Low phase noise Fundamental Quartz Crystal Oscillator IC

■FEATURES(V_{DD}=3.3V, f_0=49.152MHz, Ta=25°C)

●Phase noise	-103dBc/Hz(Typ.) @10Hz Offset
	-163dBc/Hz(Typ.) @1kHz Offset
●RMS Jitter	0.05psec(Typ.) @12kHz to 20MHz
●Oscillation Frequency	20MHz to 50MHz(Fundamental)
●Operating Voltage	1.62V to 3.63V
●Operating Current	9.0mA(Typ.) @C_L=15pF.
●3-State Output Buffer	
●Oscillation Capacitors Cg and Cd on-chip	
●Operation Temperature	-40°C to +125°C
●Package Outline	DFN6-G1(ESON6-G1)

■GENERAL DESCRIPTION

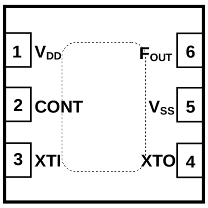
The **NJU6385** is a C-MOS quartz crystal oscillator IC (20MHz to 50MHz) realized very low phase noise. It is consisted of an oscillation amplifier and 3-state output buffer.

The NJU6385 in low voltage operation features low phase noise, it is suitable for a master-clock generator into a D-A converter of digital audio system.

■APPLICATION

- ●Car Audio / Car Navigation System
- ●Home Audio
- ●Portable Audio
- ●USB DAC

■PIN CONFIGURATION

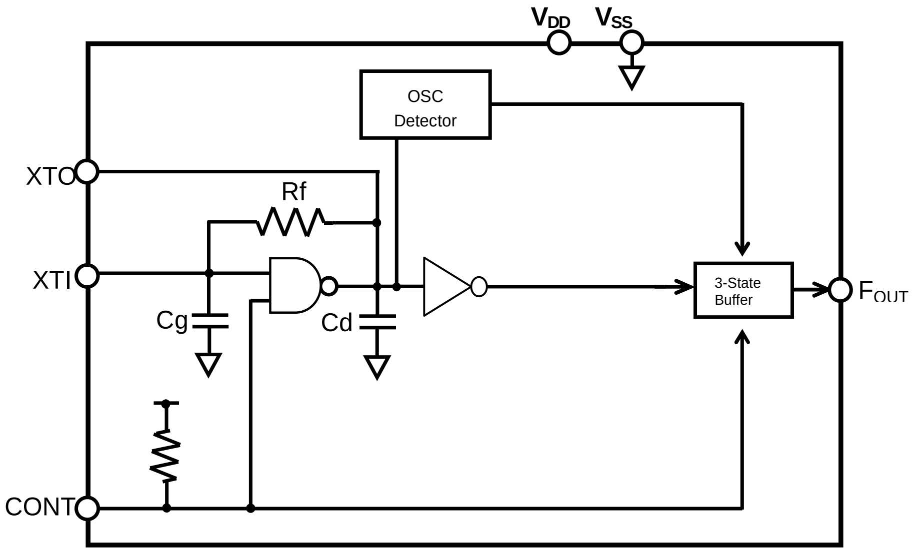
Parts Number	NJU6385KG1
Package Outline	DFN6-G1(ESON6-G1)(*)
Pin Function	TOP View 

(*)Connect to exposed pad to V_{SS} or OPEN

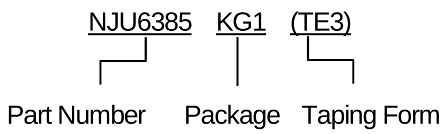
■TERMINAL DISCREPTION

<table>
<tr><th>SYMBOL</th><th>FUNCTION</th></tr>
<tr><td>CONT</td><td>Oscillation and 3-state Output Buffer Control
<table>
<tr><th>CONT</th><th>F_{OUT}</th></tr>
<tr><td>H or OPEN</td><td>Frequency Output (f_0)</td></tr>
<tr><td>L</td><td>Oscillation Stop and High impedance Output</td></tr>
</table></td></tr>
<tr><td>XTI
XTO</td><td>Quartz Crystal Connection terminals</td></tr>
<tr><td>V_{SS}</td><td>GND terminal (V_{SS}=0V)</td></tr>
<tr><td>F_{OUT}</td><td>Frequency Output terminal (3-State Output Buffer)</td></tr>
<tr><td>V_{DD}</td><td>Power Supply terminal V_{DD}=1.62 to 3.63V</td></tr>
</table>

■BLOCK DIAGRAM



■PRODUCT NAME INFORMATION



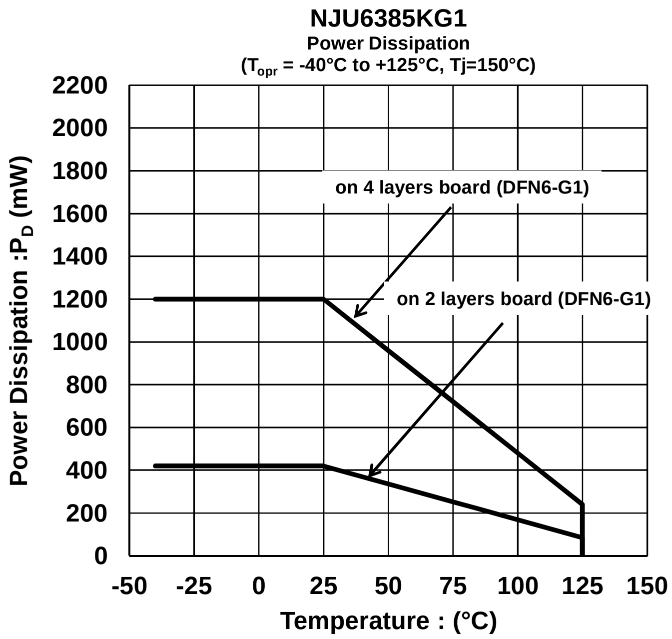
■ABSOLUTE MAXIMUM RATINGS (1)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	-0.6 to +6.0	V
Input Voltage	V_{IN}	-0.6 to +V_{DD}+0.6 and ≤ 6.0V	V
Output Voltage	V_O	-0.6 to V_{DD}+0.6	V
Input Terminal Current	I_{IN}	±10	mA
Output Terminal Current	I_O	±25	mA
Power Dissipation(Ta=25°C) DFN6-G1(ESON6-G1)(2)	P_D	(2-layer / 4-layer) 420 / 1200	mW
Junction Temperature	T_{jmax}	+150	°C
Operating Temperature Range	T_{opr}	-40 to +125	°C
Storage Temperature Range	T_{stg}	-55 to +150	°C

(1) If the LSI used condition above the absolute maximum ratings, the LSI may be destroyed. Use beyond the electric characteristics conditions will cause mal-function and poor reliability.

