

# MT4946

## N-Ch PowerTrench<sup>®</sup> MOSFET 60V, 5A, 38mΩ

### General Description

This N-Channel MOSFET has been designed specifically to improve the overall efficiency of DC/DC converters using either synchronous or conventional switching PWM controllers. It has been optimized for low gate charge, low  $R_{DS(ON)}$  and fast switching speed.

### Features

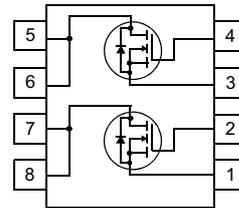
- Max  $R_{DS(on)} = 38m\Omega @ V_{GS} = 10V, I_D = 5A$
- Max  $R_{DS(on)} = 42m\Omega @ V_{GS} = 4.5V, I_D = 4A$
- Low gate charge
- 100%  $R_G$  (Gate Resistance) Tested
- RoHS Compliant



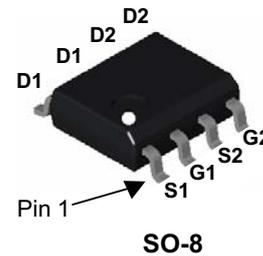
**MT Semiconductor<sup>®</sup>**

<http://www.mtsemi.com>

### Simplified Schematic



### MARKING DIAGRAM & PIN ASSIGNMENT



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

Symbol	Parameter	Ratings	Units
$V_{DS}$	Drain to Source Voltage	60	V
$V_{GS}$	Gate to Source Voltage	$\pm 20$	V
$I_D$	Drain Current Continuous (Note 1a)	5	A
	Pulsed	20	A
$E_{AS}$	Single Pulse Avalanche Energy (Note 2)	32	mJ
$P_D$	Power Dissipation for Single Operation	2	W
	Derate above $25^\circ\text{C}$	13	mW/ $^\circ\text{C}$
$T_J, T_{STG}$	Operating and Storage Temperature	-55 to 150	$^\circ\text{C}$

### Thermal Characteristics

$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	65	$^\circ\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	40	$^\circ\text{C/W}$

### Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
MT4946	MT4946	SO-8	330mm	12mm	2500 units

**Electrical Characteristics**  $T_J = 25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
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**Off Characteristics**

$BV_{DSS}$	Drain to Source Breakdown Voltage	$I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$	60			V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250\mu\text{A}$ , referenced to $25^\circ\text{C}$		23		$\text{mV}/^\circ\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 48\text{V}$ $V_{GS} = 0\text{V}$ $T_J = 125^\circ\text{C}$			1 250	$\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 20\text{V}, V_{DS} = 0\text{V}$			$\pm 100$	nA

**On Characteristics (Note 3)**

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$	1.0	1.5	2.0	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = 250\mu\text{A}$ , referenced to $25^\circ\text{C}$		- 4.3		$\text{mV}/^\circ\text{C}$
$r_{DS(on)}$	Drain to Source On Resistance	$V_{GS} = 10\text{V}, I_D = 5\text{A}$		38	40	m $\Omega$
		$V_{GS} = 4.5\text{V}, I_D = 4\text{A}$		42	45	
		$V_{GS} = 10\text{V}, I_D = 5\text{A}, T_J = 125^\circ\text{C}$		39	42	

**Dynamic Characteristics**

$C_{iss}$	Input Capacitance	$V_{DS} = 60\text{V}, V_{GS} = 0\text{V}, f = 1.0\text{MHz}$		475	970	pF
$C_{oss}$	Output Capacitance			50	70	pF
$C_{rss}$	Reverse Transfer Capacitance			35	45	pF
$R_G$	Gate Resistance	$f = 1\text{MHz}$		0.9	1.6	$\Omega$

