



# H04N65 Series

N-Channel Power Field Effect Transistor (650V, 4A)

## Description

This advanced high voltage MOSFET is designed to withstand high energy in the avalanche mode and switch efficiently. This new high energy device also offers a drain-to-source diode with fast recovery time. Designed for high voltage, high speed switching applications such as power supplies, converters, power motor controls and bridge circuits.

## Features

- Higher Current Rating
- Lower  $R_{DS(on)} < 3.0\Omega$  (@  $V_{GS}=10V$ ,  $I_D=2A$ )
- Lower Capacitances
- Lower Total Gate Charge
- Tighter VSD Specifications
- Avalanche Energy Specified

## Thermal Characteristics

Symbol	Parameter	Value		Units
$R_{\theta JC}$	Thermal Resistance Junction to Case Max.	TO-220AB	1.3	°C/W
		TO-220FP	5	
$R_{\theta JA}$	Thermal Resistance Junction to Ambient (Maximum)	62.5		°C/W

## Absolute Maximum Ratings

Symbol	Parameter	Value	Units
$V_{DS}$	Drain-Source Voltage	650	V
$I_D$	Drain to Current (Continuous)	4	A
$I_{DM}$	Drain to Current (Pulsed)	16	A
$V_{GS}$	Gate-to-Source Voltage (Continue)	±30	V
$P_D$	Total Power Dissipation ( $T_C=25^\circ C$ )		
	H04N65E (TO-220AB) H04N65F (TO-220FP)	70 30	W
$P_D$	Derate above 25°C		
	H04N65E (TO-220AB) H04N65F (TO-220FP)	0.56 0.2	W/°C
$T_j, T_{stg}$	Operating and Storage Temperature Range	-55 to 150	°C
$E_{AS}$	Single Pulse Drain-to-Source Avalanche Enrgy- $T_j=25^\circ C$ ( $V_{DD}=100V$ , $V_{GS}=10V$ , $I_L=2A$ , $L=10mH$ , $R_G=25\Omega$ )	250	mJ
$T_L$	Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 10 seconds	260	°C

H04N65 Series Pin Assignment

3-Lead Plastic **TO-220AB**  
 Package Code: E  
 Pin 1: Gate  
 Pin 2 & Tab: Drain  
 Pin 3: Source

3-Lead Plastic **TO-220FP**  
 Package Code: F  
 Pin 1: Gate  
 Pin 2: Drain  
 Pin 3: Source

H04N65 Series  
 Symbol:



### Electrical Characteristics (T<sub>j</sub>=25°C, unless otherwise specified)

Symbol	Characteristic	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-Source Breakdown Voltage (V <sub>GS</sub> =0V, I <sub>D</sub> =250uA)	650	-	-	V
I <sub>DSS</sub>	Drain-Source Leakage Current (V <sub>DS</sub> =650V, V <sub>GS</sub> =0V)	-	-	10	uA
	Drain-Source Leakage Current (V <sub>DS</sub> =480V, V <sub>GS</sub> =0V, T <sub>j</sub> =125°C)	-	-	50	uA
I <sub>GSSF</sub>	Gate-Source Leakage Current-Forward (V <sub>gsf</sub> =30V, V <sub>DS</sub> =0V)	-	-	100	nA
I <sub>GSSR</sub>	Gate-Source Leakage Current-Reverse (V <sub>gsr</sub> =-30V, V <sub>DS</sub> =0V)	-	-	-100	nA
V <sub>GS(th)</sub>	Gate Threshold Voltage (V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250uA)	2	-	4	V
R <sub>DS(on)</sub>	Static Drain-Source On-Resistance (V <sub>GS</sub> =10V, I <sub>D</sub> =2A)*	-	2.3-	3.0	Ω
g <sub>FS</sub>	Forward Transconductance (V <sub>DS</sub> =15V, I <sub>D</sub> =2A)*	2	-	-	Mhos
C <sub>iss</sub>	Input Capacitance	-	560	-	pF
C <sub>oss</sub>	Output Capacitance	-	50	-	
C <sub>rss</sub>	Reverse Transfer Capacitance	-	3	-	
t <sub>d(on)</sub>	Turn-on Delay Time	-	20	-	Ns
t <sub>r</sub>	Rise Time	-	19	-	
t <sub>d(off)</sub>	Turn-off Delay Time	-	128	-	
t <sub>f</sub>	Fall Time	-	20	-	
Q <sub>g</sub>	Total Gate Charge	-	16	-	nC
Q <sub>gs</sub>	Gate-Source Charge	-	3.5	-	
Q <sub>gd</sub>	Gate-Drain Charge	-	5.7	-	