(2) Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 2Layers FR-4, with Exposed Pad)
Mounted on glass epoxy board. (101.5×114.5×1.6mm: based on EIA/JEDEC standard, 4Layers FR-4, with Exposed Pad)
*For 4Layers: Applying 99.5×99.5mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5

■POWER DISSIPATION vs. AMBIENT TEMPERATURE



■ELECTRICAL CHARACTERISTICS(4)

(Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	f_{OSC}=50MHz	1.62	-	3.63	V
Input Voltage	V_{IN}	CONT	0	-	3.63	V
Output Voltage	V_{OUT}	F_{OUT}	0	-	V_{DD}	V
Output Frequency Stability	df/f	V_{DD}±10%	-	±1	-	ppm

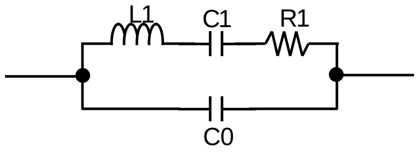
(V_{DD}=1.62 to 3.63V, V_{SS}=0V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	f_0=49.152MHz No load TEST CIRCUIT(1)(3) F_{OUT}=49.152MHz	V_{DD}=1.8V	-	1.8	2.9	mA
			V_{DD}=2.5V	-	3.3	4.8	
			V_{DD}=3.3V	-	5.5	7.7	
		f_0=49.152MHz C_L=15pF TEST CIRCUIT(1)(3) F_{OUT}=49.152MHz	V_{DD}=1.8V	-	3.1	4.1	
			V_{DD}=2.5V	-	5.1	6.6	
			V_{DD}=3.3V	-	7.9	9.9	
Stand-by Current	I_{STB}	TEST CIRCUIT(1)(3) CONT=V_{SS}	V_{DD}=1.8V	-	3.0	25.0	µA
			V_{DD}=2.5V	-	5.0	30.0	
			V_{DD}=3.3V	-	9.0	35.0	
H Level Output Voltage	V_{OH}	TEST CIRCUIT(2)(3)		V_{DD}-0.4	-	-	V
L Level Output Voltage	V_{OL}	TEST CIRCUIT(2)(3)		-	-	0.4	V
H Level Input Voltage	V_{IH}	TEST CIRCUIT(3)(3)		0.7V_{DD}	-	−	V
L Level Input Voltage	V_{IL}	TEST CIRCUIT(3)(3)		-	-	0.3V_{DD}	V
Input Current	I_{IN}	TEST CIRCUIT(4)(3), V_{DD}=1.62V, CONT=V_{DD}		-	-	+65	nA
		TEST CIRCUIT(4)(3), V_{DD}=1.62V, CONT=V_{SS}		-	-	-0.5	µA
		TEST CIRCUIT(4)(3), V_{DD}=3.63V, CONT=V_{DD}		-	-	+150	nA
		TEST CIRCUIT(4)(3), V_{DD}=3.63V, CONT=V_{SS}		-10	-	-	µA
3-state Off Leakage Current	I_{OZ}	TEST CIRCUIT(5)(3) CONT=V_{SS}, F_{OUT}=V_{DD} or V_{SS}		-	-	±0.1	µA
Feedback Resistance	Rf			35	50	65	kΩ
Built-In Oscillator Capacitance	Cg	f_{OSC}=50MHz		-	8	-	pF
	Cd	f_{OSC}=50MHz		-	17	-	pF
Oscillation Frequency	F_{OSC}	Recommendation(4)		-	-	50	MHz
Output Signal Symmetry	SYM	C_L=15pF, @V_{DD}/2, TEST CIRCUIT(1)(3)		45	50	55	%
Phase Noise	SSB	f_{OSC}=49.152MHz V_{DD}=1.8V	10Hz Offset	-	-103	-	dBc/Hz
			1kHz Offset	-	-158	-	
			Floor	-	-166	-	
		f_{OSC}=49.152MHz V_{DD}=3.3V	10Hz Offset	-	-103	-	
			1kHz Offset	-	-163	-	
			Floor	-	-172	-	
Output Signal rise Time	tr	TEST CIRCUIT(1)(3) 0.1V_{DD} to 0.9V_{DD}	V_{DD}=1.8V	-	3.1	4.7	ns
			V_{DD} ≥ 2.5V	-	1.8	2.7	ns
Output Signal fall Time	tf	TEST CIRCUIT(1)(3) 0.9V_{DD} to 0.1V_{DD}	V_{DD}=1.8V	-	2.8	4.2	ns
			V_{DD} ≥2.5V	-	1.8	2.7	ns
Output Disable Time	t_{POZ}	TEST CIRCUIT(6)(3)		-	-	200	ns
Output Enable Time	t_{PZO}	TEST CIRCUIT(6)(3)		-	-	1	ms
Oscillation Start-Up Time	t_{OSC}	TEST CIRCUIT(1)(3)		-	-	1	ms

(3) Decupling capacitor over than 0.01µF ceramic capacitor should be connected between V_{DD} and V_{SS} due to the stabilized operation for the circuit.

(4) NJR's standard crystal is used for measurement of the oscillation frequency range and it does not guarantee oscillation. (Refer to EXAMPLE OF CRYSTAL PARAMETERS FOR MEASUREMENT CIRCUITS)

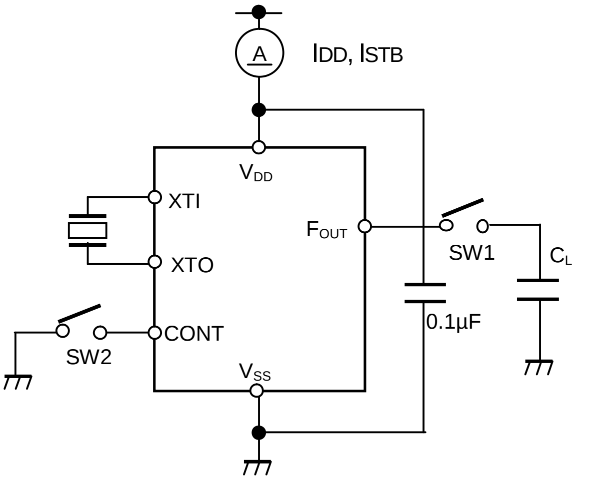
■EXAMPLE OF CRYSTAL PARAMETERS FOR MEASUREMENT CIRCUITS



f [MHz]	R1 [Ω]	L1 [mH]	C1 [f F]	C0 [pF]
49.152	17.7	3.83	2.74	1.23

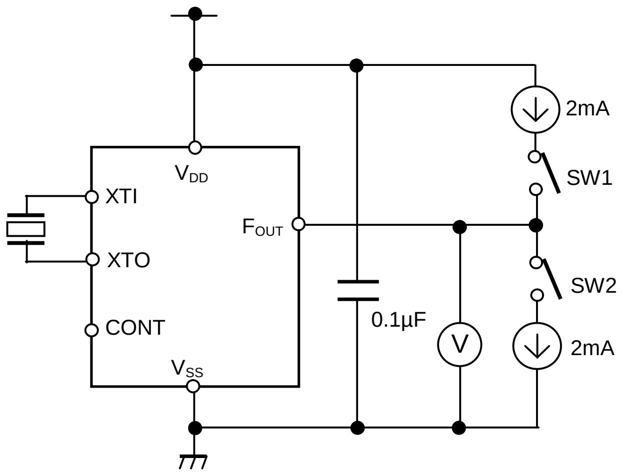
■TYPICAL TEST CIRCUIT

(1) Operating Current, Stand-by Current, Output Signal rise / Fall Time, Oscillation Start-Up Time



