



TF2136M

3-Phase Half-Bridge Gate Driver

Features

- Three floating high-side drivers in bootstrap operation to 600V
- 200mA source / 350mA sink output current capability
- Outputs tolerant to negative transients, dV/dt immune
- Wide VCC operating range: 10V to 20V
- Logic input 3.3V capability
- Internal deadtime of 290ns to protect MOSFETs
- Matched prop delay for all channels
- Outputs out of phase with inputs
- Schmitt triggered logic inputs
- Cross conduction prevention logic
- Undervoltage lockout for all channels
- Overcurrent protection shuts down drivers

Applications

- 3-Phase Motor Inverter Driver
- White Goods - Air Conditioner, Washing Machine, Refrigerator
- Industrial Motor Inverter - Power Tools, Robotics
- General Purpose 3-Phase Inverter

SOIC-28



Description

The TF2136M is a three-phase gate driver IC designed for high voltage, high speed applications, driving N-channel MOSFETs and IGBTs in a half-bridge configuration. TF Semiconductor's high voltage process enables the TF2136M high sides to switch to 600V in a bootstrap operation.

The TF2136M logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) to interface easily with controlling devices and are enabled low to better function in high noise environments. The driver outputs feature high pulse current buffers designed for minimum driver cross conduction.

The TF2136M offers numerous protection functions. A shoot-through protection logic prevents both outputs being high with both inputs high (fault state), an undervoltage lockout for V_{CC} shuts down all drivers through an internal fault control, and a UVLO for V_{BS} shuts down the respective high side output. Also an overcurrent protection will terminate the six outputs. Both the V_{CC} UVLO and the overcurrent protection trip an automatic fault clear with a timing that is adjustable with an external capacitor.

The TF2136M is offered in SOIC 28 package and operates over an extended -40 °C to +125 °C temperature range.

