Crystal oscillator for Automotive: SG2016CAA

Features

- Crystal oscillator (SPXO)
- Frequency range: 1.2 MHz to 54 MHz
- Output: CMOS
- Supply voltage: 1.6 V to 3.63 V
- Operating temperature: -40 °C to +105 °C
  -40 °C to +125 °C
- AEC-Q100/200 compliant



(2.0 × 1.6 × 0.7 mm)

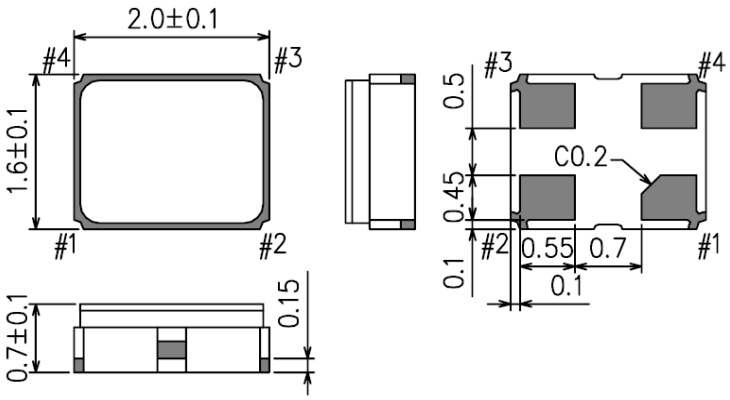
Applications

- ADAS (Advanced Driver Assistance Systems):
  Camera, LiDAR (Light Detection and Ranging), radar, networking
- Automotive Infotainment System, audio, clock, meter, cluster, body control (BCM)

Description

Epson's SG2016CAA is Simple Packaged Crystal Oscillator (SPXO) with CMOS output.
This SPXO's is ideal for automotive and high reliability applications, and conforms to AEC-Q100/200.
This SPXO has low current consumption, wide operating voltage from 1.6 V to 3.63 V and
wide operating temperature range from -40 °C to 125 °C.

Outline Drawing and Terminal Assignment



Pin #	Connection	Function		
#1	$\overline{ST}$	$\overline{ST}$ terminal		
		$\overline{ST}$ function	Osc. Circuit	Output
		"H" or OPEN	Oscillation	Specified frequency: Enable
		"L"	Oscillation stop	High impedance: Disable
#2	GND	GND terminal		
#3	OUT	Output terminal		
#4	V_{CC}	V_{CC} terminal		

[1] Product Number / Product Name

(1-1) Product Number

X1G005341xxxx00 (Please contact Epson for details)

(1-2) Product Name (Standard Form)

SG2016 C AA 25.000000MHz T J H A

① ② ③ ④⑤⑥⑦

①Model ②Output(C: CMOS) ③Frequency ④Supply voltage

⑤Frequency tolerance ⑥Operating temperature ⑦Internal identification code("A" is default)

④Supply voltage	
T	1.8 V to 3.3 V Typ.
K	2.5 V to 3.3 V Typ.

⑤Frequency tolerance / ⑥Operating temperature	
JH	±50 × 10^{-6} / -40 °C to +105 °C
LJ	±100 × 10^{-6} / -40 °C to +125 °C

[2] Absolute Maximum Ratings

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Maximum supply voltage	V_{CC}	-0.3	-	4	V	
Input voltage	Vin	-0.3	-	V_{CC} + 0.3	V	$\overline{ST}$ terminal
Storage temperature range	T_stg	-55	-	+125	°C	

[3] Operating Range

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Supply voltage	V_{CC}	1.6	-	3.63	V	
Supply voltage	GND	0.0	0.0	0.0	V	
Operating temperature range	T_use	-40	+25	+105	°C	
		-40	+25	+125	°C	
CMOS load condition	L_CMOS	-	-	15	pF	

* Power supply startup time (0 %V_{CC} → 90 %V_{CC}) should be more than 150 µs
* A 0.01 µF or over 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)

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Output frequency	fo	1.2	-	54	MHz	Please contact us for details
		8, 10, 11.2896, 12, 12.288, 14.7456, 16, 16.6666, 19.2, 20, 22.5792, 24, 24.576, 25, 27, 33, 33.3333, 40, 48, 50, 54			MHz	Standard frequency
Frequency tolerance *1	f_tol	-50	-	+50	×10^{-6}	T_use = -40 °C to +105 °C
		-100		+100	×10^{-6}	T_use = -40 °C to +125 °C
Frequency aging	f_age	-3		+3	×10^{-6}	T_use = +25 °C, First year

*1 Frequency tolerance includes initial frequency tolerance, frequency / temperature characteristics, frequency / voltage coefficient, and frequency / load coefficient

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

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Start-up time	t_str	-	-	5	ms	t = 0 at 90 %V_{CC}
Current consumption (No load) V_{CC} = 1.8 V ± 10 %	I_{CC}	-	-	2.0	mA	1.2 MHz ≤ fo ≤ 20 MHz
		-	-	2.3	mA	20 MHz < fo ≤ 40 MHz
		-	-	2.6	mA	40 MHz < fo ≤ 54 MHz
Current consumption (No load) V_{CC} = 2.5 V ± 10 %		-	-	2.1	mA	1.2 MHz ≤ fo ≤ 20 MHz
		-	-	2.5	mA	20 MHz < fo ≤ 40 MHz
		-	-	2.9	mA	40 MHz < fo ≤ 54 MHz
Current consumption (No load) V_{CC} = 3.3 V ± 10 %		-	-	2.3	mA	1.2 MHz ≤ fo ≤ 20 MHz
		-	-	2.7	mA	20 MHz < fo ≤ 40 MHz
		-	-	3.1	mA	40 MHz < fo ≤ 54 MHz
Stand-by current	I_std	-	-	2.7	µA	V_{CC} = 1.8 V ± 10 %, $\overline{ST}$ = GND
		-	-	3.1	µA	V_{CC} = 2.5 V ± 10 %, $\overline{ST}$ = GND
		-	-	3.3	µA	V_{CC} = 3.3 V ± 10 %, $\overline{ST}$ = GND
Output voltage	V_{OH}	90 %V_{CC}	-	-	V	Load current condition 1.8 V ± 10 % / 2.5 V ± 10 % / 3.3 V ± 10 % I_{OH}: -1.5 mA / -3 mA / -4 mA I_{OL}: 1.5 mA / 3 mA / 4 mA
	V_{OL}	-	-	10 %V_{CC}	V	
	V_{OH}	V_{CC} - 0.4	-	-	V	Load current condition 1.8 V ± 10 % / 2.5 V ± 10 % / 3.3 V ± 10 % I_{OH}: -3 mA / -4 mA / -6 mA I_{OL}: 3 mA / 4 mA / 6 mA
	V_{OL}	-	-	0.4	V	
Symmetry	SYM	45	50	55	%	50 % V_{CC} level, L_CMOS ≤ 15 pF
Rise time/Fall time	tr / tf	-	-	3	ns	V_{CC} = 2.5 V or 3.3 V ± 10 %, 20 % V_{CC} - 80 % V_{CC} level, L_CMOS = 15 pF
		-	-	3.5	ns	V_{CC} = 1.8 V ± 10 %, 20 % V_{CC} - 80 % V_{CC} level, L_CMOS = 15 pF
Input voltage	V_{IH}	80 % Vcc	-	-	V	$\overline{ST}$ terminal
	V_{IL}	-	-	20 % Vcc	V	
Output disable time (ST)	tstp_st	-	-	100	ns	$\overline{ST}$ terminal HIGH → LOW
Output enable time (ST)	tsta_st	-	-	5	ms	$\overline{ST}$ terminal LOW → HIGH

[6] Thermal resistance (For reference only)

Parameter	Symbol	Specification			Unit	Conditions
		Min.	Typ.	Max.		
Junction temperature	Tj	-	-	+135	°C	
Junction to case	θjc	-	9.8	-	°C/W	
Junction to ambient	θja	-	99.6	-	°C/W	

