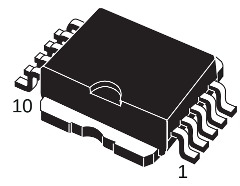
ISO HIGH SIDE SMART POWER SOLID STATE RELAY

TYPE	V_{DSS}	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN16BSP	40 V	0.06 Ω	5.6 A	26 V

- MAXIMUM CONTINUOUS OUTPUT CURRENT :20A @ T_c = 85^{o}C
- 5V LOGIC LEVEL COMPATIBLE INPUT
- THERMAL SHUT-DOWN
- UNDER VOLTAGE PROTECTION
- OPEN DRAIN DIAGNOSTIC OUTPUT
- INDUCTIVE LOAD FAST DEMAGNETIZATION
- VERY LOW STAND-BY POWER DISSIPATION



PowerSO-10

DESCRIPTION

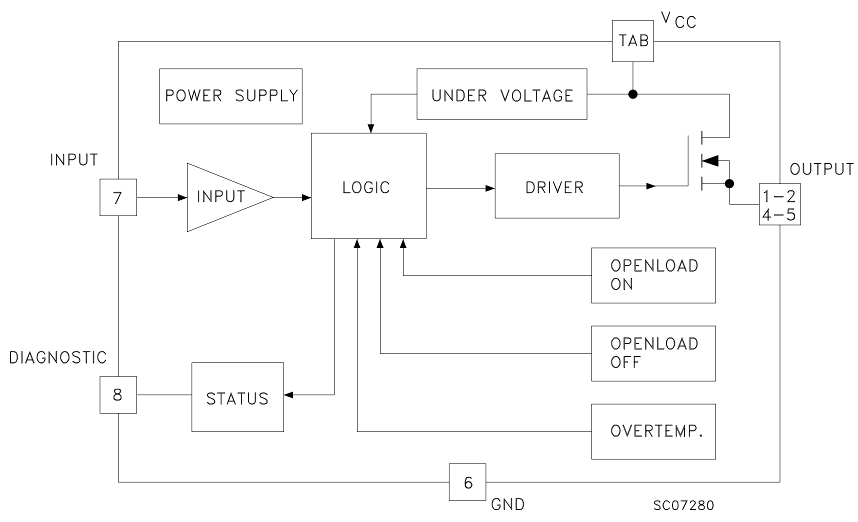
The VN16BSP is a monolithic device made using SGS-THOMSON Vertical Intelligent Power Technology, intended for driving resistive or inductive loads with one side grounded.

Built-in thermal shut-down protects the chip from over temperature and short circuit.

The open drain diagnostic output indicates: open load in off state and in on state, output shorted to V_{CC} and overtemperature.

Fast demagnetization of inductive loads is archivied by negative (-18V) load voltage at turn-off

