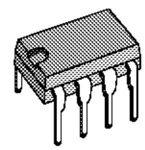
L9308

DUAL LOW SIDE DRIVER

- DARLINGTON OUTPUT STAGE
- INPUT COMPARATOR WITH WIDE RANGE COMMON MODE OPERATION AND GROUND COMPATIBLE INPUTS
- INPUT COMPARATOR HYSTERESIS
- SHORT CIRCUIT PROTECTION OF OUTPUT WITH SOA PROTECTION
- INTERNAL THERMAL PROTECTION WITH HYSTERESIS
- SINGLE SUPPLY VOLTAGE FROM 3.5V UP TO 28V



MINIDIP

ORDERING NUMBER : L9308

DESCRIPTION

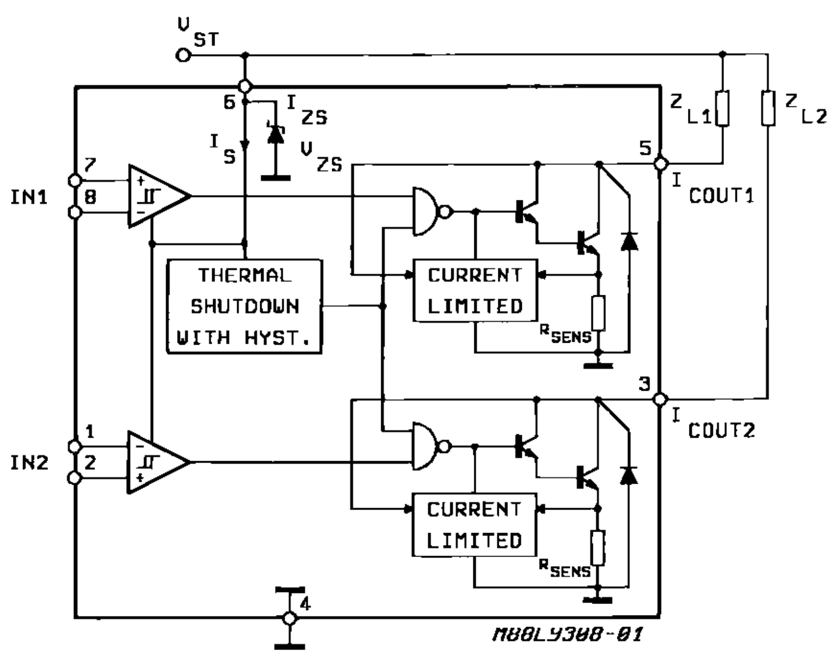
The L9308 is a monolithic interface circuit with differential input comparator and open collector output able to sink current specifically to drive lamps, relays, d.c. motors, electro valves etc.

Particular care has been taken to protect the device against destructive failures - short circuit of outputs to V_S, SOA protection, supply overvoltage.

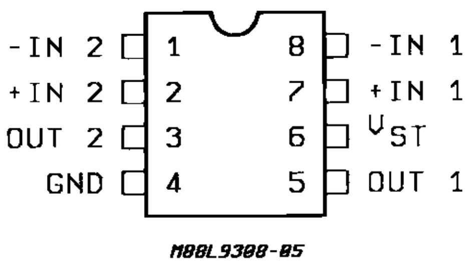
A built in thermal shut-down switches off the device when the IC's internal dissipation becomes too high and the chip temperature exceeds the security threshold.

The input comparator hysteresis increases the interface's noise immunity allowing the correct use in critical environments as automotive applications.

BLOCK DIAGRAM



PIN CONNECTION (Top view)



1) -IN2 Inverting input2
2) +IN2 Non-inverting input2
3) OUT2 Output2
4) GND Ground
5) OUT1 Output1
6) V_{ST} Supply
7) +IN1 Non-inverting input1
8) -IN1 Inverting input1

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Value	Unit
I_{ZS}	Current Into Supply Clamp Zener Diode	Tamb = 25°C, DC Pulsed (*)	30 80	mA mA
V_S	Supply Voltage		28	V(**)
I_O	Output Current		Internally Limited	
T_j, T_{stg}	Junction and Storage Temperature		– 55 to +150	°C
P_{tot}	Power Dissipation at T_{amb} = 85°C		650	mW

(*) TON ≤ 2.5ms ; repetition time > 30ms.
(**) The maximum allowed supply voltage without limiting resistor is limited by the built-in protection zener diode : see V_{ZS} spec. values. If V_S is higher than V_{ZS} a resistor R_S is necessary to limit the zener current I_{ZS}.

THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max	100	°C/W

ELECTRICAL CHARACTERISTICS ($V_s = 14.4V$; $-40°C \leq T_{amb}, \leq 85°C$; $R_S = 100\Omega$ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IH}	Hysteresis of the Input Comparater	V_{IN} = 200mVpp ; f = 1kHz	20		80	mV
I_B	Input Bias Current	$V_I^+ = V_I^- = 0$		0.2	1.0	µA
I_{OS}	Input Offset Current	$V_I^+ = V_I^- = 0$		± 50	± 400	nA
CMR	Input Common Mode Range	V_s = 6 – 18V T_{amb} = 25°C	0		$V_{ST} - 1.6$	V
I_{SC}	Output Short Circuit Current for Each Channel (see fig. 4)	$V_{IN} - V_{IN}$ > 70mV V_S = 16V T_{amb} = 25°C to 85°C T_{amb} = – 40°C to 25°C $V_{OUT\ 1,\ 2}$ = 6V			 0.6 0.7 1.2	 A A A
V_{CSAT}	On Status Saturation Voltage	T_{amb} = – 40°C to 25°C $V_I^- - V_I^+$ > 70mV $I_{OUT\ 1,\ 2}$ = 300mA T_{amb} = 25°C to 85°C		 1.0	1.5 1.4	V V
I_{OL}	Output Leakage Current	$V_I^- - V_I^-$ > 70mV V_S = 18V V_S = 5V		 10	 300 20	 µA µA
V_{ST}	Supply voltage (pin 6)		3.5		18	V
$I_{"st.by"}$	Supply Current	$V_I^+\ V_I^-$ > 70mV		5	8	mA
$I_{"ON"}$	Supply Current	$V_I^-\ V_I^+$ > 70mV		18		mA
V_{ZS}	Voltage Clamp Supply Protection	I_{ZS} = 10mA	20		27	V
I_{Omin}	Minimum Output Current wiyth the Outputs connected Together	V_{CSAT} = 1.5V	400			mA
t_r t_f	Rise Time (see fig. 2) Fall Time	I_{OUT} = 50mA T_{amb} = 25°C			2 2	µs
t_{don} t_{doff}	Delay Time on Delay Time off	I_{OUT} = 50mA T_{amb} = 25°C			10 10	µs

Figure 1 : Switching Time Test Circuit.

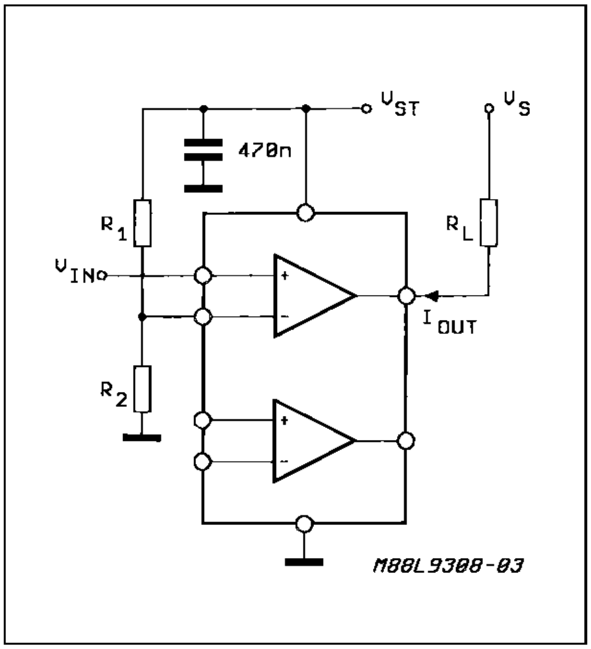


Figure 2 : Switching Time Waveforms for Resistive Loads.

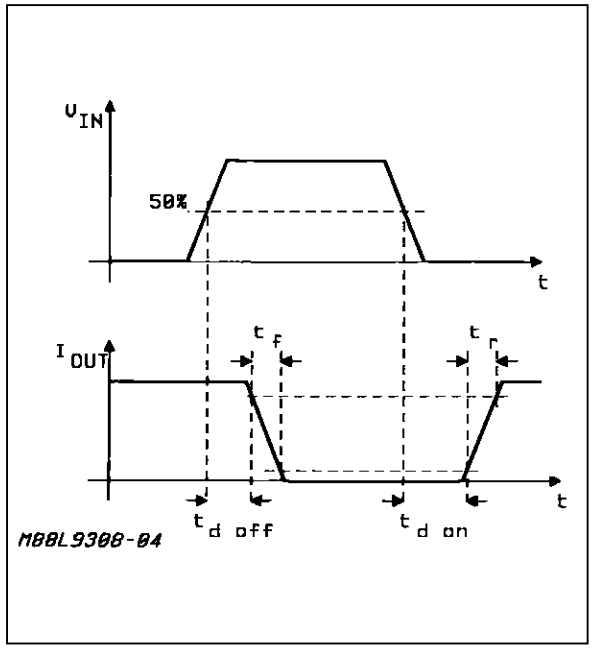
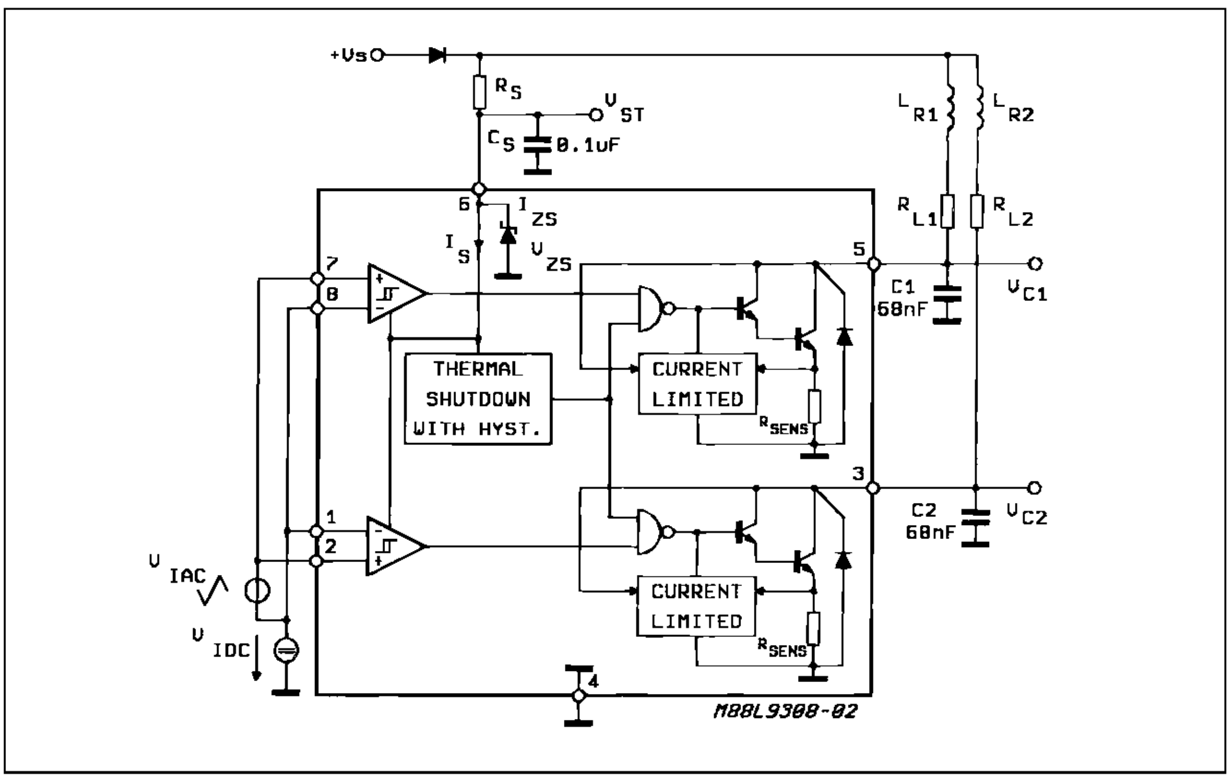
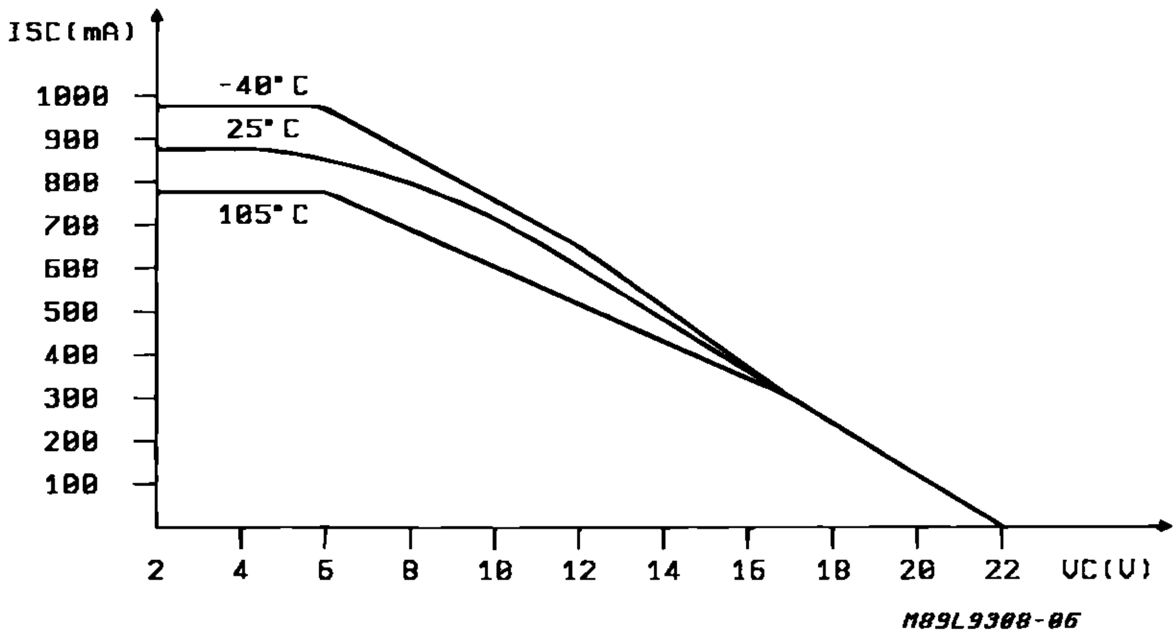


Figure 3 : Typical Application and Test Circuit.



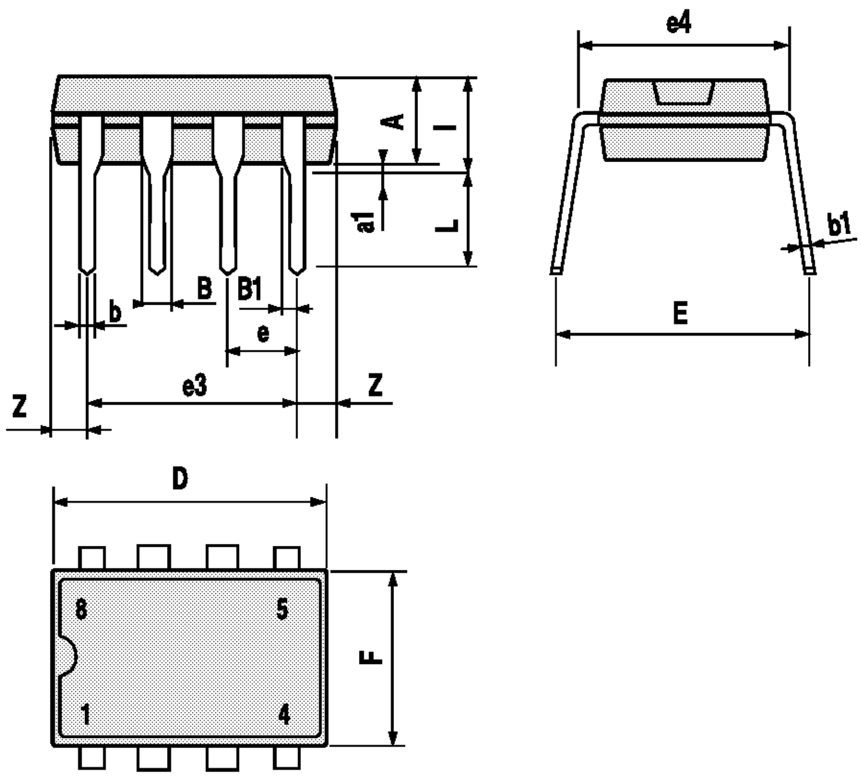
Notes : a) R_S required only to limit I_{ZS} whenever V_S exceeds V_{ZS} voltage value.
b) C_1, C_2 cut high frequency gain during current limiting.

Figure 4 : Typical SOA Characteristic.



MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060



SGS-THOMSON Microelectronics GROUP OF COMPANIES

Australia - Brazil - France - Germany - Hong Kong - Italy - Japan - Korea - Malaysia - Malta - Morocco - The Netherlands - Singapore - Spain - Sweden - Switzerland - Taiwan - Thaliand - United Kingdom - U.S.A.