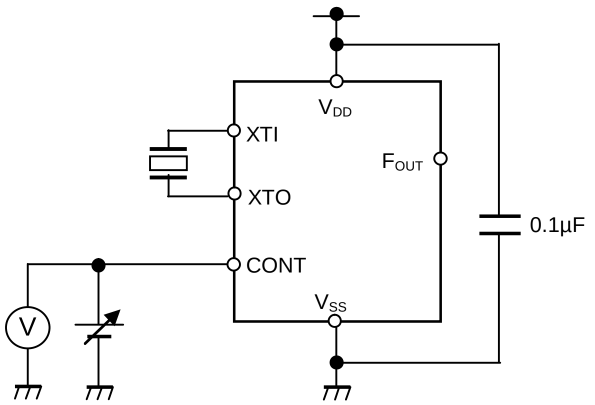
PARAMETER	SW1	SW2
IDD (CL=0pF)	OFF	OFF
IDD (CL=15pF)	ON	OFF
ISTB	ON or OFF	ON
SYM, tr, tf	ON	OFF
tOSC	ON	OFF

(2) **High-level / Low-level Output Voltage (VOH / VOL)**



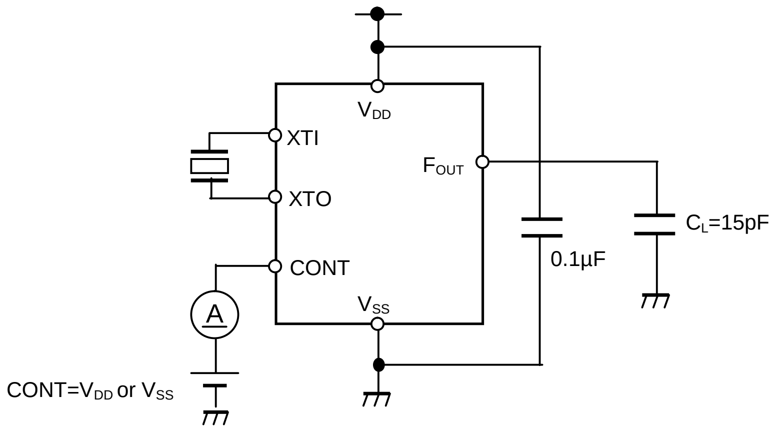
PARAMETER	SW1	SW2
VOH	OFF	ON
VOL	ON	OFF

(3) **High-level / Low-level Input Voltage (VIH / VIL)**

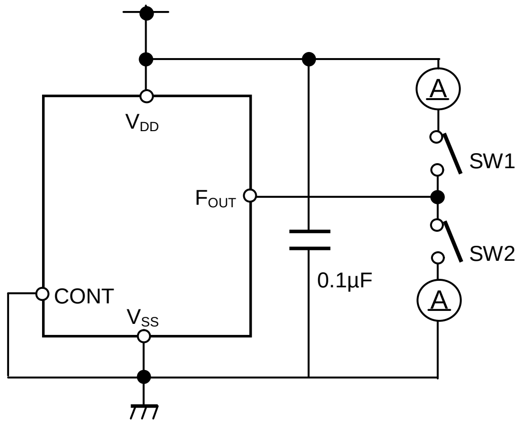


PARAMETER	FOUT
CONT $\geq$ 0.7VDD	Oscillation
CONT$\leq$ 0.3VDD	Stop

(4) Input Current (I_{IN})

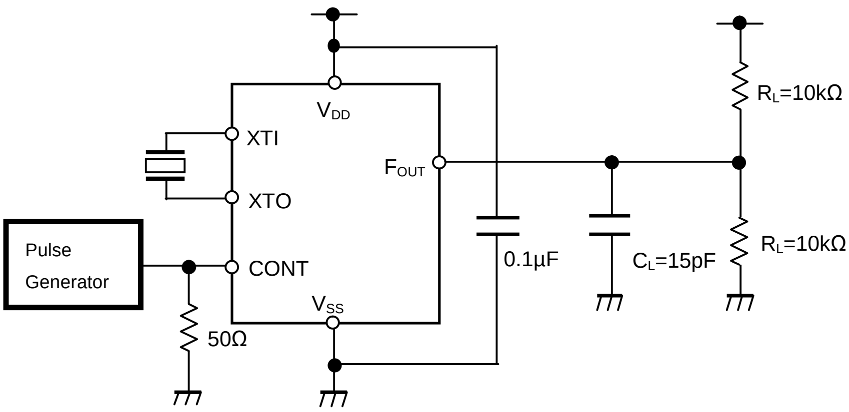


(5) 3-State Off Leakage Current (I_{OZH} / I_{OZL})



PARAMETER	SW1	SW2
I_{OZH}	OFF	ON
I_{OZL}	ON	OFF

(6) Output Disable Time, Output Enable Time (t_{POZ} / t_{PZO})



■TIMING CHART

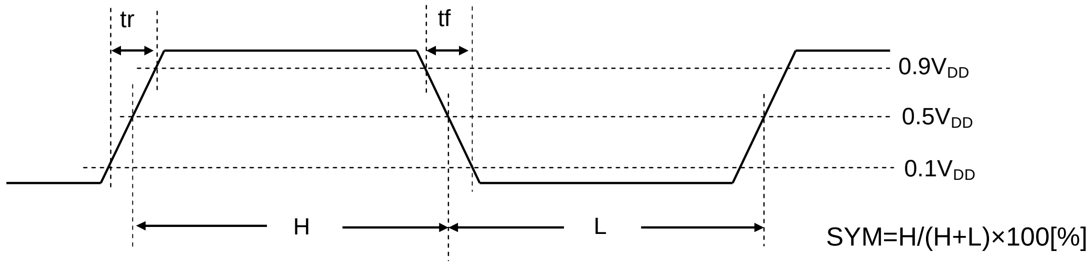


Fig.1 Output Signal Rise Time: tr, Output Signal Fall Time: tf, Output Symmetry: SYM

