



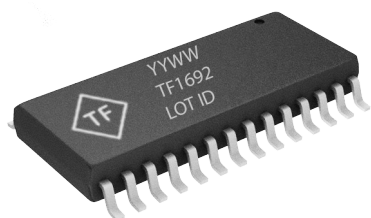
## Features

- Three floating high-side drivers in bootstrap operation to 250V
- 350mA source / 650mA sink output current capability
- Outputs tolerant to negative transients, dV/dt immune
- 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
- Built-in soft turn off function

## Applications

- 3-Phase Motor Inverter Driver
- BLDC Motor Driver
- Industrial Motor Inverter - Power Tools, Robotics
- General Purpose 3-Phase Inverter

SOIC-28



## Description

The TF1692 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 TF1692 high sides to switch to 250V in a bootstrap operation.

The TF1692 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 TF1692 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 TF1692 is offered in SOIC 28 package and operates over an extended -40 °C to +125 °C temperature range.

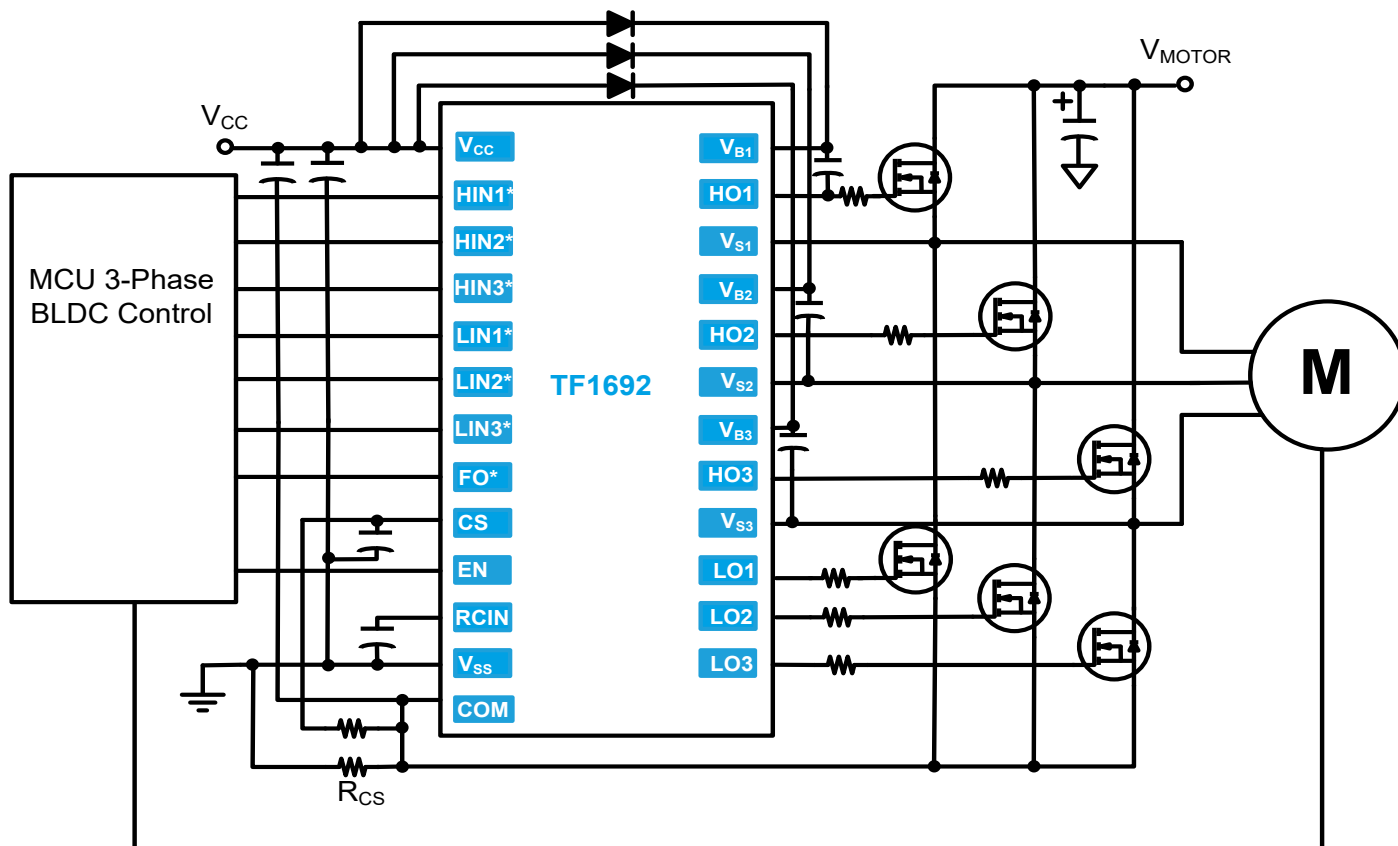
## Ordering Information

Year Year Week Week

PART NUMBER	PACKAGE	PACK / Qty	MARK
TF1692-TLS	SOIC-28	Tube / 25	YYWW TF1692
TF1692-TLH	SOIC-28	T&R / 1500	Lot ID

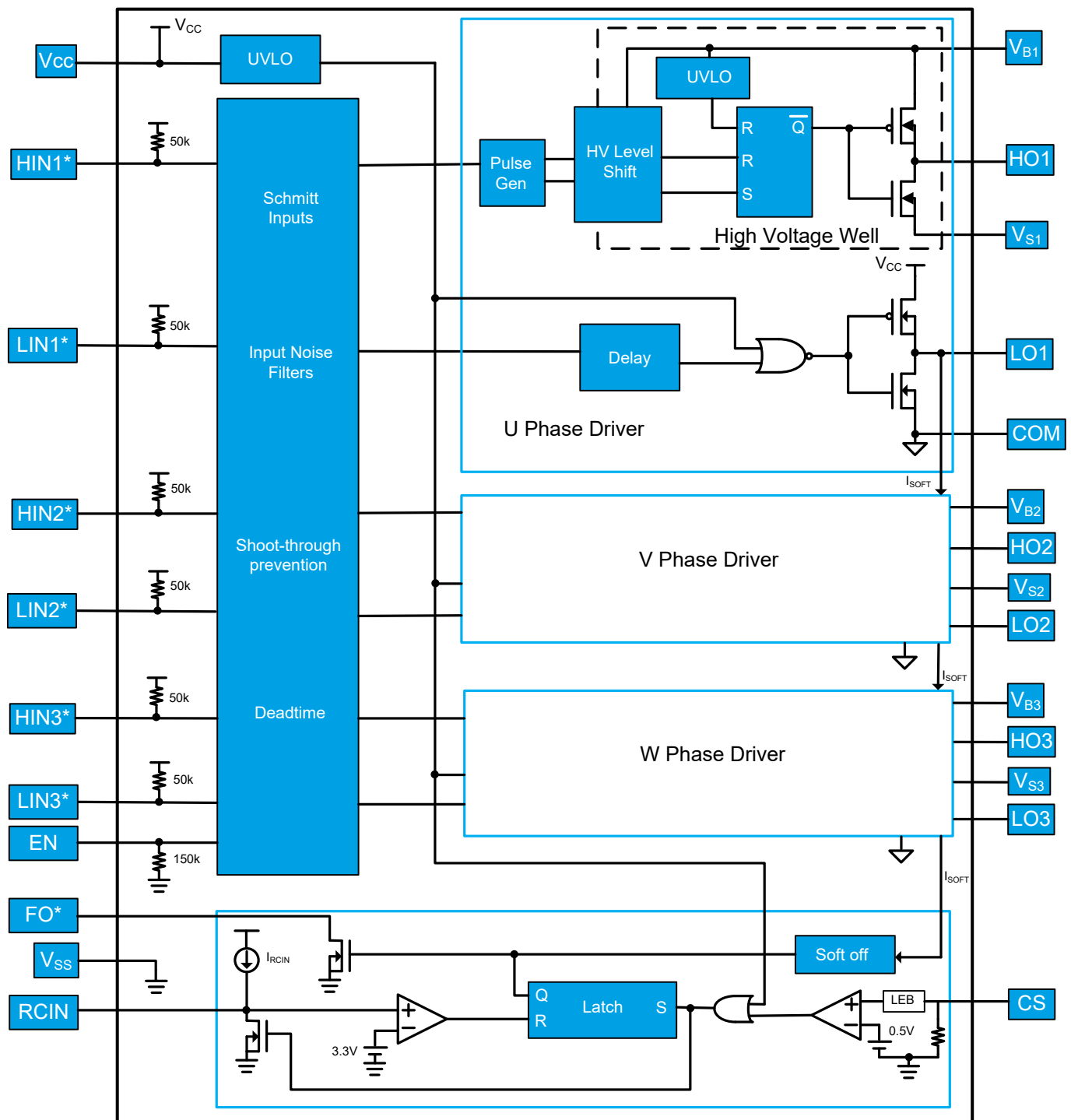


## Typical Application



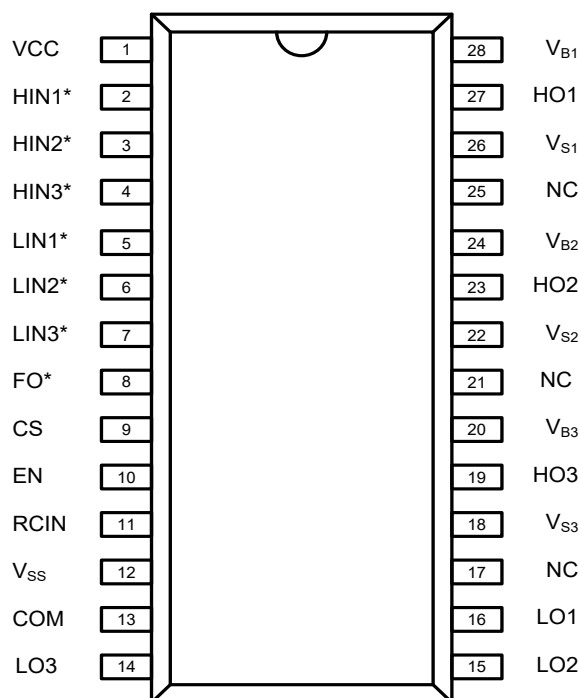


# Functional Block Diagram





## Pin Diagrams



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)
