

Low power, wide temp range and automotive compliant
32.768kHz D-TCXO

TG-3541CE / TG-3541CEA

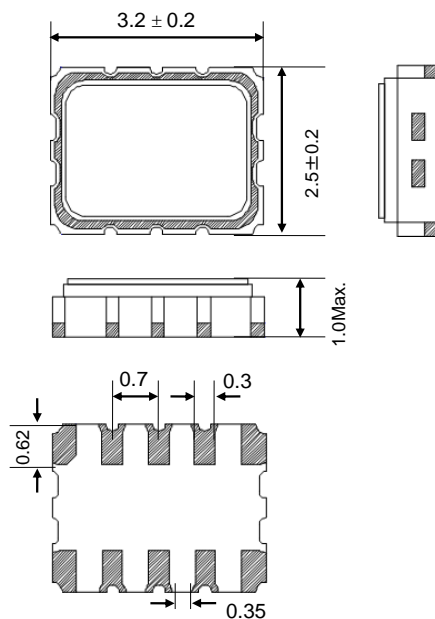
Features

- Built-in frequency adjusted 32.768 kHz crystal unit and D-TCXO.
- Operation temperature -40 °C to +105 °C
- Use of CMOS IC enables reduction of current consumption.
- V_{IO} controls swing amplitude.
- AEC-Q100 compliant (TG-3541CEA)

Applications

- TG-3541CE
Industrial, Security, Smart Meter,
Clock for Time counting and Sleep function
- TG-3541CEA
Infotainment and communication devices, Body (ECU*)
Clock for Time counting and Sleep function.
*ECU: Electronic control unit

Outline Drawing



Terminal

- | | | |
|--------------------|--|----------|
| 1. OE | | 10. TEST |
| 2. V _{CC} | | 9. GND |
| 3. TEST | | 8. TEST |
| 4. OUT | | 7. TEST |
| 5. TEST | | 6. TEST |

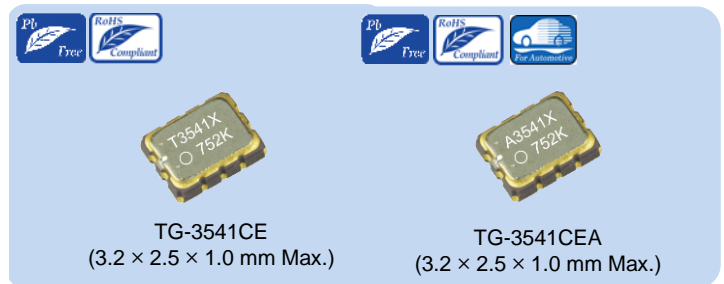
Pin	Connection
1	OE
2	V _{CC}
3	TEST (*1)
4	OUT
5	TEST (*2)
6	TEST (*3)
7	TEST (*2)
8	TEST (*2)
9	GND
10	TEST (*3)

*OE is active HIGH input,
Do not leave floating.

(*1) #3 connect to V_{CC}

(*2) #5, 7, 8 connect to GND

(*3) #6, 10: N.C. must be left open



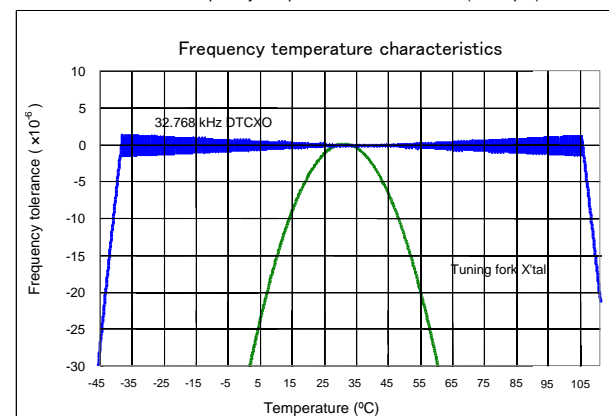
Description

low power, wide temp range and automotive compliant

32.768 kHz Crystal Oscillator with D-TCXO,
offered in 3.2 x 2.5 mm, 10 pins package.

Typical Performance

■ 32.768 kHz-DTCXO Frequency temperature characteristics (Example)



1. Number / Product Name

1.1 Product Number

TG-3541CE XA : X 1B00035 1 0001 00

TG-3541CE XB : X 1B00035 1 0002 00

TG-3541CEA XA : X 1B00036 1 A001 00

TG-3541CEA XB : X 1B00036 1 A002 00

(1) (2) (3) (4) (5)

- (1) Crystal devices
- (2) Model
- (3) Pb free code (1 : EU RoHS compliant / Pb free)
- (4) Detail specifications
- (5) Packing (00 : 2 000 pcs/reel)

