VN770K

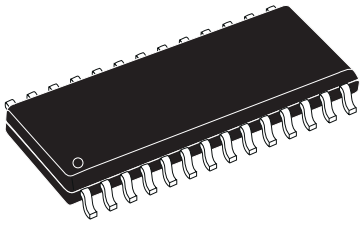
QUAD SMART POWER SOLID STATE RELAY FOR COMPLETE H BRIDGE CONFIGURATIONS

TYPE	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN770K	220mΩ (*)	9A (**)	36V

(*) Total resistance of one side in bridge configuration

(**) Typical current limitation value

- 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



SO-28

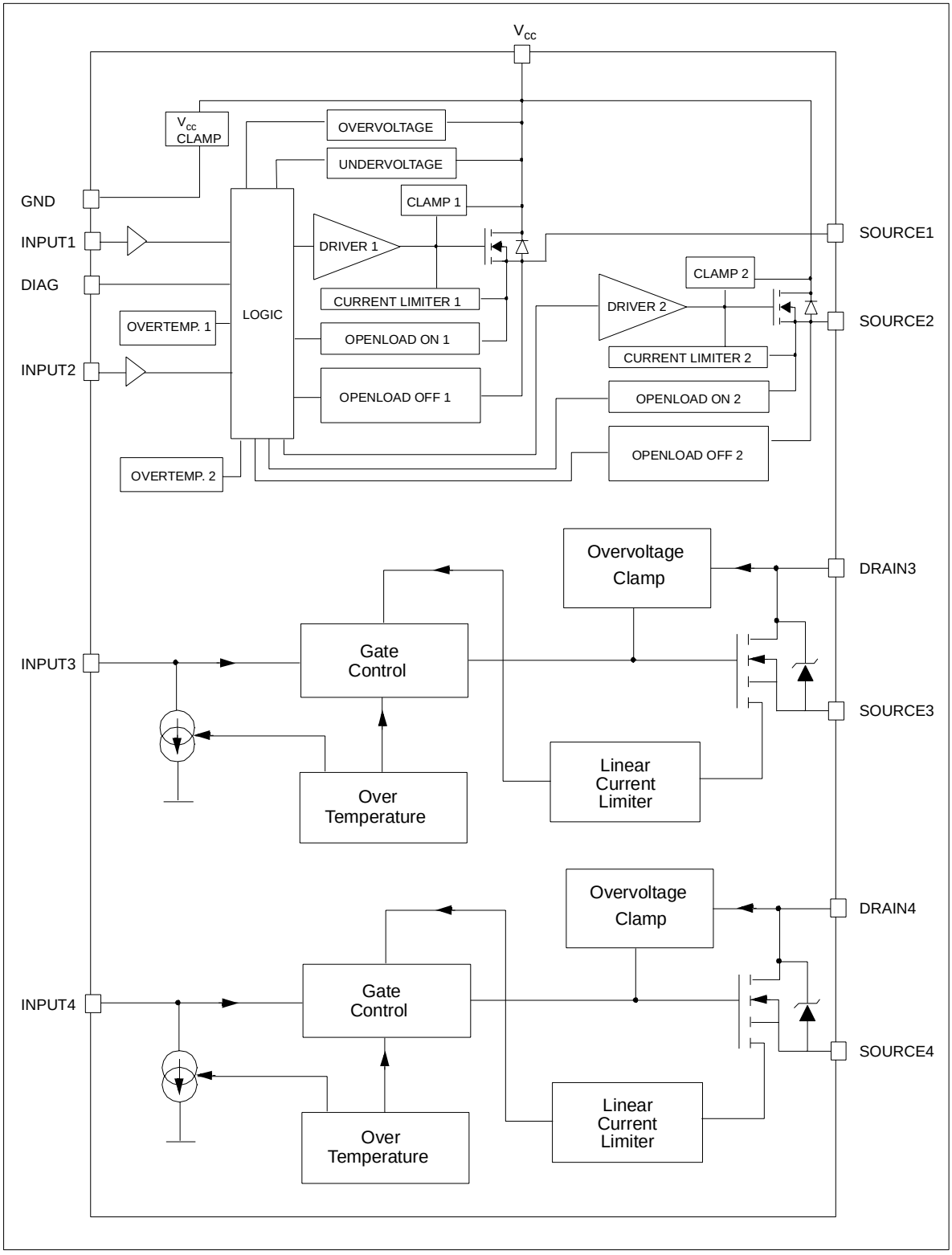
DESCRIPTION

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 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.

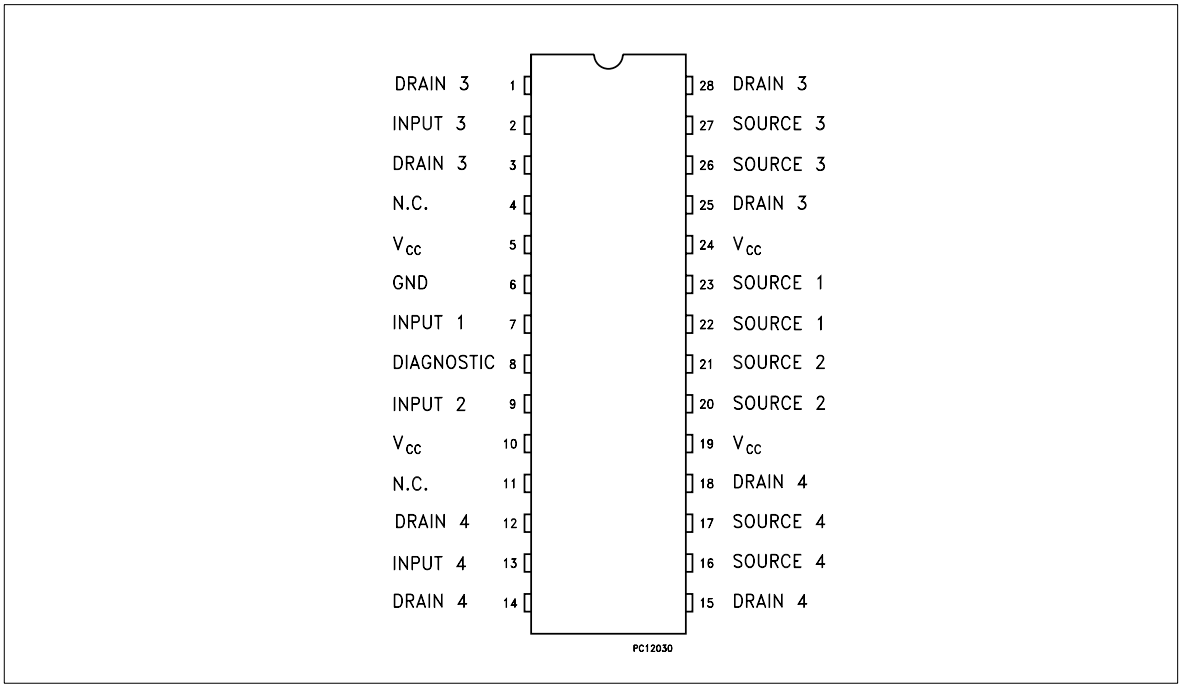
PIN FUNCTION

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
$R_{thj\text{-}case}$	Thermal Resistance Junction-case (High-side switch)	MAX	20	°C/W
$R_{thj\text{-}case}$	Thermal Resistance Junction-case (Low-side switch)	MAX	20	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient	MAX	60	°C/W

