

Internal 2A MOSFET Switching Regulator IC for Synchronous Buck Converter

■FEATURES

- Synchronous Rectification
- Current Mode Control
- External Clock Synchronization
- Wide Operating Voltage Range 3.6V to 40V
- Switching Current 2.8A min.
- PWM Control
- Maximum Duty Cycle 100%
- PFM operation for Light Loads (MODE pin Selectable)
- Built-in Compensation Circuit
- Correspond to Ceramic Capacitor (MLCC)
- Oscillating Frequency 450kHz typ. (A ver.)
300kHz typ. (B ver.)
- Soft Start Function 4ms typ.
- UVLO (Under Voltage Lockout)
- Over Current Protection (Hiccup type)
- Thermal Shutdown Protection
- Power Good Function
- Standby Function
- Package Outline HSOP8-M1

■GENERAL DESCRIPTION

The NJW4177 is a synchronous buck converter with 40V/2A MOSFET. It can support the application of the high efficiency by synchronous rectification. The NJW4177 can select PFM mode to ensure high efficiency in the light load.

Operating voltage range is wide input range from 3.4V to 40V, it can correspond to supply voltage drop such as cold crank. Moreover, 100% maximum duty cycle contribute to maintain stable output voltage even if supply voltage drops.

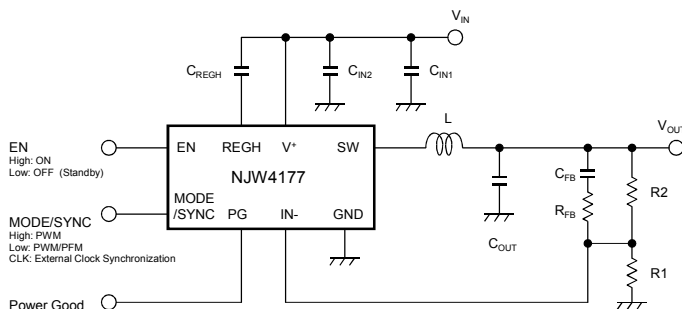
The built-in phase compensation circuit and internally fixed soft start function minimize external parts. Also, current mode control contributes to using a small low ESR Output Capacitor(MLCC). Therefore, the NJW4177 can realize downsizing of applications.

It is suitable for power supply circuit of microprocessor, DSP and so on that need fast transient response.

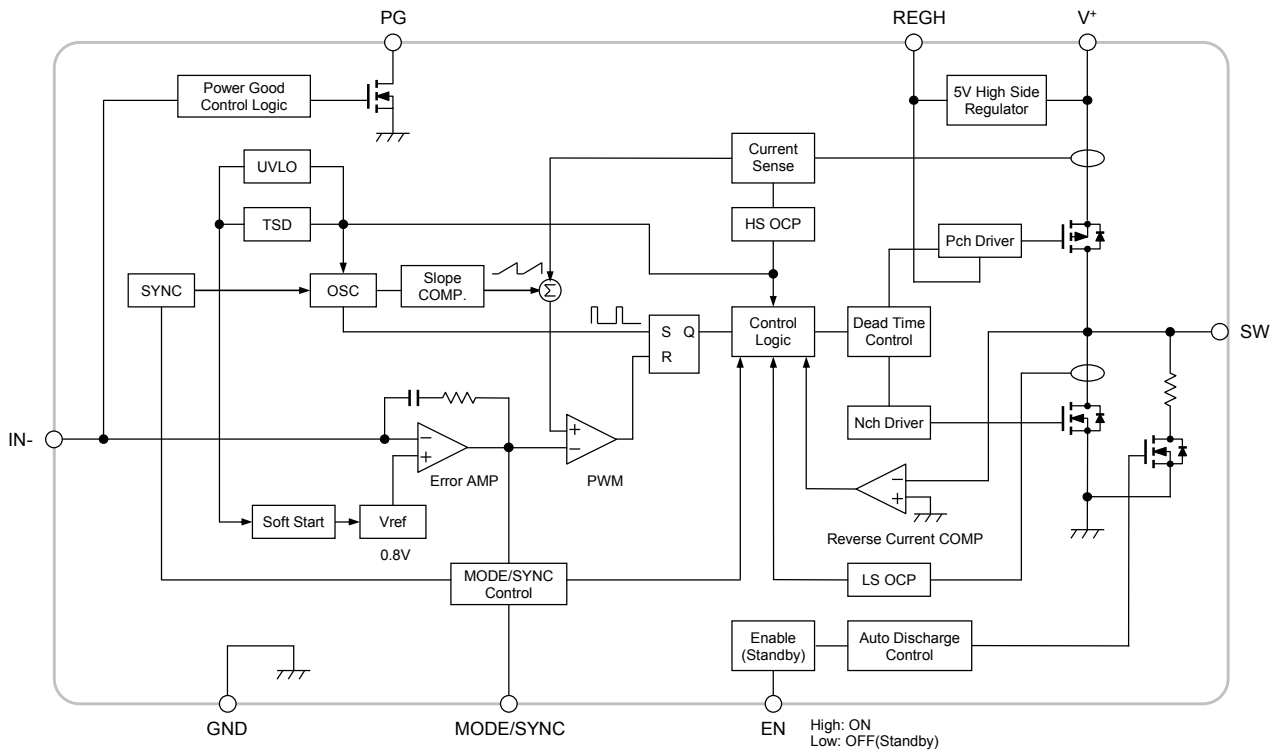
■APPLICATION

- Power supply for Automotive
- Infotainment
- Industrial Equipment

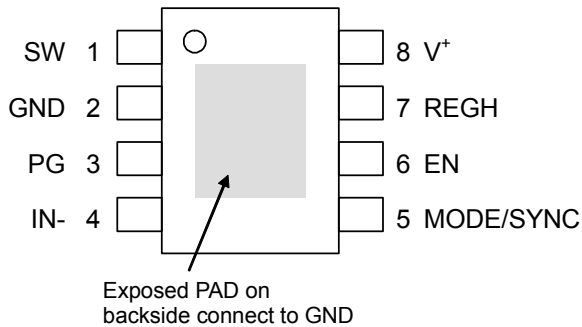
■TYPICAL APPLICATION



■BLOCK DIAGRAM



■PIN CONFIGURATION



PIN NO.	SYMBOL	DESCRIPTION
1	SW	Switch output
2	GND	Ground
3	PG	Power Good output
4	IN-	Feedback input
5	MODE/SYNC	Light Load mode select and external clock synchronization
6	EN	Enable control
7	REGH	High side regulator output
8	V+	Power supply

Note) Exposed Pad on backside should be connected to ground and soldered to PCB.

