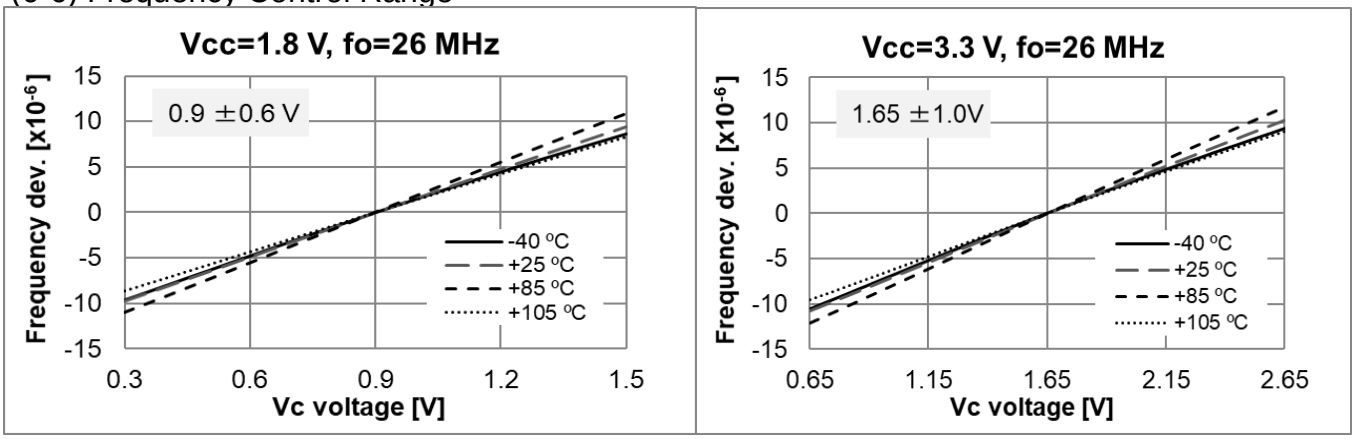


(6-5) G Sensitivity

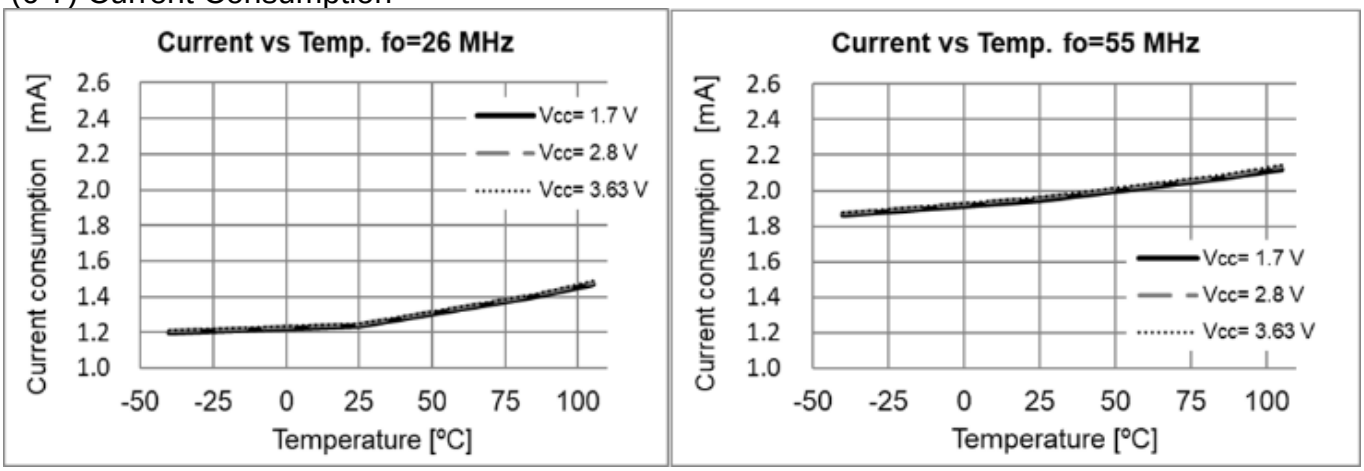


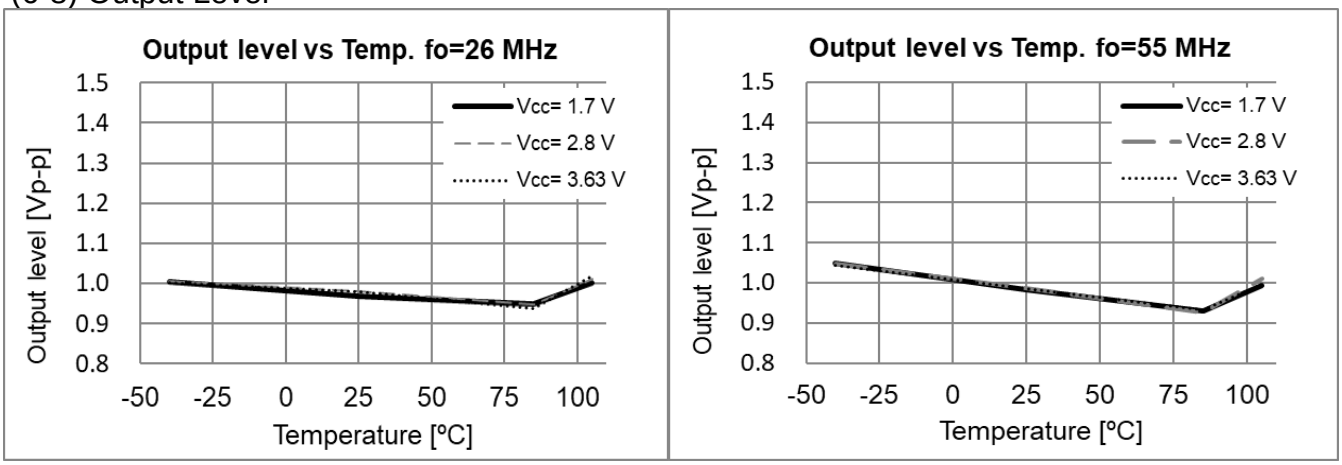

(6-6) Frequency Control Range



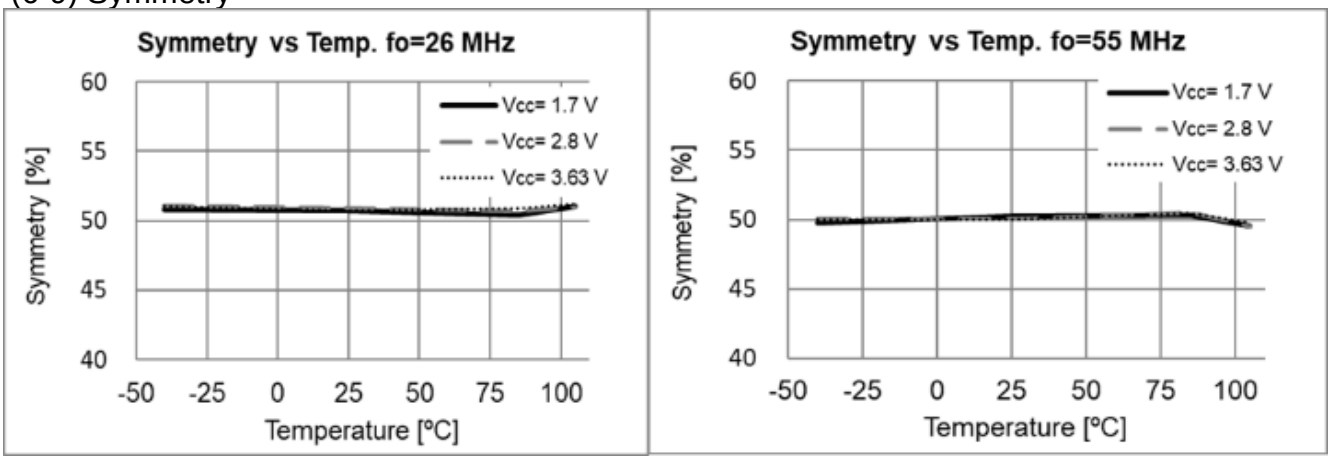

(6-7) Current Consumption



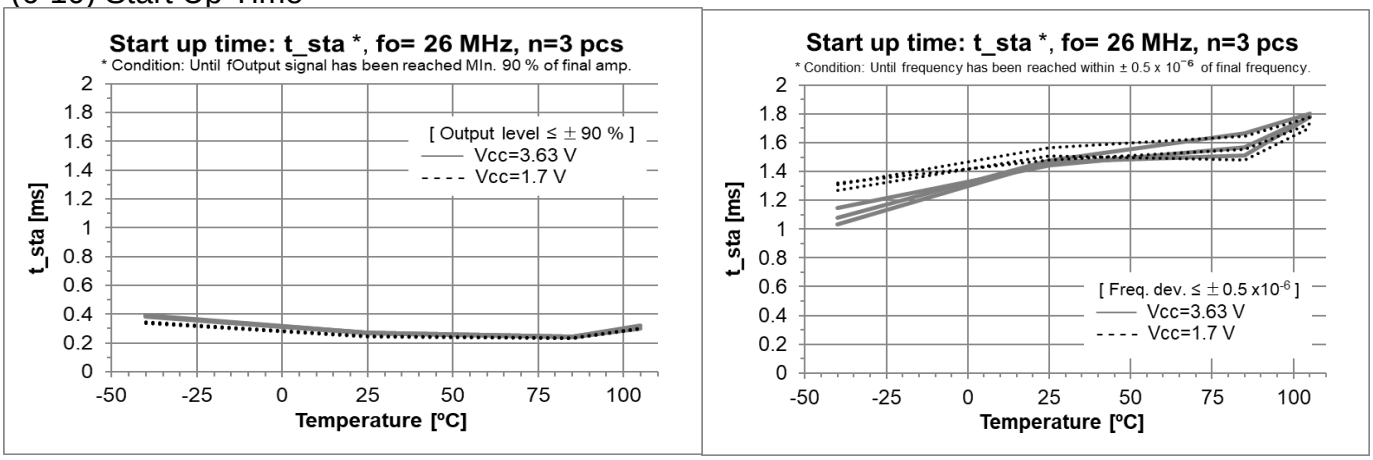
(6-8) Output Level




(6-9) Symmetry

