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.

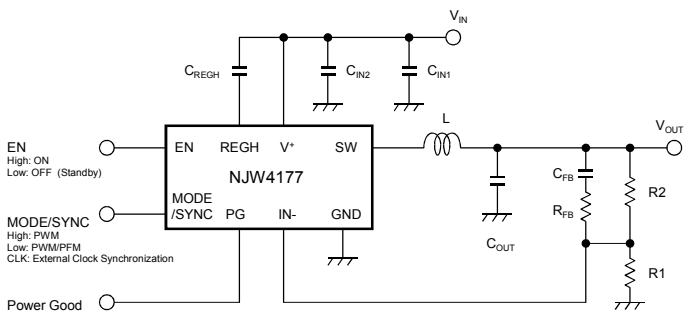
The built-in phase compensation circuit and internally fixed soft start function minimize external parts. Also, current mode control contributes to using a small low ESR Output Capacitor(MLCC).Therefore, the NJW4177 can realize downsizing of applications.

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

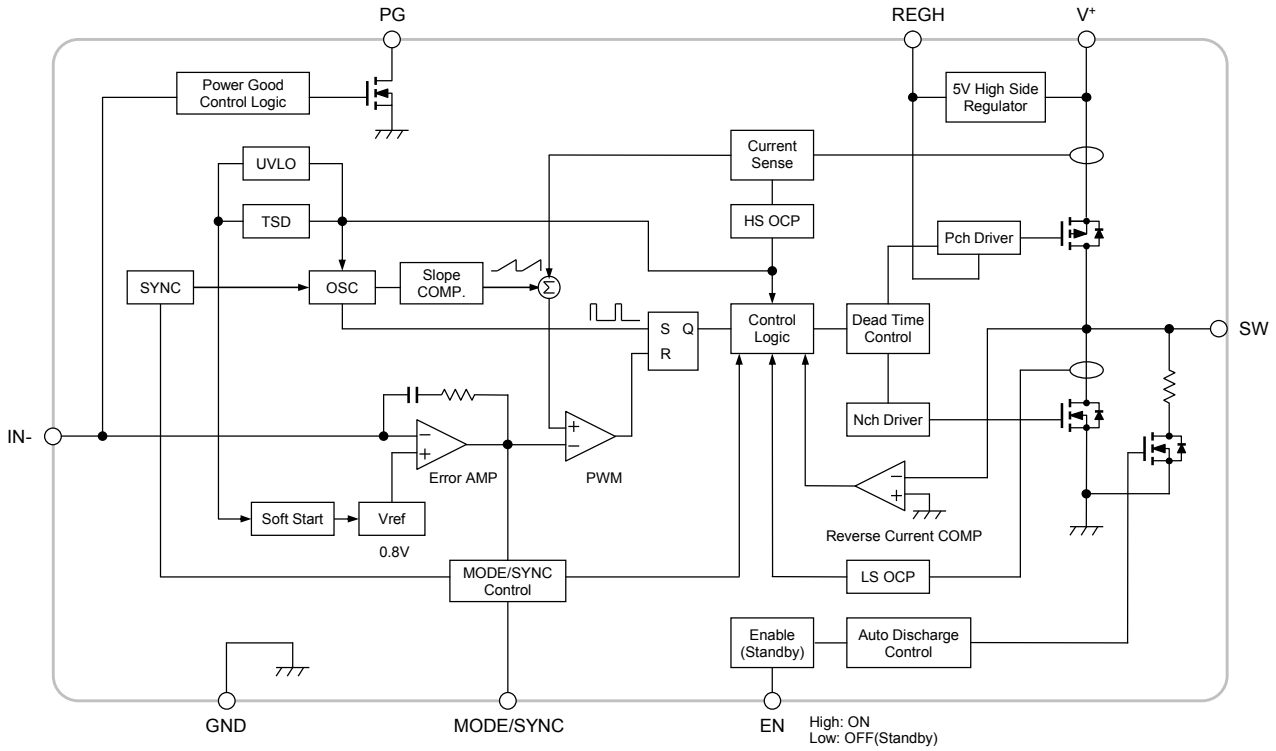
■APPLICATION

- ●Power supply for Automotive
- ●Infotainment
- ●Industrial Equipment

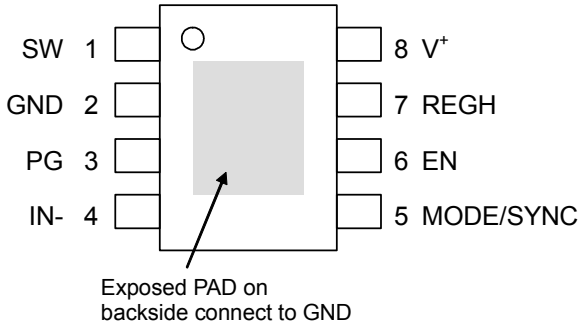
■TYPICAL APPLICATION



■BLOCK DIAGRAM



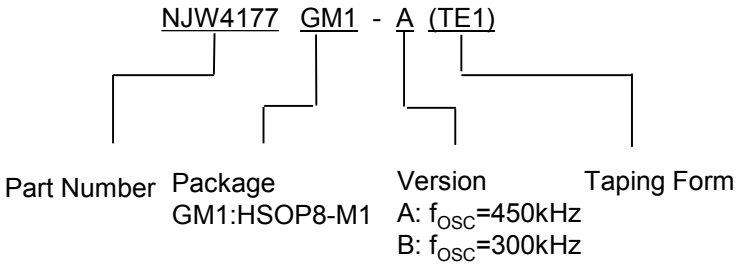
■PIN CONFIGURATION



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.

