



# VN770K

## QUAD SMART POWER SOLID STATE RELAY FOR COMPLETE H BRIDGE CONFIGURATIONS

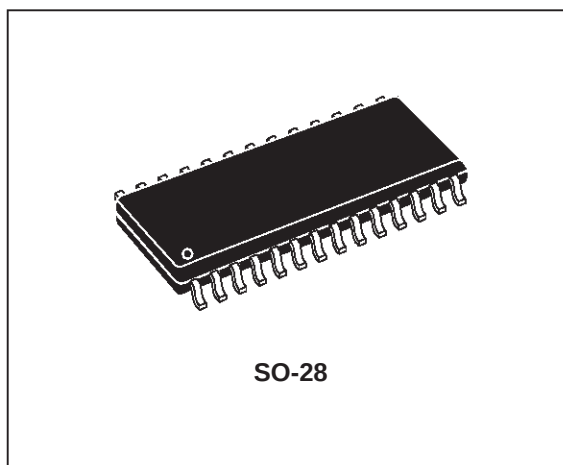
| TYPE   | $R_{DS(on)}$      | $I_{OUT}$ | $V_{CC}$ |
|--------|-------------------|-----------|----------|
| VN770K | 220m $\Omega$ (*) | 6A        | 36V      |

(\*) Total resistance of one side in bridge configuration

- SUITED AS LOW VOLTAGE BRIDGE
- LINEAR CURRENT LIMITATION
- VERY LOW STAND-BY POWER DISSIPATION
- SHORT CIRCUIT PROTECTED
- STATUS FLAG DIAGNOSTIC (OPEN DRAIN)
- INTEGRATED CLAMPING CIRCUITS
- UNDERVOLTAGE PROTECTION
- ESD PROTECTION

### DESCRIPTION

The VN770K is a device formed by three monolithic chips housed in a standard SO-28 package: a double high side and two low side switches. Both the double high side and low side switches are made using STMicroelectronics VIPower™ M0-3 Technology. This device is suitable to drive a DC motor in a bridge configuration as well as to be used as a quad switch for any low voltage application. The dual high side switches have built-in thermal shutdown to protect the chips from overtemperature and current limiter blocks to protect the device from short circuit. Status output is provided to indicate



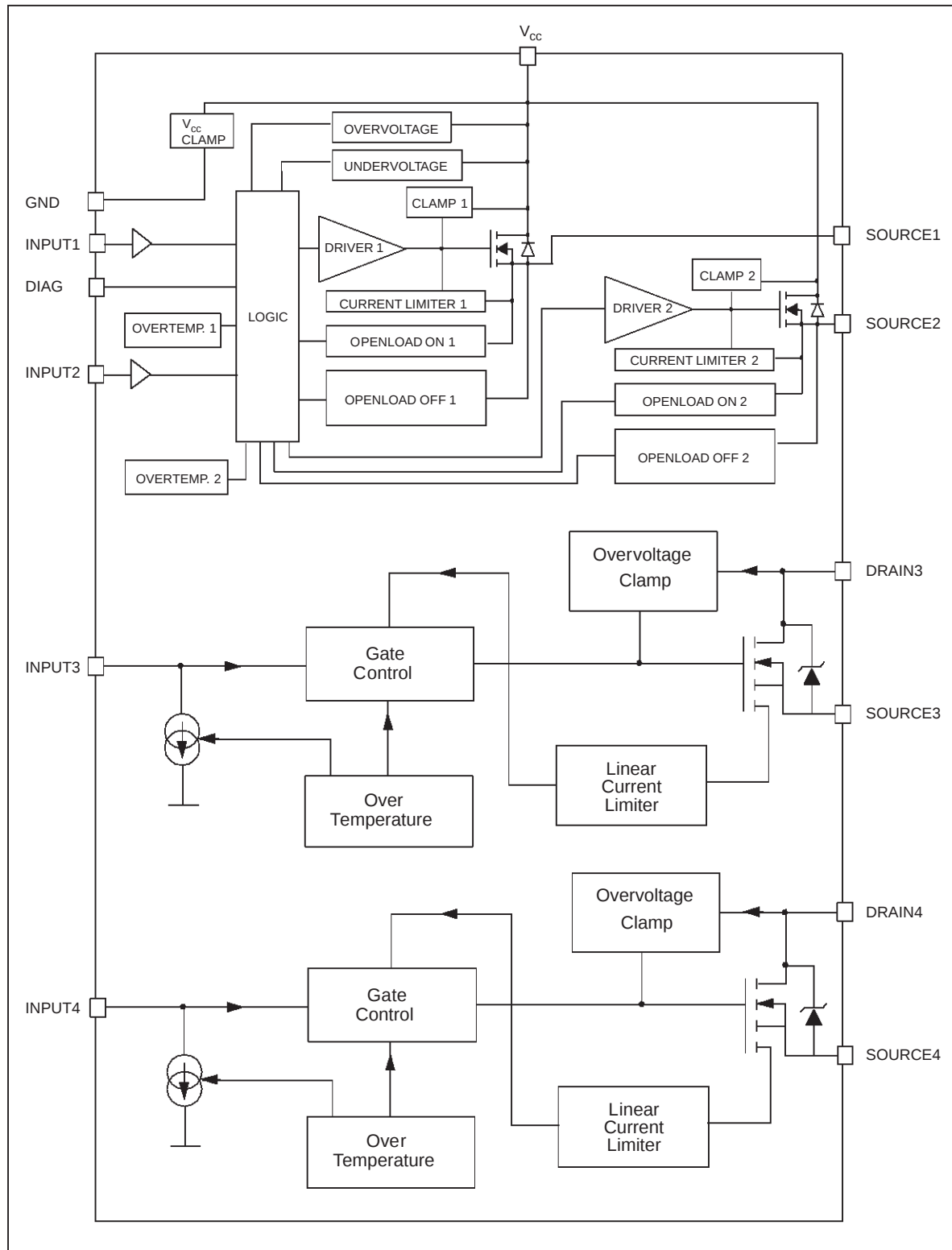
SO-28

open load in off and on state and overtemperature. The low side switches are two OMNIFET II types (fully autoprotected Power MOSFET in VIPower™ technology). They have built-in thermal shutdown, linear current limitation and overvoltage clamping. Fault feedback for thermal intervention can be detected by monitoring the voltage at the input pin.

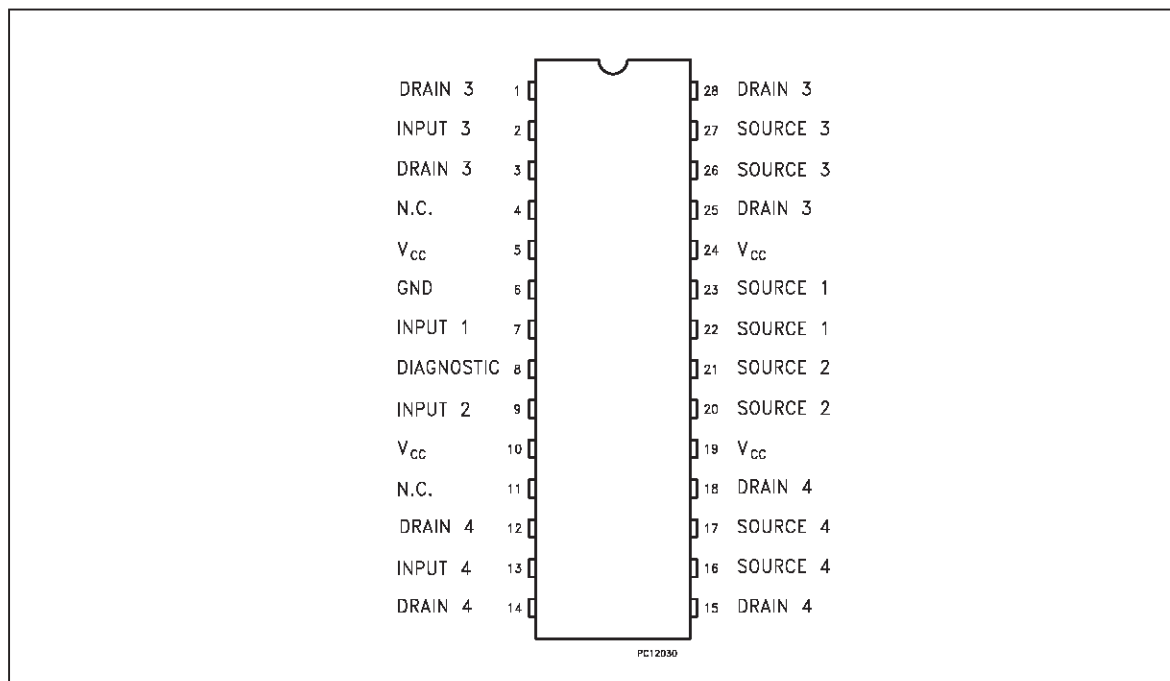
### PIN FUNCTION

| No             | NAME       | FUNCTION                                                                |
|----------------|------------|-------------------------------------------------------------------------|
| 1, 3, 25, 28   | DRAIN 3    | Drain of Switch 3 (low-side switch)                                     |
| 2              | INPUT 3    | Input of Switch 3 (low-side switch)                                     |
| 4, 11          | N.C.       | Not Connected                                                           |
| 5, 10, 19, 24  | $V_{CC}$   | Drain of Switches 1 and 2 (high-side switches) and Power Supply Voltage |
| 6              | GND        | Ground of Switches 1 and 2 (high-side switches)                         |
| 7              | INPUT 1    | Input of Switch 1 (high-side switches)                                  |
| 8              | DIAGNOSTIC | Diagnostic of Switches 1 and 2 (high-side switches)                     |
| 9              | INPUT 2    | Input of Switch 2 (high-side switch)                                    |
| 12, 14, 15, 18 | DRAIN 4    | Drain of switch 4 (low-side switch)                                     |
| 13             | INPUT 4    | Input of Switch 4 (low-side switch)                                     |
| 16, 17         | SOURCE 4   | Source of Switch 4 (low-side switch)                                    |
| 20, 21         | SOURCE 2   | Source of Switch 2 (high-side switch)                                   |
| 22, 23         | SOURCE 1   | Source of Switch 1 (high-side switch)                                   |
| 26, 27         | SOURCE 3   | Source of Switch 3 (low-side switch)                                    |

