



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
- 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
- Extended temperature range: -40°C to +125°C

Applications

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

Description

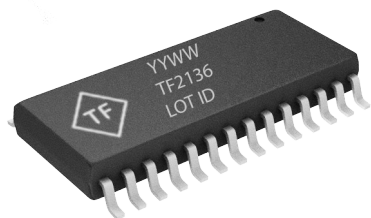
The TF2136 is a three-phase gate driver IC designed for high voltage, high speed applications, driving N-channel MOSFETs and IGBTs in a half-bridge configuration. Telefunken’s high voltage process enables the TF2136 high sides to switch to 600V in a bootstrap operation.

The TF2136 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 TF2136 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 TF2136 is offered in SOIC 28 package and operates over an extended -40 °C to +125 °C temperature range.

SOIC-28

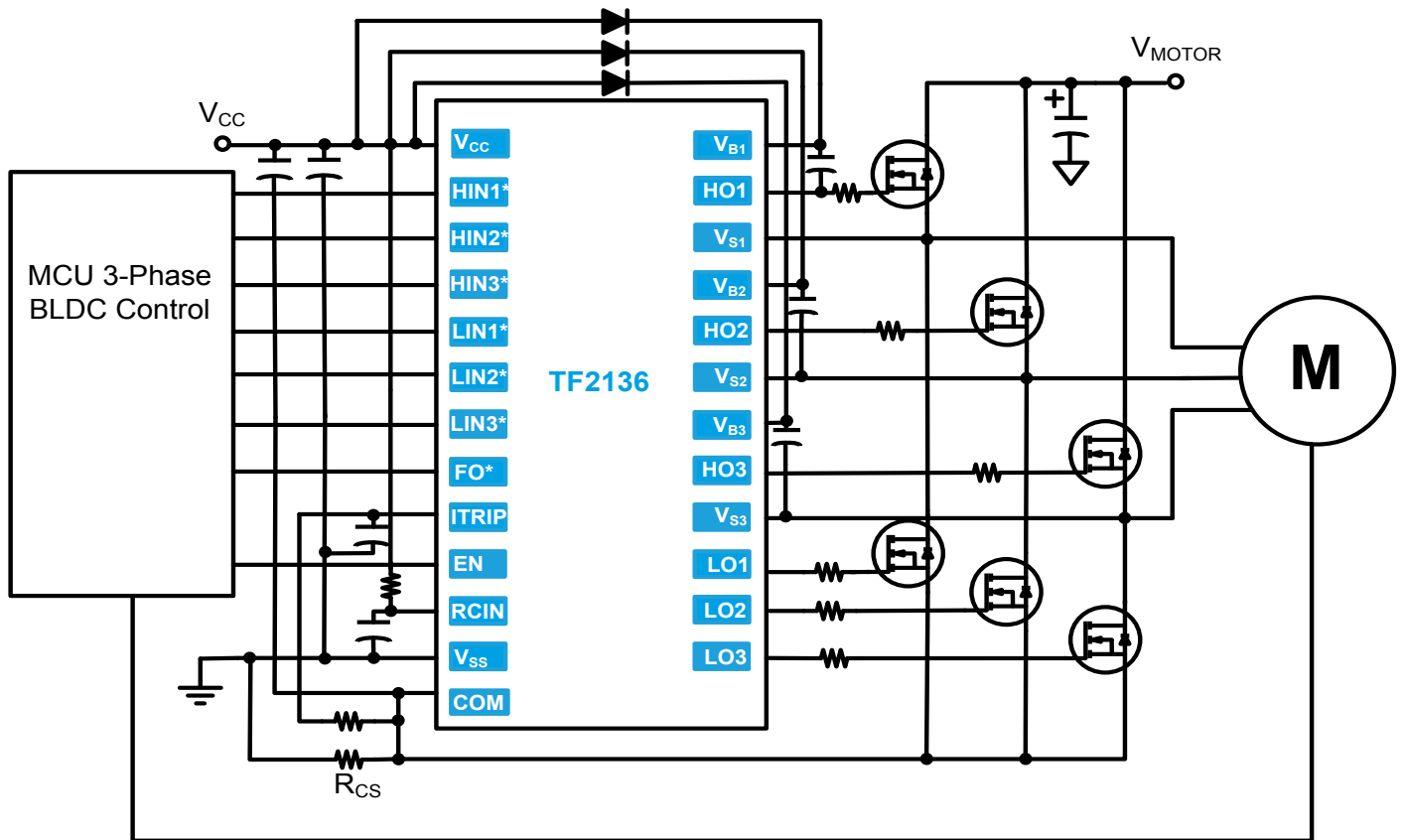


Ordering Information

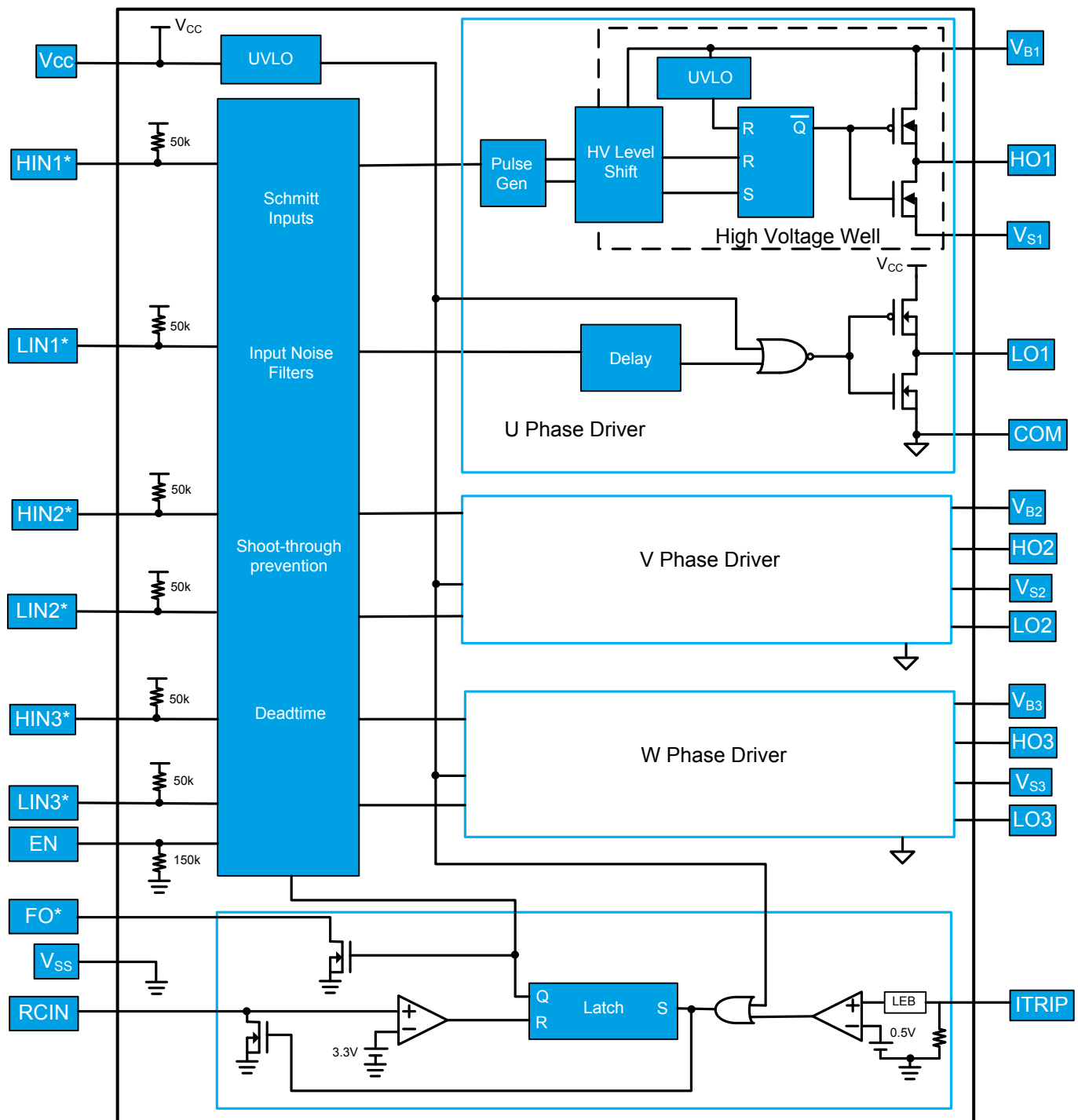
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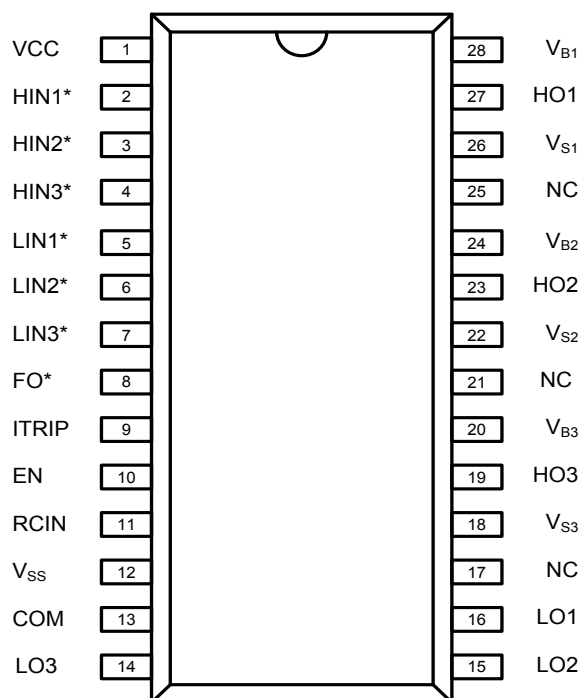
| PART NUMBER | PACKAGE | PACK / Qty | MARK |
|-------------|---------|------------|----------------|
| TF2136-TAU | SOIC-28 | Tube / 25 | YYWW TF2136 |
| TF2136-TAH | SOIC-28 | T&R / 1500 | Lot ID |

