

## IR3312(S)

### PROGRAMMABLE CURRENT SENSING HIGH SIDE SWITCH

#### Features

- Load current feedback
- Programmable over current shutdown
- Active clamp
- E.S.D protection
- Input referenced to Vcc
- Over temperature shutdown
- Reverse battery protection

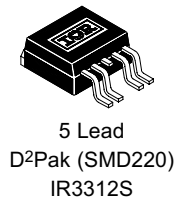
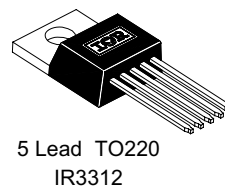
#### Description

The IR 3312(S) is a Fully Protected 4 terminal high side switch. The input signal is referenced to Vcc. When the input voltage  $V_{cc} - V_{in}$  is higher than the specified  $V_{ih}$  threshold, the output power MOSFET is turned-on. When  $V_{cc} - V_{in}$  is lower than the specified  $V_{il}$  threshold, the output MOSFET is turned-off. A sense current proportional to the current in the power Mosfet is sourced to the Ifb pin. Over-current shutdown occurs when  $V_{ifb} - V_{in} > 4.5 V$ . The current shutdown threshold is adjusted by selecting the proper R<sub>Ifb</sub>. Either over-current and over-temperature latches off the switch. The device is reset by pulling the input pin high. Other integrated protections ( ESD, reverse battery, active clamp ) make the IR3312(S) very rugged and suitable for the automotive environment.

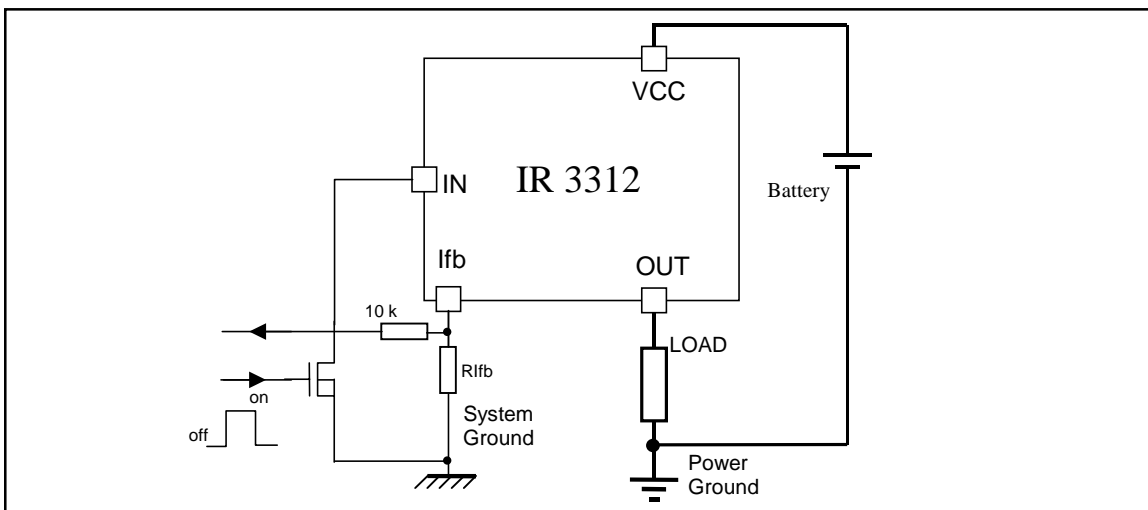
#### Product Summary

|                       |          |
|-----------------------|----------|
| R <sub>ds(on)</sub>   | 20mΩ     |
| V <sub>cc.op.</sub>   | 6 to 28V |
| Current ratio         | 2800     |
| I <sub>shutdown</sub> | 3 to 30A |
| Active clamp          | 35V      |
| Load Dump             | 40V      |

#### Package



#### Typical Connection



## Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Vcc lead. (T<sub>Ambient</sub> = 25°C unless otherwise specified).

| Symbol                                  | Parameter   | Min. | Max. | Units |
|---|---|------|------|-------|
| V <sub>cc</sub> - V <sub>in</sub> max   | Maximum input voltage   | -16  | 50   | V     |
| V <sub>cc</sub> -V <sub>lfb</sub> max   | Maximum lfb voltage   | -0.3 | 50   |       |
| V <sub>cc</sub> - V <sub>out</sub> max. | Maximum output voltage  | -0.3 | 33   |       |
| I <sub>ds</sub> cont.                   | Diode max. permanent current (R <sub>th</sub> = 60 °C/W) (1)  | —    | 2.8  | A     |
| I <sub>ds1</sub> cont                   | Diode max. permanent current (R <sub>th</sub> = 5 °C/W) (1)   | —    | 25   |       |
| I <sub>ds</sub> pulsed                  | Diode max. pulsed current (1)                                 | —    | 100  |       |
| ESD 1                                   | Electrostatic discharge ( human body model )C=100pF, R=1500Ω, | —    | 4    | kV    |
| ESD 2                                   | Electrostatic discharge (machine model)C=200pF,R=0Ω, L=10μH   | —    | 0.5  |       |
| P <sub>d</sub>                          | Power dissipation ( R <sub>th</sub> = 60 °C/W )               | —    | 2    | W     |
| T <sub>J</sub> max.                     | Max. storage and junction temperature                         | -40  | 150  | °C    |
| Min R <sub>lfb</sub>                    | Minimum resistor on the lfb pin                               | 0.3  | —    | kΩ    |
| I <sub>fb</sub> max                     | Max. lfb current  | -20  | +20  | mA    |