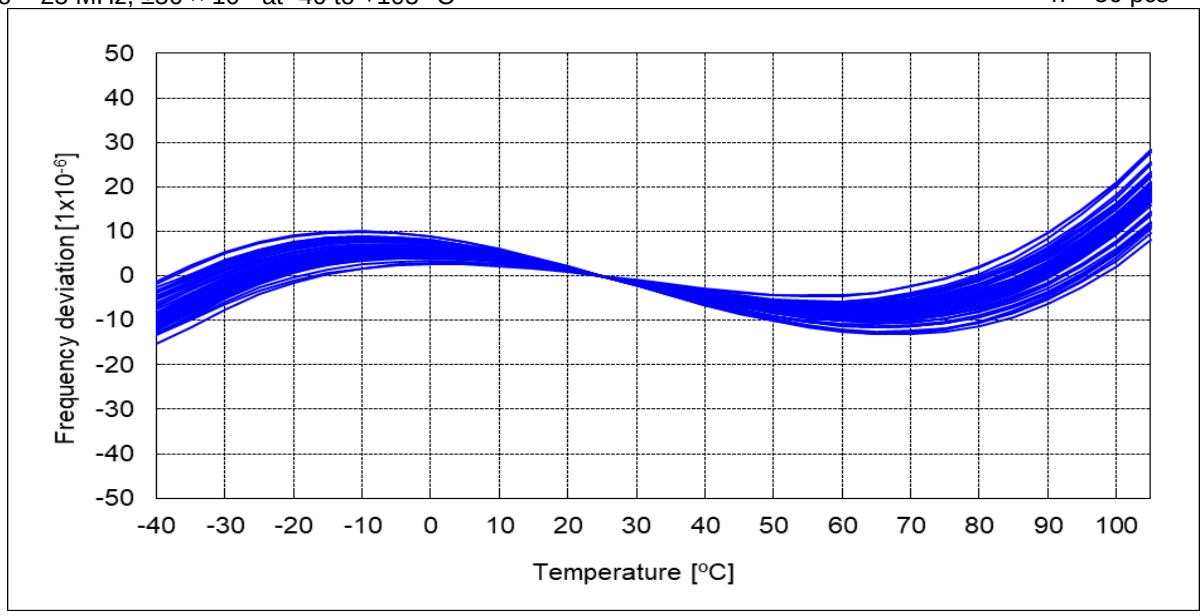
[7] Typical Performance Characteristics (For reference only)

The following data shows typical performance characteristics

(7-1) Frequency / Temperature Characteristics

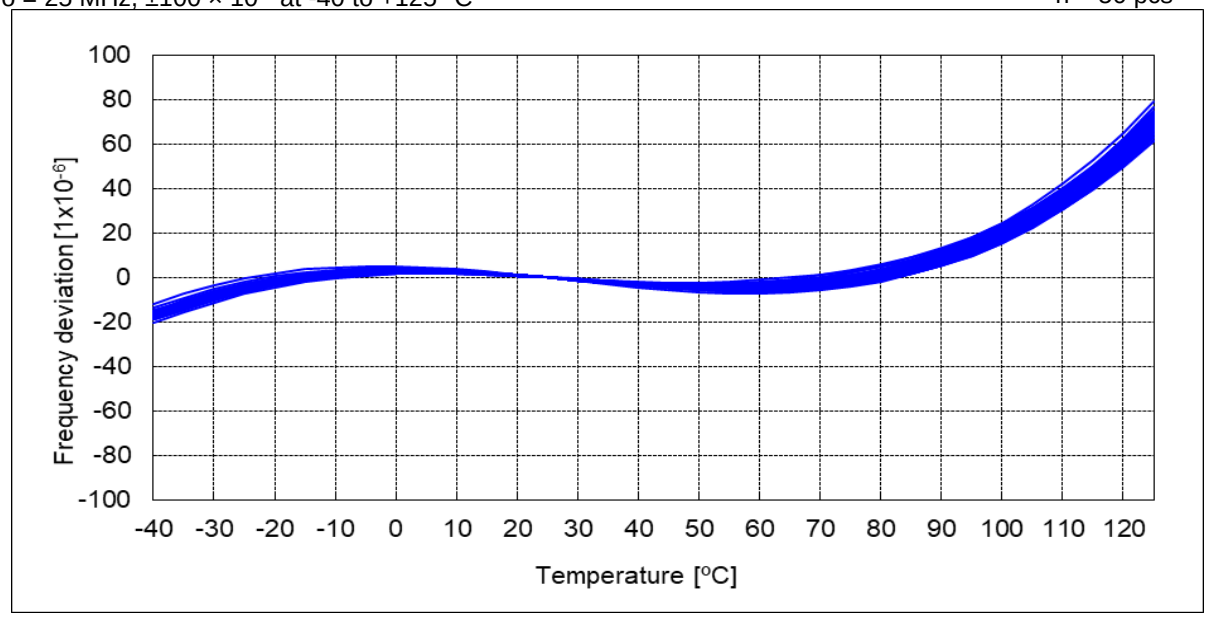
fo = 25 MHz, ±50 × 10^{-6} at -40 to +105 °C

n = 50 pcs



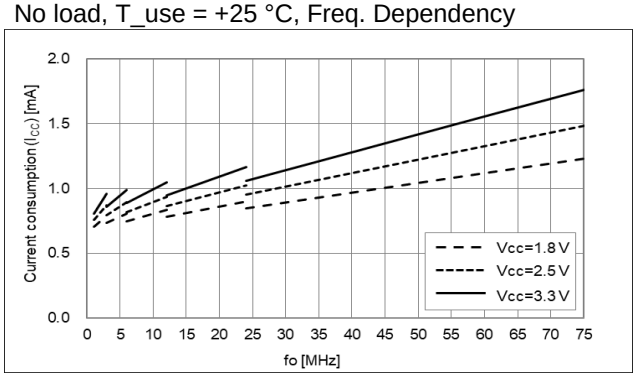
fo = 25 MHz, ±100 × 10^{-6} at -40 to +125 °C