■PRODUCT NAME INFORMATION



■ORDERING INFORMATION

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(Ta=25°C) HSOP8-M1	P_D	(2-layer / 4-layer) 900[1]/ 3,100[2]	mW
Junction Temperature	T_j	-40 to +150	°C
Operating Temperature	T_{opr}	-40 to +125	°C
Storage Temperature	T_{stg}	-50 to +150	°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 (0.1μF 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, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Under Voltage Lockout Block						
ON Threshold Voltage	V_{T_ON}	V^+= L → H	3.3	3.45	3.6	V
OFF Threshold Voltage	V_{T_OFF}	V^+= H → 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
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}	Ta=-40°C to +85°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 Comparate Block						
Maximum Duty Cycle	$M_{AX}D_{UTY}$	V_{IN-}=0.7V	100	–	–	%
Minimum ON Time1 (Use Built-in Oscillator)	$t_{ON\text{-}min1}$	A version	–	110	170	ns
		B version	–	100	160	ns
Minimum ON Time2 (Use Ext CLK)	$t_{ON\text{-}min2}$	A version, f_{SYNC} =500kHz	–	100	160	ns
		B version, f_{SYNC} =400kHz	–	90	150	ns
Minimum OFF Time1 (Use Built-in Oscillator)	$t_{OFF\text{-}min1}$	A version	–	160	210	ns
		B version	–	200	260	ns
Minimum OFF Time1 (Use Ext CLK)	$t_{OFF\text{-}min2}$	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

■ELECTRICAL CHARACTERISTICS (CONTINUED)

(Unless otherwise noted, $V^+=V_{EN}=V_{MODE./SYNC}$=12V, Ta=25°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 → H	1.6	–	V^+	V
OFF Threshold Voltage	V_{OFF}	V_{EN}= H → 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 → H	1.6	—	V^+	V
MODE/SYNC pin Low Threshold Voltage	$V_{THL\_MODE/SYNC}$	$V_{MODE/SYNC}$= H → 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	%
Hysterisis 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=No load, Not Switching	–	2.8	4.5	mA
Quiescent Current 2	I_{DD2}	R_L=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

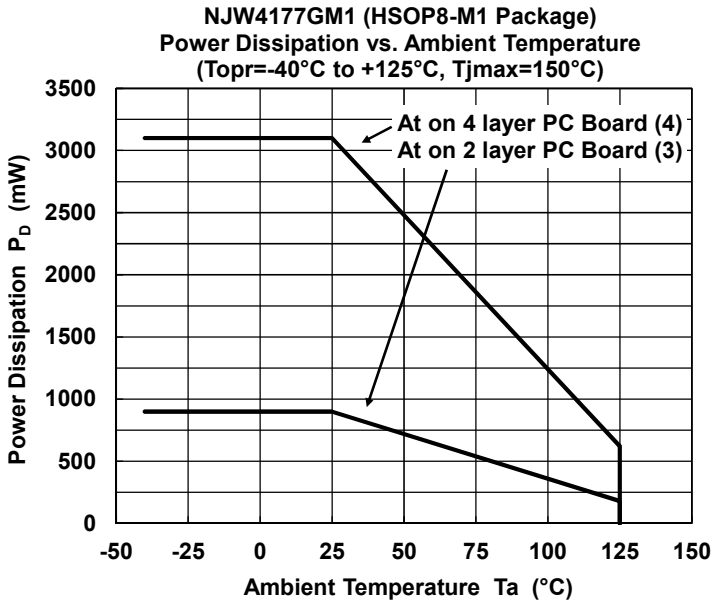
PARAMETER	SYMBOL	VALUE		UNIT
Junction-to-ambient thermal resistance	θja	HSOP8-M1	139(3) 40(4)	°C/W
Junction-to-Top of package characterization parameter	ψjt	HSOP8-M1	19(3) 3.7(4)	°C/W

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

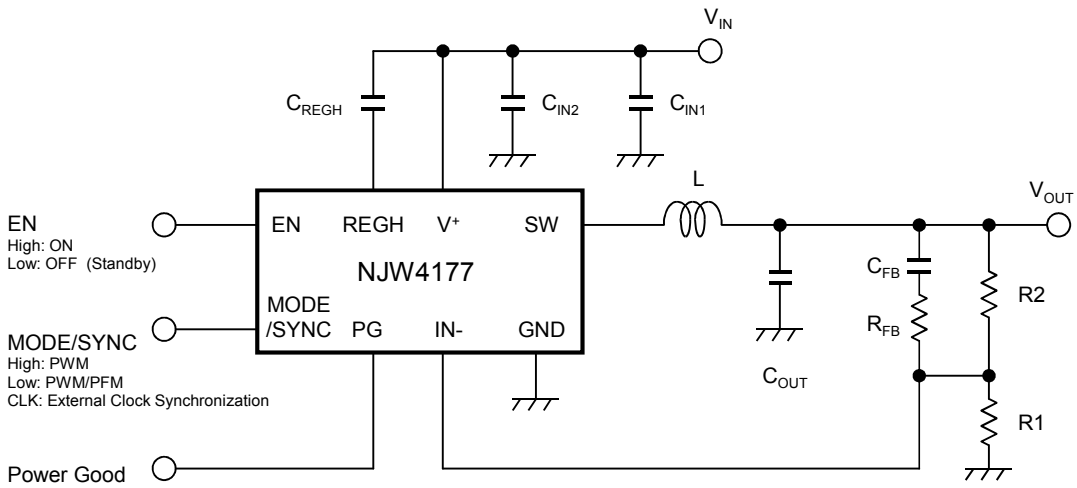
(4): Mounted on glass epoxy board. (76.2×114.3×1.6mm:based on EIA/JEDEC standard, 4Layers)