ABSOLUTE MAXIMUM RATING

DUAL HIGH SIDE SWITCH

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage	41	V
- V_{CC}	Reverse DC Supply Voltage	- 0.3	V
- I_{GND}	DC Reverse Ground Pin Current	- 200	mA
I_{OUT}	DC Output Current	Internally Limited	A
- I_{OUT}	Reverse DC Output Current	- 6	A
I_{IN}	DC Input Current	+/- 10	mA
I_{stat}	DC Status Current	+/- 10	mA
V_{ESD}	Electrostatic Discharge (Human Body Model: R=1.5KΩ; C=100pF) - INPUT - STATUS - OUTPUT - V_{CC}	 4000 4000 5000 5000	 V V V V
P_{tot}	Power Dissipation (T_C=25°C)	6	W
T_j	Junction Operating Temperature	Internally Limited	°C
T_c	Case Operating Temperature	- 40 to 150	°C
T_{stg}	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	Ω
I_D	Drain Current	Internally Limited	A
I_R	Reverse DC Output Current	-10.5	A
V_{ESD1}	Electrostatic Discharge (R=1.5KΩ, C=100pF)	4000	V
V_{ESD2}	Electrostatic Discharge on output pin only (R=330Ω, C=150pF)	16500	V
P_{tot}	Power Dissipation (T_C=25°C)	6	W
T_j	Operating Junction Temperature	Internally limited	°C
T_c	Case Operating Temperature	Internally limited	°C
T_{stg}	Storage Temperature	-55 to 150	°C

ELECTRICAL CHARACTERISTICS FOR DUAL HIGH SIDE SWITCH

(8V < V_{CC} < 36V; -40°C < T_j < 150°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°C			160	mΩ
		I_{OUT}=1A; V_{CC}>8V			320	mΩ
I_S (**)	Supply Current	Off State; V_{CC}=13V; V_{IN}=V_{OUT}=0V		12	40	µA
		Off State; V_{CC}=13V; V_{IN}=V_{OUT}=0V; T_j=25°C		12	25	µA
		On State; V_{CC}=13V; V_{IN}=5V; I_{OUT}=0A		5	7	mA
$I_{L(off1)}$	Off State Output Current	V_{IN}=V_{OUT}=0V	0		50	µA
$I_{L(off2)}$	Off State Output Current	V_{IN}=0V; V_{OUT}=3.5V	-75		0	µA
$I_{L(off3)}$	Off State Output Current	V_{IN}=V_{OUT}=0V; Vcc=13V; T_j =125°C			5	µA
$I_{L(off4)}$	Off State Output Current	V_{IN}=V_{OUT}=0V; Vcc=13V; T_j =25°C			3	µA

(**) Per device

SWITCHING (V_{CC}=13V)

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

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			µA
V_{IH}	Input High Level		3.25			V
I_{IH}	High Level Input Current	V_{IN} = 3.25V			10	µA
V_{hyst}	Input Hysteresis Voltage		0.5			V
V_{ICL}	Input Clamp Voltage	I_{IN} = 1mA I_{IN} = -1mA	6	6.8 -0.7	8	V 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	µA
C_{STAT}	Status Pin Input Capacitance	Normal Operation; V_{STAT}= 5V			100	pF
V_{SCL}	Status Clamp Voltage	I_{STAT}= 1mA I_{STAT}= - 1mA	6	6.8 -0.7	8	V V

PROTECTIONS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
T_{TSD}	Shut-down Temperature		150	175	200	°C
T_R	Reset Temperature		135			°C
T_{hyst}	Thermal Hysteresis		7	15		°C
t_{sdl}	Status Delay in Overload Conditions	T_j>T_{TSD}			20	µs
I_{lim}	Current limitation	T_j=125°C 5.5V<V_{CC}<36V	7 8	10	13 13 13	A A 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	µs
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	µs

ELECTRICAL CHARACTERISTICS FOR LOW SIDE SWITCHES

(-40°C < T_j < 150°C, unless otherwise specified)

OFF

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{CLAMP}	Drain-source Clamp Voltage	V_{IN}=0V; I_D=3.5A	40	45	55	V
V_{CLTH}	Drain-source Clamp Threshold Voltage	V_{IN}=0V; I_D=2mA	36			V
V_{INTH}	Input Threshold Voltage	V_{DS}=V_{IN}; I_D=1mA	0.5		2.5	V
I_{ISS}	Supply Current from Input Pin	V_{DS}=0V; V_{IN}=5V		100	150	µA
V_{INCL}	Input-Source Clamp Voltage	I_{IN}=1mA I_{IN}=-1mA	6 -1.0	6.8	8 -0.3	V
I_{DSS}	Zero Input Voltage Drain Current (V_{IN}=0V)	V_{DS}=13V; V_{IN}=0V; T_j=25°C V_{DS}=25V; V_{IN}=0V			30 75	µA

ON

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$R_{DS(on)}$	Static Drain-source On Resistance	V_{IN}=5V; I_D=3.5A; T_j=25°C V_{IN}=5V; I_D=3.5A			60 120	mΩ

(T_j=25°C, unless otherwise specified)

DYNAMIC

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
g_{fs} (*)	Forward Transconductance	V_{DD}=13V; I_D=3.5A		9		S
C_{OSS}	Output Capacitance	V_{DS}=13V; f=1MHz; V_{IN}=0V		220		pF

SWITCHING

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on Delay Time	V_{DD}=15V; I_D=3.5A V_{gen}=5V; R_{gen}=$R_{IN\ MIN}$=150Ω		100	300	ns
t_r	Rise Time			470	1500	ns
$t_{d(off)}$	Turn-off Delay Time			500	1500	ns
t_f	Fall Time			350	1000	ns
$t_{d(on)}$	Turn-on Delay Time	V_{DD}=15V; I_D=3.5A V_{gen}=5V; R_{gen}=2.2KΩ		0.75	2.3	µs
t_r	Rise Time			4.6	14.0	µs
$t_{d(off)}$	Turn-off Delay Time			5.4	16.0	µs
t_f	Fall Time			3.6	11.0	µs
$(dI/dt)_{on}$	Turn-on Current Slope	V_{DD}=15V; I_D=3.5A V_{gen}=5V; R_{gen}=$R_{IN\ MIN}$=150Ω		6.5		A/µs
Q_i	Total Input Charge	V_{DD}=12V; I_D=3.5A; V_{IN}=5V I_{gen}=2.13mA		18		nC

SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{SD} (*)	Forward On Voltage	I_{SD}=3.5A; V_{IN}=0V		0.8		V
t_{rr}	Reverse Recovery Time	I_{SD}=3.5A; dI/dt=20A/µs V_{DD}=30V; L=200µH		220		ns
Q_{rr}	Reverse Recovery Charge			0.28		µC
I_{RRM}	Reverse Recovery Current			2.5		A

ELECTRICAL CHARACTERISTICS FOR LOW SIDE SWITCHES (continued)