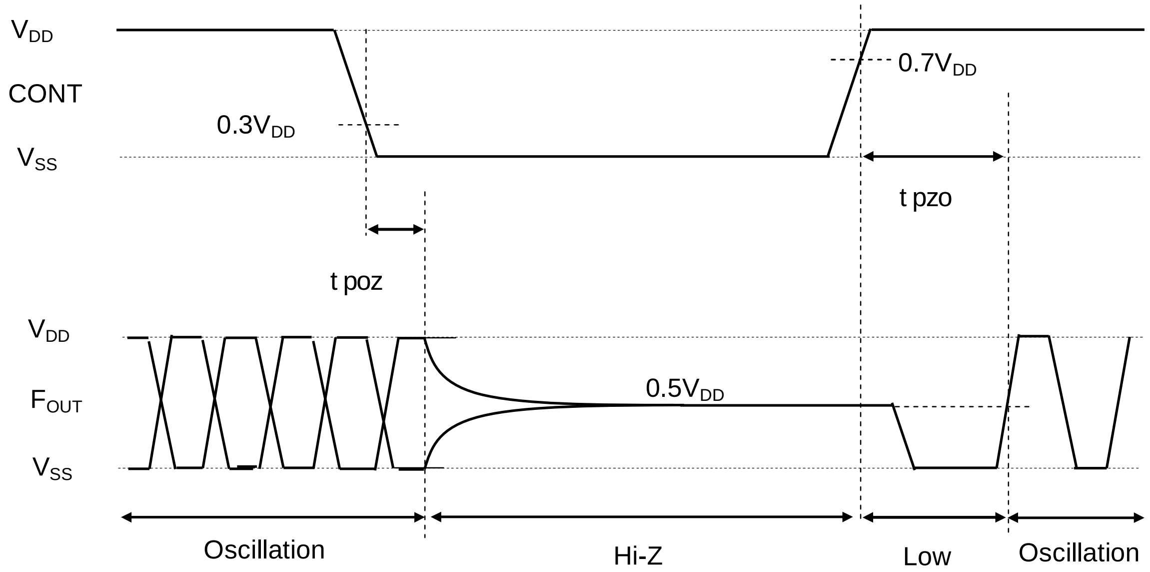


Fig.2 Output Disable time: t poz, Output Enable time: t pzo.

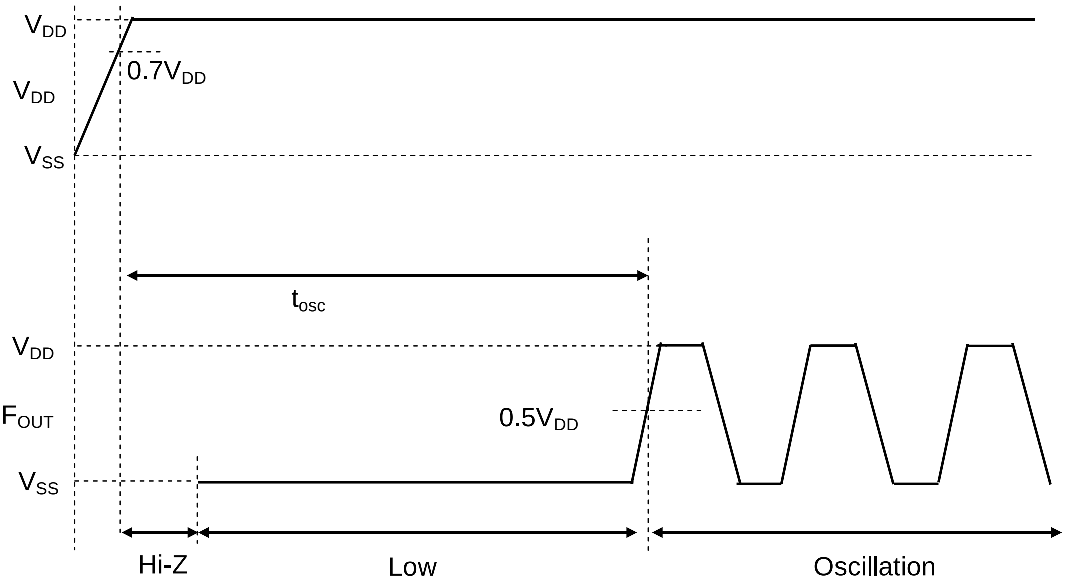
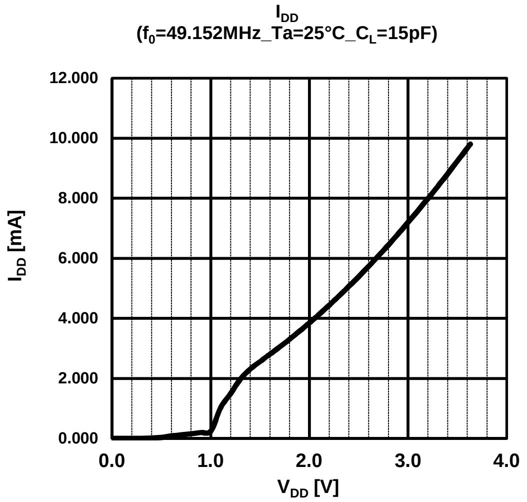