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

■POWER DISSIPATION vs. AMBIENT TEMPERATURE



■TYPICAL APPLICATION

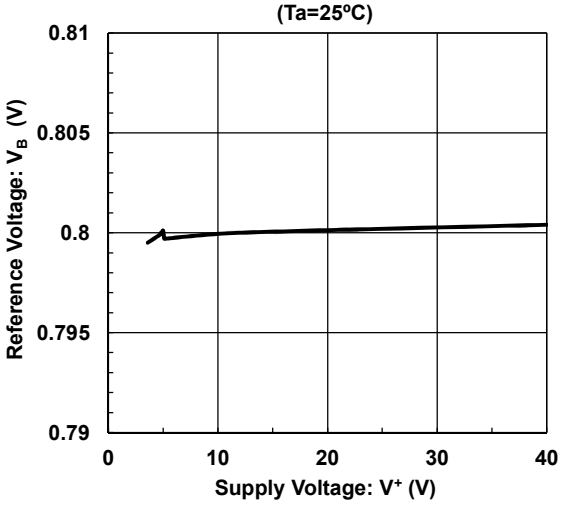


Operating mode select with the MODE/SYNC pin

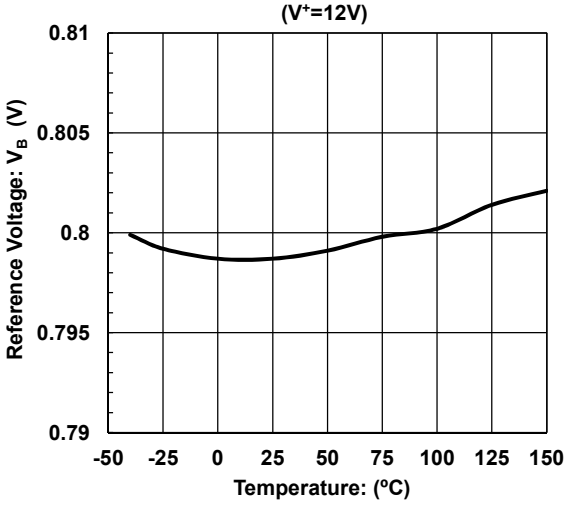
MODE/SYNC pin Voltage	Operating Mode	Oscillating Frequency
1.6V to V^+	Forced PWM operation	Internal frequency
0V to 0.5V	PWM/PFM operation for light loads	Internal frequency
External clock input	Forced PWM operation	External clock frequency

■TYPICAL CHARACTERISTICS (A, B version)

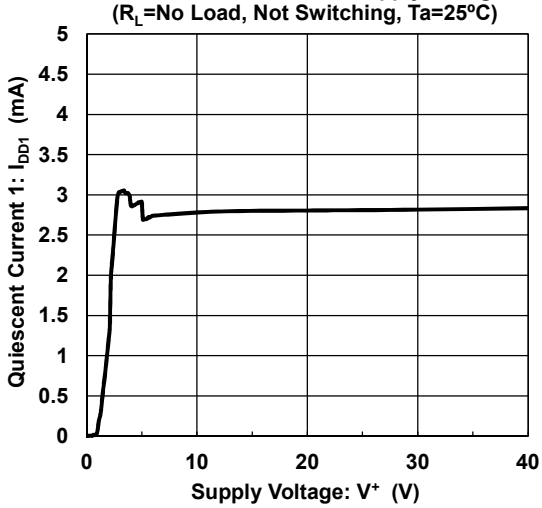
Reference Voltage vs. Supply Voltage
(Ta=25ºC)



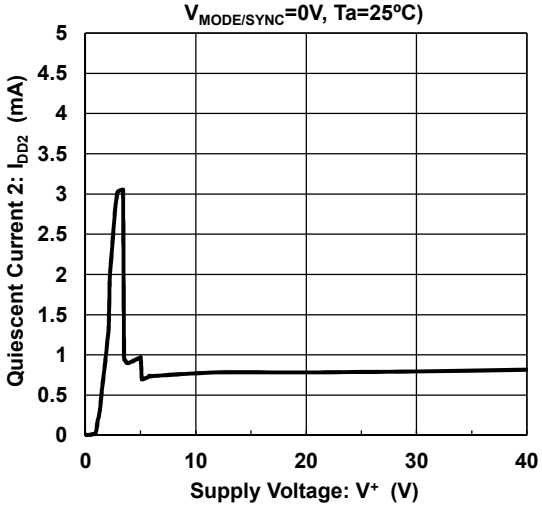
Reference Voltage vs. Temperature
(V^+=12V)



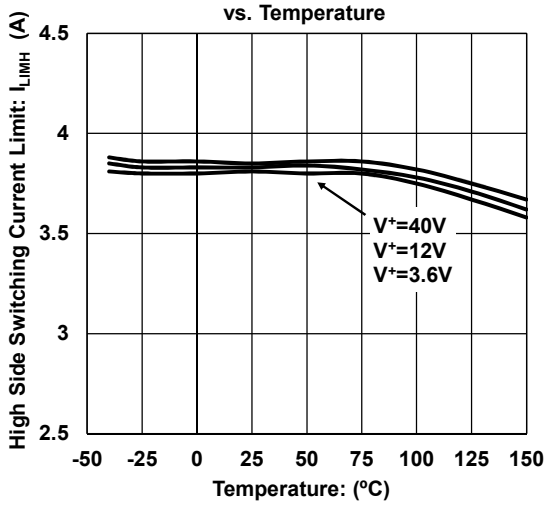
Quiescent Current 1 vs. Supply Voltage
(R_L=No Load, Not Switching, Ta=25ºC)