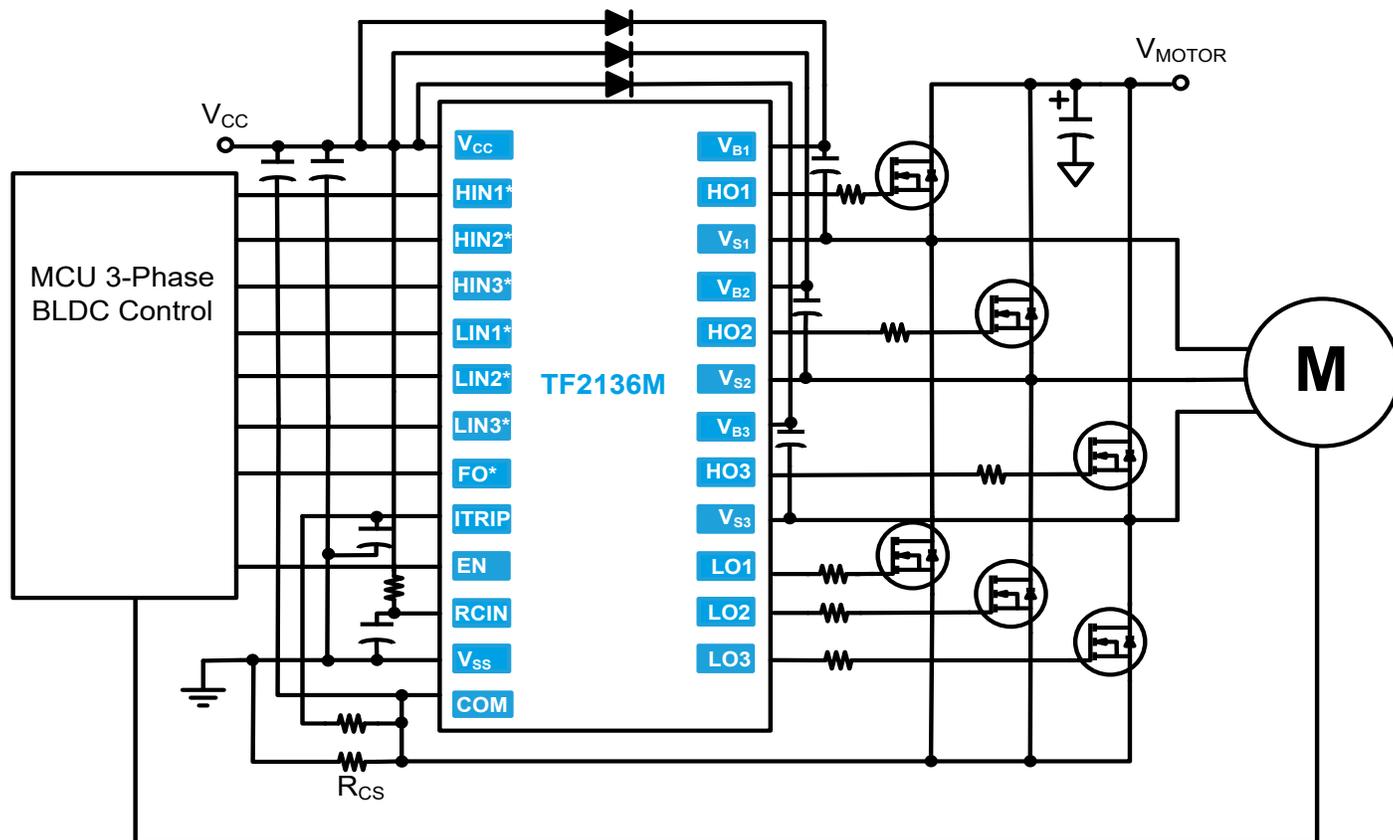
Ordering Information

Year Year Week Week

PART NUMBER	PACKAGE	PACK / Qty	MARK
TF2136M-TLS	SOIC-28	Tube / 25	YYWW TF2136M
TF2136M-TLH	SOIC-28	T&R / 1500	Lot ID

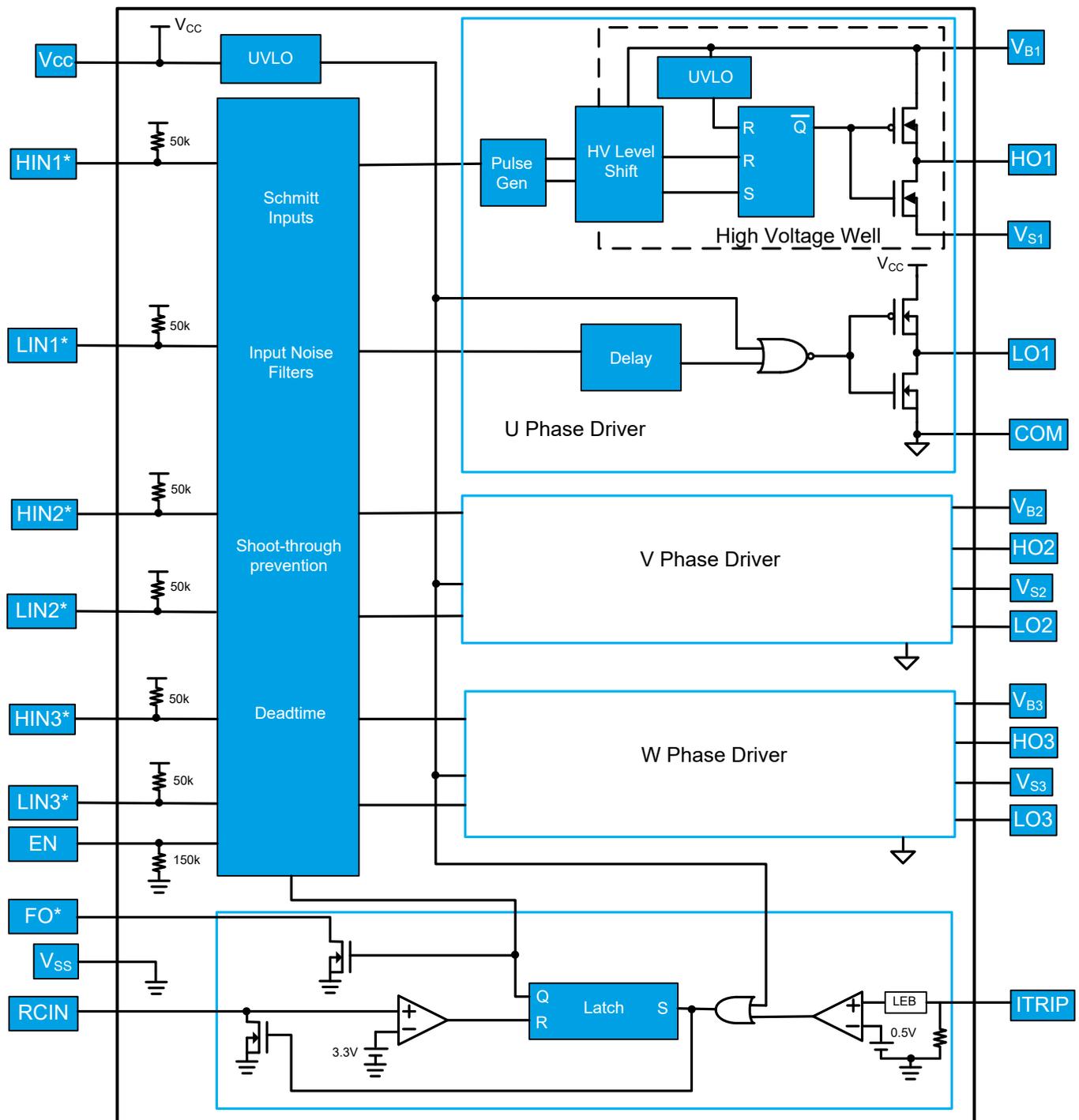


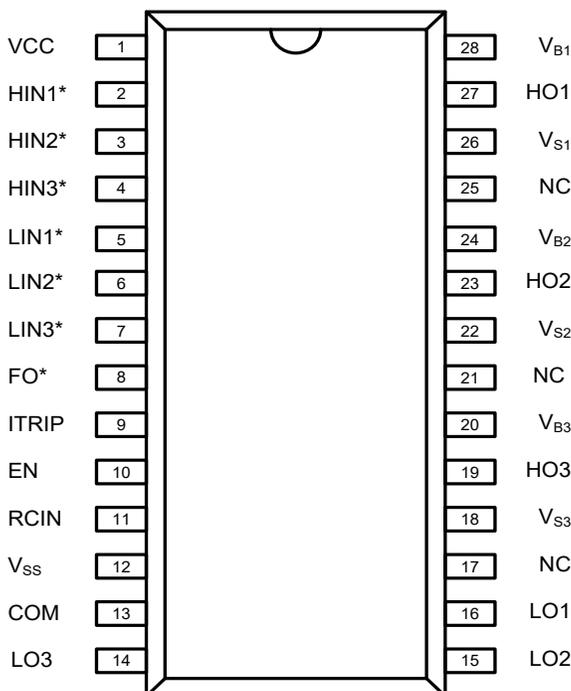
Typical Application





Functional Block Diagram





Top View: SOIC-28

Pin Descriptions

PIN NAME	PIN NUMBER	PIN DESCRIPTION
VCC	1	Low-side and logic fixed supply
HIN1*, HIN2*, HIN3*	2, 3, 4	Logic input for high-side gate driver output, out of phase with HO.
LIN1*, LIN2*, LIN3*	5, 6, 7	Logic input for low-side gate driver output, out of phase with LO.
FO*	8	Fault output with open drain (fault with over-current and VCC UVLO)
ITRIP	9	Analog input for over-current shutdown
EN	10	Logic input for functionality, I/O logic functions when EN is high.
RCIN	11	An external RC network input used to define FAULT CLEAR delay
V _{SS}	12	Logic ground
COM	13	Low-side driver return
LO3, LO2, LO1	14, 15, 16	Low-side gate driver output
NC	17, 21, 25	No Connect
V _{S3} , V _{S2} , V _{S1}	18, 22, 26	High-side floating supply return
HO3, HO2, HO1	19, 23, 27	High-side gate driver output
V _{B3} , V _{B2} , V _{B1}	20, 24, 28	High-side floating supply



Absolute Maximum Ratings (NOTE1)

V_B - High-side floating supply voltage.....-0.3V to +624V
 V_S - High-side floating supply offset voltage... V_B -24V to V_B +0.3V
 V_{HO} - High-side floating output voltage..... V_S -0.3V to V_B +0.3V
 V_{LO} - Low-side output voltage.....-0.3V to V_{CC} +0.3V
 dV_S/dt - Offset supply voltage transient.....50V/ns
 V_{CC} - Low-side fixed supply voltage.....-0.3V to +24V
 V_{IN} - Logic input voltage (HIN*, LIN*, ITRIP, EN and FO*).....-0.3V to 5.5V

NOTE1 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.