\*: Pulse Test: Pulse Width ≤300us, Duty Cycle≤2%

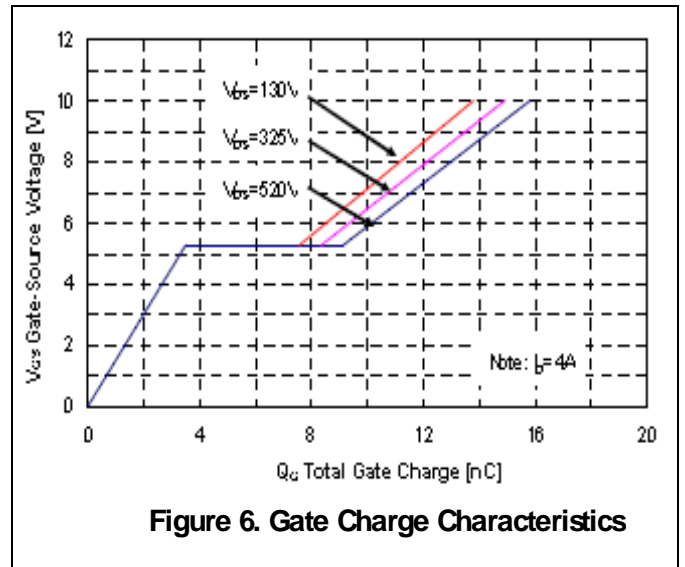
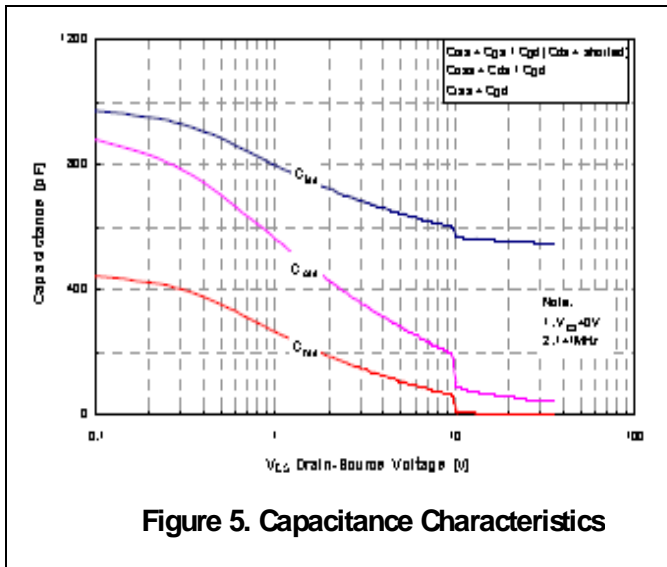
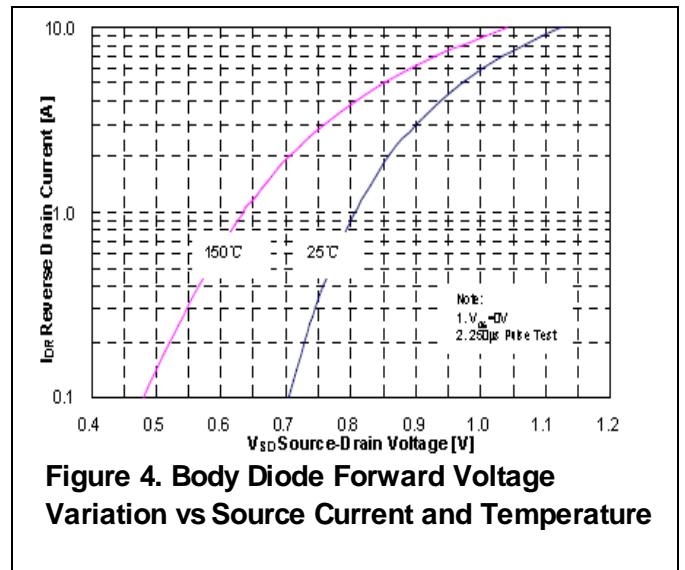
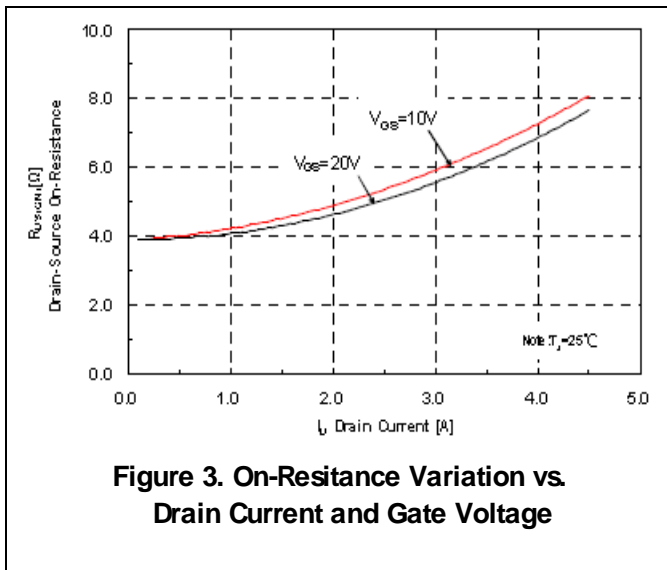
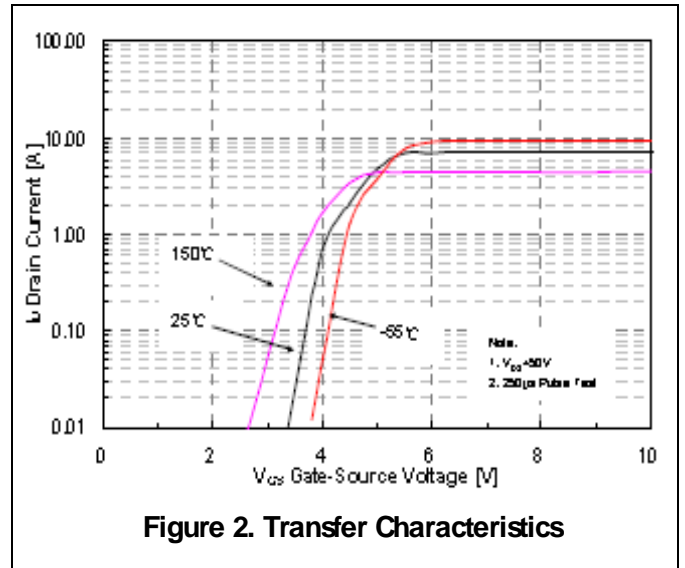