## BLOCK DIAGRAM



## CONNECTION DIAGRAM



## THERMAL DATA

| Symbol                | Parameter                                           | Value | Unit    |
|-----------------------|-----------------------------------------------------|-------|---------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case (High-side switch) | MAX   | 20 °C/W |
| R <sub>thj-case</sub> | Thermal Resistance Junction-case (Low-side switch)  | MAX   | 20 °C/W |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient                 | MAX   | 60 °C/W |

## ABSOLUTE MAXIMUM RATING

## DUAL HIGH SIDE SWITCH

| Symbol             | Parameter                                                    | Value              | Unit |
|--------------------|--------------------------------------------------------------|--------------------|------|
| V <sub>CC</sub>    | DC Supply Voltage                                            | 41                 | V    |
| - V <sub>CC</sub>  | Reverse DC Supply Voltage                                    | - 0.3              | V    |
| - I <sub>GND</sub> | DC Reverse Ground Pin Current                                | - 200              | mA   |
| I <sub>OUT</sub>   | DC Output Current                                            | Internally Limited | A    |
| - I <sub>OUT</sub> | Reverse DC Output Current                                    | - 6                | A    |
| I <sub>IN</sub>    | DC Input Current                                             | +/- 10             | mA   |
| I <sub>stat</sub>  | DC Status Current                                            | +/- 10             | mA   |
| V <sub>ESD</sub>   | Electrostatic Discharge (Human Body Model: R=1.5KΩ; C=100pF) |                    |      |
|                    | - INPUT                                                      | 4000               | V    |
|                    | - STATUS                                                     | 4000               | V    |
|                    | - OUTPUT                                                     | 5000               | V    |
|                    | - V <sub>CC</sub>                                            | 5000               | V    |
| P <sub>tot</sub>   | Power Dissipation (T <sub>C</sub> =25°C)                     | 6                  | W    |
| T <sub>j</sub>     | Junction Operating Temperature                               | Internally Limited | °C   |
| T <sub>C</sub>     | Case Operating Temperature                                   | - 40 to 150        | °C   |
| T <sub>stg</sub>   | Storage Temperature                                          | - 55 to 150        | °C   |

**ABSOLUTE MAXIMUM RATING** (continued)

## LOW SIDE SWITCH

| Symbol        | Parameter                                                                   | Value              | Unit       |
|---------------|-----------------------------------------------------------------------------|--------------------|------------|
| $V_{DS}$      | Drain-source Voltage ( $V_{IN}=0V$ )                                        | Internally Clamped | V          |
| $V_{IN}$      | Input Voltage                                                               | Internally Clamped | V          |
| $I_{IN}$      | Input Current                                                               | +/-20              | mA         |
| $R_{IN\ MIN}$ | Minimum Input Series Impedance                                              | 150                | $\Omega$   |
| $I_D$         | Drain Current                                                               | Internally Limited | A          |
| $I_R$         | Reverse DC Output Current                                                   | -10.5              | A          |
| $V_{ESD1}$    | Electrostatic Discharge ( $R=1.5K\Omega$ , $C=100pF$ )                      | 4000               | V          |
| $V_{ESD2}$    | Electrostatic Discharge on output pin only<br>( $R=330\Omega$ , $C=150pF$ ) | 16500              | V          |
| $P_{tot}$     | Power Dissipation ( $T_C=25^\circ C$ )                                      | 6                  | W          |
| $T_j$         | Operating Junction Temperature                                              | Internally limited | $^\circ C$ |
| $T_C$         | Case Operating Temperature                                                  | Internally limited | $^\circ C$ |
| $T_{stg}$     | Storage Temperature                                                         | -55 to 150         | $^\circ C$ |

**ELECTRICAL CHARACTERISTICS FOR DUAL HIGH SIDE SWITCH**(8V <  $V_{CC}$  < 36V;  $-40^\circ C < T_j < 150^\circ C$ , unless otherwise specified)

## POWER OUTPUTS (Per each channel)

| Symbol         | Parameter                | Test Conditions                                                                                                                                                             | Min | Typ           | Max           | Unit                     |
|----------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---------------|---------------|--------------------------|
| $V_{CC}$ (**)  | Operating Supply Voltage |                                                                                                                                                                             | 5.5 | 13            | 36            | V                        |
| $V_{USD}$ (**) | Undervoltage Shut-down   |                                                                                                                                                                             | 3   | 4             | 5.5           | V                        |
| $V_{OV}$ (**)  | Overvoltage Shut-down    |                                                                                                                                                                             | 36  |               |               | V                        |
| $R_{ON}$       | On State Resistance      | $I_{OUT}=1A$ ; $T_j=25^\circ C$<br>$I_{OUT}=1A$ ; $V_{CC}>8V$                                                                                                               |     |               | 160<br>320    | $m\Omega$<br>$m\Omega$   |
| $I_S$ (**)     | Supply Current           | Off State; $V_{CC}=13V$ ; $V_{IN}=V_{OUT}=0V$<br>Off State; $V_{CC}=13V$ ; $V_{IN}=V_{OUT}=0V$ ;<br>$T_j=25^\circ C$<br>On State; $V_{CC}=13V$ ; $V_{IN}=5V$ ; $I_{OUT}=0A$ |     | 12<br>12<br>5 | 40<br>25<br>7 | $\mu A$<br>$\mu A$<br>mA |
| $I_{L(off1)}$  | Off State Output Current | $V_{IN}=V_{OUT}=0V$                                                                                                                                                         | 0   |               | 50            | $\mu A$                  |
| $I_{L(off2)}$  | Off State Output Current | $V_{IN}=0V$ ; $V_{OUT}=3.5V$                                                                                                                                                | -75 |               | 0             | $\mu A$                  |
| $I_{L(off3)}$  | Off State Output Current | $V_{IN}=V_{OUT}=0V$ ; $V_{CC}=13V$ ; $T_j=125^\circ C$                                                                                                                      |     |               | 5             | $\mu A$                  |
| $I_{L(off4)}$  | Off State Output Current | $V_{IN}=V_{OUT}=0V$ ; $V_{CC}=13V$ ; $T_j=25^\circ C$                                                                                                                       |     |               | 3             | $\mu A$                  |

(\*\*) Per device

SWITCHING ( $V_{CC}=13V$ )

| Symbol                | Parameter              | Test Conditions                                                 | Min | Typ                        | Max | Unit       |
|-----------------------|------------------------|-----------------------------------------------------------------|-----|----------------------------|-----|------------|
| $t_{d(on)}$           | Turn-on Delay Time     | $R_L=13\Omega$ from $V_{IN}$ rising edge to<br>$V_{OUT}=1.3V$   |     | 30                         |     | $\mu s$    |
| $t_{d(off)}$          | Turn-off Delay Time    | $R_L=13\Omega$ from $V_{IN}$ falling edge to<br>$V_{OUT}=11.7V$ |     | 30                         |     | $\mu s$    |
| $dV_{OUT}/dt_{(on)}$  | Turn-on Voltage Slope  | $R_L=13\Omega$ from $V_{OUT}=1.3V$ to<br>$V_{OUT}=10.4V$        |     | See<br>relative<br>diagram |     | V/ $\mu s$ |
| $dV_{OUT}/dt_{(off)}$ | Turn-off Voltage Slope | $R_L=13\Omega$ from $V_{OUT}=11.7V$ to<br>$V_{OUT}=1.3V$        |     | See<br>relative<br>diagram |     | V/ $\mu s$ |

**ELECTRICAL CHARACTERISTICS FOR DUAL HIGH SIDE SWITCH (continued)****LOGIC INPUT**

| Symbol     | Parameter                | Test Conditions  | Min  | Typ  | Max  | Unit    |
|------------|--------------------------|------------------|------|------|------|---------|
| $V_{IL}$   | Input Low Level          |                  |      |      | 1.25 | V       |
| $I_{IL}$   | Low Level Input Current  | $V_{IN} = 1.25V$ | 1    |      |      | $\mu A$ |
| $V_{IH}$   | Input High Level         |                  | 3.25 |      |      | V       |
| $I_{IH}$   | High Level Input Current | $V_{IN} = 3.25V$ |      |      | 10   | $\mu A$ |
| $V_{hyst}$ | Input Hysteresis Voltage |                  | 0.5  |      |      | V       |
| $V_{ICL}$  | Input Clamp Voltage      | $I_{IN} = 1mA$   | 6    | 6.8  | 8    | V       |
|            |                          | $I_{IN} = -1mA$  |      | -0.7 |      | V       |

**STATUS PIN**

| Symbol      | Parameter                    | Test Conditions                   | Min | Typ  | Max | Unit    |
|-------------|------------------------------|-----------------------------------|-----|------|-----|---------|
| $V_{STAT}$  | Status Low Output Voltage    | $I_{STAT} = 1.6 mA$               |     |      | 0.5 | V       |
| $I_{LSTAT}$ | Status Leakage Current       | Normal Operation; $V_{STAT} = 5V$ |     |      | 10  | $\mu A$ |
| $C_{STAT}$  | Status Pin Input Capacitance | Normal Operation; $V_{STAT} = 5V$ |     |      | 100 | pF      |
| $V_{SCL}$   | Status Clamp Voltage         | $I_{STAT} = 1mA$                  | 6   | 6.8  | 8   | V       |
|             |                              | $I_{STAT} = -1mA$                 |     | -0.7 |     | V       |

