MCP87090

High-Speed N-Channel Power MOSFET

Features:

- Low Drain-to-Source On Resistance ($R_{DS(ON)}$)
- Low Total Gate Charge (Q_G) and Gate-to-Drain Charge (Q_{GD})
- Low Series Gate Resistance (R_G)
- Capable of Short Dead-Time Operation
- RoHS Compliant

Applications:

- Point-of-Load DC-DC Converters
- High Efficiency Power Management in Servers, Networking, and Automotive Applications

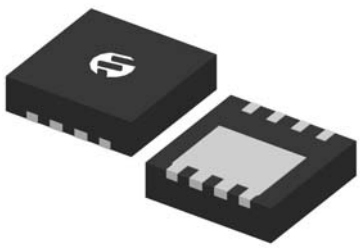
Description:

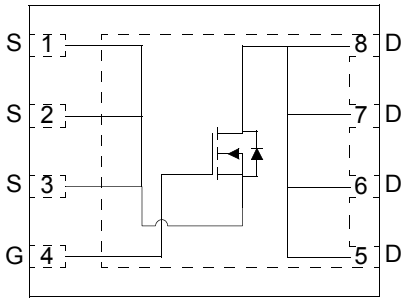
The MCP87090 is an N-Channel power MOSFET in a popular PDFN 5 mm x 6 mm package, as well as a PDFN 3.3 mm x 3.3 mm package. Advanced packaging and silicon processing technologies allow the MCP87090 to achieve a low Q_G for a given $R_{DS(ON)}$ value, resulting in a low Figure of Merit (FOM). Combined with low R_G, the low FOM of the MCP87090 device allows high efficiency power conversion with reduced switching and conduction losses.

Package Type

PDFN 5 x 6

PDFN 3.3 x 3.3





Product Summary Table: Unless otherwise indicated, T_A = +25°C

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Operating Characteristics						
Drain-to-Source Breakdown Voltage	BV_{DSS}	25	—	—	V	V_{GS} = 0V, I_D = 250 µA
Gate-to-Source Threshold Voltage	$V_{GS(TH)}$	1.1	1.35	1.7	V	V_{DS} = V_{GS}, I_D = 250 µA
Drain-to-Source On Resistance	$R_{DS(ON)}$	—	10	12	mΩ	V_{GS} = 4.5V, I_D = 17A
		—	8.5	10.5	mΩ	V_{GS} = 10V, I_D = 17A
Total Gate Charge	Q_G	—	7.5	10	nC	V_{DS} = 12.5V, I_D = 17A, V_{GS} = 4.5V
Gate-to-Drain Charge	Q_{GD}	—	2.8	—	nC	V_{DS} = 12.5V, I_D = 17A
Series Gate Resistance	R_G	—	1.8	—	Ω	
Thermal Characteristics						
Thermal Resistance Junction-to-X, 8L 3.3x3.3-PDFN	$R_{θJX}$	—	—	70	°C/W	**Note 1**
Thermal Resistance Junction-to-Case, 8L 3.3x3.3-PDFN	$R_{θJC}$	—	—	3.3	°C/W	**Note 2**
Thermal Resistance Junction-to-X, 8L 5x6-PDFN	$R_{θJX}$	—	—	55	°C/W	**Note 1**
Thermal Resistance Junction-to-Case, 8L 5x6-PDFN	$R_{θJC}$	—	—	3.2	°C/W	**Note 2**

Note 1: $R_{θJX}$ is determined with the device surface mounted on a 4-Layer FR4 PCB, with a 1" x 1" mounting pad of 2 oz. copper. This characteristic is dependent on user's board design.

2: $R_{θJC}$ is determined using JEDEC 51-14 Method. This characteristic is determined by design.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{DS} .....+25V

V_{GS} ..... +10.0V / -8V

I_D, Continuous .....

8L 5x6-PDFN ..... 51A, T_C = +25°C

8L 3.3x3.3-PDFN ..... 50A, T_C = +25°C

P_D .....

