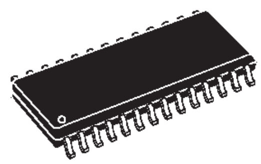
VN770

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

TYPE	$R_{DS(on)}$ *	I_{OUT}	V_{CC}
VN770	0.240 Ω	9 A	26 V

* Total resistance of one side in bridge configuration

- IDEAL AS A LOW VOLTAGE BRIDGE
- VERY LOW STAND-BY POWER DISSIPATION
- OVER-CURRENT PROTECTED
- STATUS FLAG DIAGNOSTICS ON UPPER SIDE
- OPEN DRAIN DIAGNOSTICS OUTPUT
- UNDER-VOLTAGE PROTECTION
- SUITABLE AS QUAD SWITCH



SO-28

DESCRIPTION

The VN770 is a device formed by three monolithic chips housed in a standard SO-28 package: a double high side and two Power MOSFETs. The double high side are made using STMicroelectronics VIPower technology; Power MOSFETs are made by using the new advanced strip lay-out 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 shut-down to protect the chip from over temperature and short circuit, status output to provide indication for open load in off and on state, overtemperature conditions and stuck-on to V_{CC}.

DUAL HIGH-SIDE SWITCH

From the falling edge of the input signal, the status output, initially low to signal a fault condition (overtemperature or open load on-state), will go back to a high state with a different delay in case of overtemperature (tpovl) and in case of open open load (t_{pol}) respectively. This feature allows to discriminate the nature of the detected fault. To protect the device against short circuit and over current condition, the thermal protection turns the integrated Power MOS off at a minimum junction temperature of 140 ^oC. When this temperature returns to 125 ^oC the switch is automatically turned on again. In short circuit the protection reacts with virtually no delay, the sensor (one for each channel) being located inside each of the two Power MOS areas. This positioning allows the device to operate with one channel in automatic thermal cycling and the other one on a normal load. An internal function of the devices ensures the fast demagnetization of inductive loads with a typical voltage (V_{demag}) of -18V. This function allows to greatly reduces the power dissipation according to the formula:

$P_{dem} = 0.5 \bullet L_{load} \bullet (I_{load})^2 \bullet [(V_{CC}+V_{demag})/V_{demag}] \bullet f$