**PROTECTIONS**

| Symbol      | Parameter                           | Test Conditions            | Min           | Typ           | Max           | Unit        |
|-------------|-------------------------------------|----------------------------|---------------|---------------|---------------|-------------|
| $T_{TSD}$   | Shut-down Temperature               |                            | 150           | 175           | 200           | $^{\circ}C$ |
| $T_R$       | Reset Temperature                   |                            | 135           |               |               | $^{\circ}C$ |
| $T_{hyst}$  | Thermal Hysteresis                  |                            | 7             | 15            |               | $^{\circ}C$ |
| $t_{sdl}$   | Status Delay in Overload Conditions | $T_j > T_{TSD}$            |               |               | 20            | $\mu s$     |
| $I_{lim}$   | Current limitation                  | $5.5V < V_{CC} < 36V$      | 7             | 10            | 13            | A           |
|             |                                     |                            |               |               | 13            | A           |
| $V_{demag}$ | Turn-off Output Clamp Voltage       | $I_{OUT} = 1A$ ; $L = 6mH$ | $V_{CC} - 41$ | $V_{CC} - 48$ | $V_{CC} - 55$ | V           |

**OPENLOAD DETECTION**

| Symbol         | Parameter                                      | Test Conditions | Min | Typ | Max  | Unit    |
|----------------|------------------------------------------------|-----------------|-----|-----|------|---------|
| $I_{OL}$       | Openload ON State Detection Threshold          | $V_{IN} = 5V$   | 20  | 40  | 80   | mA      |
| $t_{DOL(on)}$  | Openload ON State Detection Delay              | $I_{OUT} = 0A$  |     |     | 200  | $\mu s$ |
| $V_{OL}$       | Openload OFF State Voltage Detection Threshold | $V_{IN} = 0V$   | 1.5 | 2.5 | 3.5  | V       |
| $t_{DOL(off)}$ | Openload Detection Delay at Turn Off           |                 |     |     | 1000 | $\mu s$ |

## VN770K

### ELECTRICAL CHARACTERISTICS FOR LOW SIDE SWITCHES

(-40°C < T<sub>j</sub> < 150°C, unless otherwise specified)

OFF

| Symbol             | Parameter                                              | Test Conditions                                                                                              | Min       | Typ | Max       | Unit |
|--------------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------|-----|-----------|------|
| V <sub>CLAMP</sub> | Drain-source Clamp Voltage                             | V <sub>IN</sub> =0V; I <sub>D</sub> =3.5A                                                                    | 40        | 45  | 55        | V    |
| V <sub>CLTH</sub>  | Drain-source Clamp Threshold Voltage                   | V <sub>IN</sub> =0V; I <sub>D</sub> =2mA                                                                     | 36        |     |           | V    |
| V <sub>INTH</sub>  | Input Threshold Voltage                                | V <sub>DS</sub> =V <sub>IN</sub> ; I <sub>D</sub> =1mA                                                       | 0.5       |     | 2.5       | V    |
| I <sub>ISS</sub>   | Supply Current from Input Pin                          | V <sub>DS</sub> =0V; V <sub>IN</sub> =5V                                                                     |           | 100 | 150       | μA   |
| V <sub>INCL</sub>  | Input-Source Clamp Voltage                             | I <sub>IN</sub> =1mA<br>I <sub>IN</sub> =-1mA                                                                | 6<br>-1.0 | 6.8 | 8<br>-0.3 | V    |
| I <sub>DSS</sub>   | Zero Input Voltage Drain Current (V <sub>IN</sub> =0V) | V <sub>DS</sub> =13V; V <sub>IN</sub> =0V; T <sub>j</sub> =25°C<br>V <sub>DS</sub> =25V; V <sub>IN</sub> =0V |           |     | 30<br>75  | μA   |

ON

| Symbol              | Parameter                         | Test Conditions                                                                                              | Min | Typ | Max       | Unit |
|---------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------|-----|-----|-----------|------|
| R <sub>DS(on)</sub> | Static Drain-source On Resistance | V <sub>IN</sub> =5V; I <sub>D</sub> =3.5A; T <sub>j</sub> =25°C<br>V <sub>IN</sub> =5V; I <sub>D</sub> =3.5A |     |     | 60<br>120 | mΩ   |

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

DYNAMIC

| Symbol              | Parameter                | Test Conditions                                   | Min | Typ | Max | Unit |
|---------------------|--------------------------|---------------------------------------------------|-----|-----|-----|------|
| g <sub>fs</sub> (*) | Forward Transconductance | V <sub>DD</sub> =13V; I <sub>D</sub> =3.5A        |     | 9   |     | S    |
| C <sub>OSS</sub>    | Output Capacitance       | V <sub>DS</sub> =13V; f=1MHz; V <sub>IN</sub> =0V |     | 220 |     | pF   |

SWITCHING

| Symbol                | Parameter             | Test Conditions                                                                                                 | Min | Typ  | Max  | Unit |
|-----------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------|-----|------|------|------|
| t <sub>d(on)</sub>    | Turn-on Delay Time    | V <sub>DD</sub> =15V; I <sub>D</sub> =3.5A<br>V <sub>gen</sub> =5V; R <sub>gen</sub> =R <sub>IN MIN</sub> =150Ω |     | 100  | 300  | ns   |
| t <sub>r</sub>        | Rise Time             |                                                                                                                 |     | 470  | 1500 | ns   |
| t <sub>d(off)</sub>   | Turn-off Delay Time   |                                                                                                                 |     | 500  | 1500 | ns   |
| t <sub>f</sub>        | Fall Time             |                                                                                                                 |     | 350  | 1000 | ns   |
| t <sub>d(on)</sub>    | Turn-on Delay Time    | V <sub>DD</sub> =15V; I <sub>D</sub> =3.5A<br>V <sub>gen</sub> =5V; R <sub>gen</sub> =2.2KΩ                     |     | 0.75 | 2.3  | μs   |
| t <sub>r</sub>        | Rise Time             |                                                                                                                 |     | 4.6  | 14.0 | μs   |
| t <sub>d(off)</sub>   | Turn-off Delay Time   |                                                                                                                 |     | 5.4  | 16.0 | μs   |
| t <sub>f</sub>        | Fall Time             |                                                                                                                 |     | 3.6  | 11.0 | μs   |
| (di/dt) <sub>on</sub> | Turn-on Current Slope | V <sub>DD</sub> =15V; I <sub>D</sub> =3.5A<br>V <sub>gen</sub> =5V; R <sub>gen</sub> =R <sub>IN MIN</sub> =150Ω |     | 6.5  |      | A/μs |
| Q <sub>i</sub>        | Total Input Charge    | V <sub>DD</sub> =12V; I <sub>D</sub> =3.5A; V <sub>IN</sub> =5V<br>I <sub>gen</sub> =2.13mA                     |     | 18   |      | nC   |

SOURCE DRAIN DIODE

| Symbol              | Parameter                | Test Conditions                                                      | Min | Typ  | Max | Unit |
|---------------------|--------------------------|----------------------------------------------------------------------|-----|------|-----|------|
| V <sub>SD</sub> (*) | Forward On Voltage       | I <sub>SD</sub> =3.5A; V <sub>IN</sub> =0V                           |     | 0.8  |     | V    |
| t <sub>rr</sub>     | Reverse Recovery Time    | I <sub>SD</sub> =3.5A; di/dt=20A/μs<br>V <sub>DD</sub> =30V; L=200μH |     | 220  |     | ns   |
| Q <sub>rr</sub>     | Reverse Recovery Charge  |                                                                      |     | 0.28 |     | μC   |
| I <sub>RPM</sub>    | Reverse Recovery Current |                                                                      |     | 2.5  |     | A    |

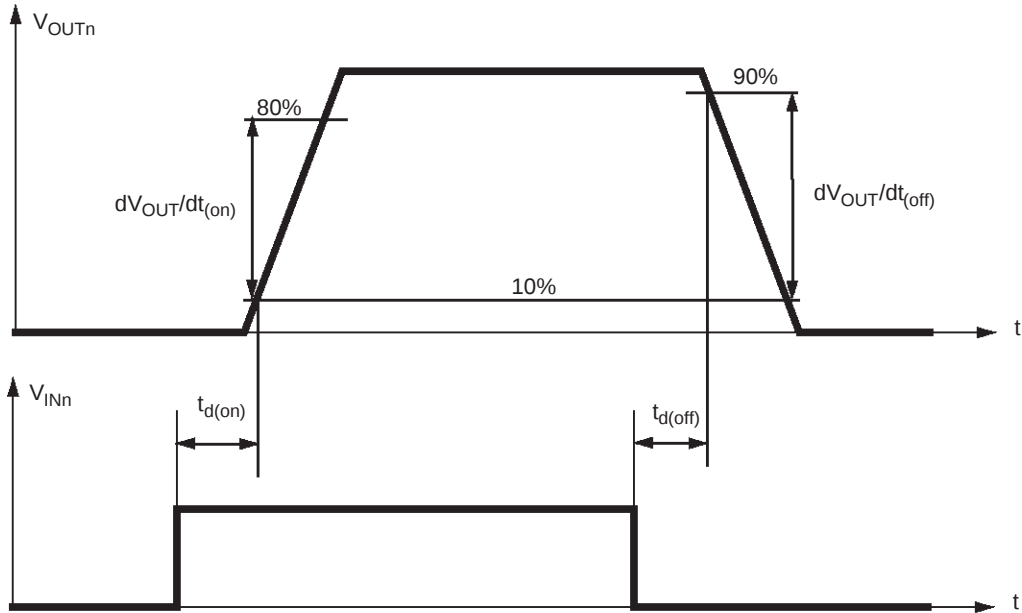
**ELECTRICAL CHARACTERISTICS FOR LOW SIDE SWITCHES** (continued)  
**PROTECTIONS** ( $-40^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$ , unless otherwise specified)