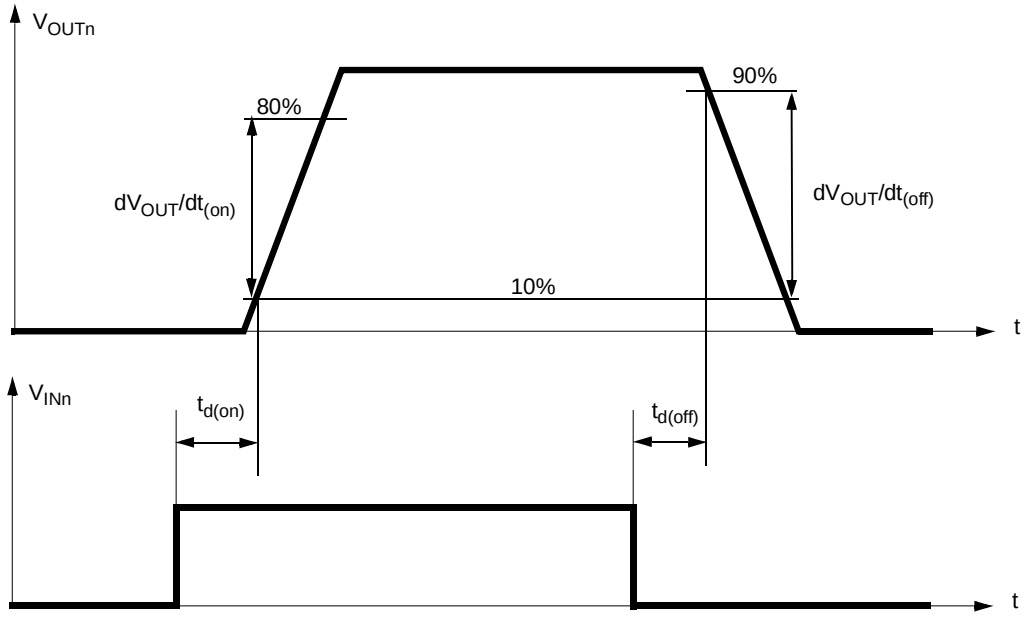
PROTECTIONS (-40°C < T_j < 150°C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{lim}	Drain Current Limit	V_{IN}=5V; V_{DS}=13V V_{IN}=5V; V_{DS}=13V; T_j=125°C	6 6.5	9	12 12	A A
t_{dlim}	Step Response Current Limit	V_{IN}=5V; V_{DS}=13V		4.0		µs
T_{jsh}	Overtemperature Shutdown		150	175		°C
T_{jrs}	Overtemperature Reset		135			°C
I_{gf}	Fault Sink Current	V_{IN}= 5V; V_{DS}=13V; T_j=T_{jsh}		15		mA
E_{as}	Single Pulse Avalanche Energy	starting T_j=25°C; V_{DD}=24V V_{IN}=5V; R_{gen}=$R_{IN\ MIN}$=150Ω; L=24mH	200			mJ