NJW4177 GM1 - A (TE1)
 Part Number Package Version Taping Form
 GM1:HSOP8-M1 A: $f_{OSC}=450kHz$
 B: $f_{OSC}=300kHz$

PRODUCT NAME	PACKAGE OUTLINE	OSCILLATING FREQUENCY	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJW4177GM1-A (TE1)	HSOP8-M1	450kHz	yes	yes	Sn100%	4177A	81	3000
NJW4177GM1-B (TE1)	HSOP8-M1	300kHz	yes	yes	Sn100%	4177B	81	3000

■ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V^+	-0.3 to +45	V
SW pin Voltage	V_{SW}	-0.3 to +45	V
EN pin Voltage	V_{EN}	-0.3 to +45	V
IN- pin Voltage	V_{IN-}	-0.3 to +6	V
PG pin Voltage	V_{PG}	-0.3 to +6	V
REGH pin Voltage	V_{REGH}	$V^+ - 6$ to V^+	V
MODE/SYNC pin Voltage	$V_{MODE/SYNC}$	-0.3 to +45	V
Power Dissipation($T_a=25^{\circ}\text{C}$) HSOP8-M1	P_D	(2-layer / 4-layer) 900 ⁽¹⁾ / 3,100 ⁽²⁾	mW
Junction Temperature	T_j	-40 to +150	$^{\circ}\text{C}$
Operating Temperature	T_{opr}	-40 to +125	$^{\circ}\text{C}$
Storage Temperature	T_{stg}	-50 to +150	$^{\circ}\text{C}$

(1): Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JEDEC standard, 2Layers)

(2): Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JEDEC standard, 4Layers)

(For 4Layers: Applying 74.2×74.2mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5)

■RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	V^+	3.6 to 40	V
PG pin Voltage	V_{PG}	0 to 5.5	V
MODE/SYNC pin Voltage	$V_{MODE/SYNC}$	0 to 40	V
REGH Capacitor	C_{REGH}	0.01 to 1 (0.1 μF typ.)	μF
External Clock Input	f_{SYNC}	A version: 440 to 600 B version: 280 to 500	kHz

■ELECTRICAL CHARACTERISTICS

(Unless otherwise noted, $V^+=V_{EN}=V_{MODE/SYNC}=12V$, $T_a=25^{\circ}C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
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Under Voltage Lockout Block

ON Threshold Voltage	V_{T_ON}	$V^+=L \rightarrow H$	3.3	3.45	3.6	V
OFF Threshold Voltage	V_{T_OFF}	$V^+=H \rightarrow L$	3.2	3.35	3.5	V
Hysteresis Voltage	V_{HYS}		70	100	—	mV

Soft Start Block

Soft Start Time	t_{SS}	$V_B=0.75V$	2	4	8	ms
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Oscillator Block

Oscillating Frequency	f_{OSC}	A version	405	450	495	kHz
		B version	270	300	330	kHz
Oscillating Frequency deviation (Supply voltage)	f_{DV}	$V^+=3.6V$ to $40V$	—	1	—	%
Oscillating Frequency deviation (Temperature)	f_{DT}	$T_a=-40^{\circ}C$ to $+85^{\circ}C$	—	5	—	%

Error Amplifier Block

Reference Voltage	V_B		-1.0%	0.8	+1.0%	V
Input Bias Current	I_B		-0.1	—	0.1	μA

PWM Compare Block

Maximum Duty Cycle	$M_{AX}D_{UTY}$	$V_{IN}=0.7V$	100	—	—	%
Minimum ON Time1 (Use Built-in Oscillator)	$t_{ON-min1}$	A version	—	110	170	ns
		B version	—	100	160	ns
Minimum ON Time2 (Use Ext CLK)	$t_{ON-min2}$	A version, $f_{SYNC}=500kHz$	—	100	160	ns
		B version, $f_{SYNC}=400kHz$	—	90	150	ns
Minimum OFF Time1 (Use Built-in Oscillator)	$t_{OFF-min1}$	A version	—	160	210	ns
		B version	—	200	260	ns
Minimum OFF Time1 (Use Ext CLK)	$t_{OFF-min2}$	A version, $f_{SYNC}=500kHz$	—	170	240	ns
		B version, $f_{SYNC}=400kHz$	—	210	280	ns

OCP Block

COOL DOWN Time	t_{COOL}		—	100	—	ms
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■ ELECTRICAL CHARACTERISTICS (CONTINUED)

(Unless otherwise noted, $V^+ = V_{EN} = V_{MODE/SYNC} = 12V$, $T_a = 25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Block						
High-side SW ON Resistance	R_{ONH}	$I_{SW} = -2A$	—	0.28	0.4	Ω
Low-side SW ON Resistance	R_{ONL}	$I_{SW} = 2A$	—	0.16	0.23	Ω
High-side Switching Current Limit	I_{LIMH}		2.8	3.8	4.5	A
Low-side Switching Current Limit	I_{LIML}	SW to GND	2.5	3.5	4.5	A
REGH Output Voltage	V_{REGH}		$V^+ - 5.0$	$V^+ - 4.0$	$V^+ - 3.0$	V
REGH Output Current	I_{REGH}		50	100	200	mA
Auto Discharge Resistance	$R_{AUTODIS}$	$I_{SW} = 10mA$	—	65	100	Ω
High-Side SW Leak Current	I_{LEAKH}	$V^+ - V_{SW} = 40V$	—	—	3	μA
Low-Side SW Leak Current	I_{LEAKL}	$V_{SW} - GND = 40V$	—	—	3	μA

Enable Control Block

ON Threshold Voltage	V_{ON}	$V_{EN} = L \rightarrow H$	1.6	—	V^+	V
OFF Threshold Voltage	V_{OFF}	$V_{EN} = H \rightarrow L$	0	—	0.5	V
Input Bias Current (EN pin)	I_{EN}	$V_{EN} = 12V$	—	35	70	μA

MODE Control / Sync Block

MODE/SYNC pin High Threshold Voltage	$V_{THH_MODE/SYNC}$	$V_{MODE/SYNC} = L \rightarrow H$	1.6	—	V^+	V
MODE/SYNC pin Low Threshold Voltage	$V_{THL_MODE/SYNC}$	$V_{MODE/SYNC} = H \rightarrow L$	0	—	0.5	V
Input Bias Current (MODE/SYNC pin)	$I_{MODE/SYNC}$	$V_{MODE/SYNC} = 12V$	—	120	250	μA

Power Good Block

High Level Detection Voltage	V_{THH_PG}	Measured at IN- pin	105	110	115	%
Low Level Detection Voltage	V_{THL_PG}	Measured at IN- pin	85	90	95	%
Hysteresis Region	V_{HYS_PG}		—	2	—	%
Power Good ON Resistance	R_{ON_PG}	$I_{PG} = 10mA$	—	15	30	Ω
Leak Current at OFF State	I_{LEAK_PG}	$V_{PG} = 6V$	—	—	0.1	μA

General Characteristics

Quiescent Current 1	I_{DD1}	$R_L = \text{No load, Not Switching}$	—	2.8	4.5	mA
Quiescent Current 2	I_{DD2}	$R_L = \text{No load, Not Switching, } V_{MODE/SYNC} = 0V$	—	0.8	1.4	mA
Standby Current	I_{DD_STB}	$V_{EN} = 0V, V_{MODE/SYNC} = 0V$	—	—	5	μA