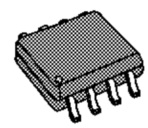
SGS-THOMSON MICROELECTRONICS

TDE1707

INTELLIGENT POWER SWITCH

ADVANCE DATA

- 0.5A OUTPUT CURRENT
- LOW SIDE OR HIGH SIDE SWITCH CONFIGURATION
- 6V TO 48V SUPPLY VOLTAGE RANGE
- OVERLOAD AND SHORT CIRCUIT PROTECTIONS
- INTERNAL VOLTAGE CLAMPING
- SUPPLY AND OUTPUT REVERSAL PROTECTION
- THERMAL SHUTDOWN
- GND AND V_S OPEN WIRE PROTECTION
- ADJUSTABLE DELAY AT SWITCH ON
- INDICATOR STATUS LED DRIVER
- +5V REGULATED AUX. VOLTAGE



SO8

ORDERING NUMBER: TDE1707FP

DESCRIPTION

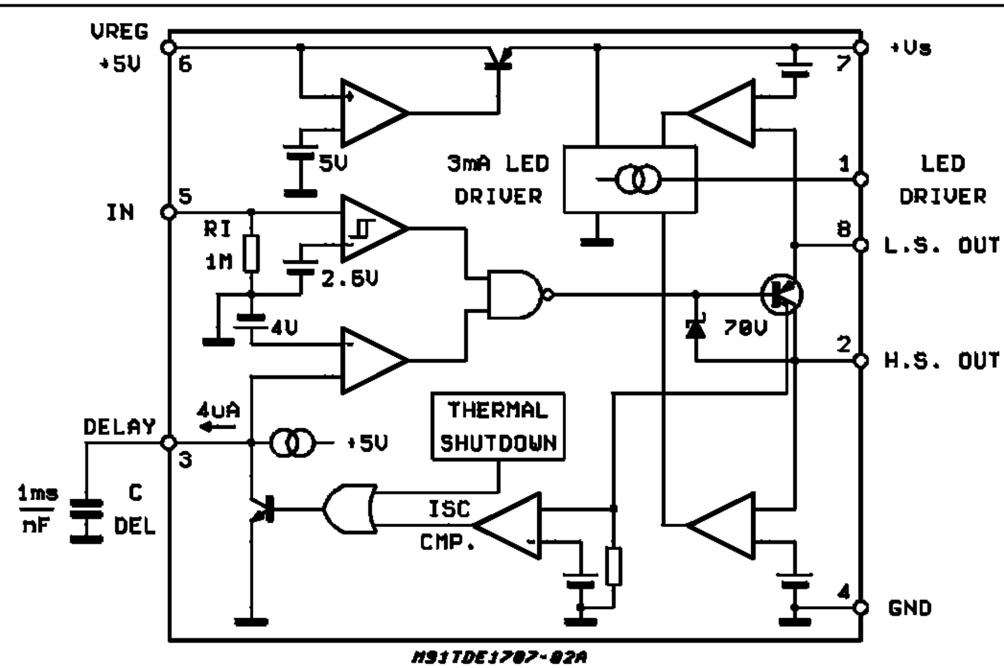
The TDE1707 is a 0.5A Integrated Power Switch with up to 48V Power supply capability.

Two output configurations are possible:

- Load to Gnd. (High Side Mode)
- Load to V_S (Low side Mode)

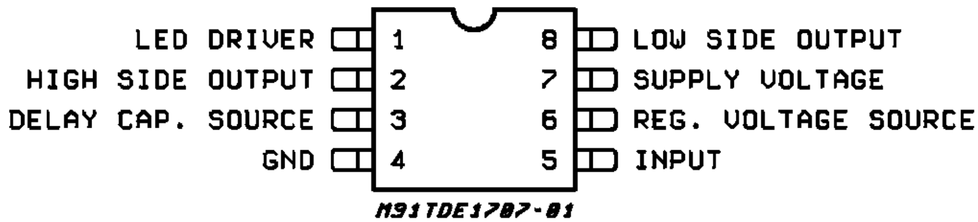
Especially dedicated to proximity detectors, its internal +5V supply can be used to supply external circuits (See also AN495/0692). A signal is internally generated to block the In signal, and prevent activation of the output switch, as long as an abnormal condition is detected. The power-on transition, as well as the chip overtemperature and the output overcurrent, concurr to the generation of such signal. A minimum delay of 25µs (Typ. value) is added to the trailing edge of such signal to ensure that a stable normal situation is present when the signal disappears. The delay (of the disapperance of the block signal; no delay at its on set) can be further increased connecting a capacitor between pin3 and ground. It can drive resistive or inductive loads.

BLOCK DIAGRAM



This is advanced information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

PIN CONNECTION (Top view)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	50	V
V_{Sr}	Supply Reverse Voltage	50	V
I_O	Output Current	internally limited	A
V_{reg}	Regulated Voltage Pin	0 to 7	V
V_{delay}	Delay Cap. Surce Pin	0 to 5	V
V_O	Output Diff. Voltage	55	V
V_i	Input Voltage	-10 to 50	V
T_{op}	Operating Temperature Range	-25 to +85	°C
T_{stg}	Storage Temperature	-55 to 150	°C
P_{tot}	Power Dissipation	internally limited	W
E_I	Energy Induct. Load	150	mJ

THERMAL DATA

Symbol	Description		Value	Unit
$R_{th\ j-amb}$	Thermal Resistance Junction-ambient	Max.	150	°C/W

ELECTRICAL CHARACTERISTICS (V_S = 24V; T_j = –25 to +85°C, unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_s 7	Supply Voltage		6		48	V
I_{sr} 7	Supply Reverse Current	V_{SR} = –48V			1.5	mA
I_q 7	Quiescent Current	I_{reg} = I_{led} = 0; V_i < 2V; V_S = 6 to 48V			1.5	mA
I_o 8/2	Output Current	V_s = 6V to 32V			500	mA
I_o 8/2	Output Current	Vs = 32V to 48V			300	mA
V_{sat} 8/2	Output Voltage Drop V_{8-2}	I_o = 500mA		1.1	1.6	V
V_{sat} 8/2	Output Voltage Drop V8-2	Io = 300mA			1.5	V
I_{sc} 8/2	Short Circuit Current		0.5	0.8	2	A
V_{cl} 8/2	Internal Voltage Clamp	I_{CL} = 10mA	55	65		V
I_{olk} 8/2	Output Leakage	(Pin 2) V_i < 2V; V_o = 0 to V_s (Pin 8)		100	300 100	µA µA
V_{ith} 5	Input Voltage Threshold		2		3	V
V_{ihis} 5	Input Threshold Hysteresis			300		mV
I_{lk} 5	Input Current	V_i = 5V		2	5	µA
V_{reg} 6	Regulated Output Voltage	I_{reg} < 5mA	4.5	5	5.5	V
I_{scr} 6	Short Circuit Regulated		6	30	50	mA
I_{reg} 6	Ouput Regulator Current	V_s = 35V V_s = 48V			6 4	mA mA
I_{old} 1	Current Surce Sink Led Driver	Output ON (±)	2	3	4	mA
V_{old} 1	Voltage Drop Led Driver	I_{os} = 2mA (±)		1.2	1.6	V
Oldlk 1	Lead Driver (off) Leak.	V_i < 2V; R_L < 1KΩ			10	µA
I_{dch} 3	Del. Cap. Charge Current	T_J = 25°C	2	4	6	µA
V_{dth} 3	Delay Voltage Trigger	T_J = 25°C		4		V

APPLICATION INFORMATION (See Application Circuit)

The LED driver tells the output status.
It can source or sink current ($I_{old\ typ}$ = 3mA), according to the output configuration chosen.
The thresholds, represented by the output comparator in the Block Diagram, are set at about 1.5V - 2V.
For instance, in the High Side Load case of the Application Circuit, when the voltage on pin 8 (the output) differs from V_{CC} less than 1.5V, the output is sensed in "OFF" state and the LED driver is disabled.
If instead pin 8 differs from V_{CC} more than 3V (the output comparator threshold value plus the drop voltage on the LED), then the output is sensed "ON" and the driver will force the current on the LED.

DYNAMIC CHARACTERISTICS (V_S = 24V; R_L = 48Ω; T_J = 25°C)

t_{on}	Propagation Turn on Time	V_i = 0 to 5V		15		µs
t_{off}	Propagation Turn off Time	V_i = 5 to 0V		15		µs
t_{don}	Delayed Turn on Time / nF Delay Capacitor		0.65	1	2	ms
$t_{d\ min}$	Minimum Delayed t_{on} Delay Capacitor = 0			25		µs

APPLICATION CIRCUIT

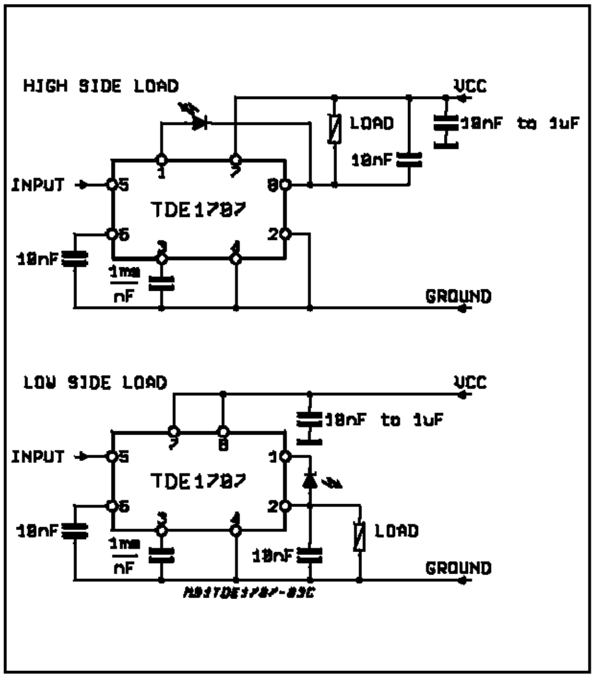


Figure 1: Input Thresholds Voltage vs. Temperature (V_S = 24V)

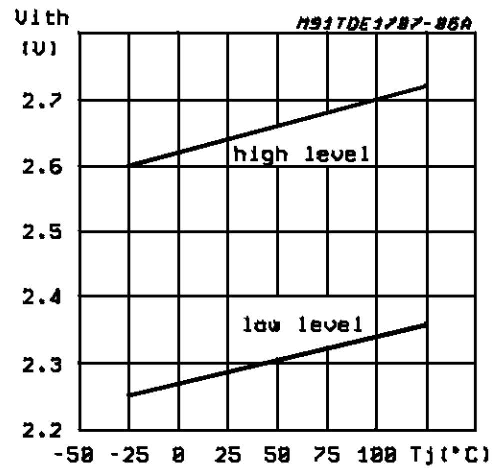


Figure 2: Saturation Voltage vs. Temperature (V_S = 24V; I_O = 500mA)

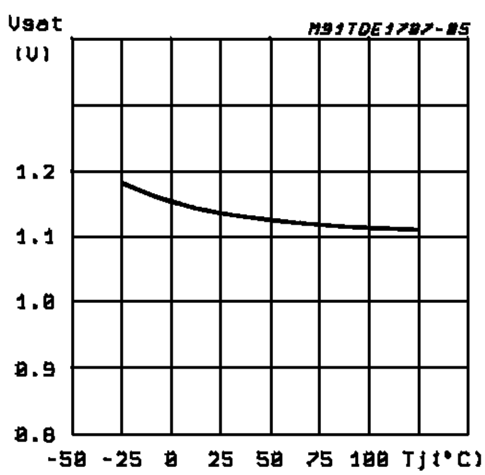
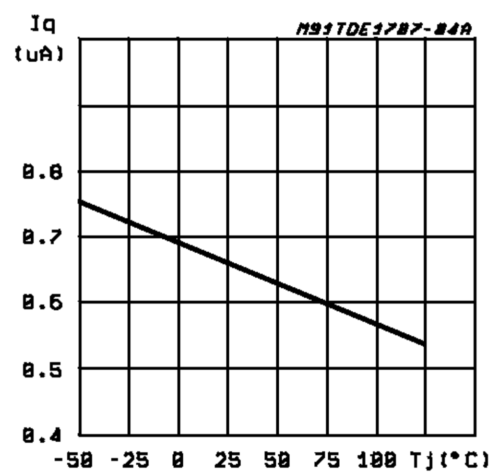
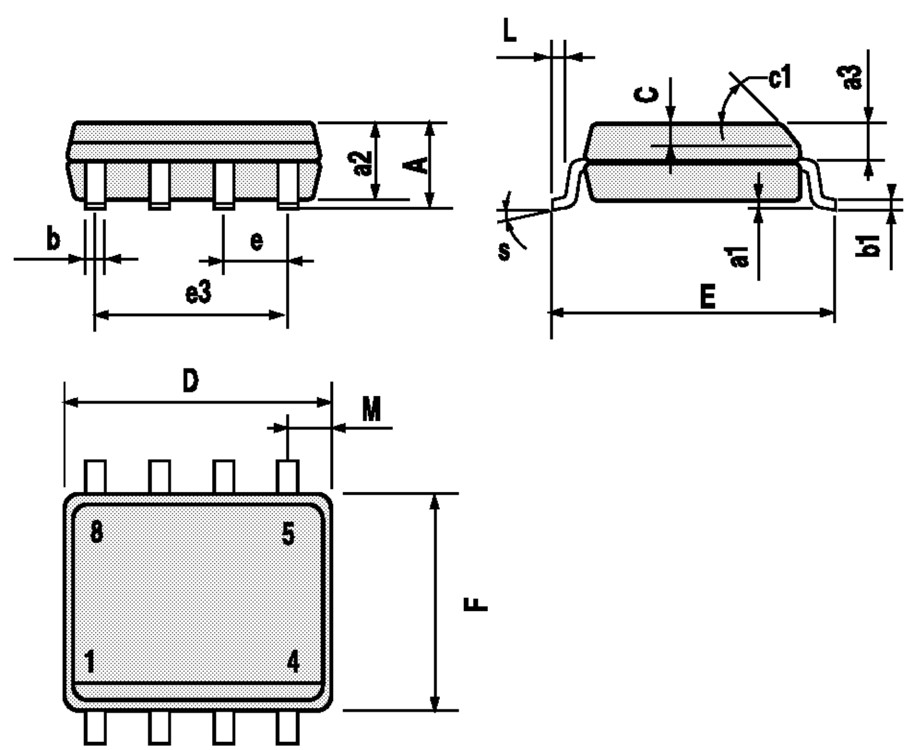


Figure 3: Quiescent Current) vs.Temperature (V_S = 24V)



SO8 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.15		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

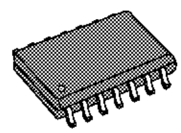


TDE1737
TDF1737

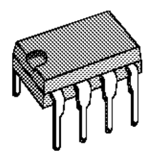
SGS-THOMSON MICROELECTRONICS

INTERFACE CIRCUIT - RELAY AND LAMP-DRIVER

- HIGH OUTPUT CURRENT
- ADJUSTABLE SHORT-CIRCUIT PROTECTION
- THERMAL PROTECTION WITH HYSTERESIS TO AVOID THE INTERMEDIATE OUTPUT LEVELS
- LARGE SUPPLY VOLTAGE RANGE : + 8 V to + 45 V



SO14
FP SUFFIX



MINIDIP
DP SUFFIX

DESCRIPTION

The TDE1737-TDF1737 is a monolithic amplifier designed for high current and high voltage applications, specifically to drive lamps, relays and control of stepper motors.

This device is essentially blow-out proof. Current limiting is available to limit the peak output current to a safe value, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the I.C. from overheating. If internal dissipation becomes too great, the driver will shut down to prevent excessive heating.

The output is also protected against short-circuits with the positive power supply.

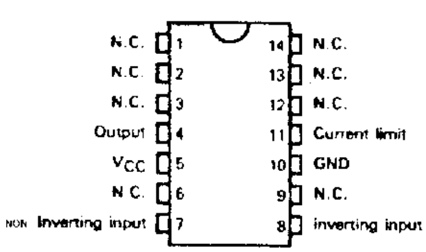
The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 used for industrial electronic systems.

ORDER CODES

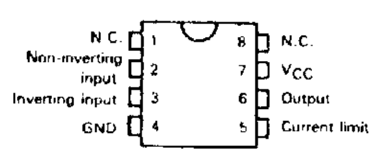
Part Number	Temperature Range	Package	
		DP	FP
TDE1737	– 25 °C to + 85 °C	•	•
TDF1737	– 40 °C to + 85 °C	•	•
Example : TDE1737DP			

PIN CONNECTIONS (top views)

SO-14



MINIDIP



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_s	Supply Voltage	50	V
V_I	Input Voltage	50	V
V_{ID}	Differential Input Voltage	50	V
I_O	Output Current	1000	mA
P_{tot}	Power Dissipation	Internally Limited	W
T_{oper}	Operating Free–air Temperature Range for TDE1737	– 25 to + 85	°C
T_{oper}	Operating Free–air Temperature Range for TDF1737	– 40 to + 85	°C
T_{stg}	Storage Temperature Range	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Maximum Junction-case Thermal Resistance MINIDIP	50	°C/W
$R_{th(j-a)}$	Maximum Junction-ambient Thermal Resistance MINIDIP	120	°C/W
	Junction-ceramic Substrate (case glued to substrate) SO14	90	°C/W

ELECTRICAL CHARACTERISTICS

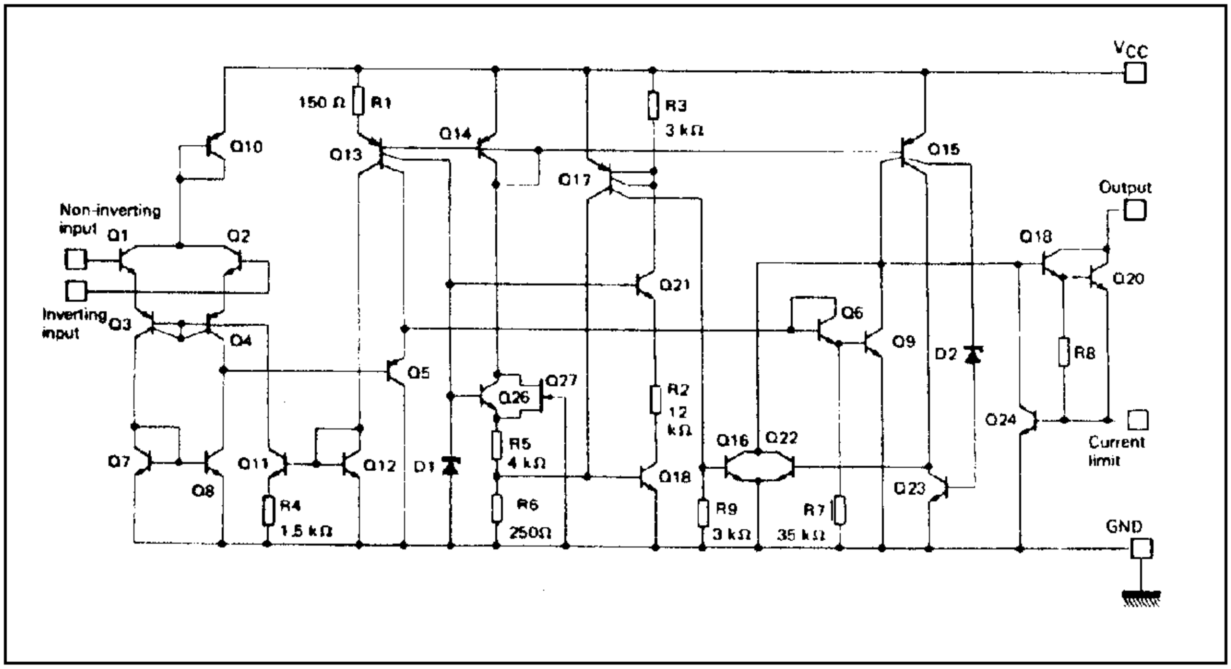
TDE1737 $-25\ °C \le T_{amb} \le +85\ °C$, $+8\ V \le V_{CC} \le +45\ V$, $I_O \le 300\ mA$, $T_j \le +150\ °C$ (unless otherwise specified)