| Symbol     | Parameter                        | Test Conditions                                                                                                          | Min | Typ | Max | Unit               |
|------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|--------------------|
| $I_{lim}$  | Drain Current Limit              | $V_{IN}=5\text{V}; V_{DS}=13\text{V}$                                                                                    | 6   | 9   | 12  | A                  |
| $t_{dlim}$ | Step Response Current Limit      | $V_{IN}=5\text{V}; V_{DS}=13\text{V}$                                                                                    |     | 4.0 |     | $\mu\text{s}$      |
| $T_{jsh}$  | Overtemperature Shutdown         |                                                                                                                          | 150 | 175 |     | $^{\circ}\text{C}$ |
| $T_{jrs}$  | Overtemperature Reset            |                                                                                                                          | 135 |     |     | $^{\circ}\text{C}$ |
| $I_{gf}$   | Fault Sink Current               | $V_{IN}=5\text{V}; V_{DS}=13\text{V}; T_j=T_{jsh}$                                                                       |     | 15  |     | mA                 |
| $E_{as}$   | Single Pulse<br>Avalanche Energy | starting $T_j=25^{\circ}\text{C}; V_{DD}=24\text{V}$<br>$V_{IN}=5\text{V}; R_{gen}=R_{IN\ MIN}=150\Omega; L=24\text{mH}$ | 200 |     |     | mJ                 |

(\*) Pulsed: Pulse duration = 300 $\mu\text{s}$ , duty cycle 1.5%

DUAL HIGH-SIDE SWITCH

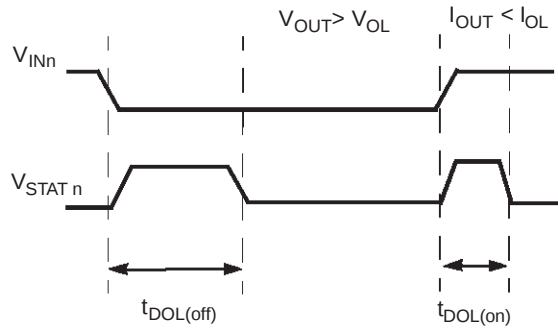
SWITCHING TIME WAVEFORMS



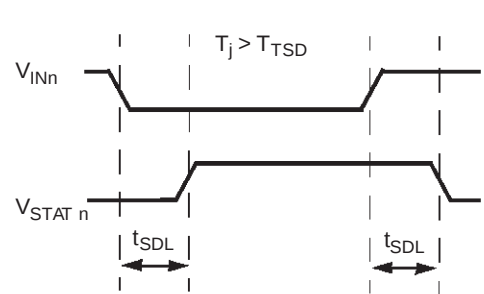
TRUTH TABLE

| CONDITIONS                | INPUT | OUTPUT | STATUS                |
|---------------------------|-------|--------|-----------------------|
| Normal Operation          | L     | L      | H                     |
|                           | H     | H      | H                     |
| Current Limitation        | L     | L      | H                     |
|                           | H     | X      | ( $T_j < T_{TSD}$ ) H |
|                           | H     | X      | ( $T_j > T_{TSD}$ ) L |
| Overtemperature           | L     | L      | H                     |
|                           | H     | L      | L                     |
| Undervoltage              | L     | L      | X                     |
|                           | H     | L      | X                     |
| Overvoltage               | L     | L      | H                     |
|                           | H     | L      | H                     |
| Output Voltage $> V_{OL}$ | L     | H      | L                     |
|                           | H     | H      | H                     |
| Output Current $< I_{OL}$ | L     | L      | H                     |
|                           | H     | H      | L                     |

OPEN LOAD STATUS TIMING (with external pull-up)



OVER TEMP STATUS TIMING



## TYPICAL APPLICATION DIAGRAM

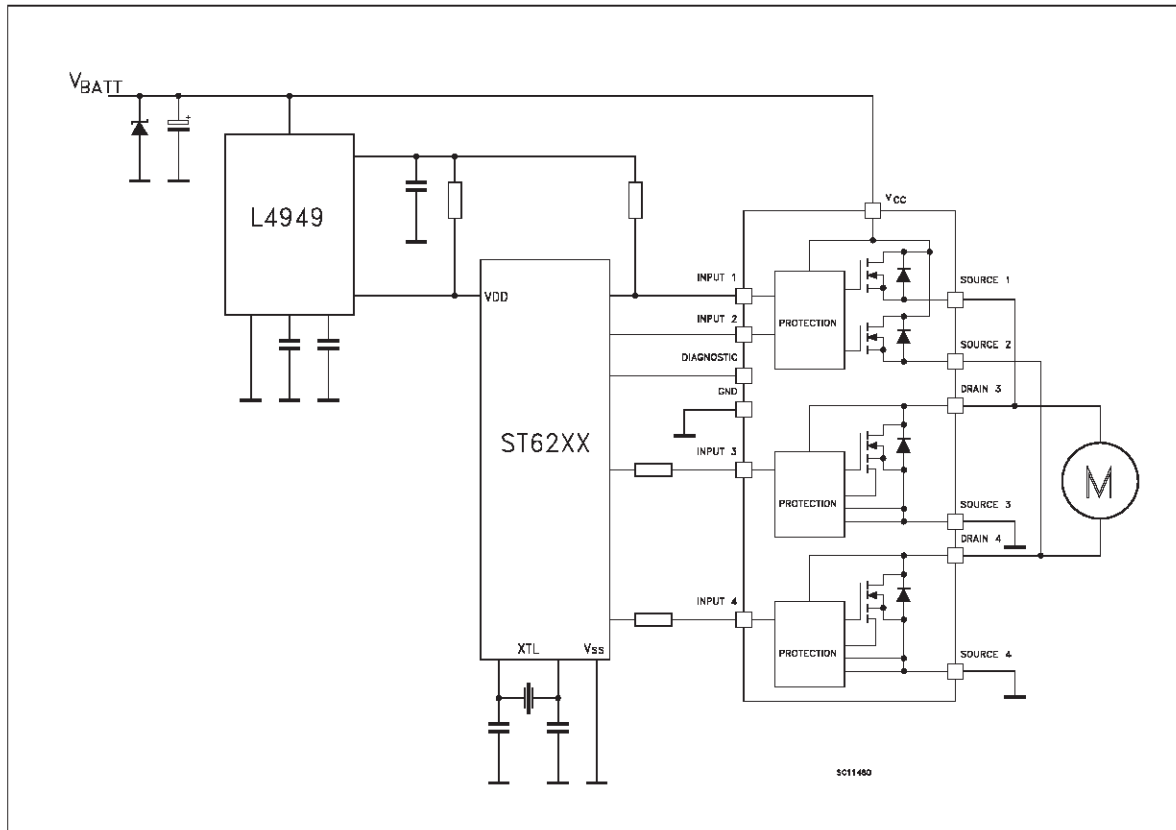
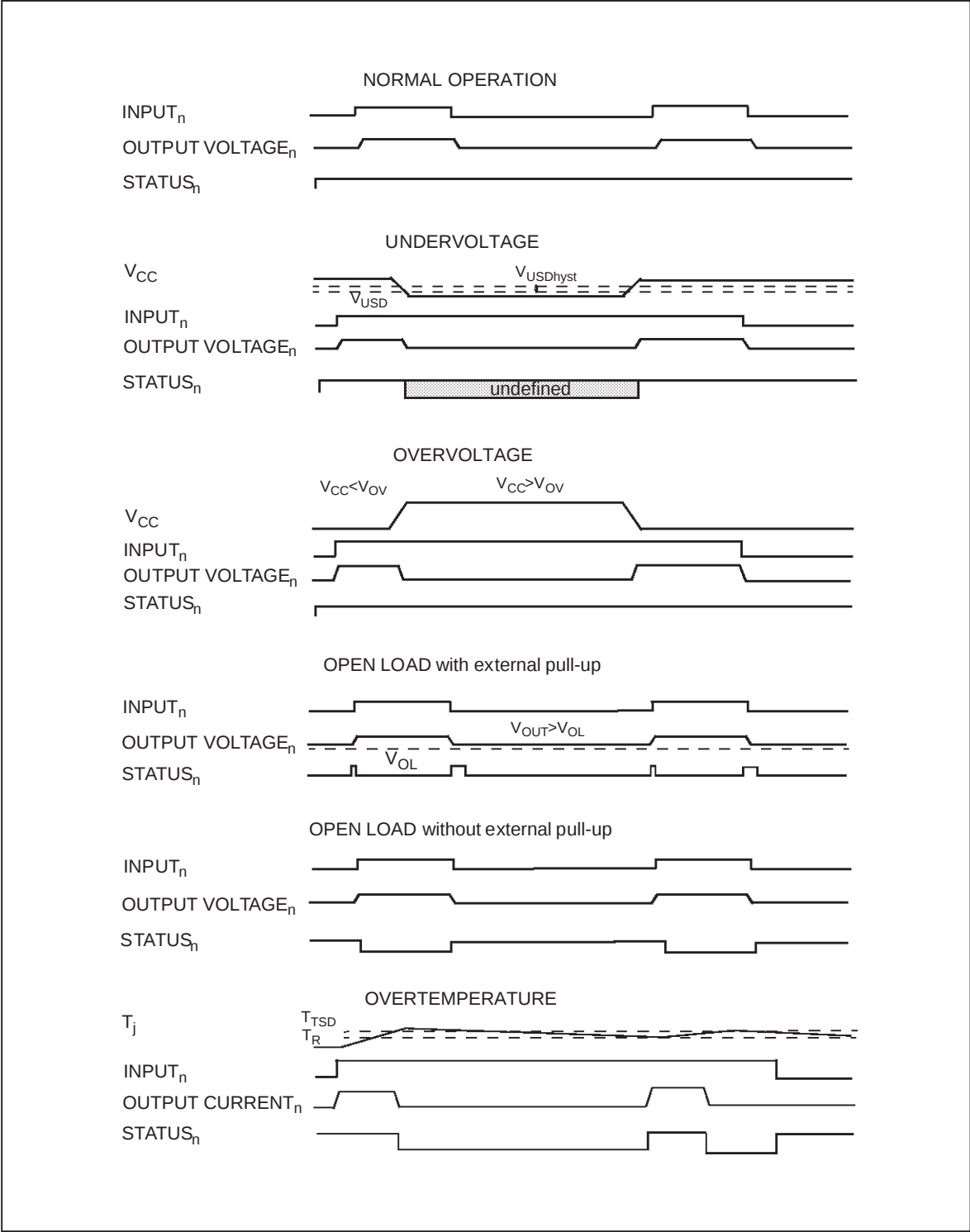
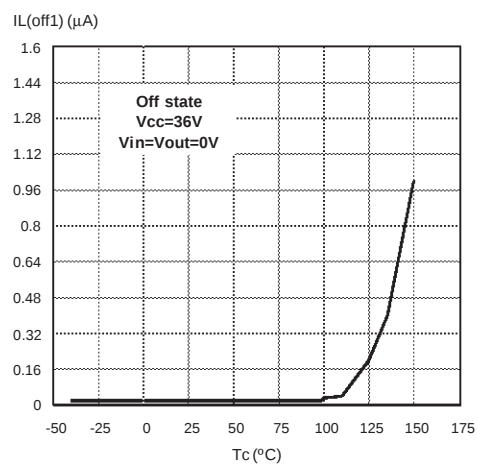