where f = switching frequency and

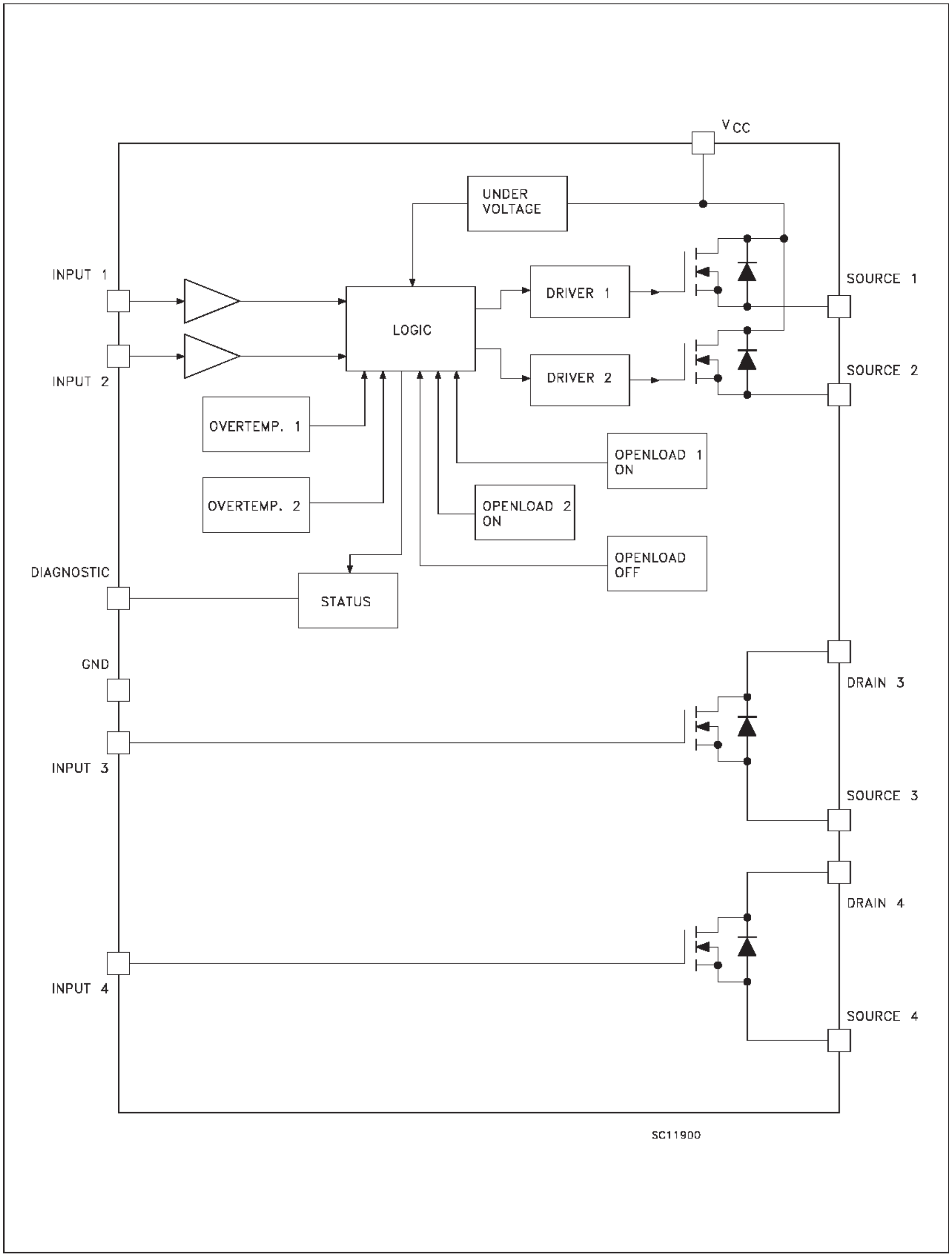
V_{demag} = demagnetization voltage.

In this device if the GND pin is disconnected, with V_{CC} not exceeding 16V, both channel will switch off.

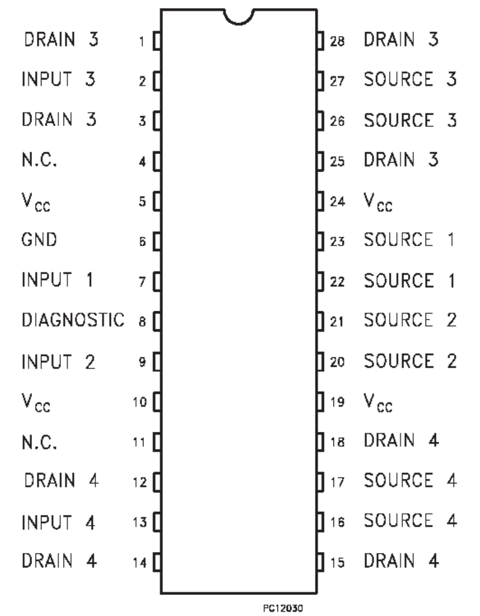
Power MOSFETs

During normal operation, the Input pin is electrically connected to the gate of the internal power MOSFET. The devices can be used as a switch from DC to very high frequency.

BLOCK DIAGRAM



CONNECTION DIAGRAM



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 1and 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 switch)
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)

PROTECTION CIRCUITS

DUAL HIGH SIDE SWITCH

The simplest way to protect the device against a continuous reverse battery voltage (-26V) is to insert a a small resistor between pin 2 (GND) and ground. The suggested resistance value is about 150Ω. In any case the maximum voltage drop on this resistor should not overcome 0.5V.

