



# Overvoltage Protection Controllers with Current Limit in TDFN

## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)

IN	-0.3V to +30V
GATE	-0.3V to +12V
EN, CB, OV, FLAGI, BTA, BTB	-0.3V to +6V
Continuous Power Dissipation (T <sub>A</sub> = +70°C)	
10-Pin TDFN (derate 18.5mW/°C above +70°C)	1481.5mW

Operating Temperature Range	-40°C to +85°C
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(V<sub>IN</sub> = +5V (MAX4881/MAX4883/MAX4893B), V<sub>IN</sub> = +4V (MAX4882/MAX4884), T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>INPUT VOLTAGE (IN)</b>							
Input Voltage Range	V <sub>IN</sub>		1.2		28.0	V	
Overvoltage Trip Level	OVLO	V <sub>IN</sub> rising	MAX4881/MAX4883/MAX4893B	5.5	5.6	5.7	V
			MAX4882/MAX4884	4.4	4.5	4.6	
Overvoltage-Trip-Level Hysteresis				50		mV	
Undervoltage Lockout Threshold	UVLO	V <sub>IN</sub> falling	MAX4881/MAX4883/MAX4893B	4.2	4.35	4.5	V
			MAX4882/MAX4884	2.4	2.55	2.7	
Undervoltage Lockout Hysteresis				50		mV	
Supply Current	I <sub>IN</sub> + I <sub>BTB</sub>	No load, V <sub>EN</sub> = 0 or 5.5V, V <sub>IN</sub> = VOVLO (MIN) - 0.1V, V <sub>CB</sub> = V <sub>IN</sub>		240	380	μA	
<b>INTERNAL SWITCH</b>							
BTA Input Range	V <sub>BTA</sub>		2.8		5.7	V	
BTA Undervoltage Lockout	BTAUVLO	V <sub>BTA</sub> falling	2.4		2.7	V	
BTA-Undervoltage-Lockout Hysteresis				50		mV	
Switch-Forward Current Limit	I <sub>FWD</sub>	MAX4881/MAX4882, V <sub>BTB</sub> = GND	1.00	1.1	1.25	A	
		MAX4883/MAX4884, V <sub>BTB</sub> = GND	0.600	0.7	0.775		
		MAX4893B, V <sub>BTB</sub> = GND	0.800		1		
Switch-Reverse Current Limit	I <sub>REV</sub>	MAX4881/MAX4882			1.25	A	
		MAX4883/MAX4884			0.775		
		MAX4893B			1		
Voltage Drop (V <sub>BTA</sub> - V <sub>BTB</sub> )		I <sub>L</sub> = 400mA	V <sub>BTA</sub> = 5V (MAX4881/MAX4883/MAX4893B)		110	mV	
			V <sub>BTA</sub> = 4V (MAX4882/MAX4884)		110		
Blanking Time	t <sub>BLANK</sub>		20	50	80	ms	
BTB Off Current	I <sub>BTB-OFF</sub>	V <sub>EN</sub> = 0, V <sub>CB</sub> = 0			1	μA	

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MAX4881-MAX4884/MAX4893B

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{IN} = +5V$  (MAX4881/MAX4883/MAX4893B),  $V_{IN} = +4V$  (MAX4882/MAX4884),  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}C$ .) (Note 1)