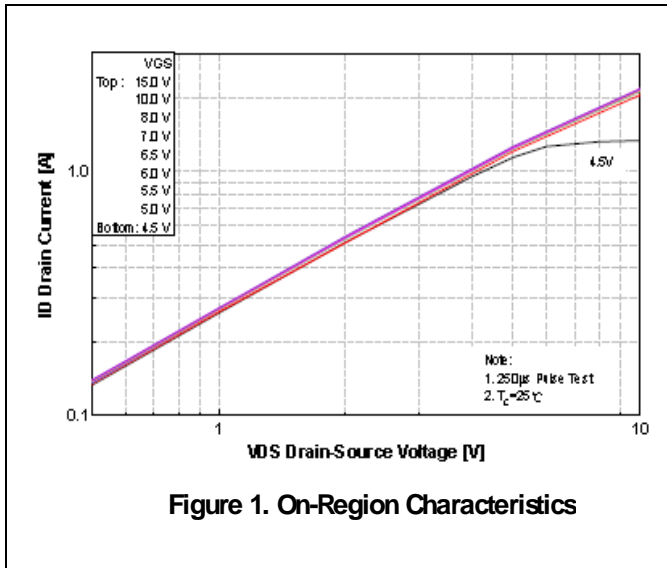
### Source-Drain Diode

Symbol	Characteristic	Min.	Typ.	Max.	Units
V <sub>SD</sub>	Forward On Voltage(1)	-	-	1.4	V
t <sub>rr</sub>	Reverse Recovery Time	-	300	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge	-	2.2	-	uC