n = 50 pcs

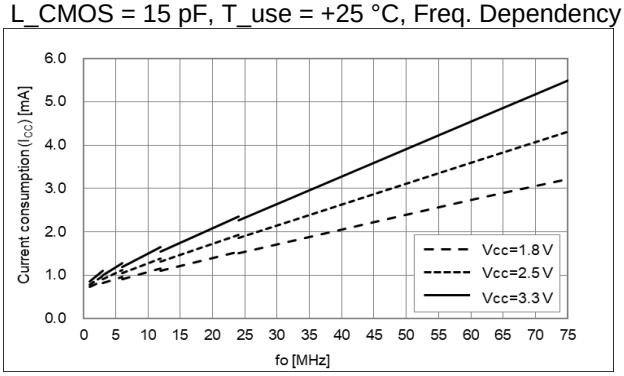


(7-2) Current Consumption

No load, T_use = +25 °C, Freq. Dependency

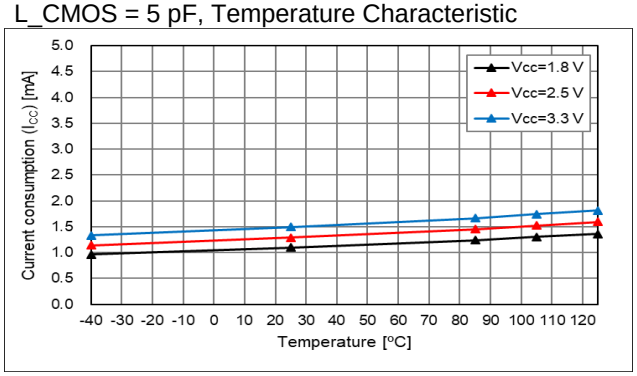


L_CMOS = 15 pF, T_use = +25 °C, Freq. Dependency

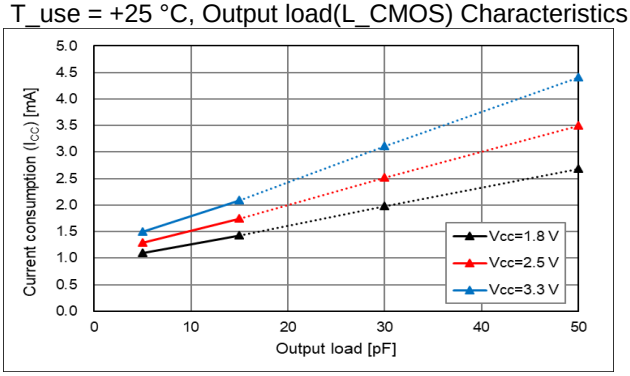


fo = 20 MHz

L_CMOS = 5 pF, Temperature Characteristic

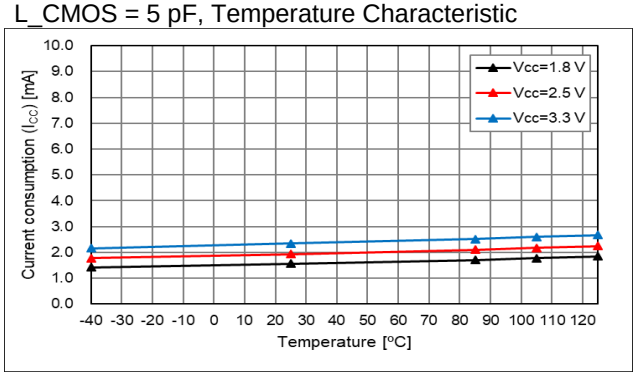


T_use = +25 °C, Output load(L_CMOS) Characteristics

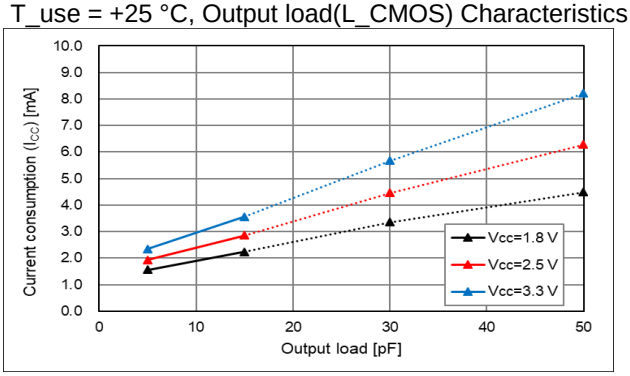


fo = 40 MHz

L_CMOS = 5 pF, Temperature Characteristic



T_use = +25 °C, Output load(L_CMOS) Characteristics



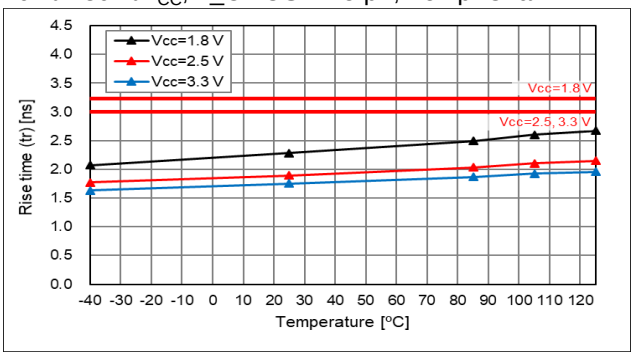
* Output load condition under L_CMOS > 15 pF (dotted line area) is not guaranteed, and the data is for reference.

The actual current consumption is the total of the current under the condition of no load and the current to drive the output load (fo × L_CMOS × V_{CC}). To reduce the current consumption, it is effective to use lower frequency, lower supply voltage and lower output load.

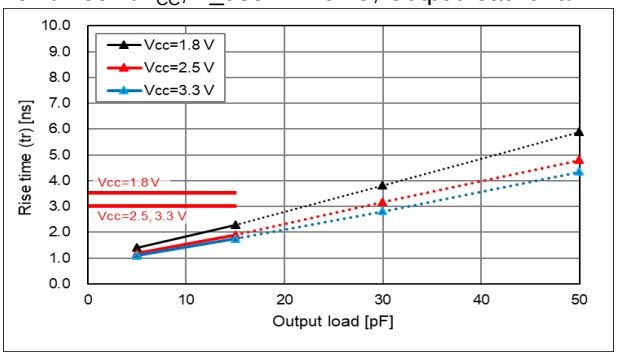
(7-3) Rise Time / Fall Time

fo = 20 MHz, Rise Time

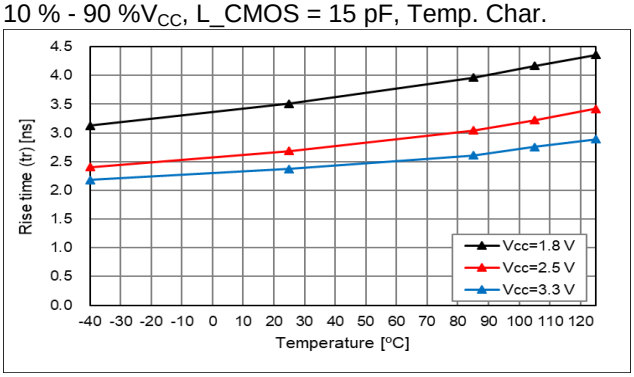
20 % - 80 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



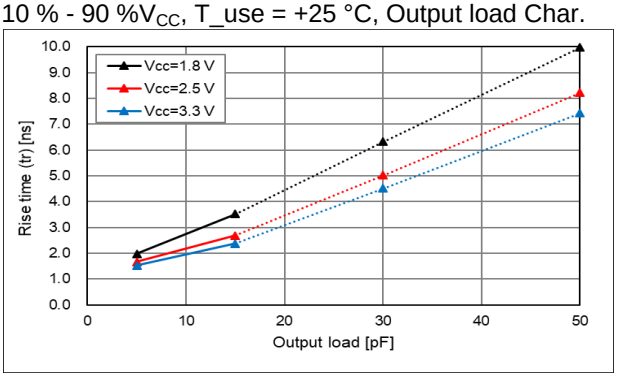
20 % - 80 %V_{CC}, T_use = +25 °C, Output load Char.



10 % - 90 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



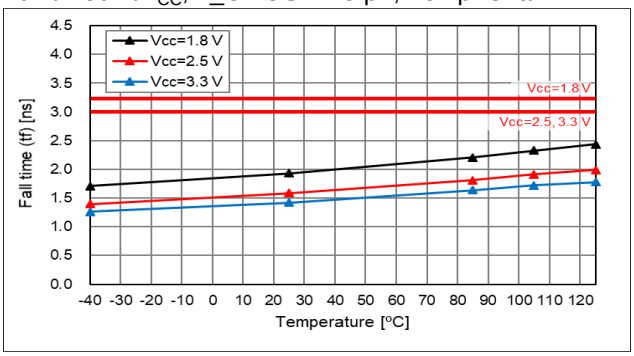
10 % - 90 %V_{CC}, T_use = +25 °C, Output load Char.



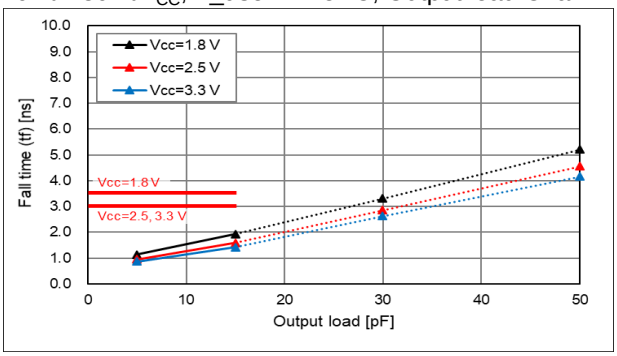
* Output load condition under L_CMOS > 15 pF (dotted line area) is not guaranteed, and the data is for reference.

fo = 20 MHz, Fall Time

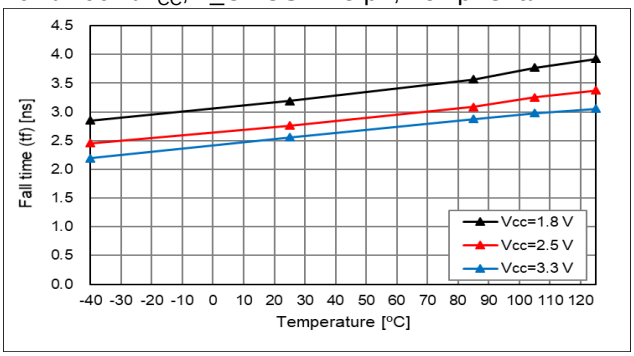
20 % - 80 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



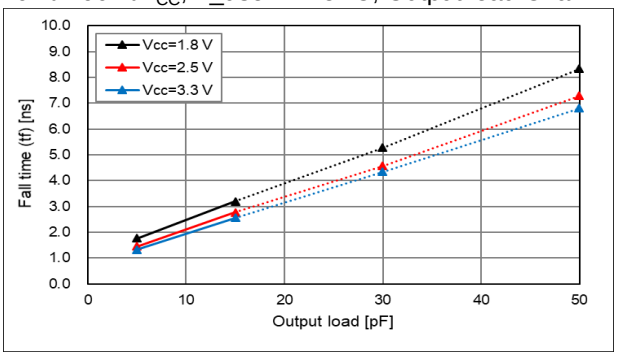
20 % - 80 %V_{CC}, T_use = +25 °C, Output load Char.



