

## N-Channel Power MOSFET

60V, 35A, 22mΩ

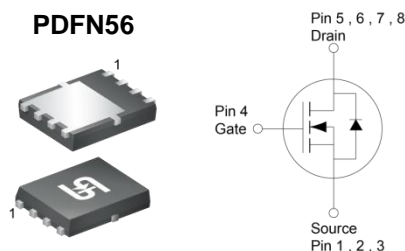
**FEATURES**

- Low  $R_{DS(ON)}$  to minimize conductive losses
- Logic level
- Low gate charge for fast power switching
- 100% UIS and  $R_g$  tested.
- 175°C Operating Junction Temperature
- Compliant to RoHS directive 2011/65/EU and in accordance to WEEE 2002/96/EC
- Halogen-free according to IEC 61249-2-21

**APPLICATIONS**

- BLDC Motor Control
- Battery Power Management
- DC-DC converter
- Secondary Synchronous Rectification

KEY PERFORMANCE PARAMETERS		
PARAMETER	VALUE	UNIT
$V_{DS}$	60	V
$R_{DS(on)}$ (max)	$V_{GS} = 10V$	22
	$V_{GS} = 4.5V$	28
$Q_g$	12	nC



**Note:** MSL 1 (Moisture Sensitivity Level) per J-STD-020

ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)			
PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	$V_{DS}$	60	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	V
Continuous Drain Current (Note 1)	$I_D$	$T_C = 25^\circ\text{C}$	35
		$T_A = 25^\circ\text{C}$	8
Pulsed Drain Current	$I_{DM}$	140	A
Single Pulse Avalanche Current (Note 2)	$I_{AS}$	13	A
Single Pulse Avalanche Energy (Note 2)	$E_{AS}$	25	mJ
Total Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$	68
		$T_C = 125^\circ\text{C}$	23
Total Power Dissipation	$P_D$	$T_A = 25^\circ\text{C}$	3.1
		$T_A = 125^\circ\text{C}$	1
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	- 55 to +175	$^\circ\text{C}$

THERMAL PERFORMANCE			
PARAMETER	SYMBOL	LIMIT	UNIT
Junction to Case Thermal Resistance	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$
Junction to Ambient Thermal Resistance	$R_{\theta JA}$	48	$^\circ\text{C/W}$

**Thermal Performance Note:**  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistances. The case-thermal reference is defined at the solder mounting surface of the drain pins.  $R_{\theta JA}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design. The  $R_{\theta JA}$  limit presented here is based on mounting on a 1 in<sup>2</sup> pad of 2 oz copper.

<b>ELECTRICAL SPECIFICATIONS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise noted)						
PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{GS} = 0\text{V}, I_D = 250\mu\text{A}$	$BV_{DSS}$	60	--	--	V
Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 250\mu\text{A}$	$V_{GS(TH)}$	1	1.7	2.5	V
Gate-Source Leakage Current	$V_{GS} = \pm 20\text{V}, V_{DS} = 0\text{V}$	$I_{GSS}$	--	--	$\pm 100$	nA
Drain-Source Leakage Current	$V_{GS} = 0\text{V}, V_{DS} = 60\text{V}$	$I_{DSS}$	--	--	1	$\mu\text{A}$
	$V_{GS} = 0\text{V}, V_{DS} = 60\text{V}$ $T_J = 125^\circ\text{C}$		--	--	100	
Drain-Source On-State Resistance (Note 3)	$V_{GS} = 10\text{V}, I_D = 8\text{A}$	$R_{DS(on)}$	--	18	22	m $\Omega$
	$V_{GS} = 4.5\text{V}, I_D = 7\text{A}$		--	21	28	
Forward Transconductance (Note 3)	$V_{DS} = 10\text{V}, I_D = 8\text{A}$	$g_{fs}$	--	36	--	S
<b>Dynamic</b> (Note 4)						
Total Gate Charge	$V_{GS} = 10\text{V}, V_{DS} = 30\text{V},$ $I_D = 8\text{A}$	$Q_g$	--	23	--	nC
Total Gate Charge	$V_{GS} = 4.5\text{V}, V_{DS} = 30\text{V},$ $I_D = 7\text{A}$	$Q_g$	--	12	--	
Gate-Source Charge		$Q_{gs}$	--	4	--	
Gate-Drain Charge		$Q_{gd}$	--	5	--	
Input Capacitance	$V_{GS} = 0\text{V}, V_{DS} = 30\text{V}$ $f = 1.0\text{MHz}$	$C_{iss}$	--	1314	--	pF
Output Capacitance		$C_{oss}$	--	91	--	
Reverse Transfer Capacitance		$C_{rss}$	--	26	--	
Gate Resistance	$f = 1.0\text{MHz}$	$R_g$	0.6	2	4	$\Omega$
<b>Switching</b> (Note 4)						
Turn-On Delay Time	$V_{GS} = 10\text{V}, V_{DS} = 30\text{V},$ $I_D = 8\text{A}, R_G = 2\Omega$	$t_{d(on)}$	--	1	--	ns
Turn-On Rise Time		$t_r$	--	19	--	
Turn-Off Delay Time		$t_{d(off)}$	--	14	--	
Turn-Off Fall Time		$t_f$	--	18	--	
<b>Source-Drain Diode</b>						
Forward Voltage (Note 3)	$V_{GS} = 0\text{V}, I_S = 8\text{A}$	$V_{SD}$	--	--	1.2	V
Reverse Recovery Time	$I_S = 8\text{A},$	$t_{rr}$	--	12	--	ns
Reverse Recovery Charge	$di/dt = 100\text{A}/\mu\text{s}$	$Q_{rr}$	--	6	--	nC