If there is no need for the control unit to handle external analog signals referred to the power GND, the best approach is to connect the reference potential of the control unit to the device ground (see application circuit in fig. 3), which becomes the common signal GND for the whole control board avoiding shift of V_{ih}, V_{il} and V_{stat}.

TRUTH TABLE (for Dual high-side switch only)

		INPUT 1	INPUT 2	SOURCE 1	SOURCE 2	DIAGNOSTIC
Normal Operation		L H L H	L H H L	L H L H	L H H L	H H H H
Under-voltage		X	X	L	L	H
Thermal Shutdown	Channel 1	H	X	L	X	L
	Channel 2	X	H	X	L	L
Open Load	Channel 1	H L	X L	H L	X L	L L
	Channel 2	X L	H L	X L	H L	L L
Output Shorted to V_{CC}	Channel 1	H L	X L	H H	X L	L L
	Channel 2	X L	H L	X L	H H	L L

NOTE: The low-side switches have the fault feedback which can be detected by monitoring the voltage at the input pins.
L = Logic LOW, H = Logic HIGH, X = Don't care

ABSOLUTE MAXIMUM RATING ($-40\,^{o}C < T_j < 150\,^{o}C$)

HIGH SIDE SWITCH

Symbol	Parameter	Value	Unit
$V_{(BR)DSS}$	Drain-Source Brekdown Voltage	40	V
I_{OUT}	Output Current (continuous)	9	A
I_R	Reverse Output Current	-9	A
I_{IN}	Input Current	±10	mA
$-V_{CC}$	Reverse Supply Current	-4	V
I_{STAT}	Status Current	±10	mA
V_{ESD}	Electrostatic Discharge (C = 100 pF, R = 1.5 KΩ)	2000	V
P_{tot}	Power Dissipation @ T_c = 25 ^{o}C	Internally Limited	W
T_j	Junction Operating Temperature	-40 to 150	^{o}C
T_{stg}	Storage Temperature	-55 to 150	^{o}C

LOW SIDE SWITCH

Symbol	Parameter	Value	Unit
V_{DS}	Drain-Source Voltage (V_{GS} = 0)	60	V
V_{DGR}	Drain-Gate Voltage (R_{GS} = 20 KΩ)	60	V
V_{GS}	Gate-Source Voltage	±20	V
I_D	Drain Current (continuous) @ T_C = 25 °C	36	A
I_D	Drain Current (continuous) @ T_C = 100 °C	24	A
$I_{DM(*)}$	Drain Current (pulsed)	144	A
dv/dt (1)	Peak Diode Recovery Voltage Slope	7	V/ns
T_{stg}	Storage Temperature	-55 to 150	°C
T_j	Junction Operating Temperature	-40 to 150	°C

THERMAL DATA

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

ELECTRICAL CHARACTERISTICS FOR DUAL HIGH SIDE SWITCH

(8 < V_{CC} < 16 V; -40 ≤ T_j ≤ 125 °C unless otherwise specified)

POWER

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply Voltage		6	13	26	V
In(*)	Nominal Current	T_c = 85 °C $V_{DS(on)}$ ≤ 0.5 V_{CC} = 13 V	1.6		2.6	A
R_{on}	On State Resistance	I_{OUT} = I_n V_{CC} = 13 V T_j = 25 °C	0.13		0.2	Ω
I_S	Supply Current	Off State T_j = 25 °C V_{CC} = 13 V		35	100	μA
$V_{DS(MAX)}$	Maximum Voltage Drop	I_{OUT} = 7.5 A T_j = 85 °C V_{CC} = 13 V	1.44		2.3	V
R_i	Output to GND internal Impedance	T_j = 25 °C	5	10	20	KΩ