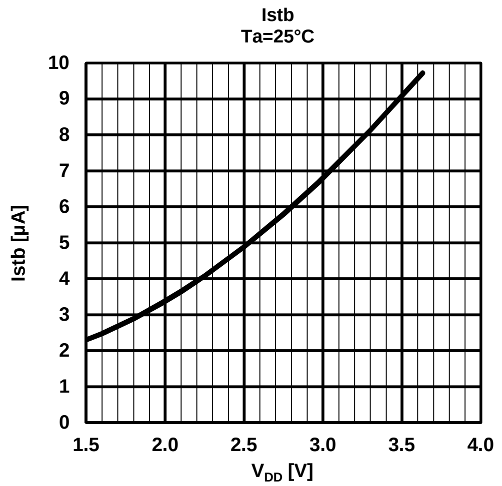
Fig.3 Oscillation Start time: t_{OSC}

■TYPICAL CHARACTERISTICS

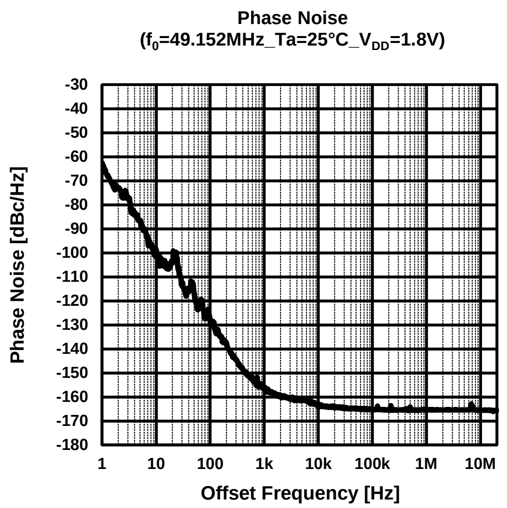
・Operating Current

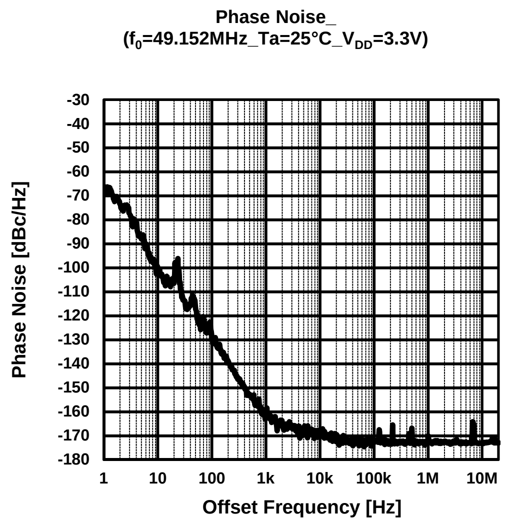


・Stand-by Current

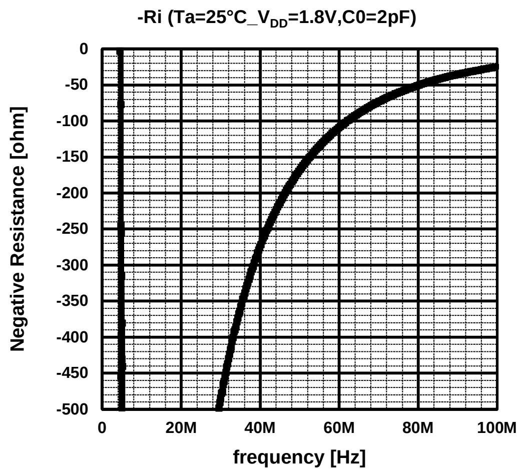


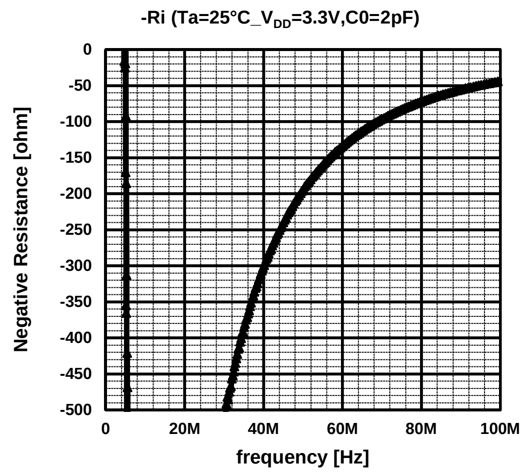
・Phase Noise





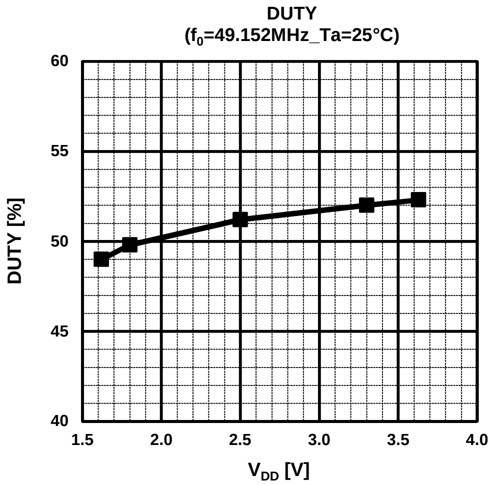
・Negative Resistance



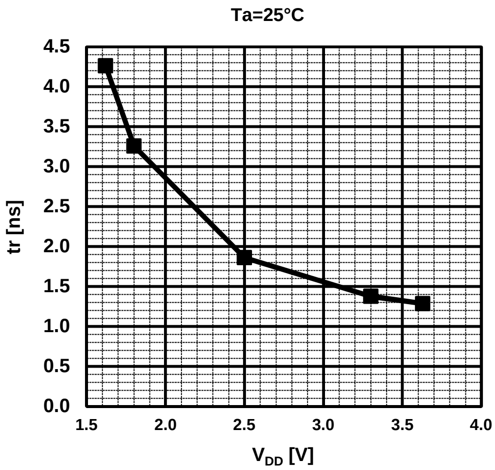


Note; A negative resistance 3 to 5 times the equivalent series resistance is said to be required for sufficient oscillation margin.