**Switching Characteristics (Note 3)**

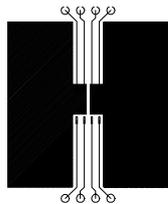
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 60\text{V}, I_D = 5\text{A}$ $V_{GS} = 10\text{V}, R_{GS} = 33\Omega$		5	10	ns
$t_r$	Rise Time			9	18	ns
$t_{d(off)}$	Turn-Off Delay Time			42	68	ns
$t_f$	Fall Time			21	34	ns
$Q_g$	Total Gate Charge	$V_{DS} = 60\text{V}, V_{GS} = 10\text{V}, I_D = 5\text{A}$		9.2	13	nC
$Q_g$	Total Gate Charge	$V_{DS} = 60\text{V}, V_{GS} = 5\text{V}, I_D = 5\text{A}$		5.0	7	nC
$Q_{gs}$	Gate to Source Gate Charge			1.5		nC
$Q_{gd}$	Gate to Drain "Miller" Charge			2.0		nC

**Drain-Source Diode Characteristics**

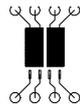
$V_{SD}$	Source to Drain Diode Voltage	$I_{SD} = 5\text{A}$ (Note 4)		0.9	1.25	V
		$I_{SD} = 2.1\text{A}$		0.8	1.0	V
$t_{rr}$	Diode Reverse Recovery Time	$I_F = 5\text{A}, di/dt = 100\text{A}/\mu\text{s}$			33	ns
$Q_{rr}$	Diode Reverse Recovery Charge				20	nC

**Notes:**

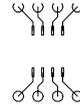
1:  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



a)  $78^\circ\text{C}/\text{W}$  when mounted on a  $0.5\text{in}^2$  pad of 2 oz copper



b)  $125^\circ\text{C}/\text{W}$  when mounted on a  $0.02\text{in}^2$  pad of oz copper



c)  $135^\circ\text{C}/\text{W}$  when mounted on a minimum pad

Scale 1 : 1 on letter size paper

2: Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1\text{mH}$ ,  $I_{AS} = 8\text{A}$ ,  $V_{DD} = 27\text{V}$ ,  $V_{GS} = 10\text{V}$ .

3: Pulse Test: Pulse Width  $< 300\mu\text{s}$ , Duty Cycle  $< 2\%$ .

4: Is Continuous Source Current (Body Diode)  $> 5\text{A}$ . Ism : Pulsed Source Current (Body Diode)  $> 15\text{A}$