P_D - Package power dissipation at $T_A \leq 25^\circ\text{C}$
 SOIC-28.....2.3W

SOIC-28 Thermal Resistance (NOTE2)

θ_{JC}45 $^\circ\text{C}/\text{W}$
 θ_{JA}60 $^\circ\text{C}/\text{W}$

T_J - Junction operating temperature.....+150 $^\circ\text{C}$
 T_L - Lead Temperature (soldering, 10 seconds).....+300 $^\circ\text{C}$
 T_{stg} - Storage temperature-55 to 150 $^\circ\text{C}$

NOTE2 Thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

Recommended Operating Conditions

Symbol	Parameter	MIN	MAX	Unit
V_B	High side floating supply absolute voltage	$V_S + 10$	$V_S + 20$	V
V_S	High side floating supply offset voltage	NOTE3	600	V
V_{HO}	High side floating output voltage	V_S	V_B	V
V_{CC}	Low side fixed supply voltage	10	20	V
V_{LO}	Low side output voltage	COM	V_{CC}	V
V_{IN}	Logic input voltage (HIN*, LIN*, ITRIP, EN)	V_{SS}	5	V
V_{FO}	Fault output Voltage	V_{SS}	V_{CC}	V
V_{SS}	Logic Ground	-5	5	C
T_A	Ambient temperature	-40	125	$^\circ\text{C}$

NOTE3 Logic operational for VS of -5V to +600V.



DC Electrical Characteristics (NOTE4)

$V_{BIAS} (V_{CC}, V_{BS}) = 15V, T_A = 25^\circ C$, unless otherwise specified.

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
V_{IH}	Logic "0" input voltage		2.4			V
V_{IL}	Logic "1" input voltage				0.8	
V_{OH}	High level output voltage, $V_{BIAS} - V_O$	$I_O = 0mA$			0.1	
V_{OL}	Low level output voltage, V_O	$I_O = 0mA$			0.1	
I_{LK}	Offset supply leakage current	$V_B = V_S = 600V$			10	μA
I_{BSQ}	Quiescent V_{BS} supply current	$V_{IN} = 0V$ or $5V, EN=0V$	10	85	130	
I_{CCQ}	Quiescent V_{CC} supply current	$V_{IN} = 0V$ or $5V, EN=0V$		1.1	1.6	mA
I_{IN+}	Logic input bias current (HO=LO=HIGH)	$V_{IN} = 0V$		130	200	μA
I_{IN-}	Logic input bias current (HO=LO=LOW)	$V_{IN} = 5V$		3.0	20	
I_{EN+}	Logic Enable "1" input bias current	$V_{EN} = 5V$		33	80	μA
I_{EN-}	Logic Enable "0" input bias current	$V_{EN} = 0V$			2	μA
V_{BSUV+} V_{CCUV+}	V_{BS} and V_{CC} supply under-voltage positive going threshold		7.6	8.9	9.9	V
V_{BSUV-} V_{CCUV-}	V_{BS} and V_{CC} supply under-voltage negative going threshold		7.1	8.3	9.4	
I_{O+}	Output high short circuit pulsed current	$V_O = 0V, PW \leq 10 \mu s$	120	200		mA
I_{O-}	Output low short circuit pulsed current	$V_O = 15V, PW \leq 10 \mu s$	250	350		
V_{ITH+}	Overcurrent detect positive threshold		400	500	600	mV
V_{ITH-}	Overcurrent detect negative threshold		340	420	500	mV
I_{CSIN}	Short-circuit input current	$V_{CSIN}=1V$	6.0	11	16	μA
$V_{RCINTH+}$	RCIN Positive going threshold voltage		7.0	8.4	9.8	V
$V_{RCINTH-}$	RCIN Negative going threshold voltage			5		V
V_{FOL}	Fault output low level voltage	$V_{CS}=1V, I_{FO}=1.5mA$		0.2	0.5	V
R_{DSRCIN}	RCIN On resistance	$I_{RCIN}=1.5mA$	40	75	110	Ω
R_{DSFO}	Fault output on resistance	$I_{FO}=1.5mA$	80	130	180	Ω

NOTE4 The V_{IH} , V_{IL} , and I_{IN} parameters are referenced to V_{SS} and are applicable to all six channels (HIN1,2,3* and LIN1,2,3*). The V_O and I_O parameters are applicable to the outputs (HO1,2,3 and LO1,2,3 and are referenced to COM.