8L 5x6-PDFN ..... 2.2W, T_A = +25°C

8L 3.3x3.3-PDFN ..... 1.8W, T_A = +25°C

T_J, T_{STG} .....-55°C to +150°C

E_{AS} Avalanche Energy ..... 84.5 mJ

I_D = 13A, L = 1 mH, R_G = 25Ω

† **Notice:** Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Static Characteristics						
Drain-to-Source Breakdown Voltage	BV_{DSS}	25	—	—	V	V_{GS} = 0V, I_D = 250 µA
Drain-to-Source Leakage Current	I_{DSS}	—	—	1	µA	V_{GS} = 0V, V_{DS} = 20V
Gate-to-Source Leakage Current	I_{GSS}	—	—	100	nA	V_{DS} = 0V, V_{GS} = 10V/-8V
Gate-to-Source Threshold Voltage	$V_{GS(TH)}$	1.1	1.35	1.7	V	V_{DS} = V_{GS}, I_D = 250 µA
Drain-to-Source On Resistance	$R_{DS(ON)}$	—	10	12	mΩ	V_{GS} = 4.5V, I_D = 17A
		—	8.5	10.5	mΩ	V_{GS} = 10V, I_D = 17A
Transconductance	g_{fs}	—	62	—	S	V_{DS} = 12.5V, I_D = 17A
Dynamic Characteristics						
Input Capacitance	C_{ISS}	—	580	—	pF	V_{GS} = 0V, V_{DS} = 12.5V, f = 1 MHz
Output Capacitance	C_{OSS}	—	265	—	pF	V_{GS} = 0V, V_{DS} = 12.5V, f = 1 MHz
Reverse Transfer Capacitance	C_{RSS}	—	70	—	pF	V_{GS} = 0V, V_{DS} = 12.5V, f = 1 MHz
Total Gate Charge	Q_G	—	7.5	10	nC	V_{DS} = 12.5V, I_D = 17A, V_{GS} = 4.5V
Gate-to-Drain Charge	Q_{GD}	—	2.8	—	nC	V_{DS} = 12.5V, I_D = 17A
Gate-to-Source Charge	Q_{GS}	—	1.2	—	nC	V_{DS} = 12.5V, I_D = 17A
Gate Charge at $V_{GS(TH)}$	$Q_{G(TH)}$	—	0.8	—	nC	V_{DS} = 12.5V, I_D = 17A
Output Charge	Q_{OSS}	—	5	—	nC	V_{DS} = 12.5V, V_{GS} = 0
Turn-On Delay Time	$t_{d(on)}$	—	2.5	—	ns	V_{DS} = 12.5V, V_{GS} = 4.5V, I_D = 17A, R_G = 2Ω
Rise Time	t_r	—	9.3	—	ns	V_{DS} = 12.5V, V_{GS} = 4.5V, I_D = 17A, R_G = 2Ω
Turn-Off Delay Time	$t_{d(off)}$	—	5.3	—	ns	V_{DS} = 12.5V, V_{GS} = 4.5V, I_D = 17A, R_G = 2Ω
Fall Time	t_f	—	2.9	—	ns	V_{DS} = 12.5V, V_{GS} = 4.5V, I_D = 17A, R_G = 2Ω
Series Gate Resistance	R_G	—	1.8	—	Ω	
Diode Characteristics						
Diode Forward Voltage	V_{FD}	—	0.8	1	V	I_S = 17A, V_{GS} = 0V
Reverse Recovery Charge	Q_{RR}	—	11	—	nC	I_S = 17A, di/dt = 300 A/µs
Reverse Recovery Time	t_{rr}	—	11.5	—	nS	I_S = 17A, di/dt = 300 A/µs

DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C.						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Avalanche Characteristics						
Avalanche Energy	E_{AS}	18	—	—	mJ	I_D = 6A, L = 1 mH, R_G = 25Ω

TEMPERATURE CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Temperature Ranges						
Operating Junction Temperature Range	T_J	-55	—	+150	°C	
Storage Temperature Range	T_A	-55	—	+150	°C	
Package Thermal Resistances						
Thermal Resistance Junction-to-X, 8L 3.3x3.3-PDFN	$R_{\theta JX}$	—	—	70	°C/W	**Note 1**
Thermal Resistance Junction-to-Case, 8L 3.3x3.3-PDFN	$R_{\theta JC}$	—	—	3.3	°C/W	**Note 2**
Thermal Resistance Junction-to-X, 8L 5x6-PDFN	$R_{\theta JX}$	—	—	55	°C/W	**Note 1**
Thermal Resistance Junction-to-Case, 8L 5x6-PDFN	$R_{\theta JC}$	—	—	3.2	°C/W	**Note 2**

Note 1: $R_{\theta JX}$ is determined with the device surface mounted on a 4-Layer FR4 PCB, with a 1” x 1” mounting pad of 2 oz. copper. This characteristic is dependent on user’s board design.

2: $R_{\theta JC}$ is determined using JEDEC 51-14 Method. This characteristic is determined by design.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

Note: Unless otherwise indicated, T_A = +25°C.