## Thermal Characteristics

| Symbol            | Parameter  | Typ. | Max. | Units |
|-------------------|--|------|------|-------|
| R <sub>th</sub> 1 | Thermal resistance junction to Ambient - TO220       | 60   | —    | °C/W  |
| R <sub>th</sub> 2 | Thermal resistance junction to case - TO220          | 0.7  | —    |       |
| R <sub>th</sub> 1 | Thermal resistance with standard footprint - SMD220  | 60   | —    |       |
| R <sub>th</sub> 2 | Thermal resistance with 1" square footprint - SMD220 | 35   | —    |       |
| R <sub>th</sub> 3 | Thermal resistance junction to case - SMD220         | 0.7  | —    |       |

## Recommended Operating Conditions

These values are given for a quick design. For operation outside these conditions, please consult the application notes.

| Symbol                            | Parameter   | Min. | Max. | Units |
|-----------------------------------|---|------|------|-------|
| V <sub>cc</sub> -V <sub>in</sub>  | Continuous input voltage  | 6    | 28   | V     |
| V <sub>cc</sub> -V <sub>lfb</sub> | Continuous lfb pin voltage  | 0.3  | 28   |       |
| V <sub>cc</sub>                   | Supply to power ground voltage  | 6    | 28   |       |
| I <sub>out</sub>                  | Continuous output current ( R <sub>th</sub> /amb < 5 °C/W, T <sub>j</sub> = 125°C)  | —    | 14   | A     |
| I <sub>out</sub> 85°C amb.        | Continuous output current ( R <sub>th</sub> /amb < 60 °C/W, T <sub>j</sub> = 125°C) | —    | 3.9  |       |
| R <sub>lfb</sub>                  | lfb resistor to program I <sub>sd</sub> and scale ( 2 & 3)                          | 0.5  | 3.5  | kΩ    |
| Pulse min.                        | Minimum turn-on pulse width   | 1    | —    | ms    |
| F <sub>max</sub>                  | Maximum operating frequency   | —    | 500  | Hz    |
| F <sub>max</sub> Prot.            | Maximum frequency with protections activated  | —    | 200  |       |

- 1) Limited by junction temperature. Pulsed current is also limited by wiring
- 2) <500 Ohm or shorting lfb to gnd may damage the part with I<sub>sd</sub> around 37A
- 3) >5000 Ohm or leaving lfb open will shutdown the part. No current will flow in the load.

### Protection Characteristics

T<sub>j</sub> = 25°C (unless otherwise specified), R<sub>lfb</sub> = 500 to 5kΩ.

| Symbol   | Parameter                           | Min. | Typ. | Max. | Units | Test Conditions   |
|--|-------------------------------------|------|------|------|-------|---|
| V <sub>lfb</sub> -V <sub>in</sub><br>@ I <sub>sd</sub> | Over-current shutdown threshold     | 4    | 4.5  | 5.4  | V     |   |
| T <sub>sd</sub>  | Over-temp. shutdown threshold       | —    | 165  | —    | °C    | see Fig. 7  |
| T <sub>reset</sub>                                     | Protection reset time               | —    | 50   | 300  | μs    | see Fig. 7  |
| OV   | Over voltage shutdown (not latched) | 33   | 36   | 41   | V     |   |
| I <sub>sd</sub> f                                      | Fixed over current shutdown         | 30   | 37   | 45   | A     | V <sub>lfb</sub> <V <sub>in</sub>                             |
| I <sub>sd</sub> _1k                                    | Adjustable over current shutdown 1K | 9    | 12   | 16   | A     | R <sub>lfb</sub> =1k  |
| Min.Pulse  | Minimum pulse width (no WAIT state) | 200  | 500  | 1200 | μs    | see Fig. 6  |
| WAIT   | WAIT function timer                 | 0.5  | 1.2  | 3.5  | ms    | see Figs. 6 and 7   |
| Rev.Rds <sub>on</sub>                                  | Rds(on) reverse battery protection  | 10   | 16   | 28   | mΩ    | V <sub>cc</sub> -V <sub>in</sub> =-12V, I <sub>load</sub> =5A |

### Static Electrical Characteristics

(T<sub>j</sub> = 25°C, V<sub>cc</sub> = 14V unless otherwise specified.)