SWITCHING

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$(^)	Turn-on Delay Time Of Output Current	R_{out} = 5.4 Ω	5	25	200	μs
t_r(^)	Rise Time Of Output Current	R_{out} = 5.4 Ω	10	50	180	μs
$t_{d(off)}$(^)	Turn-off Delay Time Of Output Current	R_{out} = 5.4 Ω	10	75	250	μs
t_f(^)	Fall Time Of Output Current	R_{out} = 5.4 Ω	10	35	180	μs
$(di/dt)_{on}$	Turn-on Current Slope	R_{out} = 5.4 Ω	0.003		0.1	A/μs
$(di/dt)_{off}$	Turn-off Current Slope	R_{out} = 5.4 Ω	0.005		0.1	A/μs

ELECTRICAL CHARACTERISTICS FOR DUAL HIGH SIDE SWITCH (continued)

LOGIC INPUT

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IL}	Input Low Level Voltage				1.5	V
V_{IH}	Input High Level Voltage		3.5		(•)	V
$V_{I(hyst.)}$	Input Hysteresis Voltage		0.2	0.9	1.5	V
I_{IN}	Input Current	V_{IN} = 5 V T_j = 25 °C		30	100	µA
V_{ICL}	Input Clamp Voltage	I_{IN} = 10 mA I_{IN} = -10 mA	5	6 -0.7	7	V V

PROTECTION AND DIAGNOSTICS

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{STAT}	Status Voltage Output Low	I_{STAT} = 1.6 mA			0.4	V
V_{USD}	Under Voltage Shut Down		3.5	4.5	6	V
V_{SCL}	Status Clamp Voltage	I_{STAT} = 10 mA I_{STAT} = -10 mA	5	6 -0.7	7	V V
T_{TSD}	Thermal Shut-down Temperature		140	160	180	°C
$T_{SD(hyst.)}$	Thermal Shut-down Hysteresis				50	°C
T_R	Reset Temperature		125			°C
V_{OL}	Open Voltage Level	Off-State (note 2)	2.5	4	5	V
I_{OL}	Open Load Current Level	On-State	5		180	mA
t_{povl}	Status Delay	(note 3)		5	10	µs
t_{pol}	Status Delay	(note 3)	50	500	2500	µs

(*) In= Nominal current according to ISO definition for high side automotive switch (see note 1)
(^) See switching time waveform
() The V_{IH} is internally clamped at 6V about. It is possible to connect this pin to an higher voltage via an external resistor calculated to not exceed 10 mA at the input pin.
note 1: The Nominal Current is the current at T_c = 85 °C for battery voltage of 13V which produces a voltage drop of 0.5 V
note 2: $I_{OL(off)} = (V_{CC} - V_{OL})/R_{OL}$
note 3: t_{povl} t_{pol}: ISO definition

ELECTRICAL CHARACTERISTICS FOR LOW SIDE SWITCHES (T_{case} = 25 ^{o}C unless otherwise specified)

OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BRDSS)}$	Drain-source Brekdown Voltage	I_D = 250 µA V_{GS} = 0	60			V
I_{DSS}	Zero Gate Voltage Drain Current (V_{GS} = 0)	V_{DS} = Max Rating V_{DS} = Max Rating, T_C = 125 ^{o}C			1 10	µA µA
I_{GSS}	Gate-Body Leakage Current (V_{DS} = 0)	V_{GS} = ± 20 V			± 100	nA

ON (*)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS} I_D = 250 µA	1.0		2.5	V
$R_{DS(on)}$	Static Drain-Source On Resistance	V_{GS} = 10 V I_D = 18 A		0.032	0.04	Ω
$I_{D(on)}$	On State Drain Current (V_{DS} = 0)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)max}$ V_{GS} = 10 V	36			A

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} (*)	Forward Transconductance	V_{DS} > $I_{D(on)}$ x $R_{DS(on)max}$ I_D = 18A	7			S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{DS} = 25 V f = 1 MHz V_{GS} = 0		2115 260 65	2800 350 90	pF pF pF