**Typical Characteristics**  $T_J = 25^\circ\text{C}$  unless otherwise noted

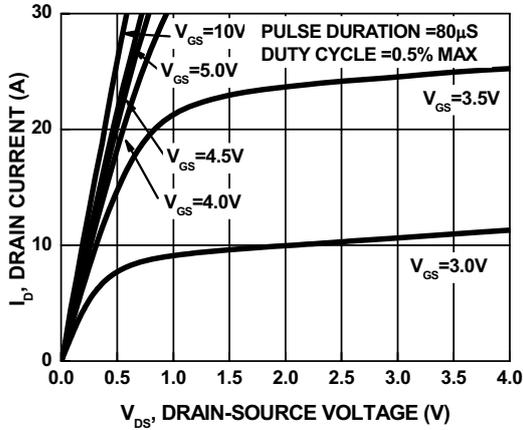


Figure 1. On Region Characteristics

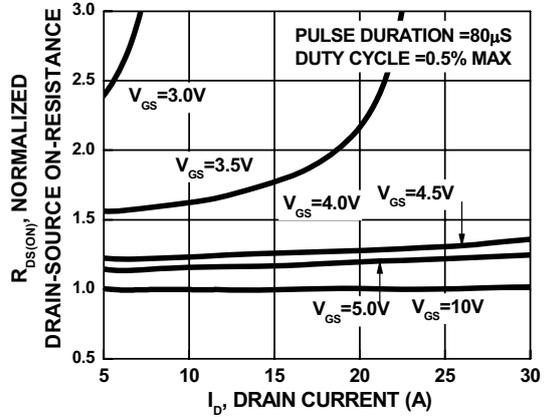


Figure 2. On-Resistance vs Drain Current and Gate Voltage

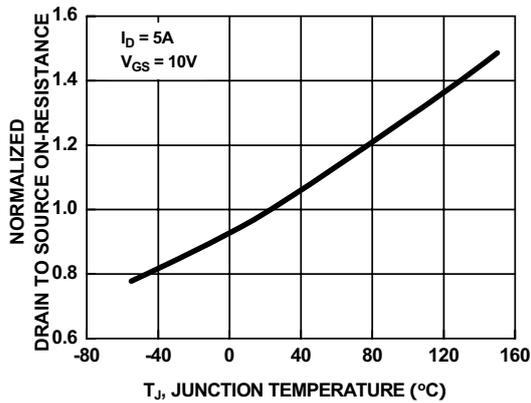


Figure 3. On Resistance vs Temperature

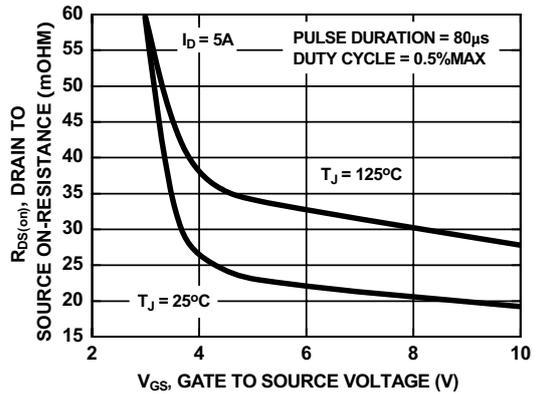


Figure 4. On-Resistance vs Gate to Source Voltage

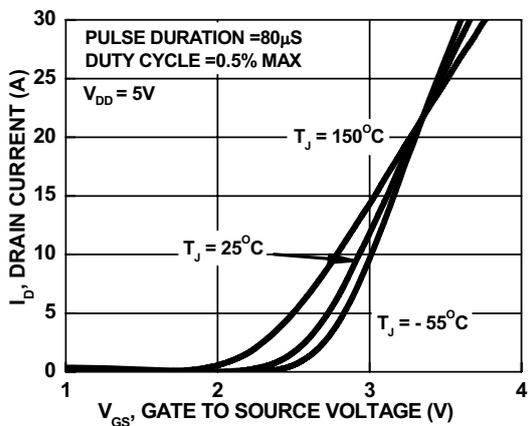


Figure 5. Transfer Characteristics

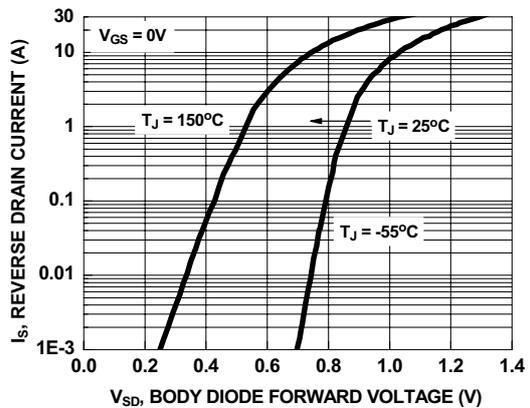


Figure 6. Source to Drain Diode Forward Voltage vs Source Current