(*) Pulsed: Pulse duration = 300µs, duty cycle 1.5%

DUAL HIGH-SIDE SWITCH

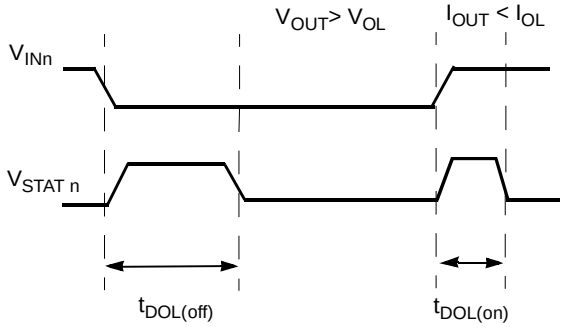
SWITCHING TIME WAVEFORMS



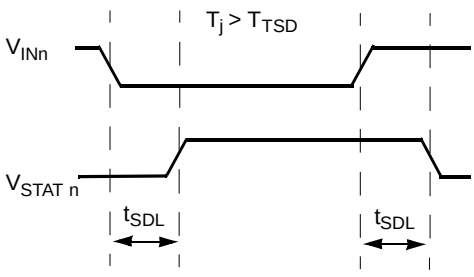
TRUTH TABLE

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

OPEN LOAD STATUS TIMING (with external pull-up)



OVER TEMP STATUS TIMING



TYPICAL APPLICATION DIAGRAM

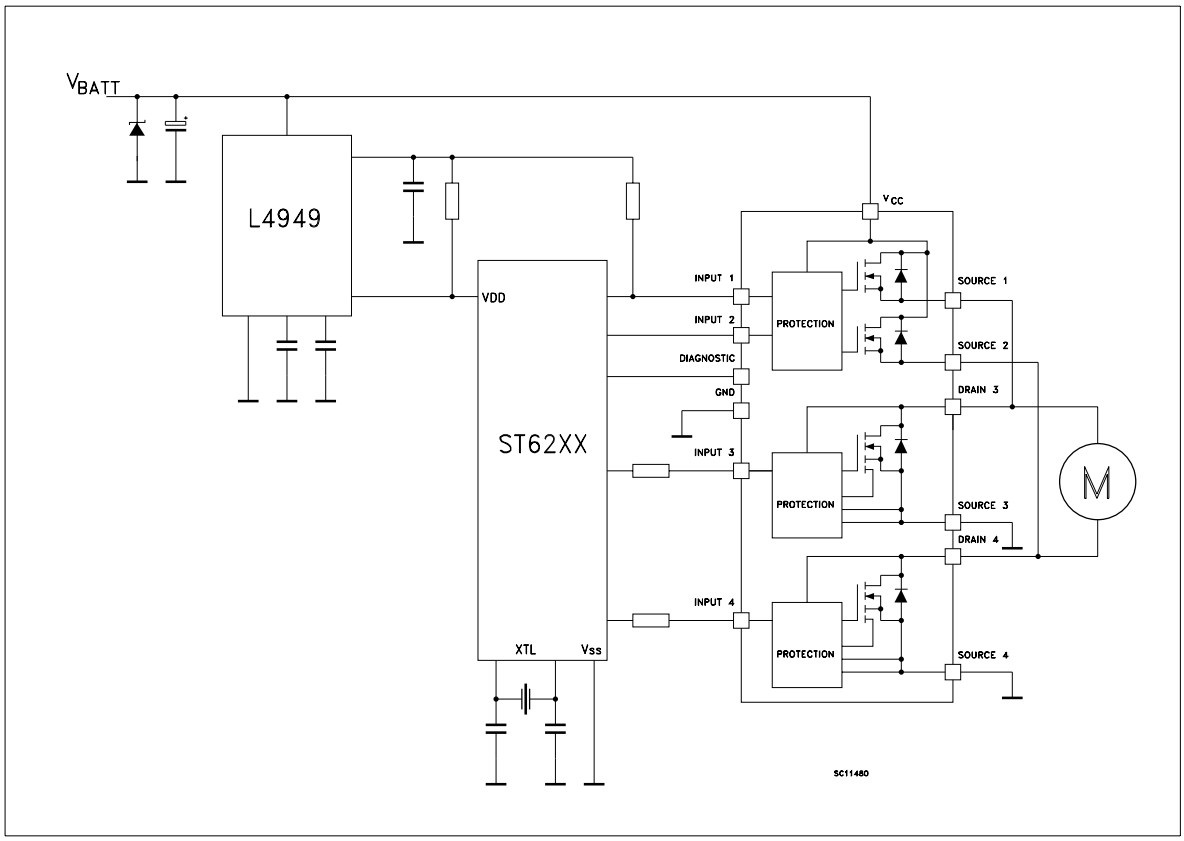
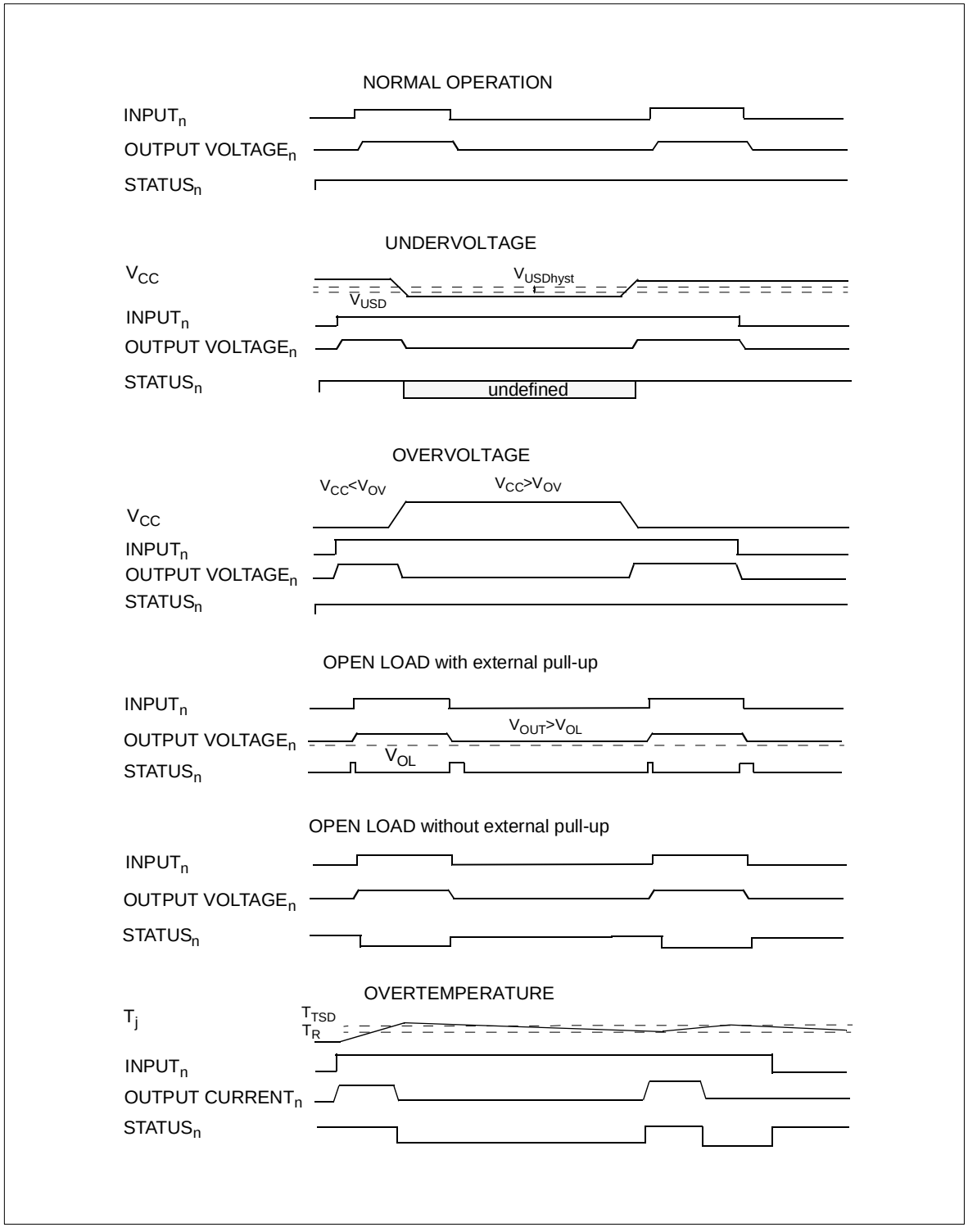
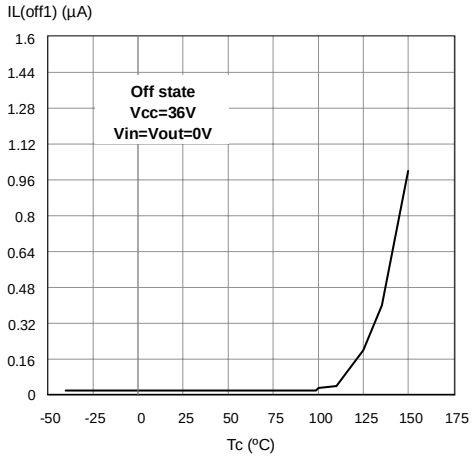