Figure 1: Waveforms

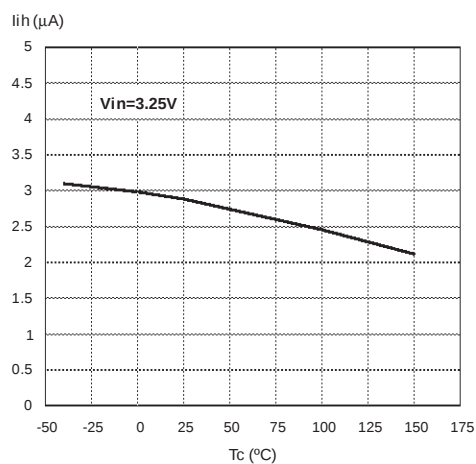


## ELECTRICAL CHARACTERIZATION FOR DUAL HIGH SIDE SWITCH

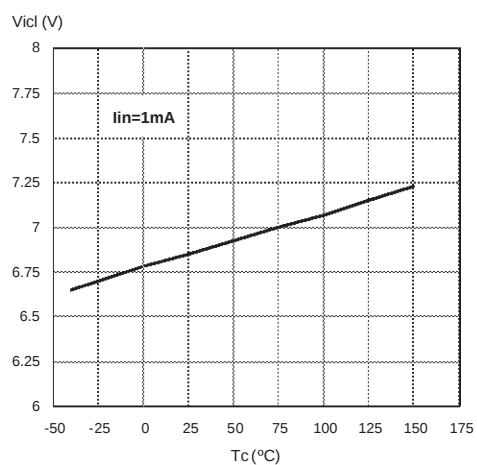
Off State Output Current



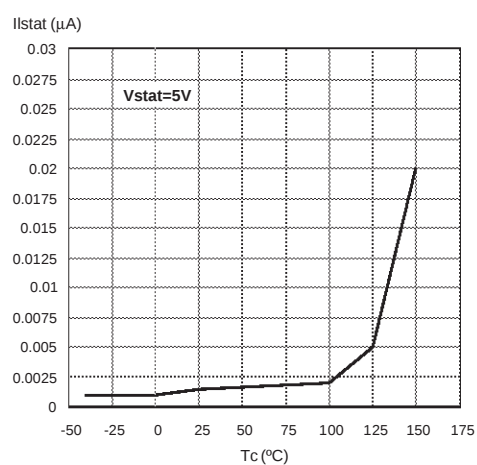
High Level Input Current



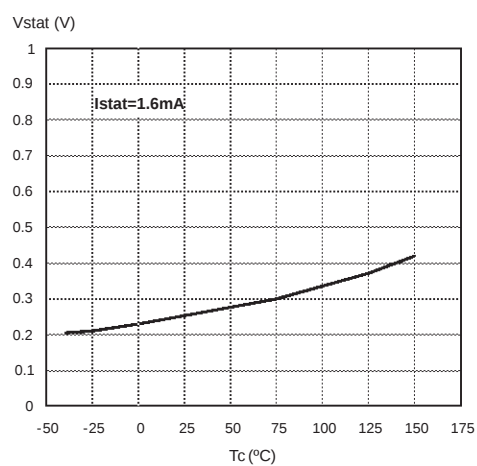
Input Clamp Voltage



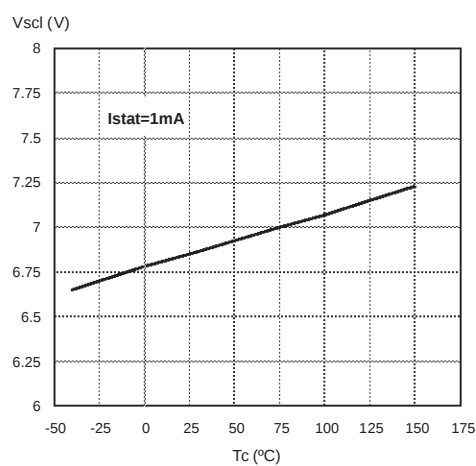
Status Leakage Current



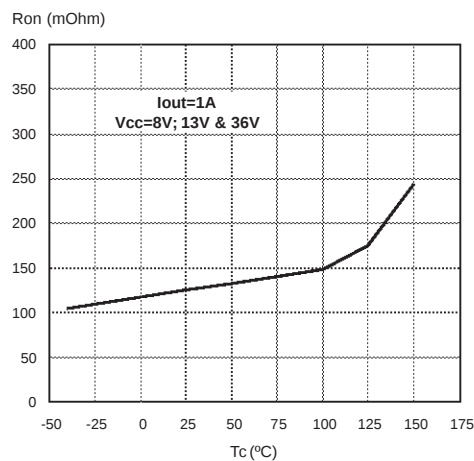
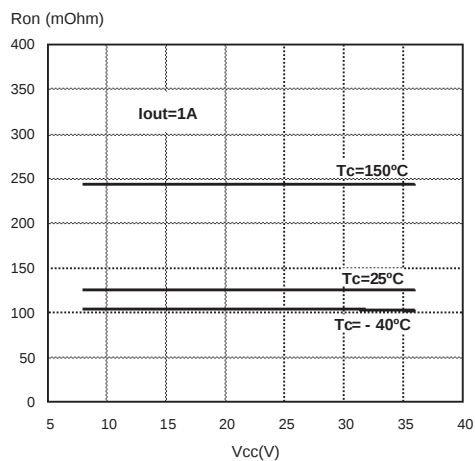
Status Low Output Voltage



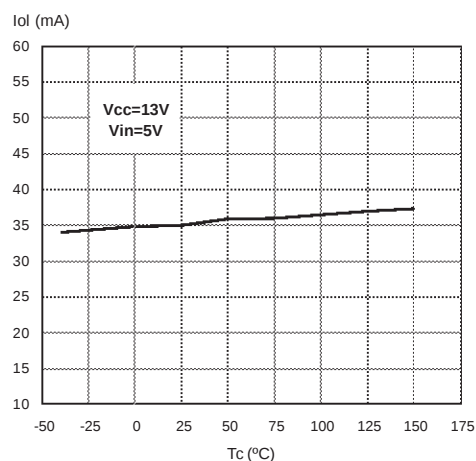
Status Clamp Voltage



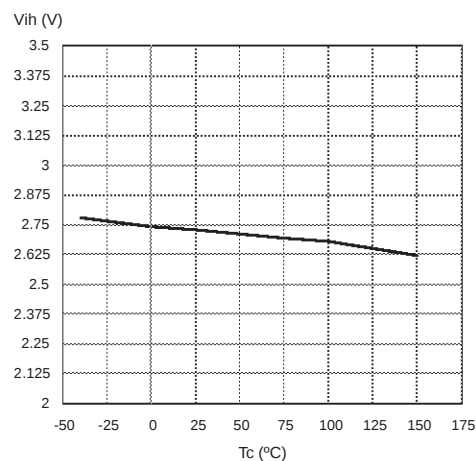
## ELECTRICAL CHARACTERIZATION FOR DUAL HIGH SIDE SWITCH (continued)