10 % - 90 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



10 % - 90 %V_{CC}, T_use = +25 °C, Output load Char.

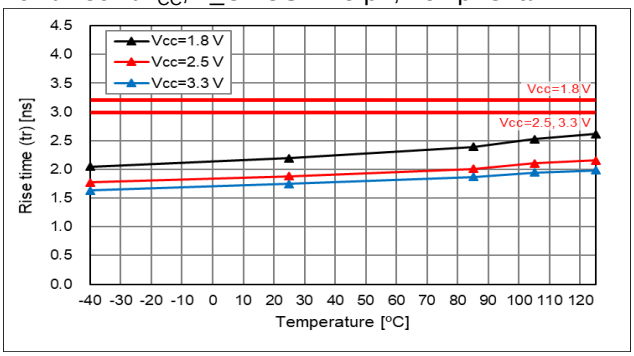


* Output load condition under L_CMOS > 15 pF (dotted line area) is not guaranteed, and the data is for reference.

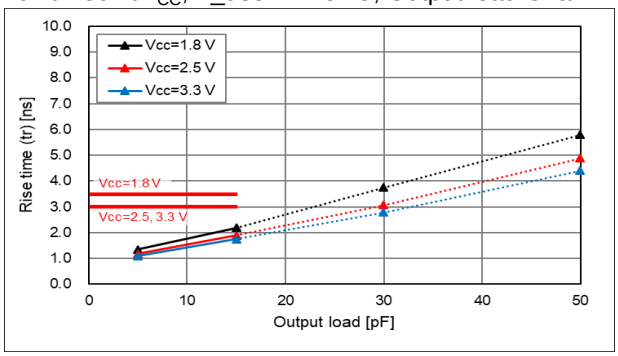
(7-3) Rise Time / Fall Time [cont'd]

fo = 40 MHz, Rise Time

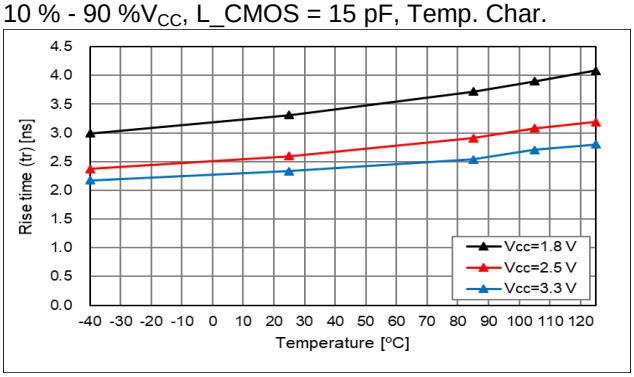
20 % - 80 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



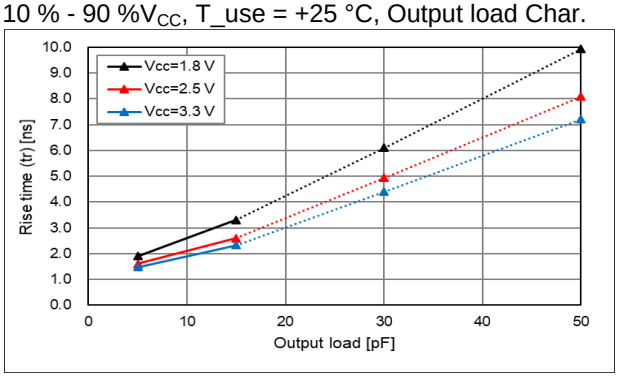
20 % - 80 %V_{CC}, T_use = +25 °C, Output load Char.



10 % - 90 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



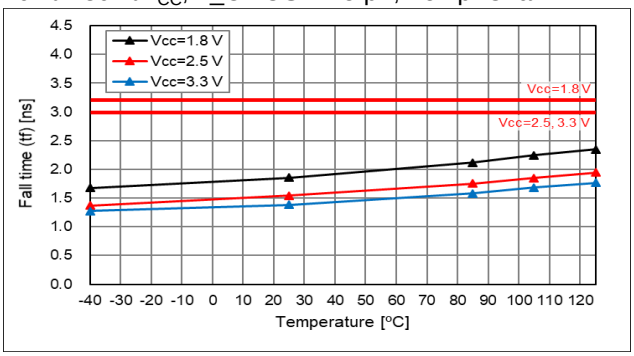
10 % - 90 %V_{CC}, T_use = +25 °C, Output load Char.



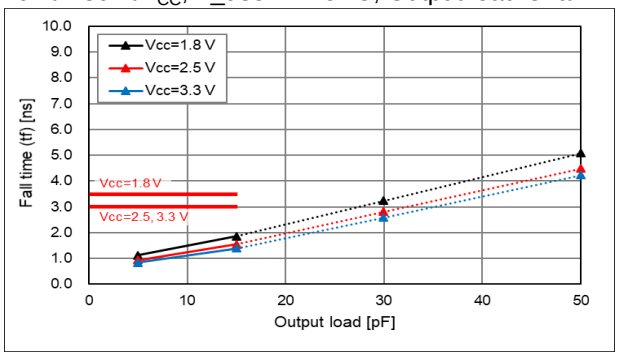
* Output load condition under L_CMOS > 15 pF (dotted line area) is not guaranteed, and the data is for reference.

fo = 40 MHz, Fall Time

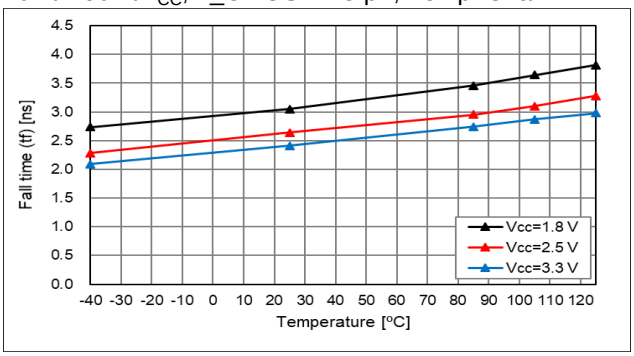
20 % - 80 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



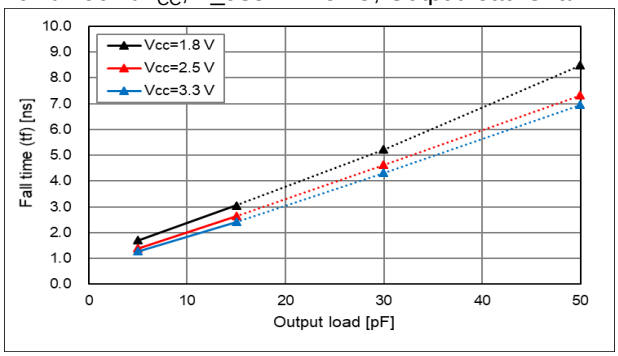
20 % - 80 %V_{CC}, T_use = +25 °C, Output load Char.



10 % - 90 %V_{CC}, L_CMOS = 15 pF, Temp. Char.



10 % - 90 %V_{CC}, T_use = +25 °C, Output load Char.