1.2 Product Name (Standard Form)

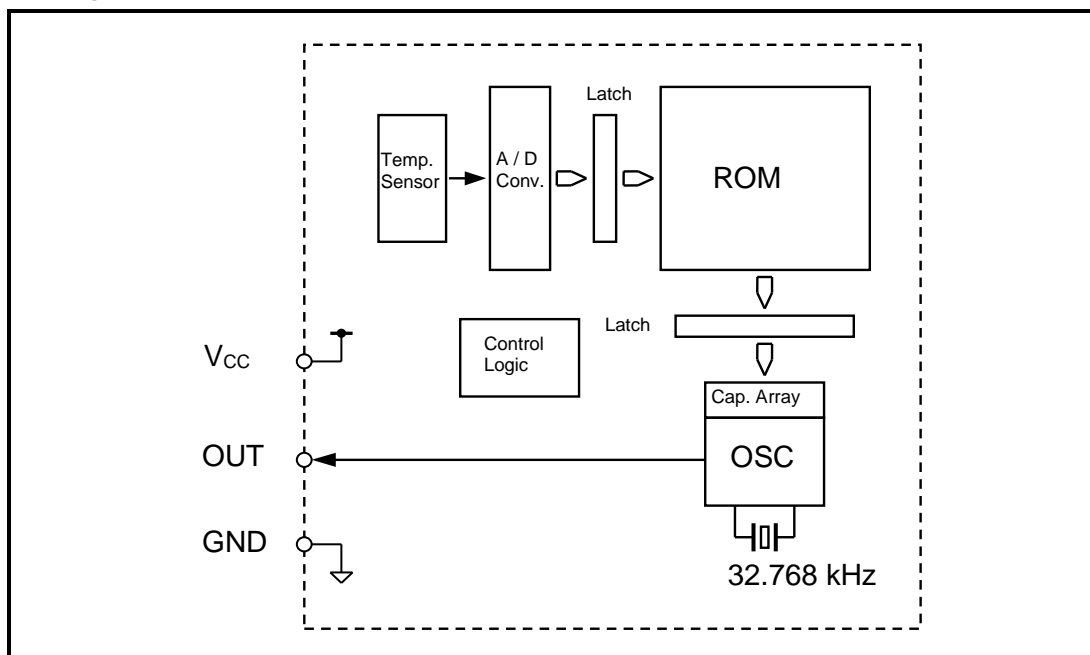
TG-3541 CE XA 32.768000 kHz

TG-3541 CE A XB 32.768000 kHz

(a) (b) (d) (e) (c)

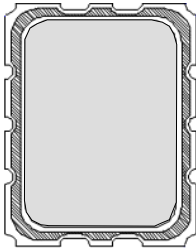
- (a) Model
- (b) Package type (CE : 3.2 x 2.5 x 1.0 mm size)
- (c) Output Frequency
- (d) For Automotive
- (e) Frequency / Temperature characteristics

2. Block Diagram



3. Terminal Description

3.1. Terminal Arrangement

1. OE		10. TEST
2. V _{CC}		9. GND
3. TEST		8. TEST
4. OUT		7. TEST
5. TEST		6. TEST

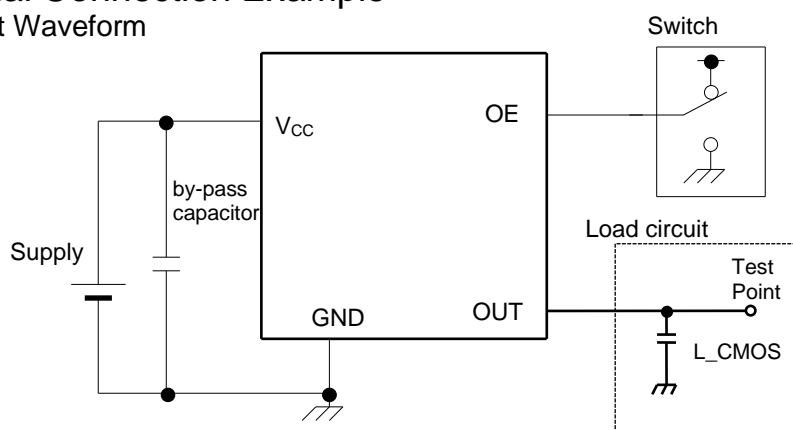
3.2. Terminal Function

Signal name	I/O	Function
OUT	Output	This is the C-MOS output pin with output control provided via the OE pin. OE = "H" (high level), this pin outputs a 32.768 kHz signal. When OE = "L" (low level), output is stopped, the OUT pin = Hi-Z (high impedance).
OE	Input	This is an input pin used to control the output mode of the OUT pin. When this pin's level is high, the OUT pin is in output mode. When it is low, output via the OUT pin is stopped.
V _{CC}	–	This pin is connected to a positive power supply.
GND	–	This pin is connected to a ground.
TEST	–	Test terminal. TEST should be connected as below. #3: V _{CC} , #5,7,8: GND, #6,10: N.C.

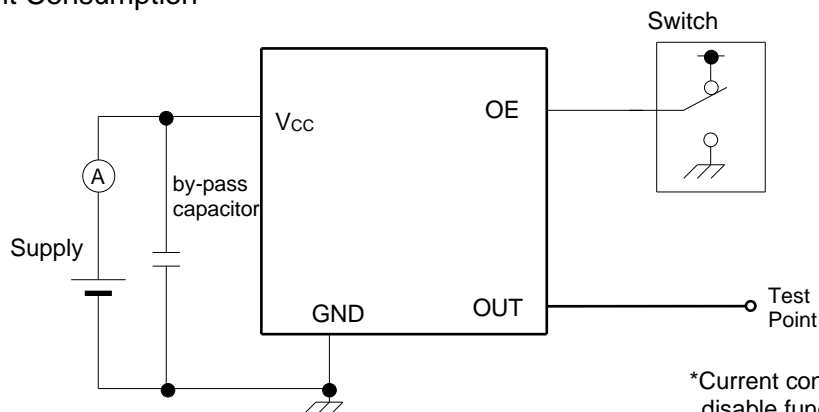
Note: Be sure to connect a bypass capacitor rated at least 0.1 μ F between V_{CC} and GND.