| Symbol              | Parameter  | Min. | Typ. | Max. | Units | Test Conditions   |
|---------------------|--|------|------|------|-------|---|
| I <sub>q</sub>      | Total quiescent current (I <sub>out</sub> +I <sub>fb</sub> ) | —    | 22   | 50   | μA    | V <sub>cc</sub> -V <sub>in</sub> =0, V <sub>cc</sub> -V <sub>out</sub> =12V<br>V <sub>cc</sub> -V <sub>lfb</sub> =12V |
| I <sub>in</sub>     | Input current  | 1.5  | 4    | 6    | mA    | V <sub>cc</sub> -V <sub>in</sub> =14V   |
| V <sub>ih</sub>     | High level input threshold voltage (4)                       | —    | 5    | 5.5  |       |   |
| V <sub>il</sub>     | Low level input threshold voltage (4)                        | 3.5  | 4    | —    | V     |   |
| V <sub>hys</sub>    | Input hysteresis = V <sub>ih</sub> -V <sub>il</sub>          | 0.4  | 1    | 1.5  |       |   |
| I <sub>out</sub> qs | Output quiescent current                                     | —    | 9    | 15   | μA    | V <sub>cc</sub> -V <sub>in</sub> =0; V <sub>cc</sub> -V <sub>lfb</sub> =0;<br>V <sub>cc</sub> -V <sub>out</sub> =12V  |
| R <sub>ds1</sub> on | ON state resistance (5)                                      | 10   | 15   | 20   |       | I <sub>out</sub> =15A, V <sub>cc</sub> -V <sub>in</sub> =14V  |
| R <sub>ds2</sub> on | ON state resistance (5)                                      | 10   | 16   | 28   | mΩ    | I <sub>out</sub> =10A, V <sub>cc</sub> -V <sub>in</sub> =6V   |
| R <sub>ds3</sub> on | ON state resistance (5)                                      | 20   | 28.5 | 38   |       | I <sub>out</sub> =15A, T <sub>j</sub> = 150°C   |
| V <sub>clamp1</sub> | V <sub>cc</sub> to V <sub>out</sub> active clamp voltage     | 33   | 35   | —    |       | I <sub>out</sub> = 10mA   |
| V <sub>clamp2</sub> | V <sub>cc</sub> to V <sub>out</sub> active clamp voltage     | —    | 36   | 40   |       | I <sub>out</sub> =30A, V <sub>cc</sub> -V <sub>lfb</sub> <20V   |
| V <sub>sd</sub>     | Body diode forward voltage                                   | —    | 0.85 | 1    | V     | I <sub>out</sub> =5A  |
| V <sub>aval.</sub>  | V <sub>cc</sub> to V <sub>out</sub> avalanche voltage        | 40   | 43   | 50   |       | I <sub>out</sub> =100mA, V <sub>cc</sub> -V <sub>lfb</sub> > 35V  |

### Switching Electrical Characteristics

V<sub>cc</sub> = 14V, Resistive Load = 0.4Ω, T<sub>j</sub> = 25°C, (unless otherwise specified).

| Symbol            | Parameter   | Min. | Typ. | Max. | Units | Test Conditions |
|-------------------|---|------|------|------|-------|-----------------|
| T <sub>don</sub>  | Turn-on delay time to V <sub>cc</sub> -V <sub>out</sub> = 0.9 V <sub>cc</sub> | 2    | 9    | 20   |       | see figure 2    |
| T <sub>r1</sub>   | Rise time to V <sub>cc</sub> -V <sub>out</sub> =5V                            | 0.2  | 1    | 5    | μs    |                 |
| T <sub>r2</sub>   | Rise time to V <sub>cc</sub> -V <sub>out</sub> = 0.1V <sub>cc</sub>           | 5    | 15   | 60   |       |                 |
| E <sub>on</sub>   | Turn ON energy  | —    | 0.75 | 1.5  | mJ    | see figure 3    |
| T <sub>doff</sub> | Turn-off delay to V <sub>cc</sub> -V <sub>out</sub> = 0.1V <sub>cc</sub>      | 5    | 14   | 60   | μs    |                 |
| T <sub>f</sub>    | Fall time to V <sub>cc</sub> -V <sub>out</sub> = 0.9 V <sub>cc</sub>          | 2    | 7    | 25   |       |                 |
| E <sub>off</sub>  | Turn OFF energy   | —    | 0.5  | 1    | mJ    |                 |