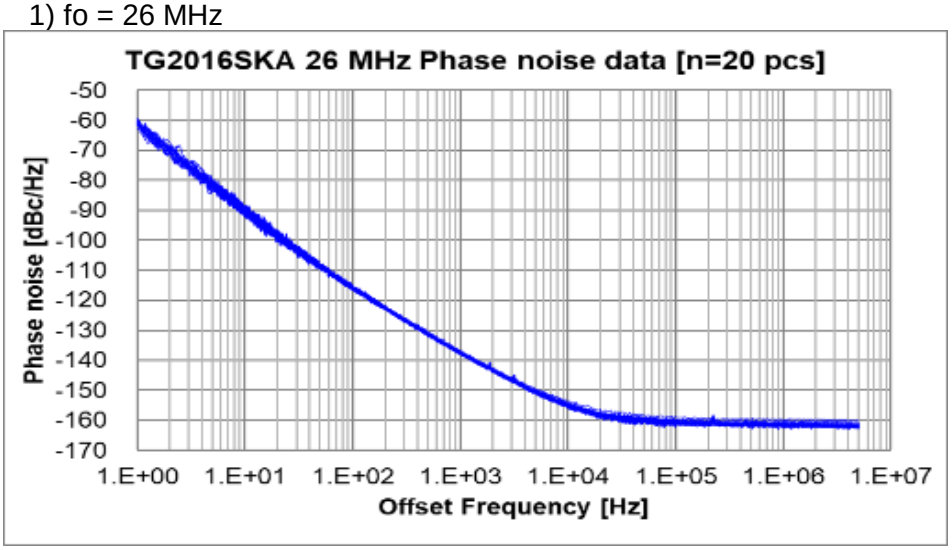



(6-10) Start Up Time



## (6-11) Phase Noise

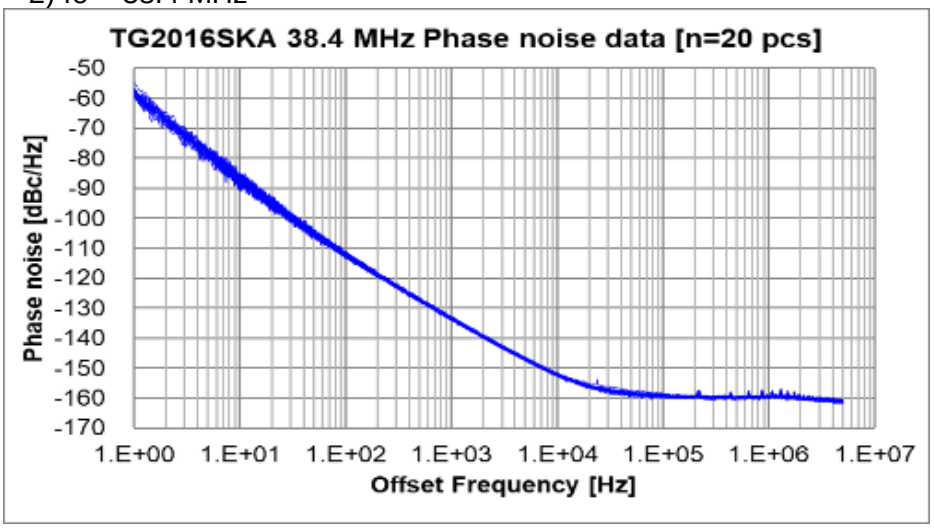
### 1) fo = 26 MHz




fo=26 MHz

| Offset Freq. | P. noise [dBc/Hz] |
|---|---|
| 1 Hz | -61 |
| 10 Hz | -90 |
| 100 Hz | -116 |
| 1 kHz | -138 |
| 10 kHz | -155 |
| 100 kHz | -161 |
| 1 MHz | -161 |
| 5 MHz | -162 |
| Phase Jitter (12 kHz to 5 MHz) | |