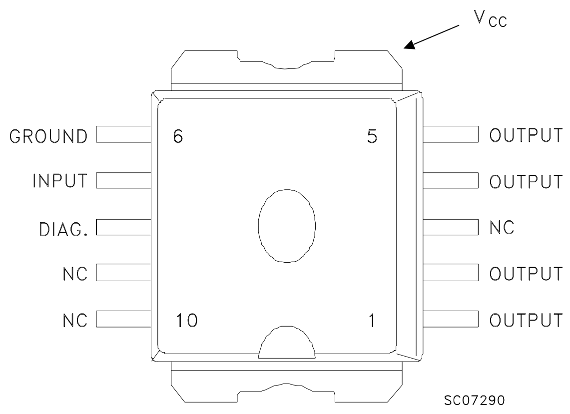
BLOCK DIAGRAM



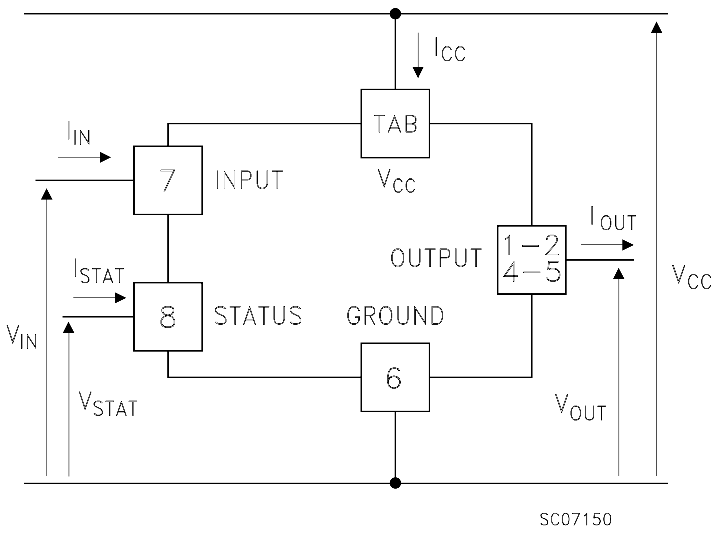
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	40	V
I_{OUT}	Output Current (cont.) at T_c = 85 ^oC	20	A
I_{OUT}(RMS)	RMS Output Current at T_c = 85 ^oC	20	A
I_R	Reverse Output Current at T_c = 85 ^oC (f > 1Hz)	-20	A
I_{IN}	Input Current	±10	mA
$-V_{CC}$	Reverse Supply Voltage	-4	V
I_{STAT}	Status Current	±10	mA
V_{ESD}	Electrostatic Discharge (1.5 kΩ, 100 pF)	2000	V
P_{tot}	Power Dissipation at T_c = 25 ^oC	82	W
T_j	Junction Operating Temperature	-40 to 150	^oC
T_{stg}	Storage Temperature	-55 to 150	^oC

CONNECTION DIAGRAMS



CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

$R_{thj-case}$	Thermal Resistance Junction-case	Max	1.5	$^oC/W$
$R_{thj-amb}$	Thermal Resistance Junction-ambient ($)	Max	50	$^oC/W$

($) When mounted using minimum recommended pad size on FR-4 board

ELECTRICAL CHARACTERISTICS (8 < V_{CC} < 16 V; -40 ≤ T_j ≤ 125 ^oC 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 ^oC $V_{DS(on)} \leq 0.5$ V_{CC} = 13 V	5.6		8.8	A
R_{on}	On State Resistance	I_{OUT} = In V_{CC} = 13 V T_j = 25 ^oC	0.038		0.06	Ω
I_S	Supply Current	Off State V_{CC} = 13 V $T_j \geq 25$ ^oC		25	50	μA
$V_{DS(MAX)}$	Maximum Voltage Drop	I_{OUT} = 20 A V_{CC} = 13 V T_c = 85 ^oC	1		1.8	V
R_i	Output to GND Internal Impedance	T_j = 25 ^oC	5	10	20	KΩ

SWITCHING

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$(^)	Turn-on Delay Time Of Output Current	R_{load} = 1.6 Ω	5	50	500	μs
t_r(^)	Rise Time Of Output Current	R_{load} = 1.6 Ω	40	100	680	μs
$t_{d(off)}$(^)	Turn-off Delay Time Of Output Current	R_{load} = 1.6 Ω	10	100	500	μs
t_f(^)	Fall Time Of Output Current	R_{load} = 1.6 Ω	40	100	680	μs
$(di/dt)_{on}$	Turn-on Current Slope	R_{load} = 1.6 Ω V_{CC} = 13 V	0.008		0.1	A/μs
$(di/dt)_{off}$	Turn-off Current Slope	R_{load} = 1.6 Ω V_{CC} = 13 V	0.008		0.1	A/μs
V_{demag}	Inductive Load Clamp Voltage	R_{load} = 1.6 Ω L = 1 mH	-24	-18	-14	V