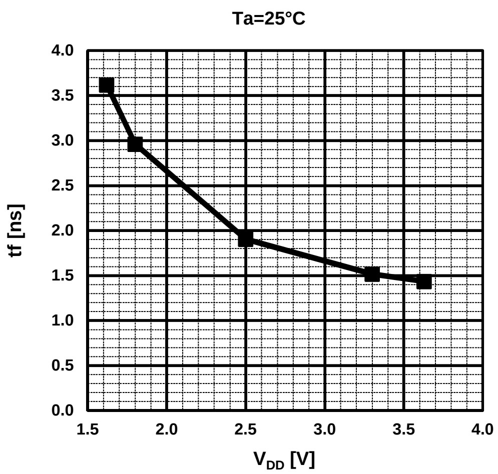
・Output Signal Symmetry



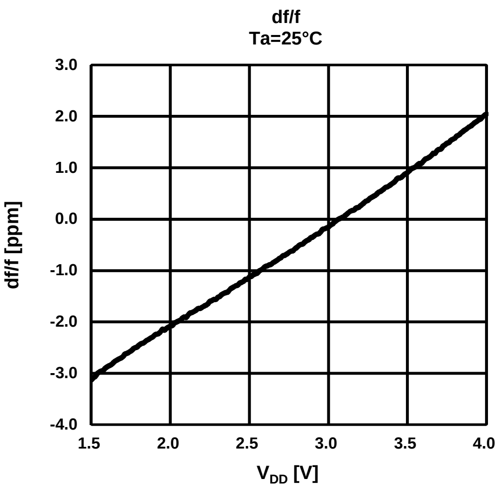
・Output Signal rise Time



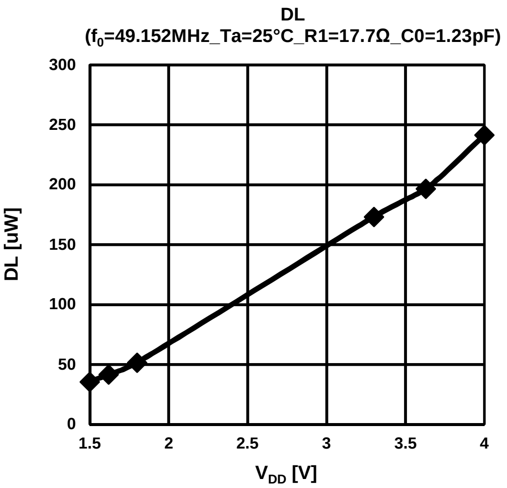
・Output Signal fall Time



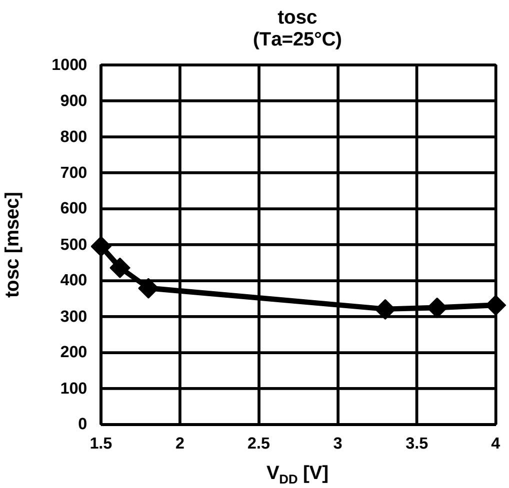
・ Output Frequency Stability



・ Drive Level



・ Oscillation Start-Up Time



■**Application Note**

FUNCTIONAL DESCRIPTION

•Standby Function

When CONT Terminal is “Low”, the F_{OUT} Terminal output is High impedance.

CONT	F_{OUT}	Oscillator
High(Open)	Frequency output	Normal operation
Low	High impedance	Stop

When not using Stand-by function, CONT terminal is recommended to connect to V_{DD}.

•Built-in Variable Pull-up Resistance of CONT terminal

The built-in pull-up resistance value of CONT Terminal changes in response to the input level. When CONT is “Low” level, the pull-up resistance value is large to reduce the current consumption by the resistance. When CONT is open or connected to V_{DD}, the pull-up resistance value is small to decrease the input susceptibility to external noise. It works to prevent an unexpectedly stopping of the output by external noise.

Choice of crystal at notice

Standard crystal unit example

	Dxx2520xx
Frequency Range	30 to 54 MHz
Overtone Order	Fundamental
Equivalent Series Resistance	50Ω max.
Drive Level	10µW (Max. 200µW)
Load Capacitance	8, 12, 15 pF

This range is related to crystal oscillation IC.

Equivalent Series Resistance: Equivalent resistance of crystal unit when series resonation.(refer to perspective of –Ri)

Drive Level: Loading condition of crystal resonator, which is determined by electric current or power.

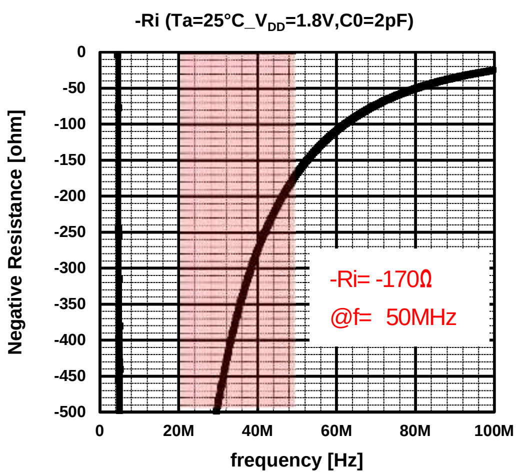
(refer to perspective of drive level)

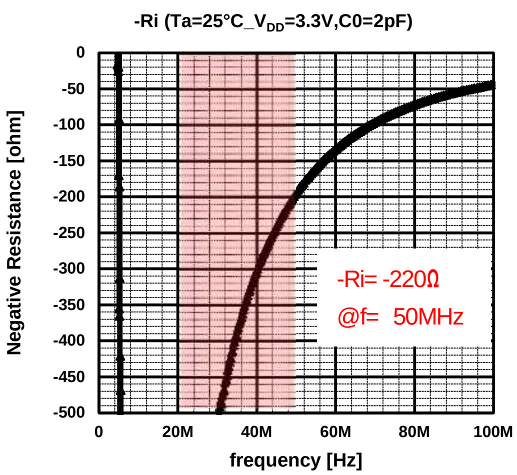
Load Capacitance: The effective external capacitance that determines the resonance frequency of a crystal resonator.

(refer to A formula of load capacitance.)

Perspective of -Ri

:NJU6385 Oscillation Frequency Range.(20MHz to 50MHz)



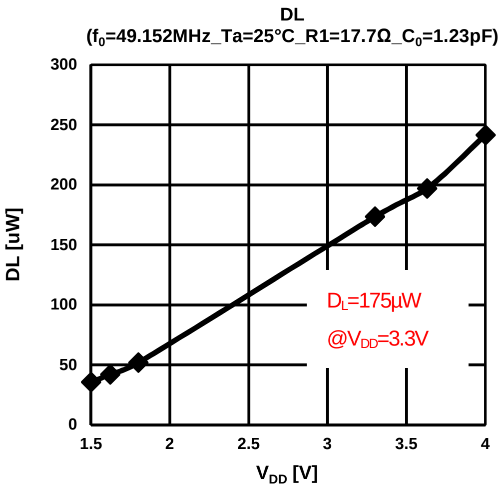


Note: A negative resistance 3 to 5 times the equivalent series resistance is said to be required for sufficient oscillation margin.

Perspective of Drive Level

According it graph, D_L = 175µW. at V_{DD} = 3.3V, f=49.1592MHz

We recommend the high drive level crystal unit. example 200µW [max.]