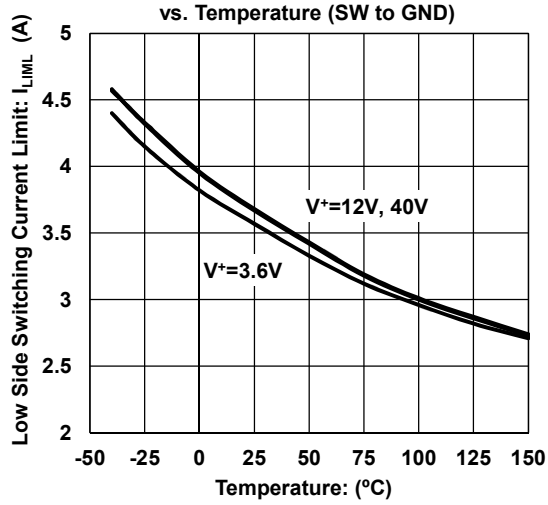
Quiescent Current 2 vs. Supply Voltage
(R_L=No Load, Not Switching,
$V_{MODE/SYNC}$=0V, Ta=25ºC)



High Side Switching Current Limit
vs. Temperature

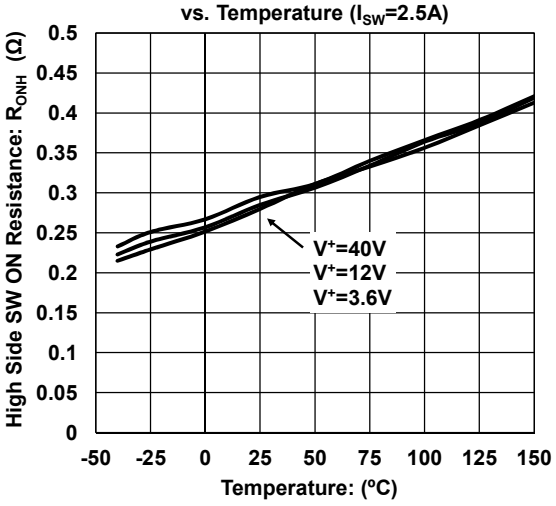


Low Side Switching Current Limit
vs. Temperature (SW to GND)

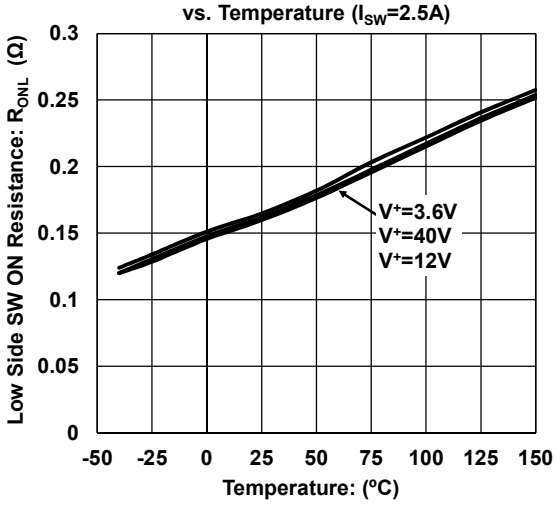


■ TYPICAL CHARACTERISTICS (A, B version)

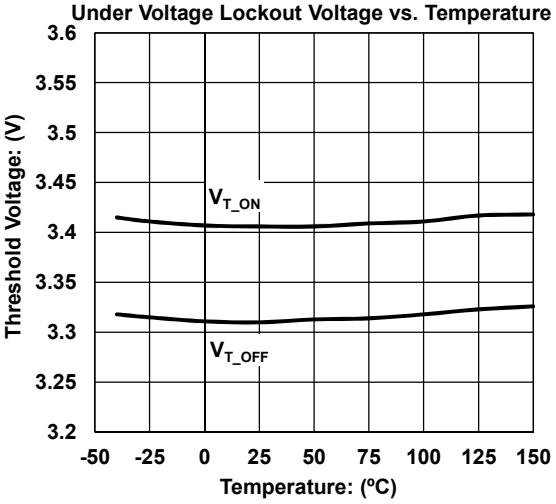
High Side SW ON Resistance vs. Temperature (I_{SW}=2.5A)



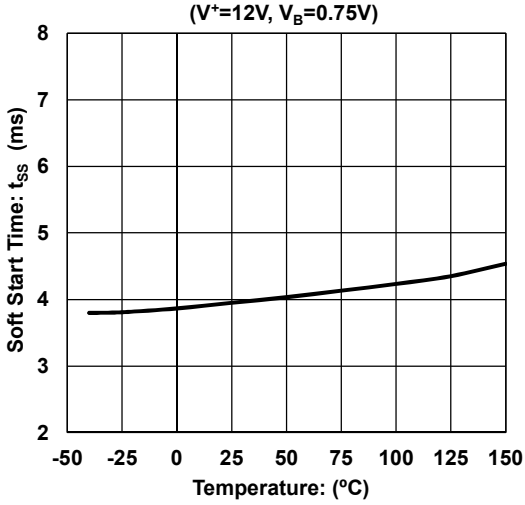
Low Side SW ON Resistance vs. Temperature (I_{SW}=2.5A)



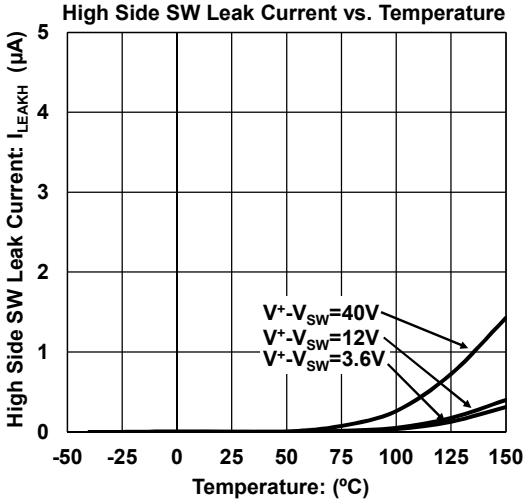
Under Voltage Lockout Voltage vs. Temperature