On State Resistance Vs  $T_{case}$ On State Resistance Vs  $V_{CC}$ 

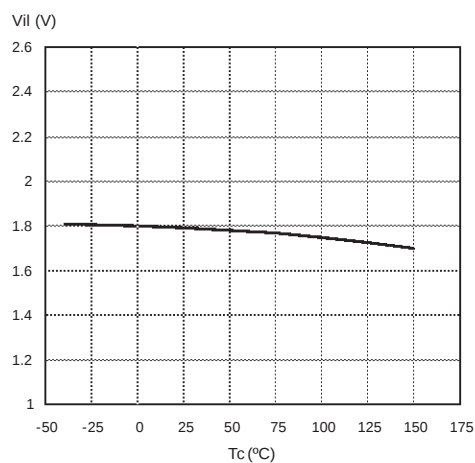
Overload On State Detection Threshold



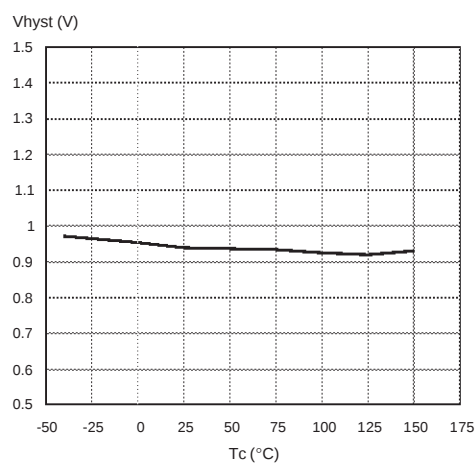
Input High Level

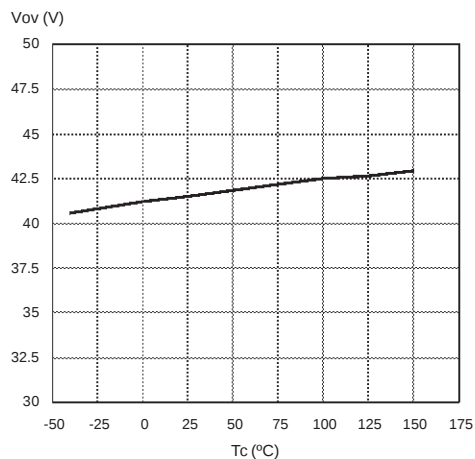
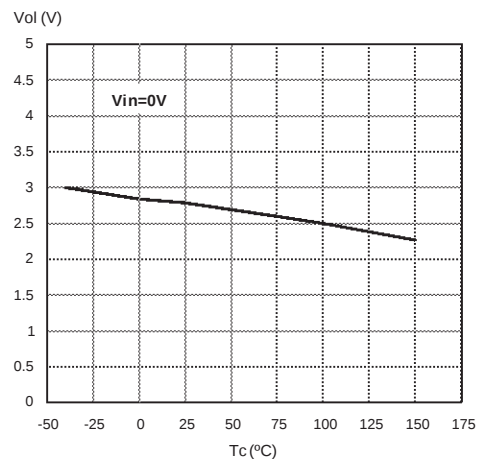
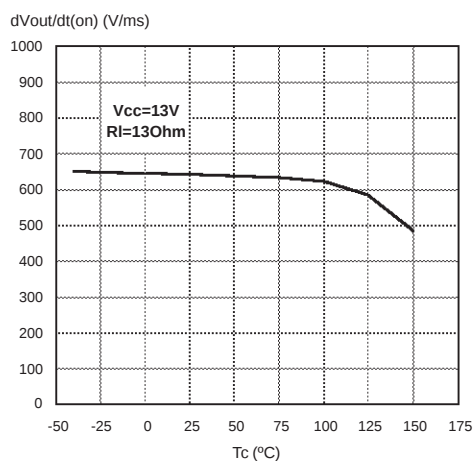
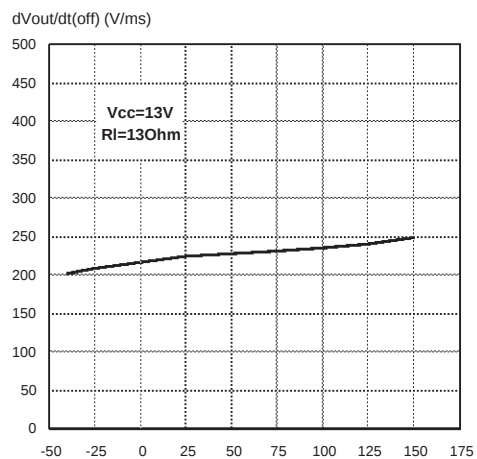
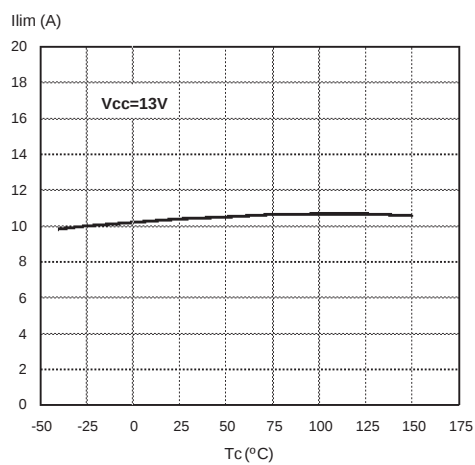


Input Low Level



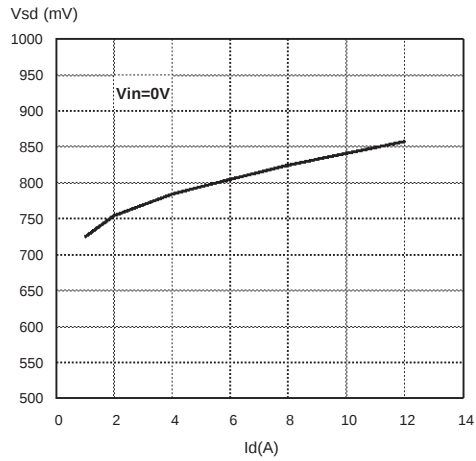
Input Hysteresis Voltage



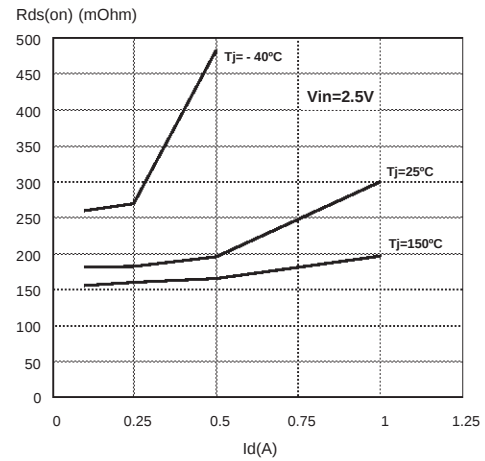
**ELECTRICAL CHARACTERIZATION FOR DUAL HIGH SIDE SWITCH (continued)****Overvoltage Shutdown****Openload Off State Voltage Detection Threshold****Turn-on Voltage Slope****Turn-off Voltage Slope** **$I_{LIM}$  Vs  $T_{case}$** 

## ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES

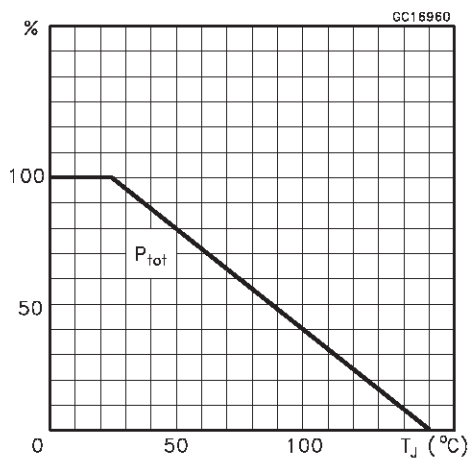
Source-Drain Diode Forward Characteristics



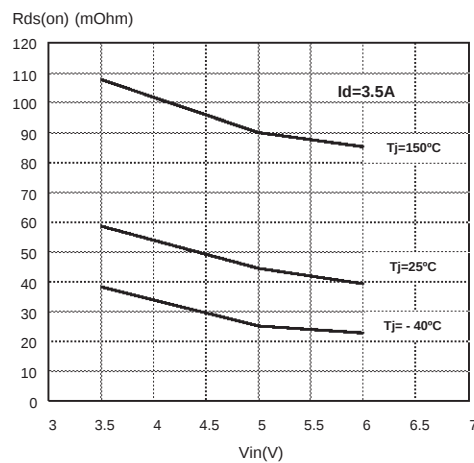
Static Drain Source On Resistance



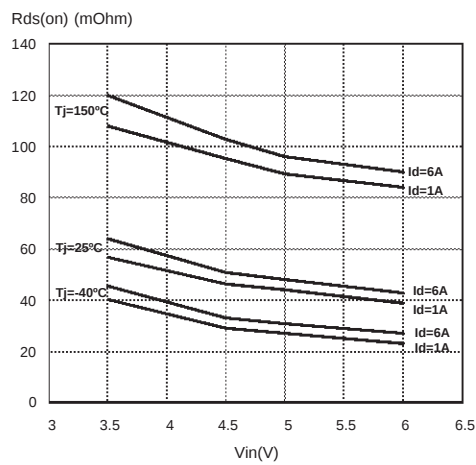
Derating Curve



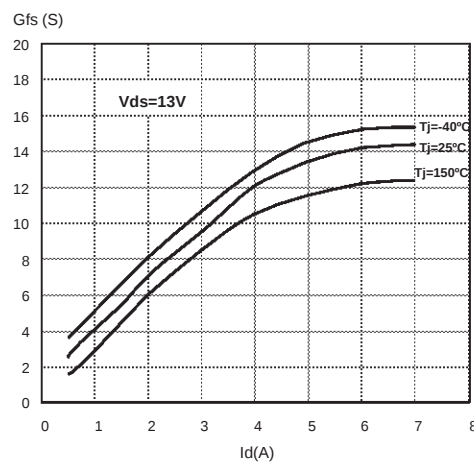
Static Drain-Source On resistance Vs. Input Voltage