| 0.22 [ps] | |

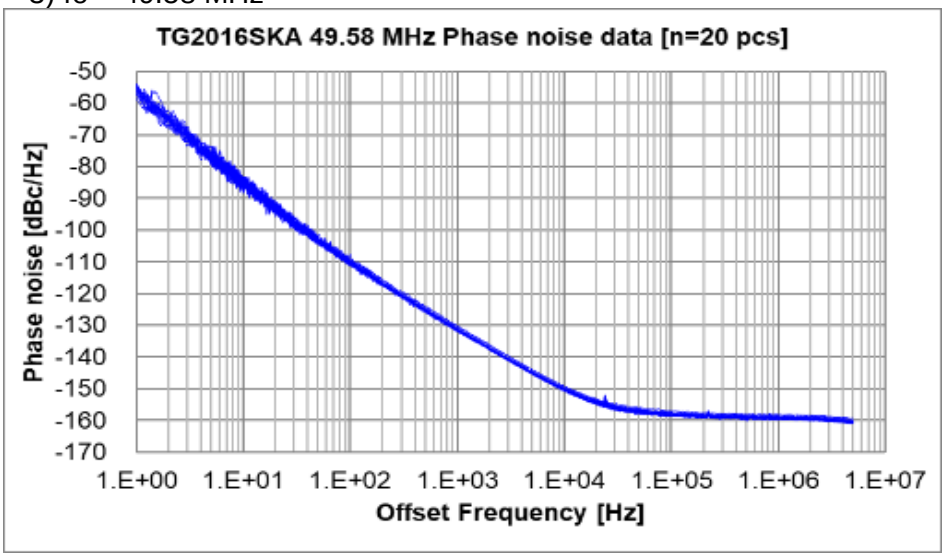
### 2) fo = 38.4 MHz




fo=38.4 MHz

| Offset Freq. | P. noise [dBc/Hz] |
|---|---|
| 1 Hz | -58 |
| 10 Hz | -87 |
| 100 Hz | -112 |
| 1 kHz | -134 |
| 10 kHz | -152 |
| 100 kHz | -159 |
| 1 MHz | -159 |
| 5 MHz | -161 |
| Phase Jitter (12 kHz to 5 MHz) | |
| 0.13 [ps] | |