TDF1737 $-40\ °C \le T_{amb} \le +85\ °C$, $+8\ V \le V_{CC} \le +45\ V$, $I_O \le 300\ mA$, $T_j \le 150\ °C$

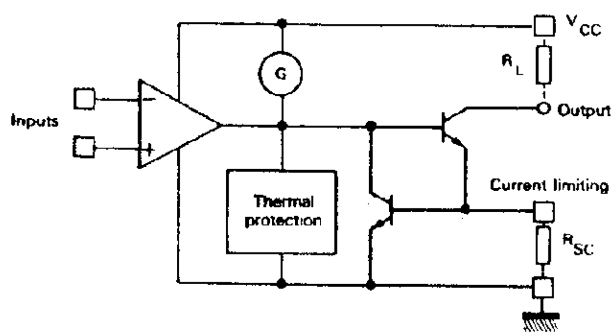
Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IO}	Input Offset Voltage – (note 1)	–	2	50	mV
I_{IB}	Input Bias Current	–	0.1	1.5	µA
I_{CC}	Supply Current (V_{CC} = + 24 V, I_O = 0)	–	3	5	mA
V_{CM}	Common–mode Input Voltage Range	2	–	V_{CC}–2	V
I_{SC}	Short–circuit Current Limit (R_{SC} = 1.5 Ω, T_{case} = + 25 °C)	–	500	–	mA
$V_{CC}–V_O$	Output Saturation Voltage (output low) ($V_I^+ - V_I^- \ge 50$ mV I_O = 300 mA, R_{SC} = 0)	–	1	1.5	V
I_{OL}	Output Leakage Current (output high) ($V_O = V_{CC}$ = + 24 V, T_{amb} = + 25 °C)	–	–	10	µA

Notes : 1. The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.
2. Devices bonded on a 40 cm^2 glass-epoxy printed circuit 0.15 cm thick with 4 cm^2 of cooper.

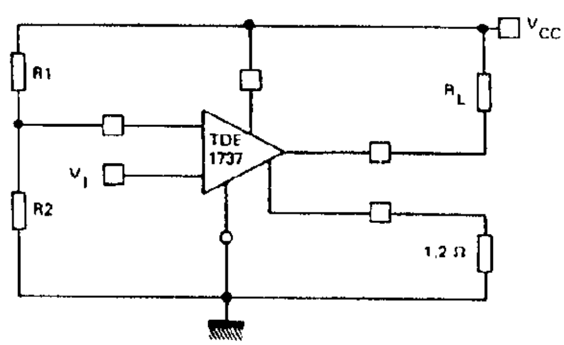
SCHEMATIC DIAGRAM



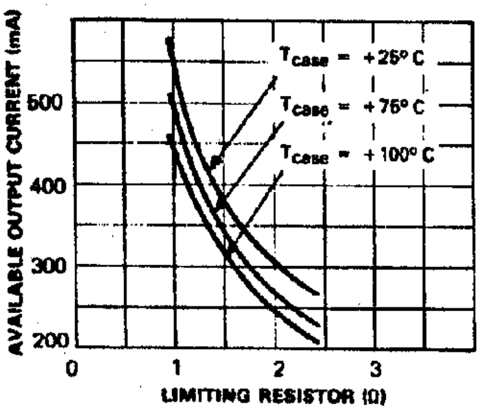
SIMPLIFIED SCHEMATIC



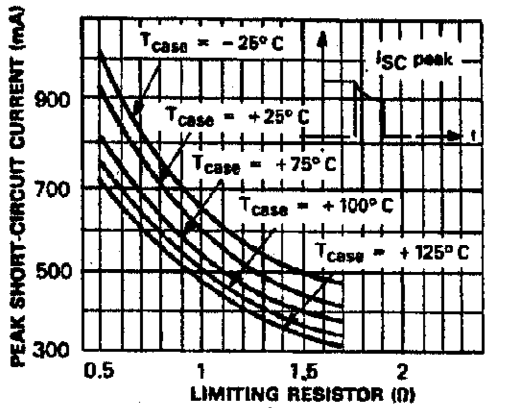
TYPICAL APPLICATION -



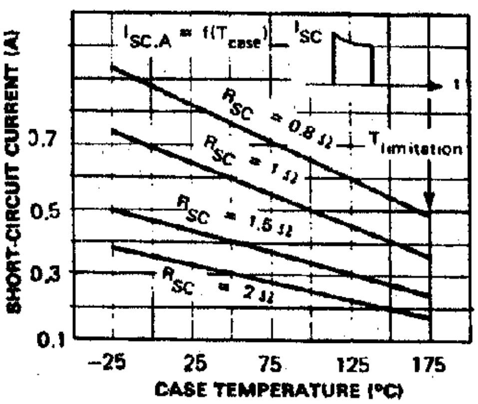
Available output current versus limiting resistors



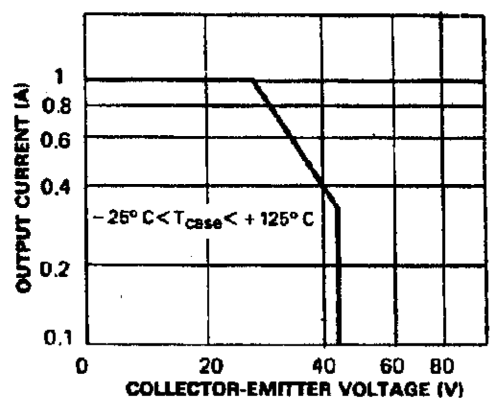
Peak short-circuit current versus limiting resistor



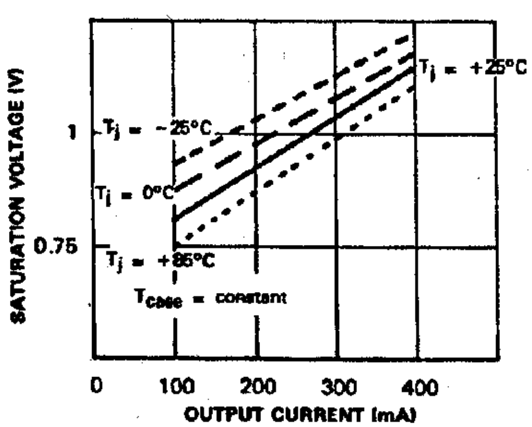
Short-circuit current versus case temperature



Safe operating area (non repetitive overload)

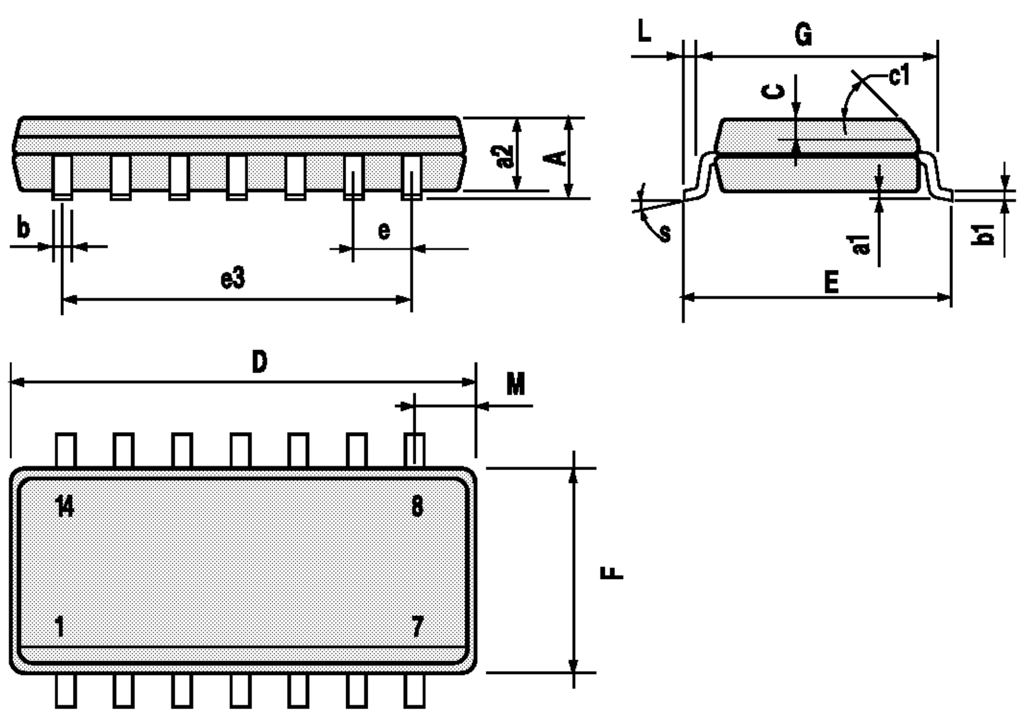


Saturation voltage versus output current



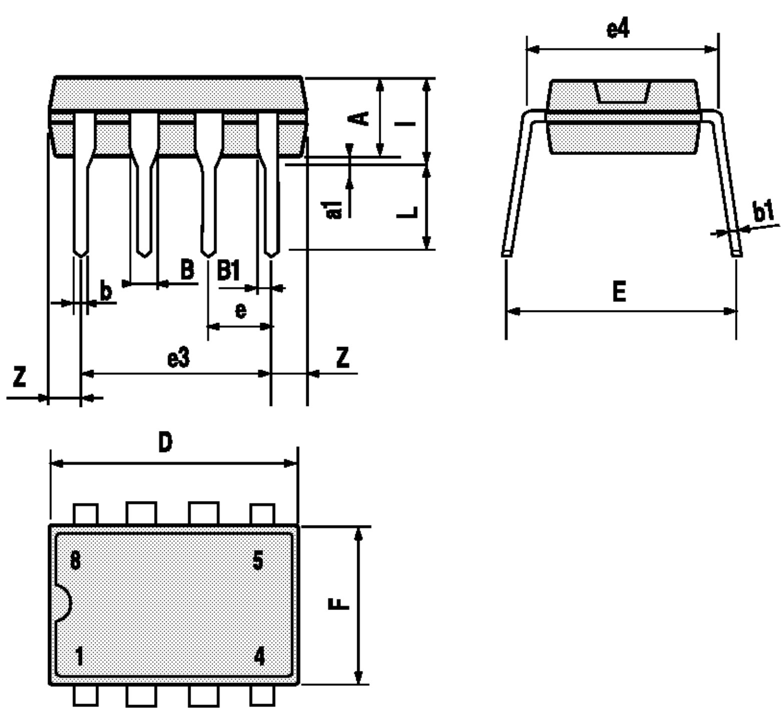
SO14 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45 (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.15		0.157
L	0.4		1.27	0.016		0.050
M			0.68			0.027
S	8 (max.)					



MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

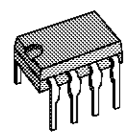


SGS-THOMSON MICROELECTRONICS

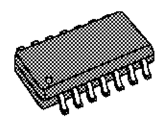
TDE1747
TDF1747

INTERFACE CIRCUIT – RELAY AND LAMP – DRIVER

- OPEN GROUND PROTECTION
- HIGH OUTPUT CURRENT
- ADJUSTABLE SHORT-CIRCUIT PROTECTION TO GROUND
- THERMAL PROTECTION WITH HYSTERESIS TO AVOID THE INTERMEDIATE OUTPUT LEVELS
- LARGE SUPPLY VOLTAGE RANGE : + 10 V TO + 45 V
- SHORT-CIRCUIT PROTECTION TO V_{CC}



Minidip (DP)



SO14 (FP)

ORDERING NUMBERS:
TDE1747DP
TDE1747FP
TDF1747DP

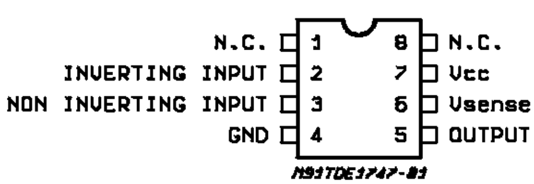
DESCRIPTION

The TDE/TDF1747 is a monolithic comparator designed for high current and high voltage applications, specifically to drive lamps, relays, stepping motors.

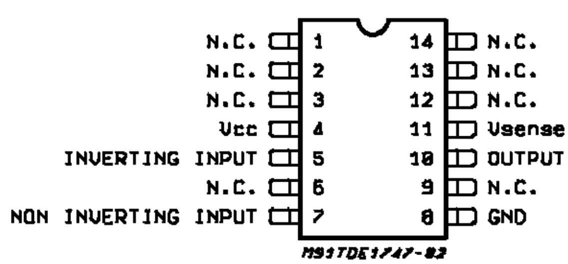
These device is essentially blow-out proof. Current limiting is available to limit the peak output current to safe values, the adjustment only requires one external resistor. In addition, thermal shut down is provided to keep the I.C. from overheating. If internals dissipation becomes too great, the driver will shut down to prevent excessive heating. TDE1747 has an open ground protection. The output is also protected from short-circuits with the positive power supply.

The device operates over a wide range of supply voltages from standard ± 15 V operational amplifier supplies down to the single + 12 V or + 24 used for industrial electronic systems.

PIN CONNECTIONS (Top view)



Minidip



SO14

ABSOLUTE MAXIMUM RATINGS

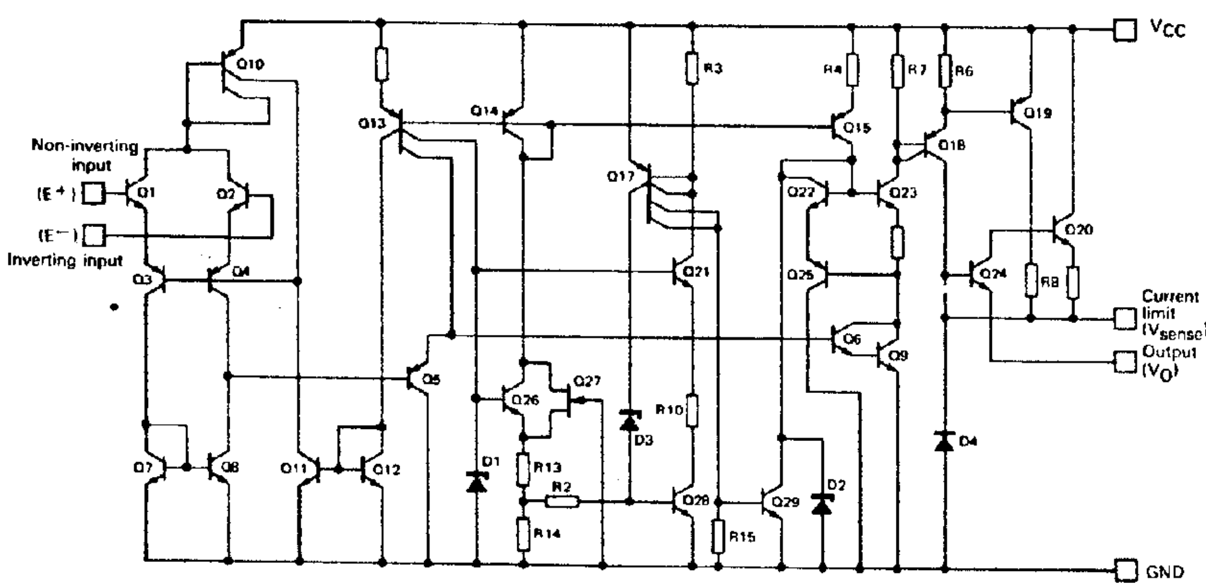
Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	50 *	V
V_{ID}	Differantial Input Voltage	50	V
V_I	Input Voltage	50	V
I_O	Output Current	1	A
P_{tot}	Power Dissipation (T_{amb} = + 25 °C)	Internally Limited	W
T_{stg}	Storage Temperature Range	– 65 to + 150	°C
T_{oper}	Operating Ambient Temperature Range TDE1747 TDF1747	 – 25 to + 85 – 40 to + 85	 °C °C

(*) 60V, t â 10ms

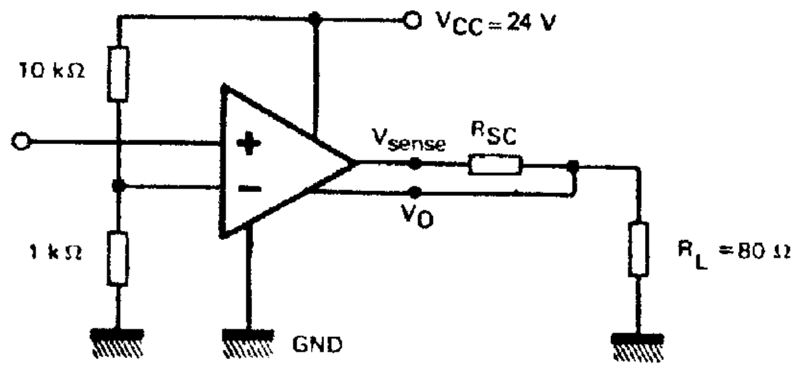
THERMAL CHARACTERISTICS

Symbol	Parameter	Value	Unit
$R_{th(j\text{-}c)}$	Maximum Junction-case Thermal Resistance	50	°C/W
$R_{th(j\text{-}a)}$	Maximum Junction-ambient Thermal Resistance	120	°C/W
R_{th}	Junction-ceramic Substrate (case glued to substrate) SO14	90	°C/W
R_{th}	Junction-ceramic Substrate (case glued to substrate, substrate temperature maintened constant) SO14	65	°C/W

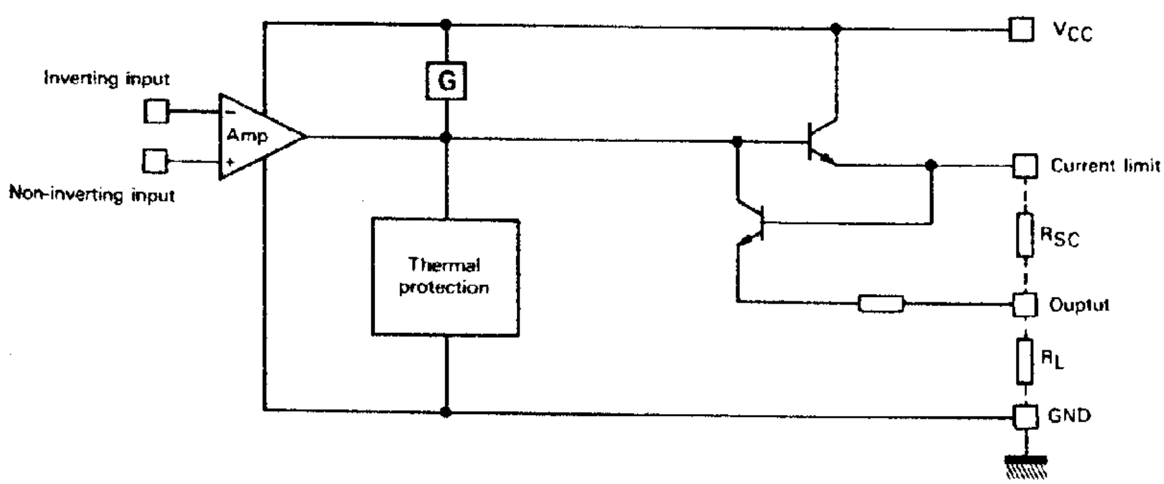
SCHEMATIC DIAGRAM



TEST CIRCUIT



SIMPLIFIED CIRCUIT



ELECTRICAL CHARACTERISTICS T_j = – 25 to +85 °C, V_{CC} = 8 to 45 V, unless otherwise specified (note 1).