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	1	1.5	V
I_{IN}	Input Current	V_{IN} = 5 V T_j = 25 ^oC			100	μA
V_{ICL}	Input Clamp Voltage	I_{IN} = 10 mA I_{IN} = -10 mA	5	6 -0.7	7	V V

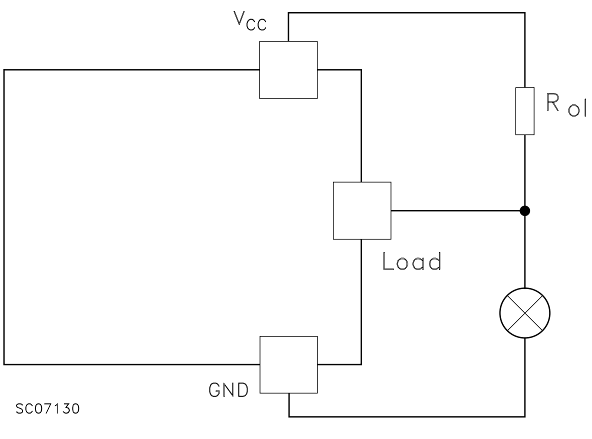
ELECTRICAL CHARACTERISTICS (continued)

PROTECTION AND DIAGNOSTICS (continued)

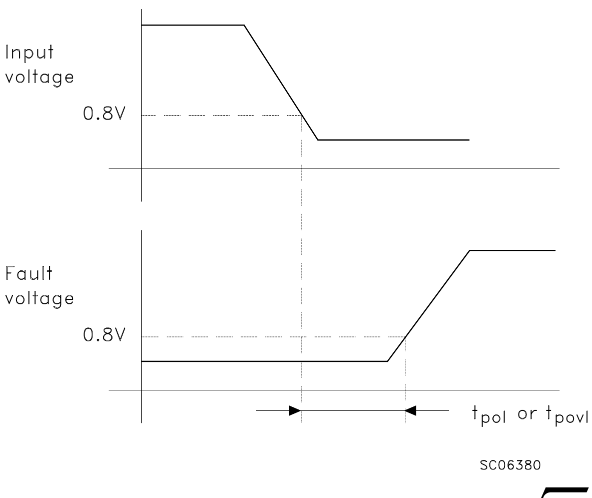
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{STAT}	Status Voltage Output Low	I_{STAT} = 1.6 mA			0.4	V
V_{USD}	Under Voltage Shut Down		3.5	5	6	V
V_{SCL}	Status Clamp Voltage	I_{STAT} = 10 mA I_{STAT} = -10 mA	5	6 -0.7	7	V V
T_{TSD}	Thermal Shut-down Temperature		140	160	180	^oC
$T_{SD(hyst.)}$	Thermal Shut-down Hysteresis			15	50	^oC
T_R	Reset Temperature		125			^oC
V_{OL}	Open Voltage Level	Off-State (note 2)	2.5	3.8	5	V
I_{OL}	Open Load Current Level	On-State	0.15		0.85	A
t_{povl}	Status Delay	(note 3)		5	10	μs
t_{pol}	Status Delay	(note 3)	50	400	2500	μs

(*) In= Nominal current according to ISO definition for high side automotive switch (see note 1)
(^) See Switchig Time Waveforms
(•) 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 ^oC for battery voltage of 13V which produces a voltage drop of 0.5 V
note 2: $I_{OL(off)} = (V_{CC} - V_{OL})/R_{OL}$ (see figure)
note 3: t_{povl} t_{pol}: ISO definition (see figure)