**Typical Characteristics**  $T_J = 25^\circ\text{C}$  unless otherwise noted

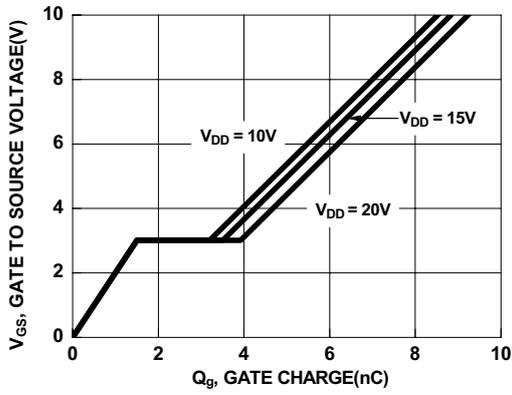


Figure 7. Gate Charge Characteristics

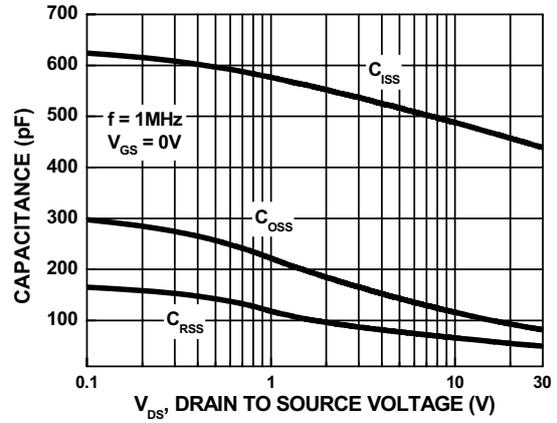


Figure 8. Capacitance vs Drain to Source Voltage

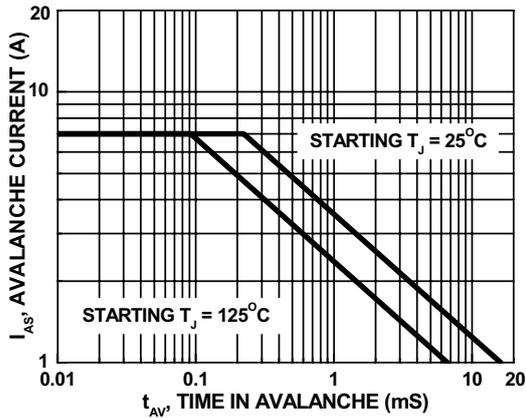


Figure 9. Unclamped Inductive Switching Capability

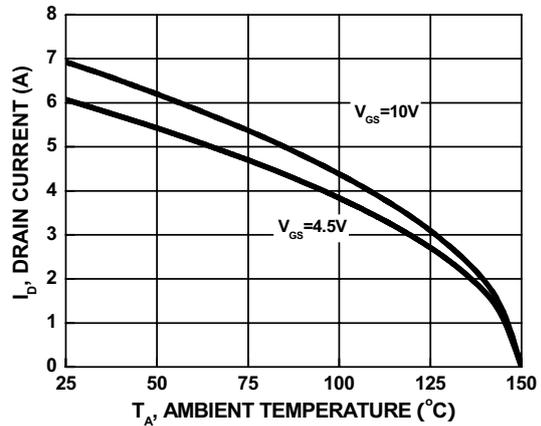


Figure 10. Maximum Continuous Drain Current vs Ambient Temperature

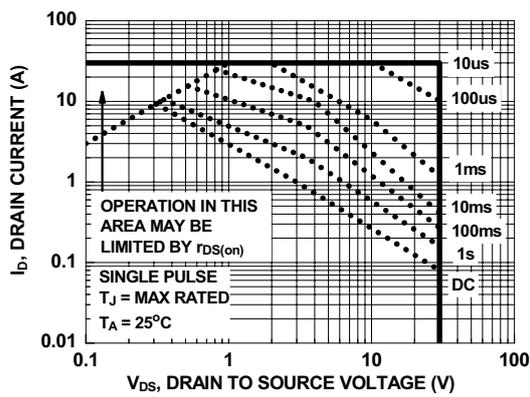


Figure 11. Forward Bias Safe Operating Area

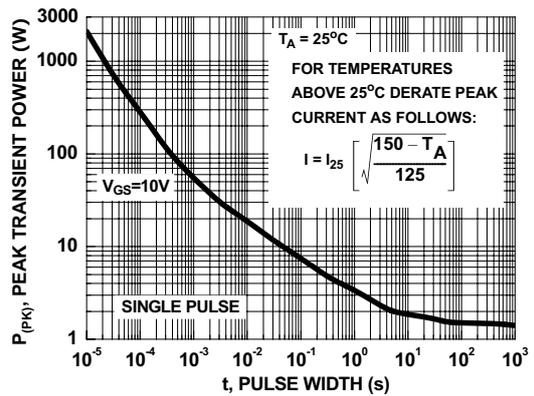
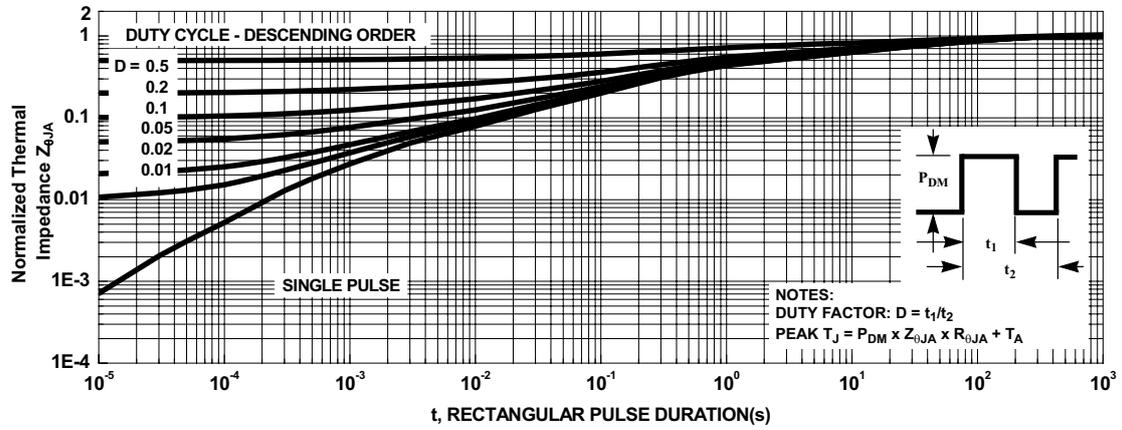