### 3) fo = 49.58 MHz



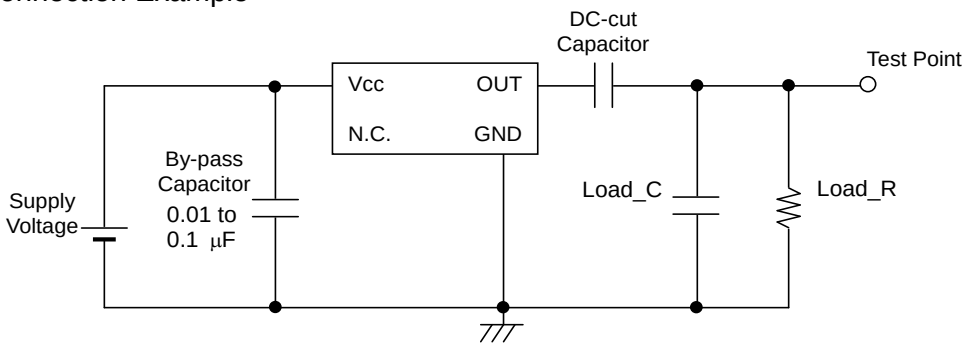

fo=49.58 MHz

| Offset Freq. | P. noise [dBc/Hz] |
|---|---|
| 1 Hz | -56 |
| 10 Hz | -85 |
| 100 Hz | -110 |
| 1 kHz | -131 |
| 10 kHz | -150 |
| 100 kHz | -158 |
| 1 MHz | -159 |
| 5 MHz | -160 |
| Phase Jitter (12 kHz to 5 MHz) | |
| 0.11 [ps] | |