4. External Connection Example

1) Output Waveform



2) Current Consumption



*Current consumption under the disable function should be OE = GND.

3) Condition

(1) Oscilloscope

- Band width should be minimum 5 times higher (wider) than measurement frequency.
- Probe earth should be placed closely from test point and lead length should be as short as possible.

* Recommendable to use miniature socket. (Don't use earth lead.)

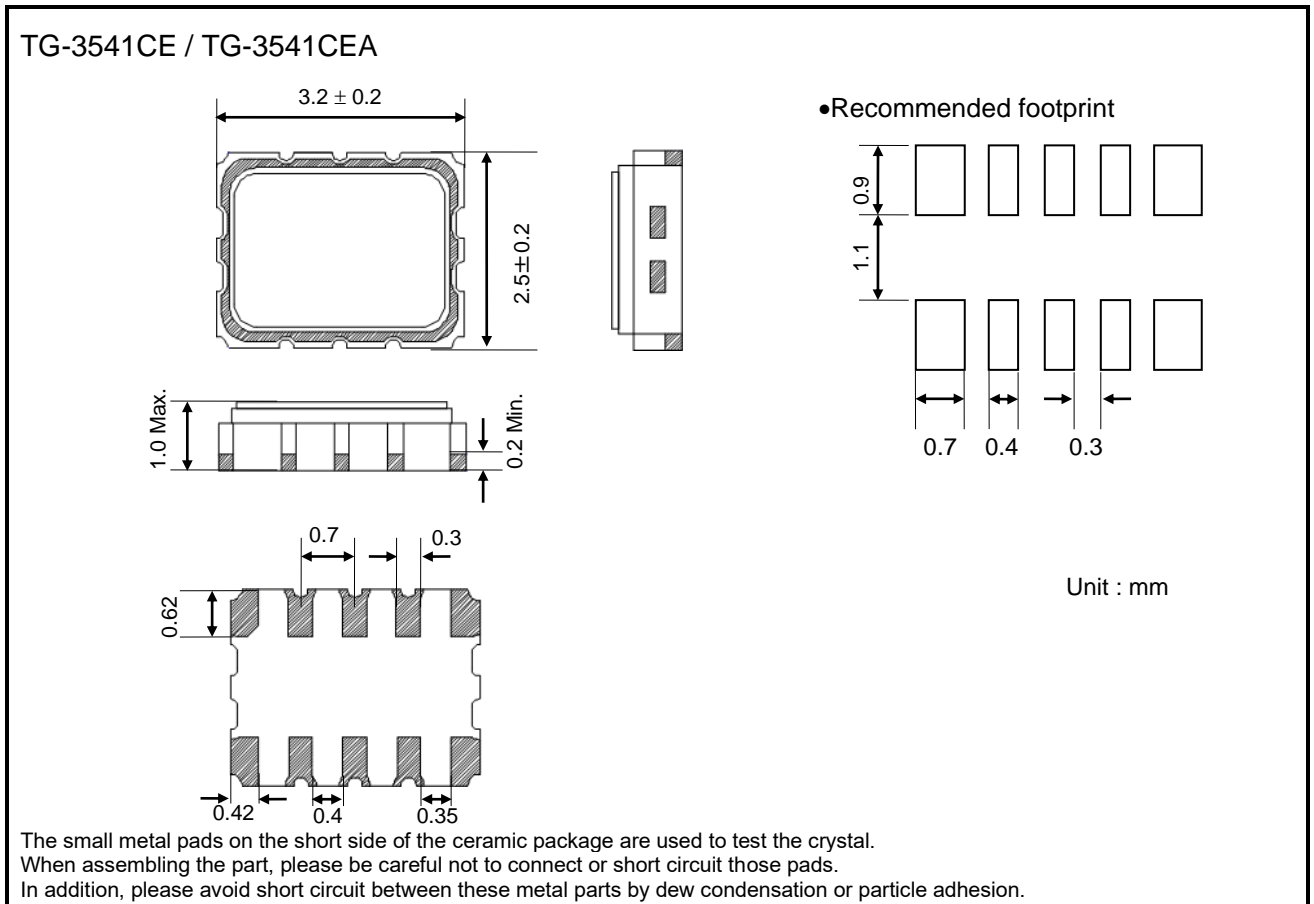
(2) L_{CMOS} also includes probe capacitance.

(3) By-pass capacitor (at least 0.1 μ F) is placed closely between V_{CC} and GND.