■ THERMAL CHARACTERISTICS

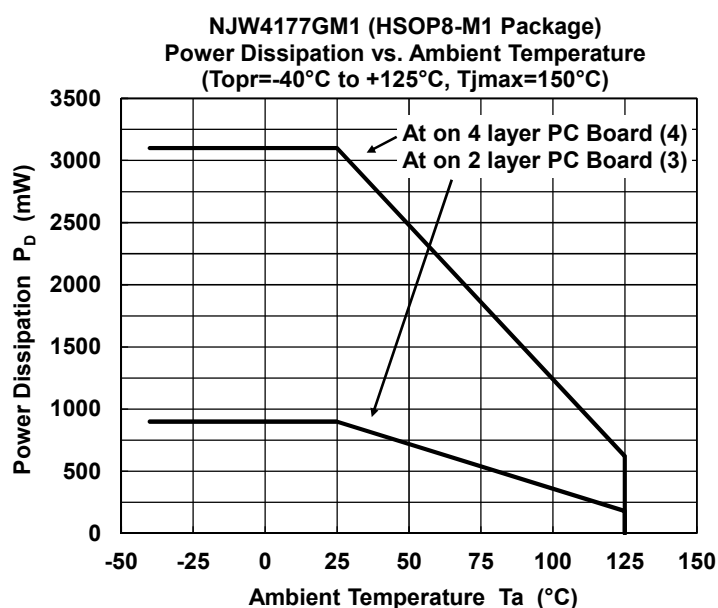
PARAMETER	SYMBOL	VALUE		UNIT
Junction-to-ambient thermal resistance	θ_{ja}	HSOP8-M1	139 ⁽³⁾ 40 ⁽⁴⁾	°C/W
Junction-to-Top of package characterization parameter	ψ_{jt}	HSOP8-M1	19 ⁽³⁾ 3.7 ⁽⁴⁾	°C/W

(3): Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JEDEC standard, 2Layers)

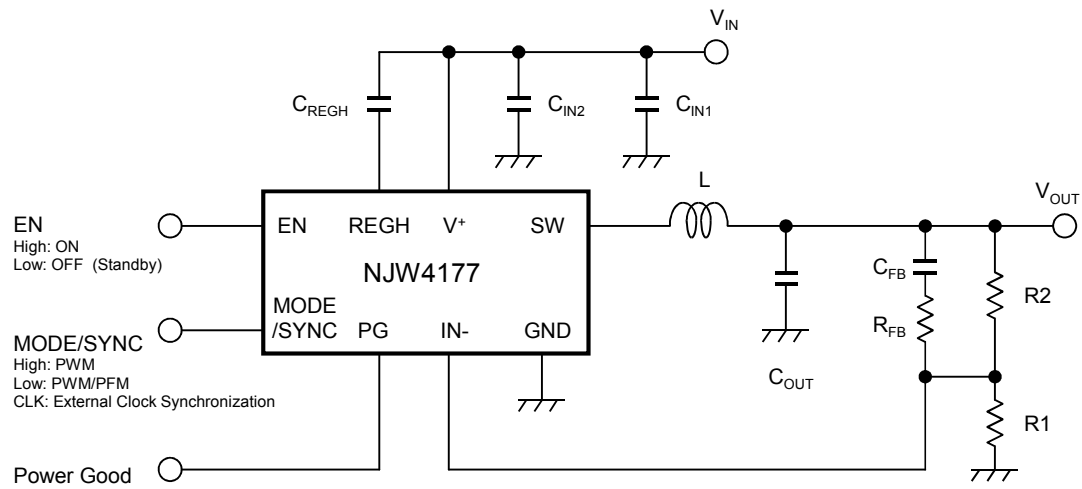
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(For 4Layers: Applying 74.2×74.2mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5)

