SGS-THOMSON
MICROELECTRONICS

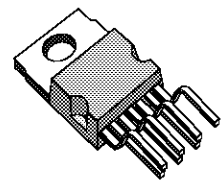
VND10B

DOUBLE CHANNEL
HIGH SIDE SMART POWER SOLID STATE RELAY

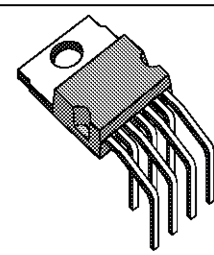
PRELIMINARY DATA

TYPE	V_{DSS}	$R_{DS(on)}$	I_n(*)	V_{CC}
VND10B	40 V	0.1 Ω	3.4 A	26 V

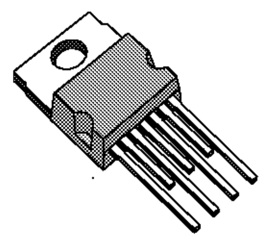
- OUTPUT CURRENT (CONTINUOUS): 14 A @ T_c=85^{o}C PER CHANNEL
- 5V LOGIC LEVEL COMPATIBLE INPUT
- THERMAL SHUT-DOWN
- UNDER VOLTAGE PROTECTION
- OPEN DRAIN DIAGNOSTIC OUTPUT
- INDUCTIVE LOAD FAST DEMAGNETIZATION
- VERY LOW STAND-BY POWER DISSIPATION



HEPTAWATT (vertical)



HEPTAWATT (horizontal)



HEPTAWATT (in-line)

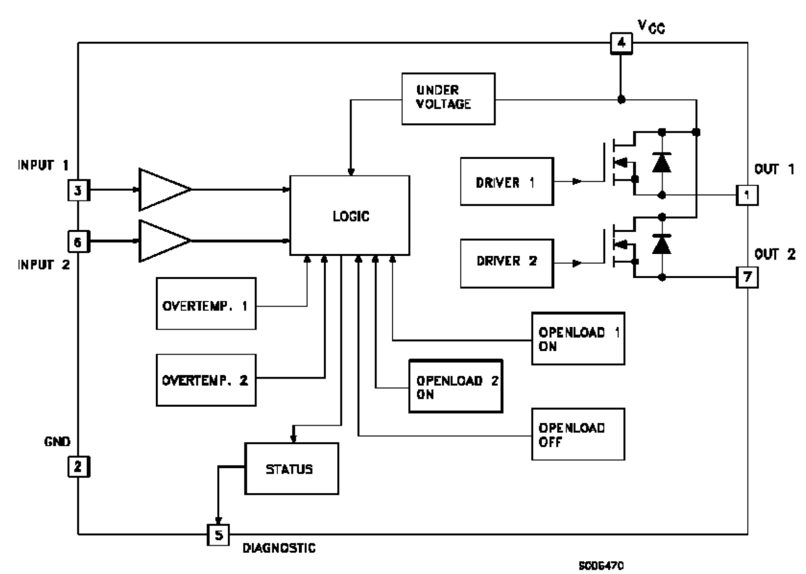
ORDER CODES:

HEPTAWATT vertical	VND10B
HEPTAWATT horizontal	VND10B (011Y)
HEPTAWATT in-line	VND10B (012Y)

DESCRIPTION

The VND10B is a monolithic device made using SGS-THOMSON Vertical Intelligent Power Technology, intended for driving resistive or inductive loads with one side grounded. This device has two channels, and a common diagnostic. Built-in thermal shut-down protects the chip from over temperature and short circuit. The status output provides an indication of open load in on state, open load in off state, overtemperature conditions and stuck-on to V_{CC}.