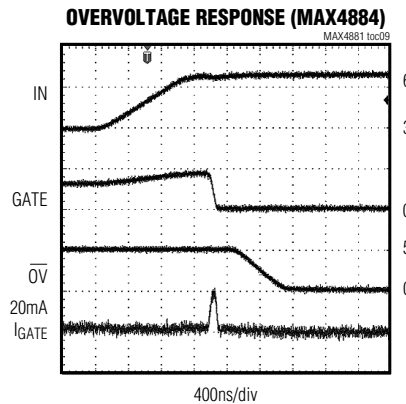
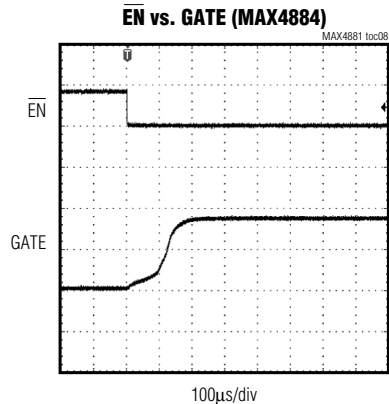
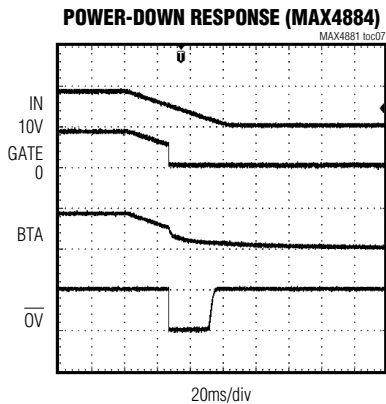
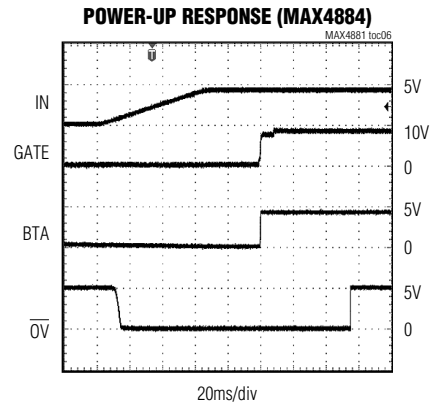
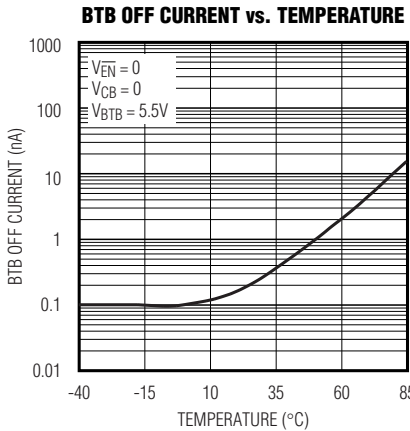
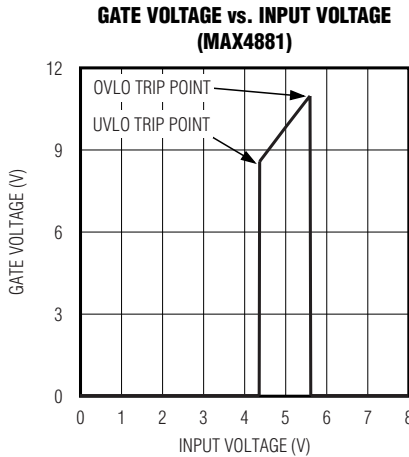
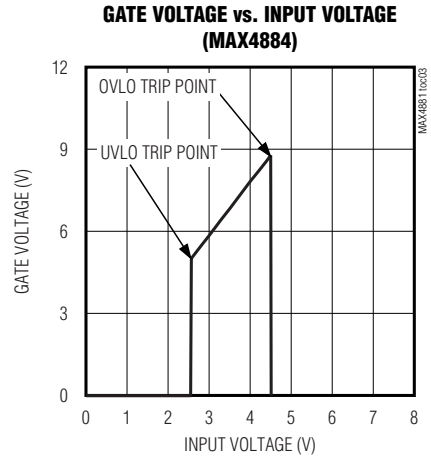
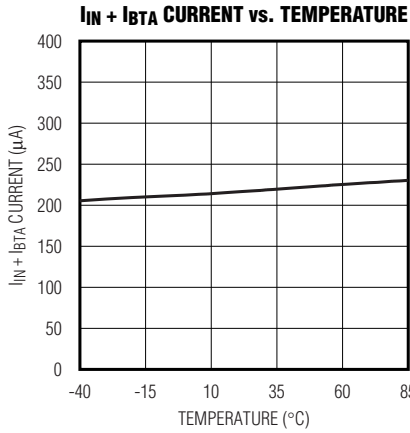
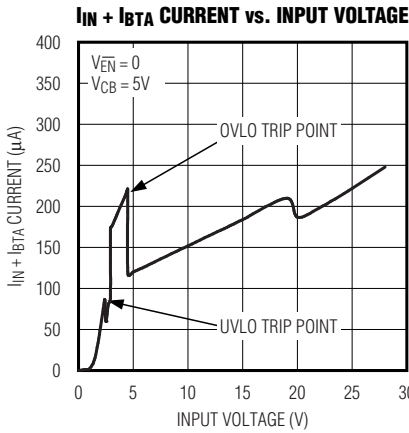
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>GATE</b>						
GATE Voltage	$V_{GATE}$	$I_{GATE}$ sourcing $1\mu A$	$V_{IN} = 5V$ (MAX4881/MAX4883/MAX4893B)	9	10	V
			$V_{IN} = 4.3V$ (MAX4882/MAX4884)	7.6	8.6	
GATE Pulldown Current	$I_{PD}$	$V_{IN} > V_{OVLO}$ , $V_{GATE} = 5.5V$		60		mA
<b>TIMING</b>						
Startup Delay	$t_{START}$	$V_{IN} > V_{UVLO}$ , $V_{GATE} > 0.3V$ (Figure 1)	20	50	80	ms
$\overline{OV}$ Blanking Time	$t_{OV-BLANK}$	$V_{GATE} = 0.3V$ , $V_{\overline{OV}} = 2.4V$ (Figure 1)	20	50	80	ms
GATE Turn-On Time	$t_{GON}$	$V_{GATE} = 0.3V$ to $7V$ , $C_{GATE} = 1500pF$ (Figure 1)		7		ms
GATE Turn-Off Time	$t_{GOFF}$	$V_{IN}$ increasing from $5V$ to $8V$ at $3V/\mu s$ , $V_{GATE} = 0.3V$ , $C_{GATE} = 1500pF$ (Figure 2) (MAX4881/MAX4883/MAX4893B)		6	20	$\mu s$
		$V_{IN}$ increasing from $4V$ to $7V$ at $3V/\mu s$ , $V_{GATE} = 0.3V$ , $C_{GATE} = 1500pF$ (Figure 2) (MAX4882/MAX4884)		6	20	
$\overline{OV}$ Assertion Delay	$t_{\overline{OV}}$	$V_{IN}$ increasing from $5V$ to $8V$ at $3V/\mu s$ , $V_{OV} = 0.4V$ (Figure 2) (MAX4881/MAX4883/MAX4893B)		5.8		$\mu s$
		$V_{IN}$ increasing from $4V$ to $7V$ at $3V/\mu s$ , $V_{OV} = 0.4V$ (Figure 2) (MAX4882/MAX4884)		5.8		
Initial Overvoltage Fault Delay	$t_{OVP}$	$V_{IN}$ increasing from $0$ to $8V$ , $I_{GATE} = 80\%$ of $I_{PD}$ (Figure 3)		100		ns
Disable Time	$t_{DIS}$	$V_{EN} = 2.4V$ , $V_{GATE} = 0.3V$ (Figure 4)		580		ns
<b><math>\overline{EN}</math>, CB INPUTS</b>						
Input-High Voltage	$V_{IH}$		1.4			V
Input-Low Voltage	$V_{IL}$				0.5	V
Input Leakage					1	$\mu A$
<b><math>\overline{OV}</math>, FLAG1 OUTPUTS</b>						
Output Voltage Low	$V_{OL}$	$I_{SINK} = 1mA$ , $\overline{OV}$ , FLAG1 assert			0.4	V
Leakage Current		$V_{FLAG1} = V_{\overline{OV}} = 5.5V$			1	$\mu A$
<b>THERMAL PROTECTION</b>						
Thermal Shutdown				150		$^{\circ}C$
Thermal Hysteresis				40		$^{\circ}C$

**Note 1:** All devices are 100% tested at  $T_A = +25^{\circ}C$ . Electrical limits over the full temperature range are guaranteed by design.