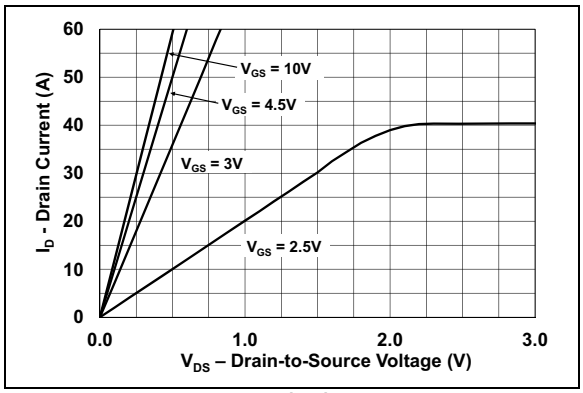


FIGURE 2-1: *Typical Output Characteristics.*

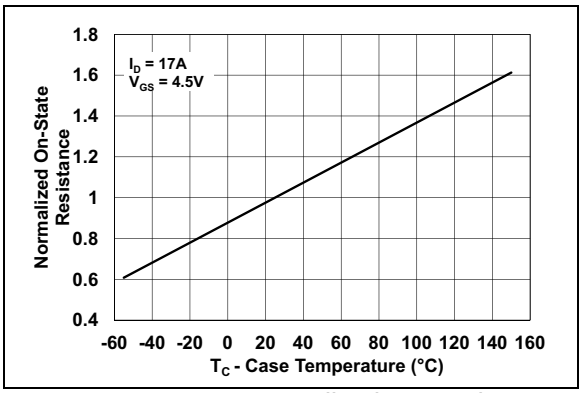


FIGURE 2-4: *Normalized On Resistance vs. Temperature.*

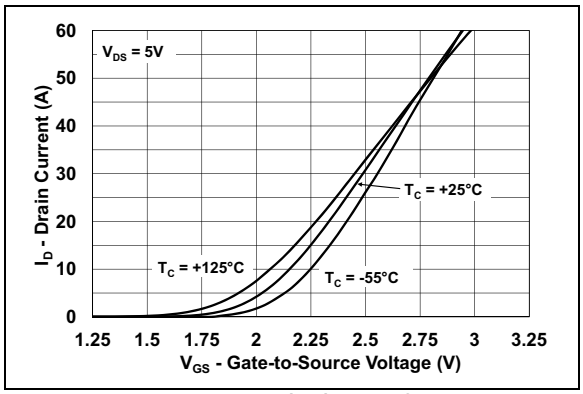


FIGURE 2-2: *Typical Transfer Characteristics.*

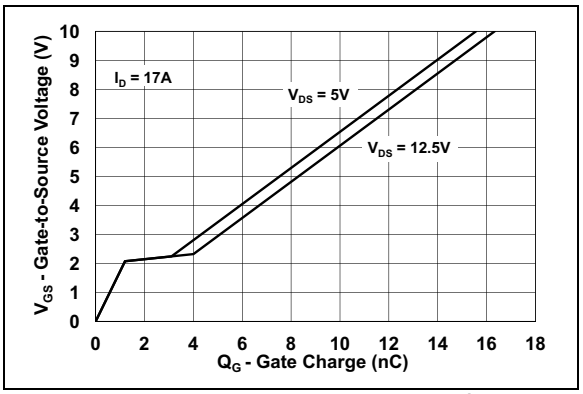


FIGURE 2-5: *Gate-to-Source Voltage vs. Gate Charge.*

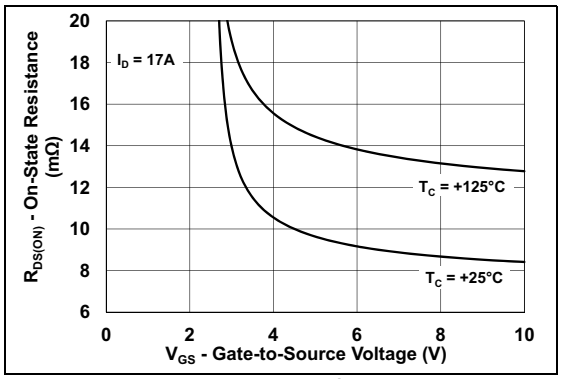


FIGURE 2-3: *On Resistance vs. Gate-to-Source Voltage.*

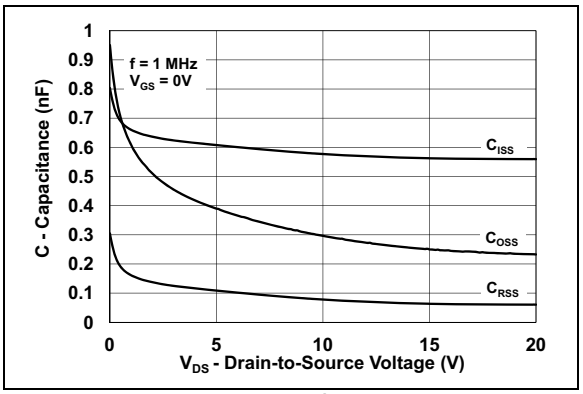


FIGURE 2-6: *Capacitance vs. Drain-to-Source Voltage.*

Note: Unless otherwise indicated, T_A = +25°C.