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) |
| 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 |

3-Phase Half-Bridge Gate Driver**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*, 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 +600V. Logic state held for VS of -5V to -VBS

DC Electrical Characteristics (NOTE4)
 $V_{BIAS} (V_{CC}, V_{BS}) = 15V, T_A = 25\text{ }^\circ\text{C}$, 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 | | | | 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 | 50 | 80 | |
| I_{CCQ} | Quiescent V_{CC} supply current | $V_{IN} = 0V$ or $5V, EN=0V$ | | 200 | | μA |
| I_{IN+} | Logic input bias current (HO=LO=HIGH) | $V_{IN} = 0V$ | | 100 | | μA |
| 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 | | 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 | | 7.5 | 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 | $V_O = 0V, PW \leq 10\ \mu s$ | 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 | | | 440 | | mV |
| I_{CSIN} | Short-circuit input current | $V_{CSIN}=1V$ | 5 | 10 | 15 | μA |
| I_{SOFT} | Soft turn-off sink current | | 25 | 40 | 55 | μA |
| $V_{RCINTH+}$ | RCIN Positive going threshold voltage | | | 8 | | V |
| $V_{RCINTH-}$ | RCIN Nositive 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 | $I_{RCIN}=1.5mA$ | 50 | 75 | 100 | Ω |
| R_{DSFO} | Fault output on resistance | $I_{FO}=1.5mA$ | 90 | 130 | 170 | Ω |

NOTE4 The V_{IN} , V_{TH} 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 $T_A = 25\text{ }^\circ\text{C}$, 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 | $V_S = 0V$ | | 125 | 190 | |
| t_f | Turn-off fall time | | | 50 | 75 | |
| t_{DM} | Delay matching | | | | 50 | ns |
| t_{EN} | Enable low to output shutdown delay | | 400 | 500 | 600 | 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 | | 630 | | ns |
| t_{ITRIP} | Time from ITRIP triggering to all gate outputs turn off | From $V_{ITRIP} = 1V$ 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 (NOTES) | $PW_{IN} > 1\mu s$ | | 50 | 100 | ns |