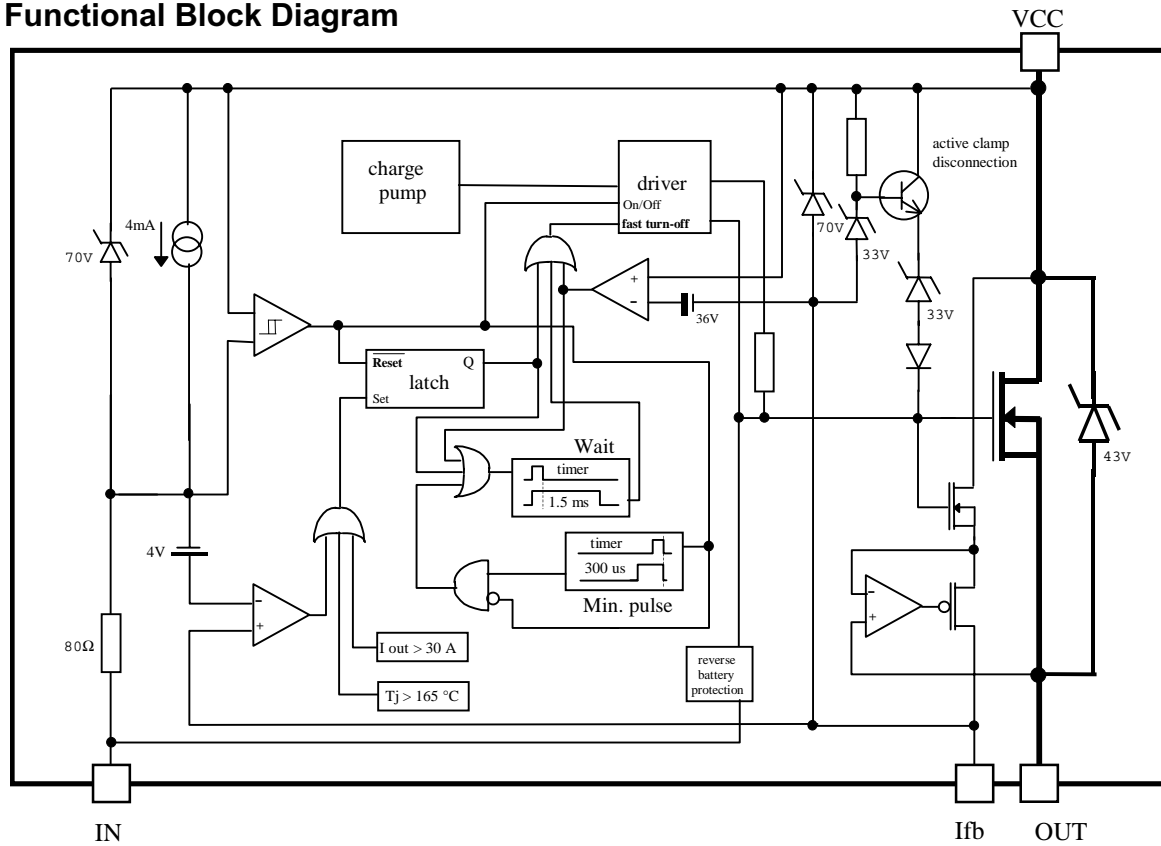
4) Input thresholds are measured directly between the input pin and the tab. Any parasitic resistance in common between the load current path and the input signal path can significantly affect the thresholds.

5) Rds(on) is measured between the Tab and the Out pin, 5mm away from the package.

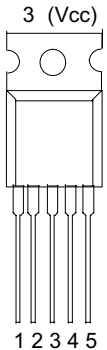
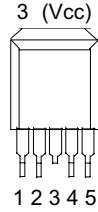
## Current Sense Characteristics

| Symbol   | Parameter   | Min.  | Typ.  | Max.  | Units | Test Conditions  |
|----------|---|-------|-------|-------|-------|--|
| Ratio    | I load / I <sub>fb</sub> current ratio                        | 2,400 | 2,800 | 3,300 | —     | T <sub>j</sub> = 25°C, R <sub>fb</sub> = 500Ω, I = 30A |
| Ratio_TC | I <sub>load</sub> /I <sub>fb</sub> variation over temperature | -5    | 0     | +5    | %     | T <sub>j</sub> = -40 T <sub>0</sub> +150°C             |
| offset   | Load current diagnostic offset                                | -0.45 | 0     | 0.45  | A     | I = 2A   |
| Trst     | I <sub>fb</sub> response time (low signal)                    | —     | 5     | 15    | μs    | 90% of the I load step                                 |

## Functional Block Diagram



**Lead Assignments**

|  |  |  |
|--|--|--|
|  <p>3 (Vcc)<br/>1 2 3 4 5</p> <p>5 Lead - TO220</p> | <p>1 - In<br/>2 - Ifb<br/>3 - Vcc (tab)<br/>4 - NC<br/>5 - Out</p> |  <p>3 (Vcc)<br/>1 2 3 4 5</p> <p>5 Lead - D<sup>2</sup>PAK (SMD220)</p> |
| <b>IR3312</b>  |  | <b>IR3312S</b>   |
| <b>Part Number</b>   |  |  |

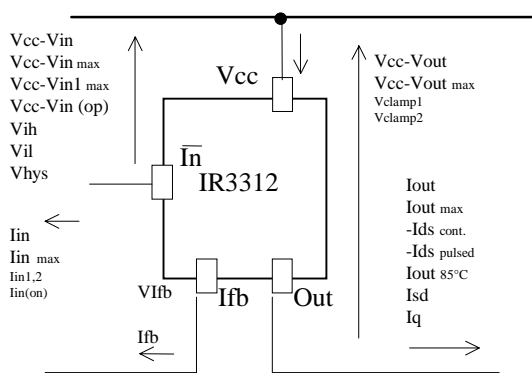


Figure 1 - Voltages and currents definitions

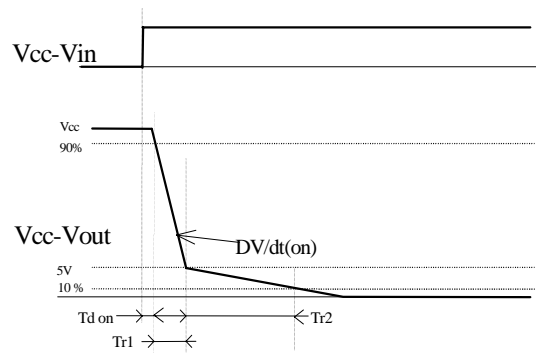


Figure 2 - Switching time definitions (turn-on)