Figure 1: Waveforms

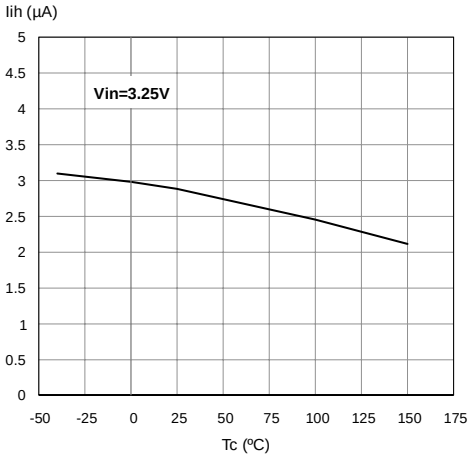


ELECTRICAL CHARACTERIZATION FOR DUAL HIGH SIDE SWITCH

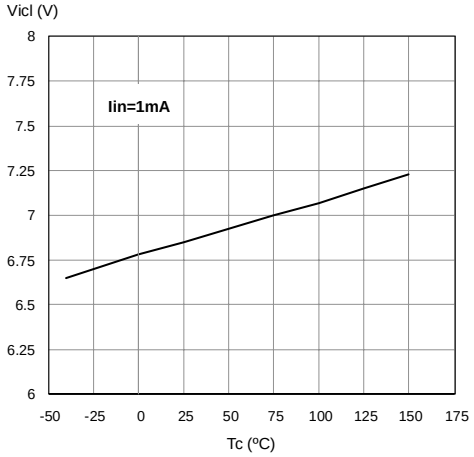
Off State Output Current



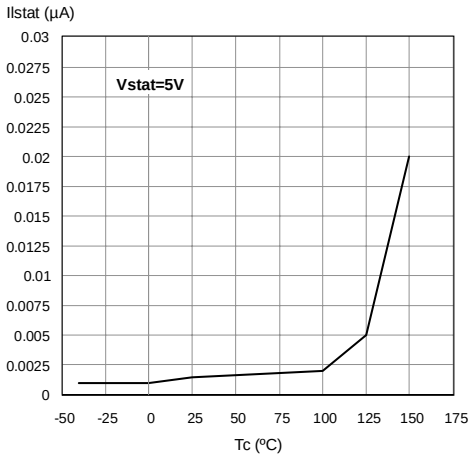
High Level Input Current



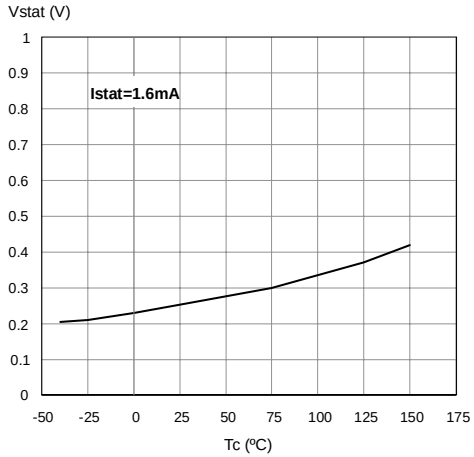
Input Clamp Voltage



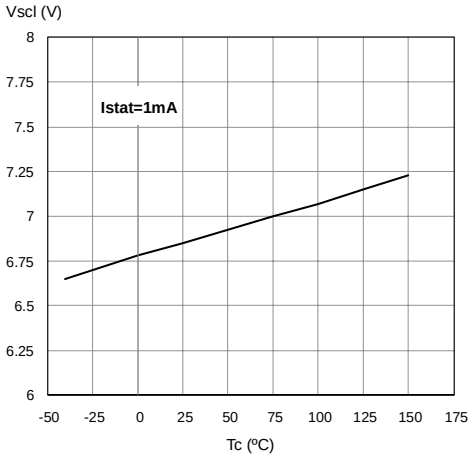
Status Leakage Current



Status Low Output Voltage

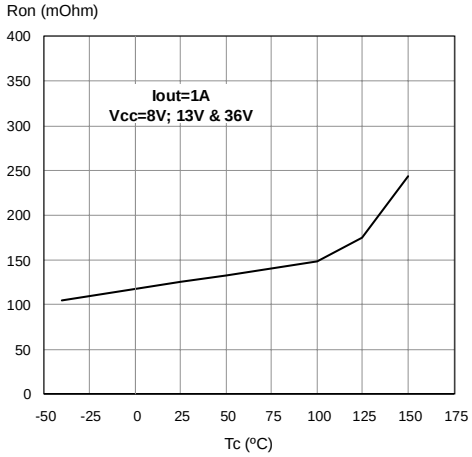


Status Clamp Voltage

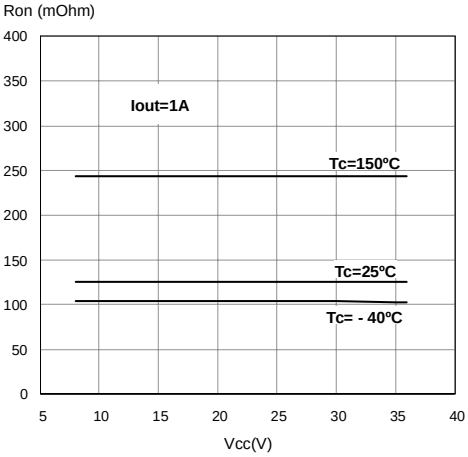


ELECTRICAL CHARACTERIZATION FOR DUAL HIGH SIDE SWITCH (continued)

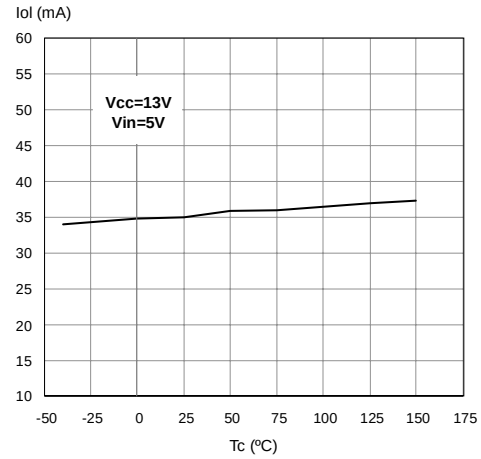
On State Resistance Vs T_{case}



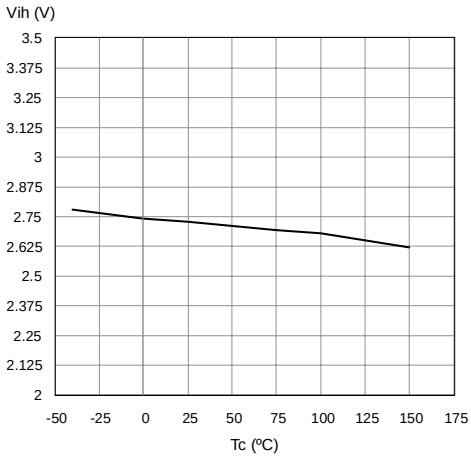
On State Resistance Vs V_{CC}



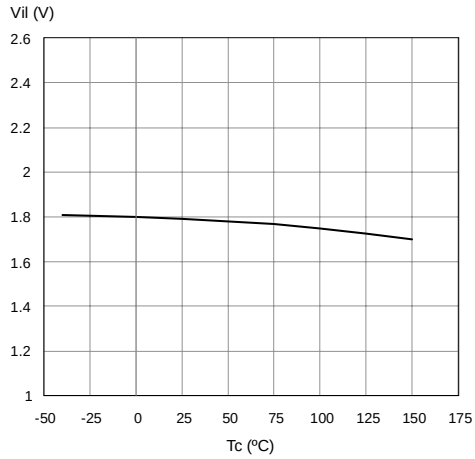
Openload On State Detection Threshold



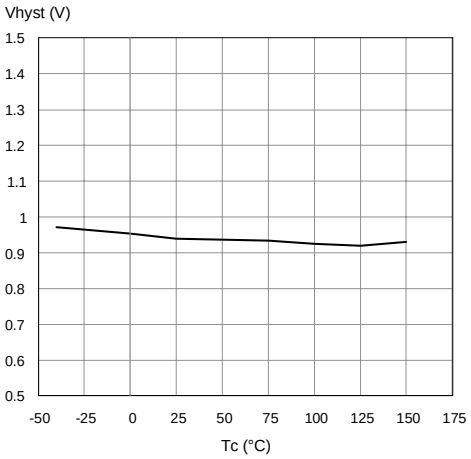
Input High Level



Input Low Level

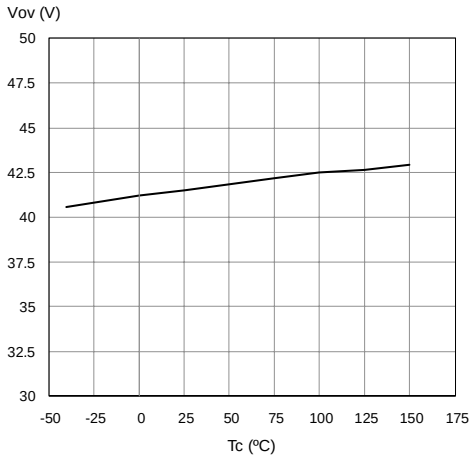


Input Hysteresis Voltage

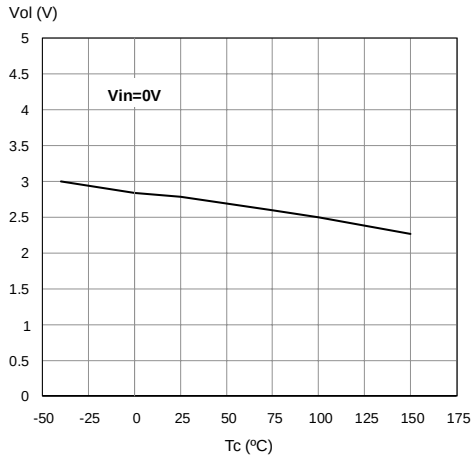


ELECTRICAL CHARACTERIZATION FOR DUAL HIGH SIDE SWITCH (continued)

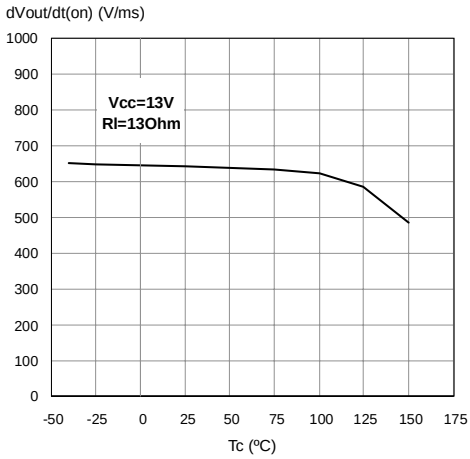
Overvoltage Shutdown



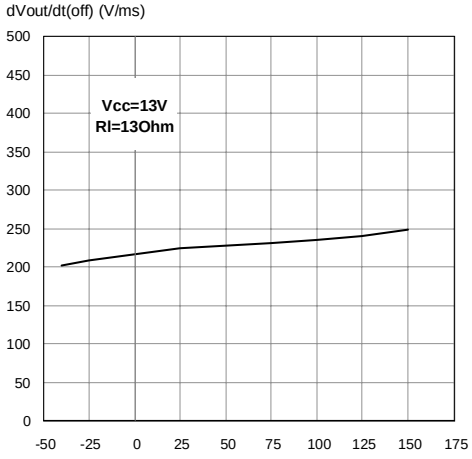
Openload Off State Voltage Detection Threshold