■ POWER DISSIPATION vs. AMBIENT TEMPERATURE

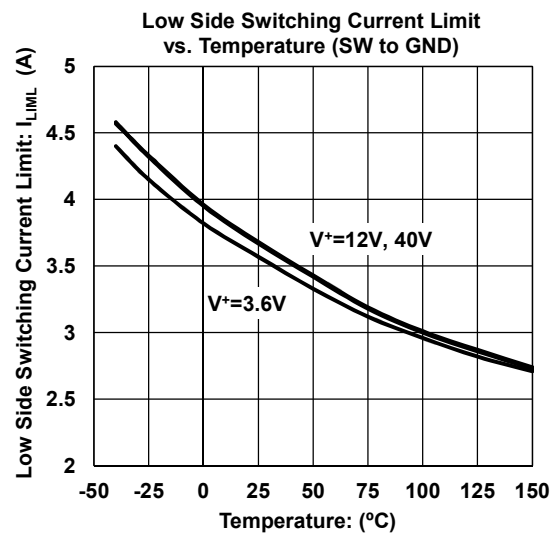
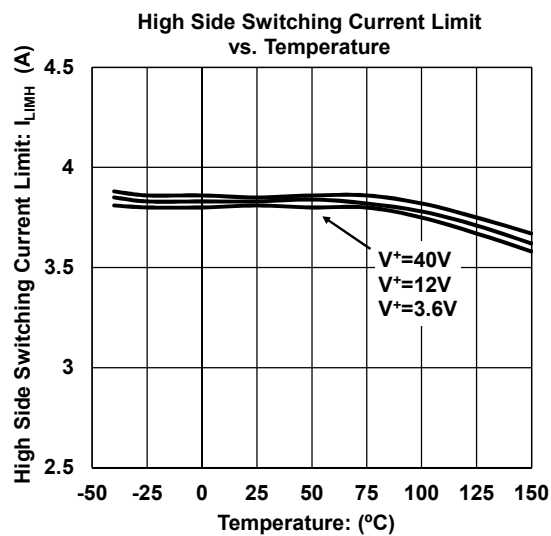
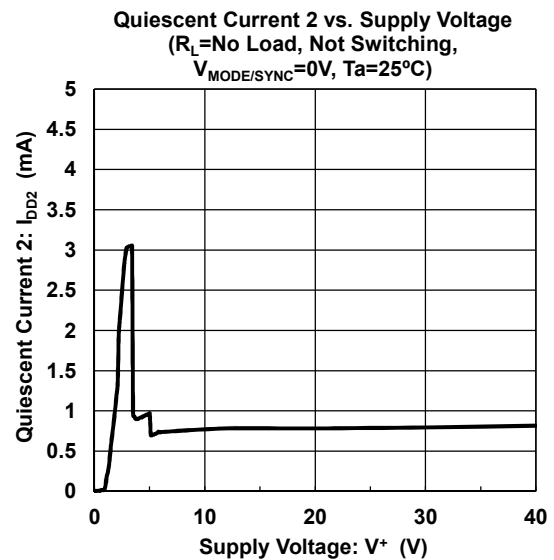
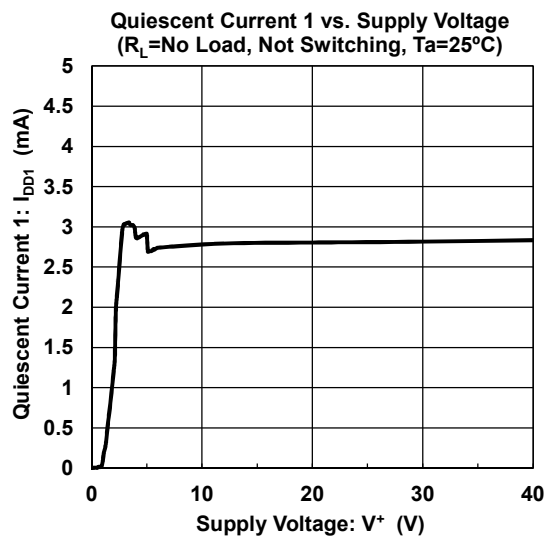
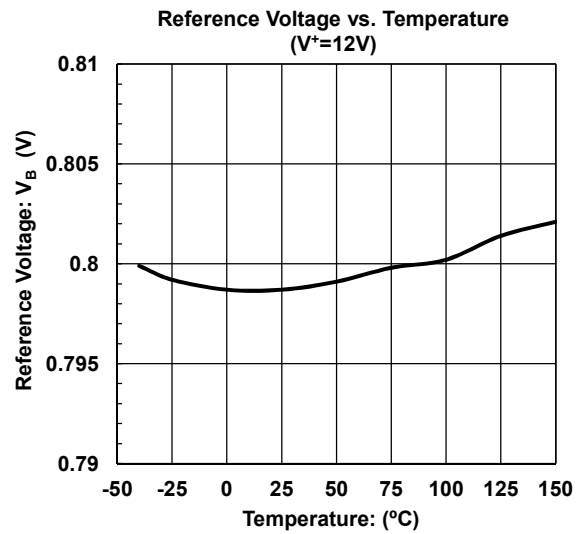
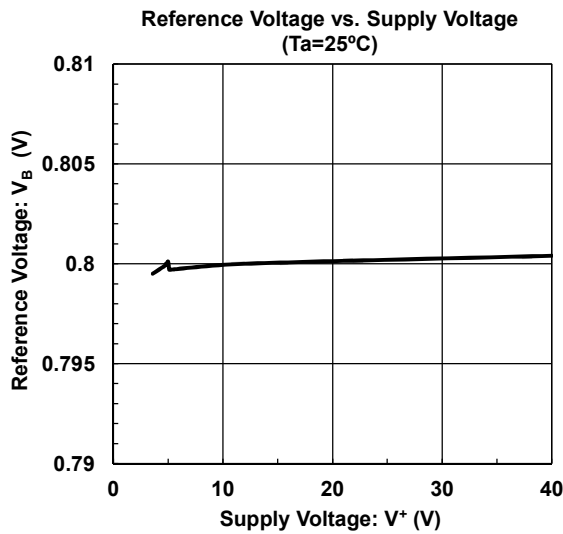


■TYPICAL APPLICATION

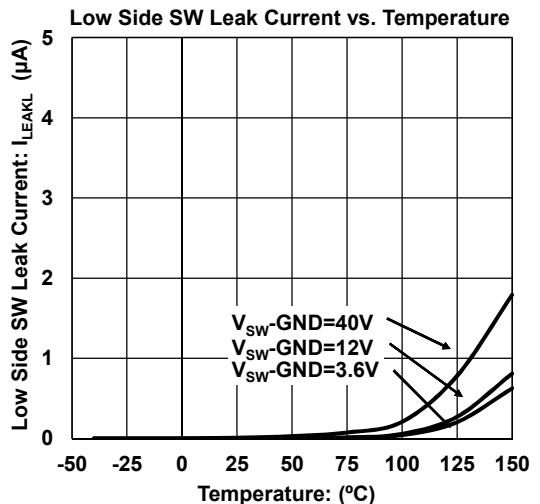
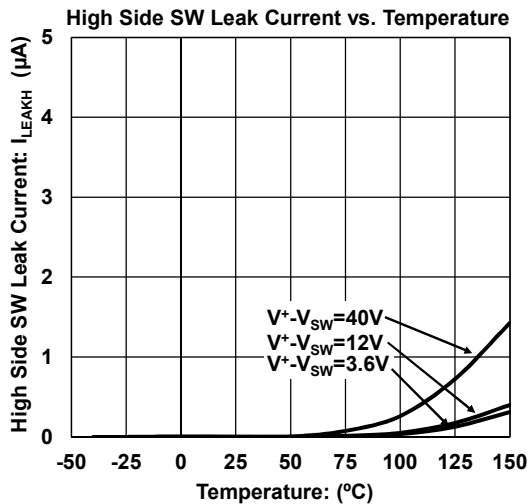
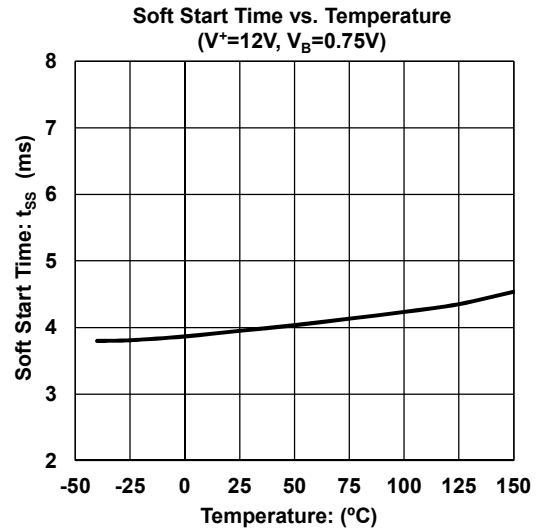
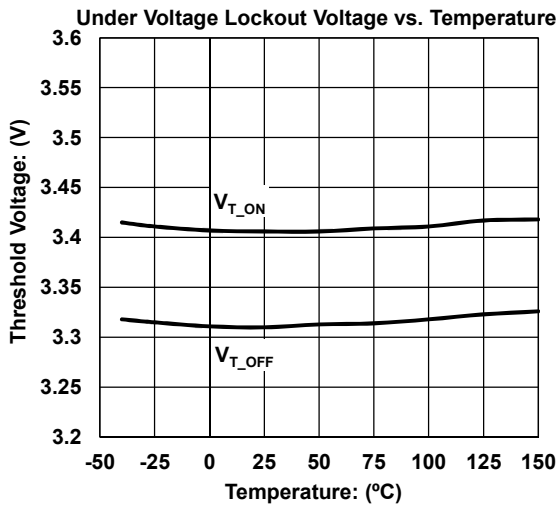
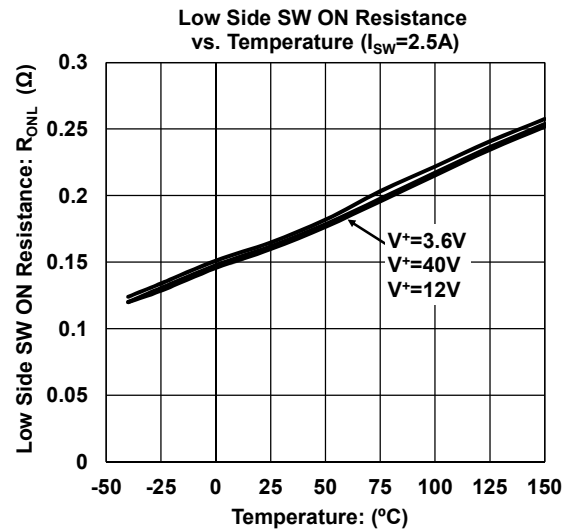
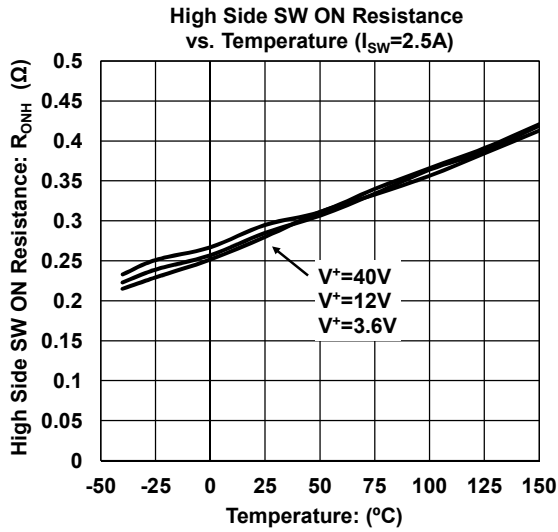