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

Timing Waveforms

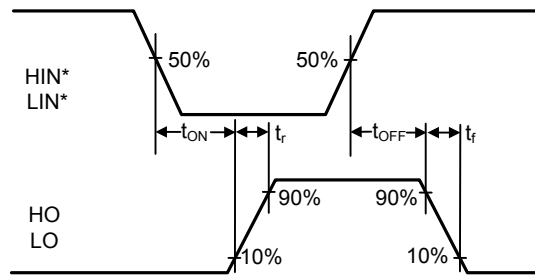


Figure 1. Switching Time Waveform Definitions

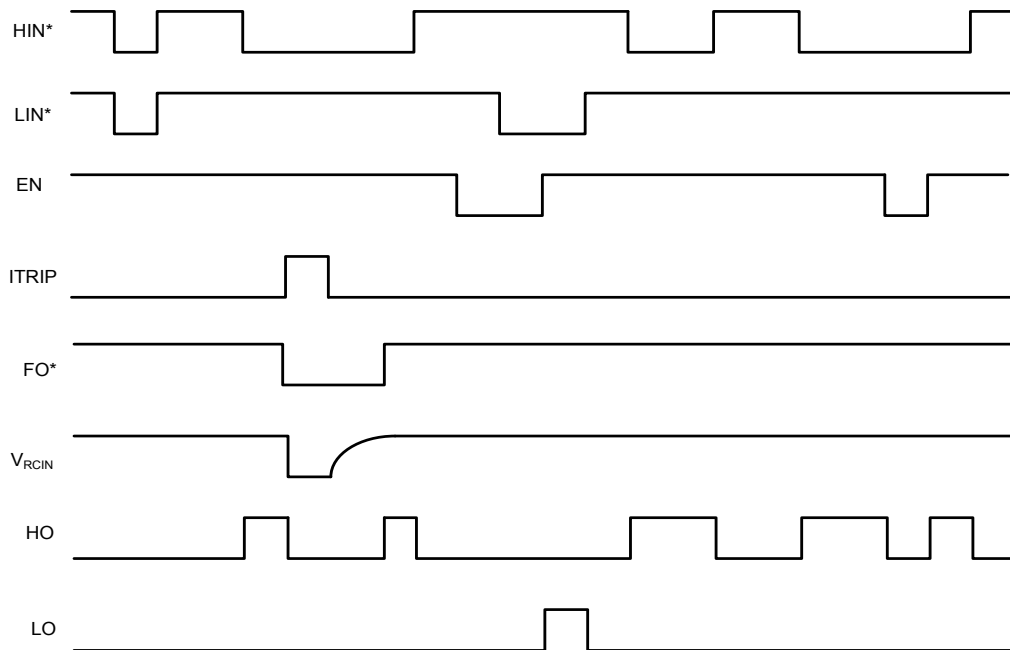


Figure 2. Input/Output Timing Diagram

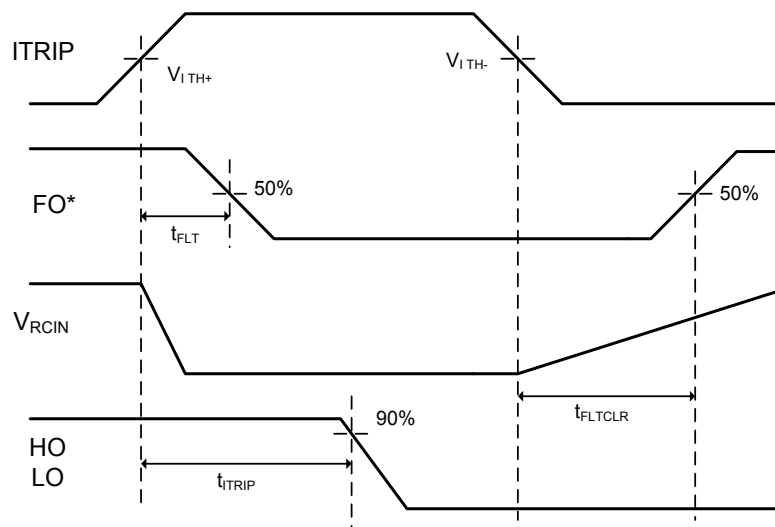
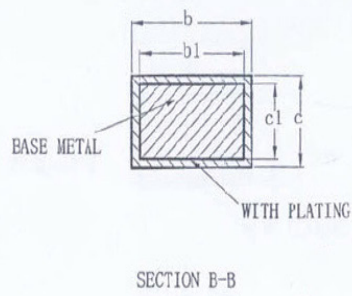
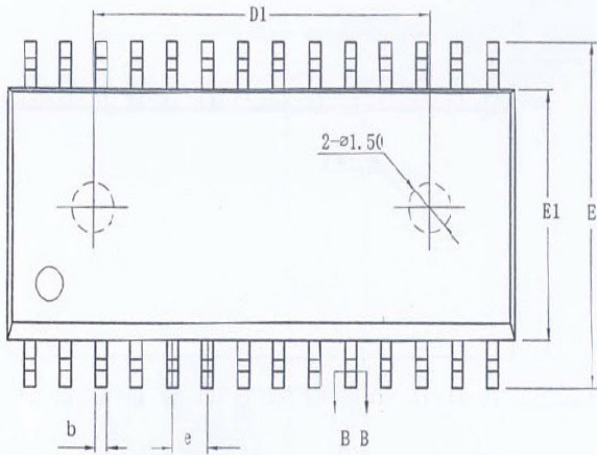
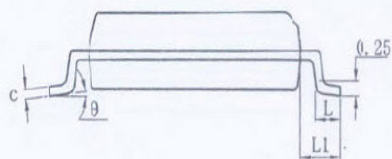
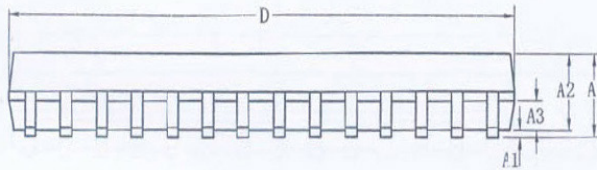


Figure 3. Overcurrent Timing Definitions

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 | 0.39 | — | 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 | | |

Notes

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