BLOCK DIAGRAM

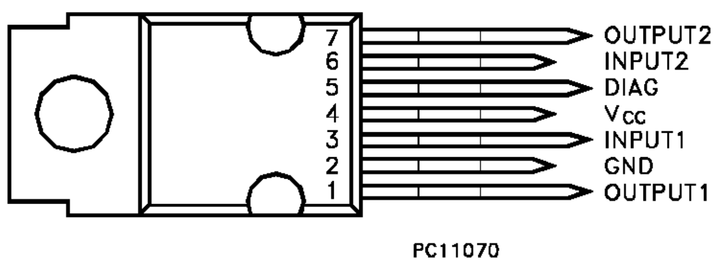


(*) In= Nominal current according to ISO definition for high side automotive switch (see note 1)

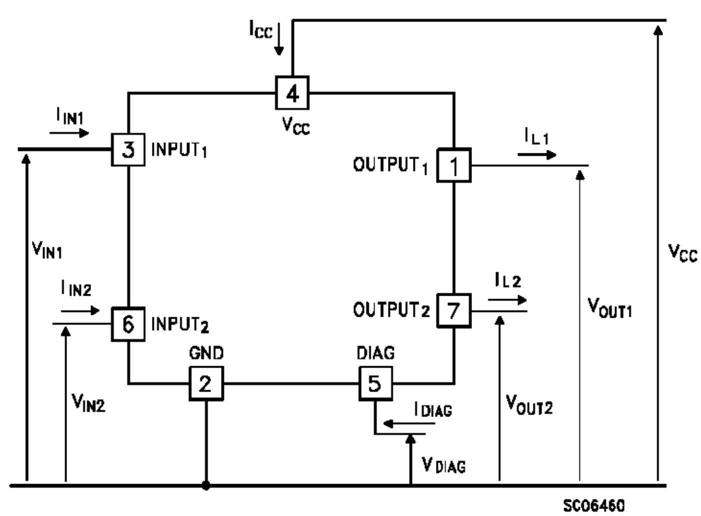
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	40	V
I_{OUT}	Output Current (cont.) at T_c = 85 °C	14	A
I_{OUT}(RMS)	RMS Output Current at T_c = 85 °C and f > 1Hz	14	A
I_R	Reverse Output Current at T_c = 85 °C	-14	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 °C	75	W
T_j	Junction Operating Temperature	-40 to 150	°C
T_{stg}	Storage Temperature	-55 to 150	°C

CONNECTION DIAGRAM



CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

$R_{thj\text{-}case}$ $R_{thj\text{-}amb}$	Thermal Resistance Junction-case Thermal Resistance Junction-ambient	Max Max	1.65 60	$^oC/W$ $^oC/W$

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	3.4		5.2	A
R_{on}	On State Resistance	$I_{OUT} = I_n$ V_{CC} = 13 V T_j = 25 ^oC	0.065		0.1	Ω
I_S	Supply Current	Off State T_j = 25 ^oC V_{CC} = 13 V		35	100	μA
$V_{DS(MAX)}$	Maximum Voltage Drop	I_{OUT} = 13 A T_j = 85 ^oC V_{CC} = 13 V	1.2		2	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_{out} = 2.7 Ω	5	35	200	μs
t_r(^)	Rise Time Of Output Current	R_{out} = 2.7 Ω	28	110	360	μs
$t_{d(off)}$(^)	Turn-off Delay Time Of Output Current	R_{out} = 2.7 Ω	10	140	500	μs
t_f(^)	Fall Time Of Output Current	R_{out} = 2.7 Ω	28	75	360	μs
$(di/dt)_{on}$	Turn-on Current Slope	R_{out} = 2.7 Ω	0.003		0.1	A/μs
$(di/dt)_{off}$	Turn-off Current Slope	R_{out} = 2.7 Ω	0.005		0.1	A/μs

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 ^oC		30	100	μA
V_{ICL}	Input Clamp Voltage	I_{IN} = 10 mA I_{IN} = -10 mA	5	6 -0.7	7	V V

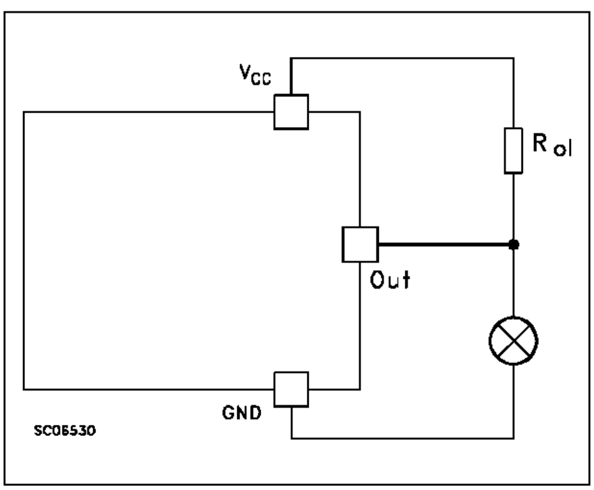
ELECTRICAL CHARACTERISTICS (continued)