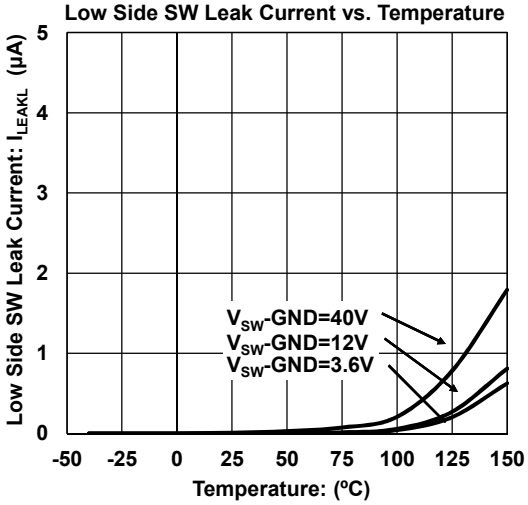
Soft Start Time vs. Temperature (V^+=12V, V_B=0.75V)



High Side SW Leak Current vs. Temperature

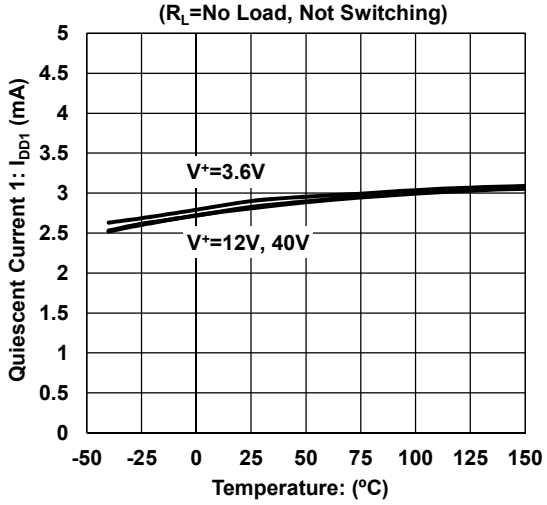


Low Side SW Leak Current vs. Temperature

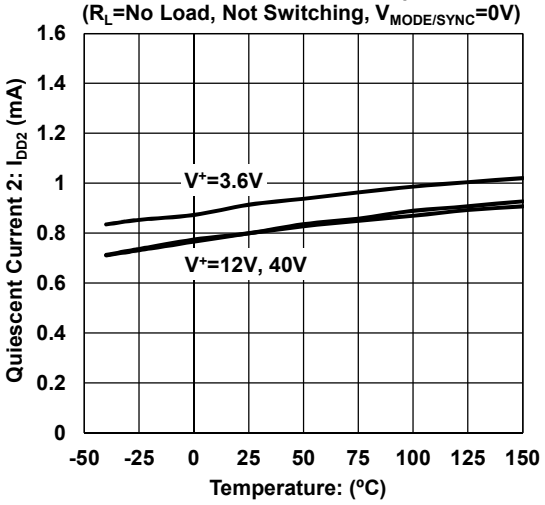


■ TYPICAL CHARACTERISTICS (A, B version)

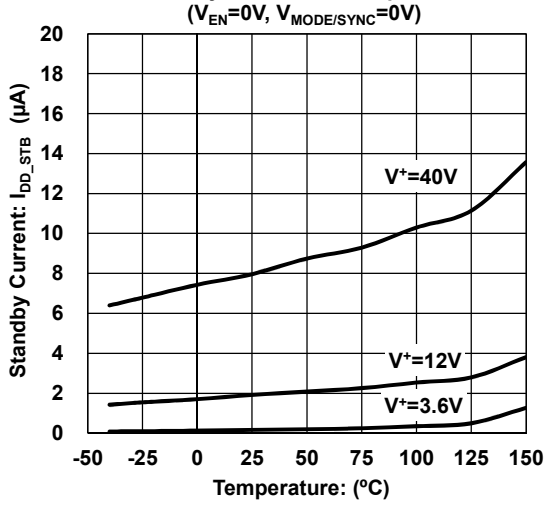
Quiescent Current 1 vs. Temperature
(R_L=No Load, Not Switching)



Quiescent Current 2 vs. Temperature
(R_L=No Load, Not Switching, $V_{MODE/SYNC}$=0V)

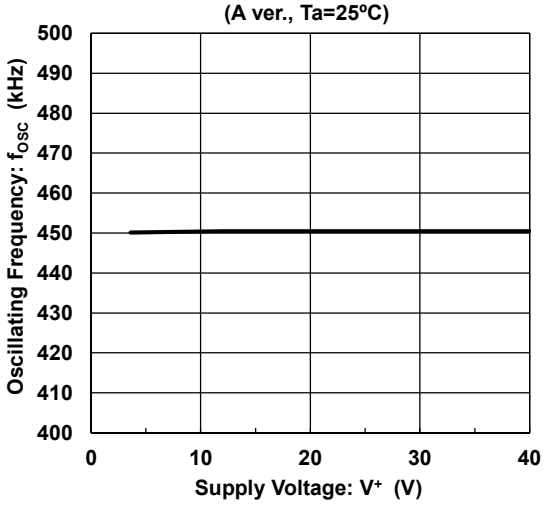


Standby Current vs. Temperature
(V_{EN}=0V, $V_{MODE/SYNC}$=0V)

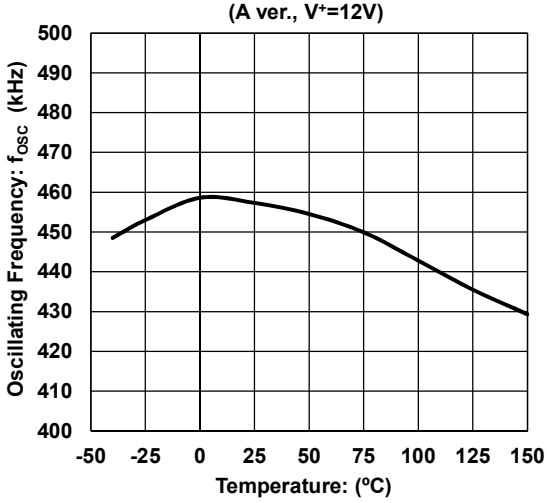


■ TYPICAL CHARACTERISTICS (A version)