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IO}	Input Offset Voltage - (note 2)	–	2	50	mV
I_{IB}	Input Bias Current	–	0.1	1.5	mA
I_{CC}	Supply Current (V_{CC} = + 24 V, I_O = 0) High Level Low Level	 – –	 4 2	 6 4	 mA mA
$V_{I(max)}$	Common-mode Input Voltage Range	2	–	V_{CC}–2	V
I_{SC}	Short-circuit Current Limit (T_{amb} = + 25 °C, V_{CC} = + 24) R_{SC} = 1.5 Ω TDE1747 R_{SC} = ∞	 – –	 480 35	 – 50	 mA mA
V_{CC}–V_O	Output Saturation Voltage (output high) (R_{SC} = 0, V_{I+}–V_{I-} ≥ 50 mV) I_O = 300 mA, T_j = + 25 °C T_j = + 150 °C	 – –	 1.15 1.05	 1.4 1.3	 V V
I_{OL}	Low Level Output Current (V_O = 0, V_{CC} = + 24 V) T_j = + 25 °C	 –	 0.01	 10	 µA

Notes :

1) For operating at high temperature, the TDE/TDF1747, must be derated based on a + 150 C maximum junction temperature and a junction-ambient thermal resistance of 120 °C/W for Minidip and 100 °C/W for the SO14.

2) The offset voltage given is the maximum value of input voltage required to drive the output voltage within 2 V of the ground or the supply voltage.

Figure 1: Available Output Current vs. Limiting Resistor

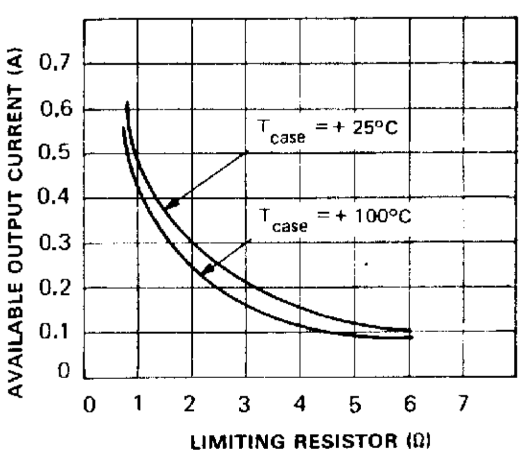


Figure 2: Peak Short-circuit Output Current vs. Limiting Resistor

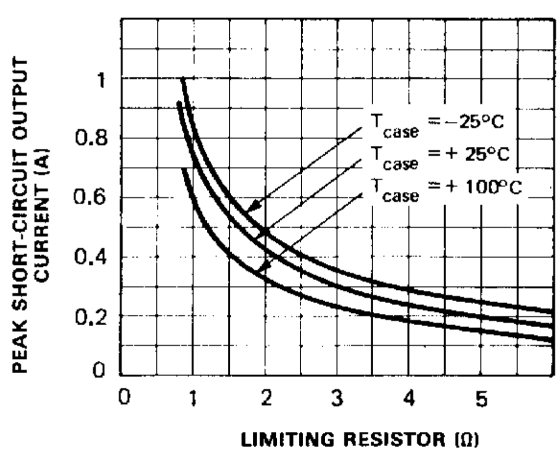


Figure 3: Short-circuit Current vs. Case Temperature

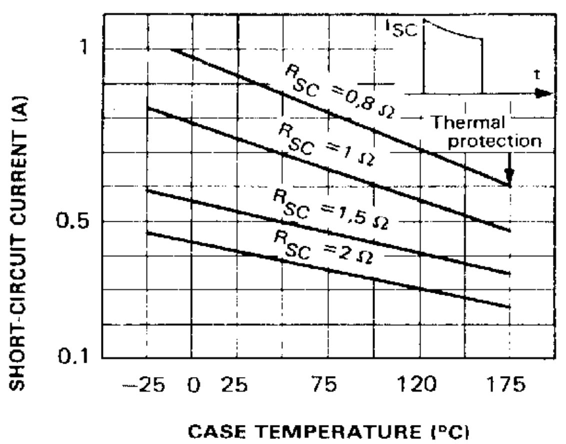


Figure 4: Minimum Limiting Resistor Value vs. Supply Voltage

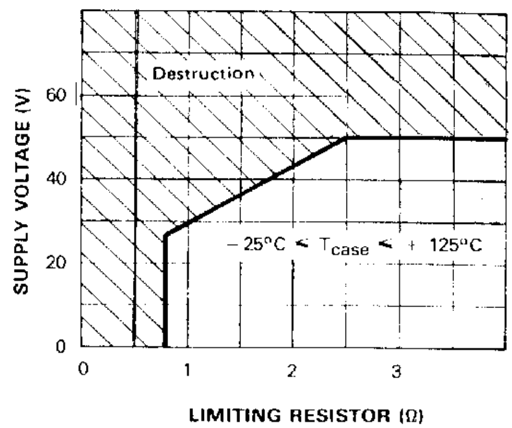


Figure 5: Output Current vs. Output Saturation Voltage

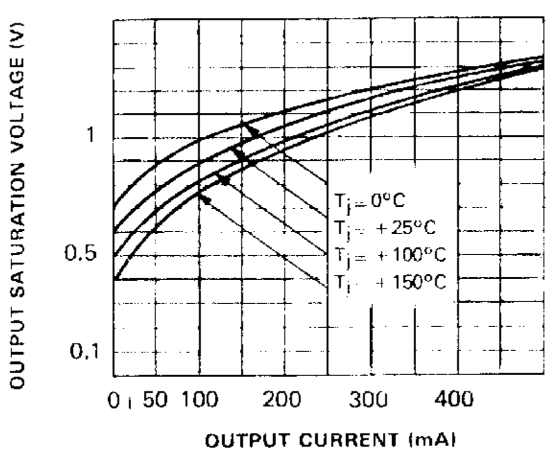


Figure 6: Supply Current vs. Supply Voltage

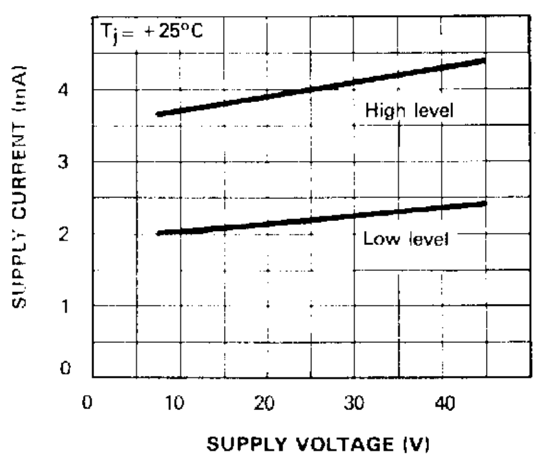


Figure 7: Supply Current vs. Junction Temperature

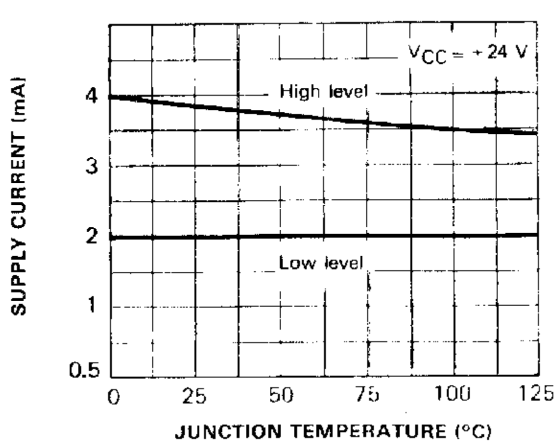


Figure 8: Safe Operating Area (non repetitive surge)

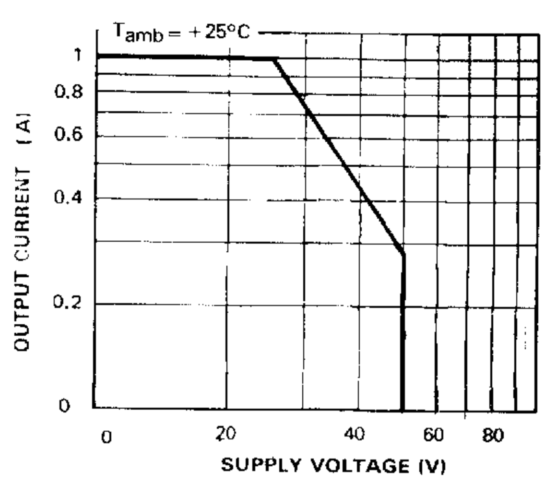
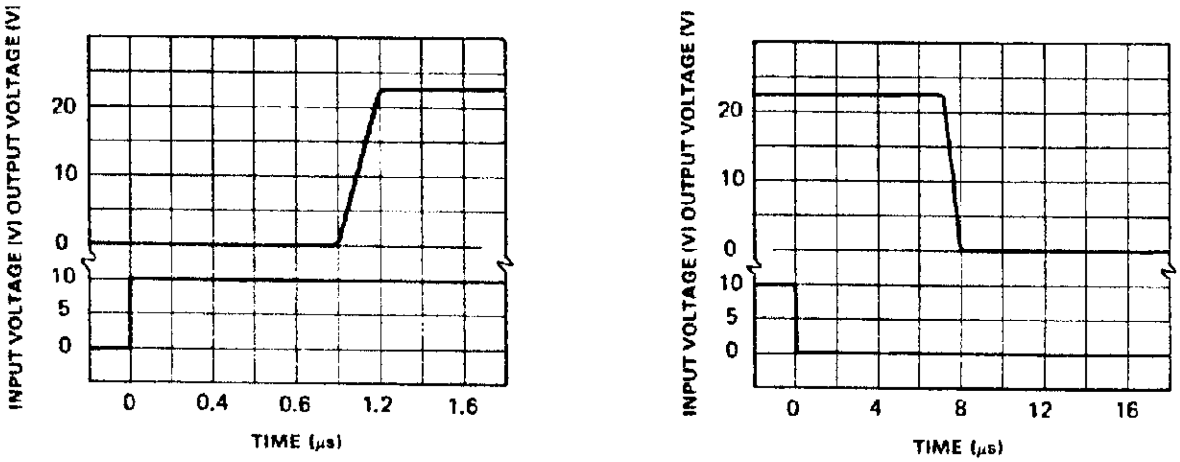


Figure 9: Response Time



TYPICAL APPLICATIONS

Figure 10: Base Circuit

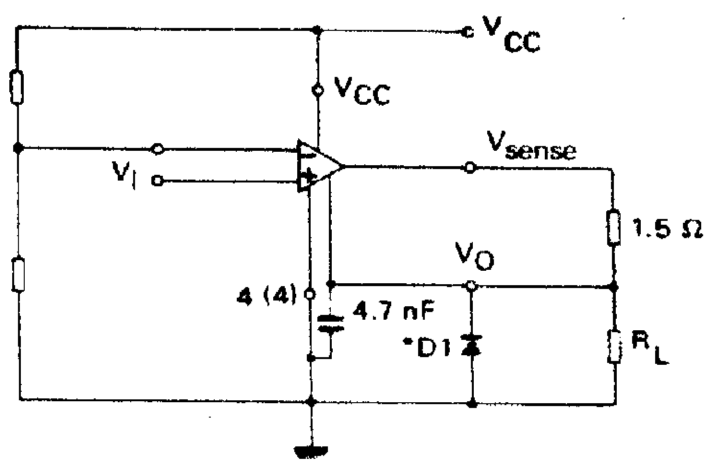


Figure 11: Output Current Extension (5A)

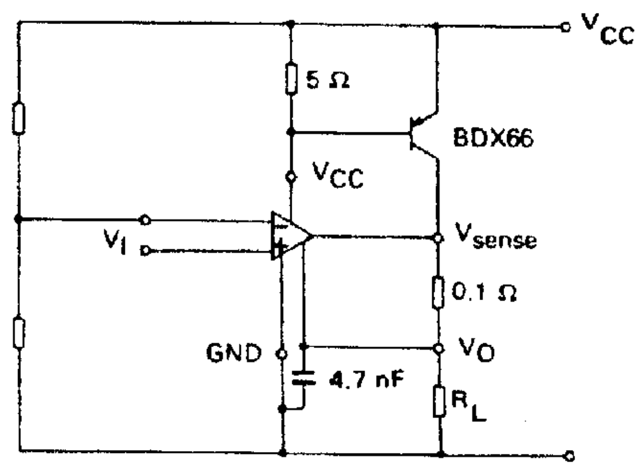
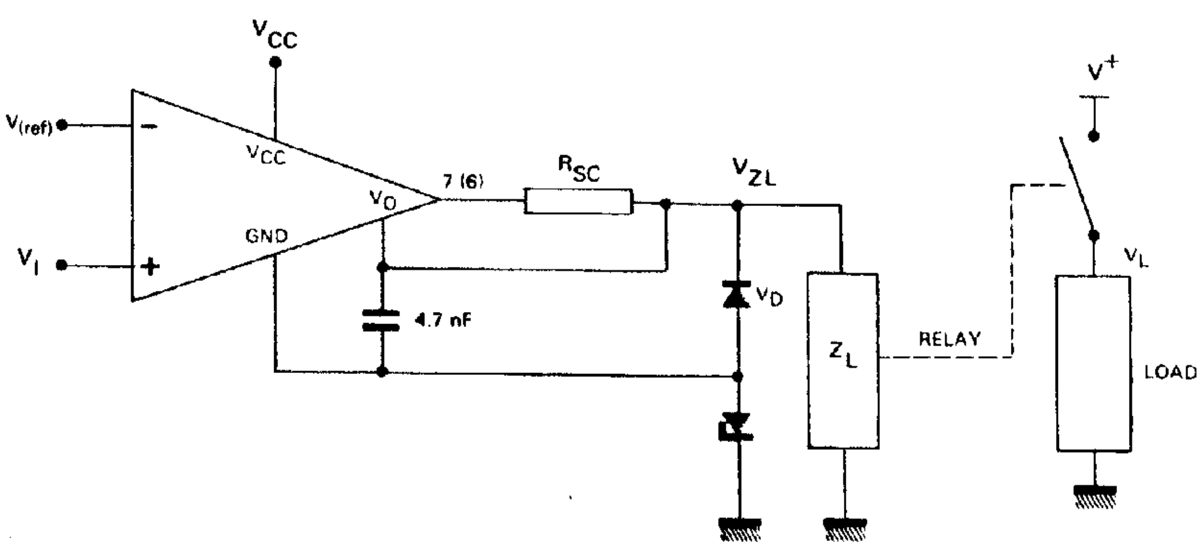
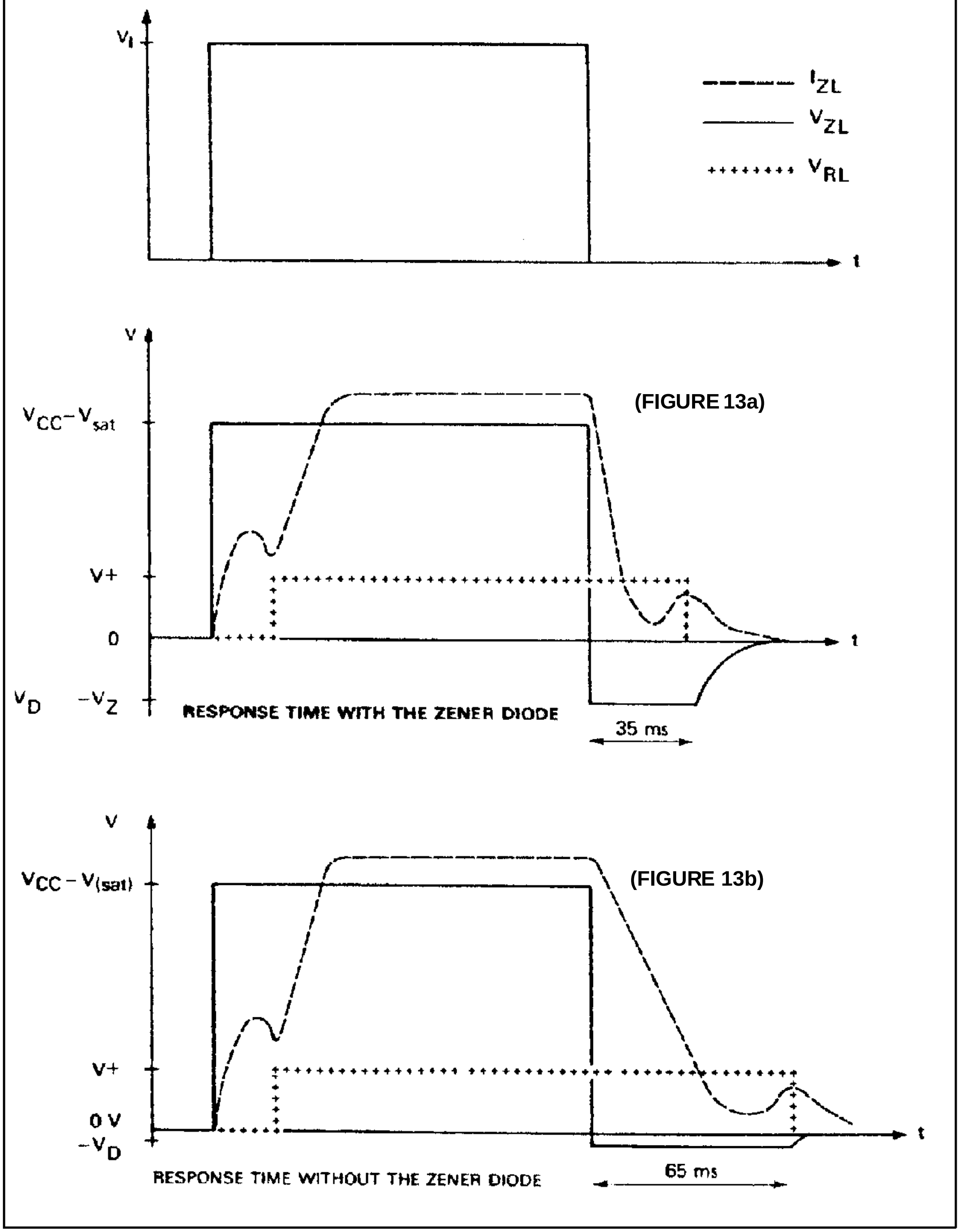