\*\* : Negligible, Dominated by circuit inductance

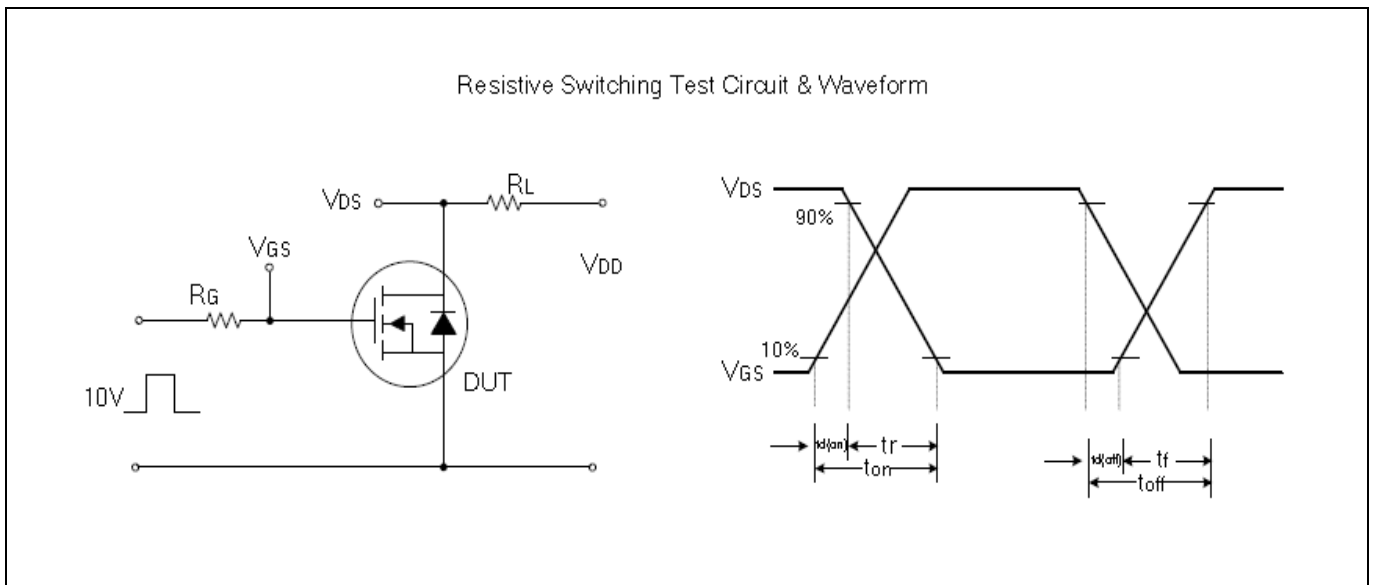