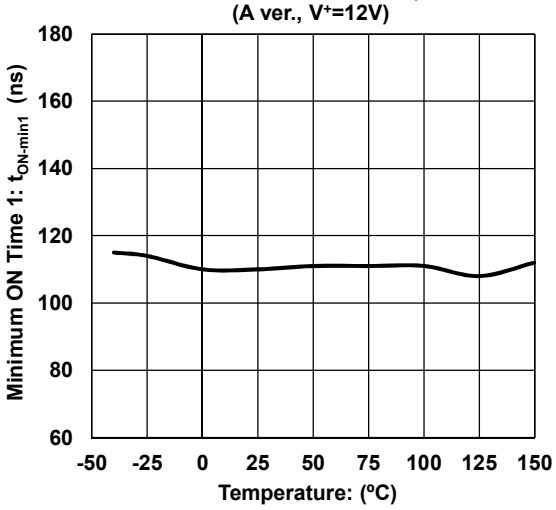
Oscillating Frequency vs. Supply Voltage
(A ver., Ta=25ºC)



Oscillating Frequency vs Temperature
(A ver., V^+=12V)

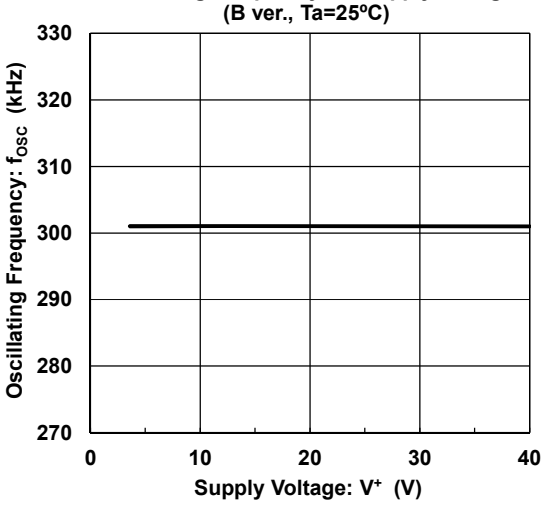


Minimum ON Time 1 vs. Temperature
(A ver., V^+=12V)

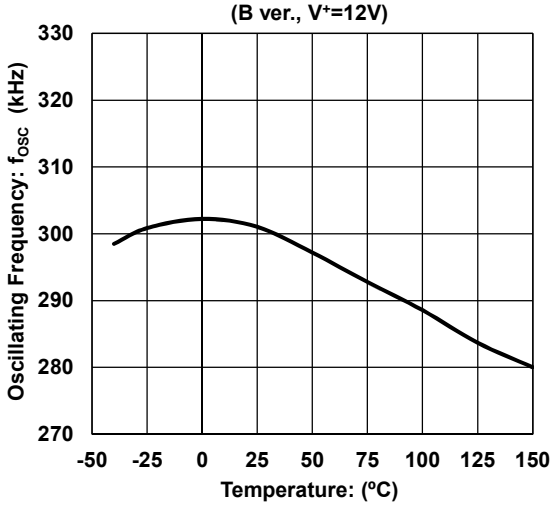


■ TYPICAL CHARACTERISTICS (B version)

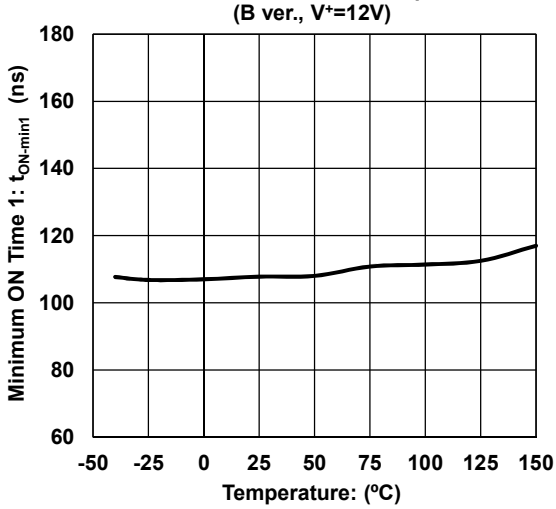
Oscillating Frequency vs. Supply Voltage
(B ver., Ta=25ºC)



Oscillating Frequency vs Temperature
(B ver., V^+=12V)



Minimum ON Time 1 vs. Temperature
(B ver., V^+=12V)