Figure 12: Driving Low Impedance Relays (I_O = 300mA)



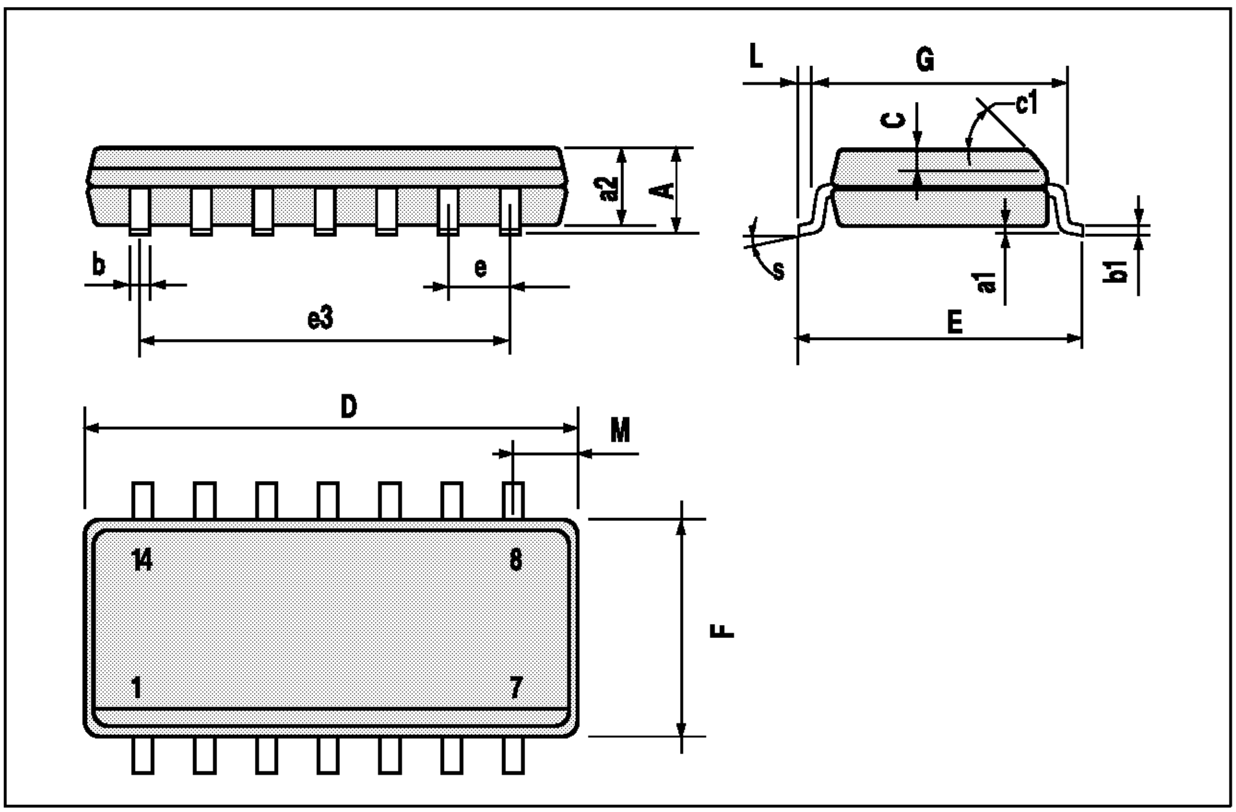
The device in the above application operates at: V_{CC} = +45V, I_O = 300mA with a heatsink such that $R_{th(j-a)} \leq$ 80°C/W. The device supports an output voltage of $V_{CC} = V_Z$ during the current cut off time, which is decreased by the zener diode. This voltage must be ≤ to the maximum supply voltage.

Figure 13: Waveforms



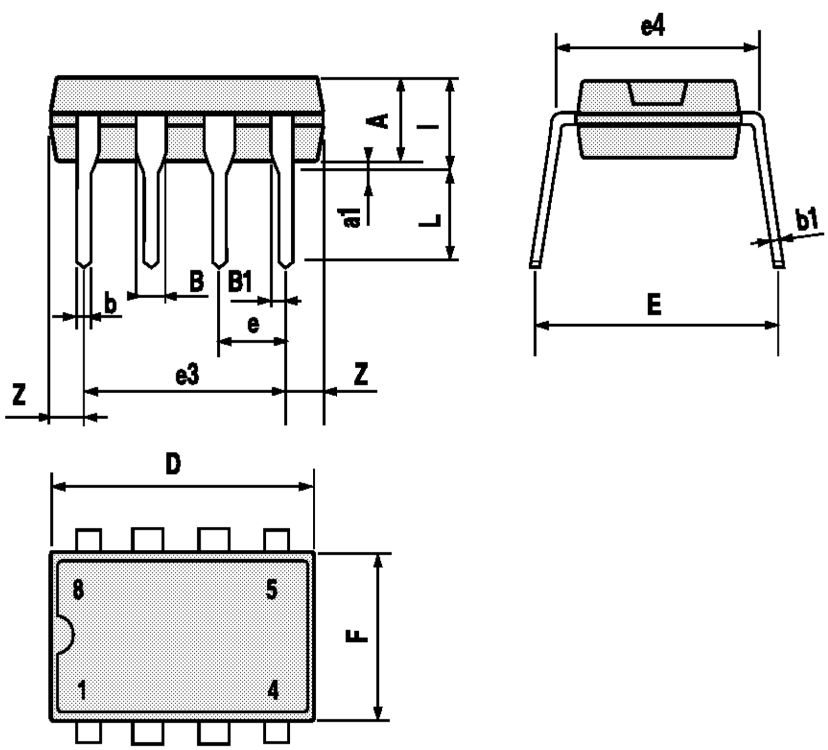
SO14 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45 (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.15		0.157
L	0.4		1.27	0.016		0.050
M			0.68			0.027
S	8 (max.)					



MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

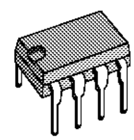


SGS-THOMSON MICROELECTRONICS

TDE1767, A
TDE1787, A

INTERFACE CIRCUIT (RELAY AND LAMP-DRIVER)

- OPEN GROUND PROTECTION
- HIGH OUTPUT CURRENT
- ADJUSTABLE SHORT-CIRCUIT PROTECTION
- INTERNAL THERMAL PROTECTION WITH EXTERNAL RESET
- LARGE SUPPLY VOLTAGE RANGE
- ALARM OUTPUT
- INPUT VOLTAGE CAN BE HIGHER THAN V_{CC}
- OUTPUT VOLTAGE CAN BE LOWER THAN GROUND (V_{CC} - $V_O \leq V_{CC}$[max])



Minidip

ORDERING NUMBERS : TDE1767 DP
TDE1767 ADP
TDE1787 DP
TDE1787 ADP

DESCRIPTION

The TDE1767, A/TDE1787, A are a monolithic amplifiers designed for high current and high voltage applications, specifically to drive lamps, relays, stepping motors.

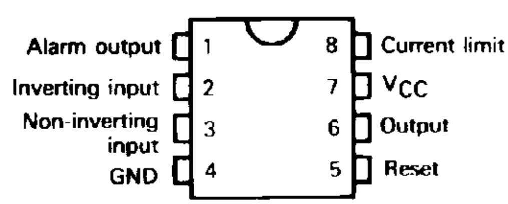
The devices are assentially blow-out proof. The output is prois protected from short-circuits with the positive supply or drive. In addition thermal shut down is provited to keep the IC from overheathing. If internal dissipation becomes too high, the driver will shut down to prevent excessive heating. The output stays null after the overheating is off, if the reset input is low. If high the output will alternatively switch-on and off until the overload is removed.

The devices operates over a wide range voltages from standard 15 V operational amplifier supplies to the single +6V or +48V used for industrial electric systems. Input voltages can be higher than in the V_{CC}.

An alarm output suitable for driving a LED is provited. This LED, normally on (if referred to ground), will die out or flash during an overload depending on the state of the reset input.

The output is low in open ground conditions.

PIN CONNECTION (top view)



THERMAL DATA

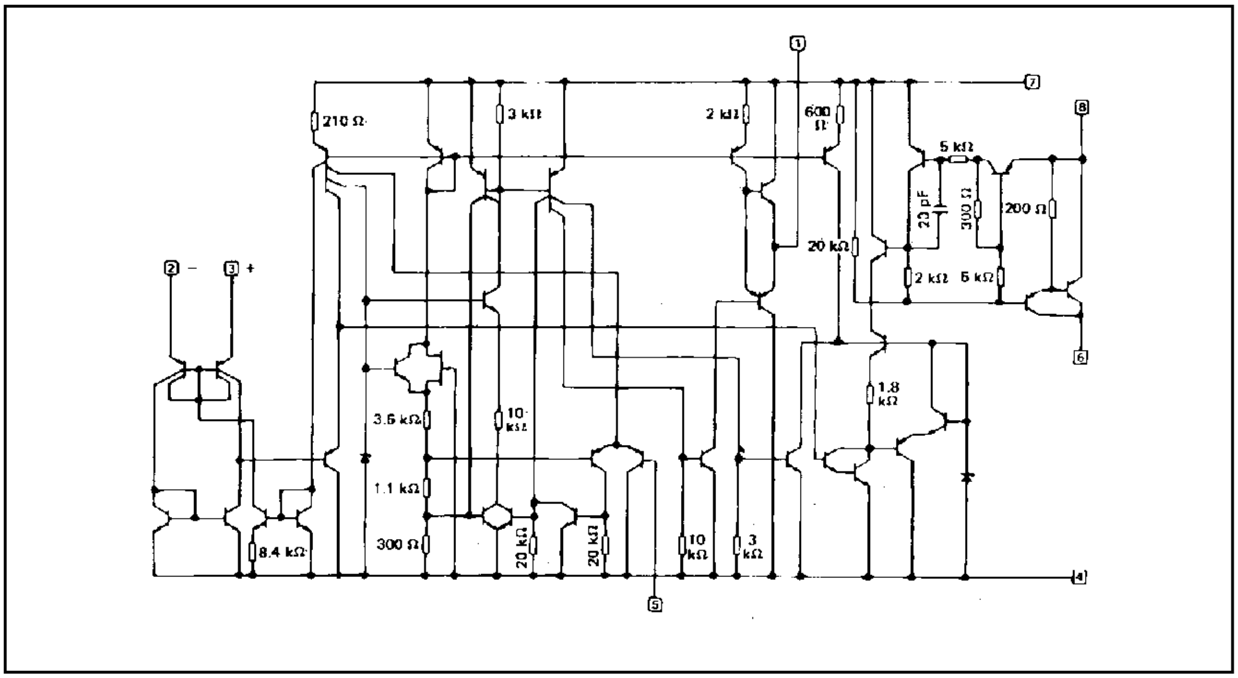
Symbol	Parameter	Value	Unit
$R_{th\ (j-c)}$	Maximum Junction-case Thermal Resistance	30	°C/W
$R_{th\ (j-a)}$	Maximum Junction-ambient Thermal Resistence	80	°C/W

* Devices bonded on a 40 cm2 glass-epoxy printed circuit 0.15 cm thick with 4 cm2 of copper.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	TDE1767A/TDE1787A	TDE1767/TDE1787	Unit
V_{CC}	Supply Voltage	60	50	V
V_{ID}	Input Differential Voltage	60	50	V
V_I	Input Voltage	- 10 to + 60	- 10 to + 50	V
I_O	Output Current	1.3	1.2	A
$V_{I(reset)}$	Reset Input Voltage	- 0.5 to + 60	- 0.5 to + 50	V
I_{OA}	Alarm Output Current	- 10 to + 20	- 10 to + 20	mA
P_{tot}	Power Dissipation	Internally Limited		mW
T_{oper}	Operating Ambient Temperature Range	- 25 to + 85	- 25 to + 85	°C
T_{stg}	Storage Temperature Range	- 65 to + 150	- 65 to + 150	°C

SCHEMATIC DIAGRAM



EQUIVALENT SCHEMATIC

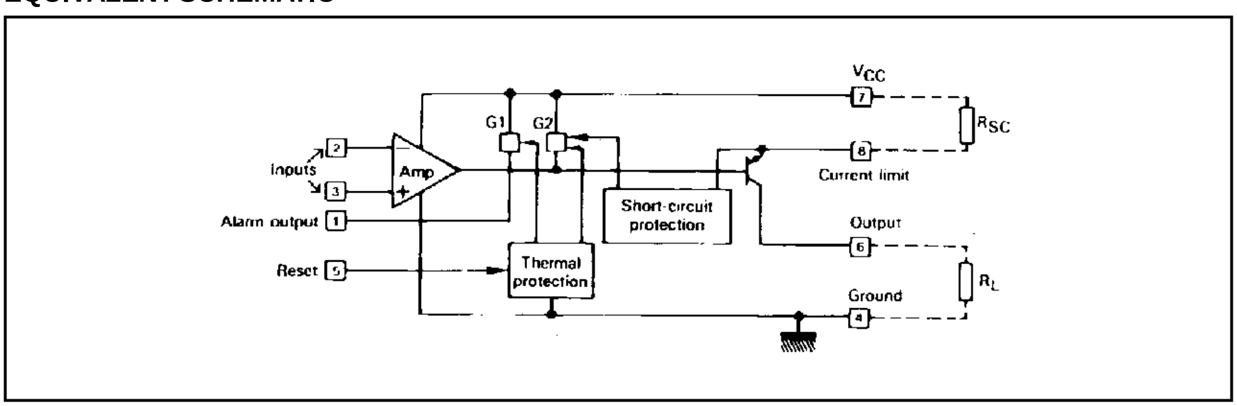
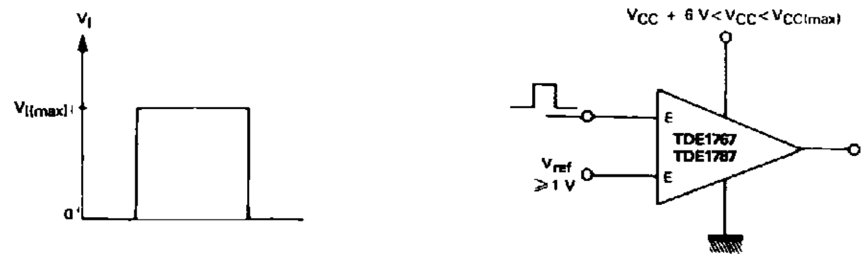


Figure 1.



The reference input can be the inverting or non-inverting one.