**Notes:**

- Silicon limited current only.
- $L = 0.3\text{mH}, V_{GS} = 10\text{V}, V_{DD} = 30\text{V}, R_G = 25\Omega, I_{AS} = 13\text{A},$  Starting  $T_J = 25^\circ\text{C}$
- Pulse test: Pulse Width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- Switching time is essentially independent of operating temperature.

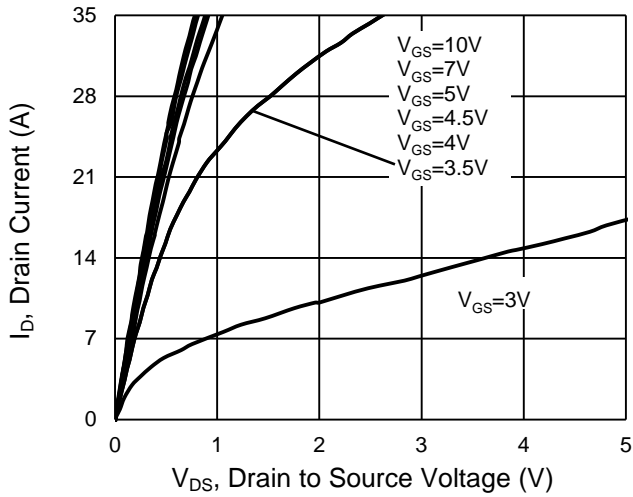
**ORDERING INFORMATION**

PART NO.	PACKAGE	PACKING
TSM220NB06LCR RLG	PDFN56	2,500pcs / 13" Reel

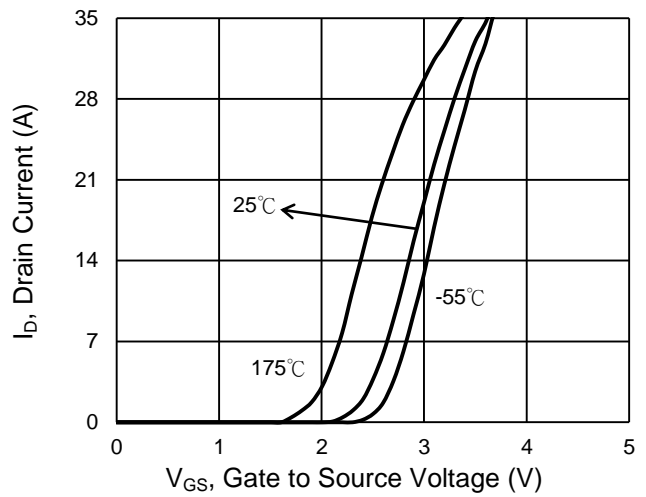
**CHARACTERISTICS CURVES**

( $T_A = 25^\circ\text{C}$  unless otherwise noted)