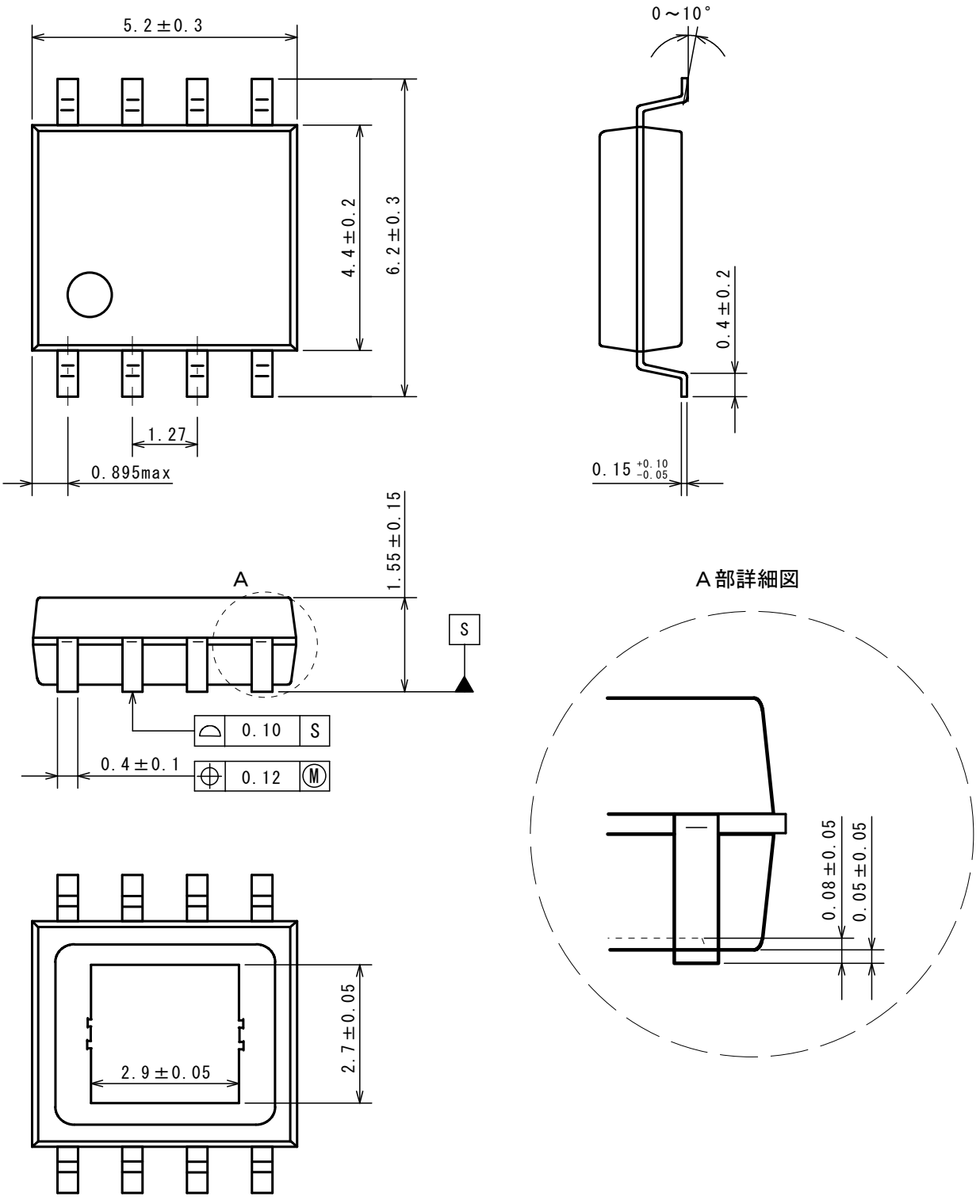
■ PIN DESCRIPTIONS

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 ±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.

HSOP8

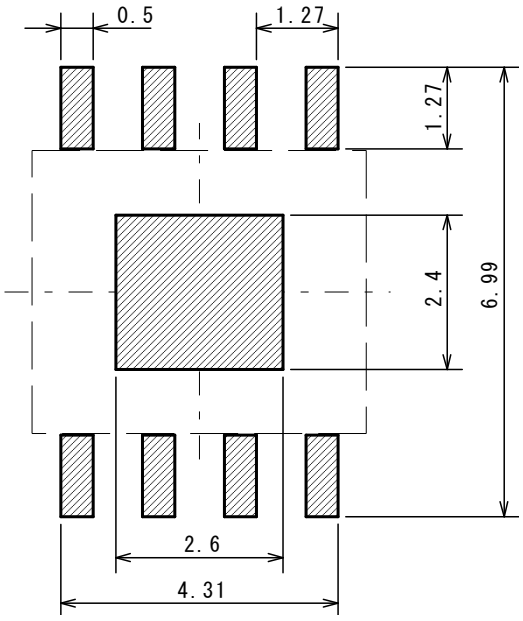
Unit: mm

■ **PACKAGE DIMENSIONS**

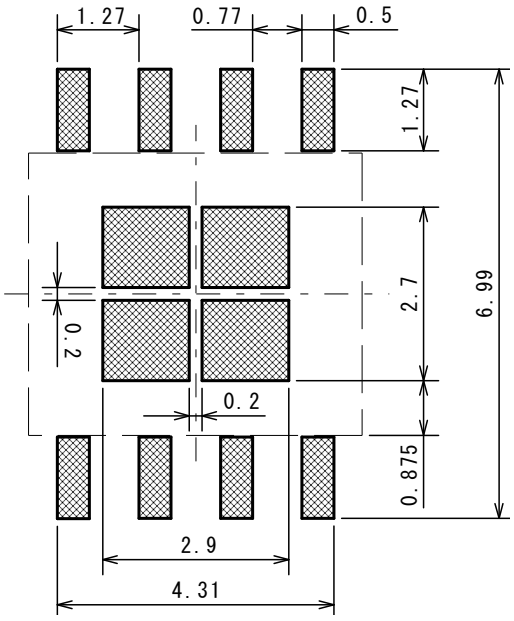


Unit: mm

■ 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.

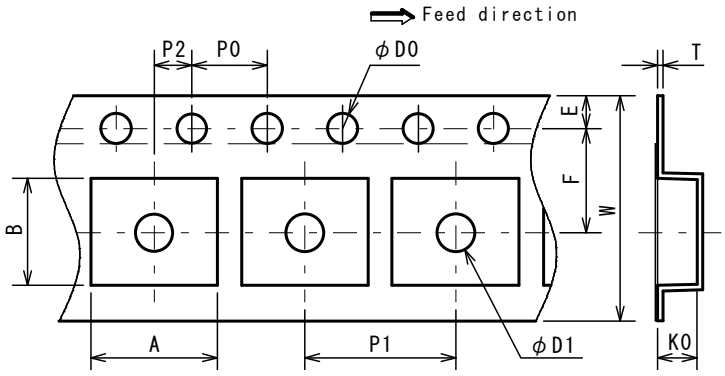
We will strongly recommend to evaluate mounting previously with using foot pattern, metal mask and solder paste.