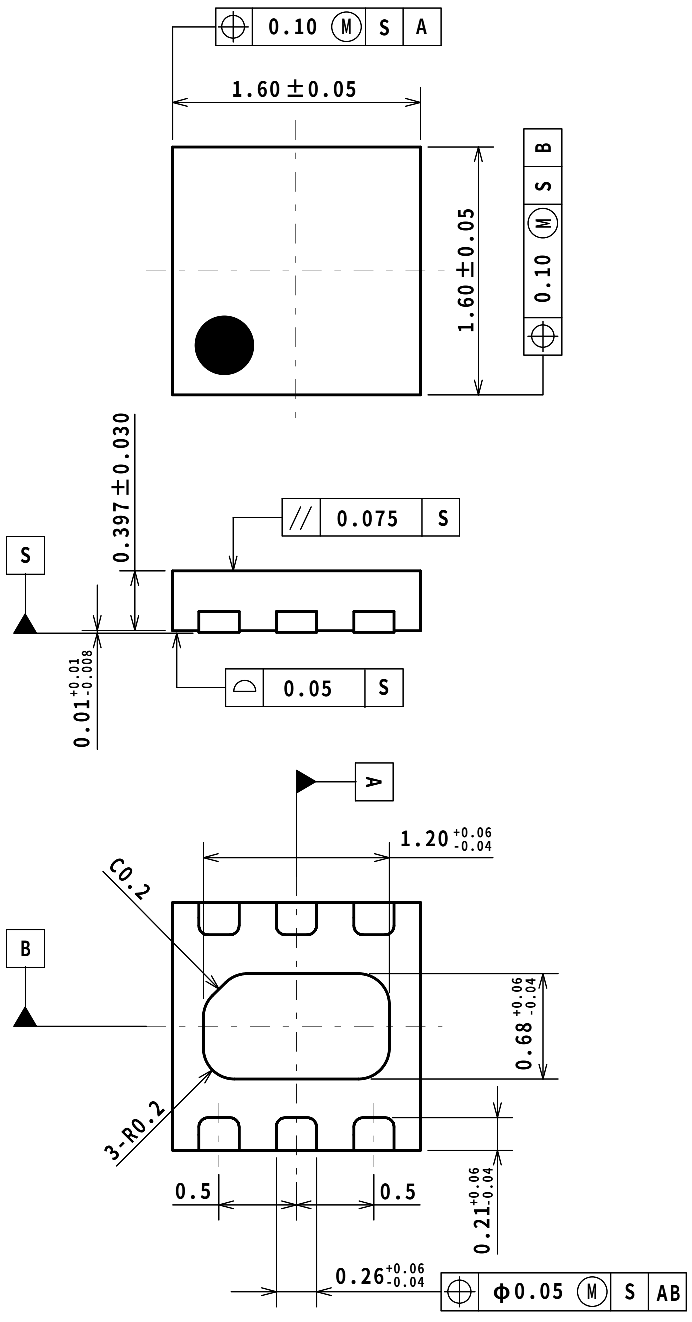
A formula of Load Capacitance. (In case of internal capacitance of NJU6385)

C_L = Cg x Cd / (Cg + Cd) = 8pF x 17pF / (8pF + 17pF) ≒ <u>5.44pF</u> <- Load Capacitance of crystal unit.

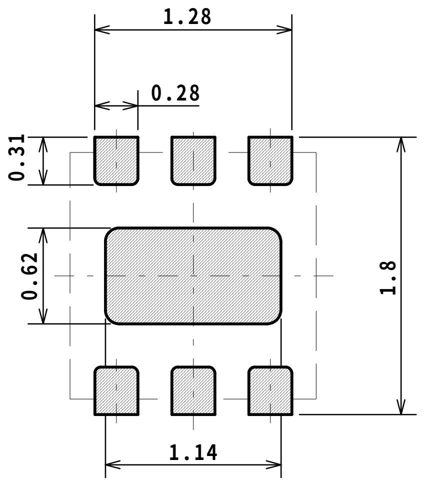
DFN6-G1(ESON6-G1)

Unit: mm

■PACKAGE DIMENSIONS



■EXAMPLE OF SOLDER PADS DIMENSIONS

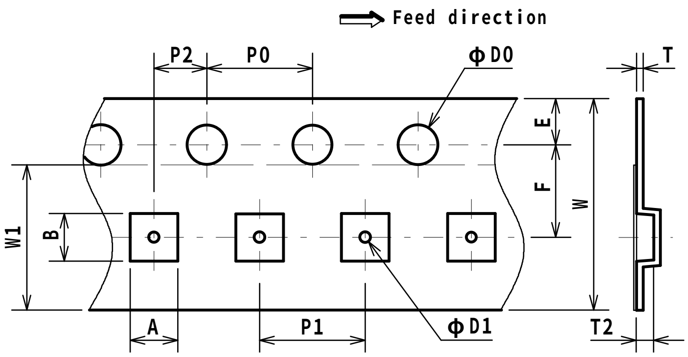


■PACKING SPEC

DFN6-G1(ESON6-G1)

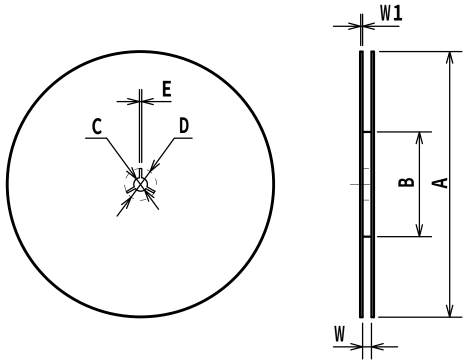
Unit: mm

TAPING DIMENSIONS



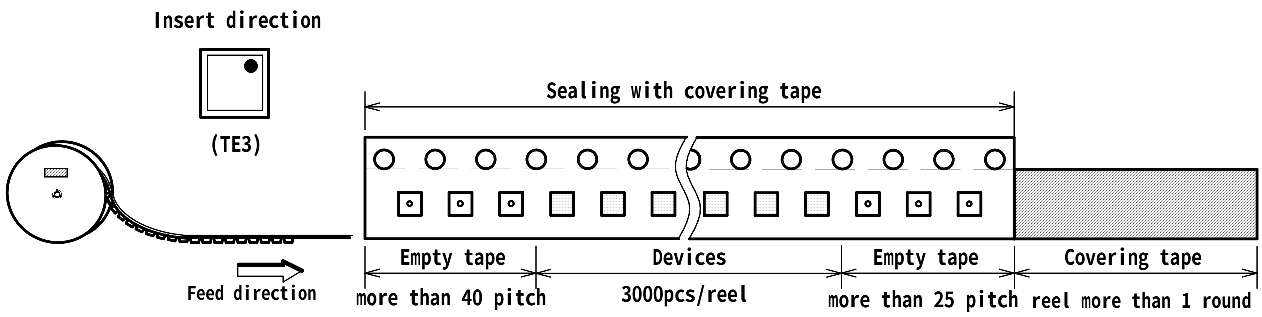
SYMBOL	DIMENSION	REMARKS
A	1.85±0.05	BOTTOM DIMENSION
B	1.85±0.05	BOTTOM DIMENSION
D0	$1.5^{+0.1}_{0}$	
D1	0.5±0.1	
E	1.75±0.1	
F	3.5±0.05	
P0	4.0±0.1	
P1	4.0±0.1	
P2	2.0±0.05	
T	0.25±0.05	
T2	0.65±0.05	
W	8.0±0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