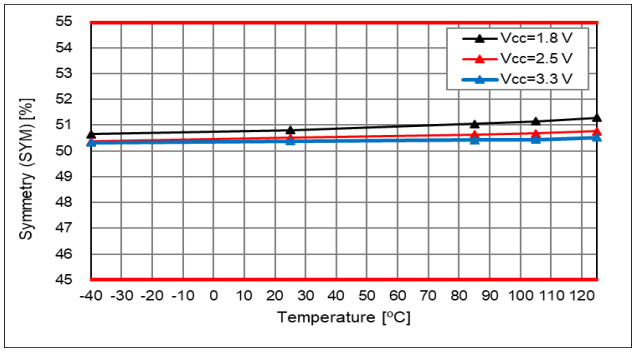


* Output load condition under L_CMOS > 15 pF (dotted line area) is not guaranteed, and the data is for reference.

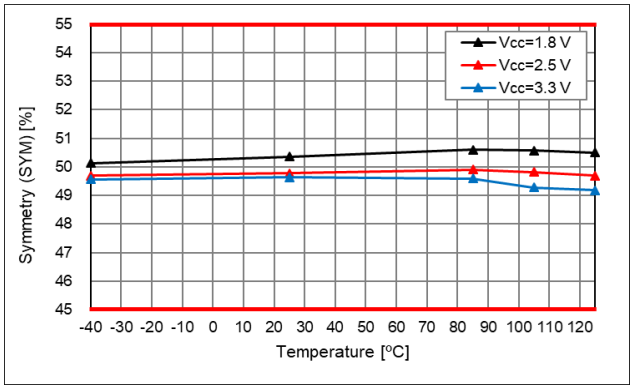
(7-4) Symmetry

50 %V_{CC}, L_CMOS = 15 pF, Temp. Char.

fo = 20 MHz



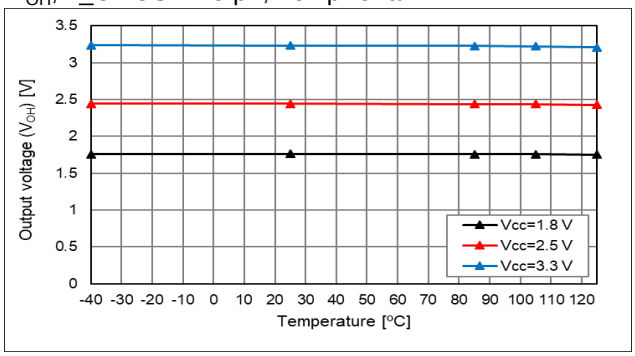
fo = 40 MHz



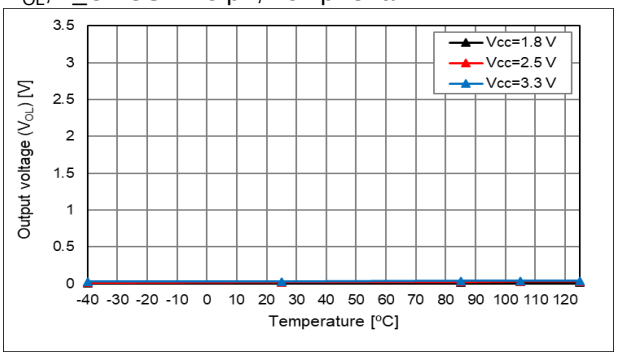
(7-5) Output Voltage

fo = 20 MHz

V_{OH}, L_CMOS = 15 pF, Temp. Char.

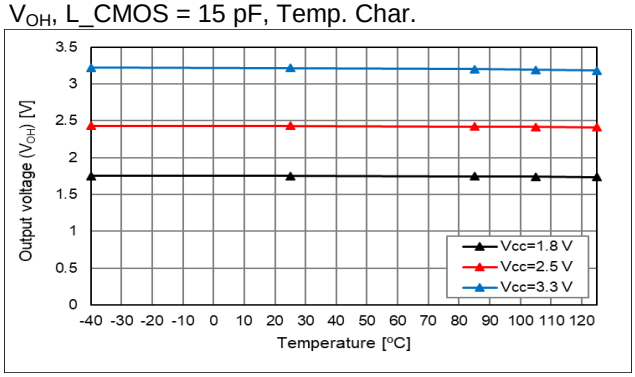


V_{OL}, L_CMOS = 15 pF, Temp. Char.

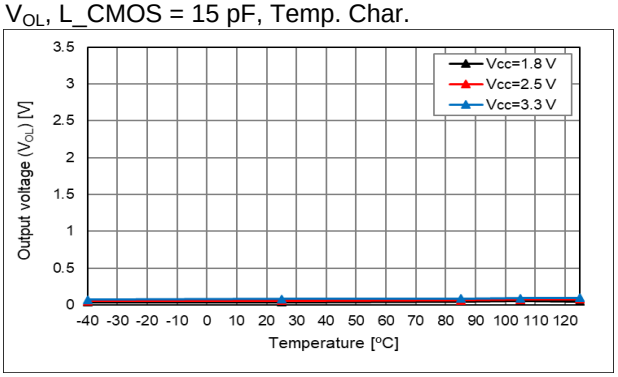


fo = 40 MHz

V_{OH}, L_CMOS = 15 pF, Temp. Char.



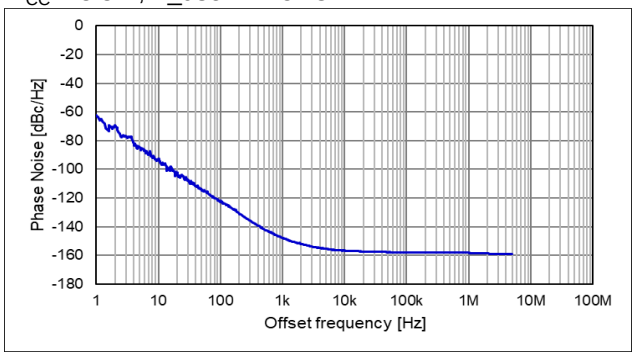
V_{OL}, L_CMOS = 15 pF, Temp. Char.



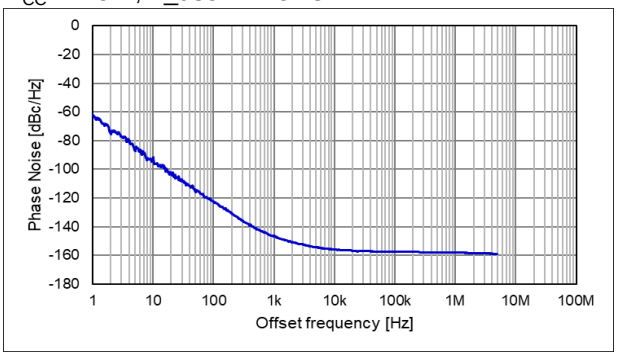
(7-6) Phase Noise and Phase Jitter

fo = 20 MHz

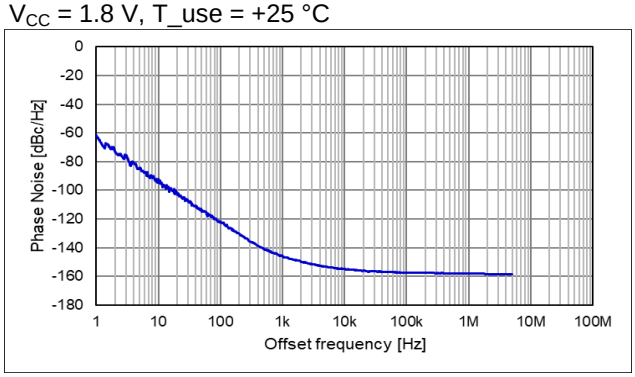
V_{CC} = 3.3 V, T_use = +25 °C



V_{CC} = 2.5 V, T_use = +25 °C



V_{CC} = 1.8 V, T_use = +25 °C



V_{CC}	Phase Jitter*
3.3 V	0.30 ps
2.5 V	0.32 ps
1.8 V	0.32 ps

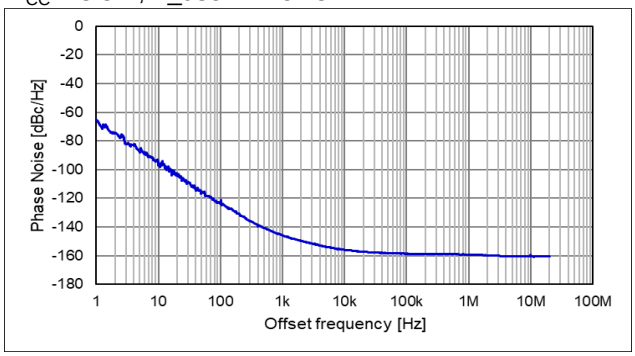
* Offset frequency: 12 kHz to 5 MHz

Jitter (T_use = +25 °C, V_{CC} = 3.3 V)