PROTECTION AND DIAGNOSTICS

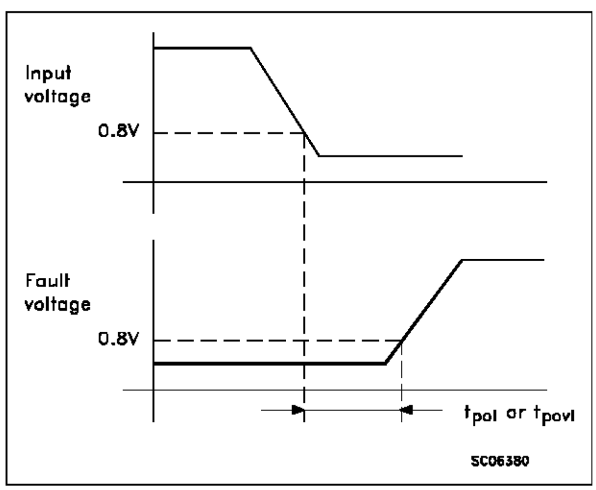
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{STAT}	Status Voltage Output Low	I_{STAT} = 1.6 mA			0.4	V
V_{USD}	Under Voltage Shut Down		3.5	4.5	6	V
V_{SCL}	Status Clamp Voltage	I_{STAT} = 10 mA I_{STAT} = -10 mA	5	6 -0.7	7	V V
T_{TSD}	Thermal Shut-down Temperature		140	160	180	^oC
$T_{SD(hyst.)}$	Thermal Shut-down Hysteresis				50	^oC
T_R	Reset Temperature		125			^oC
V_{OL}	Open Voltage Level	Off-State (note 2)	2.5	4	5	V
I_{OL}	Open Load Current Level	On-State	0.6	0.9	1.4	A
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 ^oC for battery voltage of 13V which produces a voltage drop of 0.5 V
note 2: $I_{OL(off)} = (V_{CC} - V_{OL})/R_{OL}$
note 3: t_{povl} t_{pol}: ISO definition

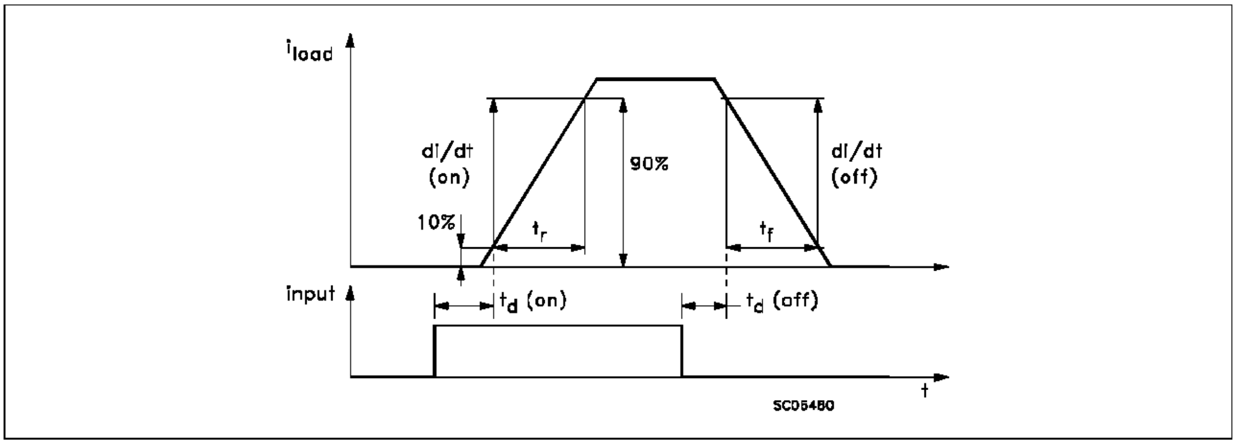
Note 2 Relevant Figure



Note 3 Relevant Figure



Switching Time Waveforms



FUNCTIONAL DESCRIPTION

The device has a common diagnostic output for both channels 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 (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.