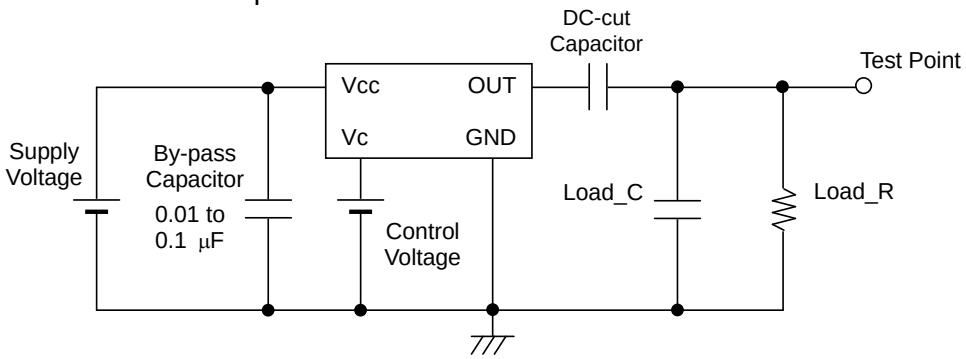
## [ 7 ] Test Circuit

### (7-1) Output Load : Load_R // Load_C = 10 kΩ // 10 pF

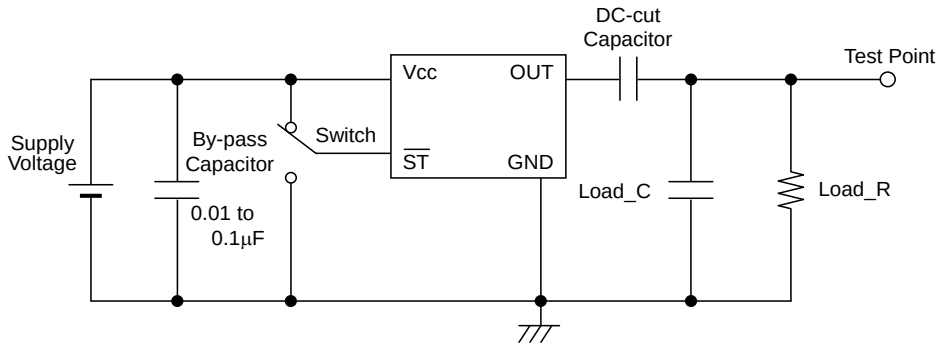
#### (1) TCXO Connection Example




#### (2) VC-TCXO Connection Example

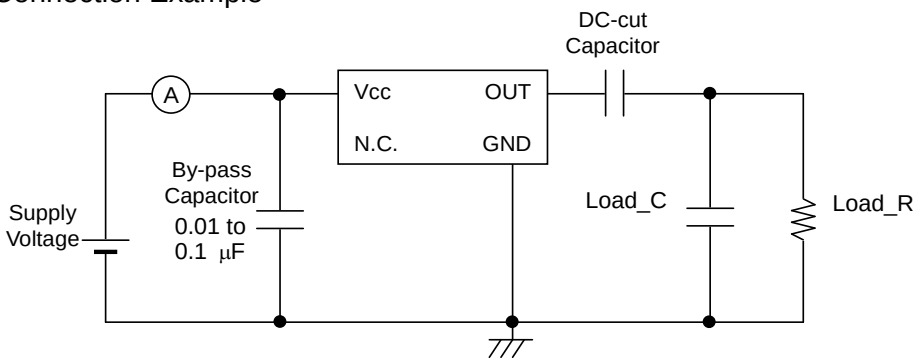



#### (3) TCXO-Standby Connection Example

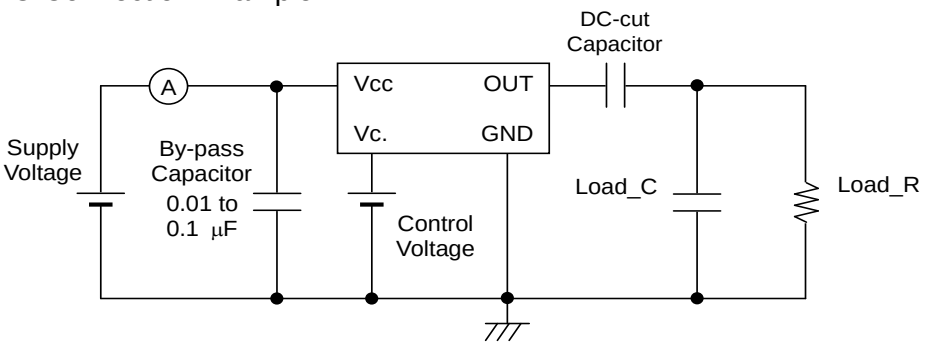


(7-2) Current Consumption

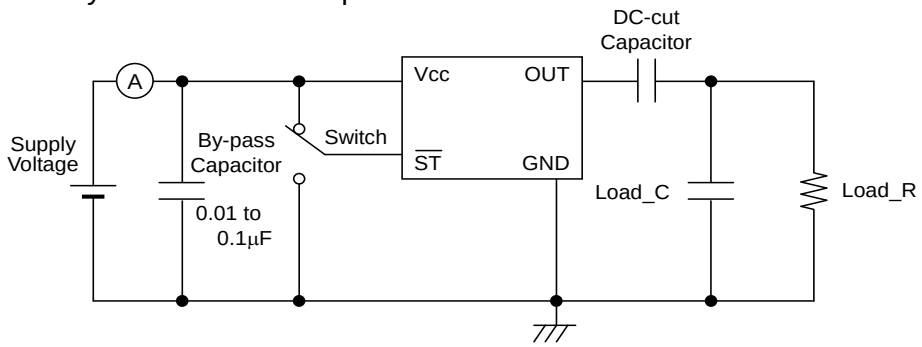
(1) TCXO Connection Example




(2) VC-TCXO Connection Example




(3) TCXO-Standby Connection Example



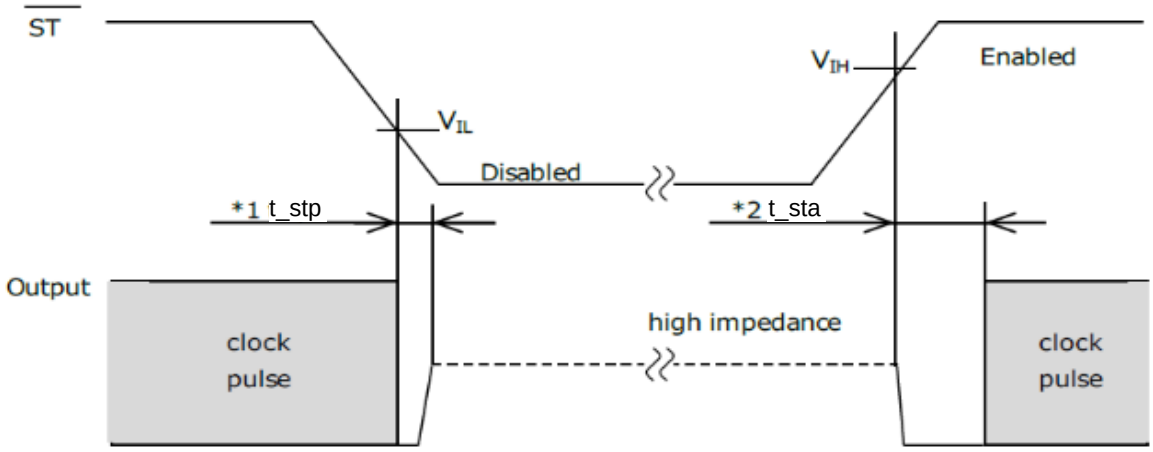

(7-3) Conditions

1. Oscilloscope: Impedance Min. 1MΩ
   Input capacitance Max. 10 pF
   Band width Min. 300 MHz
   Impossible to measure both frequency and wave form at the same time.
   (In case of using oscilloscope's amplifier output, possible to measure both at the same time.)
2. Load_C includes probe capacitance.
3. A capacitor (By-pass: 0.01 μF to 0.1 μF) should be placed between $V_{CC}$ and GND, and closely to TCXO.
4. Use the current meter with a low internal impedance.
5. Power Supply
   ・Impedance of power supply should be as low as possible.
6. GND pin should be connected to low impedance GND.