Figure 12. Single Pulse Maximum Power Dissipation

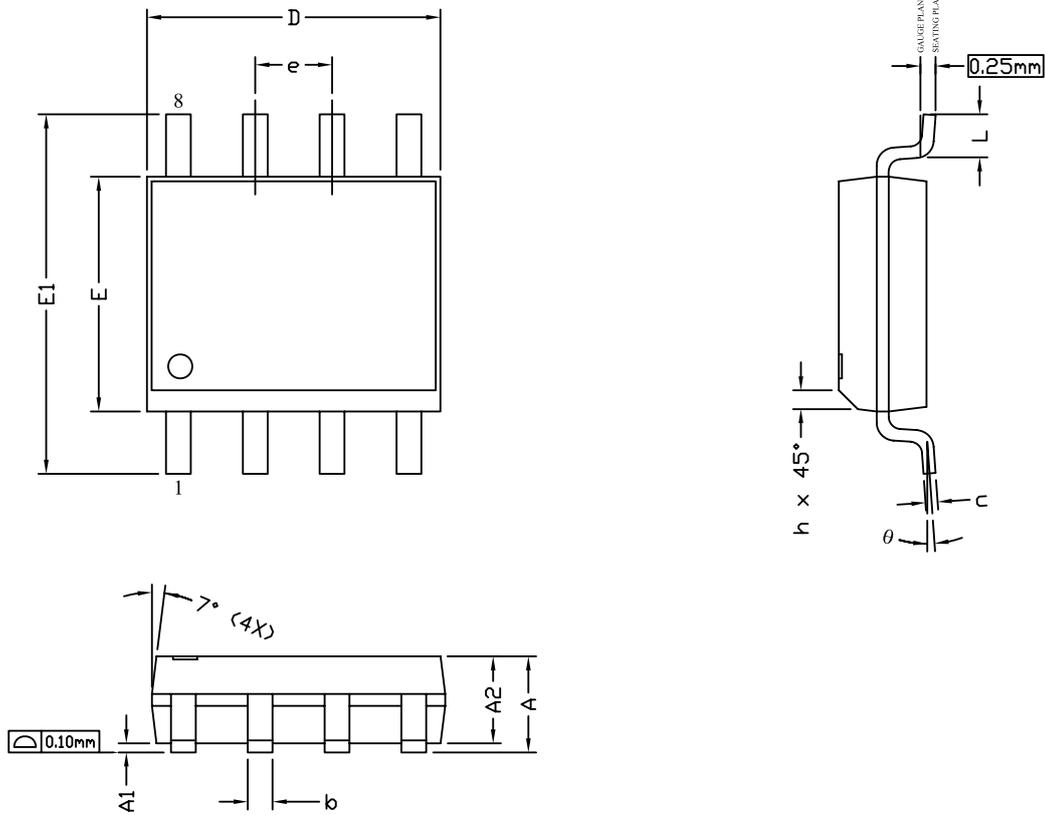
**Typical Characteristics**  $T_J = 25^\circ\text{C}$  unless otherwise noted