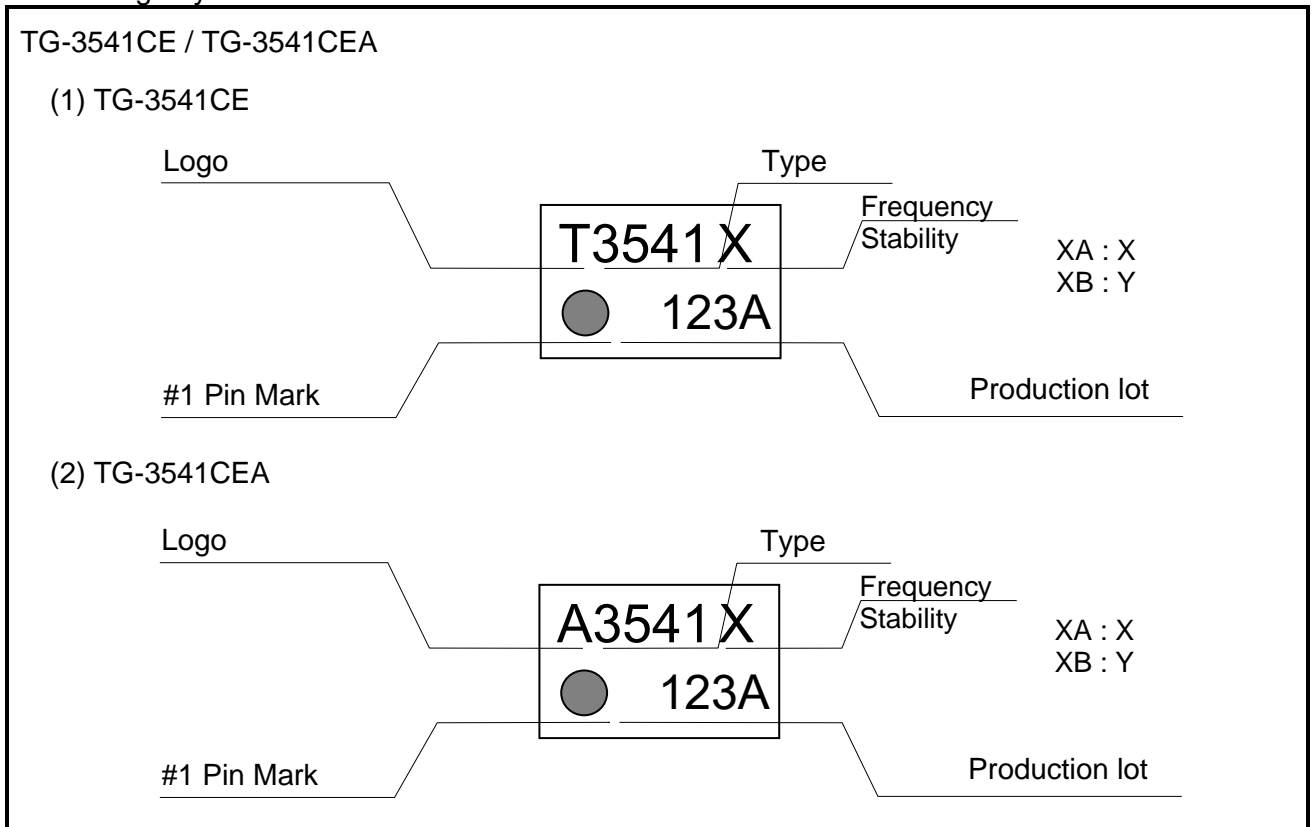
(4) Use the current meter whose internal impedance value is small.

5. Outline Drawing / Marking Layout

5.1. Outline Drawing



5.2. Marking Layout



* The display contents indicate the outline of the seal and display, and do not specify the details of the shape, size and position.

6. Absolute Maximum Ratings

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Supply voltage	V _{CC} -GND	-0.3	-	+6.5	V	
Input voltage	V _{IN}	GND – 0.3	-	+6.5	V	OE pin
Output voltage	V _{OUT1}	GND – 0.3	-	V _{CC} + 0.3	V	OUT pin
Storage temperature range	T _{stg}	-55	-	+125	°C	When stored separately, without packaging

7. Recommended Operating Conditions

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Supply voltage	V _{CC}	1.5	3.0	5.5	V	
	GND	0.0	-	0.0	V	
Operating temperature range	T _{use}	-40	+25	+105	°C	No condensation
Output load	L _{CMOS}	-	-	30	pF	

8. Frequency Characteristics

(Condition : GND = 0.0 V, L_{CMOS} = 30 pF Max., T_{use} = +25 °C)

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Output frequency	f _o	32.768			kHz	
Frequency / Temperature characteristics (XA)	f _o -T _c	-1.9		+1.9	× 10 ⁻⁶	T _{use} = 0 °C to +50 °C V _{CC} = 3.0 V, Include initial frequency tolerance *1
		-3.4	-	+3.4		T _{use} = -40 °C to +85 °C V _{CC} = 3.0 V, Include initial frequency tolerance *2
		-8.0	-	+8.0		T _{use} = +85 °C to +105 °C V _{CC} = 3.0 V, Include initial frequency tolerance *3
Frequency / Temperature characteristics (XB)	f _o -T _c	-3.8		+3.8	× 10 ⁻⁶	T _{use} = 0 °C to +50 °C V _{CC} = 3.0 V, Include initial frequency tolerance *1
		-5.0	-	+5.0		T _{use} = -40 °C to +85 °C V _{CC} = 3.0 V, Include initial frequency tolerance *2
		-8.0	-	+8.0		T _{use} = +85 °C to +105 °C V _{CC} = 3.0 V, Include initial frequency tolerance *3
Frequency / Voltage coefficient	f _o - V _{CC}	-1.0	-	+1.0	× 10 ⁻⁶	V _{CC} = 1.6 V to 5.5 V
Start up time	t _{str}	-	-	1.0	s	T _{use} = +25 °C V _{CC} = 1.6 V to 5.5 V
		-	-	3.0		T _{use} = -40 to +105 °C, V _{CC} = 1.6 V to 5.5 V
Frequency aging	f _{age}	-3.0	-	+3.0	× 10 ⁻⁶	T _{use} = +25 °C, V _{CC} = 3.0 V First year
Reflow shift	-	-3.0	-	+3.0	× 10 ⁻⁶	+260 °C (Max.), 2 times *4