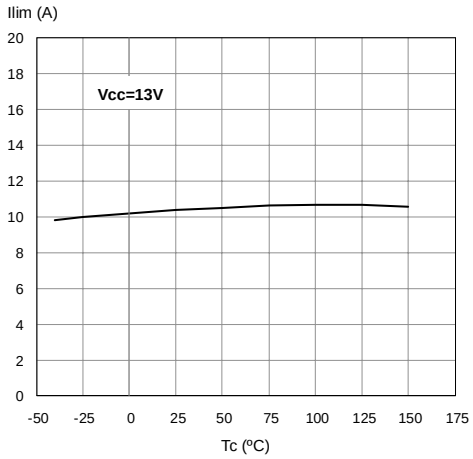
Turn-on Voltage Slope



Turn-off Voltage Slope

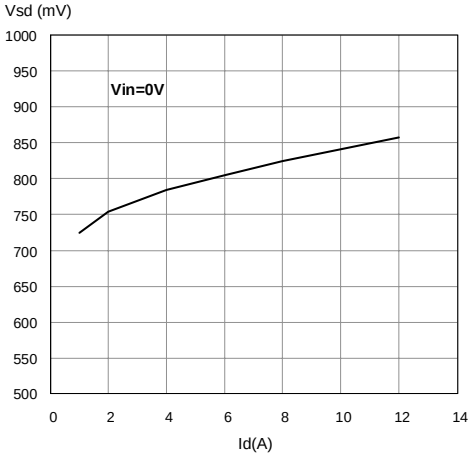


I_{LIM} Vs T_{case}

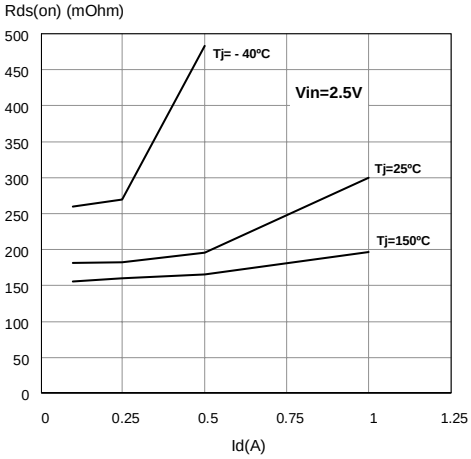


ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES

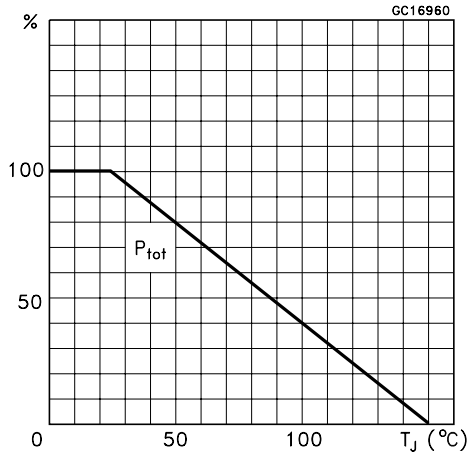
Source-Drain Diode Forward Characteristics



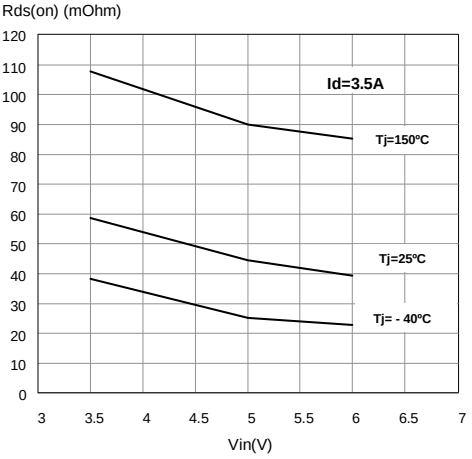
Static Drain Source On Resistance



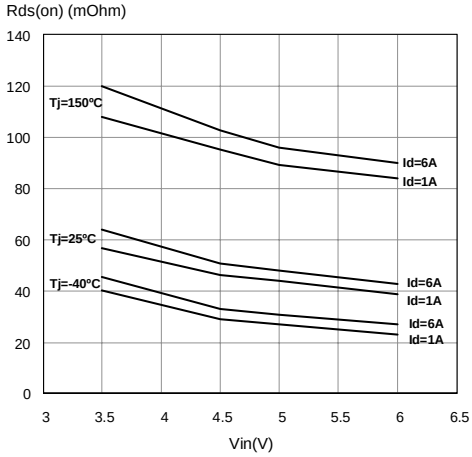
Derating Curve



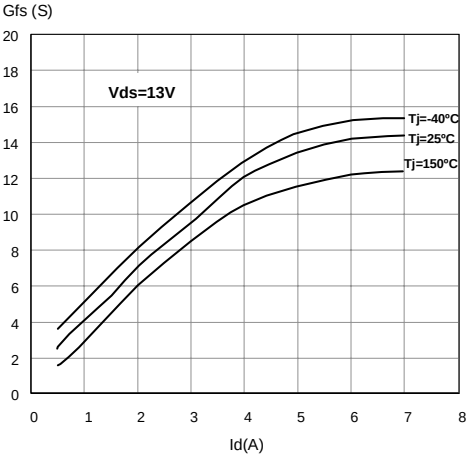
Static Drain-Source On resistance Vs. Input Voltage



Static Drain-Source On resistance Vs. Input Voltage

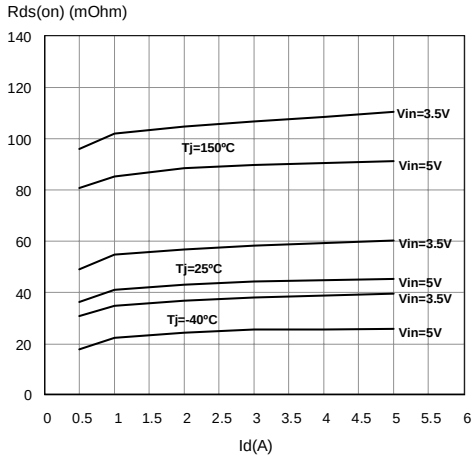


Transconductance

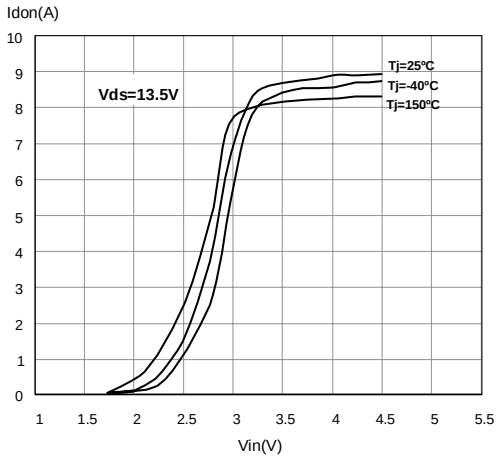


ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES (continued)