ELECTRICAL CHARACTERISTICS (Unless otherwise specified)

TDE1767A: - 25 °C ≤ T_{amb} ≤ + 85°C, + 6 V ≤ V_{CC} ≤ + 55 V, I_o ≤ 500 mA, T_j ≤ + 150°C

TDE1767: - 25 °C ≤ T_{amb} ≤ + 85°C, + 6 V ≤ V_{CC} ≤ + 45 V, I_o ≤ 500 mA, T_j ≤ + 150°C

TDE1787A: - 25 °C ≤ T_{amb} ≤ + 85°C, + 6 V ≤ V_{CC} ≤ + 55 V, I_o ≤ 300 mA, T_j ≤ + 150°C

TDE1767A: - 25 °C ≤ T_{amb} ≤ + 85°C, + 6 V ≤ V_{CC} ≤ + 45 V, I_o ≤ 300 mA, T_j ≤ + 150°C

Symbol	Parameter		Min.	Typ.	Max.	Unit
V_{IO}	Input Offset Voltage - (note 1)			2	50	mV
I_{CC}	Power Supply Current (measured on pin 4) Output High (T_{amb} = + 25 °C) Output High ($V_{CC} = V_{CC(max)}$, T_j = + 150 °C) Output Low ($V_{CC} = V_{CC(max)}$, T_{amb} = + 25 °C)		 - - -	 5.8 5 1.5	 8 7 4	mA
I_{IB}	Input Bias Current		-	15	100	µA
V_{CM}	Common-mode Input Voltage Range	**TDE1787A, TDE1767A** **TDE1787, TDE1767**	1 1	- -	60 45	V
V_I	Input Voltage Range (V_{ref} ≥ + 1 V) (figure 1, note 2)	**TDE1787A, TDE1767A** **TDE1787, TDE1767**	0 0	- -	60 45	V
I_{SC}	Short-circuit Output Current (V_{CC} = + 35 V, t = 10 ms) R_{SC} = 0.22 Ω R_{SC} = 0.33 Ω	 **TDE1767A** **TDE1787A**	 - -	 700 380	 - -	mA
V_{sense}	Output Limit Sense Voltage : $V_O = V_{CC}$ - 2 V, t = 10ms ($V_O = V_{CC}$ - 2 V) : V_O = 0 V, t = 10 ms		130 120	150 140	170 165	mV
$V_{O(sat)}$	Output Saturation Voltage (output high $V_I^+ - V_I^-$ ≥ 50 mV, R_{SC} = 0, V_{CC} = + 30 V) T_j= + 25°C T_j = + 150 °C 	 **TDE1787A, TDE1767A** **TDE1787, TDE1767** **TDE1787A, TDE1767A** **TDE1787, TDE1767**	 - - - -	 1 1 1.1 1.1	 1.1 1.2 1.2 1.3	V
I_{OL}	Output Leakage Current (output low)		-	-	100	µA
I_A	Available Alarm Output Current Output Source Current (VAH = V_{CC} - 2.5 V) Output SInk Current (in thermal shut-down) V_A = 1.4 V		 -4 5	 -5 10	 - -	mA
I_{reset}	Reset Input Current		-	2	40	µA
$V_{th\ (reset)}$	Reset Threshold		-	1.4	-	V
-	Output Leakage Current (open ground)		-	10	-	µA

Notes: 1. The offset voltage given is the maximum value of different input voltage reguired to drive the output voltage whitin 2 V of the ground or the supply voltage.
2. Input voltage range is indipendent of the supply voltage.

Figure 2. PEAK SHORT-CIRCUIT vs LIMITING RESISTOR.

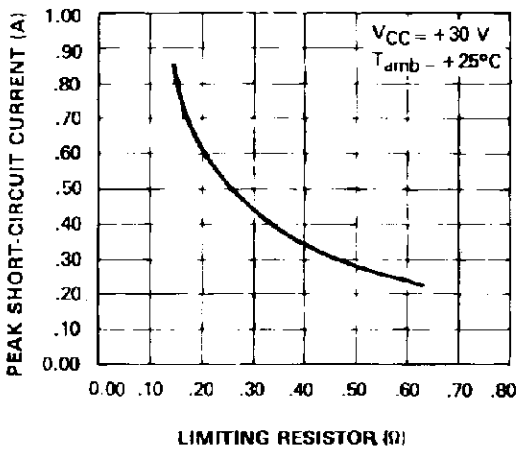


Figure 3. AVAILABLE OUTPUT CURRENT vs LIMITING RESISTOR.

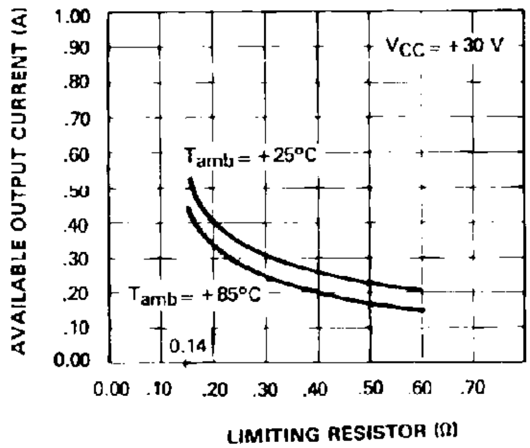


Figure 4. POWER SUPPLY CURRENT (pin 4).

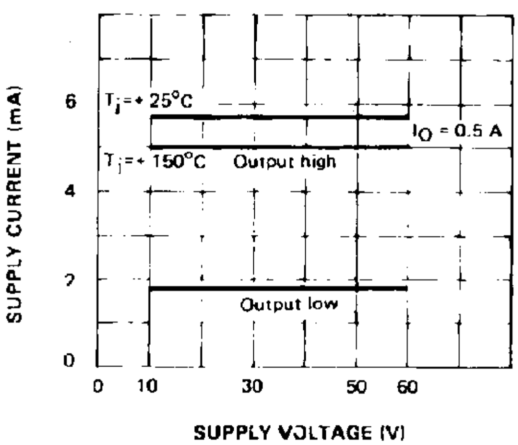


Fig.ure 5. OUTPUT SATURATION VOLTAGE vs OUTPUT CURRENT.

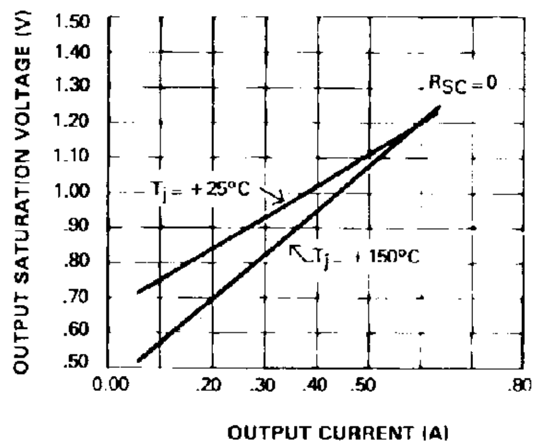


Figure 6. OUTPUT TRANSISTOR SAFE OPERATING AREA (pulsed)

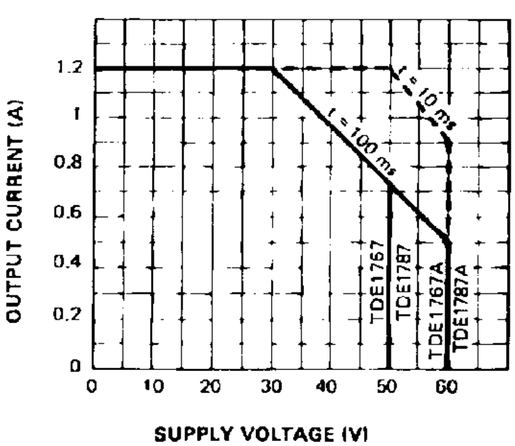
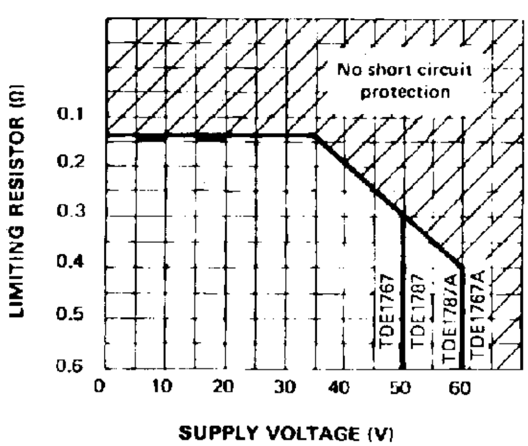


Figure 7. NORMAL OPERATING AREA (short circuit protected)



ALARM OUTPUT CAPABILITY CURRENT

Figure 8. CURRENT SINKING.

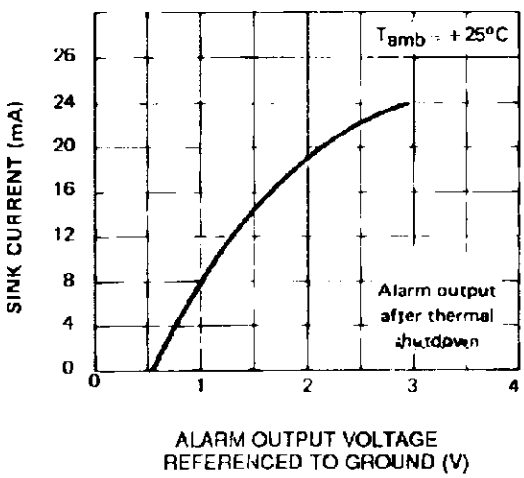


Figure 9. CURRENT SOURCING

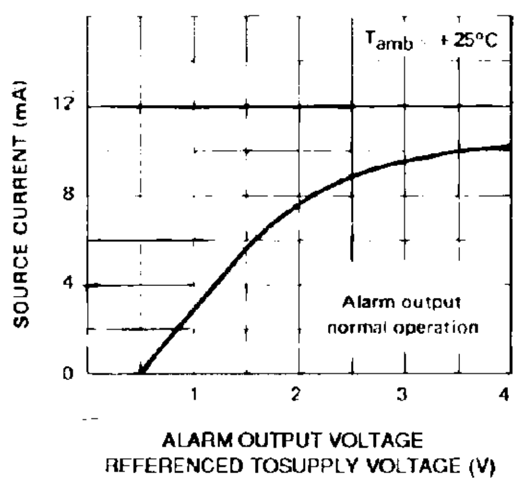


Figure 10. REPONSE TIME

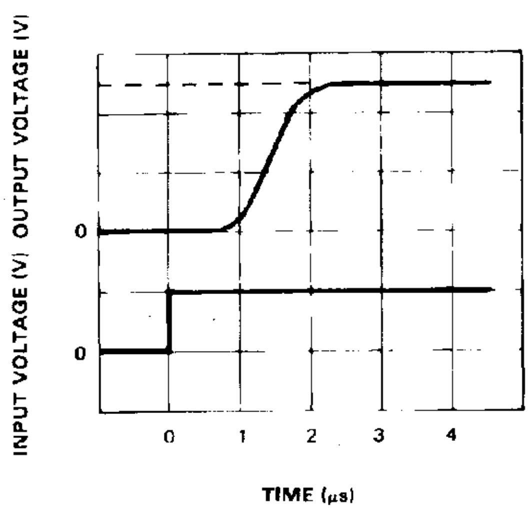


Figure 11. REPONSE TIME

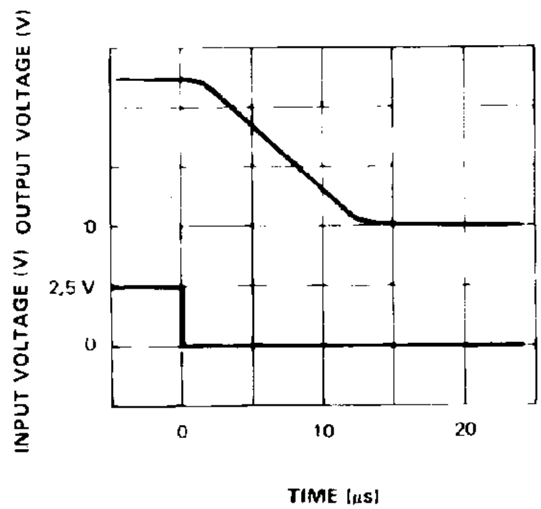
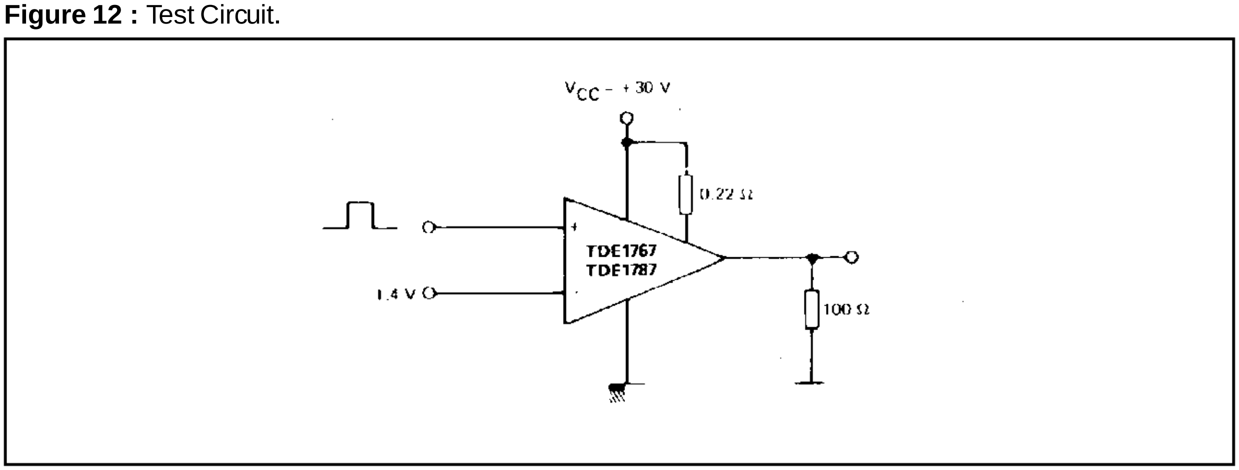


Figure 12 : Test Circuit.



TYPICAL APPLICATION

Figure 13. Open Load Detection.

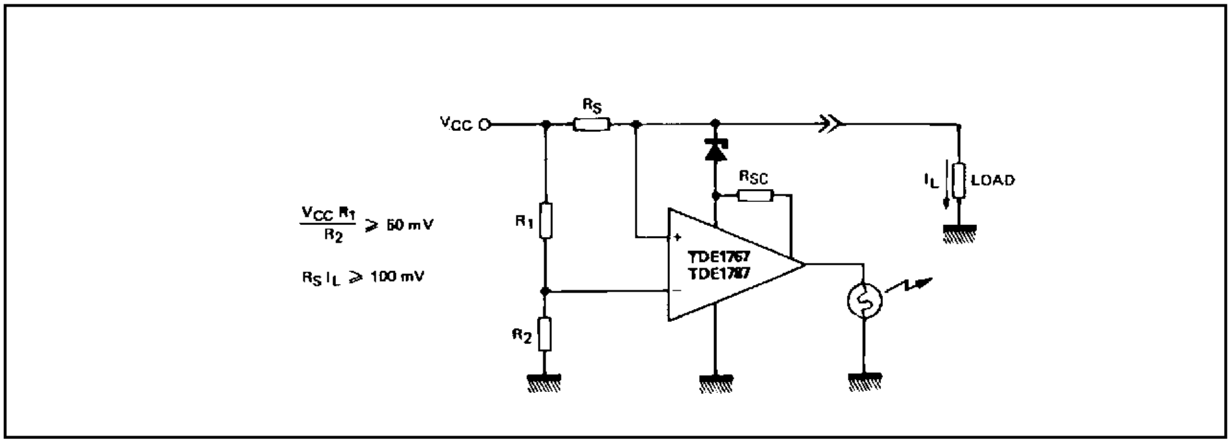


Figure 14. Driving Lamps, Relays, Etc...

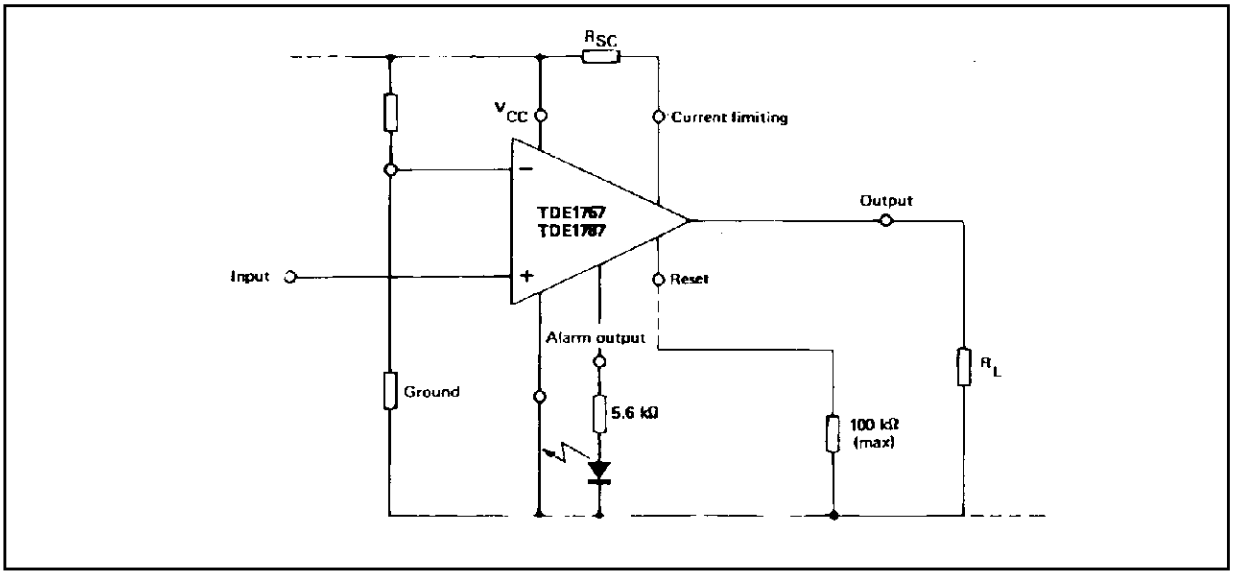


Figure 15. Common Reset.