# Overvoltage Protection Controllers with Current Limit in TDFN

## Typical Operating Characteristics

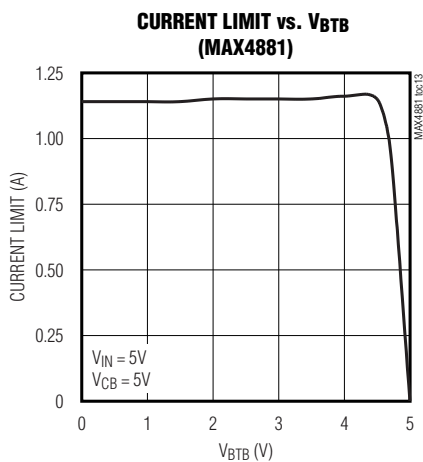
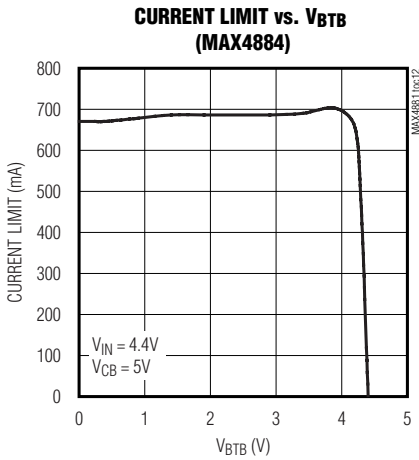
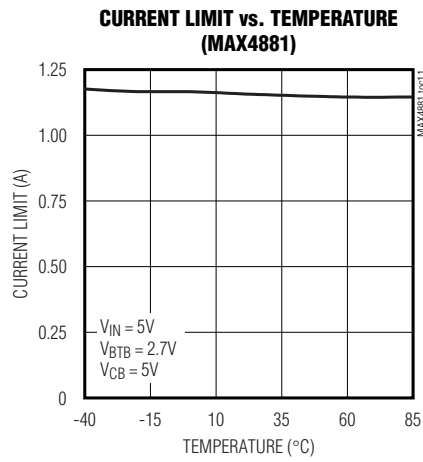
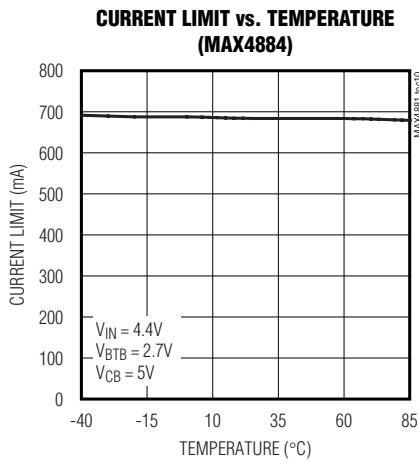
( $V_{IN} = 5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Overvoltage Protection Controllers with Current Limit in TDFN

## Typical Operating Characteristics (continued)

( $V_{IN} = 5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



MAX4881-MAX4884/MAX4893B

# Overvoltage Protection Controllers with Current Limit in TDFN

## Pin Description

PIN	NAME	FUNCTION
1	IN	Input. IN is the power input for the OVP charge pump. Bypass IN to GND with a 1 $\mu$ F or larger capacitor.
2	$\overline{\text{EN}}$	Active-Low Enable Input. Drive $\overline{\text{EN}}$ high to turn off the external MOSFET. Driving $\overline{\text{EN}}$ low activates the OVP circuitry and turns on the external MOSFET.
3	GATE	Gate Drive Output. GATE is the output of an on-chip OVP charge pump. When $V_{\text{UVLO}} < V_{\text{IN}} < V_{\text{OVLO}}$ , GATE is driven high to turn on the external n-channel MOSFET.
4	BTA	Internal Current-Limited Switch Terminal. Connect BTA to the source of the external n-channel MOSFET. BTA is the power input for the entire device (except the OVP charge pump). Bypass BTA to GND with a 0.1 $\mu$ F capacitor as close to the device as possible for proper operation.
5	CB	Active-Low Internal Current-Limited-Switch Control Input. Drive CB high to turn on the internal switch, pull CB low to turn off the internal switch.
6	GND	Ground
7	BTB	Internal Current-Limited-Switch Output. Bypass BTB to GND with 0.1 $\mu$ F capacitor as close to the device as possible.
8	$\overline{\text{FLAG}}$	Active-Low Open-Drain Internal Current-Limited Flag Output. $\overline{\text{FLAG}}$ asserts low when the current is at the limit for longer than the blanking time. $\overline{\text{FLAG}}$ is disabled when $\overline{\text{EN}}$ goes high.
9	N.C.	No Connection. Not internally connected.
10	$\overline{\text{OV}}$	Active-Low Open-Drain IN-Overvoltage Flag Output. $\overline{\text{OV}}$ goes low when an undervoltage/overvoltage fault occurs at IN. $\overline{\text{OV}}$ is disabled when $\overline{\text{EN}}$ goes high.
—	EP	Exposed Pad. EP is internally connected to GND. Connect EP to a large ground plane to act as a heat sink, but do not use EP as the only electrical ground connection.