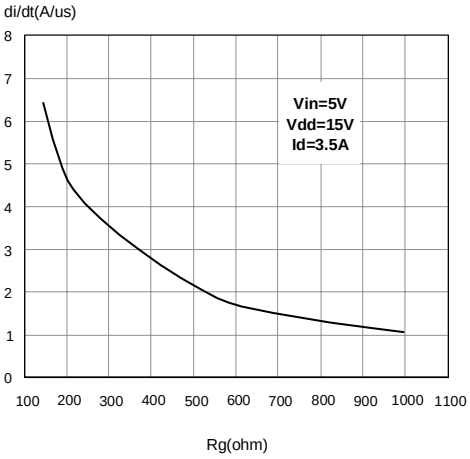
Static Drain-Source On Resistance Vs. Id



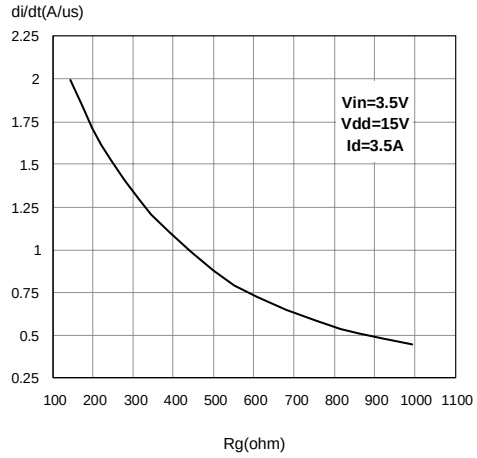
Transfer Characteristics



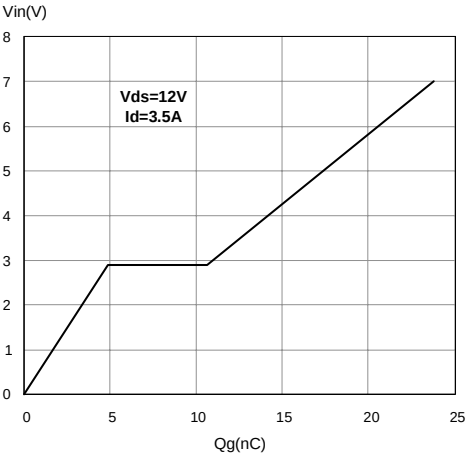
Turn On Current Slope



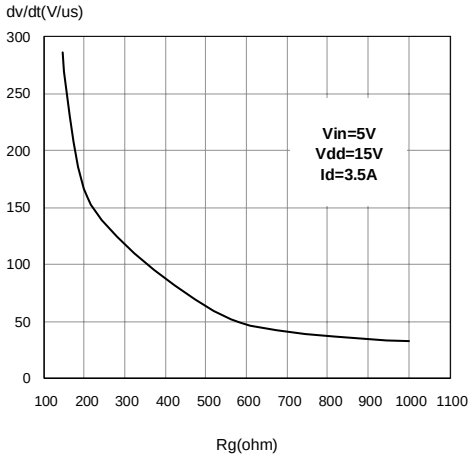
Turn On Current Slope



Input Voltage Vs. Input Charge

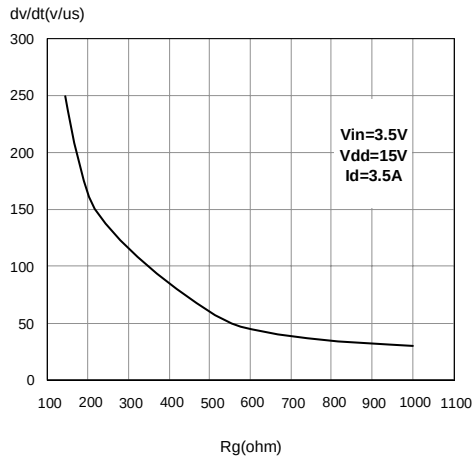


Turn off drain source voltage slope

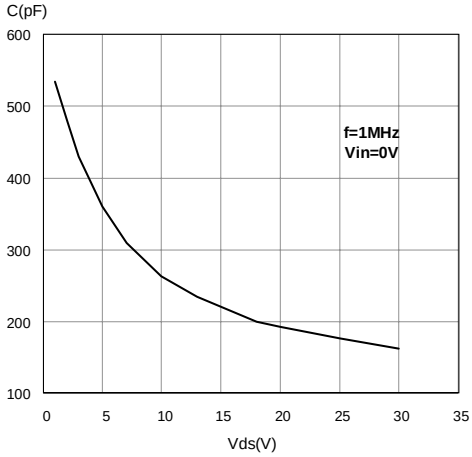


ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES (continued)