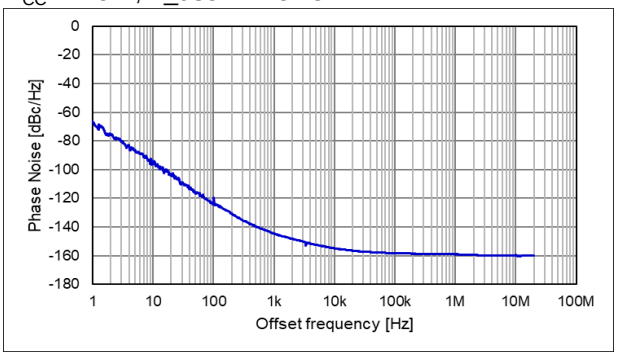
Total jitter (BER = 10^{-12})	31.3 ps
RMS jitter	1.8 ps
Peak to peak jitter	15 ps

fo = 40 MHz

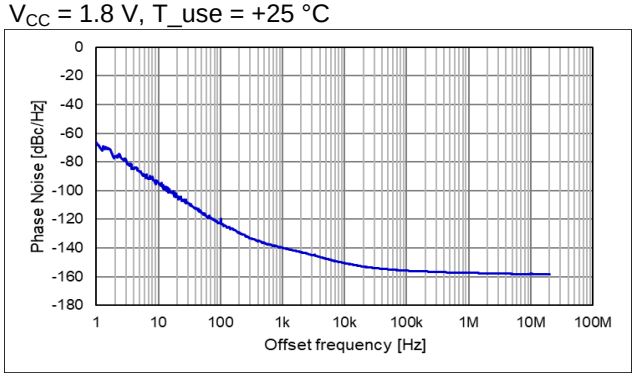
V_{CC} = 3.3 V, T_use = +25 °C



V_{CC} = 2.5 V, T_use = +25 °C



V_{CC} = 1.8 V, T_use = +25 °C



V_{CC}	Phase Jitter*
3.3 V	0.24 ps
2.5 V	0.26 ps
1.8 V	0.32 ps

* Offset frequency: 12 kHz to 20 MHz

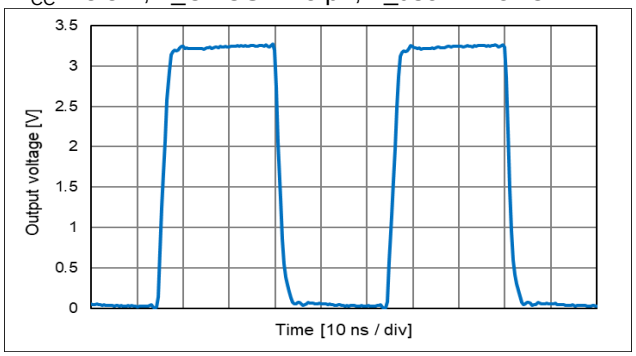
Jitter (T_use = +25 °C, V_{CC} = 3.3 V)

Total jitter (BER = 10^{-12})	22.3 ps
RMS jitter	1.8 ps
Peak to peak jitter	16 ps

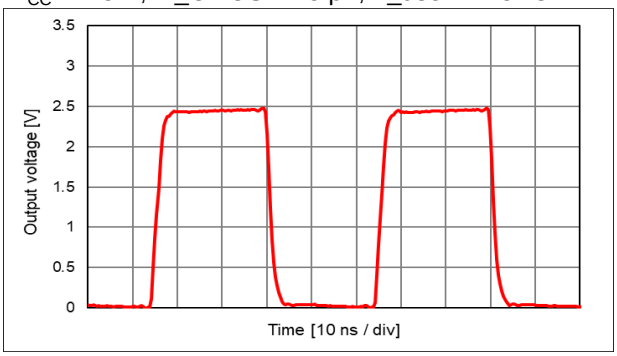
(7-7) Output Waveform

fo = 20 MHz

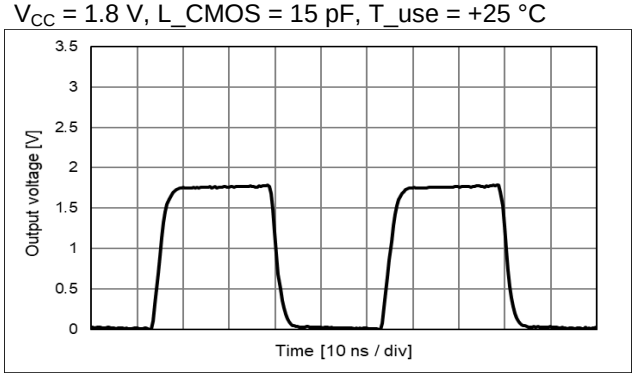
V_{CC} = 3.3 V, L_CMOS = 15 pF, T_use = +25 °C



V_{CC} = 2.5 V, L_CMOS = 15 pF, T_use = +25 °C

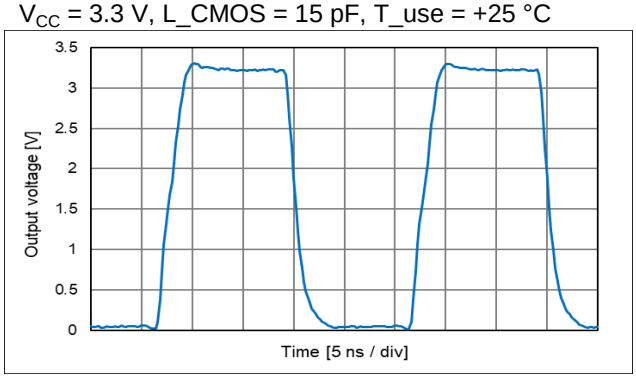


V_{CC} = 1.8 V, L_CMOS = 15 pF, T_use = +25 °C

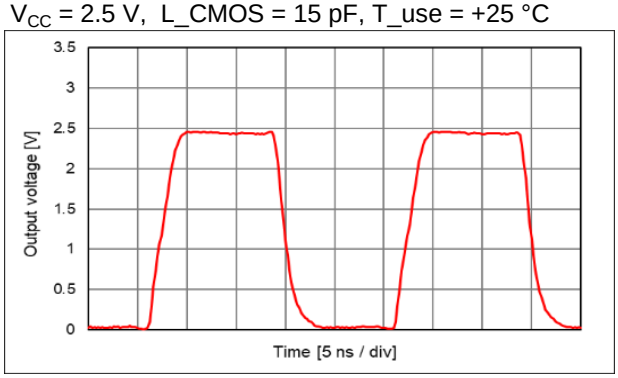


fo = 40 MHz

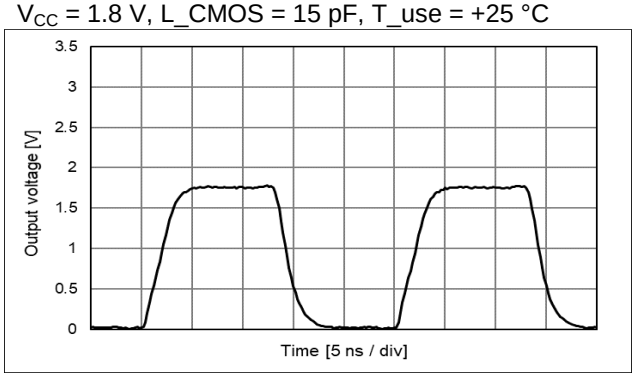
V_{CC} = 3.3 V, L_CMOS = 15 pF, T_use = +25 °C