## (7-4) Timing Chart

### (1) Standby Function and Timing

| Standby input | Osc. Circuit | Output status |
|---|---|---|
| High or OPEN | Oscillation | Specified frequency output: Enable |
| Low | Stop | Output becomes high impedance: Disable |

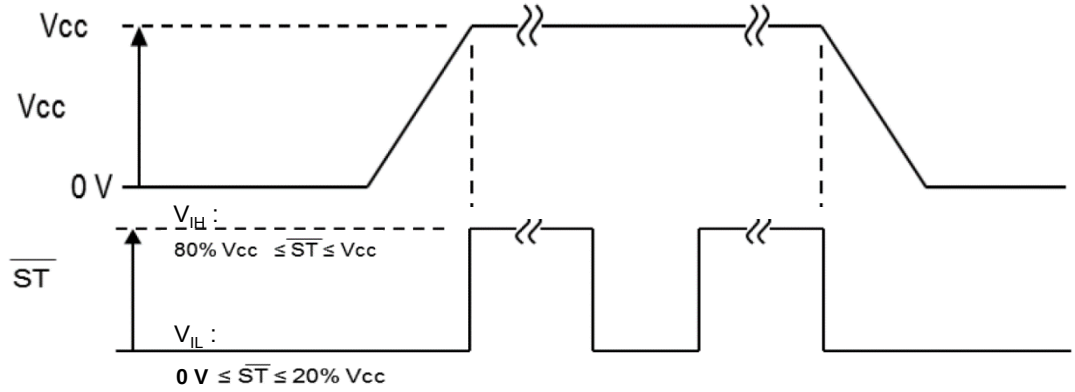



*1 t_stp: The time from $\overline{ST}$ = $V_{IL}$ to output = disable (high impedance)
*2 t_sta: The time from $\overline{ST}$ = $V_{IH}$ to starting output

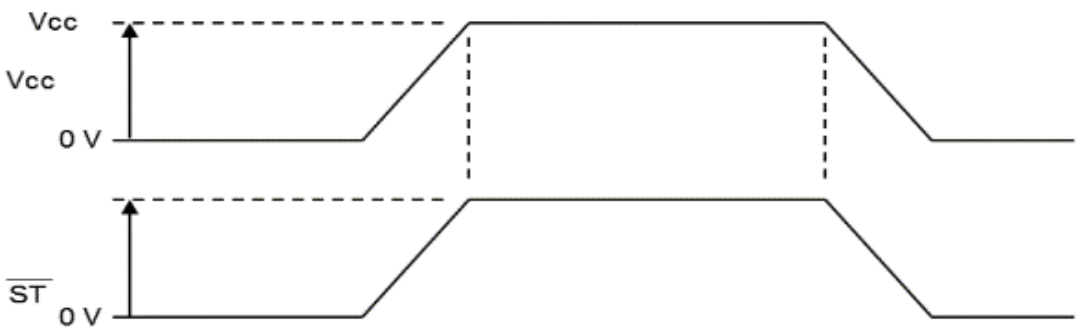
### (2) Standby Control Timing

Standby control voltage must be in the range of $V_{IN}$ ([2] Absolute maximum rating), $V_{IH}$, $V_{IL}$ ([5] Electrical characteristics).

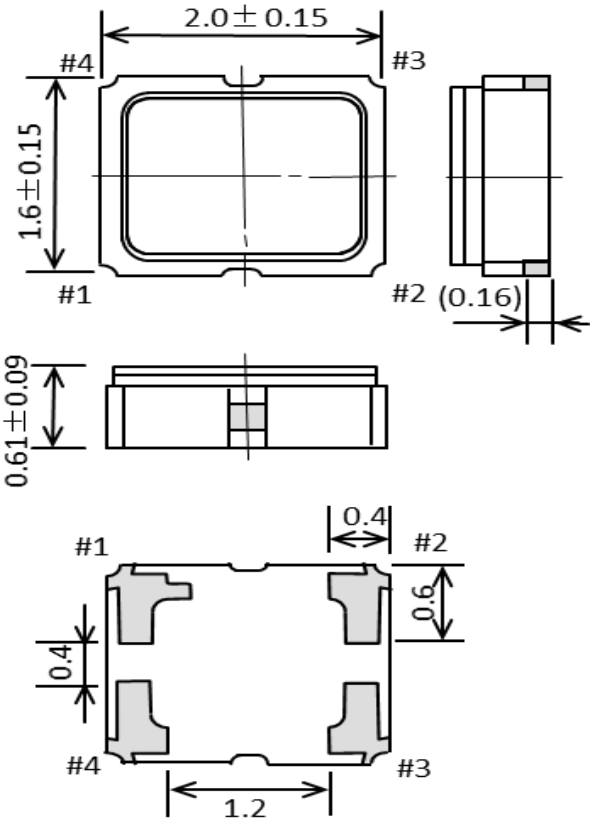
When standby control and $V_{CC}$ control are different