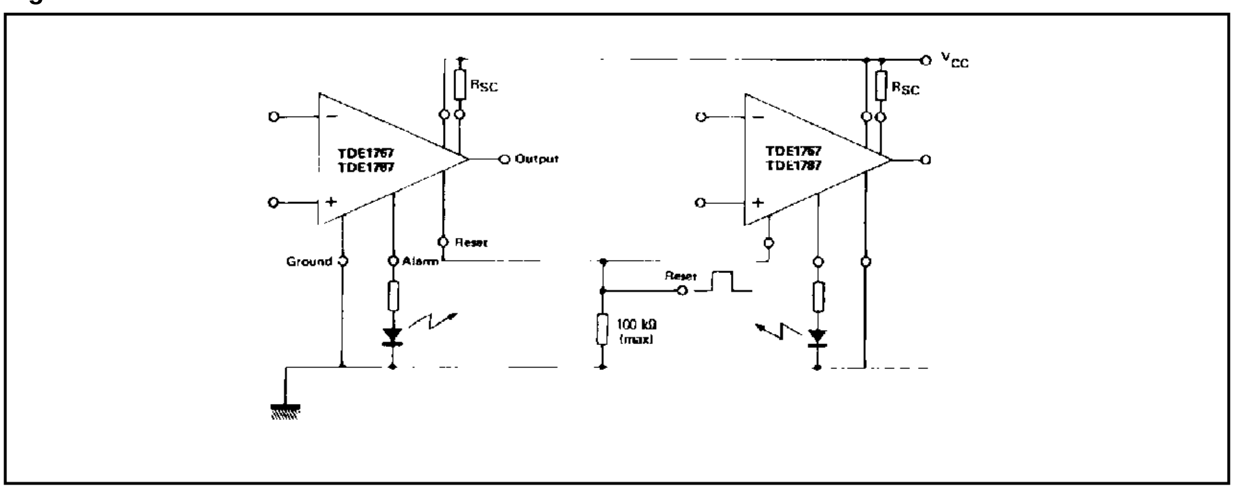
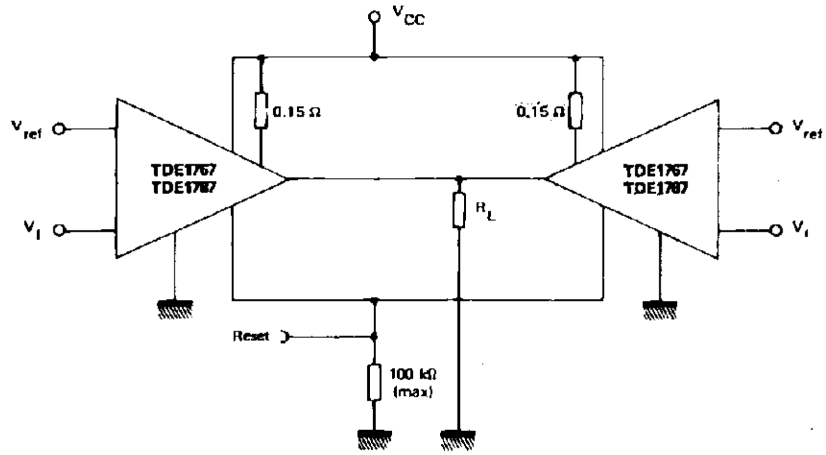


Figure 16. Parallel Driving of Loads Up to 1 A.



USING ALARM OUTPUT

Figure 17. Parallel Alarm Outputs.

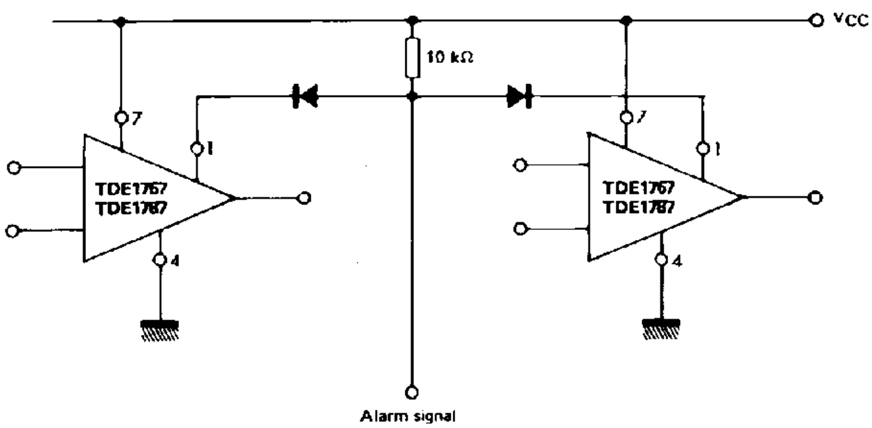


Figure 18. Led to VCC.

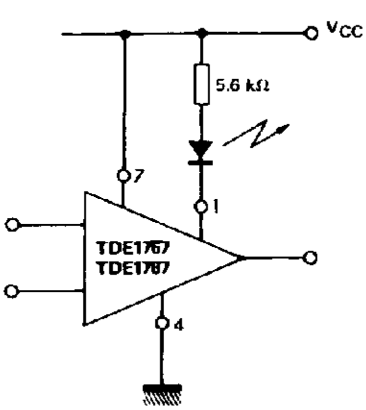


Figure 19. Led to Ground.

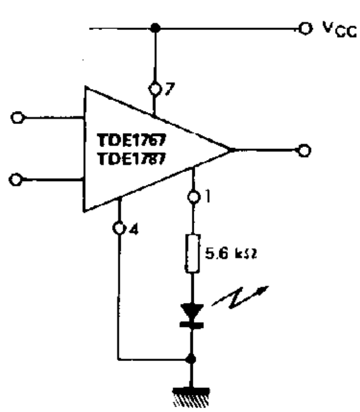


Figure 20. Interface between High oltage and Low Voltage System.

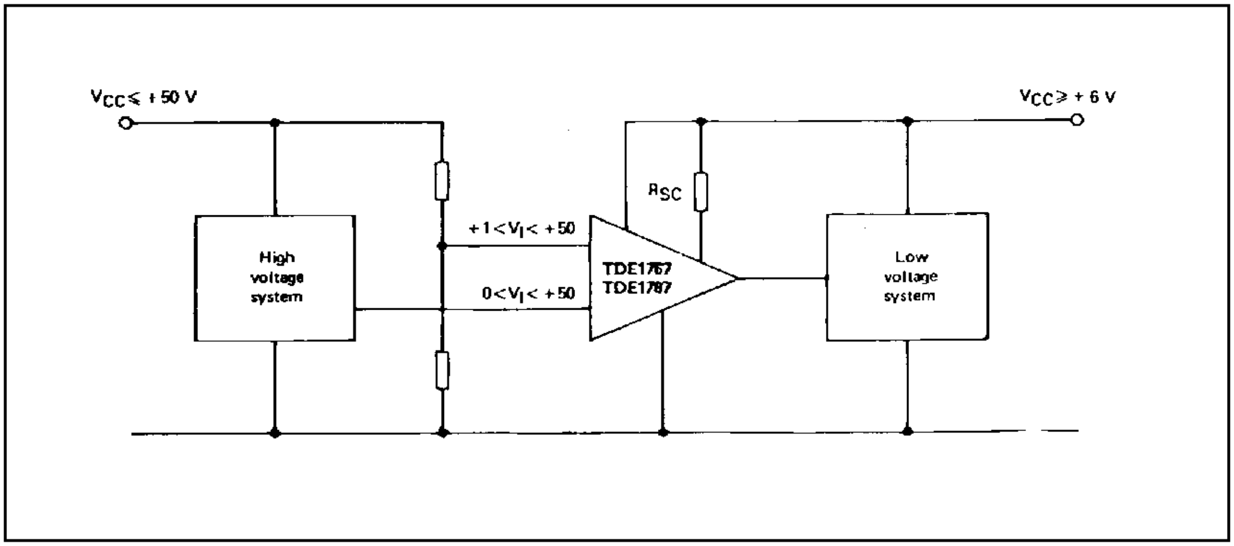
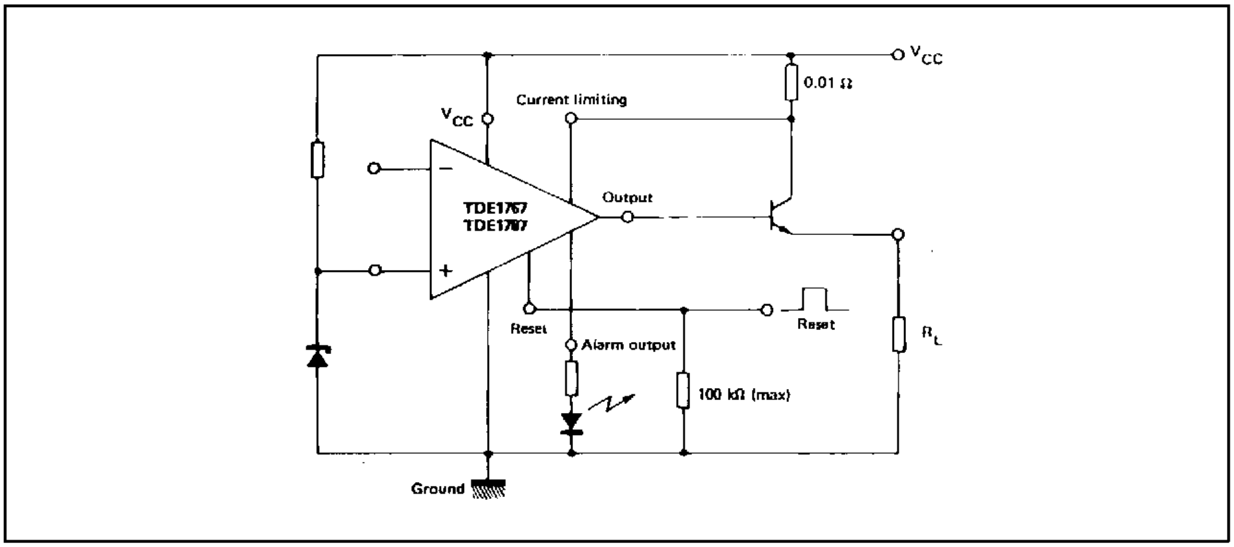
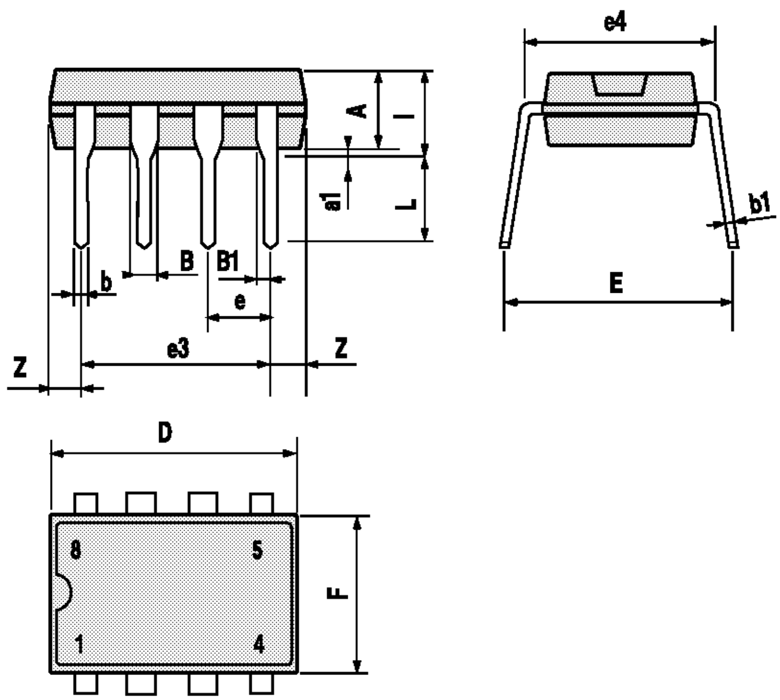


Figure 21. Increasing Current Up to 10 A.



MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

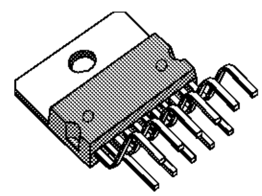


SGS-THOMSON MICROELECTRONICS

TDF1778

DUAL 2-A SOURCE DRIVER

- OUTPUT CURRENT UP TO 2.5 A
- WIDE RANGE OF SUPPLY VOLTAGES : + 8 to + 32 V
- CAN WITHSTAND OVERVOLTAGES OF AS HIGH AS 60 V BETWEEN V_{CC} AND GROUND
- INTERNAL ZENER DIODE PROVIDES FAST SWITCHING OF INDUCTIVE LOADS
- OUTPUT VOLTAGE CAN BE LOWER THAN GROUND



MULTIWATT11

ORDERING NUMBER : TDF1778SP

DESCRIPTION

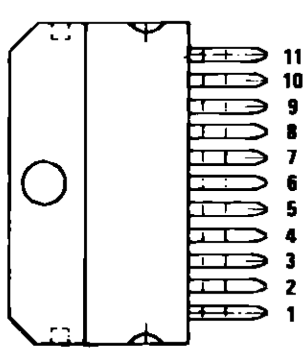
The TDF1778 is a dual source driver delivering high output currents and capable to drive any type of loads (Electrovalves, contactors, lamps).

This device is essentially blow-out proof, each output is protected against short-circuits. If internal dissipation becomes too high, drivers will shut down to prevent excessive heating. An ”ALARM” output is provided to indicate the action of the thermal protection. To reactivate the power outputs, the reset input must be forced to low state.

”SENSE” information of both power outputs are ORed together and then processed internally.

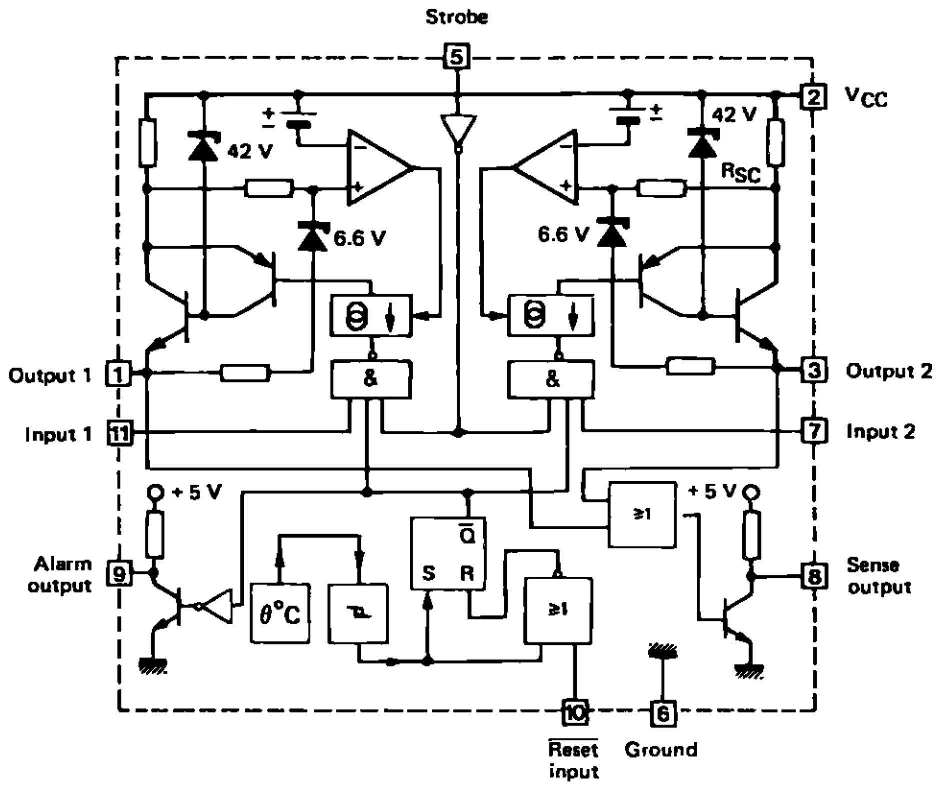
A ”STROBE” input is also provided to offer the possibility of disabling the power outputs.

PIN CONNECTION



1 - Output 1
2 - VCC
3 - Output 2
4 - N.C.
5 - Strobe
6 - Ground
7 - Input 2
8 - Sense output
9 - Alarm output
10 - $\overline{\text{Reset}}$ input
11 - Input 1

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	35 V (60 V/10 ms)	V
V_I, V_{reset}	Input Voltage (pins 7, 10 and 11)	– 30 to + 50	V
V_{strobe}	Strobe Input Voltage	– 0.5 to V_{CC}	V
I_O	Output Current	Internally Limited	A
P_{tot}	Power Dissipation	Internally Limited	W
T_{oper}	Operating Ambient Temperature Range	– 40 to + 85	°C
T_j	Junction Temperature	+ 150	°C

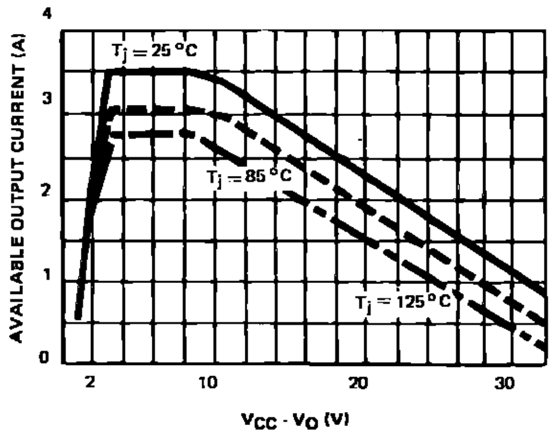
THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction-case Thermal Resistance	Max.	3	°C/W
$R_{th(j-a)}$	Junction-ambient Thermal Resistance	Max.	40	°C/W

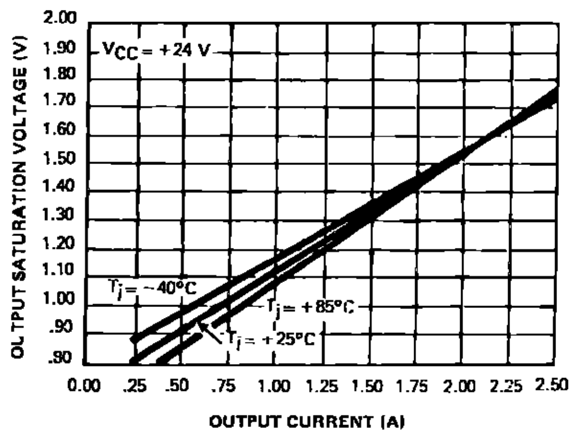
ELECTRICAL CHARACTERISTICS (V_{CC} = + 24V, – 40°C < T_j < + 85°C, unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Power Supply Voltage	8	–	32	V
I_{CC}	Power Supply Current (pin 6), I_{01} = I_{02} = 2A	–	–	20	mA
V_{IL} V_{IH}	Logic Input Voltage (pins 7, 10, 11)	– 2	– –	0.8 –	V
V_I	Logic Input Threshold (pin 5)	–	0.8	–	V
I_{IH}	High Level Input Current (pins 7, 10, 11) V_I = + 2V	–	20	50	µA
I_{IL}	Low Level Input Current (pins 7, 10, 11) V_I = + 0.8V	– 5	0	+ 5	µA
V_{OH}	High Level Logic Output Voltage (pins 8, 9) I(8) = I(9) = – 30 µA	2.4	4	–	V
V_{OL}	Low Level Logic Output Voltage (pins 8, 9) I(8) = I(9) = 2 mA		–	0.4	V
$V_{CC} – V_{O1}$ $V_{CC} – V_{O2}$	Output Saturation Voltage (V(7) high, V(11) high, I_O = 2A)	– –	1.5	1.8	V
I_{OL}	Low Level Input Current (pins 1, 3) V(7) Low, V(11) Low, V_O = 0V	–	400	1000	µA
$V_{CC} – V_{O1}$ $V_{CC} – V_{O2}$	Switch–off Output Voltage (inductive load)	40 –	44 –	48	V
I_{O1}, I_{O2}	Available Output Current (pins 1, 3), V(7) High, V(11) High, $V_{CC} – V_O$ = 32V, T_j = 25°C	100	–	–	mA
I_{Oalarm}	Available "Alarm" Output Current, V(9) = + 4V	4	8	–	mA
I_{Osense}	Available "Sense" Output Current, V(8) = + 4V	4	8	–	mA
$I_{IHsense}$	Output Sensing High Level Input Current (pins 1, 3) V_I = + 2V	–	1	2	mA
$V_{IHsense}$	High Level "Sense" Input Voltage (pins 1, 3)	0.8	1.9	2.5	V