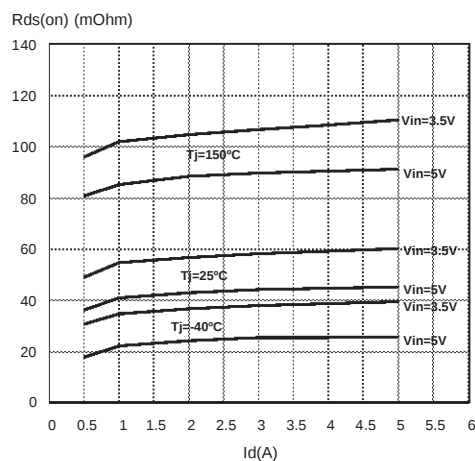
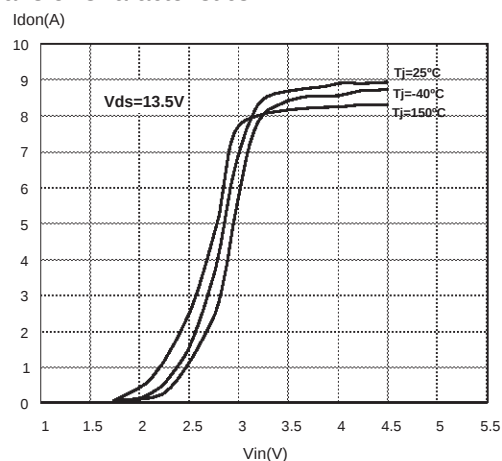
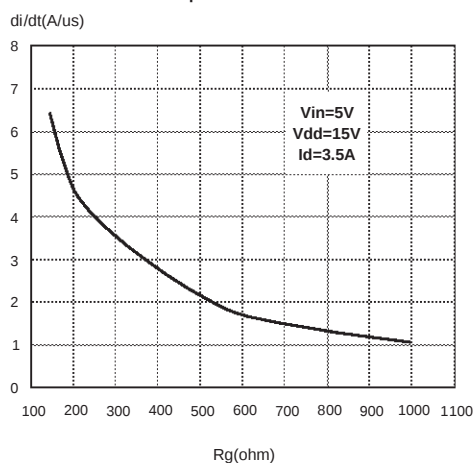
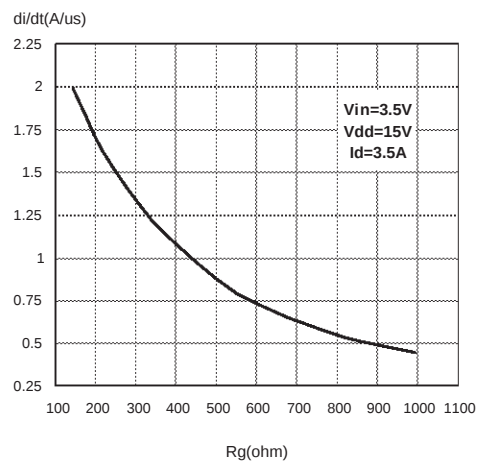
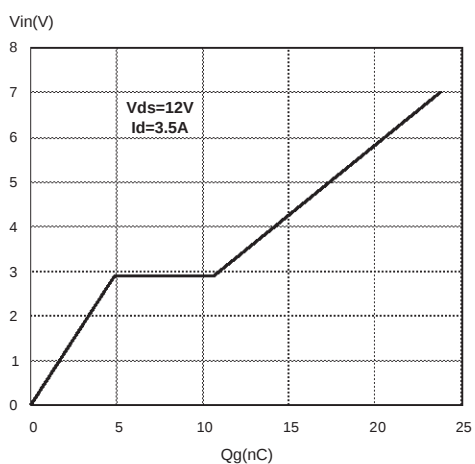
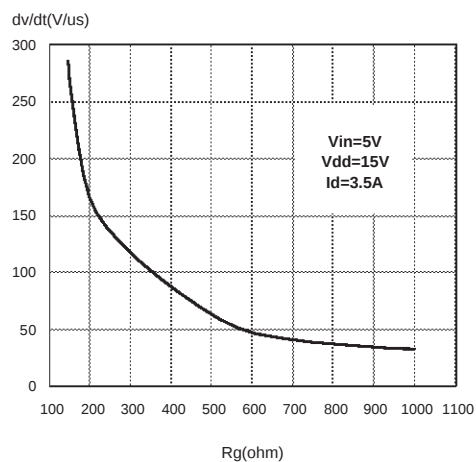


Static Drain-Source On resistance Vs. Input Voltage



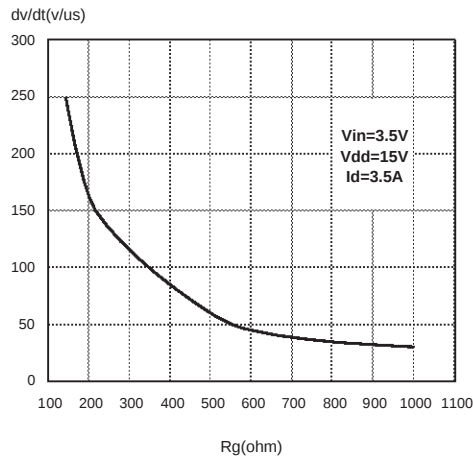
Transconductance



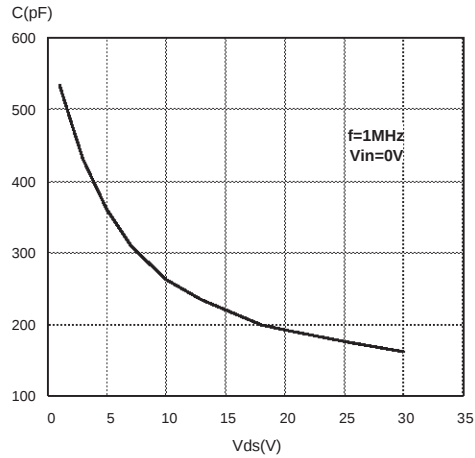
**ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES (continued)****Static Drain-Source On Resistance Vs. Id****Transfer Characteristics****Turn On Current Slope****Turn On Current Slope****Input Voltage Vs. Input Charge****Turn off drain source voltage slope**

ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES (continued)

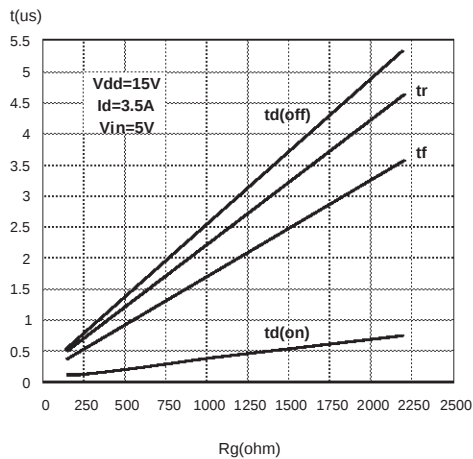
Turn Off Drain-Source Voltage Slope



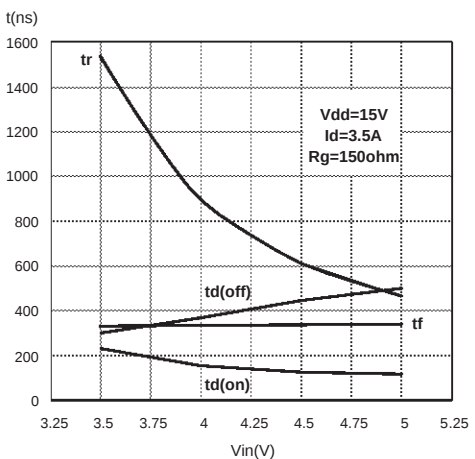
Capacitance Variations



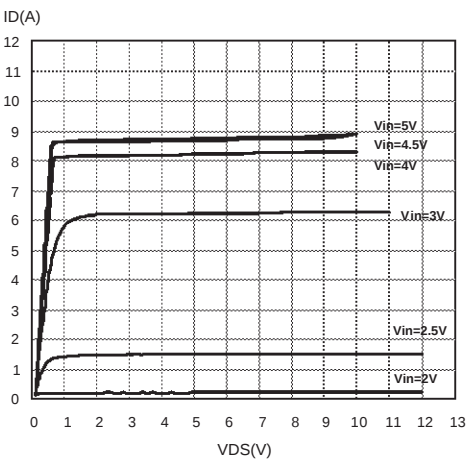
Switching Time Resistive Load



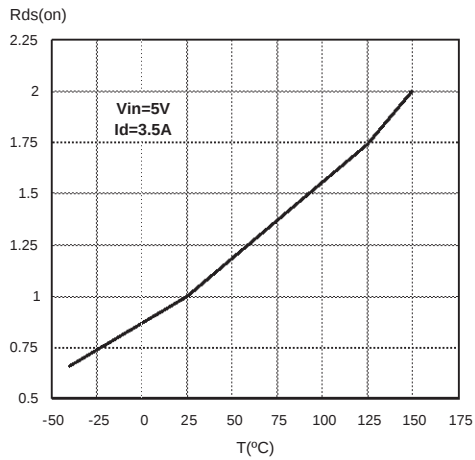
Switching Time Resistive Load



Output Characteristics

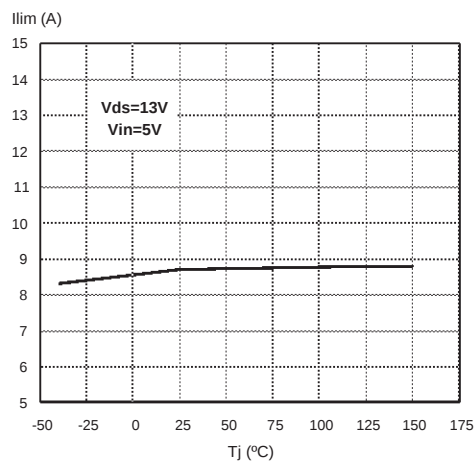
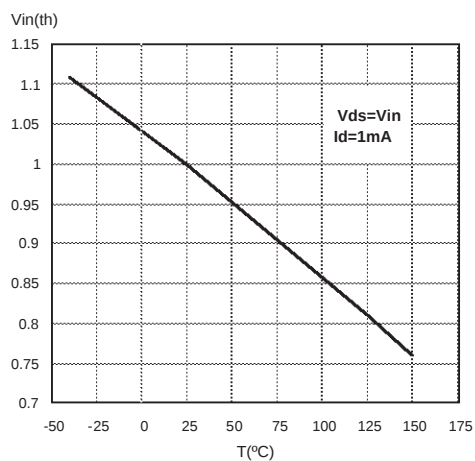
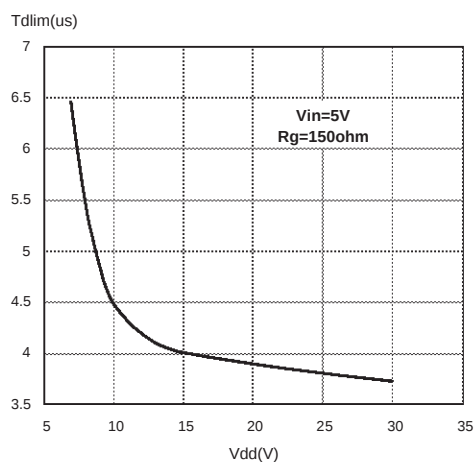