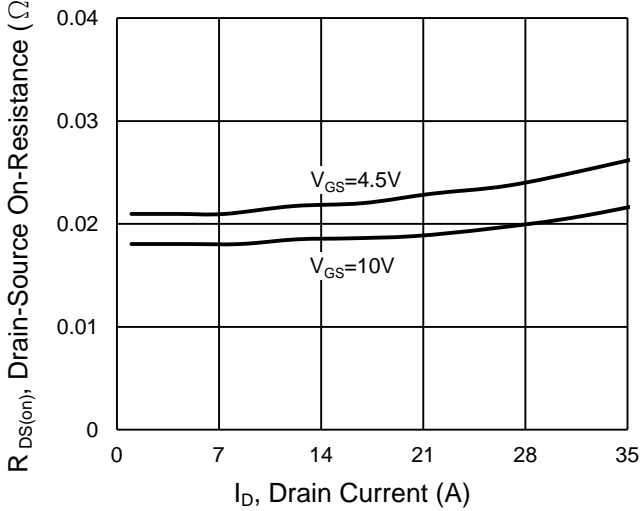
**Output Characteristics**



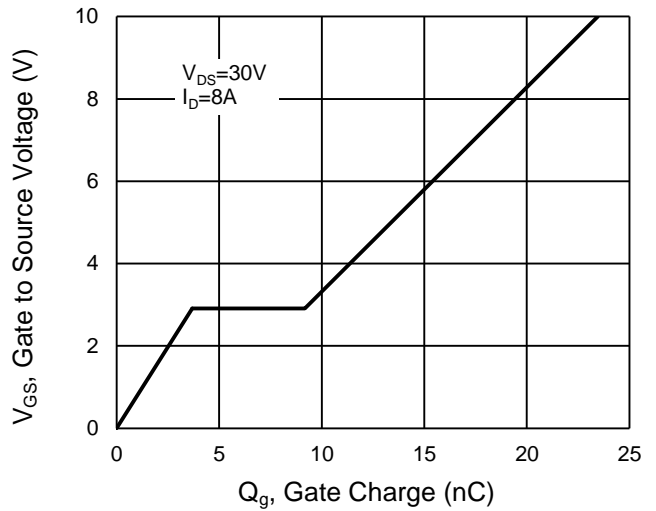
**Transfer Characteristics**



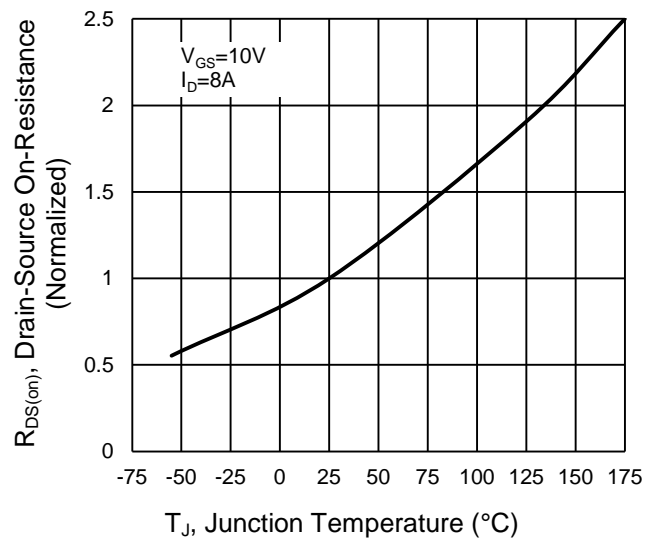
**On-Resistance vs. Drain Current**



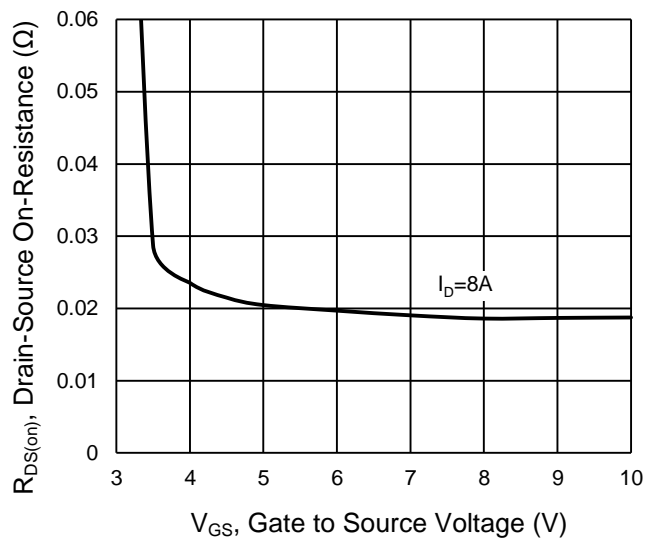
**Gate-Source Voltage vs. Gate Charge**



**On-Resistance