V_{CC} = 2.5 V, L_CMOS = 15 pF, T_use = +25 °C

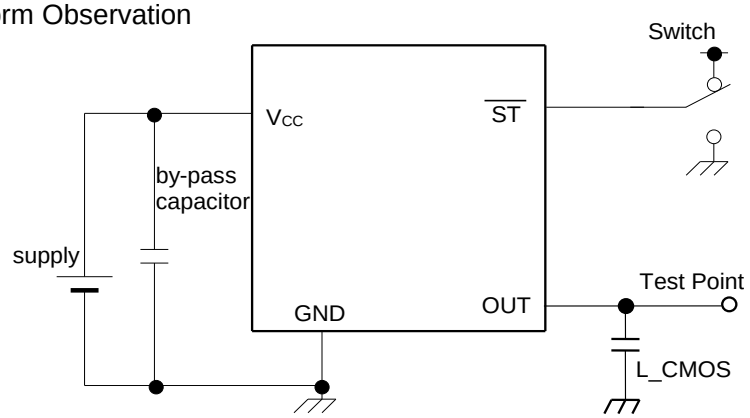


V_{CC} = 1.8 V, L_CMOS = 15 pF, T_use = +25 °C

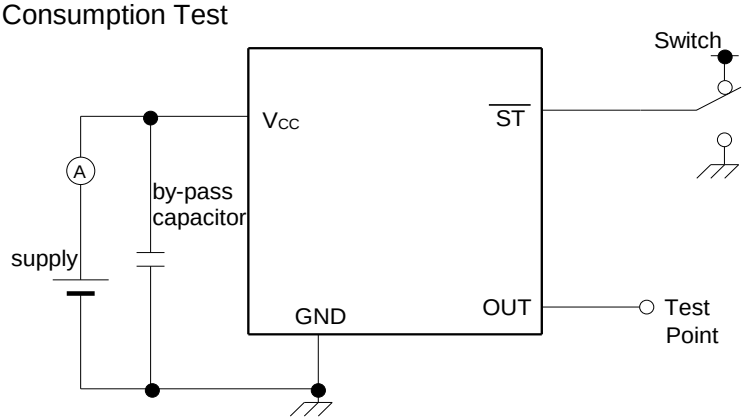


[8] Test Circuit

(8-1) Waveform Observation



(8-2) Current Consumption Test



*Standby current test should be $\overline{ST}$ = GND.

(8-3) Condition

(1) Oscilloscope

The bandwidth should be minimum 5 times the measurement frequency

The probe ground should be placed closely to the test point and the lead length should be as short as possible

* It is recommended to use miniature socket. (Don't use earth lead.)

(2) L_CMOS includes probe capacitance.

(3) A 0.01 µF to a 0.1 µF bypass capacitor should be connected between V_{CC} and GND pins located close to the device

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

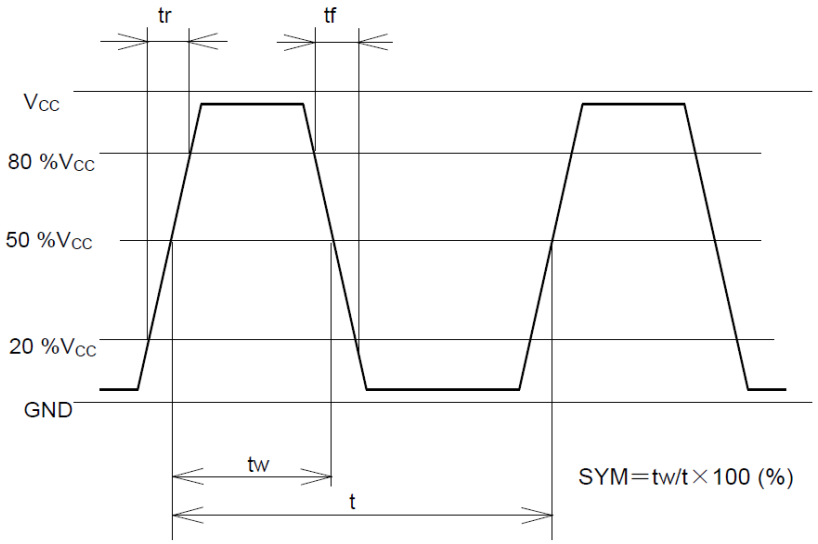
(5) Power Supply

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

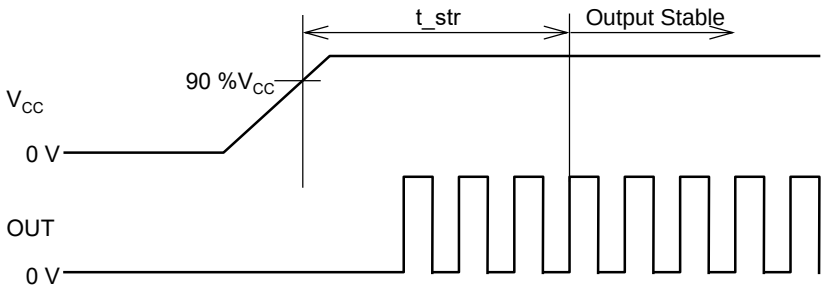
Power supply impedance should be as low as possible

(8-4) Timing Chart

(1) Output Waveform and Level

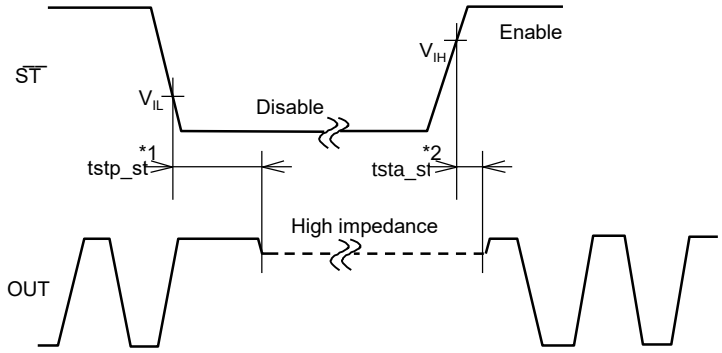


(2) Output Frequency Timing



(3) $\overline{ST}$ Function and Timing

$\overline{ST}$ Terminal	Osc. circuit	Output status
“H” or OPEN	Oscillation	Specified frequency: Enable
“L”	Oscillation stop	High impedance: Disable



*1 The period from $\overline{ST}$ = V_{IL} to OUT = High impedance (Disable)

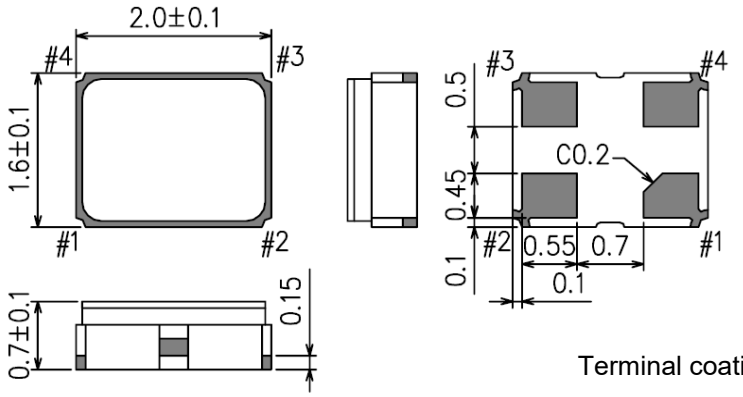
*2 The period from $\overline{ST}$ = V_{IH} to OUT = Enable

* Judge of starting output: $V_{OH} \geq 80\ \%V_{CC}$, $V_{OL} \leq 20\ \%Vcc$, fout is within fo ± 1 000 × 10^{-6}

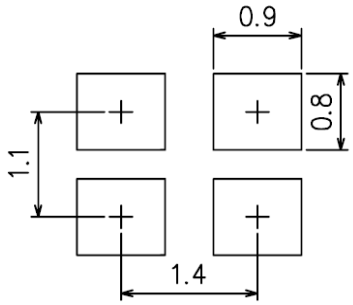
* $\overline{ST}$ terminal voltage level should not exceed supply voltage when using $\overline{ST}$ function.
Please note that $\overline{ST}$ rise time should not exceed supply voltage rise time at the start-up.