*1 (XA) Equivalent to 5 seconds of month deviation (±1.9 × 10⁻⁶)

*2 (XA) Equivalent to 9 seconds of month deviation (±3.4 × 10⁻⁶)

*3 (XA) Equivalent to 21 seconds of month deviation (±8.0 × 10⁻⁶)

*1 (XB) Equivalent to 10 seconds of month deviation (±3.8 × 10⁻⁶)

*2 (XB) Equivalent to 13.2 seconds of month deviation (±5.0 × 10⁻⁶)

*3 (XB) Equivalent to 21 seconds of month deviation (±8.0 × 10⁻⁶)

*4 Measurement of frequency deviation is made 24 h after reflow soldering

9. Electrical Characteristics

*Unless otherwise specified,
GND = 0 V, $V_{CC} = 1.5 \text{ V to } 5.5 \text{ V}$, $T_{\text{use}} = -40 \text{ }^{\circ}\text{C to } +105 \text{ }^{\circ}\text{C}$

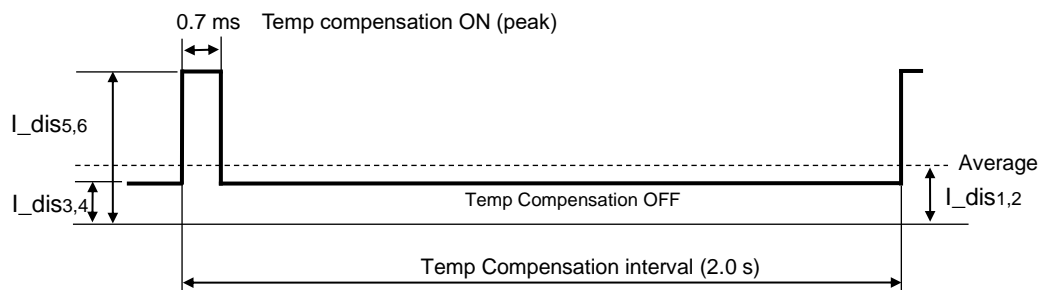
Item	Symbol	Min.	Typ.	Max.	Unit	Condition
Current consumption	I _{cc1}		1.1	3.1	μA	OE = V _{CC} , V _{CC} = 5.0 V, L_CMOS= No load Temp compensation interval 2.0 s
	I _{cc2}		1.0	3.0	μA	OE = V _{CC} , V _{CC} = 3.0 V L_CMOS= No load Temp compensation interval 2.0 s
	I _{cc3}		6.1	8.1	μA	OE = V _{CC} , V _{CC} = 5.0 V L_CMOS= 30 pF Temp compensation interval 2.0 s
	I _{cc4}		4.0	6.0	μA	OE = V _{CC} , V _{CC} = 3.0 V L_CMOS= 30 pF Temp compensation interval 2.0 s
Output disable current OUT : stopped (Hi-z)	I _{dis1}		0.40	1.6	μA	OE = GND, V _{CC} = 5.0 V Temp compensation interval 2.0 s
	I _{dis2}		0.35	1.5	μA	OE = GND, V _{CC} = 3.0 V Temp compensation interval 2.0 s
	I _{dis3}		0.38	1.55	μA	OE = GND, V _{CC} = 5.0 V Temp compensation is stopped.
	I _{dis4}		0.33	1.45	μA	OE = GND, V _{CC} = 3.0 V Temp compensation is stopped.
	I _{dis5}		55	100	μA	OE = GND, V _{CC} = 5.0 V Temp compensation ON (peak)
	I _{dis6}		50	95	μA	OE = GND, V _{CC} = 3.0 V Temp compensation ON (peak)
Symmetry	SYM	40	50	60	%	50 % V _{CC} Level, L_CMOS = 30 pF
Input voltage	V _{IH}	$0.8 \times V_{CC}$		5.5	V	OE pin
	V _{IL}	GND - 0.3		$0.2 \times V_{CC}$		
Output voltage	V _{OH1}	4.5		5.0	V	OUT pin, V _{CC} = 5.0 V, I _{OH} = -1 mA
	V _{OH2}	2.2		3.0		OUT pin, V _{CC} = 3.0 V, I _{OH} = -1 mA
	V _{OH3}	2.9		3.0		OUT pin, V _{CC} = 3.0 V, I _{OH} = -100 μA
	V _{OL1}	GND		GND + 0.5	V	OUT pin, V _{CC} = 5.0 V, I _{OL} = 1 mA
	V _{OL2}	GND		GND + 0.8		OUT pin, V _{CC} = 3.0 V, I _{OL} = 1 mA
	V _{OL3}	GND		GND + 0.1		OUT pin, V _{CC} = 3.0 V, I _{OL} = 100 μA
Input leakage current	I _{LK}	-0.5		0.5	μA	OE pin = V _{CC} or GND
Output leakage current	I _{OZ}	-0.5		0.5	μA	OUT pin = V _{CC} or GND

- Temperature compensation and consumption current

The current consumption of TG-3541 increases at a timing of a temperature compensation.

As for this peak current consumption, it occurs in about 0.7 ms.