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}, Vdemag and f according to the above formula. In this device if the GND pin is disconnected, with V_{CC} not exceeding 16V, both channel 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 2 (GND) and ground, as shown in the typical application circuit (fig. 2).

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 increased 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 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}. This solution allows the use of a standard diode.

TRUTH TABLE

		INPUT 1	INPUT 2	OUTPUT 1	OUTPUT 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

Figure 1: Waveforms

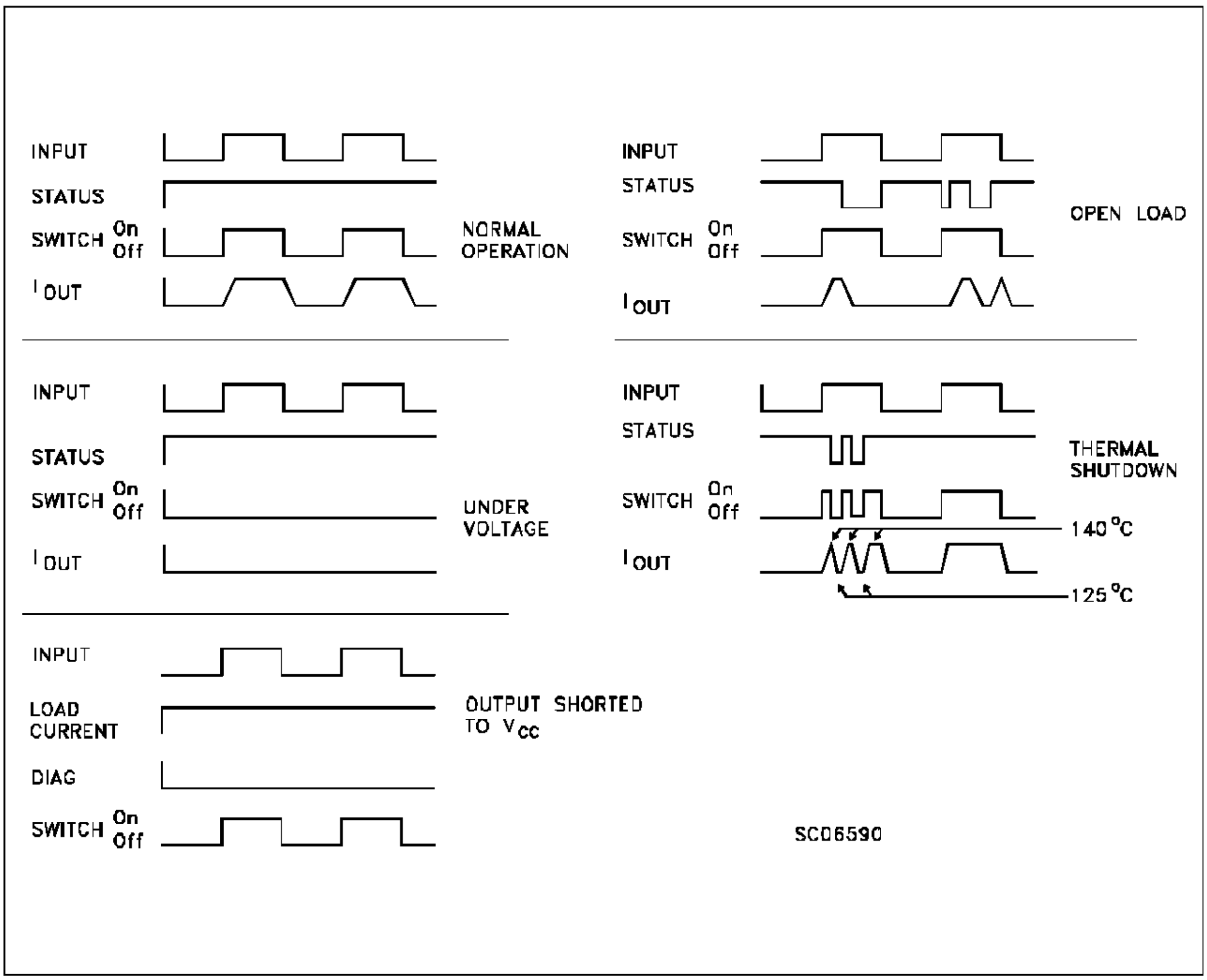


Figure 2: Typical Application Circuit With A Schottky Diode For Reverse Supply Protection