vs. Junction Temperature**



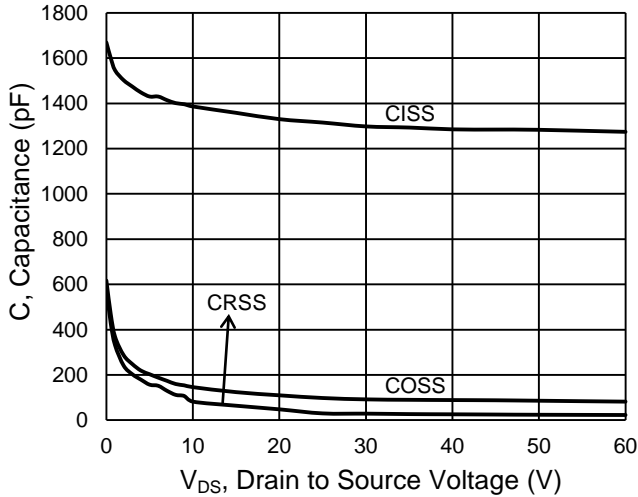
**On-Resistance vs. Gate-Source Voltage**



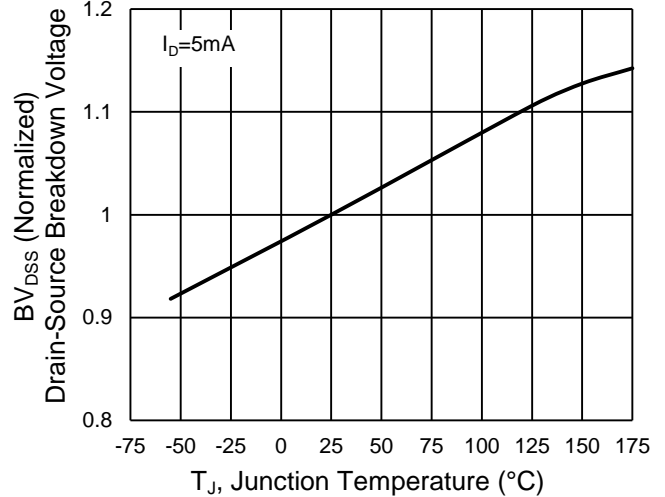
**CHARACTERISTICS CURVES**

( $T_A = 25^\circ\text{C}$  unless otherwise noted)

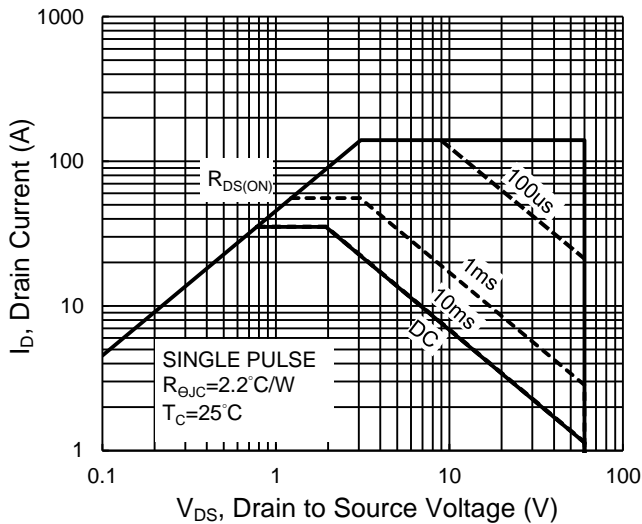
**Capacitance vs. Drain-Source Voltage**