Normalized On Resistance Vs. Temperature



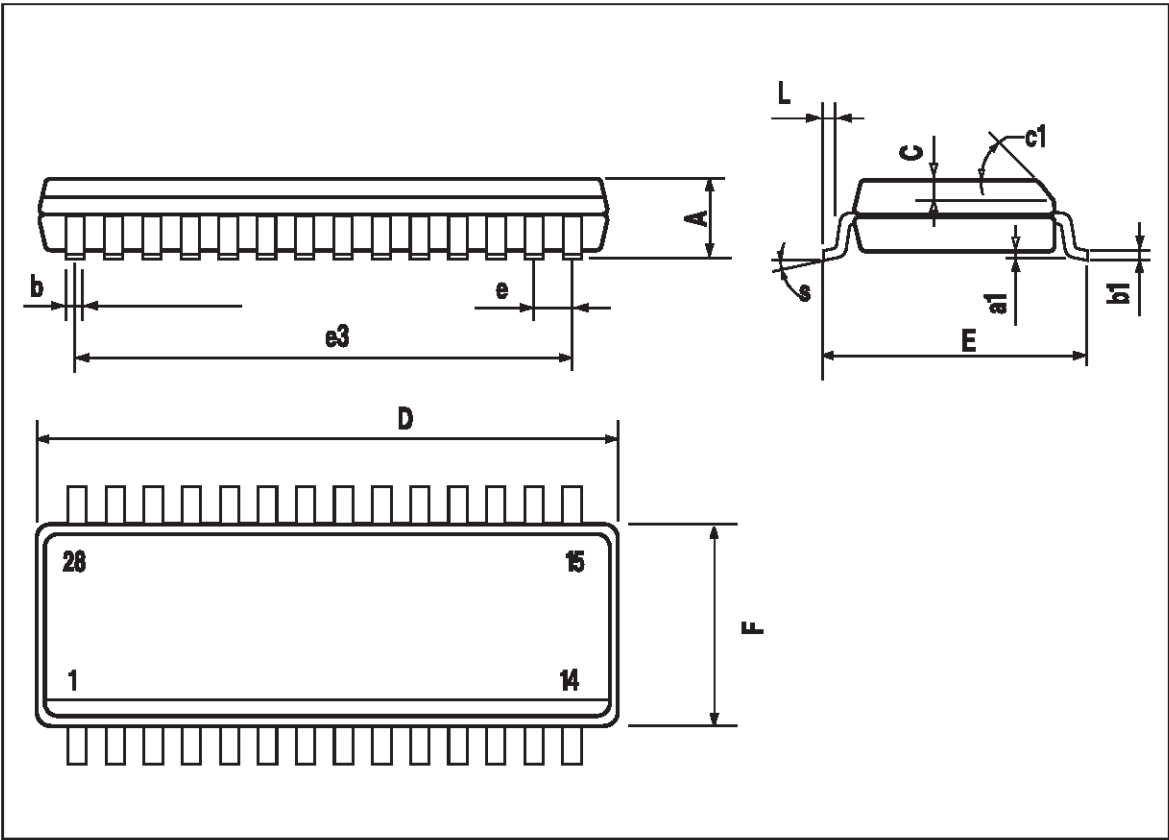
**ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES (continued)**

Normalized Input Threshold Voltage Vs. Current Limit Vs. Junction Temperature

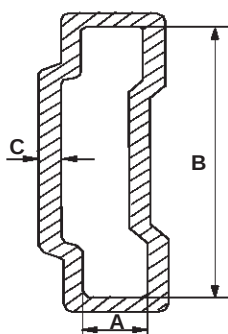
**Step Response Current Limit**

SO-28 MECHANICAL DATA

| DIM. | mm.       |       |       | inch  |       |       |
|------|-----------|-------|-------|-------|-------|-------|
|      | MIN.      | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |           |       | 2.65  |       |       | 0.104 |
| a1   | 0.10      |       | 0.30  | 0.004 |       | 0.012 |
| b    | 0.35      |       | 0.49  | 0.013 |       | 0.019 |
| b1   | 0.23      |       | 0.32  | 0.009 |       | 0.012 |
| C    |           | 0.50  |       |       | 0.020 |       |
| c1   | 45 (typ.) |       |       |       |       |       |
| D    | 17.7      |       | 18.1  | 0.697 |       | 0.713 |
| E    | 10.00     |       | 10.65 | 0.393 |       | 0.419 |
| e    |           | 1.27  |       |       | 0.050 |       |
| e3   |           | 16.51 |       |       | 0.650 |       |
| F    | 7.40      |       | 7.60  | 0.291 |       | 0.299 |
| L    | 0.40      |       | 1.27  | 0.016 |       | 0.050 |
| S    | 8 (max.)  |       |       |       |       |       |



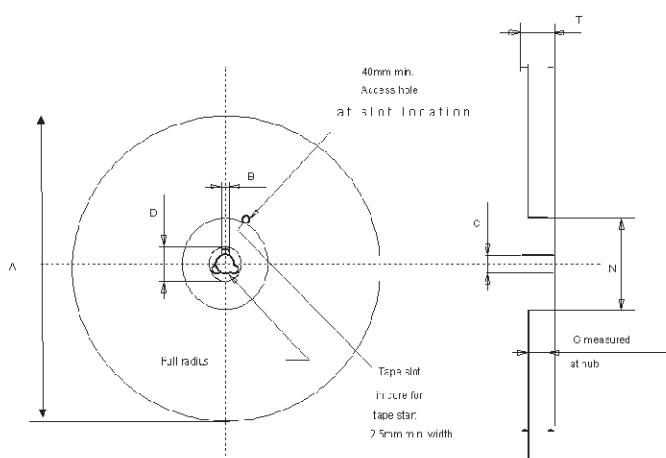
## SO-28 TUBE SHIPMENT (no suffix)



|                           |      |
|---------------------------|------|
| Base Q.ty                 | 28   |
| Bulk Q.ty                 | 700  |
| Tube length ( $\pm 0.5$ ) | 532  |
| A                         | 3.5  |
| B                         | 13.8 |
| C ( $\pm 0.1$ )           | 0.6  |

All dimensions are in mm.

## TAPE AND REEL SHIPMENT (suffix "13TR")



## REEL DIMENSIONS

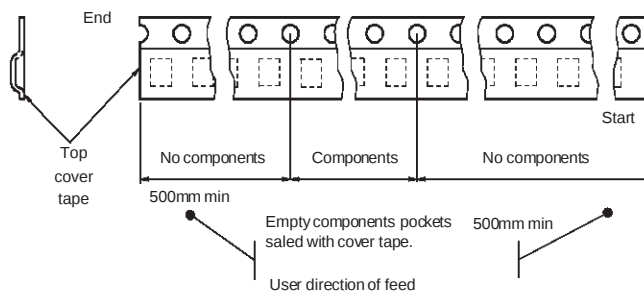
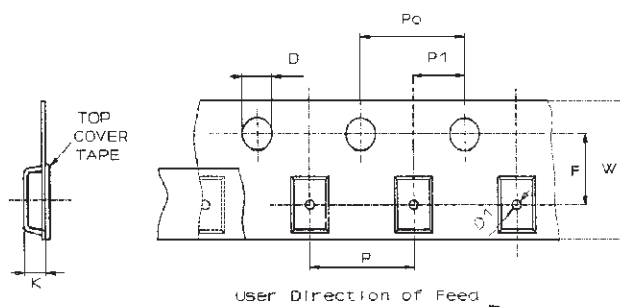
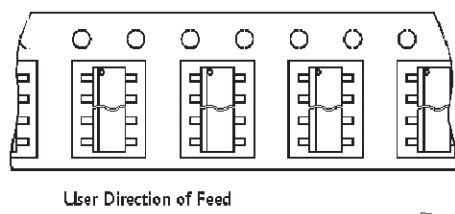
|                   |      |
|-------------------|------|
| Base Q.ty         | 1000 |
| Bulk Q.ty         | 1000 |
| A (max)           | 330  |
| B (min)           | 1.5  |
| C ( $\pm 0.2$ )   | 13   |
| F                 | 20.2 |
| G ( $+ 2 / - 0$ ) | 16.4 |
| N (min)           | 60   |
| T (max)           | 22.4 |

## TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

|                   |                    |     |
|-------------------|--------------------|-----|
| Tape width        | W                  | 16  |
| Tape Hole Spacing | P0 ( $\pm 0.1$ )   | 4   |
| Component Spacing | P                  | 12  |
| Hole Diameter     | D ( $\pm 0.1/-0$ ) | 1.5 |
| Hole Diameter     | D1 (min)           | 1.5 |
| Hole Position     | F ( $\pm 0.05$ )   | 7.5 |
| Compartment Depth | K (max)            | 6.5 |
| Hole Spacing      | P1 ( $\pm 0.1$ )   | 2   |

All dimensions are in mm.



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