CS	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 <sub>SS</sub>	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 <sub>S3</sub> , V <sub>S2</sub> , V <sub>S1</sub>	18, 22, 26	High-side floating supply return
HO3, HO2, HO1	19, 23, 27	High-side gate driver output
V <sub>B3</sub> , V <sub>B2</sub> , V <sub>B1</sub>	20, 24, 28	High-side floating supply



## Absolute Maximum Ratings (NOTE1)

$V_B$  - High-side floating supply voltage.....-0.3V to +274V  
 $V_S$  - 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\*, CS, 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)

$\theta_{JC}$ .....45  $^\circ\text{C}/\text{W}$   
 $\theta_{JA}$ .....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	<b>NOTE3</b>	250	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*, CS, 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 +250V. Logic state held for VS of -5V to -VBS



## 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		2.5			V
$V_{IL}$	Logic "1" input voltage					
$V_{OH}$	High level output voltage, $V_{BIAS} - V_O$	$I_O = 0mA$			0.1	V
$V_{OL}$	Low level output voltage, $V_O$	$I_O = 0mA$			0.1	
$I_{LK}$	Offset supply leakage current	$V_B = V_S = 250V$			10	$\mu A$
$I_{BSQ}$	Quiescent $V_{BS}$ supply current	$V_{IN} = 0V$ or $5V, EN=0V$	10	50	80	
$I_{CCQ}$	Quiescent $V_{CC}$ supply current	$V_{IN} = 0V$ or $5V, EN=0V$		200		$\mu A$