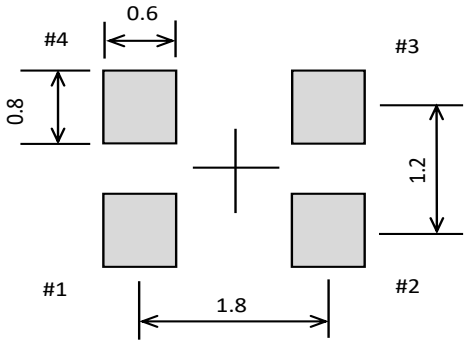

When standby control and $V_{CC}$ control are the same



[ 8 ] Outline Drawing unit: mm




Recommended Foot Print unit: mm




(TOP View)

Pin map

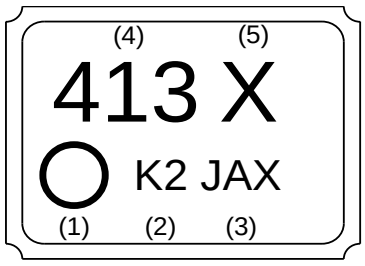
| Pin # | Connection | | |
|---|---|---|---|
| | VC-TCXO | TCXO | Standby |
| 1 | Vc | N.C. * | $\overline{ST}$ |
| 2 | GND | | |
| 3 | OUT | | |
| 4 | Vcc | | |

* Please keep “N.C.” pin OPEN condition or GND connection.
"N.C." pin doesn’t work as a ground pin.

Terminal coating : Au plating

To maintain stable operation, provide a 0.01 µF to 0.1 µF by-pass capacitor at a location as near as possible to the power source terminal of the crystal product (between $V_{CC}$ - GND).

Marking




(1) Pin 1 identifier: ○
(2) Arbitrary marking area (2 digits)
(3) TCXO Lot No. (3digits)
(4) TCXO model ID. (3digits)
TG2016SKA code: 4xx
(5) Image recognition mark (1digit)

[ 9 ] Moisture Sensitivity Level , Electro-Static Discharge

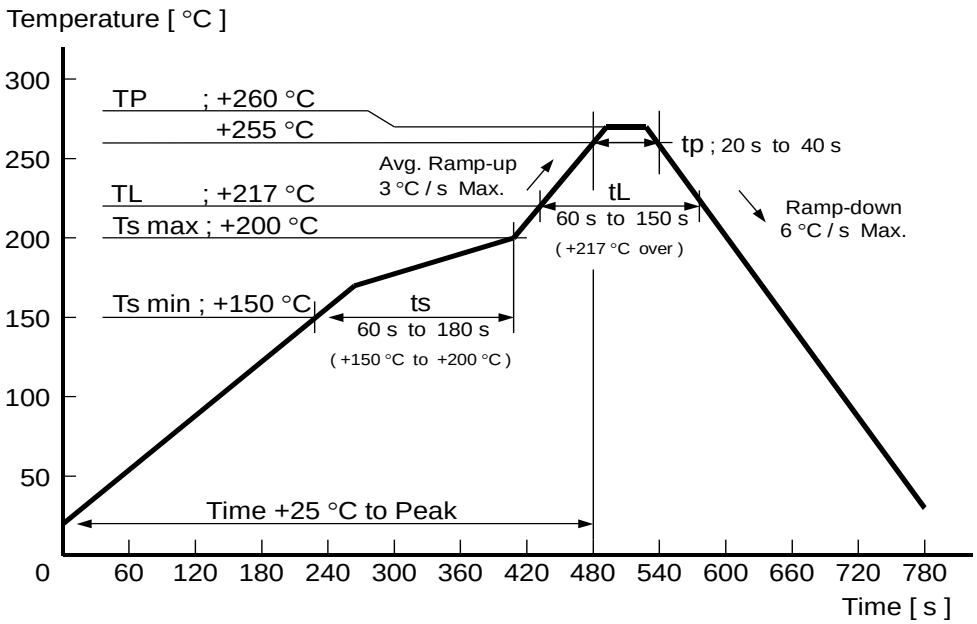
(1) Moisture Sensitivity Level (MSL)

| Parameter | Specifications | Conditions |
|---|---|---|
| MSL | LEVEL1 | JEDEC J-STD-020D |

(2) Electro-Static Discharge (ESD)

| Parameter | Specifications | Conditions |
|---|---|---|
| Human Body Model (HBM) | 2 000 V Min. | IEC 60749-26 Ed.2.0:2006(b), 100 pF, 1.5 kΩ, 3 times |
| Machine Model (MM) | 200 V Min. | IEC 60749-27 Ed.2.0:2006(b), 200 pF, 0 Ω, 1 time |
| Charging Device Model (CDM) | 750 V Min. | IEC 60749-28 ,3 times |

[ 10 ] Reflow profile (follow to IPC / JEDEC J-STD-020D.1)



## [ 11 ] Packing Information

(1) Quantity

For this product series, the standard for the last two digits of the product number is "16", 3 000 pcs/Reel.