AC Electrical Characteristics

$V_{BIAS} (V_{CC}, V_{BS}) = 15V$, $C_L = 1000pF$, and $T_A = 25^\circ C$, unless otherwise specified.

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
t_{on}	Turn-on propagation delay	$V_S = 0V$	200	330	460	ns
t_{off}	Turn-off propagation delay	$V_S = 0V$	200	330	460	
t_r	Turn-on rise time	$V_S = 0V$		90	150	
t_f	Turn-off fall time			35	60	
t_{DM}	Delay matching				50	ns
t_{EN}	Enable low to output shutdown delay		225	330	425	ns
t_{BLT}	ITRIP Pin leading-edge blanking time		200	300	400	ns
t_{FLT}	Time from ITRIP triggering to FO*	From $V_{ITRIP} = 1V$ to FO* turn off	360	550	760	ns
t_{ITRIP}	Time from ITRIP triggering to all gate outputs turn off	From $V_{ITRIP} = 1V$ to starting gate turn off	420	615	820	ns
t_{FLTIN}	Input filtering time (HIN*, LIN*, EN)			250		ns
t_{FLTCLR}	Fault clear time	$C_{RCIN} = 1nF, R_{RCIN} = 2M\Omega$		1.6		ms
t_{DT}	Deadtime		200	290	420	ns
t_{DTM}	Deadtime matching				50	ns
t_{PM}	Output pulse width matching (NOTES)	$PW_{IN} > 1\mu s$		50	75	ns

NOTES t_{PM} is defined as $PW_{IN} - PW_{OUT}$.