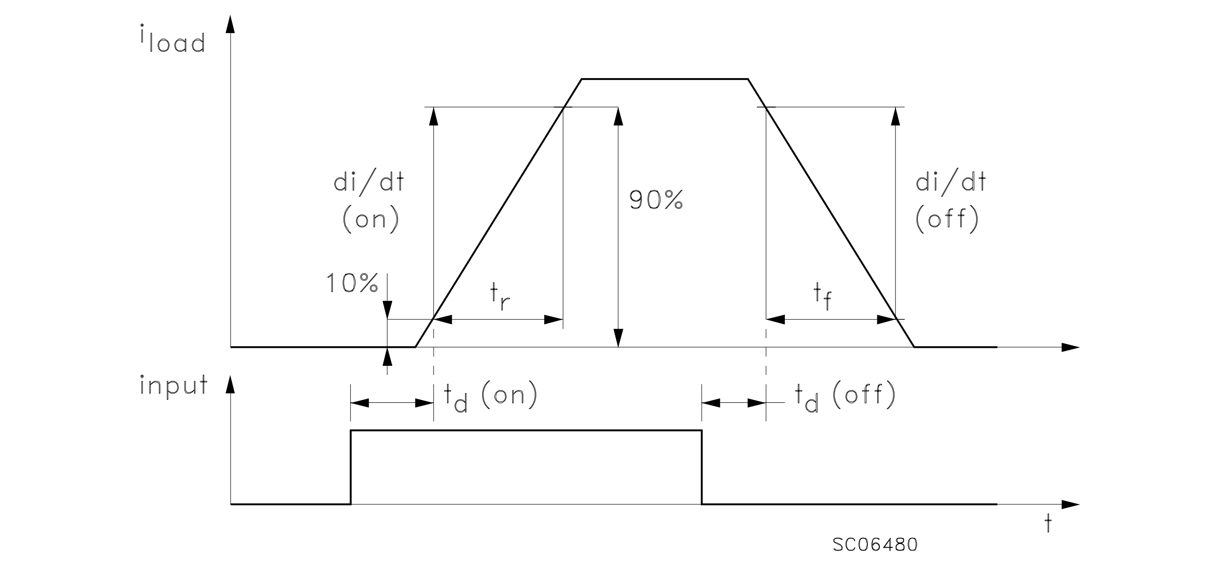
Note 2 Relevant Figure



Note 3 Relevant Figure



Switching Time Waveforms



FUNCTIONAL DESCRIPTION

The device has a diagnostic output which indicates open load in on-state, open load in off-state, over temperature conditions and stuck-on to V_{CC}.

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 (tpol) 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 ^{o}C. When this temperature returns to 125 ^{o}C the switch is automatically turned on again. In short circuit the protection reacts with virtually no delay, the sensor being located inside the Power MOS area. 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.

The maximum inductance which causes the chip temperature to reach the shut-down temperature in a specified thermal environment is a function of the load current for a fixed V_{CC}, V_{demag} and f according to the above formula. In this device if the GND pin is disconnected, with V_{CC} not exceeding 16V, it will switch off.

PROTECTING THE DEVICE AGAINST REVERSE BATTERY

The simplest way to protect the device against a continuous reverse battery voltage (-26V) is to insert a Schottky diode between pin 1 (GND) and ground, as shown in the typical application circuit (fig.3).

The consequences of the voltage drop across this diode are as follows:

If the input is pulled to power GND, a negative voltage of $-V_f$ is seen by the device. (Vil, Vih thresholds and Vstat are increased by Vf with respect to power GND).

The undervoltage shutdown level is increa- sed by Vf.

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 node [1] (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}. This solution allows the use of a standard diode.

TRUTH TABLE

	INPUT	OUTPUT	DIAGNOSTIC
Normal Operation	L H	L H	H H
Over-temperature	X	L	L
Under-voltage	X	L	H
Short load to V_{CC}	H L	H H	L L
Open Load	H L	H L	L L (#)