TG2016SKA: X 1G00537 1 xxxx **16**

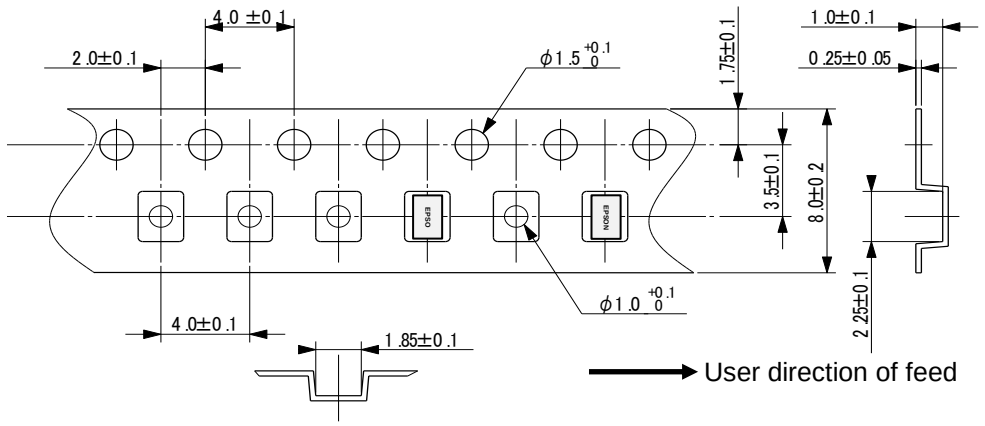
(2) Taping Specification Subject to EIA-481, IEC-60286, JIS C0806

1) Tape Dimensions TE0804L

Material of the Carrier Tape : PS (Polystyrene)

Material of the Top Tape : PET (Polyethylene Terephthalate) + PE (Polyethylene)

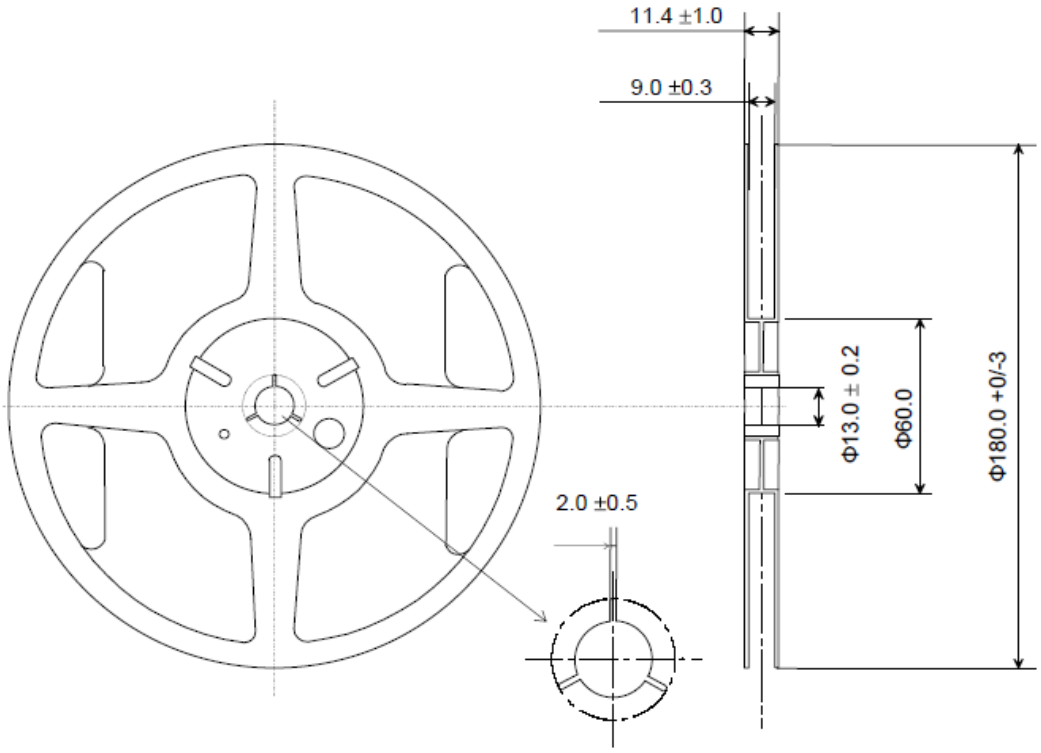
unit: mm




2) Reel Dimensions EIAJ RRM08B60

Center Material: PS (Polystyrene)

Reel Material: PS (Polystyrene)



## [ 12 ] 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 anyway and be sure to follow applicable process qualification standards before starting production.
(3) These devices are sensitive to ESD, please use appropriate precautions during handling, assembly, test, shipment, and installation.
(4) This product contains semiconductor content that should not be exposed to electromagnetic waves.
(5) 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.
(6) 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.
(7) 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.
(8) 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.
(9) 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.
(10) 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.
(11) 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.
(12) 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.
(13) 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.
(14) Keep PCB routing from the output terminal(s) to the load as short as possible for best performance.
(15) Do not short the output to GND as that will damage the product. Always use with an appropriate load resistor connected.
(16) 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.
(17) 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.
(18) 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.
(19) 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.
(20) 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.

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Email:sales@manduic.com

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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

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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.**<br>*About the products without the Pb-free mark.<br>Contains Pb in products exempted by EU RoHS directive<br>(Contains Pb in sealing glass, high melting temperature type solder or other) |
| For Automotive | ●**Designed for automotive applications such as Car Multimedia, Body Electronics, Remote Keyless Entry etc.** |

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