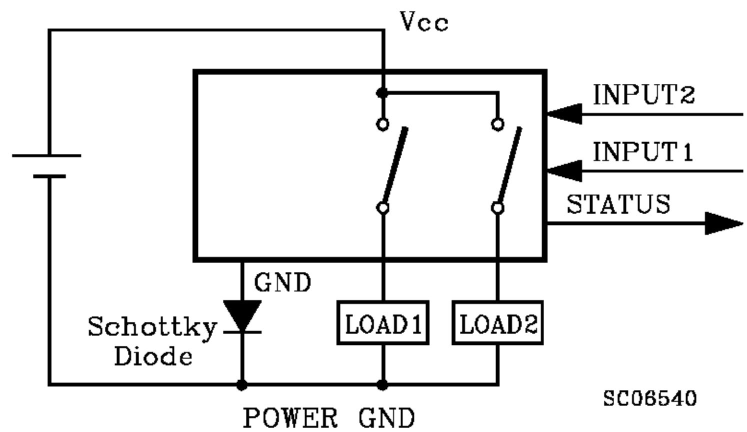
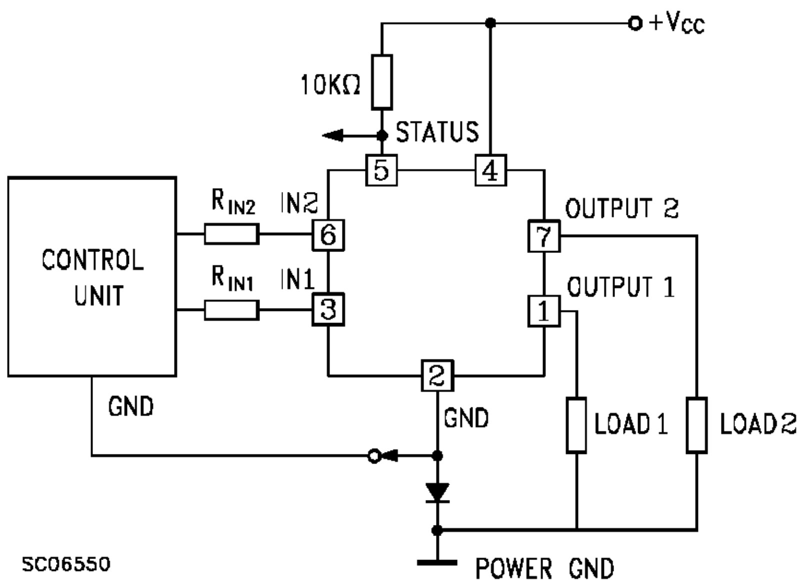
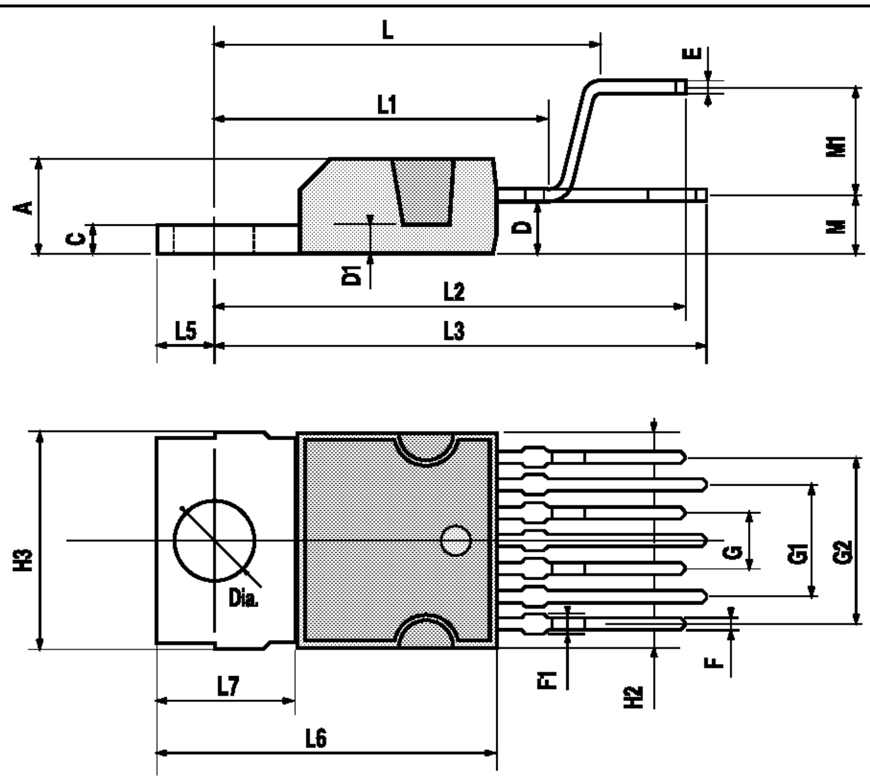