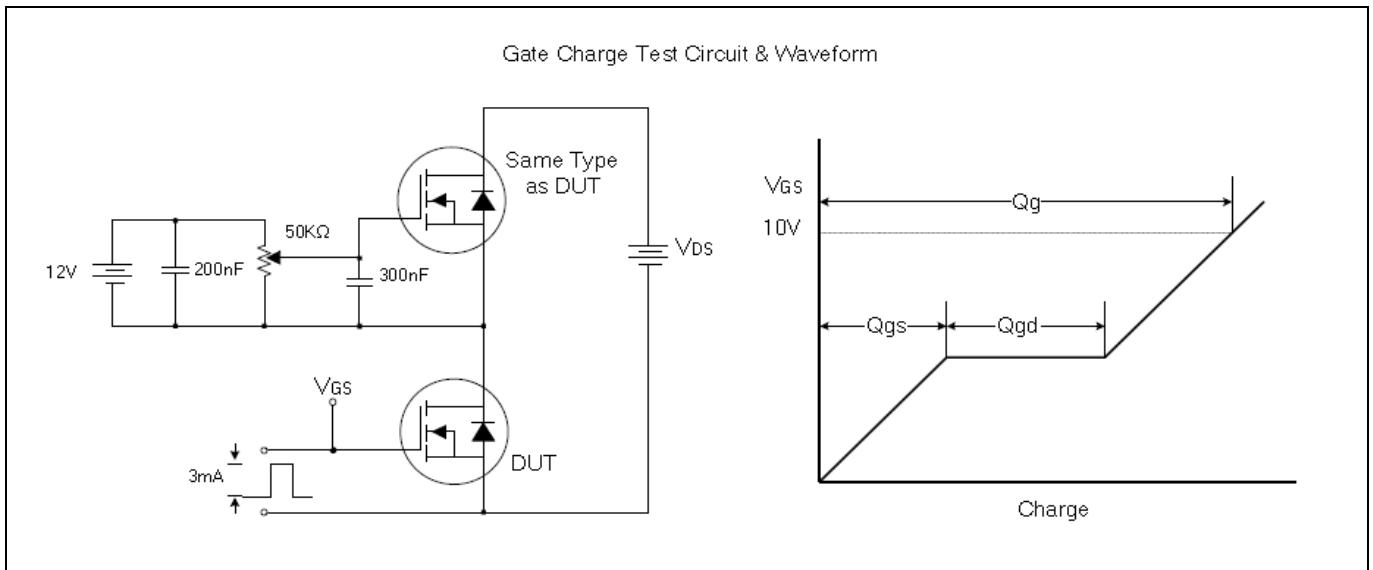
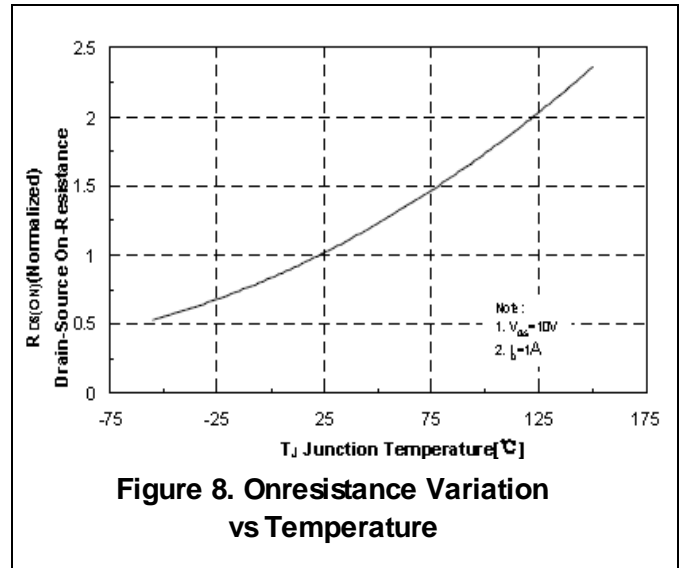
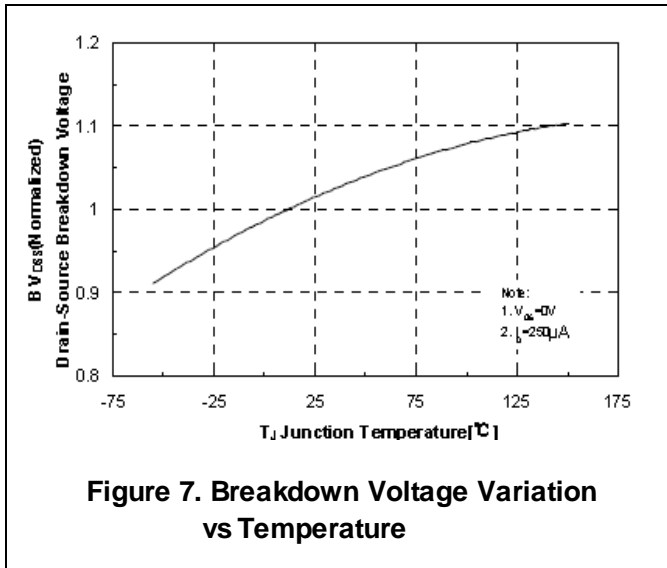