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

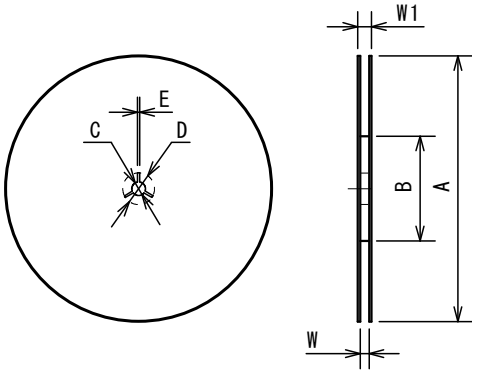
Unit: mm

TAPING DIMENSIONS



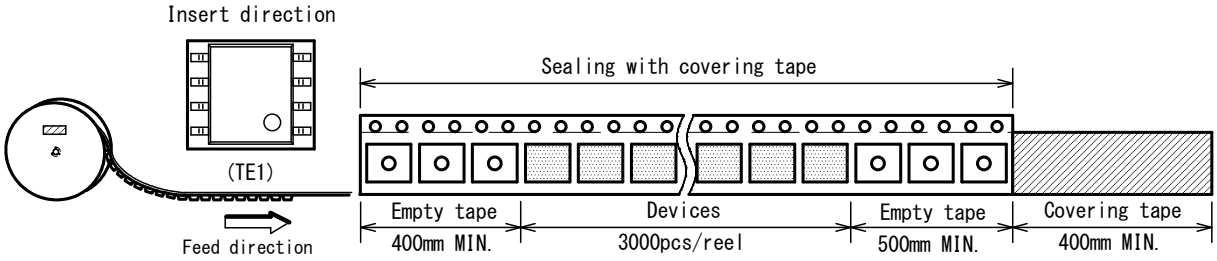
SYMBOL	DIMENSION	REMARKS
A	6.7±0.1	
B	5.55±0.1	
D0	1.55±0.05	
D1	2.05±0.05	
E	1.75±0.1	
F	5.5±0.05	
P0	4.0±0.1	
P1	8.0±0.1	
P2	2.0±0.05	
T	0.3±0.05	
T2	2.47	
K0	2.1±0.1	
W	12.0±0.2	

REEL DIMENSIONS

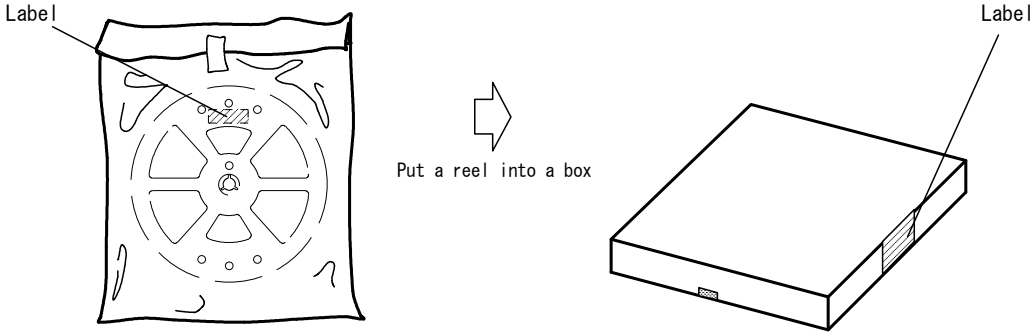


SYMBOL	DIMENSION
A	φ330±2
B	φ 80±1
C	φ 13±0.2
D	φ 21±0.8
E	2±0.5
W	13.5±0.5
W1	17.5±1

TAPING STATE



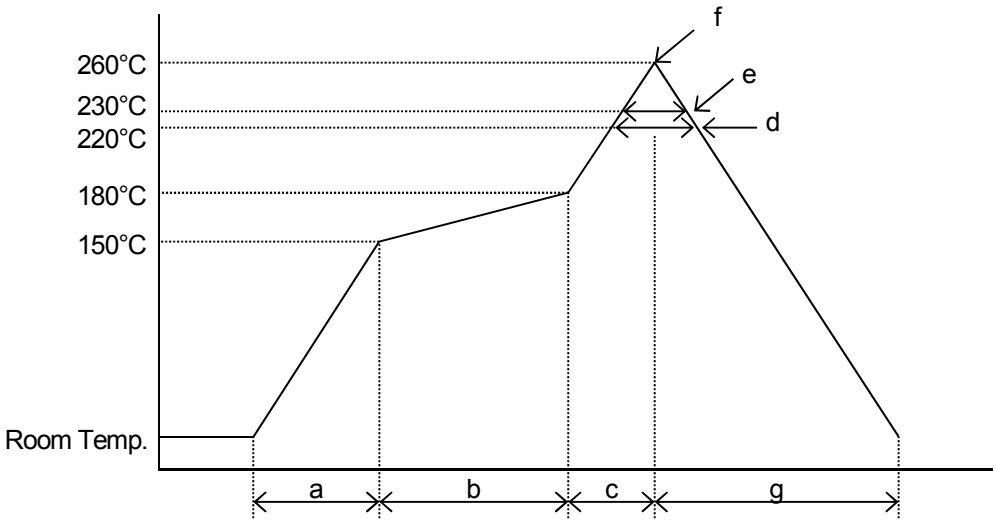
PACKING STATE



■ MOUNTING METHOD

INFRARED REFLOW SOLDERING METHOD

Recommended reflow soldering procedure



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

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