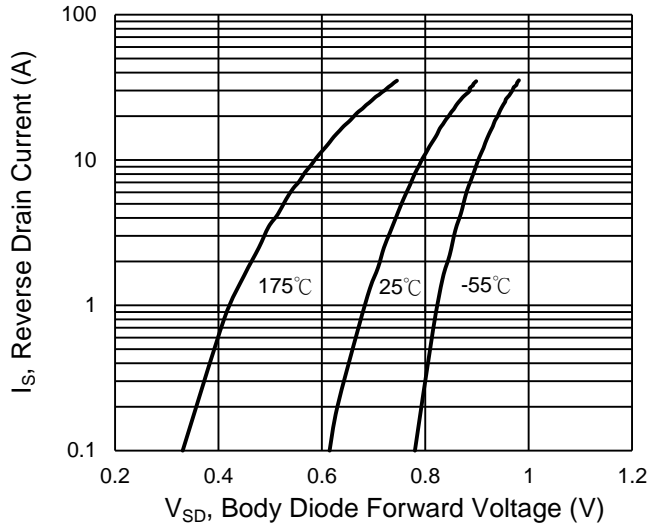
**$BV_{DSS}$  vs. Junction Temperature**



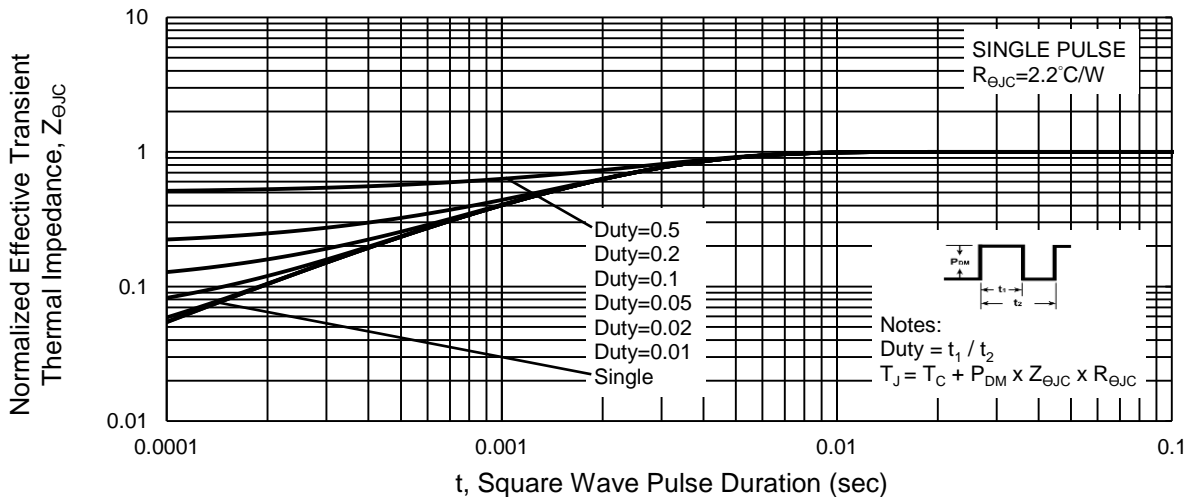
**Maximum Safe Operating Area, Junction-to-Case**