$I_{IN+}$	Logic input bias current (HO=LO=HIGH)	$V_{IN} = 0V$		100		$\mu A$
$I_{IN-}$	Logic input bias current (HO=LO=LOW)	$V_{IN} = 5V$		8.5	25	
$I_{EN+}$	Logic Enable "1" input bias current	$V_{EN} = 5V$		33		$\mu A$
$I_{EN-}$	Logic Enable "0" input bias current	$V_{EN} = 0V$			2	$\mu A$
$V_{BSUV+}$ $V_{CCUV+}$	$V_{BS}$ and $V_{CC}$ supply under-voltage positive going threshold		7.5	8.5	9.3	V
$V_{BSUV-}$ $V_{CCUV-}$	$V_{BS}$ and $V_{CC}$ supply under-voltage negative going threshold		7.0	8.0	8.7	
$I_{O+}$	Output high short circuit pulsed current	$V_O = 0V, PW \leq 10 \mu s$	250	350		mA
$I_{O-}$	Output low short circuit pulsed current	$V_O = 15V, PW \leq 10 \mu s$	500	650		
$V_{CSTH+}$	Overcurrent detect positive threshold		400	500	600	mV
$V_{CSTH-}$	Overcurrent detect negative threshold			440		mV
$I_{CSIN}$	Short-circuit input current	$V_{CSIN}=1V$	5	10	15	$\mu A$
$I_{SOFT}$	Soft turn-off sink current		25	40	55	$\mu A$
$V_{RCINTH+}$	RCIN Positive going threshold voltage			3.3		V
$V_{RCINTH-}$	RCIN Nositive going threshold voltage			2.6		V
$I_{RCIN}$	RCIN Internal current source	$C_{RCIN}=2nF$	3	5	7	$\mu A$
$V_{FOL}$	Fault output low level voltage	$V_{CS}=1V, I_{FO}=1.5mA$		0.2	0.5	V
$R_{DSRCIN}$	RCIN On resistance	$I_{RCIN}=1.5mA$	50	75	100	$\Omega$
$R_{DSFO}$	Fault output on resistance	$I_{FO}=1.5mA$	90	130	170	$\Omega$