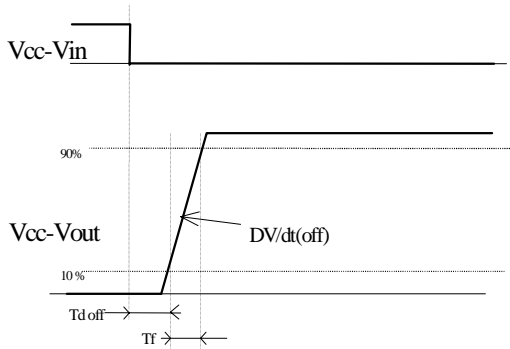


Figure 3 - Switching time definitions (turn-off)

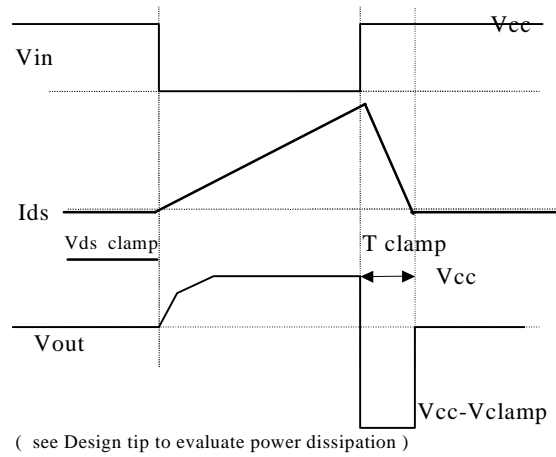
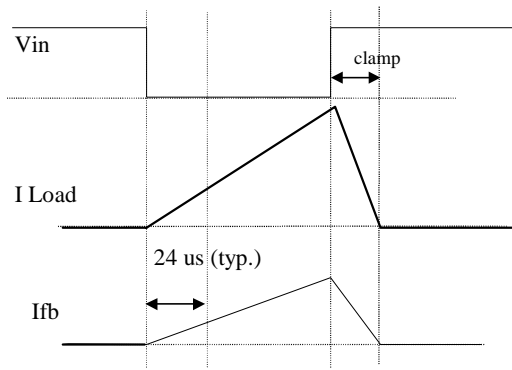


Figure 4 - Active clamp waveforms



Precise measurement

Figure 5 - Current sense precision:  
Accurate measurement only when the power Mosfet is fully ON

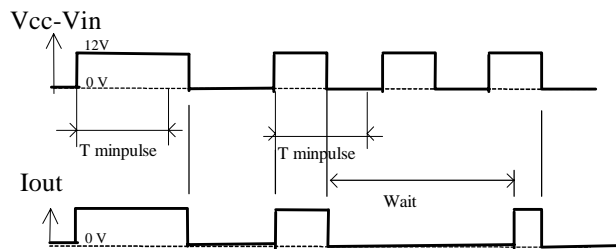


Figure 6 - Minimum pulse & WAIT function

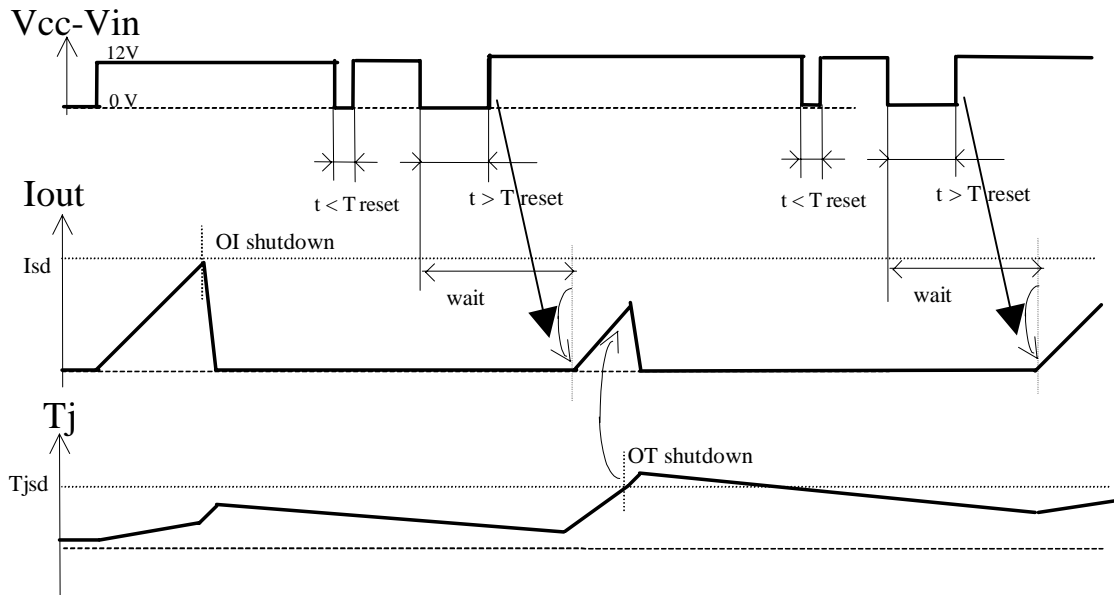


Figure 7 - Protection Timing Diagrams

All curves are typical characteristics. Operation in hatched areas is not recommended.  $T_j=25^{\circ}C$ ,  $R_{lfb}=500\ \Omega$ ,  $V_{cc}=14V$  (unless otherwise specified).