SWITCHING-ON (**)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on Time Rise Time	V_{DD} = 30 V I_D = 18 A R_G = 4.7 Ω V_{GS} = 10 V		28 85	40 115	ns ns
$(di/dt)_{on}$	Turn-on Current Slope	V_{DD} = 48 V I_D = 36 A R_G = 47 Ω V_{GS} = 10 V		250		A/µs
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V_{DD} = 48 V I_D = 36 A V_{GS} = 10 V		50 13 18	70	nC nC nC

SWITCHING-OFF

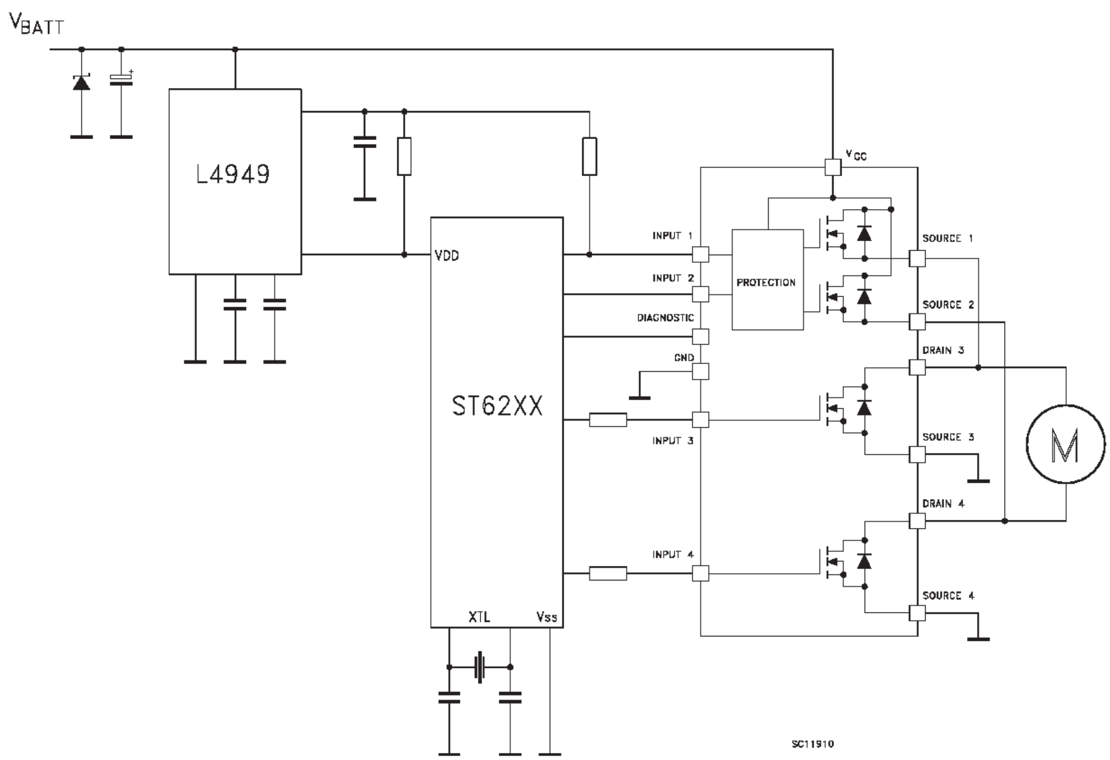
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{r(Voff)}$ t_r t_c	Off-Voltage Rise Time Fall Time Cross-Over Time	V_{DD} = 48 V I_D = 36 A R_G = 4.7 Ω V_{GS} = 10 V		12 25 40	16 35 55	ns ns ns

SOURCE-DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (**)	Source-Drain Current Source-Drain Current (pulsed)				36 144	A A
V_{SD} (*)	Forward On Voltage	I_{SD} = 36 A V_{GS} =0			1.5	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 36 A, di/dt = 100 A/µs V_r = 30 V T_j = 150 °C		75 245 6.5		ns nC A

(*) Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %
(**) Pulse width limited by Safe Operating Area.

TYPICAL APPLICATION DIAGRAM



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.)