# Overvoltage Protection Controllers with Current Limit in TDFN

MAX4881-MAX4884/MAX4893B

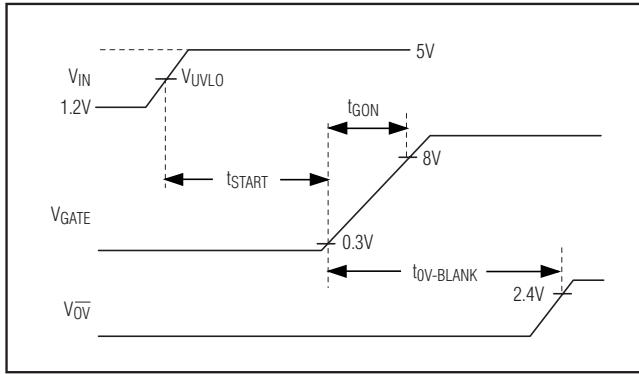


Figure 1. Startup Timing Diagram

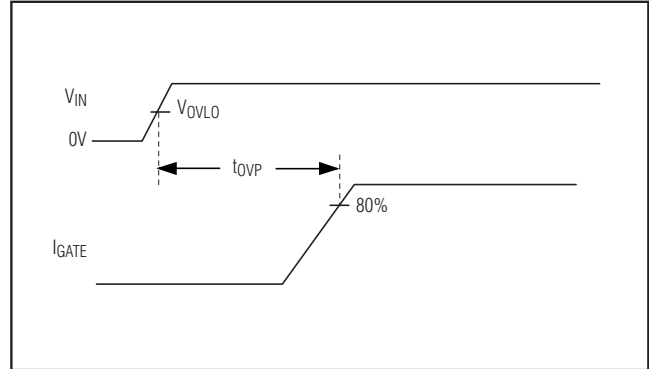


Figure 3. Power-Up Overvoltage Timing Diagram

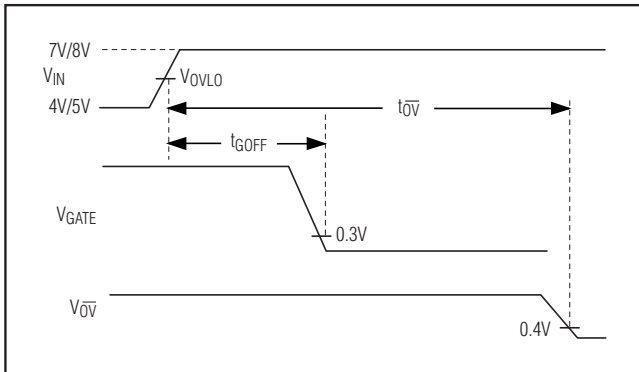


Figure 2. Shutdown Timing Diagram

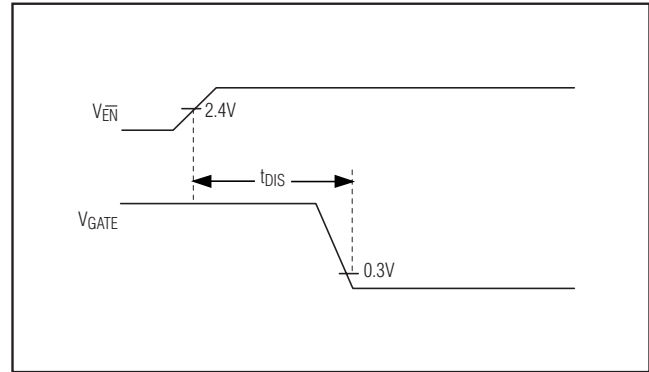


Figure 4. Disable Timing Diagram

## Detailed Description

The MAX4881-MAX4884/MAX4893B provide up to +28V overvoltage protection for low-voltage systems. When the input voltage at IN exceeds the overvoltage trip level (OVLO), the MAX4881-MAX4884/MAX4893B turn off the low-cost external n-channel FET to prevent damage to the protected components and issue an overvoltage fault flag.

The MAX4881-MAX4884 feature a built-in current-limited switch that limits the load current to 1.1A (MAX4881/MAX4882), 0.7A (MAX4883B/MAX4883C/MAX4884B/MAX4884C), and 0.9A (MAX4893B). When the load current is at the current limit for longer than the blanking time, the switch of the MAX4881/MAX4882/MAX4883B/MAX4884B/MAX4893B latches off and does not turn back on until  $\overline{\text{EN}}$  or CB or IN is cycled. A current-limit flag (FLAGI) asserts to indicate a current fault condition. The MAX4883C/MAX4884C limit the current to 0.7A indefinitely until the thermal protection trips. An overcurrent flag output asserts to indicate a current fault condition after the blanking time has elapsed.

### IN-Undervoltage Lockout (UVLO)

The MAX4881/MAX4883/MAX4893B have a fixed 4.35V undervoltage lockout level (UVLO) while the MAX4882/MAX4884 have a fixed UVLO of 2.55V. GATE goes low when  $V_{\text{IN}}$  is below  $V_{\text{UVLO}}$ , turning off the external n-channel FET.

### IN-Overvoltage Lockout (OVLO)

The MAX4881/MAX4883/MAX4893B have a fixed 5.6V overvoltage threshold (OVLO), while the MAX4882/MAX4884 have a fixed OVLO of 4.5V. GATE goes low when  $V_{\text{IN}}$  is higher than  $V_{\text{OVLO}}$ , turning off the external n-channel FET.

### Fault Flag Output ( $\overline{\text{OV}}$ )

The  $\overline{\text{OV}}$  output signals the host system that there is a fault with the input voltage.  $\overline{\text{OV}}$  asserts low in response to either an overvoltage or undervoltage fault.  $\overline{\text{OV}}$  stays low for 50ms after GATE turns on, before deasserting high.

$\overline{\text{OV}}$  is an open-drain active-low output. Connect a pullup resistor from  $\overline{\text{OV}}$  to the logic I/O voltage of the host system or to any voltage source up to 6V. Driving  $\overline{\text{EN}}$  high disables  $\overline{\text{OV}}$ .

# Overvoltage Protection Controllers with Current Limit in TDFN

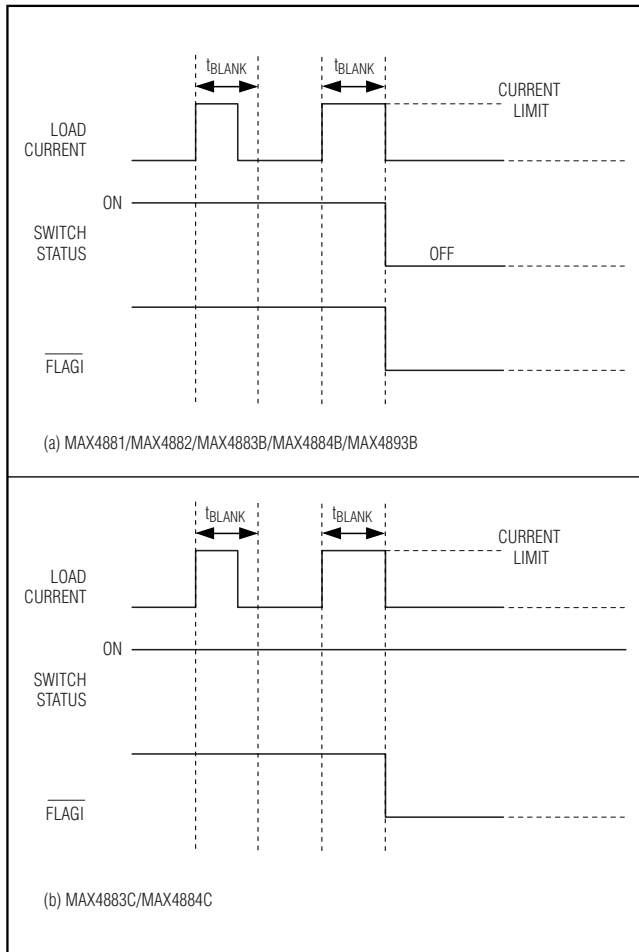


Figure 5. Current-Limit Fault Timing

## Overcurrent Flag Output (FLAGI)

The MAX4881-MAX4884/MAX4893B have an overcurrent-fault flag output (FLAGI) to indicate a current fault condition. FLAGI asserts low to indicate a fault when the current reaches the current limit for longer than the 50ms blanking time. Toggle IN or CB or EN to release FLAGI latched condition. FLAGI does not assert if the current-limit fault occurs for less than the blanking time (Figure 5).