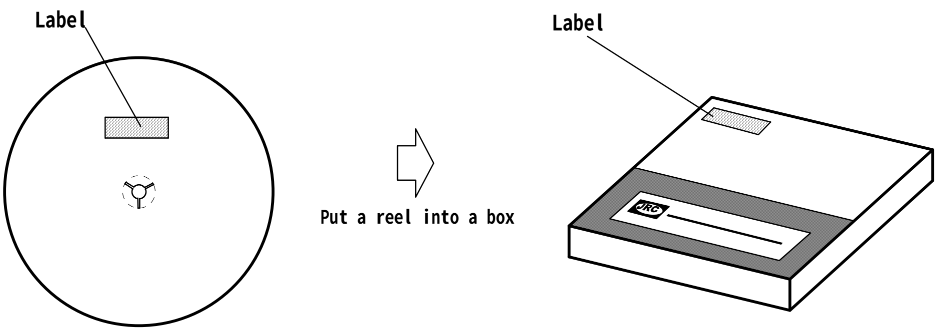


SYMBOL	DIMENSION
A	$\phi 180^{0}_{-1.5}$
B	$\phi 60^{+1}_{0}$
C	ϕ 13±0.2
D	ϕ 21±0.8
E	2±0.5
W	$9^{+0.3}_{0}$
W1	1.2

TAPING STATE

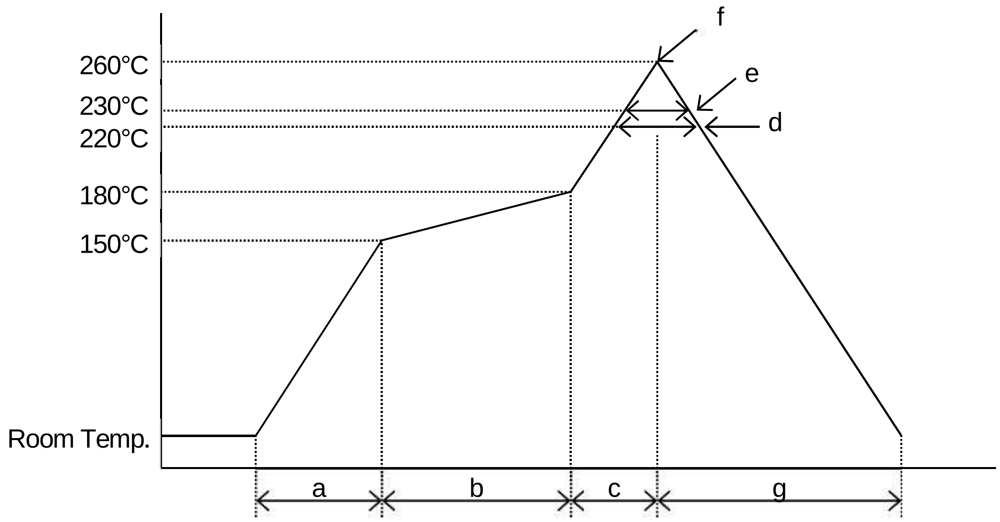


PACKING STATE



■RECOMMENDED MOUNTING METHOD

*Recommended reflow soldering procedure



a:Temperature ramping rate		: 1 to 4°C/s
b:Pre-heating temperature		: 150 to 180°C
	time	: 60 to 120s
c:Temperature ramp rate		: 1 to 4°C/s
d:220°C or higher time		: Shorter than 60s
e:230°C or higher time		: Shorter than 40s
f:Peak temperature		: Lower than 260°C
g:Temperature ramping rate		: 1 to 6°C/s

*The temperature indicates at the surface of mold package.

■REVISION HISTORY

Date	Revision	Changes
24.Apr.2018	Ver.0	First edition
06.Jun.2018	Ver.1	P.6, P.7 ■TYPICAL TEST CIRCUIT : Replacement of TYPICAL CIRCUIT
		P.8 ■TIMING CHART: Unification of terms. (Change to SYM from DUTY)
12.Feb.2019	Ver.2	P.11, P.12 ■Application Note: In addition, Chose select crystal unit
13.Oct.2020	Ver.3	P.2 ■BLOCK DIAGRAM: In addition, V_{DD} and V_{SS} terminals. ■ABSOLUTE MAXIMUM RATINGS: UNIT: Output Voltage is replace to mA to V PARAMETER: The Output Terminal Input Voltage replace to Output Current
		P.4 ■ELECTRICAL CHARACTERISTICS: 3-state Off Leakage Current: The Maximum value is change to ±0.1µA(Max.).
14.Oct.2020	Ver4	P.1 ■TERMINAL DISCREPTION: CONT: In Addition, (f0)
		P.4 ■ELECTRICAL CHARACTERISTICS: Output Signal Symmetry condition: In Addition, TEST CIRCUIT(1)(3).

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[CAUTION]

1. NJR strives to produce reliable and high quality semiconductors. NJR's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of NJR's semiconductors, the devices, machinery or equipment into which they are integrated should undergo preventative maintenance and inspection at regularly scheduled intervals. Failure to properly maintain equipment and machinery incorporating these products can result in catastrophic system failures

2. The specifications on this datasheet are only given for information without any guarantee as regards either mistakes or omissions. The application circuits in this datasheet are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial property rights.
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3. To ensure the highest levels of reliability, NJR products must always be properly handled.
The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.

4. NJR offers a variety of semiconductor products intended for particular applications. It is important that you select the proper component for your intended application. You may contact NJR's Sale's Office if you are uncertain about the products listed in this datasheet.

5. Special care is required in designing devices, machinery or equipment which demand high levels of reliability. This is particularly important when designing critical components or systems whose failure can foreseeably result in situations that could adversely affect health or safety. In designing such critical devices, equipment or machinery, careful consideration should be given to amongst other things, their safety design, fail-safe design, back-up and redundancy systems, and diffusion design.

6. The products listed in this datasheet may not be appropriate for use in certain equipment where reliability is critical or where the products may be subjected to extreme conditions. You should consult our sales office before using the products in any of the following types of equipment.

   ・Aerospace Equipment
   ・Equipment Used in the Deep Sea
   ・Power Generator Control Equipment (Nuclear, steam, hydraulic, etc.)
   ・Life Maintenance Medical Equipment
   ・Fire Alarms / Intruder Detectors
   ・Vehicle Control Equipment (Airplane, railroad, ship, etc.)
   ・Various Safety Devices

7. NJR's products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. NJR shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products. The products are sold without warranty of any kind, either express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.

8. Warning for handling Gallium and Arsenic (GaAs) Products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.

9. The product specifications and descriptions listed in this datasheet are subject to change at any time, without notice.