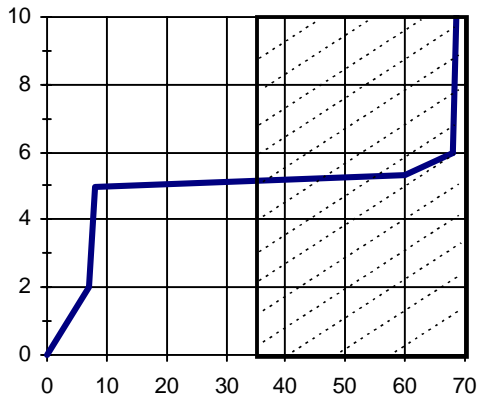


Figure 8 -  $I_{cc}$  (mA) vs  $V_{cc-Vin}$  (V)

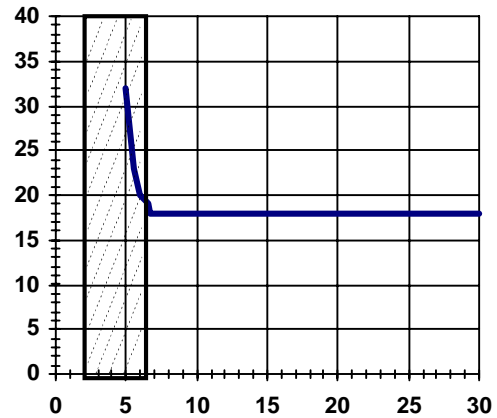


Figure 9-  $R_{dsOn}$  (m $\Omega$ ) vs  $V_{cc-Vin}$  (V)

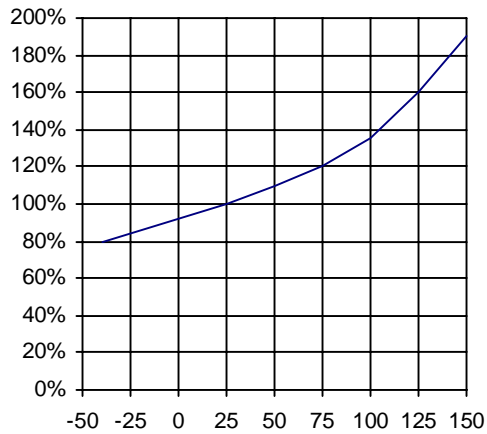


Figure 10 - Normalized Rdson (%) vs Tj (°C)

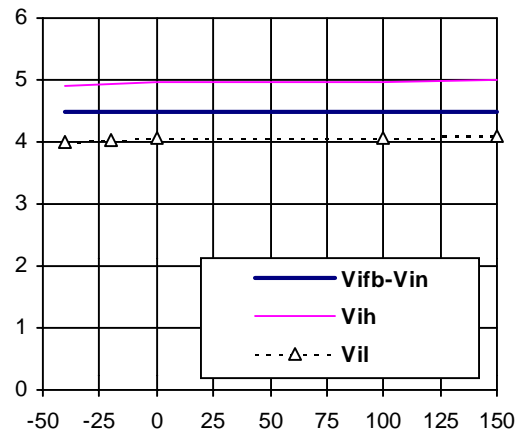


Figure 11 - Vih, Vil & Vifb - Vin (V) vs Tj (°C)

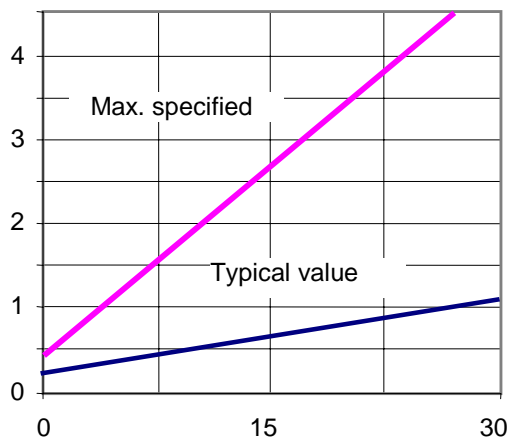


Figure 12 - Error (+/-A) vs Iload (A)

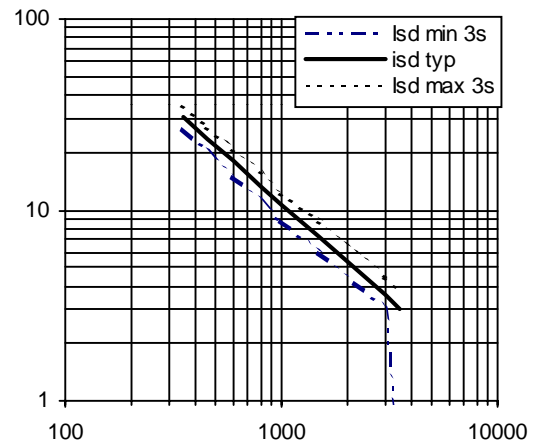


Figure 13 - Isd (A) vs Rlfb (Ohm)