FLAGI is disabled when EN goes high. When CB is low, the switch opens, but FLAGI is not active.

FLAGI is an open-drain active-low output. Connect a pullup resistor from FLAGI to the logic I/O voltage of the host system or to any voltage source up to 6V.

## Current-Limit Switch

When the forward- or reverse-current-limit threshold is exceeded, tBLANK timer begins counting. The timer

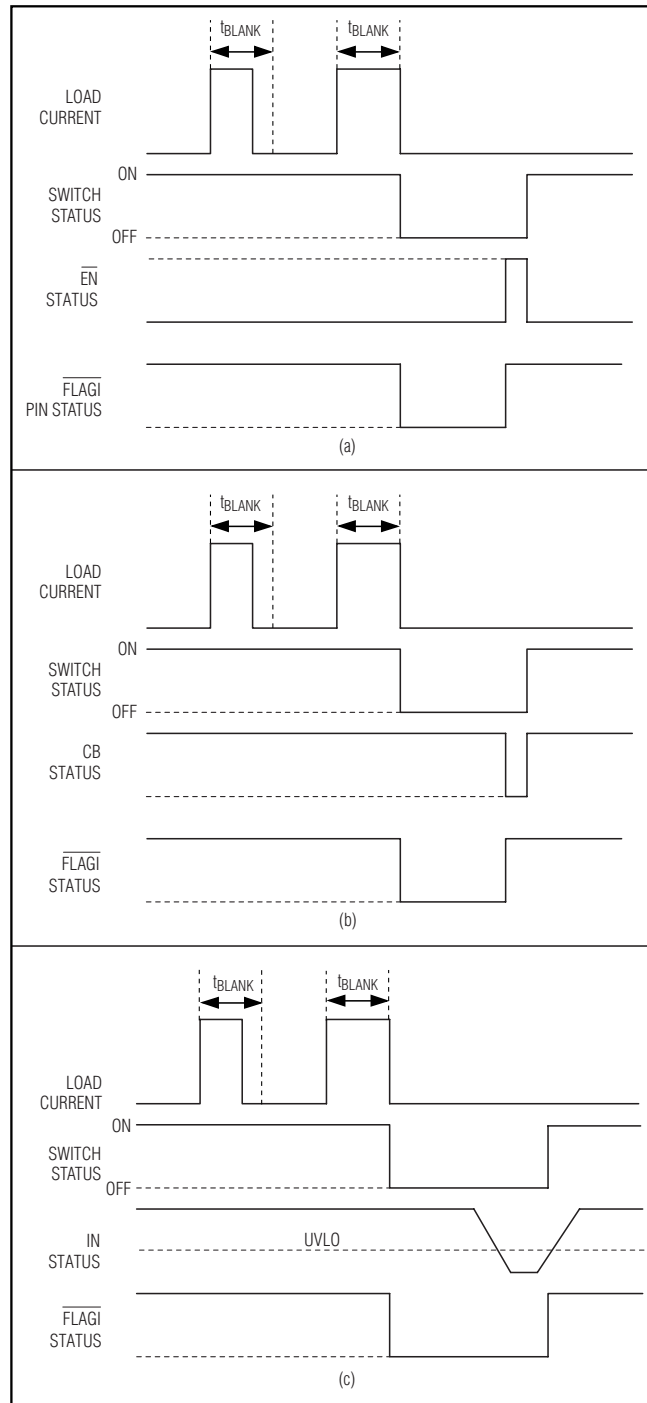


Figure 6. Latchoff Fault Blanking (MAX4881/MAX4882/MAX4883B/MAX4884B/MAX4893B)