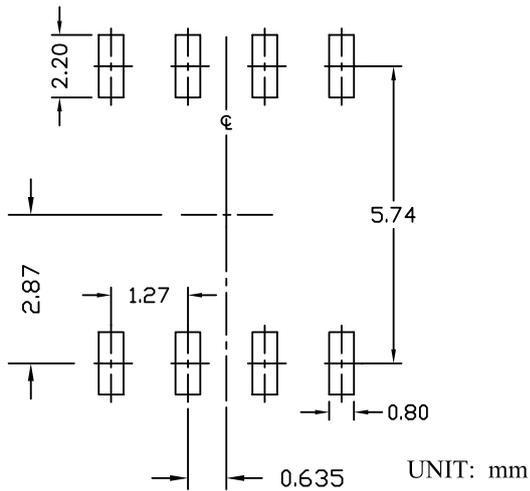
**Figure 13. Transient Thermal Response Curve**

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Version	rev H

S08 PACKAGE OUTLINE



RECOMMENDED LAND PATTERN



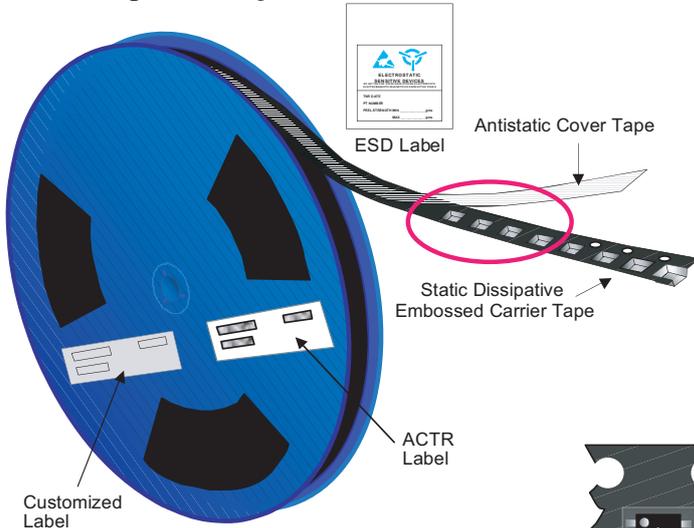
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.65	1.75	0.053	0.065	0.069
A1	0.10	---	0.25	0.004	---	0.010
A2	1.25	1.50	1.65	0.049	0.059	0.065
b	0.31	---	0.51	0.012	---	0.020
c	0.17	---	0.25	0.007	---	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	3.80	3.90	4.00	0.150	0.154	0.157
e	1.27 BSC			0.050 BSC		
E1	5.80	6.00	6.20	0.228	0.236	0.244
h	0.25	---	0.50	0.010	---	0.020
L	0.40	---	1.27	0.016	---	0.050
theta	0°	---	8°	0°	---	8°

NOTE

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS.  
MOLD FLASH AT THE NON-LEAD SIDES SHOULD BE LESS THAN 6 MILS EACH.
4. DIMENSION L IS MEASURED IN GAUGE PLANE.
5. CONTROLLING DIMENSION IS MILLIMETER.  
CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

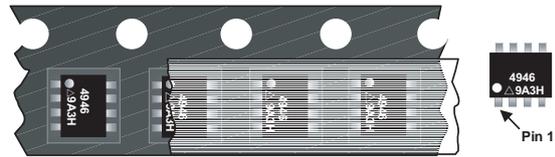
## SOIC-8 Tape and Reel Data

### SOIC(8lds) Packaging Configuration: Figure 1.0



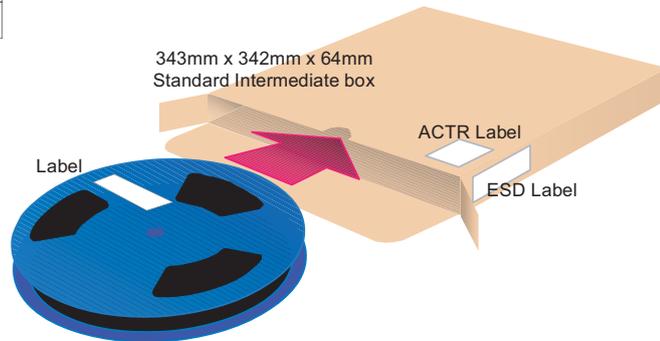
**Packaging Description:**  
 SOIC-8 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 2,500 units per 13" or 330cm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). Other option comes in 500 units per 7" or 177cm diameter reel. This and some other options are further described in the Packaging Information table.  
 These full reels are individually bar code labeled and placed inside a standard intermediate box (illustrated in figure 1.0) made of recyclable corrugated brown paper. One box contains two reels maximum. And these boxes are placed inside a barcode labeled shipping box which comes in different sizes depending on the number of parts shipped.