Operating mode select with the MODE/SYNC pin

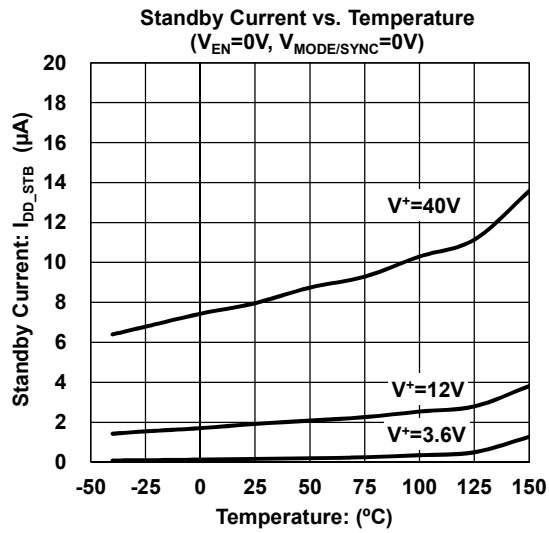
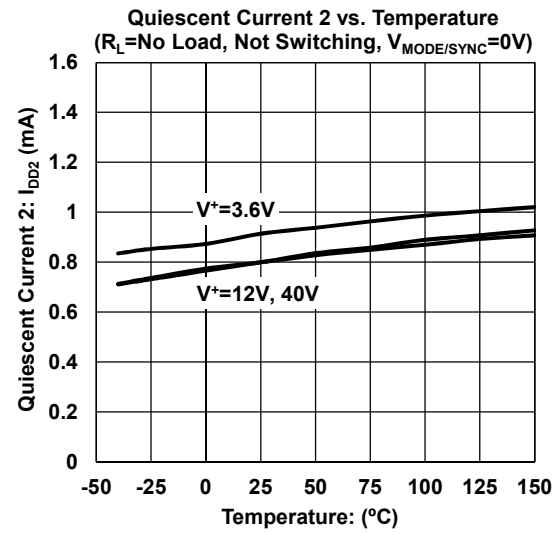
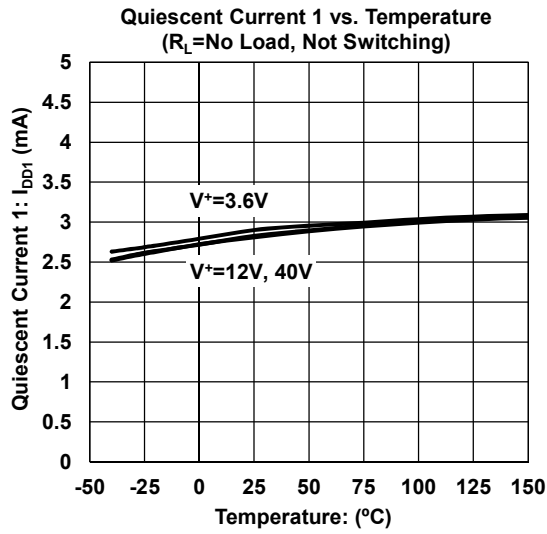
MODE/SYNC pin Voltage	Operating Mode	Oscillating Frequency
1.6V to V ⁺	Forced PWM operation	Internal frequency
0V to 0.5V	PWM/PFM operation for light loads	Internal frequency
External clock input	Forced PWM operation	External clock frequency

■TYPICAL CHARACTERISTICS (A, B version)


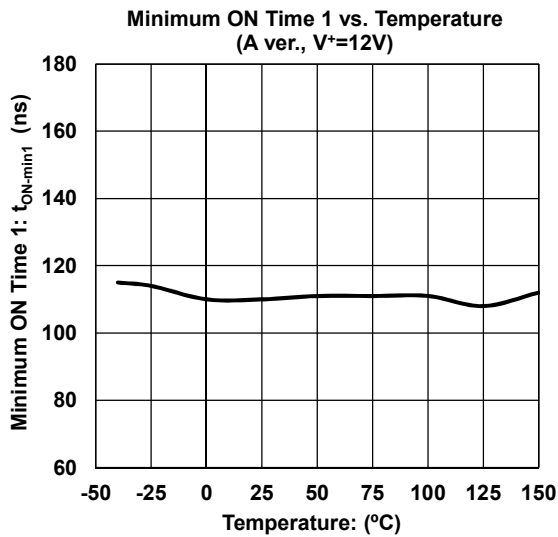
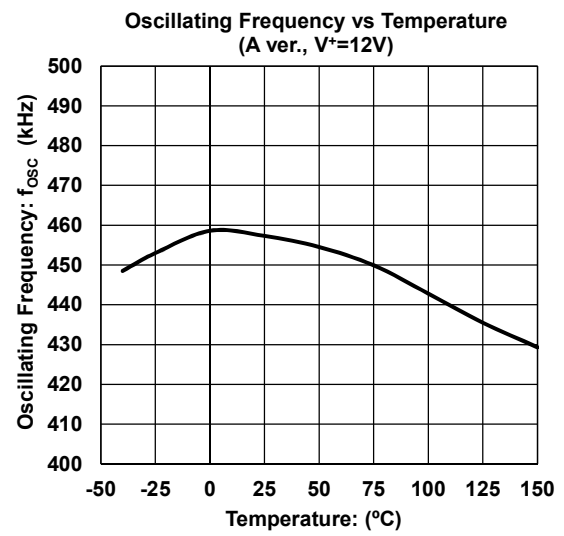
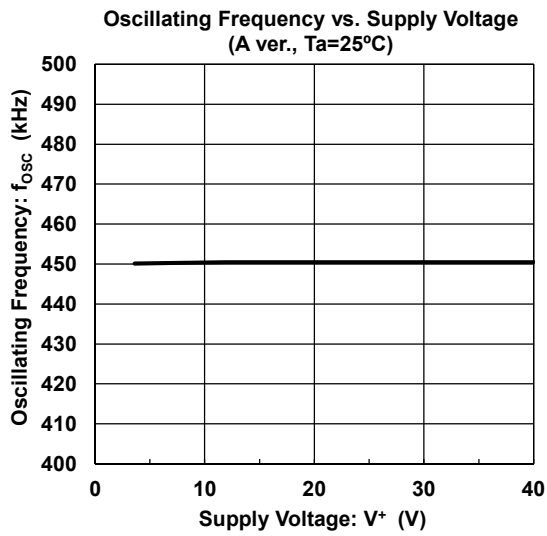
■ TYPICAL CHARACTERISTICS (A, B version)