(#) With an additional external resistor

Figure 1: Waveforms

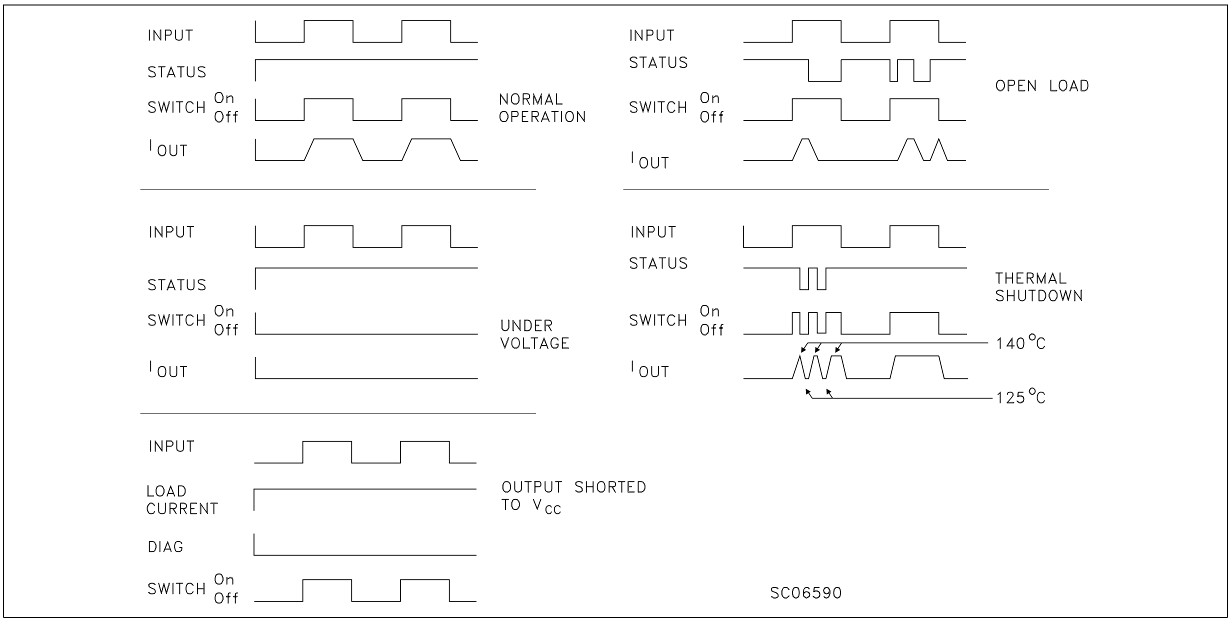


Figure 2: Over Current Test Circuit

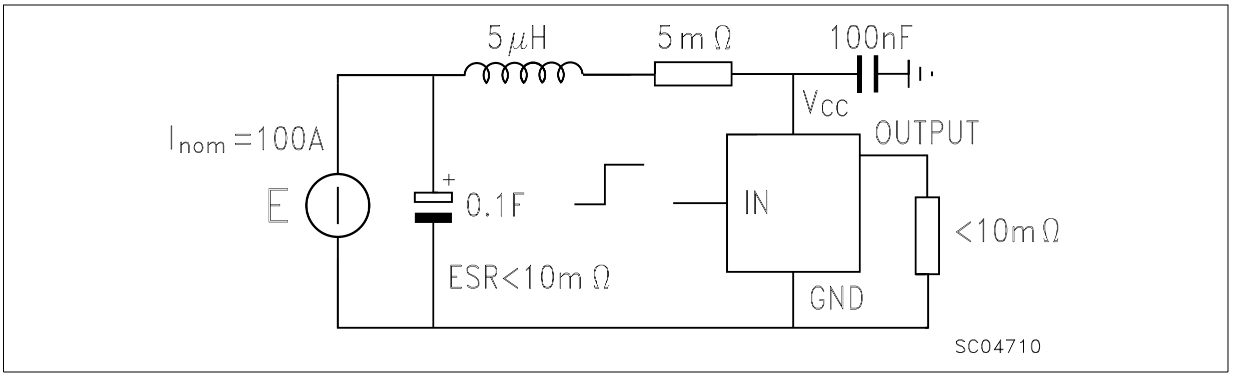


Figure 3: Typical Application Circuit With A Schottky Diode For Reverse Supply Protection