**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

$V_{BIAS} (V_{CC}, V_{BS}) = 15V$ ,  $C_L = 1000pF$ ,  $C_{RCIN} = 2nF$ , and  $T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
$t_{on}$	Turn-on propagation delay	$V_S = 0V$	350	500	650	ns
$t_{off}$	Turn-off propagation delay	$V_S = 0V$	350	500	650	
$t_r$	Turn-on rise time	$V_S = 0V$	20	50	100	
$t_f$	Turn-off fall time		10	30	80	
$t_{DM}$	Delay matching				50	ns
$t_{EN}$	Enable low to output shutdown delay		400	500	600	ns
$t_{CSBLT}$	CS Pin leading-edge blanking time		200	300	400	ns
$t_{CSFO}$	Time from CS triggering to FO*	From $V_{CSC} = 1V$ to FO* turn off		630		ns
$t_{CSOFF}$	Time from CS triggering to all gate outputs turn off	From $V_{CSC} = 1V$ to starting gate turn off		640		ns
$t_{FLTIN}$	Input filtering time (HIN*, LIN*, EN)		200	250	300	ns
$t_{FLTCLR}$	Fault clear time			1.3		ms
$t_{DT}$	Deadtime		230	290	350	ns
$t_{DTM}$	Deadtime matching				50	ns
$t_{PM}$	Output pulse width matching ( <b>NOTES</b> )	$PW_{IN} > 1\mu s$		50	100	ns