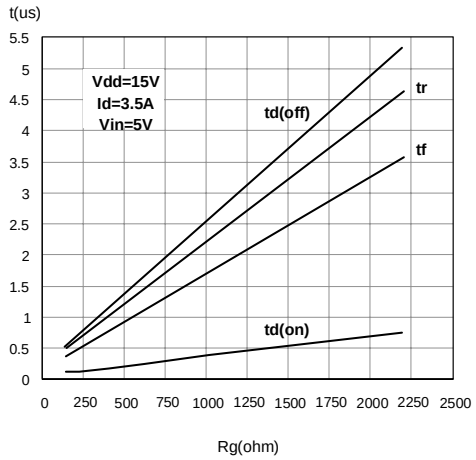
Turn Off Drain-Source Voltage Slope



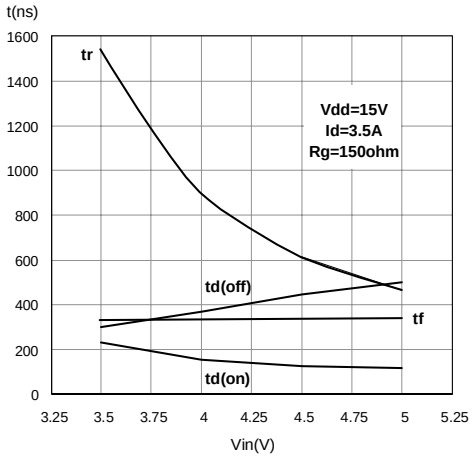
Capacitance Variations



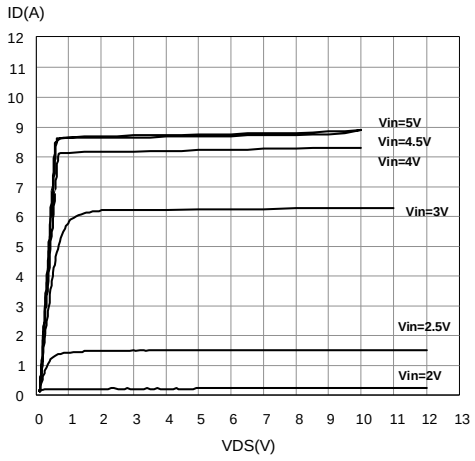
Switching Time Resistive Load



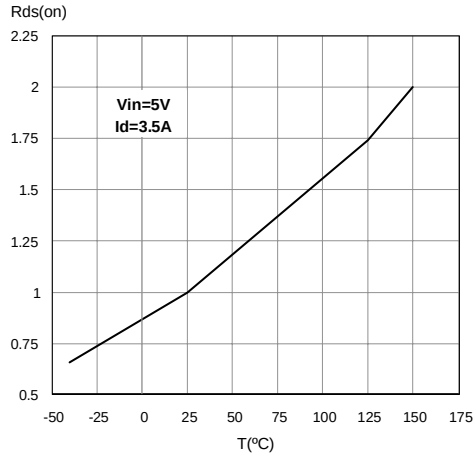
Switching Time Resistive Load



Output Characteristics

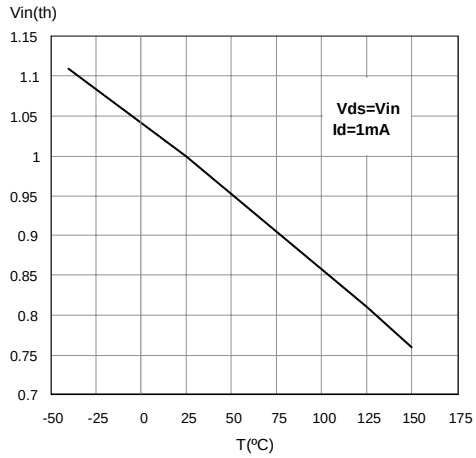


Normalized On Resistance Vs. Temperature

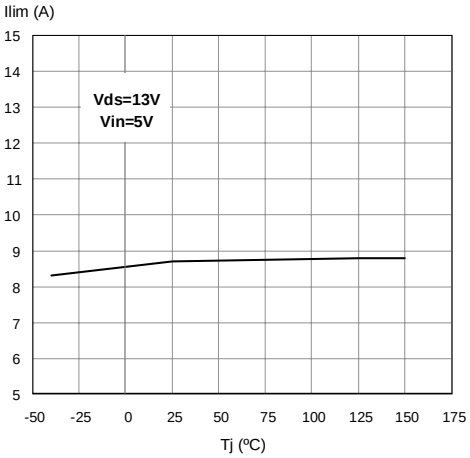


ELECTRICAL CHARACTERIZATION FOR LOW SIDE SWITCHES (continued)

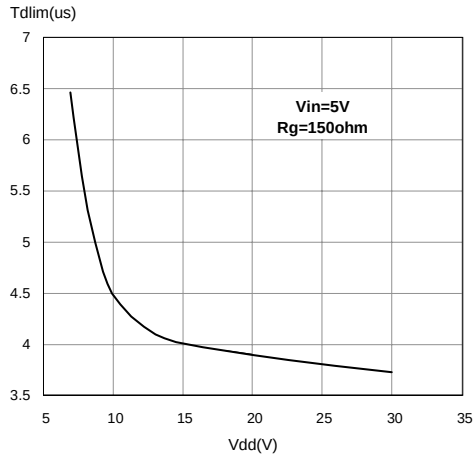
Normalized Input Threshold Voltage Vs. Temperature



Current Limit Vs. Junction Temperature

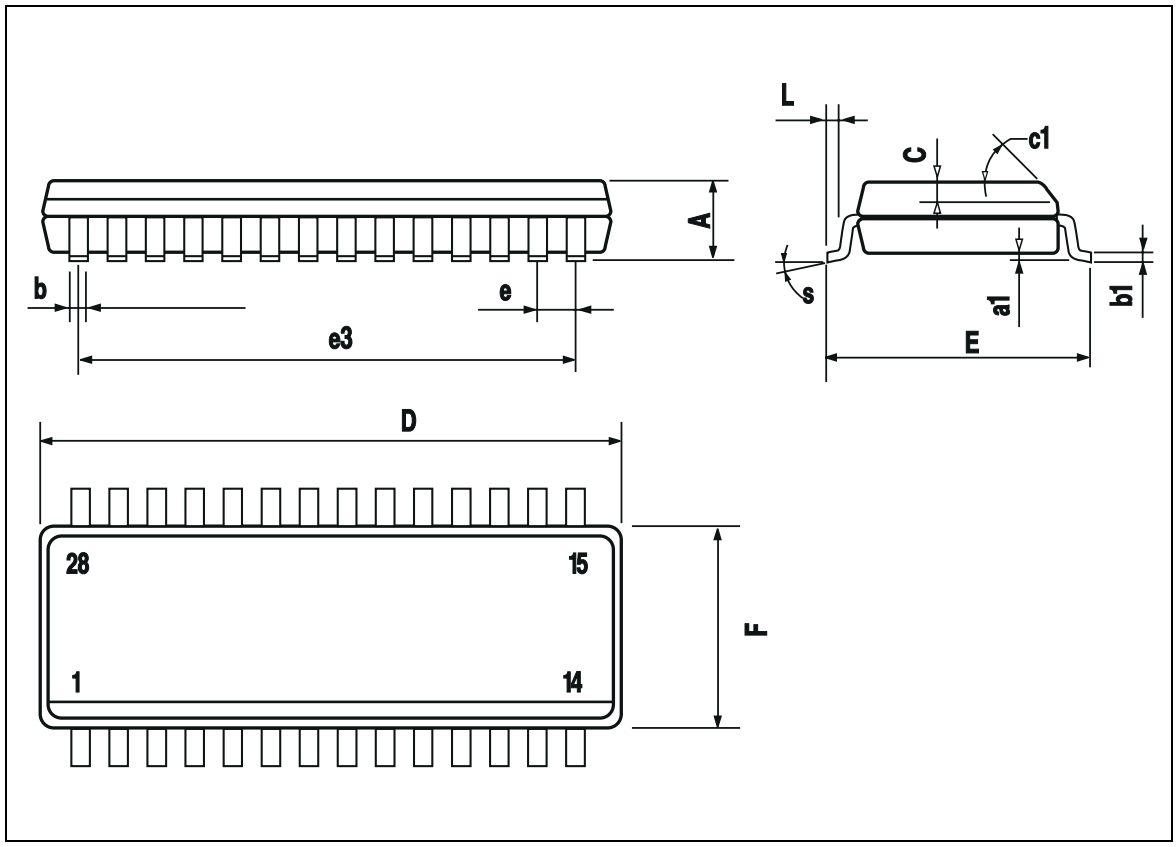


Step Response Current Limit

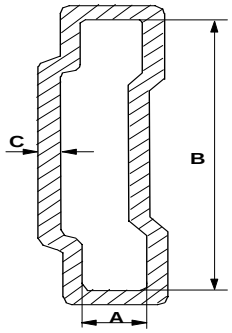


SO-28 MECHANICAL DATA

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.)					



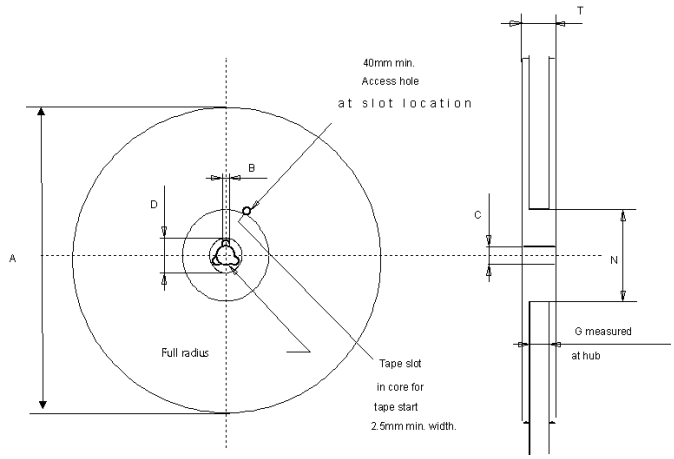
SO-28 TUBE SHIPMENT (no suffix)



Base Q.ty	28
Bulk Q.ty	700
Tube length (± 0.5)	532
A	3.5
B	13.8
C (± 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 (± 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 (± 0.1)**	4
Component Spacing	**P**	12
Hole Diameter	**D (± 0.1/-0)**	1.5
Hole Diameter	**D1 (min)**	1.5
Hole Position	**F (± 0.05)**	7.5
Compartment Depth	**K (max)**	6.5
Hole Spacing	**P1 (± 0.1)**	2

All dimensions are in mm.