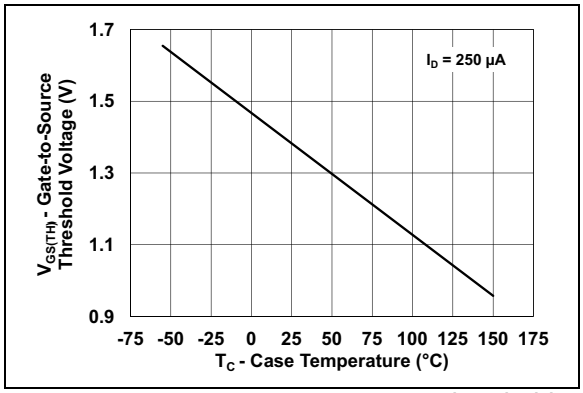


FIGURE 2-7: *Gate-to-Source Threshold Voltage vs. Temperature.*

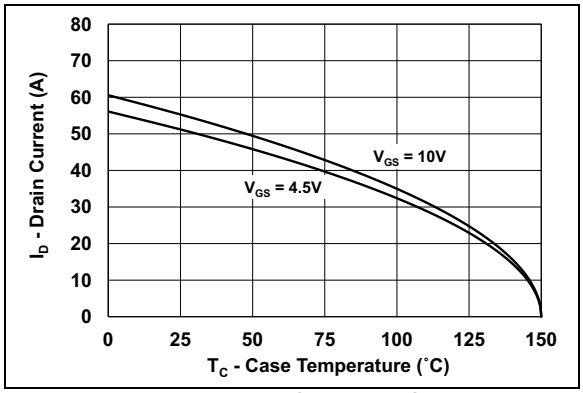


FIGURE 2-10: *Maximum Drain Current vs. Temperature 5x6-PDFN (MCP87090T-U/MF).*

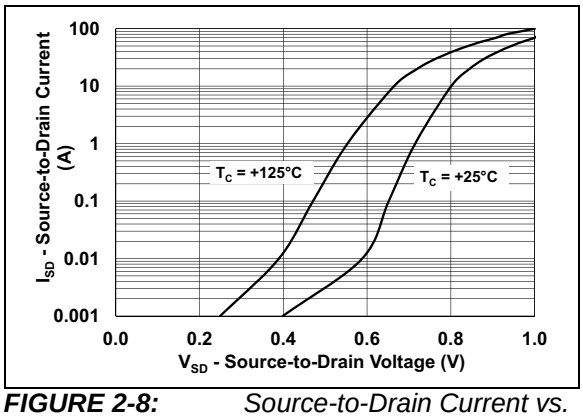


FIGURE 2-8: *Source-to-Drain Current vs. Source-to-Drain Voltage.*

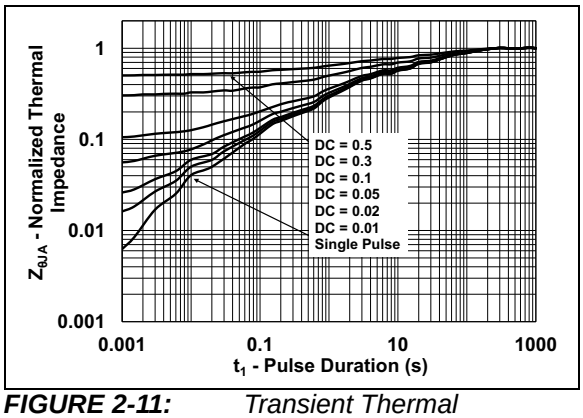


FIGURE 2-11: *Transient Thermal Impedance 5x6-PDFN (MCP87090T-U/MF).*

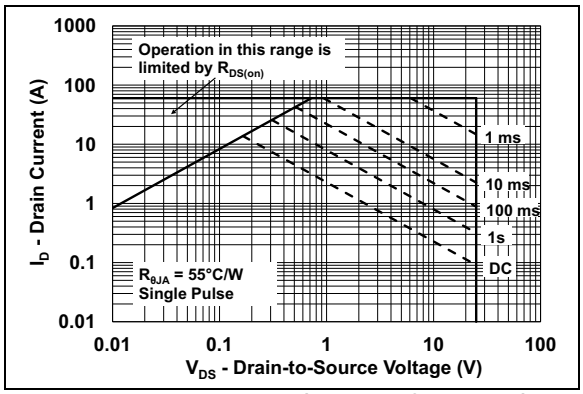


FIGURE 2-9: *Maximum Safe Operating Area 5x6-PDFN (MCP87090T-U/MF).*

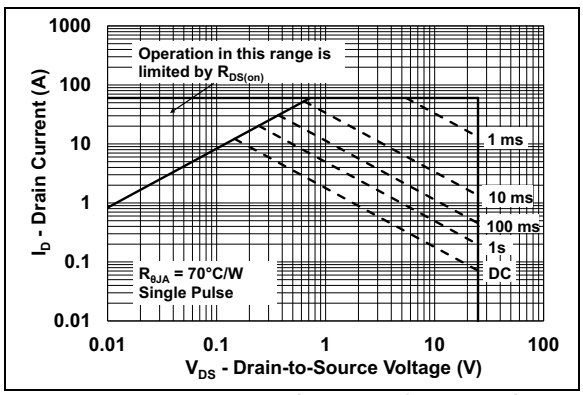


FIGURE 2-12: *Maximum Safe Operating Area 3.3x3.3-PDFN (MCP87090T-U/LC).*

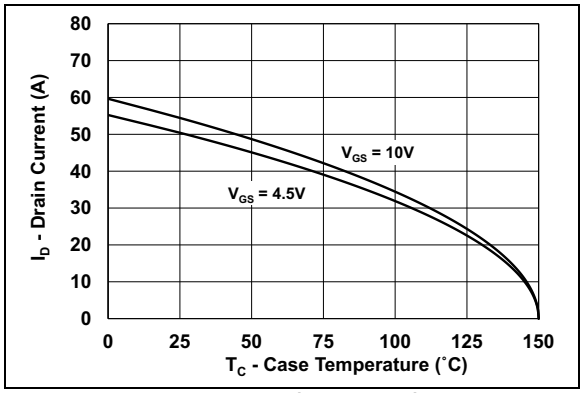


FIGURE 2-13: *Maximum Drain Current vs. Temperature 3.3x3.3-PDFN (MCP87090T-U/LC).*