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



# Timing Waveforms

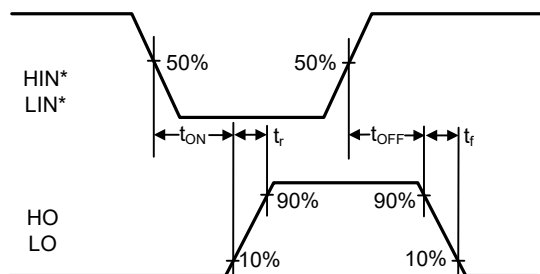


Figure 1. Switching Time Waveform Definitions

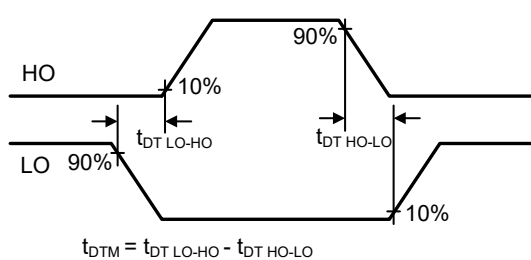


Figure 2. Deadtime Waveform Definitions

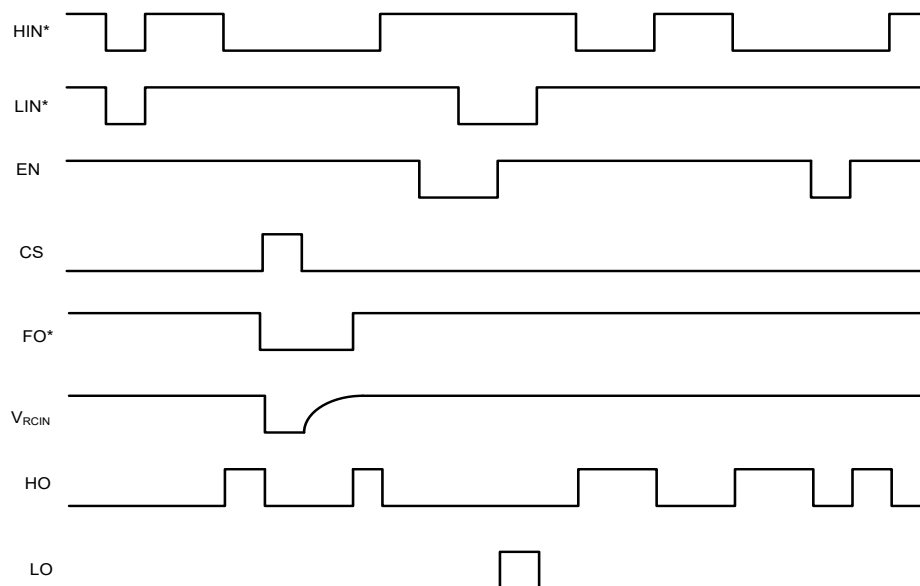


Figure 3. Input/Output Timing Diagram

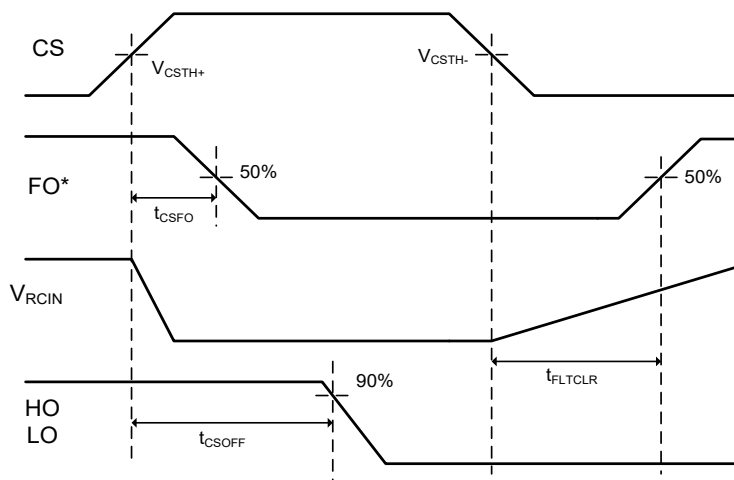


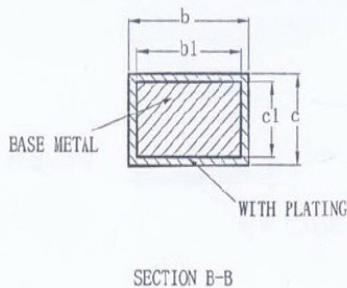
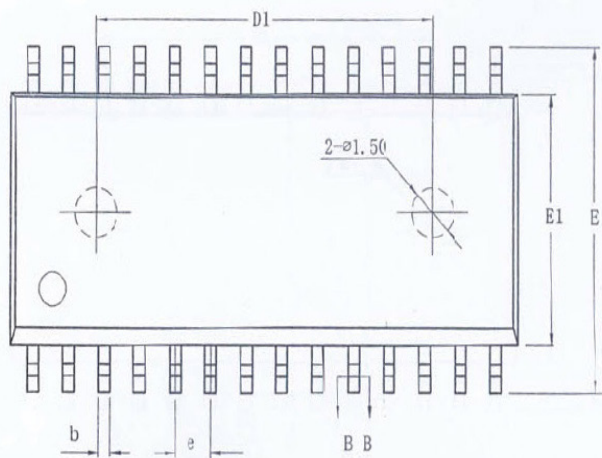
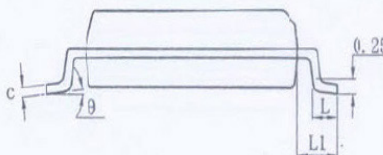
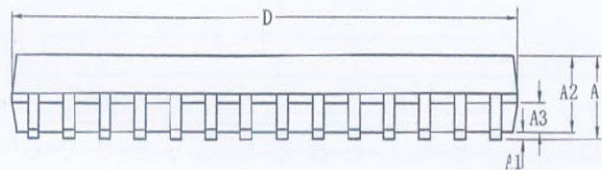
Figure 4. Overcurrent Timing Definitions





# Package Dimensions (SOIC-28)

Please contact support@tfsemi.com for package availability.



SYMBL	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	0.39	—	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	5/20/15
2.0	Revision system added	Keith Spaulding	1/20/16
2.1	Deadtime waveform definition, fig. 2 added	Keith Spaulding	3/22/16
2.2	Edit text	Keith Spaulding	1/25/18

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