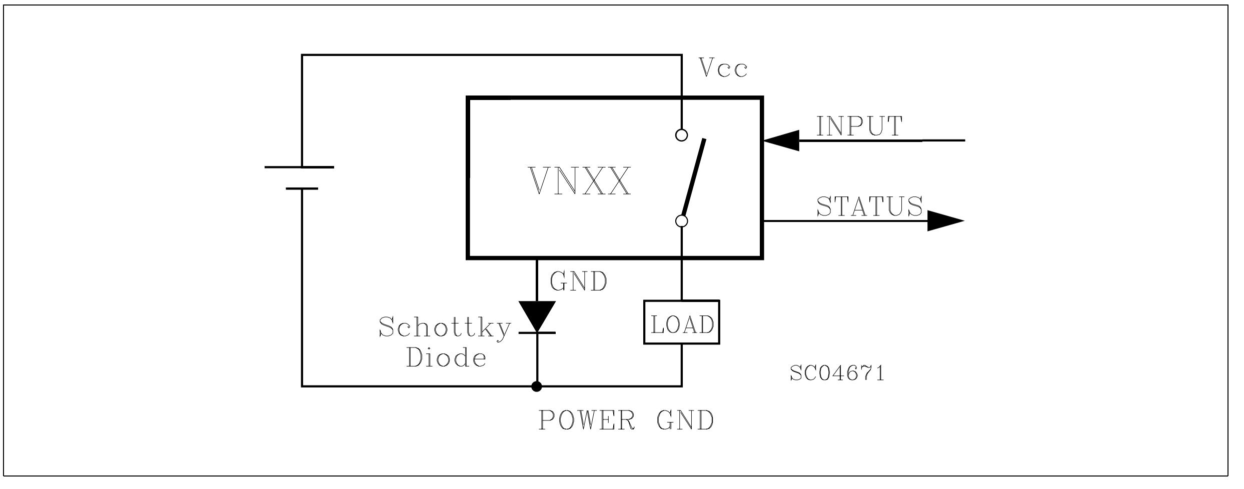
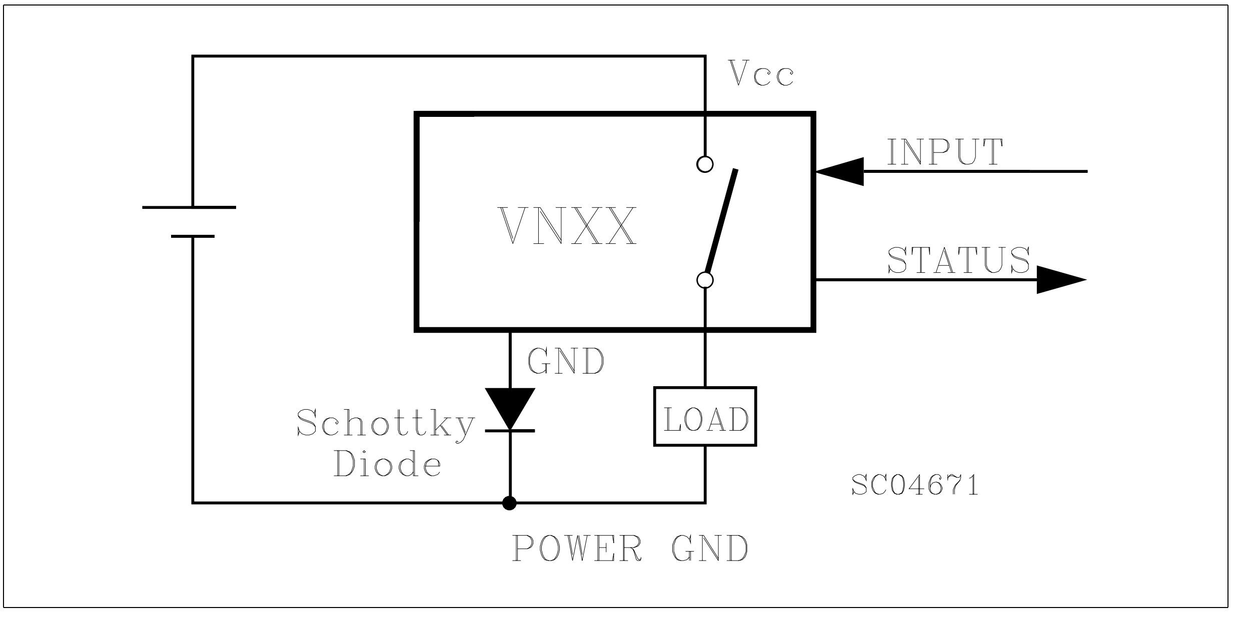
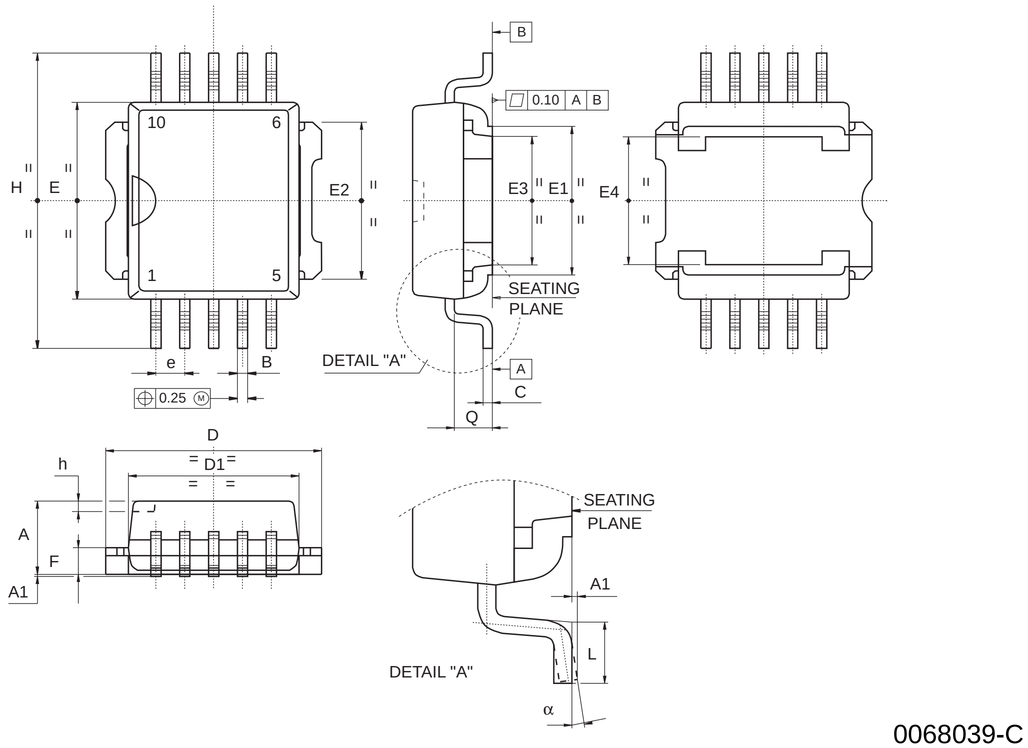


Figure 4: Typical Application Circuit With Separate Signal Ground



Power SO-10 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
c	0.35		0.55	0.013		0.022
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
E	9.30		9.50	0.366		0.374
E1	7.20		7.40	0.283		0.291
E2	7.20		7.60	0.283		0.300
E3	6.10		6.35	0.240		0.250
E4	5.90		6.10	0.232		0.240
e		1.27			0.050	
F	1.25		1.35	0.049		0.053
H	13.80		14.40	0.543		0.567
h		0.50			0.002	
L	1.20		1.80	0.047		0.071
q		1.70			0.067	
α	0°		8°			



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