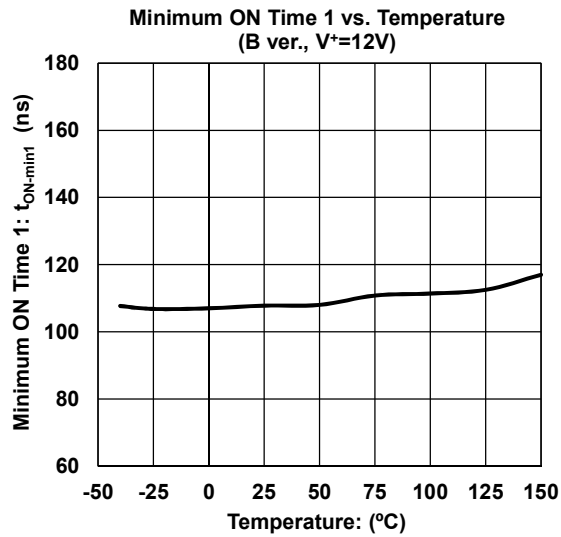
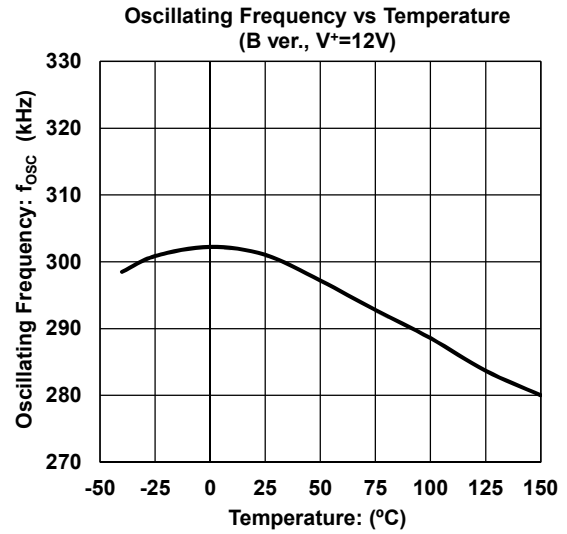
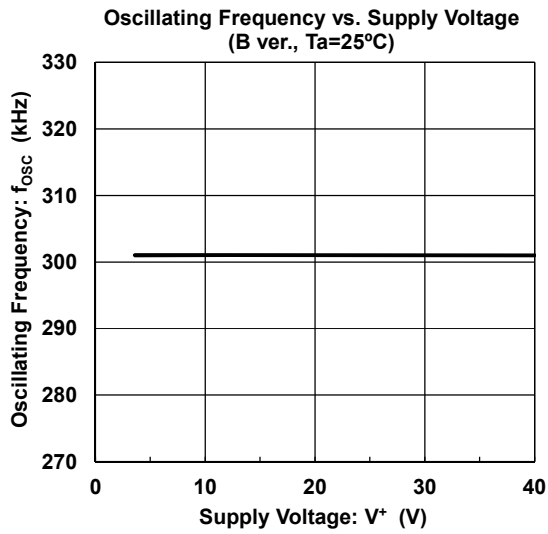
■ TYPICAL CHARACTERISTICS (A, B version)



■ TYPICAL CHARACTERISTICS (A version)



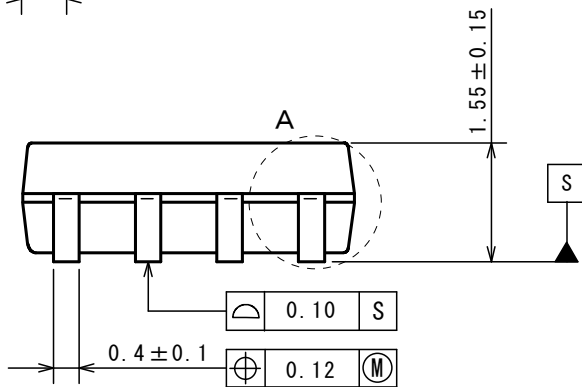
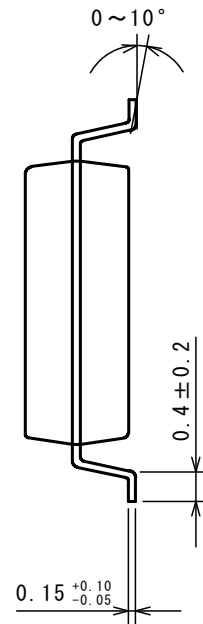
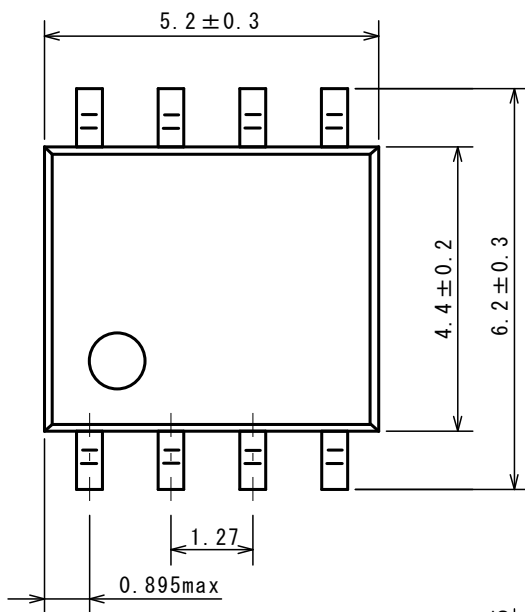
■ TYPICAL CHARACTERISTICS (B version)