Timing Waveforms

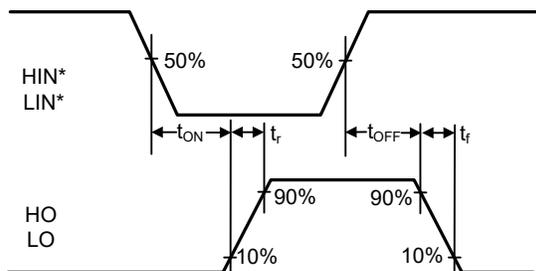


Figure 1. Switching Time Waveform Definitions

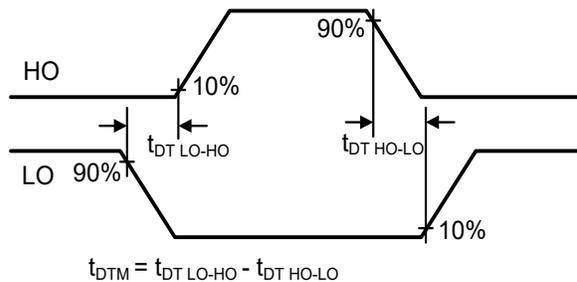


Figure 2. Deadtime Waveform Definitions

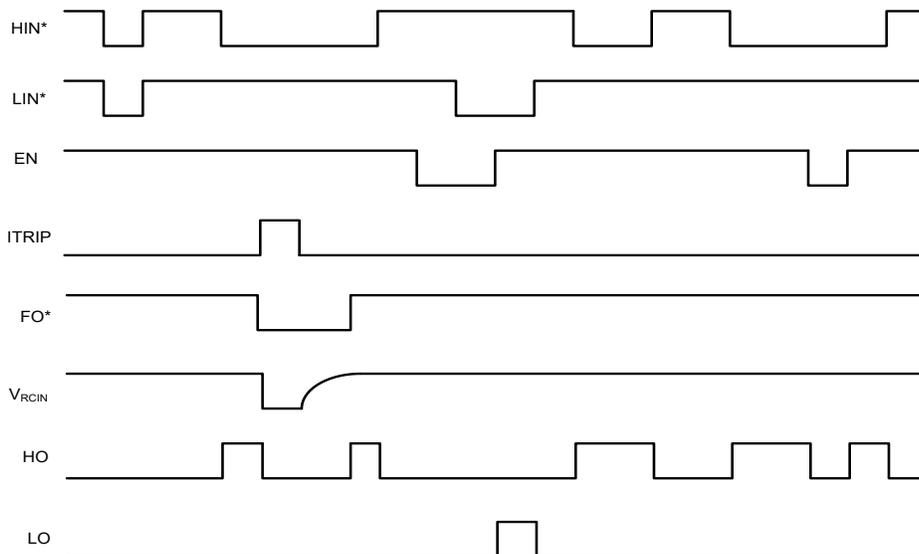


Figure 3. Input/Output Timing Diagram

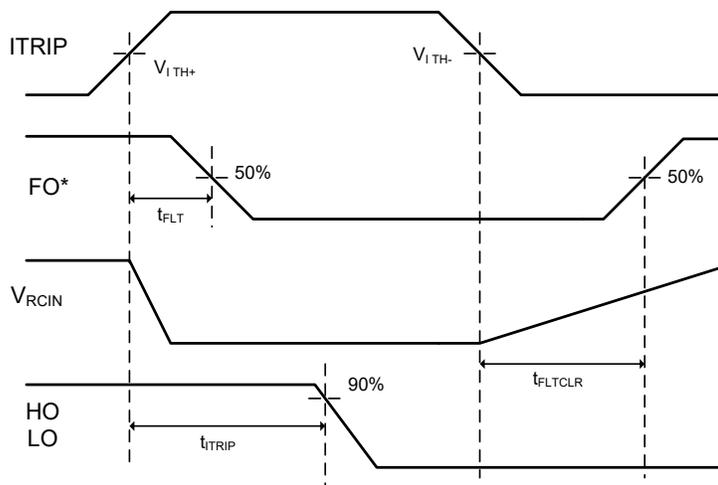
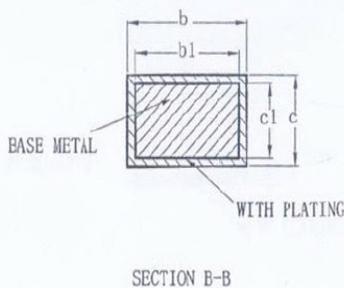
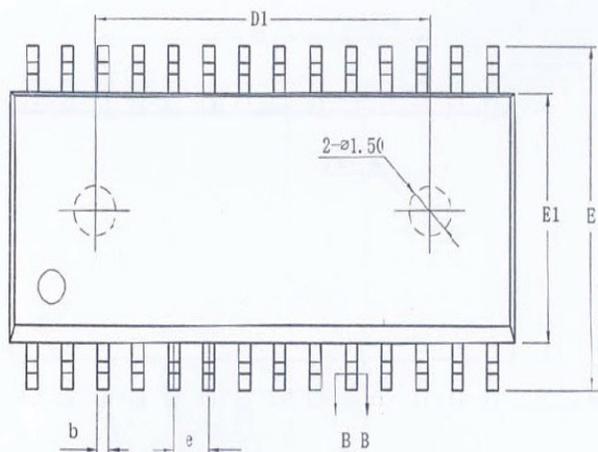
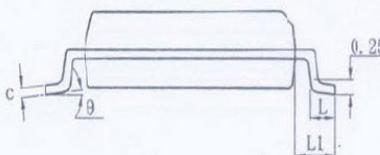
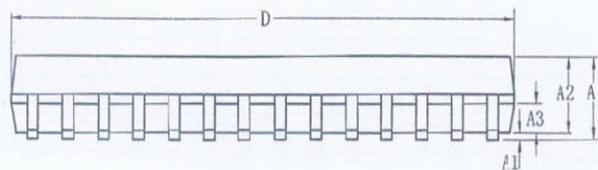


Figure 4. Overcurrent Timing Definitions



Package Dimensions (SOIC-28)

Please contact support@tfsemi.com for package availability.



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	2.65
A1	0.10	—	0.30
A2	2.25	2.30	2.35
A3	0.97	1.02	1.07
b	0.33	—	0.48
b1	0.38	0.41	0.43
c	0.25	—	0.31
c1	0.24	0.25	0.26
D	17.80	18.00	18.20
D1	11.90	12.00	12.10
E	10.10	10.30	10.50
E1	7.30	7.50	7.70
e	1.27BSC		
L	0.70	—	1.00
L1	1.40BSC		
•	0	—	8°
	120°120		



Revision History

Rev.	Change	Owner	Date
1.0	First release AI datasheet	Keith Spaulding	3/12/2018
1.1	VCC Supply ROC edit	Keith Spaulding	7/11/2018
1.2	VCC Supply 10V - 20V	Keith Spaulding	11/14/2018

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