SOIC (8lds) Packaging Information				
Packaging Option	Standard (no flow code)	L86Z	F011	D84Z
Packaging type	ACTR	Rail/Tube	TNR	TNR
Qty per Reel/Tube/Bag	2,500	95	4,000	500
Reel Size	13" Dia	-	13" Dia	7" Dia
Box Dimension (mm)	343x64x343	530x130x83	343x64x343	184x187x47
Max qty per Box	5,000	30,000	8,000	1,000
Weight per unit (gm)	0.0774	0.0774	0.0774	0.0774
Weight per Reel (kg)	0.6060	-	0.9696	0.1182
Note/Comments				

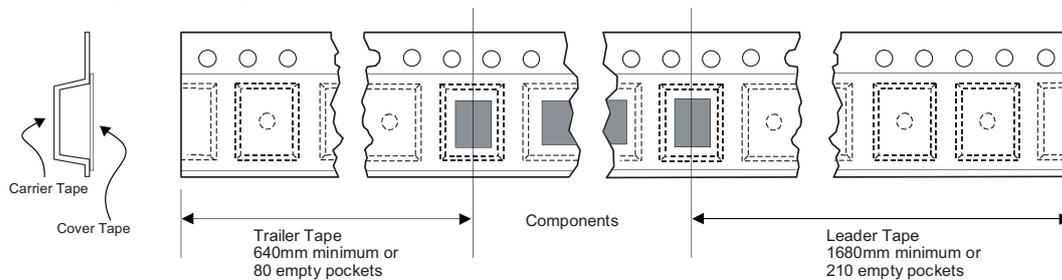


SOIC-8 Unit Orientation

### MT4946ACTR Label sample



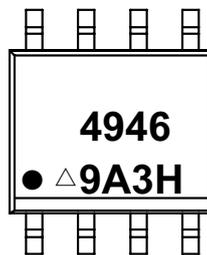
### SOIC(8lds) Tape Leader and Trailer Configuration: Figure 2.0



## Part Marking Information

### SO-8 (PMG Code )

SO-8 Devices



- 4946 = Example Base Part Number
- = Pin 1 Indicator
  - △ = ESD Symbol (⚡)
  - 9 = Year Code
  - A = Month Code
  - 3 = Week Code
  - H = Assembly Factory Code

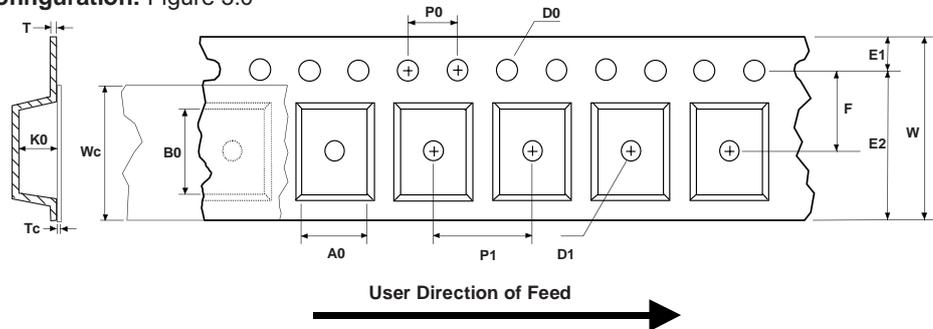
**NOTE:**

1. For analog switches base part includes DG prefix. Package suffix may or may not be present, depending on room available.

The current marking strategy is reflected. Contact your local sales representative for historical marking strategies for these packages.