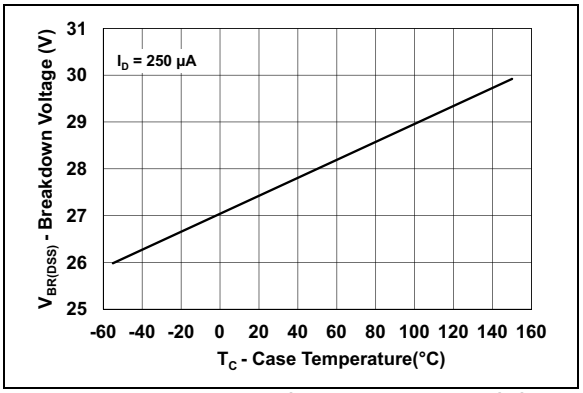


FIGURE 2-16: *Drain-to-Source Breakdown Voltage vs. Temperature.*

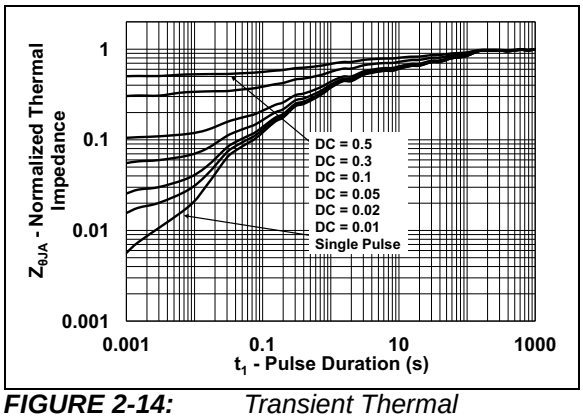


FIGURE 2-14: *Transient Thermal Impedance 3.3x3.3-PDFN (MCP87090T-U/LC).*

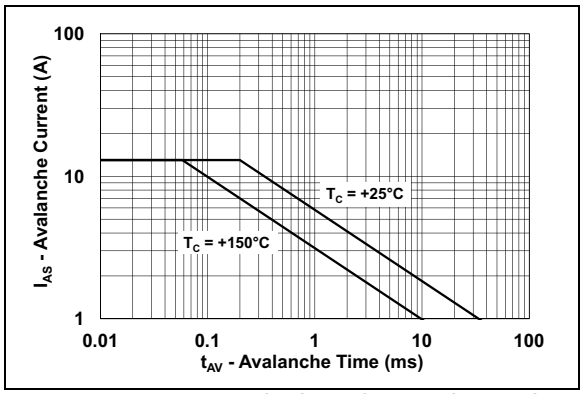


FIGURE 2-15: *Single-Pulse Unclamped Inductive Switching.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

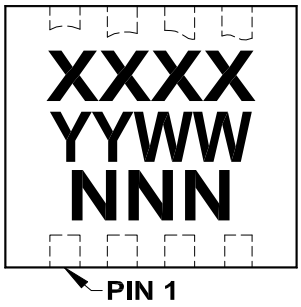
TABLE 3-1: PINOUT DESCRIPTION FOR THE MCP87090

MCP87090 5x6 PDFN, 3.3 x 3.3 PDFN	Pin Type	Function
1, 2, 3	S	Source pin
4	G	Gate pin
5, 6, 7, 8	D	Drain pin, including exposed thermal pad

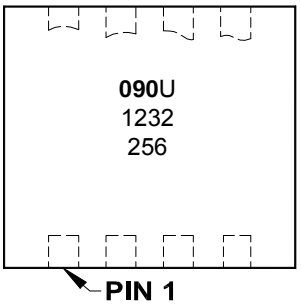
4.0 PACKAGING INFORMATION

4.1 Package Marking Information*

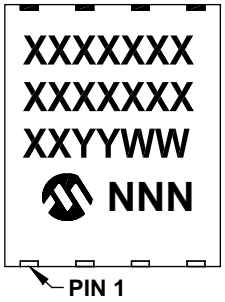
8-Lead PDFN (3.3x3.3x1.0 mm)



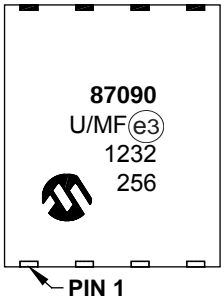
Example



8-Lead PDFN (5x6x1.0 mm)



Example



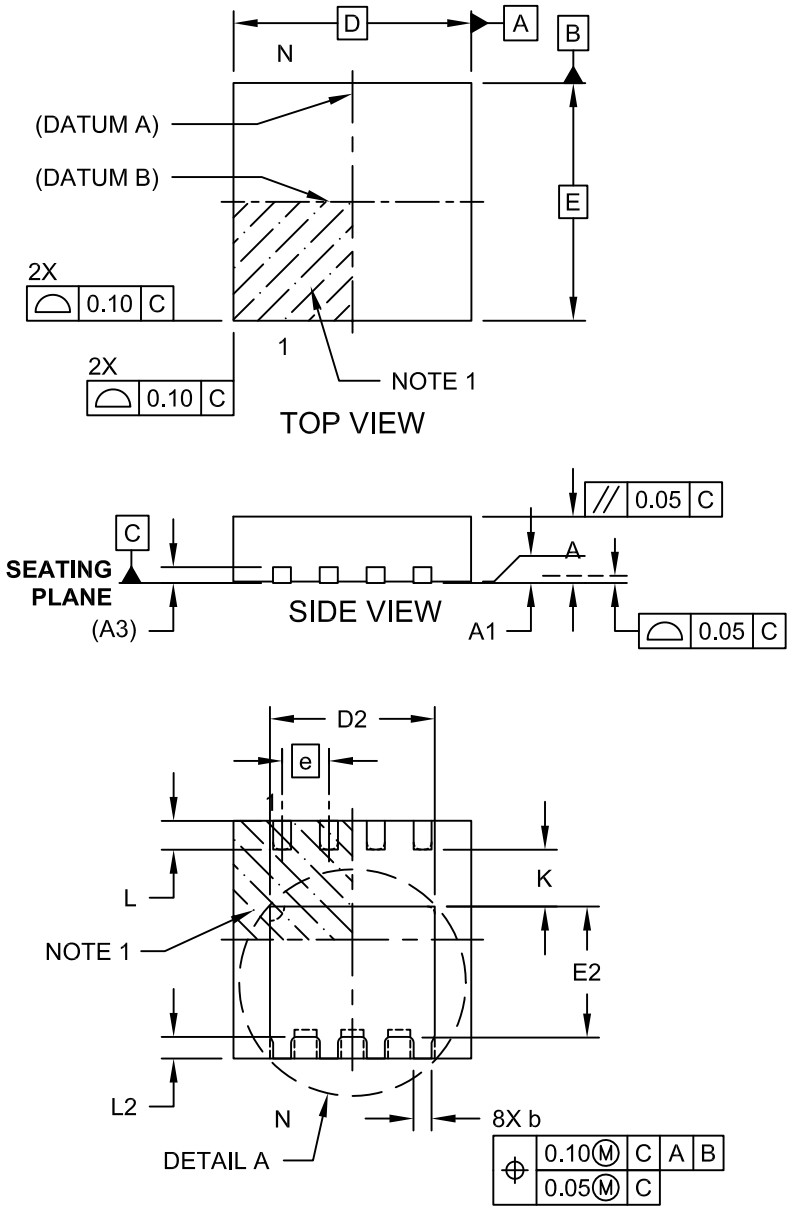
*RoHS compliant using EU-RoHS exemption: 7(a) - Lead in high-melting-temperature-type solders (i.e. lead-based alloys containing 85% by weight or more lead) can be found on the outer packaging for this package.

Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

8-Lead Power Dual Flatpack No Lead Package (LC) – 3.3x3.3x1.0 mm Body [PDFN]

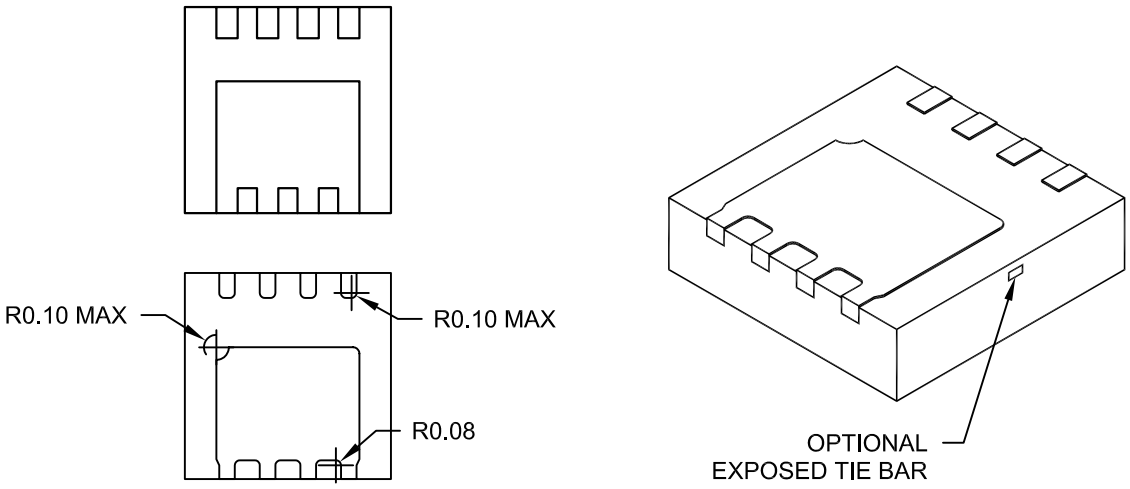
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-195A Sheet 1 of 2

8-Lead Power Dual Flatpack No Lead Package (LC) – 3.3x3.3x1.0 mm Body [PDFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



DETAIL A
ALTERNATE EXPOSED PAD CONFIGURATIONS

	Units	MILLIMETERS		
Dimension	Limits	MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.65 BSC	
Overall Height	A	0.80	1.00	1.03
Standoff	A1	0.00	-	0.05
Terminal Thickness	(A3)		0.20 REF	
Overall Length	D		3.30 BSC	
Overall Width	E		3.30 BSC	
Exposed Pad length	D2	2.14	2.29	2.39
Exposed Pad Width	E2	1.66	1.81	1.91
Terminal Width	b	0.25	0.30	0.35
Terminal Length	L	0.30	0.40	0.50
Terminal Length	L2	0.30	-	0.40
Terminal to Exposed Pad	K	0.60	-	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package may have one or more exposed tie bars.
3. Package is saw singulated.
4. Package dimension does not include mold flash, protrusions, burrs or metal smearing.
5. Dimensioning and tolerancing per ASME Y14.5M.

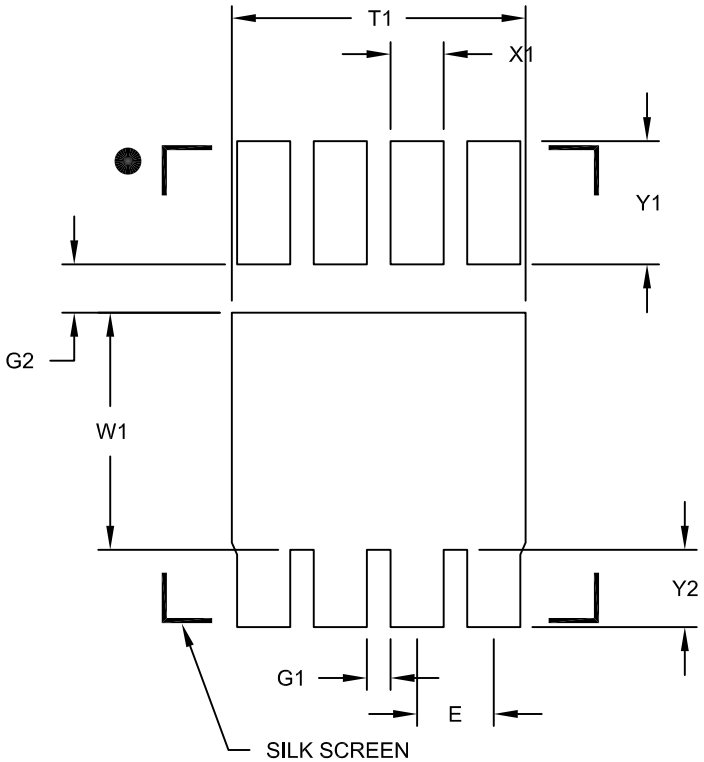
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-195A Sheet 2 of 2