# Overvoltage Protection Controllers with Current Limit in TDFN

MAX4881-MAX4884/MAX4893B

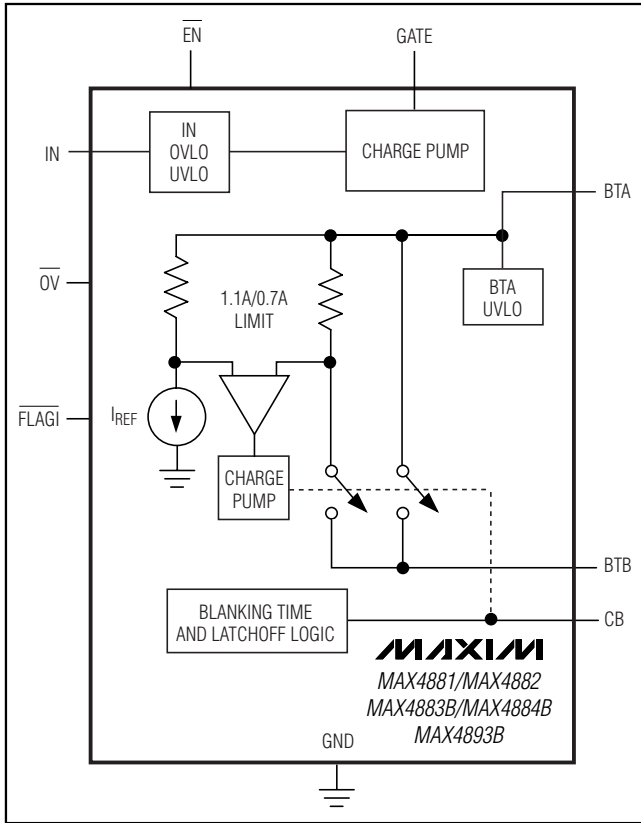


Figure 7a. MAX4881/MAX4882/MAX4883B/MAX4884B/MAX4893B Functional Diagram

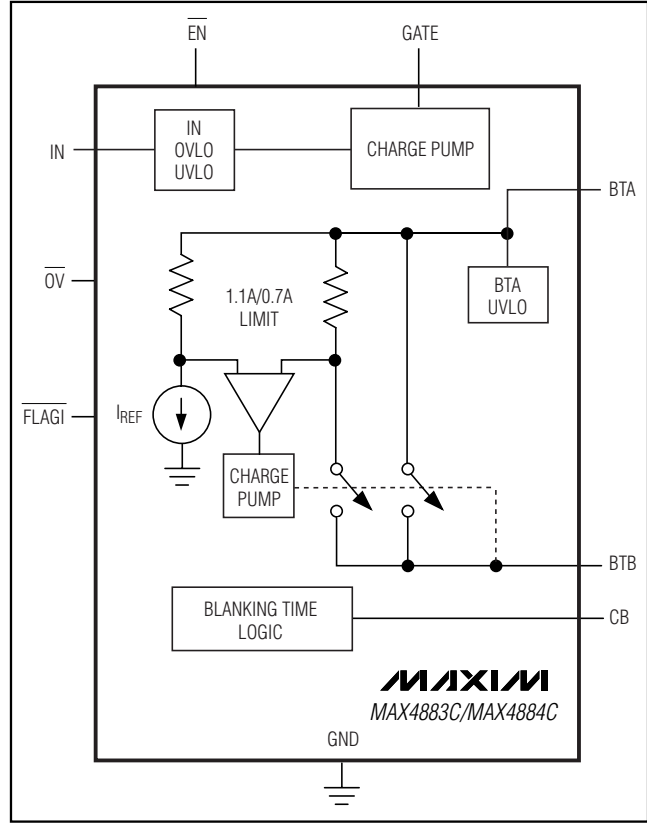


Figure 7b. MAX4883C/MAX4884C Functional Diagram

resets if the overcurrent condition disappears before  $t_{\text{BLANK}}$  has elapsed. The internal switch is latched off if the overcurrent condition continues up to the end of the blanking time (MAX4881/MAX4882/MAX4883B/MAX4884B/MAX4893B). The MAX4883C/MAX4884C limit the current infinitely until the thermal trip point occurs. Reset the switch by toggling  $\overline{\text{EN}}$  or CB or IN (Figure 6).

## $\overline{\text{EN}}$ Input

The MAX4881-MAX4884/MAX4893B feature an active-low enable input (EN). Drive  $\overline{\text{EN}}$  low or connect to ground for normal operation. Drive  $\overline{\text{EN}}$  high to force the external n-channel MOSFET off, and to disable  $\overline{\text{OV}}$  and  $\overline{\text{FLAGI}}$ .

## GATE Driver

An on-chip charge pump drives the GATE voltage to about twice above  $V_{\text{IN}}$ , allowing the use of a low-cost n-channel MOSFET (Figure 7). The actual GATE output voltage tracks approximately  $2 \times V_{\text{IN}}$  until  $V_{\text{IN}}$  exceeds the OVLO trip level, 5.6V (MAX4881/MAX4883/MAX4893B) and 4.5V (MAX4882/MAX4884) typically.

The GATE output voltage, as a function of input voltage, is shown in the *Typical Operating Characteristics*.

## Applications Information

### MOSFET Selection

The MAX4881-MAX4884/MAX4893B are designed for use with an n-channel MOSFET. MOSFETs with  $R_{\text{DS(ON)}}$ , specified for a  $V_{\text{GS}}$  of 4.5V or less, work well. If the input supply is near the UVLO minimum of 4.2V (MAX4881/MAX4883/MAX4893B), or of 2.4V (MAX4882/MAX4884), consider using a MOSFET specified for a lower  $V_{\text{GS}}$  voltage. Also, the  $V_{\text{DS}}$  should be 30V for the MOSFET to withstand the full 28V IN range of the MAX4881-MAX4884/MAX4893B. Table 1 shows a selection of MOSFETs appropriate for use with the MAX4881-MAX4884/MAX4893B.

### IN Bypass Considerations

Bypass IN to GND with a 1 $\mu\text{F}$  ceramic capacitor to achieve 15kV ESD-protected input. When the power source has significant inductance due to long lead

# Overvoltage Protection Controllers with Current Limit in TDFN

Table 1. MOSFET Suggestions

PART	CONFIGURATION/ PACKAGE	V <sub>DS</sub> MAX (V)	R <sub>ON</sub> AT 4.5V (mΩ)	MANUFACTURER
Si1426DH	Single/SC70-6	30	115	Vishay Siliconix <a href="http://www.vishay.com">http://www.vishay.com</a> (402) 563-6866
FDG315N	Single/SC70-6	30	160	Fairchild Semiconductor <a href="http://www.fairchildsemi.com">http://www.fairchildsemi.com</a> (207) 775-8100