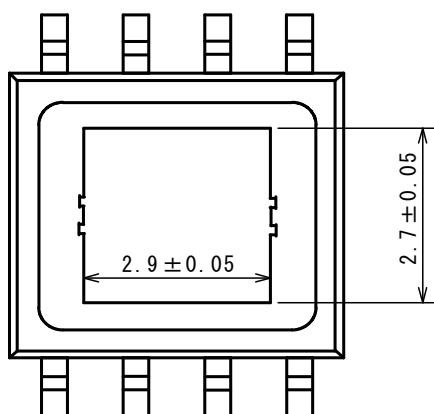
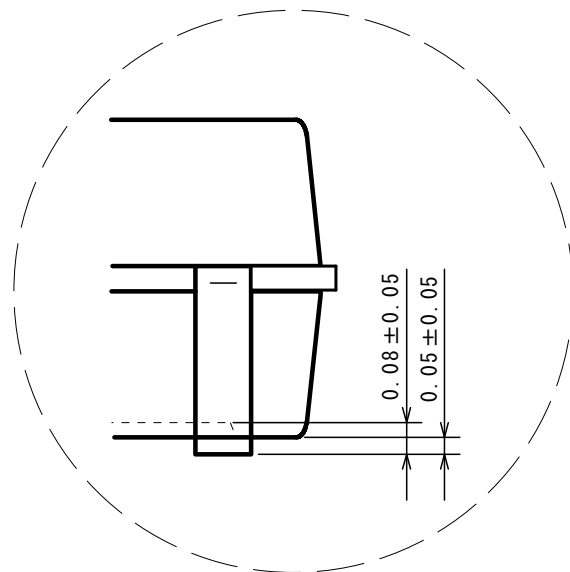
■ PIN DESCRIPTIONS

PIN NAME	PIN NUMBER	FUNCTION
SW	1	Switch Output pin of Power MOSFET
GND	2	GND pin
PG	3	Power Good pin. An open drain output that goes high impedance when the FB pin voltage is stable around $\pm 10\%$.
IN-	4	Output Voltage Detecting pin Connects output voltage through the resistor divider tap to this pin in order to voltage of the FB pin become 0.8V.
MODE/SYNC	5	Operating mode select pin. The MODE/SYNC pin internally pulls down resistor. Forced PWM operation at the time of High Level. PWM/PFM mode operation at the time of Low Level or OPEN. Moreover, it operates by inputting clock signal at the oscillatory frequency that synchronized with the input signal.
EN	6	Standby Control pin The EN pin internally pulls down resistor. Normal Operation at the time of High Level. Standby Mode at the time of Low Level or OPEN.
REGH	7	Output pin of the high side regulator. Connect a bypass capacitor to stabilize a driver circuit.
V ⁺	8	Power Supply pin for Power Line Insert a bypass capacitor close to the V ⁺ pin – the GND pin connection in order to lower high frequency impedance.
Exposed PAD	–	Exposed PAD on backside should be connected to ground and soldered to PCB.

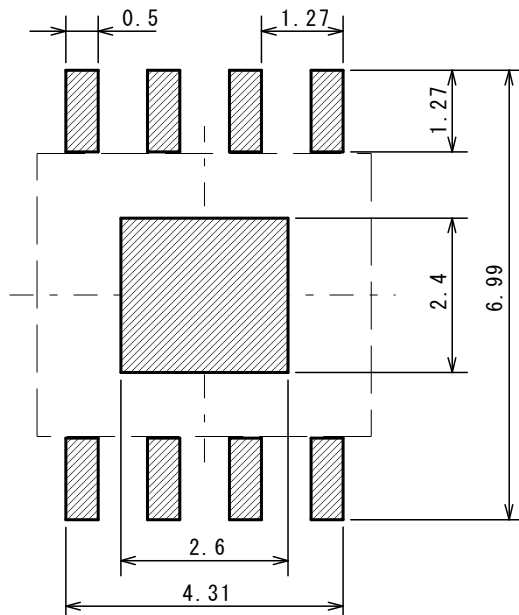
■ PACKAGE DIMENSIONS



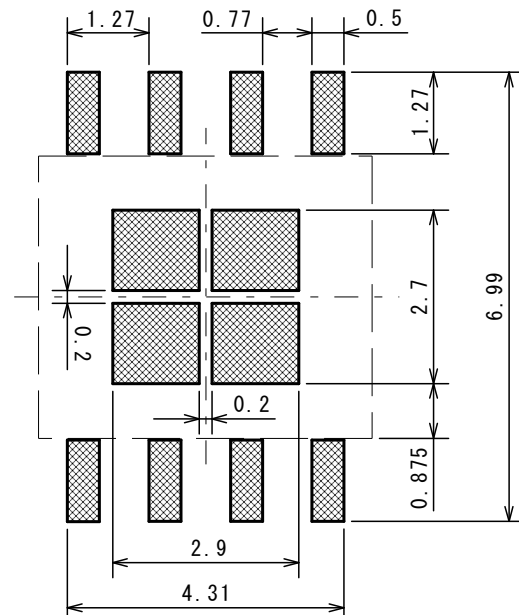
A部詳細図



EXAMPLE OF SOLDER PADS DIMENSIONS



<Solder pattern>



<Metal mask>

<Instructions for mounting>

Please note the following points when you mount HSOP-8 package IC because there is a standoff on the backside electrode.

(1) Temperature profile of lead and backside electrode.

It is necessary that both re-flow temperature profile of lead and backside electrode are higher than preset temperature.

When solder wet temperature is lower than lead/backside electrode temperature, there is possibility of defect mounting.

(2) Design of foot pattern / metal mask

Metal mask thickness of solder pattern print is more than 0.13mm.

(3) Solder paste

The mounting was evaluated with following solder paste, foot pattern and metal mask.

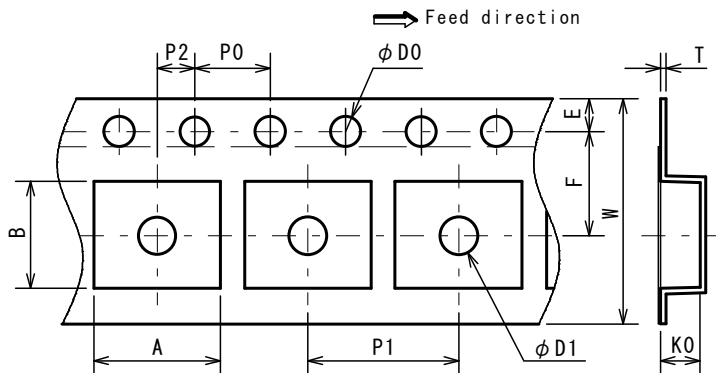
Because mounting might be greatly different according to the manufacturer and the product number even if the solder composition is the same.