8-Lead Power Dual Flatpack No Lead Package (LC) – 3.3x3.3x1.0 mm Body [PDFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Center Pad Width	W1			2.01
Center Pad Length	T1			2.49
Distance Between Terminals	G1	0.20		
Terminal Edge to Center Pad	G2	0.41		
Terminal Pad Width (X8)	X1			0.45
Terminal Pad Length (X4)	Y1			1.05
Terminal Pad Length (X8)	Y2			0.66

Notes:

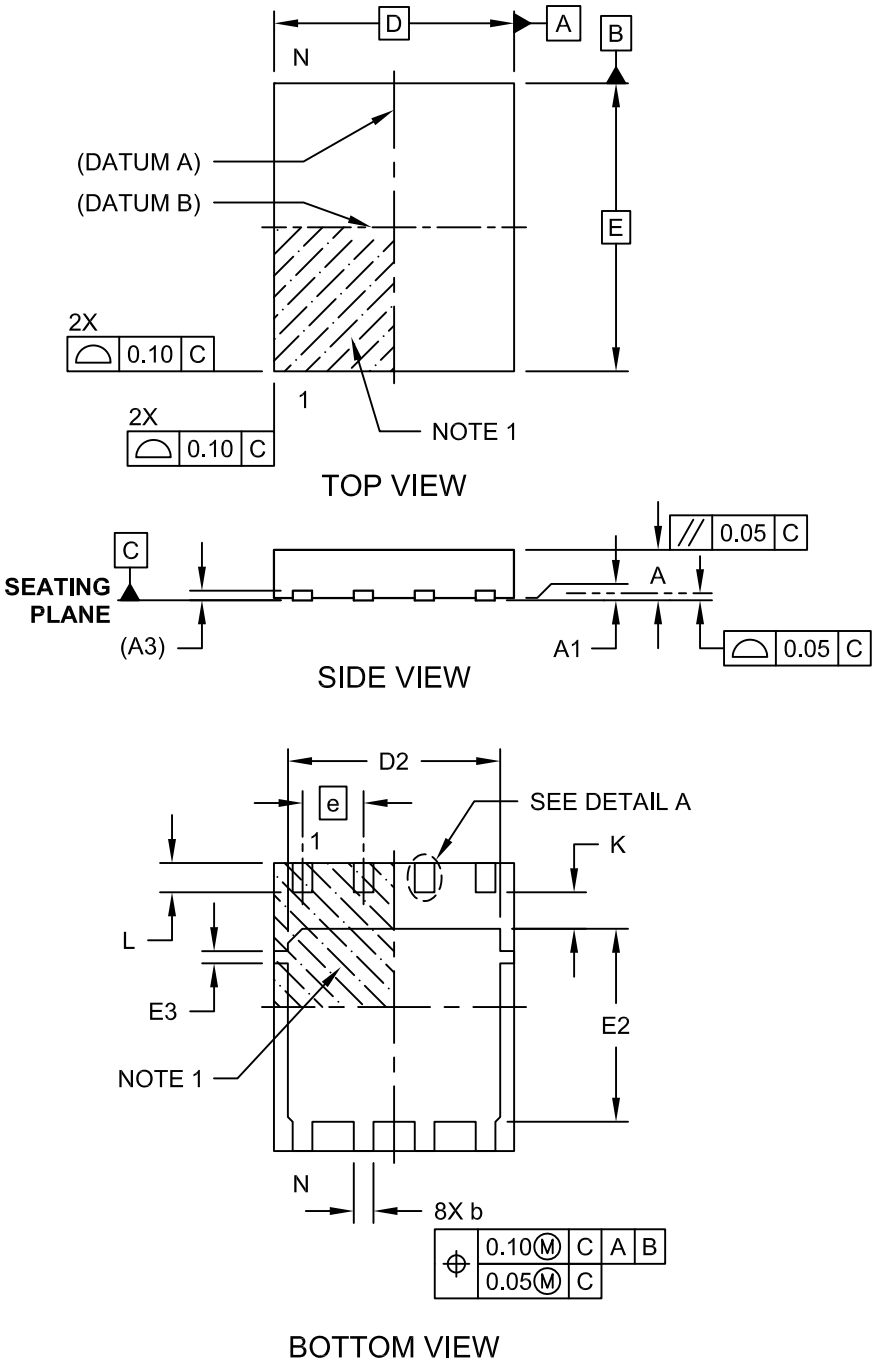
1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2195A

8-Lead Power Dual Flatpack No Lead Package (MF) – 5x6x1.0 mm Body [PDFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