[9] Outline Drawing and Recommended Footprint

Units: mm



Terminal coating : Au plating



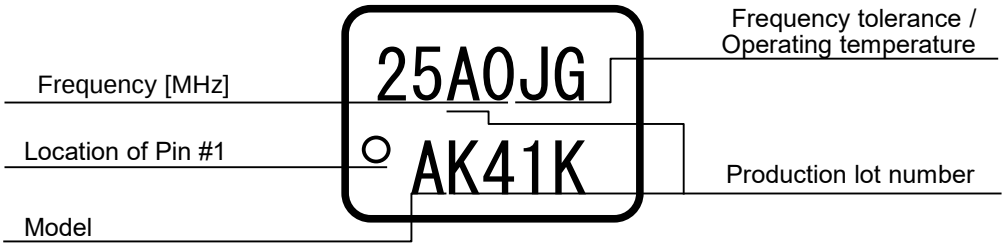
For stable operation, it is recommended that 0.01 µF to 0.1 µF bypass capacitors should be connected between V_{CC} and GND and placed as close to the V_{CC} pin as possible.

Reference Weight Typ.: 9.9 mg

Terminal Assignment

Pin #	Connection	Function		
#1	$\overline{ST}$	$\overline{ST}$ terminal		
		$\overline{ST}$ function	Osc. Circuit	Output
		"H" or OPEN	Oscillation	Specified frequency: Enable
		"L"	Oscillation stop	High impedance: Disable
#2	GND	GND terminal		
#3	OUT	Output terminal		
#4	V_{CC}	V_{CC} terminal		

Marking

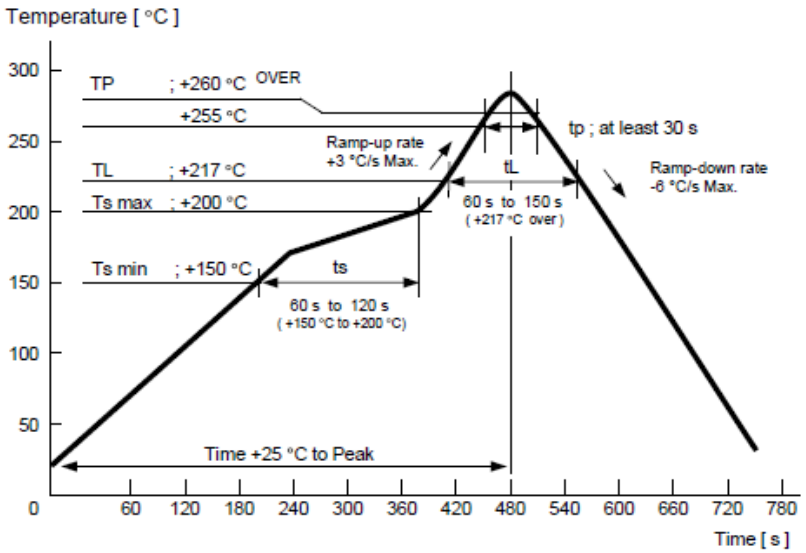


[10] Moisture Sensitivity Level

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

[11] Reflow Profiles

IPC/JEDEC J-STD-020D.1



[12] Packing Information

(12-1) Packing Quantity

The last two digits of the Product Number (X1G005341xxxx**xx**) are a code that defines the packing quantity. The standard is "00" for a 3 000 pcs/Reel.

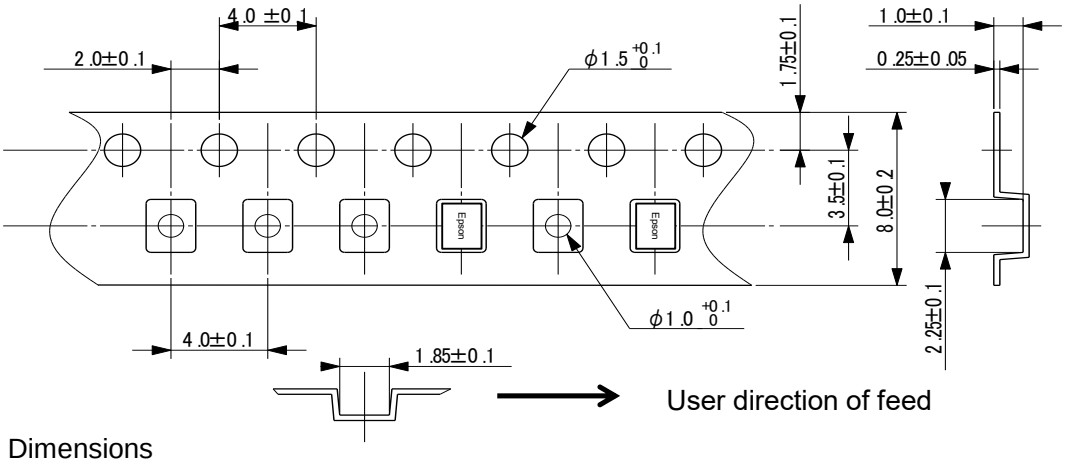
(12-2) Taping Specification

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

(1) Tape Dimensions

Carrier Tape Material: PS (Polystyrene)

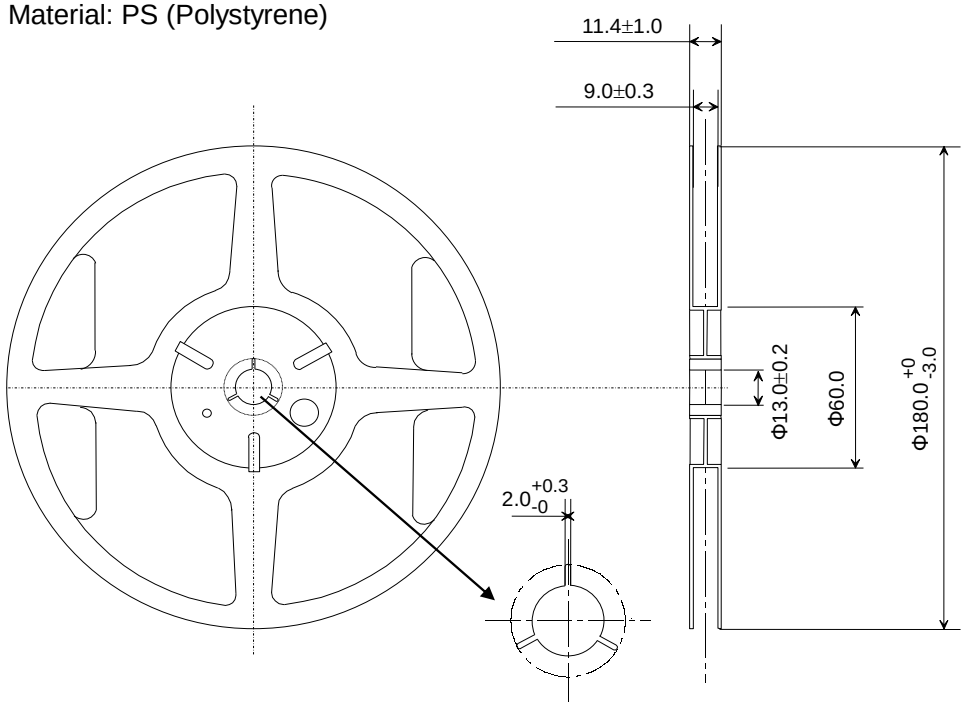
Top Tape Material: PET (Polyethylene Terephthalate) +PE (Polyethylene) Units: mm



(2) Reel Dimensions

Center Material: PS (Polystyrene)

Reel Material: PS (Polystyrene) Units: mm



(3) Storage Environment

We recommend to keep less than +30 °C and 85 %RH of humidity in a packed condition, and to use it less than 6 months after delivery.

[13] 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, please 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) 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 ($\overline{ST}$) 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	Avallable
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 Avallable**
Soldering iron	Avallable

(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.

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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.

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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.

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