I_{dis1}, I_{dis2} is the average current consumption at temperature compensation in 2.0 s cycle.



10. How To Use

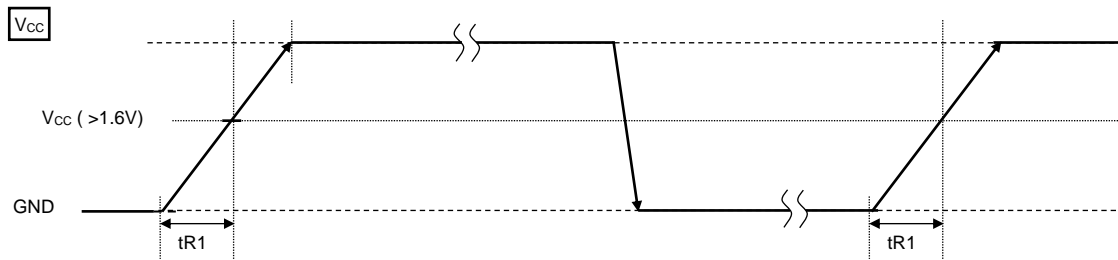
10.1. Start Up

※This circuit is sensitive to power supply noise and supply voltage should be stabilized to avoid negative impact on the accuracy.

※tR1 is needed for a proper power-on reset.

※In case of repeated ON/OFF of the power supply within short term, it is possible that the power-on reset becomes unstable.

After power-OFF, keep $V_{CC} = GND$ for more than 10 seconds for a proper power-on reset.



*Unless otherwise specified,

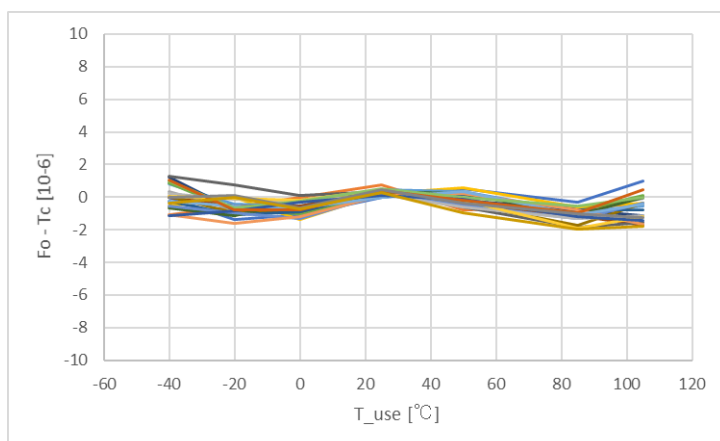
$GND = 0\text{ V}$, $V_{CC} = 1.5\text{ V to }5.5\text{ V}$, $T_{\text{use}} = -40\text{ }^{\circ}\text{C to }+105\text{ }^{\circ}\text{C}$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Power supply rise time1	tR1	$V_{CC} = GND\text{ to }1.6\text{ V}$	1	-	10	ms/V

11. Characteristic Data

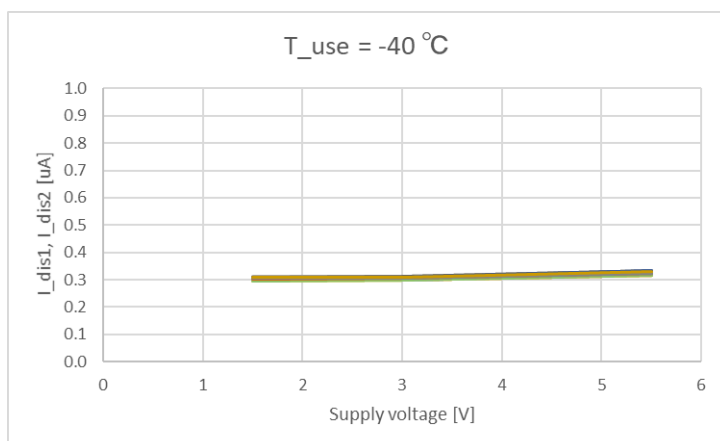
11.1. Frequency Temperature Coefficient

Frequency / temperature characteristics: fo-Tc

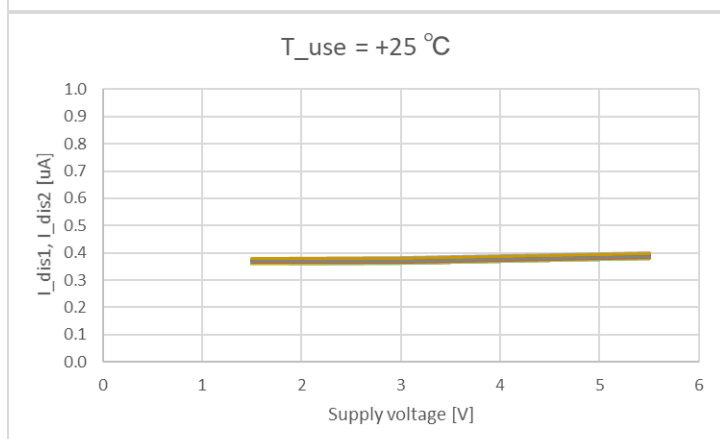


Test Conditions:
No Load, n = 22 pcs.