Figure 3: Typical Application Circuit With Separate Signal Ground



Heptawatt (vertical) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		16.97			0.668	
L1		14.92			0.587	
L2		21.54			0.848	
L3		22.62			0.891	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
M		2.8			0.110	
M1		5.08			0.200	



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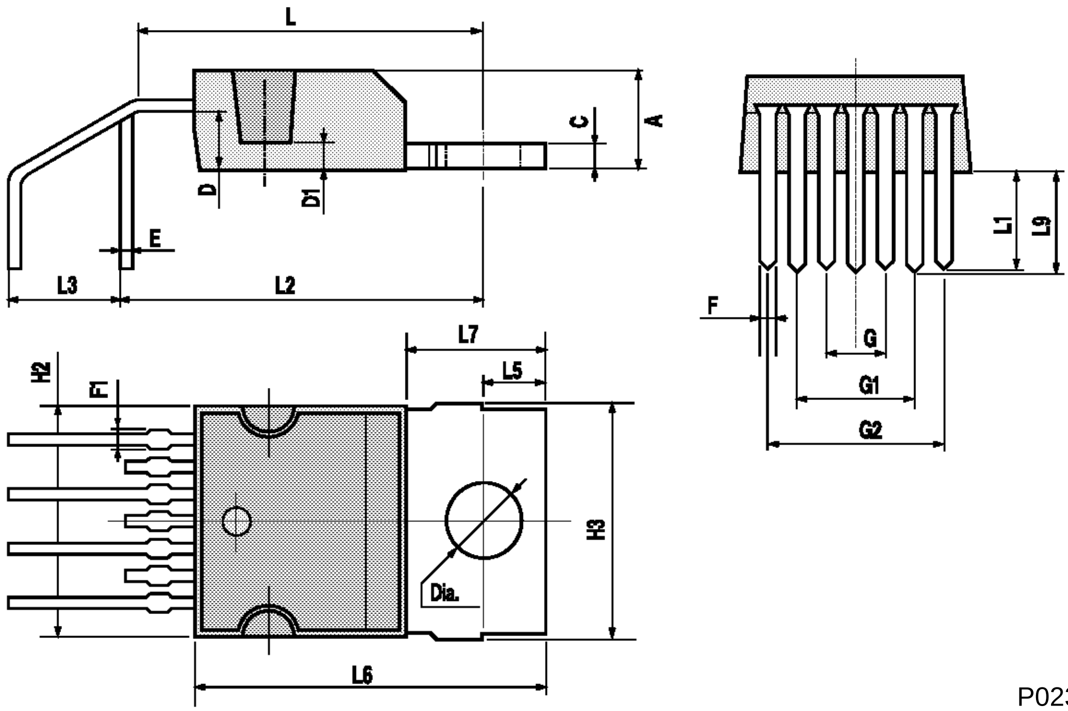
Heptawatt (horizontal) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		14.2			0.559	
L1		4.4			0.173	
L2		15.8			0.622	
L3		5.1			0.201	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
L9		4.44			0.175	
Dia	3.65		3.85	0.144		0.152



P023B

Heptawatt (In-Line) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L2	22.4		22.9	0.882		0.902
L3	25.4		26	1.000		1.024
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
Dia	3.65		3.85	0.144		0.152