We will strongly recommend to evaluate mounting previously with using foot pattern, metal mask and solder paste.

Solder paste composition	Sn37Pb (Senju Metal Industry Co., Ltd: OZ7053-340F-C)
	Sn3Ag0.5Cu (Senju Metal Industry Co., Ltd: M705-GRN350-32-11)

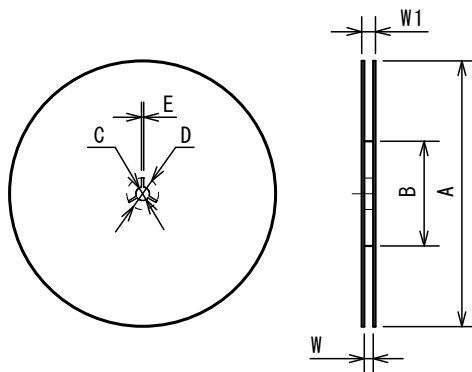
PACKING SPEC

TAPING DIMENSIONS



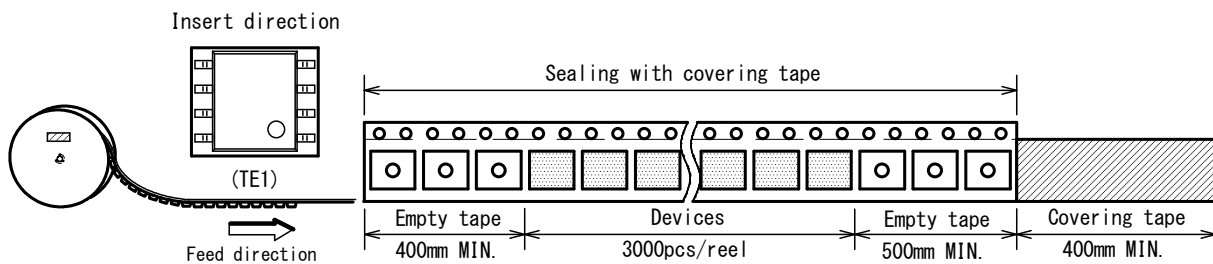
SYMBOL	DIMENSION	REMARKS
A	6.7 ± 0.1	
B	5.55 ± 0.1	
D0	1.55 ± 0.05	
D1	2.05 ± 0.05	
E	1.75 ± 0.1	
F	5.5 ± 0.05	
P0	4.0 ± 0.1	
P1	8.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.3 ± 0.05	
T2	2.47	
K0	2.1 ± 0.1	
W	12.0 ± 0.2	

REEL DIMENSIONS

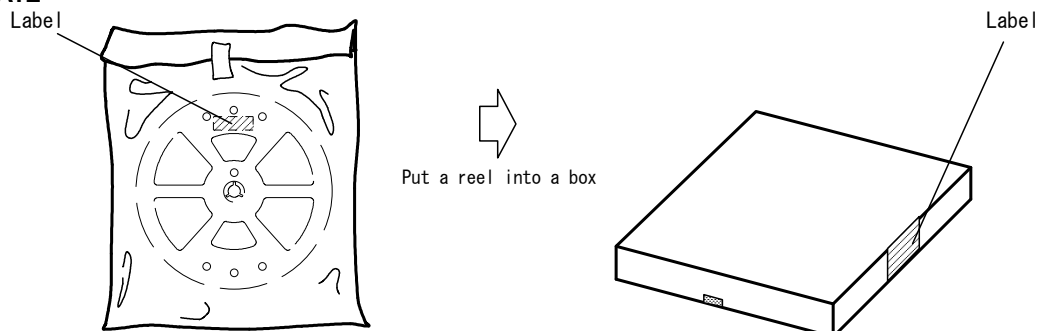


SYMBOL	DIMENSION
A	$\phi 330 \pm 2$
B	$\phi 80 \pm 1$
C	$\phi 13 \pm 0.2$
D	$\phi 21 \pm 0.8$
E	2 ± 0.5
W	13.5 ± 0.5
W1	17.5 ± 1

TAPING STATE



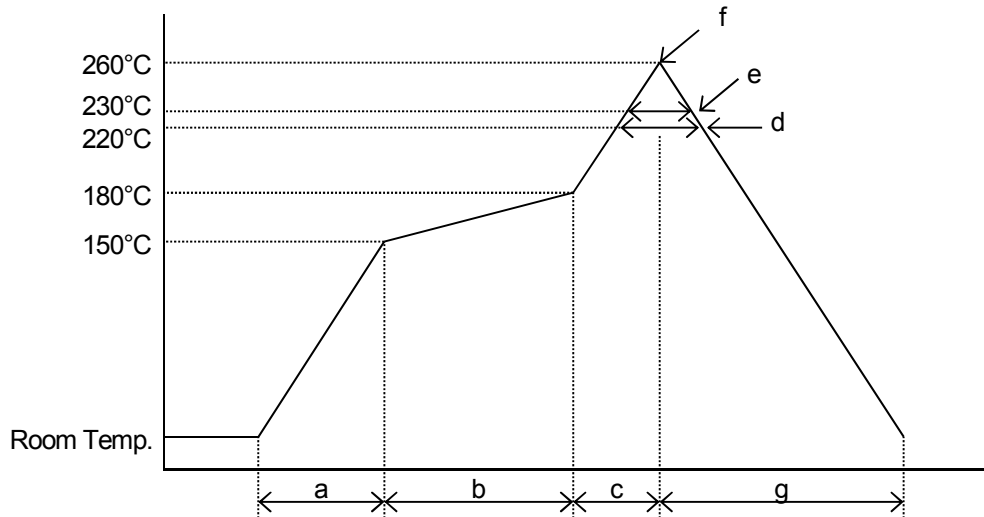
PACKING STATE



■ MOUNTING METHOD

INFRARED REFLOW SOLDERING METHOD

Recommended reflow soldering procedure



a: Temperature ramping rate	: 1 to 4°C/s
b: Pre-heating temperature time	: 150 to 180°C : 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
27.Feb.2017	Ver.0.0	Release Product Preview
04.Apr.2017	Ver.1.0	New Release

[CAUTION]

1. New JRC strives to produce reliable and high quality semiconductors. New JRC's semiconductors are intended for specific applications and require proper maintenance and handling. To enhance the performance and service of New JRC'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 rights.
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The introduction of external contaminants (e.g. dust, oil or cosmetics) can result in failures of semiconductor products.
4. New JRC 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 New JRC's Sale's Office if you are uncertain about the products listed in this catalog.
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 the catalog 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)
Life Maintenance Medical Equipment
Fire Alarm/Intruder Detector
Vehicle Control Equipment (airplane, railroad, ship, etc.)
Various Safety devices
7. New JRC'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 catalog. Failure to employ New JRC products in the proper applications can lead to deterioration, destruction or failure of the products. New JRC shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of its products. 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). This Products uses 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, 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 catalog are subject to change at any time, without notice.