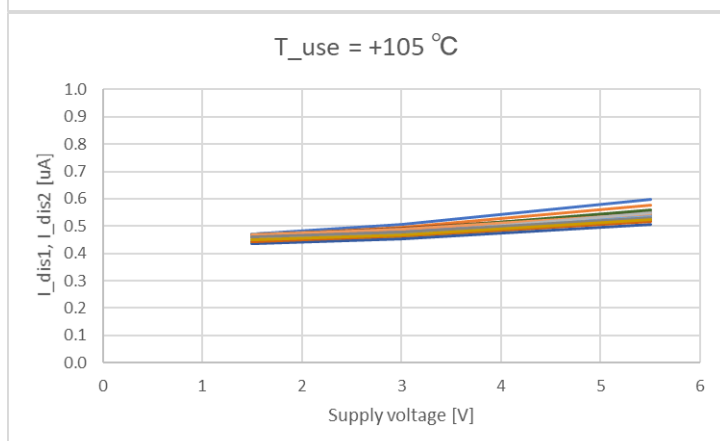
11.2. Current Consumption (Output disable)



Test Conditions:
No Load, T_use = -40 °C, n = 22 pcs.

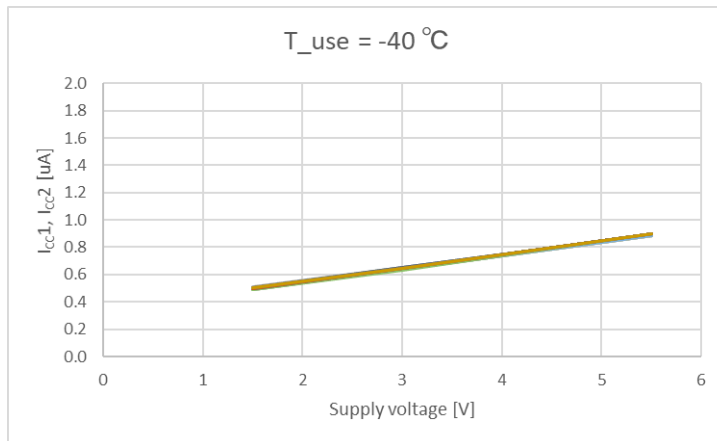


Test Conditions:
No Load, T_use = +25 °C, n = 22 pcs.

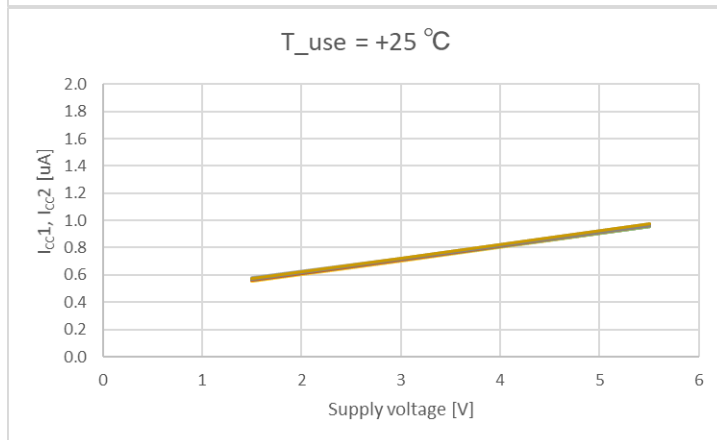


Test Conditions:
No Load, T_use = +105 °C, n = 22 pcs.

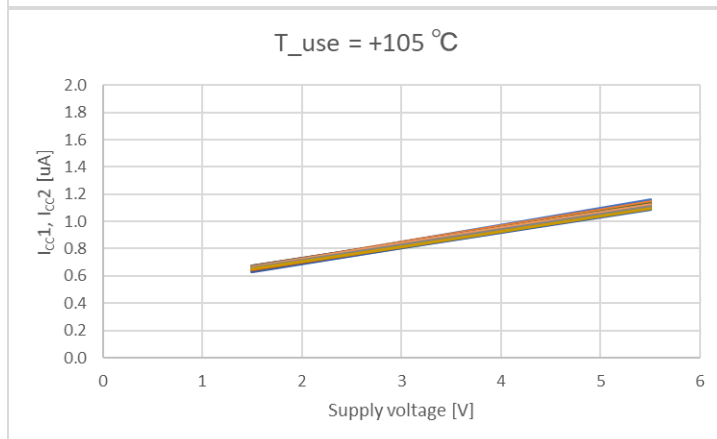
11.3. Current Consumption (Output enable)



Test Conditions:

No Load, $T_{use} = -40\text{ }^{\circ}\text{C}$, $n = 22$ pcs.

Test Conditions:

No Load, $T_{use} = +25\text{ }^{\circ}\text{C}$, $n = 10$ pcs.