**Source-Drain Diode Forward Current vs. Voltage**

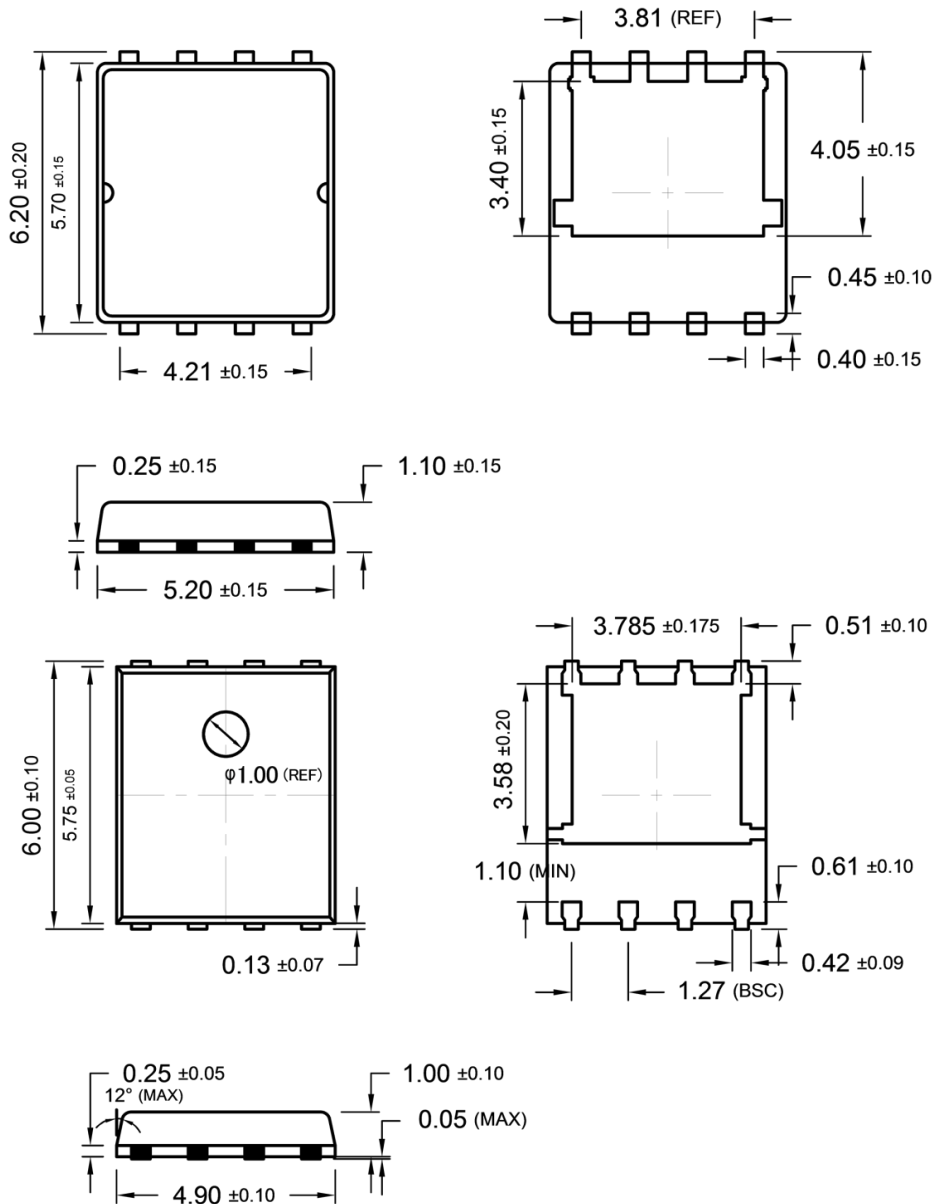


**Normalized Thermal Transient Impedance, Junction-to-Case**

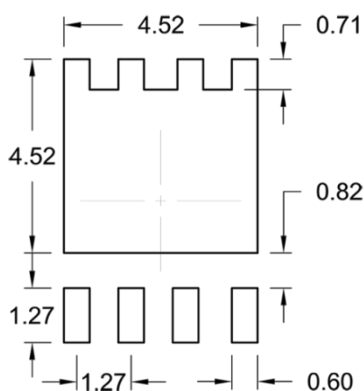


**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

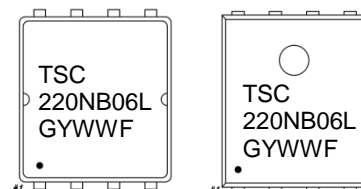
**PDFN56**



**SUGGESTED PAD LAYOUT** (Unit: Millimeters)



**MARKING DIAGRAM**



- G** = Halogen Free
- Y** = Year Code
- WW** = Week Code (01~52)
- F** = Factory Code

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