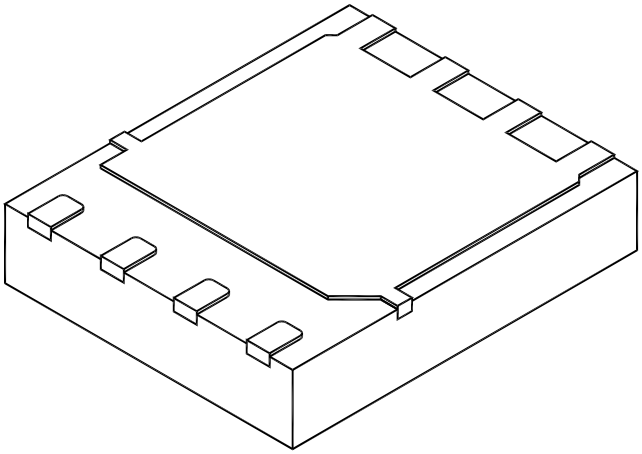
Microchip Technology Drawing C04-188B Sheet 1 of 2

8-Lead Power Dual Flatpack No Lead Package (MF) – 5x6x1.0 mm Body [PDFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

DETAIL A

ALTERNATE
CONTACT
SHAPES



	Units	MILLIMETERS		
Dimension	Limits	MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	0.80	1.00	1.03
Standoff	A1	0.00	-	0.05
Terminal Thickness	(A3)		0.20 REF	
Overall Length	D		5.00 BSC	
Overall Width	E		6.00 BSC	
Exposed Pad length	D2	4.27	4.42	4.52
Exposed Pad Width	E2	3.87	4.02	4.12
Tab Width	E3	0.20	0.25	0.30
Terminal Width	b	0.36	0.41	0.46
Terminal Length	L	0.51	0.61	0.71
Terminal to Exposed Pad	K	0.71	0.76	0.81

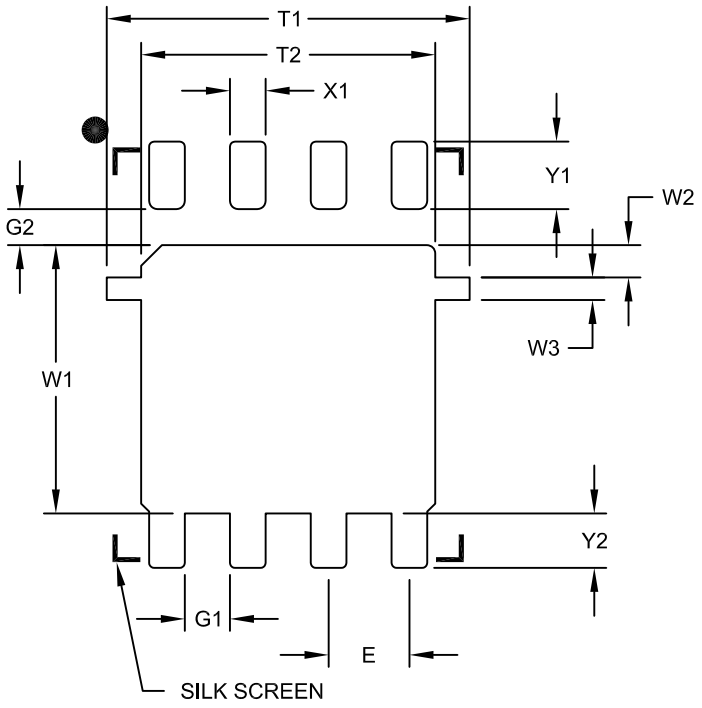
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated.
3. Package dimension does not include mold flash, protrusions, burrs or metal smearing.
4. Dimensioning and tolerancing per ASME Y14.5M.
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-188B Sheet 2 of 2

8-Lead Power Dual Flatpack No Lead Package (MF) – 5x6x1.0 mm Body [PDFN]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Center Pad Width	W1			4.22
Pad Edge to Tab	W2		0.51	
Tab Width	W3		0.35	
Center Pad Length With Tabs	T1			5.70
Center Pad Length	T2			4.62
Distance Between Terminals	G1	0.71		
Terminal To Center Pad (X4)	G2	0.57		
Terminal Pad Width (X8)	X1			0.56
Terminal Pad Length (X4)	Y1			1.06
Terminal Pad Length (X8)	Y2			0.86

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2188A

APPENDIX A: REVISION HISTORY

Revision B (August 2013)

The following is the list of modifications.

1. Updated the Thermal Resistances maximum values in the Temperature Characteristics table.
2. Added Figure 2-9, Figure 2-10, Figure 2-11, Figure 2-12, Figure 2-13 and Figure 2-14.

Revision A (January 2013)

- Original Release of this Document.

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X	/XX
Device	Temperature Range	Package

Device: MCP87090T: N-Channel power MOSFET (Tape and Reel)

Temperature Range: U = -55°C to +150°C (Ultra High)

Package: LC = High-Power Dual Flatpack, No Lead Package (3.3x3.3x1.0 mm Body) (PDFN), 8-lead
MF = High-Power Dual Flatpack, No Lead Package (5x6x1.0 mm Body) (PDFN), 8-lead

Example:

a) MCP87090T-U/LC: Tape and Reel, Ultra-High Temperature, 8LD 3.3x3.3 PDFN package

b) MCP87090T-U/MF: Tape and Reel, Ultra-High Temperature, 8LD 5x6 PDFN package

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