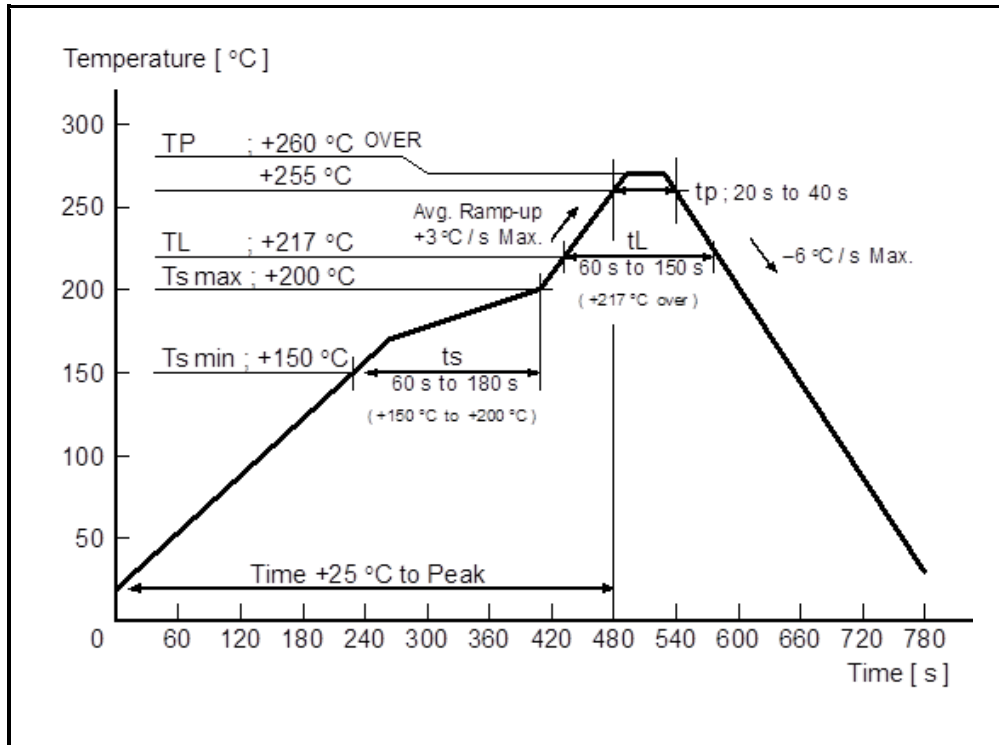
Test Conditions:

No Load, $T_{use} = +105\text{ }^{\circ}\text{C}$, $n = 22$ pcs.

12. Moisture Sensitivity

Item	Class	Test Condition
MSL	LEVEL 1	JEDEC J-STD-020D.1

13. Reflow Profiles (follow to IPC / JEDEC J-STD-020D.1)



15. Handling Precautions

1) Notes on handling

This device contains a crystal resonator, so please don't expose excessive shock or vibration.

This device uses a C-MOS IC to realize low power consumption. Carefully note the following cautions when handling.

(1) Static electricity

While this module has built-in circuitry designed to protect it against electrostatic discharge, the chip could still be damaged by a large discharge of static electricity. Containers used for packing and transport should be constructed of conductive materials. In addition, only soldering irons, measurement circuits, and other such devices which do not leak high voltage should be used with this module, which should also be grounded when such devices are being used.

(2) Noise

If a signal with excessive external noise is applied to the power supply or input pins, the device may malfunction or "latch up." In order to ensure stable operation, connect a filter capacitor (preferably ceramic) of greater than 0.1 μF as close as possible to the power supply pins (between V_{CC} and GNDs). Also, avoid placing any device that generates high level of electronic noise near this module.

* Do not connect signal lines to the shaded area in the figure shown in Fig. 1 and, if possible, embed this area in a GND land.

(3) Voltage levels of input pins

When the input pins are at the mid-level, this will cause increased current consumption and a reduced noise margin, and can impair the functioning of the device. Therefore, try as much as possible to apply the voltage level close to V_{CC} or GND.

(4) Handling of unused pins

Since the input impedance of the input pins is extremely high, operating the device with these pins in the open circuit state can lead to unstable voltage level and malfunctions due to noise. Therefore, please apply the voltage level close to V_{CC} or GND.

(5) Storage

This device is equivalent to JEDEC J-STD-020D.1 Moisture Sensitivity Level 1. After opening the packing, store it in an environment with a temperature of +30 °C or less and humidity of 85 °C or less, and mount it within 6 months.

2) Notes on packaging

(1) Soldering heat resistance.

If the temperature within the package exceeds +260 °C, the characteristics of the crystal oscillator will be degraded and it may be damaged. The reflow conditions within our reflow profile is recommended. Therefore, always check the mounting temperature and time before mounting this device. Also, check again if the mounting conditions are later changed.

* See Fig. 1 profile for our evaluation of Soldering heat resistance for reference.

(2) Mounting equipment

While this module can be used with general-purpose mounting equipment, the internal crystal oscillator may be damaged in some circumstances, depending on the equipment and conditions. Therefore, be sure to check this. In addition, if the mounting conditions are later changed, the same check should be performed again.

The high-speed moulder (stationary type of parts cassette) can not be used because storage vibrations in parts cassettes cause scraping of carrier tape due to friction between the embossed carrier tape and the product.

(3) Ultrasonic cleaning

Depending on the usage conditions, there is a possibility that the crystal oscillator will be damaged by resonance during ultrasonic cleaning. Since the conditions under which ultrasonic cleaning is carried out (the type of cleaner, power level, time, state of the inside of the cleaning vessel, etc.) vary widely, this device is not warranted against damage during ultrasonic cleaning.





(4) Mounting orientation

This device can be damaged if it is mounted in the wrong orientation. Always confirm the orientation of the device before mounting.

(5) Leakage between pins

Leakage between pins may occur if the power is turned on while the device has condensation or dirt on it. Make sure the device is dry and clean before supplying power to it.

► Explanation of the mark that are using it for the catalog

	► Pb free.
	► 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.)
	► Designed for automotive general equipment.
	► Designed for automotive applications related to driving and safety.

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