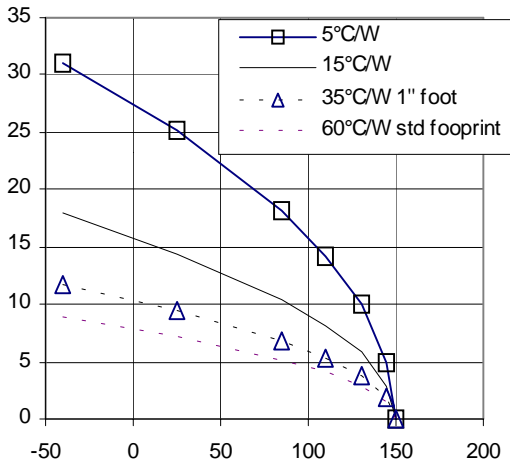


Figure 14 - Max. DC current (A) vs Temp. (°C)

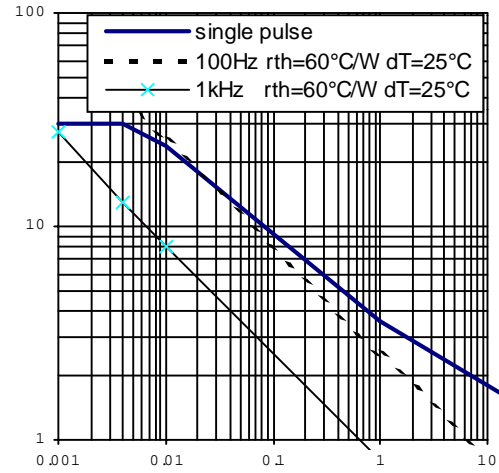


Figure 15 - Max. I (A) vs inductance (mH)

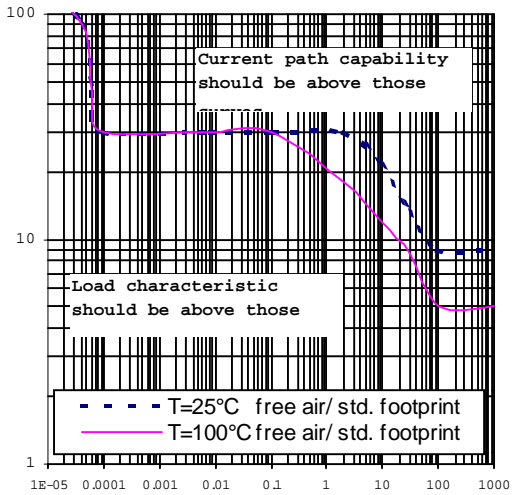


Figure 16 - I out (A) vs Protection resp. Time (s)