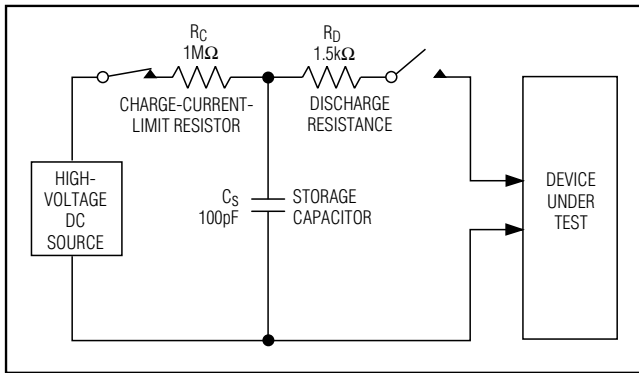


Figure 8. Human Body ESD Test Model

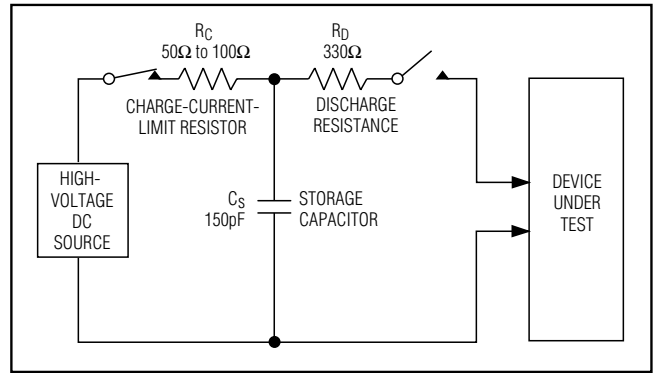


Figure 10. IEC 61000-4-2 ESD Test Model

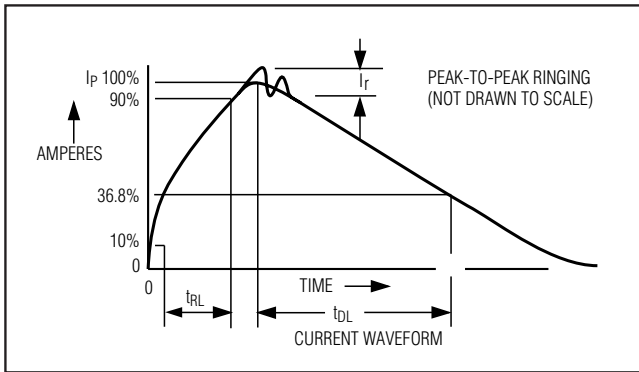


Figure 9. Human Body Model Current Waveform

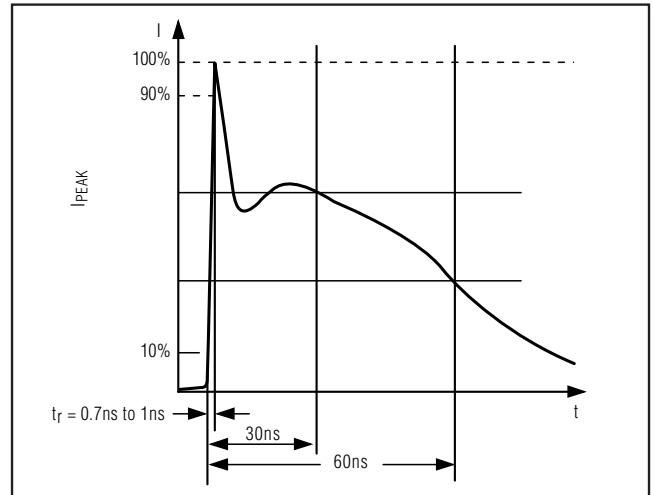


Figure 11. IEC 61000-4-2 ESD Generator Current

length, take care to prevent overshoots due to the LC tank circuit, and provide protection if necessary to prevent exceeding the 30V absolute maximum rating on IN.

The MAX4881-MAX4884/MAX4893B provide protection against voltage faults up to 28V, but this does not include negative voltages. If negative voltages are a concern, connect a Schottky diode from IN to GND to clamp negative input voltages.

### Exposed Pad

The MAX4881-MAX4884/MAX4893B provide an exposed pad on the bottom of the package. This pad is internally connected to GND. For the best thermal conductivity and higher power dissipation, solder the exposed pad to the ground plane. Do not use the

# Overvoltage Protection Controllers with Current Limit in TDFN

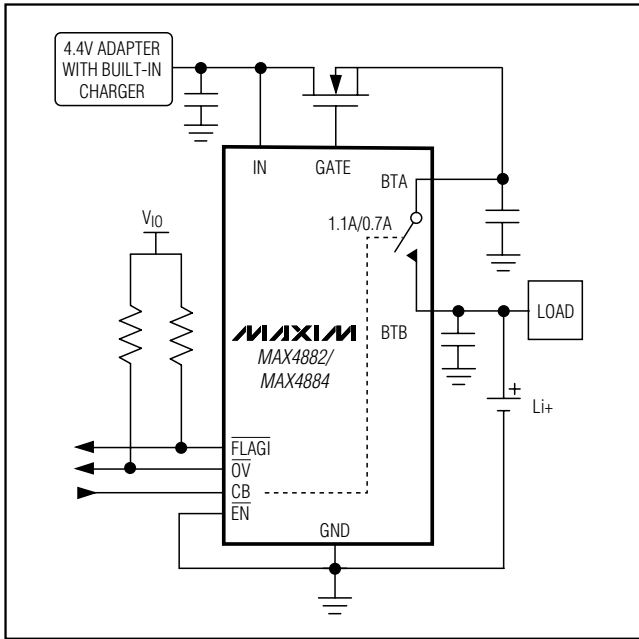


Figure 12. Connection to an AC-DC Adapter without a Built-In Battery Charger

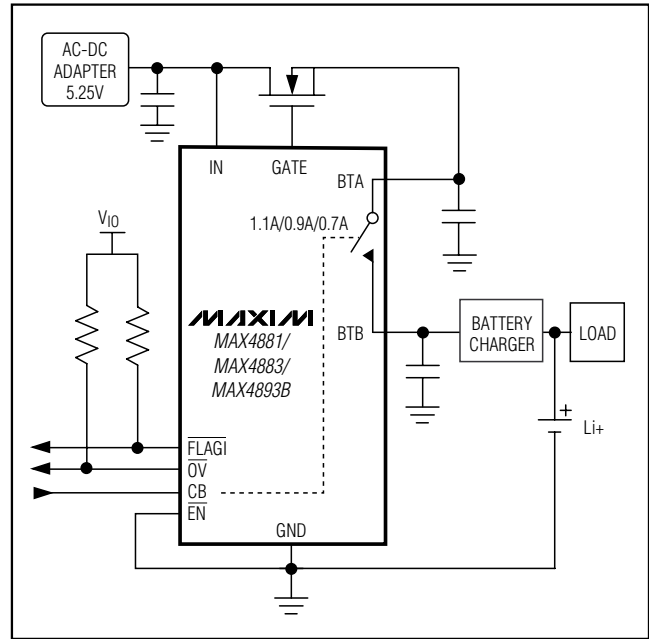


Figure 13. Connection to an AC-DC Adapter with a Built-In Battery Charger

ground-connected pad as the only electrical ground connection or ground return. Use GND (pin 6) as the only electrical ground connection.

### ESD Test Conditions

ESD performance depends on a number of conditions. The MAX4881-MAX4884/MAX4893B is specified for 15kV typical ESD resistance on IN when IN is bypassed to ground with a 1 $\mu$ F low-ESR ceramic capacitor. Contact Maxim for a reliability report that documents test setup, methodology, and results.