**SOIC-8 Tape and Reel Data, continued**

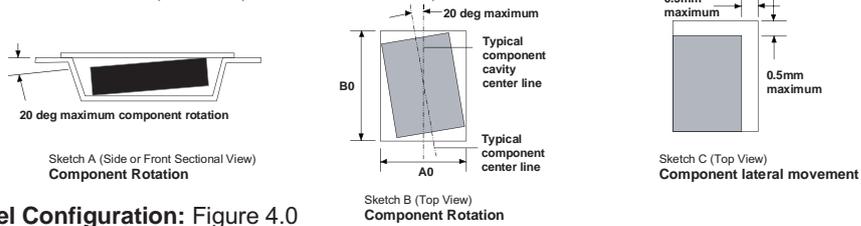
**SOIC(8lds) Embossed Carrier Tape Configuration: Figure 3.0**



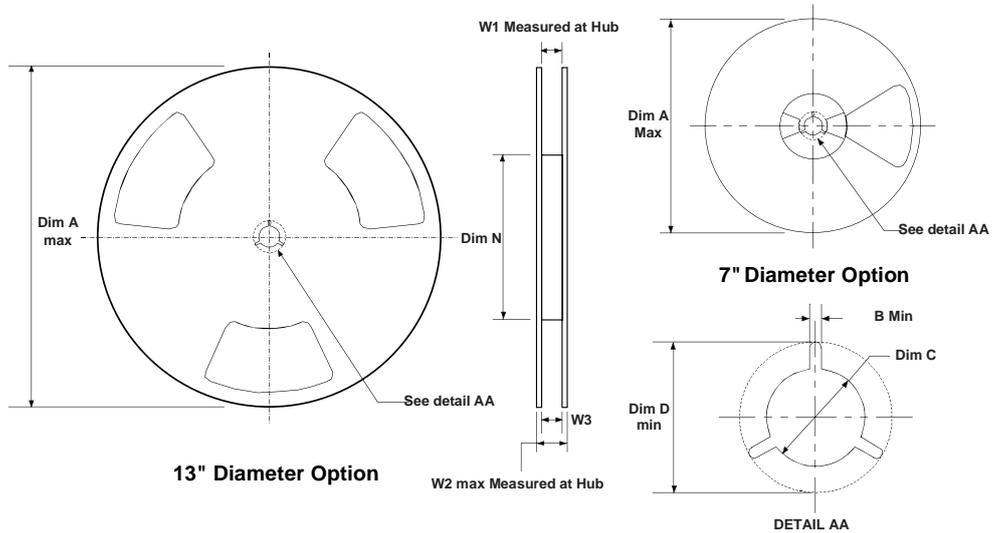
Dimensions are in millimeter

Pkg type	A0	B0	W	D0	D1	E1	E2	F	P1	P0	K0	T	Wc	Tc
SOIC(8lds) (12mm)	6.50 +/-0.10	5.30 +/-0.10	12.0 +/-0.3	1.55 +/-0.05	1.60 +/-0.10	1.75 +/-0.10	10.25 min	5.50 +/-0.05	8.0 +/-0.1	4.0 +/-0.1	2.1 +/-0.10	0.450 +/- 0.150	9.2 +/-0.3	0.06 +/-0.02

Notes: A0, B0, and K0 dimensions are determined with respect to the EIA/Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).



**SOIC(8lds) Reel Configuration: Figure 4.0**



Dimensions are in inches and millimeters

Tape Size	Reel Option	Dim A	Dim B	Dim C	Dim D	Dim N	Dim W1	Dim W2	Dim W3 (LSL-USL)
12mm	7" Dia	7.00 177.8	0.059 1.5	512+0.020/-0.008 13+0.5/-0.2	0.795 20.2	2.165 55	0.488+0.078/-0.000 12.4+2/0	0.724 18.4	0.469 - 0.606 11.9 - 15.4
12mm	13" Dia	13.00 330	0.059 1.5	512+0.020/-0.008 13+0.5/-0.2	0.795 20.2	7.00 178	0.488+0.078/-0.000 12.4+2/0	0.724 18.4	0.469 - 0.606 11.9 - 15.4

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  - 2) 植埋于人体使用的装置。
  - 3) 用于治疗(切除患部、给药等)的装置。
  - 4) 其他直接影响到人的生命的装置。
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### Keep safety first in your circuit designs!

1. MOS-TECH Semiconductor Corp. puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.