### Characteristics Curve





### Characteristics Curve





### TO-220AB Dimension

3-Lead TO-220AB  
Plastic Package  
HSMC Package Code: E

**Marking:**

Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing  
 Pin Style: 1.Gate 2 & Tab.Drain 3.Source

Material:  
 • Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)  
 • Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	5.58	7.49
B	8.38	8.90
C	4.40	4.70
D	1.15	1.39
E	0.35	0.60
F	2.03	2.92
G	9.66	10.28
H	-	*16.25
I	-	*3.83
J	3.00	4.00
K	0.75	0.95
L	2.54	3.42
M	1.14	1.40
N	-	*2.54
O	12.70	14.27
P	14.48	15.87

\*: Typical, Unit: mm

### TO-220FP Dimension

3-Lead TO-220FP  
Plastic Package  
HSMC Package Code: F

**Marking:**

Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing  
 Pin Style: 1.Gate 2.Drain 3.Source

Material:  
 • Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)  
 • Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.48	7.40
C	4.40	4.90
D	2.34	3.00
E	0.45	0.80
F	9.80	10.36
G	3.10	3.60
I	2.70	3.43
J	0.60	1.00
K	2.34	2.74
L	12.48	13.60
M	15.67	16.20
N	0.90	1.47
O	2.00	2.96
$\alpha 1/2/4/5$	-	*5°
$\alpha 3$	-	*27°

\*: Typical, Unit: mm

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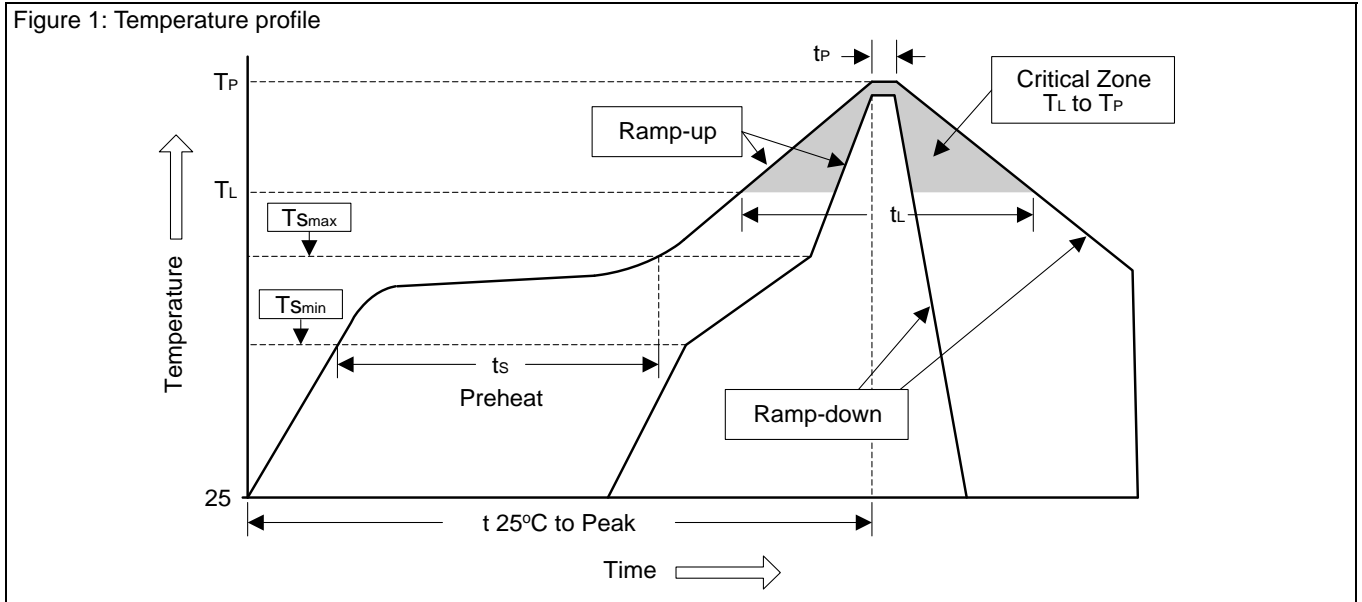
• **Head Office** (Hi-Sincerity Microelectronics Corp.): 10F., No. 61, Sec. 2, Chung-Shan N. Rd. Taipei Taiwan R.O.C.  
 Tel: 886-2-25212056 Fax: 886-2-25632712, 25368454



## Soldering Methods for HSMC's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%
2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	<3°C/sec	<3°C/sec
Preheat		
- Temperature Min ( $T_{Smin}$ )	100°C	150°C
- Temperature Max ( $T_{Smax}$ )	150°C	200°C
- Time (min to max) ( $t_s$ )	60~120 sec	60~180 sec
$T_{Smax}$ to $T_L$		
- Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above:		
- Temperature ( $T_L$ )	183°C	217°C
- Time ( $t_L$ )	60~150 sec	60~150 sec
Peak Temperature ( $T_P$ )	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature ( $t_P$ )	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	10sec ±1sec
Pb-Free devices.	260°C ±5°C	10sec ±1sec