### Human Body Model

Figure 8 shows the Human Body Model and Figure 9 shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the device through a 1.5k $\Omega$  resistor.

### IEC 61000-4-2

Since January 1996, all equipment manufactured and/or sold in the European community has been required to meet the stringent IEC 61000-4-2 specification. The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX4881-MAX4884/MAX4893B help users design

equipment that meets Level 3 of IEC 61000-4-2, without additional ESD-protection components.

The main difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2. Because series resistance is lower in the IEC 61000-4-2 ESD test model (Figure 10), the ESD-withstand voltage measured to this standard is generally lower than that measured using the Human Body Model. Figure 11 shows the current waveform for the  $\pm$ 8kV, IEC 61000-4-2, Level 4, ESD Contact Discharge test. The Air-Gap test involves approaching the device with a charger probe. The Contact Discharge method connects the probe to the device before the probe is energized.

### Typical Operating Circuits

Figures 12 and 13 depict some typical connections to the MAX4881-MAX4884/MAX4893B. Figure 12 shows a battery charger application where the source power is an AC adapter with a built-in charger, while Figure 13 shows an application where the battery charger is external.

### Chip Information

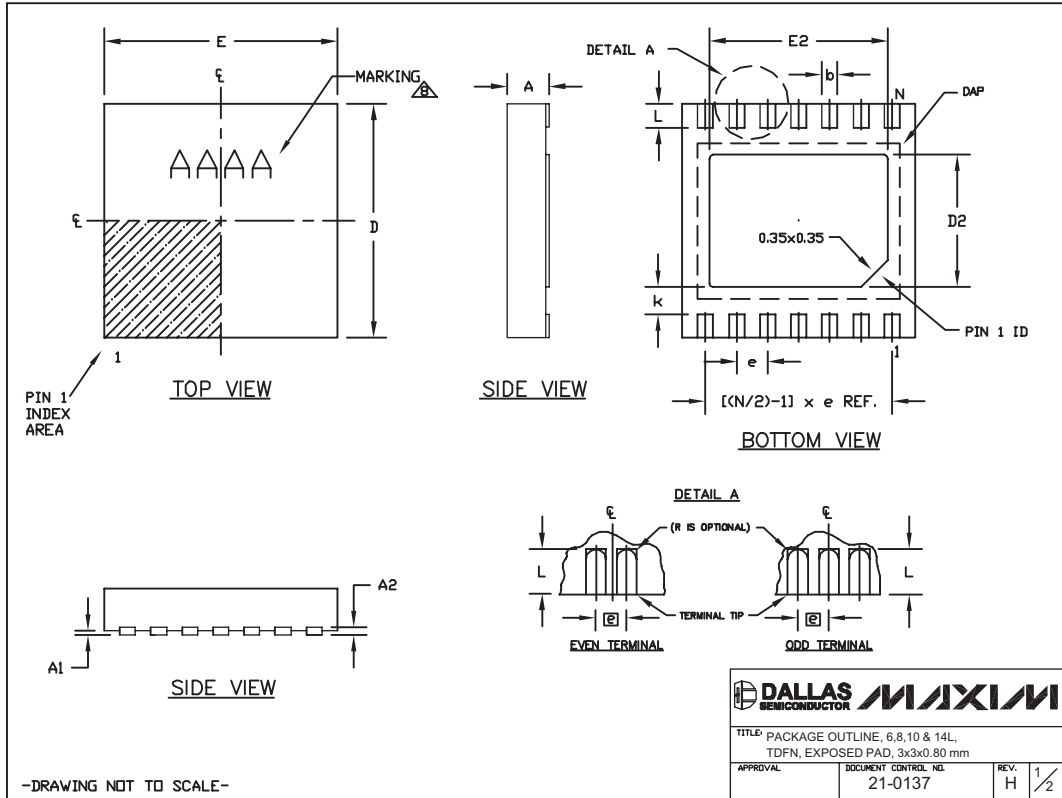
TRANSISTOR COUNT: 2391

PROCESS: BiCMOS

# Overvoltage Protection Controllers with Current Limit in TDFN

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



# Overvoltage Protection Controllers with Current Limit in TDFN


## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX4881-MAX4884/MAX4893B

COMMON DIMENSIONS			PACKAGE VARIATIONS							
SYMBOL	MIN.	MAX.	PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e
A	0.70	0.80	T633-1	6	1.50-0.10	2.30-0.10	0.95 BSC	MO229 / WEEA	0.40-0.05	1.90 REF
D	2.90	3.10	T633-2	6	1.50-0.10	2.30-0.10	0.95 BSC	MO229 / WEEA	0.40-0.05	1.90 REF
E	2.90	3.10	T833-1	8	1.50-0.10	2.30-0.10	0.65 BSC	MO229 / WEEC	0.30-0.05	1.95 REF
A1	0.00	0.05	T833-2	8	1.50-0.10	2.30-0.10	0.65 BSC	MO229 / WEEC	0.30-0.05	1.95 REF
L	0.20	0.40	T833-3	8	1.50-0.10	2.30-0.10	0.65 BSC	MO229 / WEEC	0.30-0.05	1.95 REF
k	0.25 MIN.		T1033-1	10	1.50-0.10	2.30-0.10	0.50 BSC	MO229 / WEED-3	0.25-0.05	2.00 REF
A2	0.20 REF.		T1033-2	10	1.50-0.10	2.30-0.10	0.50 BSC	MO229 / WEED-3	0.25-0.05	2.00 REF
			T1433-1	14	1.70-0.10	2.30-0.10	0.40 BSC	----	0.20-0.05	2.40 REF
			T1433-2	14	1.70-0.10	2.30-0.10	0.40 BSC	----	0.20-0.05	2.40 REF

NOTES:  
 1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.  
 2. COPLANARITY SHALL NOT EXCEED 0.08 mm.  
 3. WARPAGE SHALL NOT EXCEED 0.10 mm.  
 4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).  
 5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.  
 6. "N" IS THE TOTAL NUMBER OF LEADS.  
 7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.  
 8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

  
 TITLE: PACKAGE OUTLINE, 6, 8, 10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm  
 APPROVAL: \_\_\_\_\_ DOCUMENT CONTROL NO. 21-0137 REV. H 2/2

-DRAWING NOT TO SCALE-

## Revision History

All pages changed at Rev 2.

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