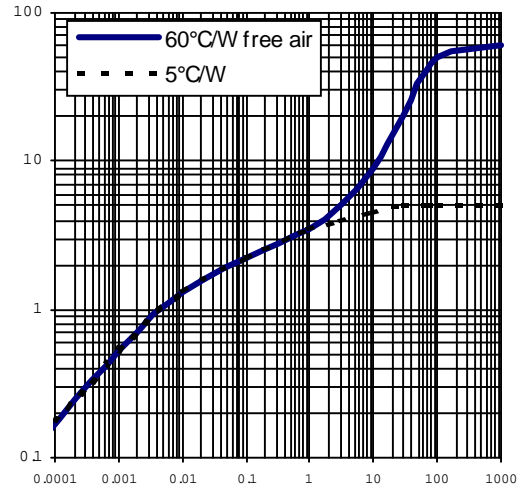
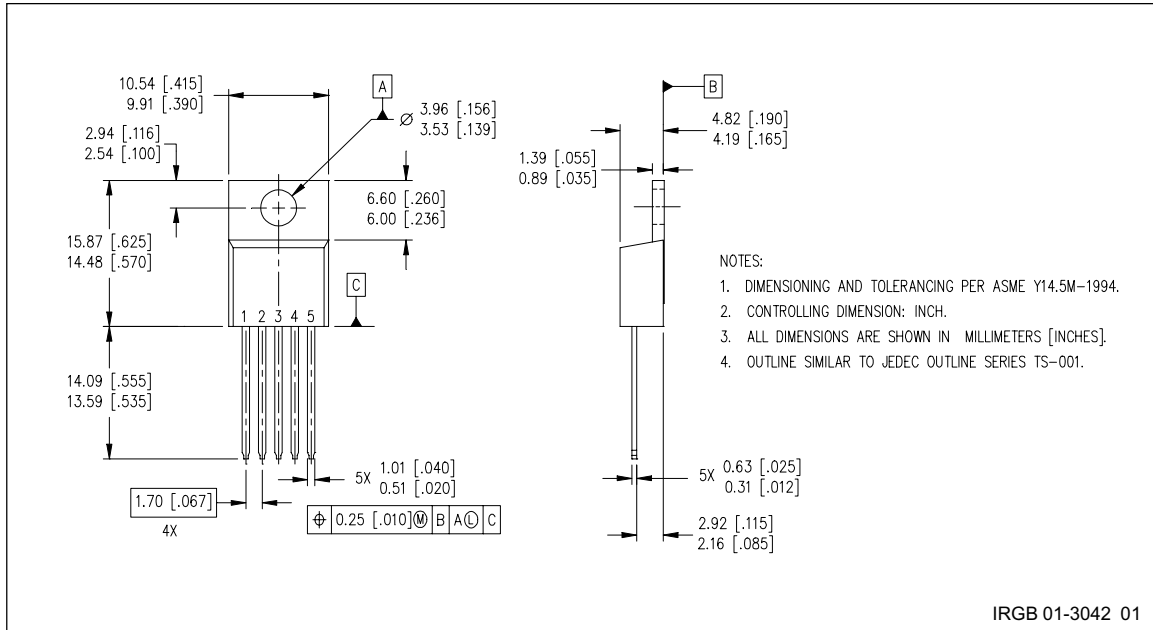
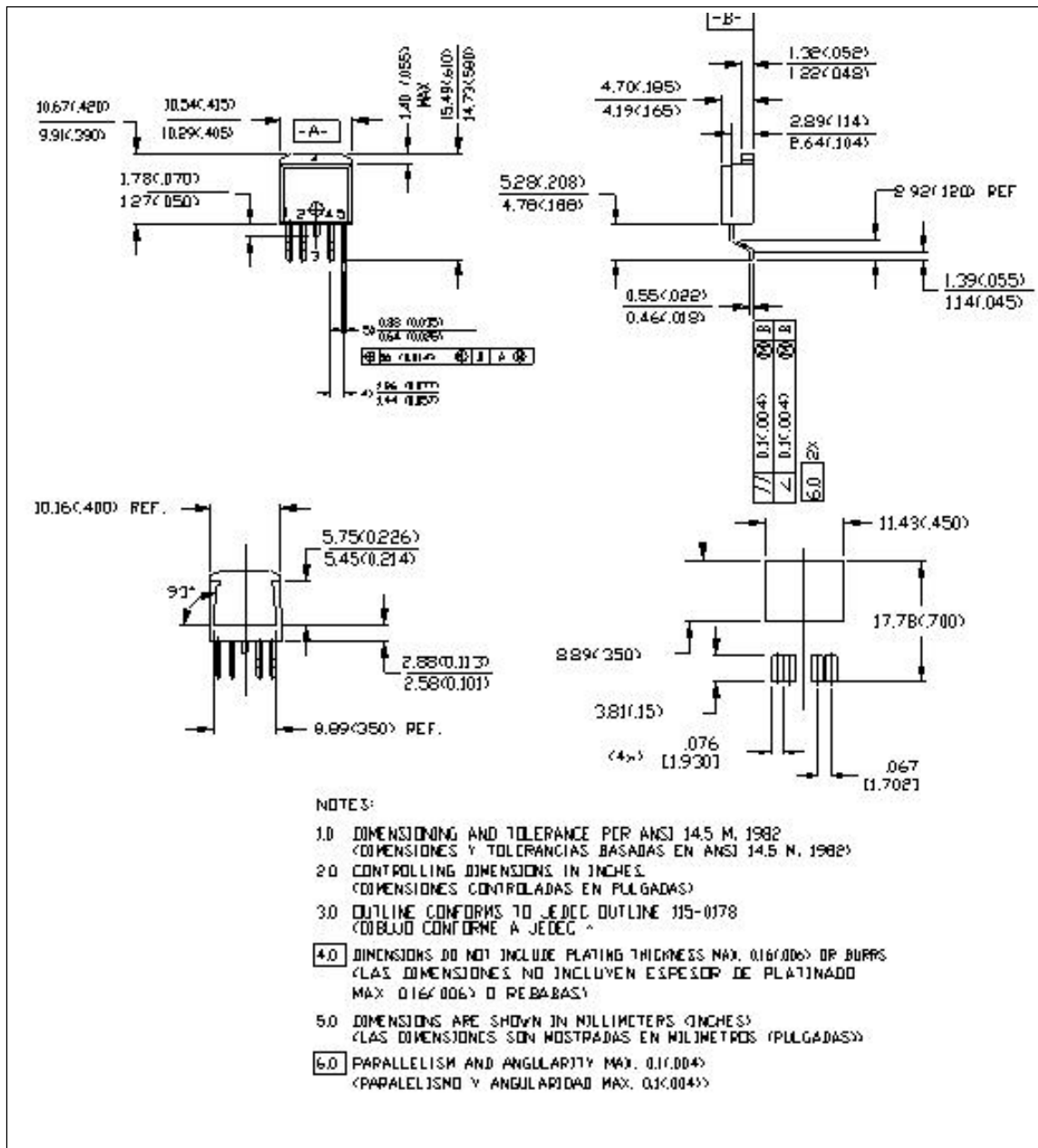


Figure 17 - Rth (°C/W) vs Time (s)

**Case Outline - TO220 (5 lead)**



**Case Outline 5 Lead - D<sup>2</sup>PAK (SMD220)**



**Tape & Reel 5 Lead - D<sup>2</sup>PAK (SMD220)**