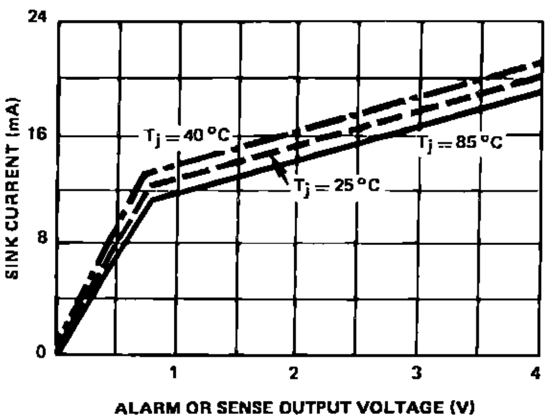
AVAILABLE OUTPUT CURRENT



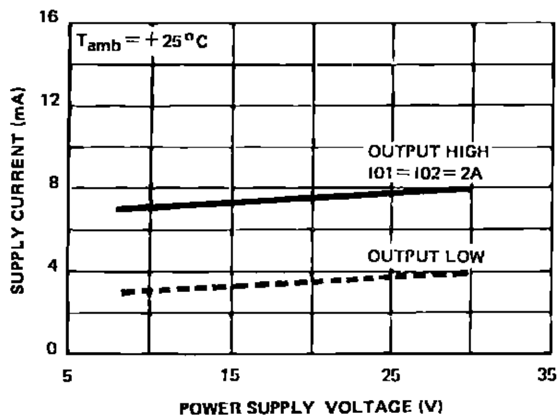
OUTPUT SATURATION VOLTAGE



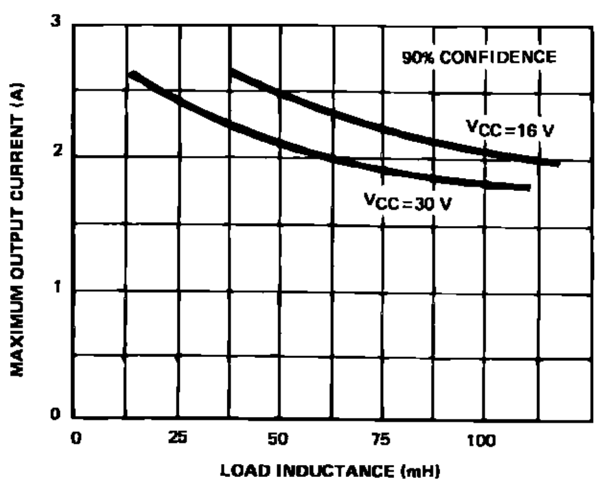
AVAILABLE ALARM OR SENSE OUTPUT CURRENTS



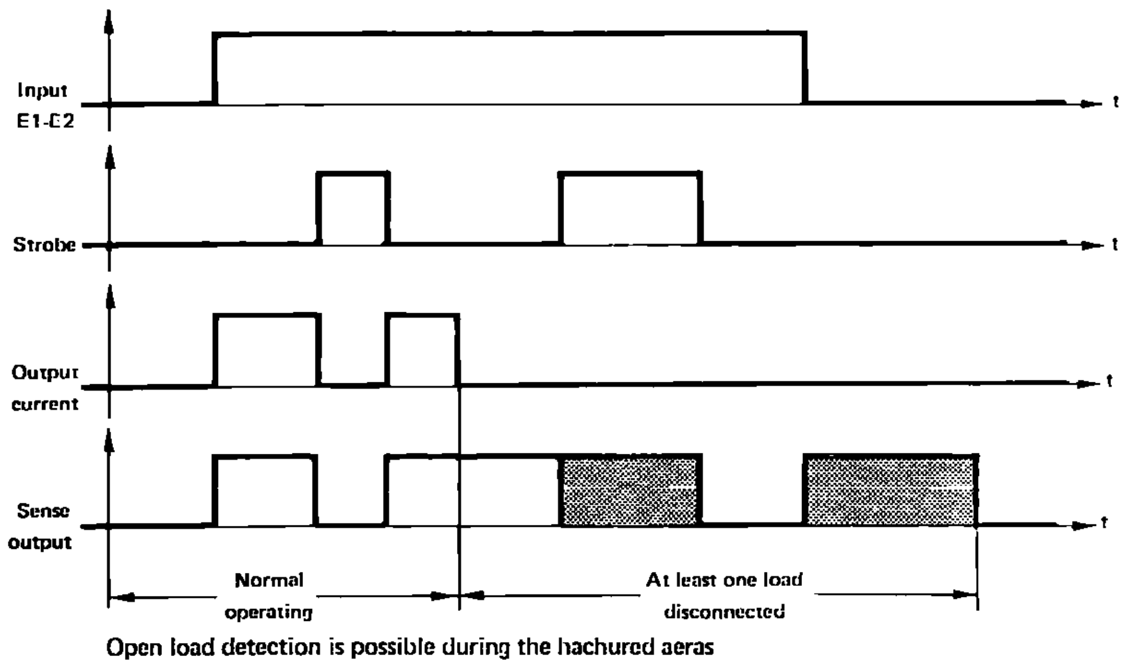
POWER SUPPLY CURRENT



MAXIMUM OUTPUT CURRENT VS LOAD INDUCTANCE

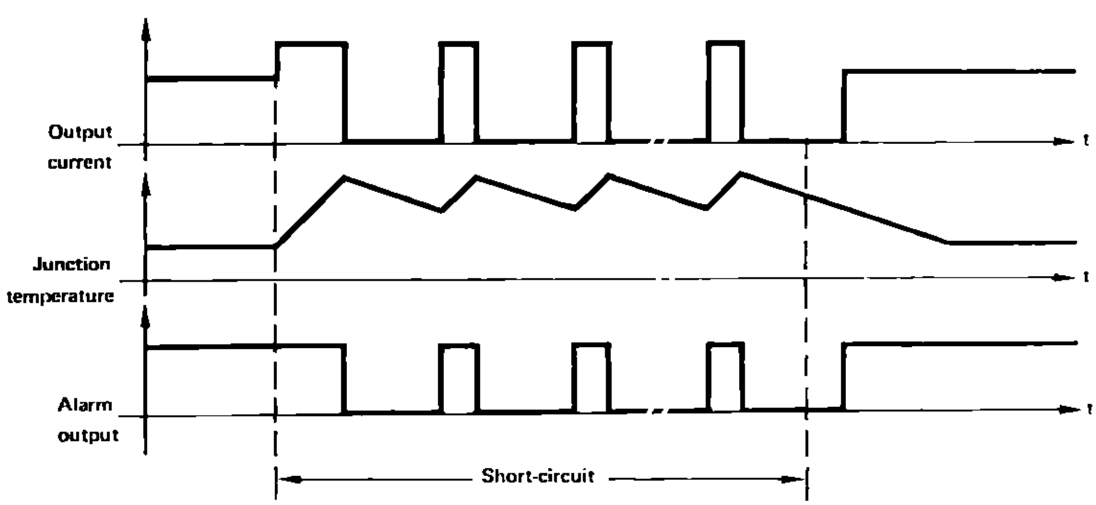


OPEN LOAD DETECTION

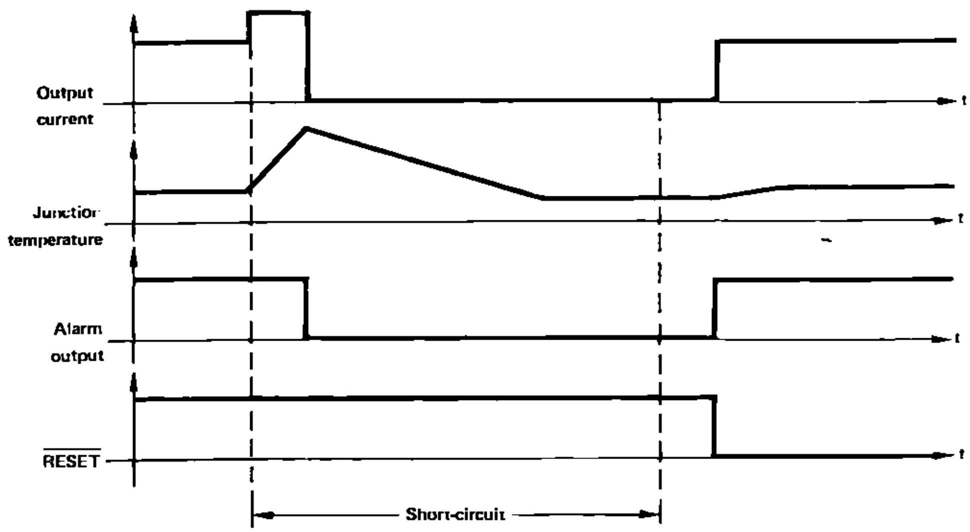


Open load detection is possible during the hachured aeras.

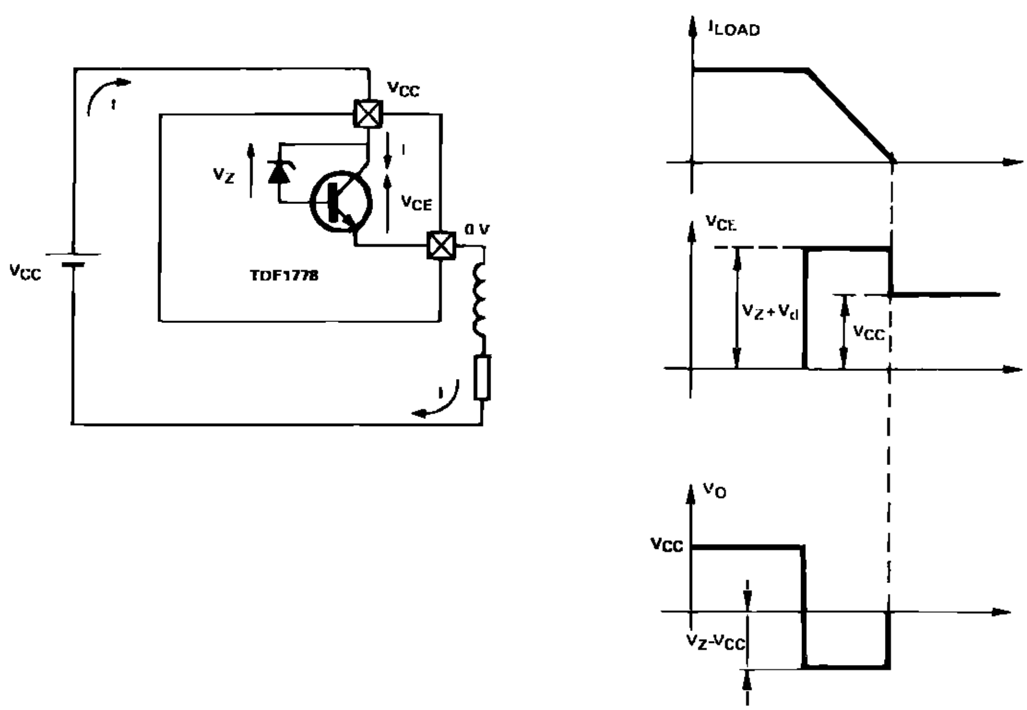
SHORT CIRCUIT CONDITIONS WAVEFORMS WITH AUTOMATIC RESET/$\overline{\text{RESET}}$ = 0



SHORT CIRCUIT WAVEFORMS WITH CONTROLLED RESET/$\overline{RESET}$ = 1

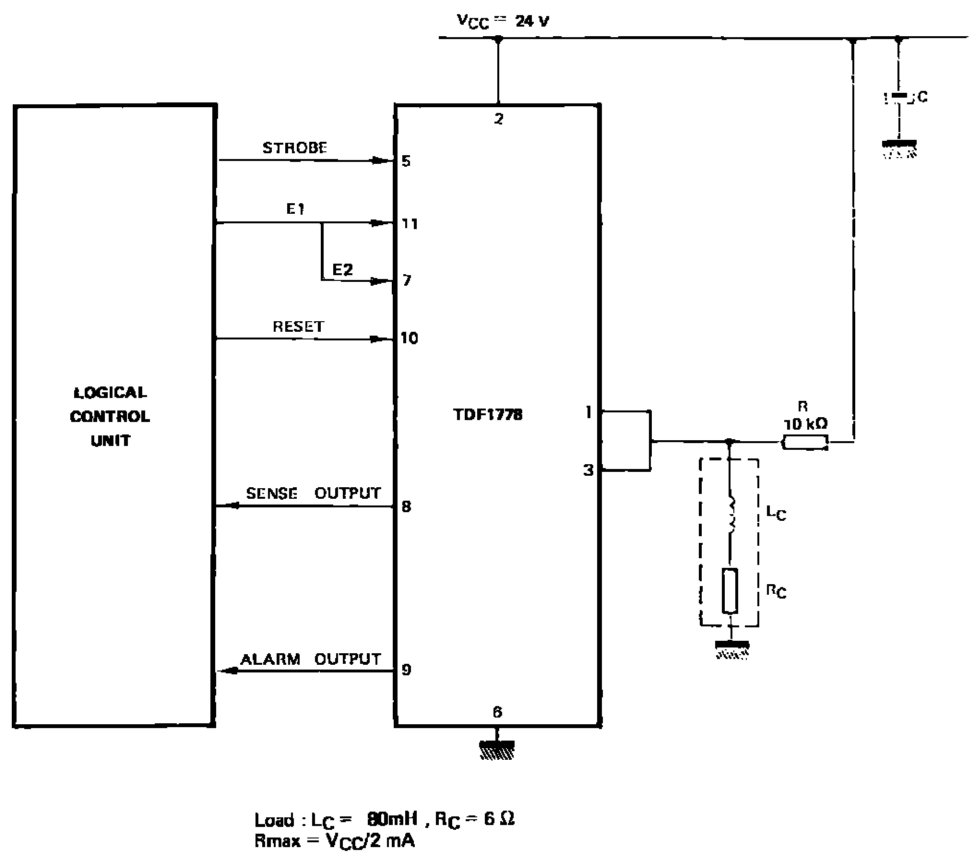


DEMAGNETIZATION UNDER INDUCTIVE LOAD



TYPICAL APPLICATION

TYPICAL APPLICATION WITH TDF1778 TWO INDUCTIVE LOADS 2 A - 24 V



Load : L_C = 80 mH, R_C = 12 Ω
R_{max} = V_{CC}/1 mA

MAIN FEATURES

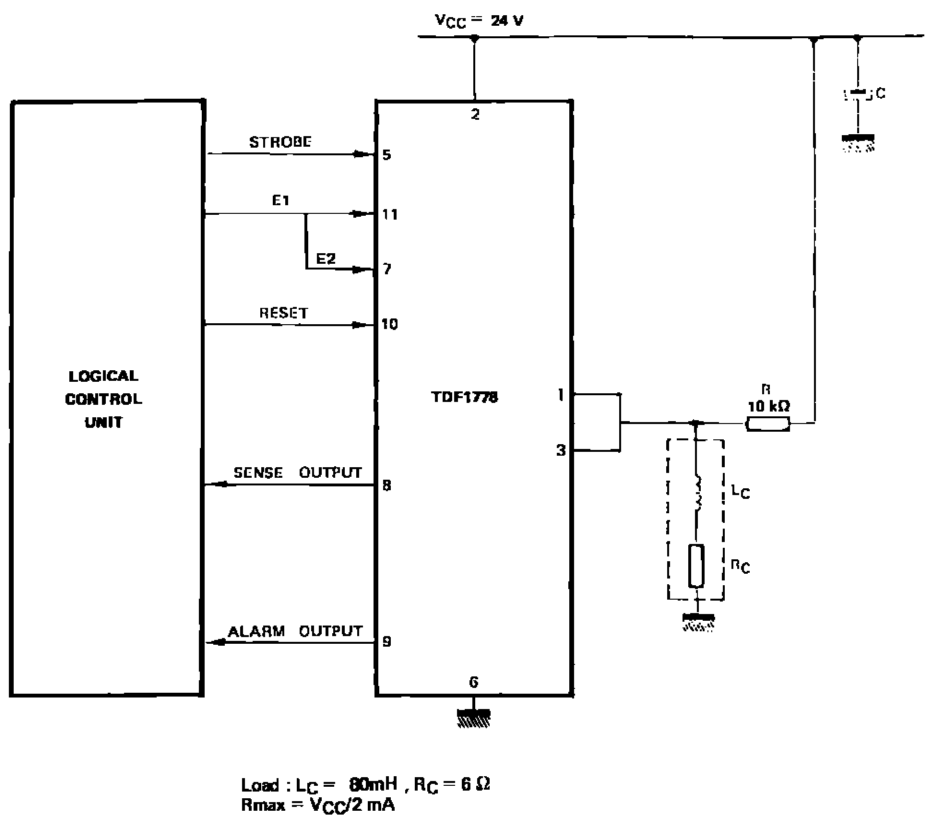
This application protected against short circuits.

The load disconnection is detected when inputs E1 and E2 are low and the sense output is high.

When thermal protection is activated the pin 9 is low.

Inputs and outputs are TTL comptable.

TDF1778 HIGH CURRENT APPLICATION WITH INDUCTIVE LOAD 24 V - 4 A



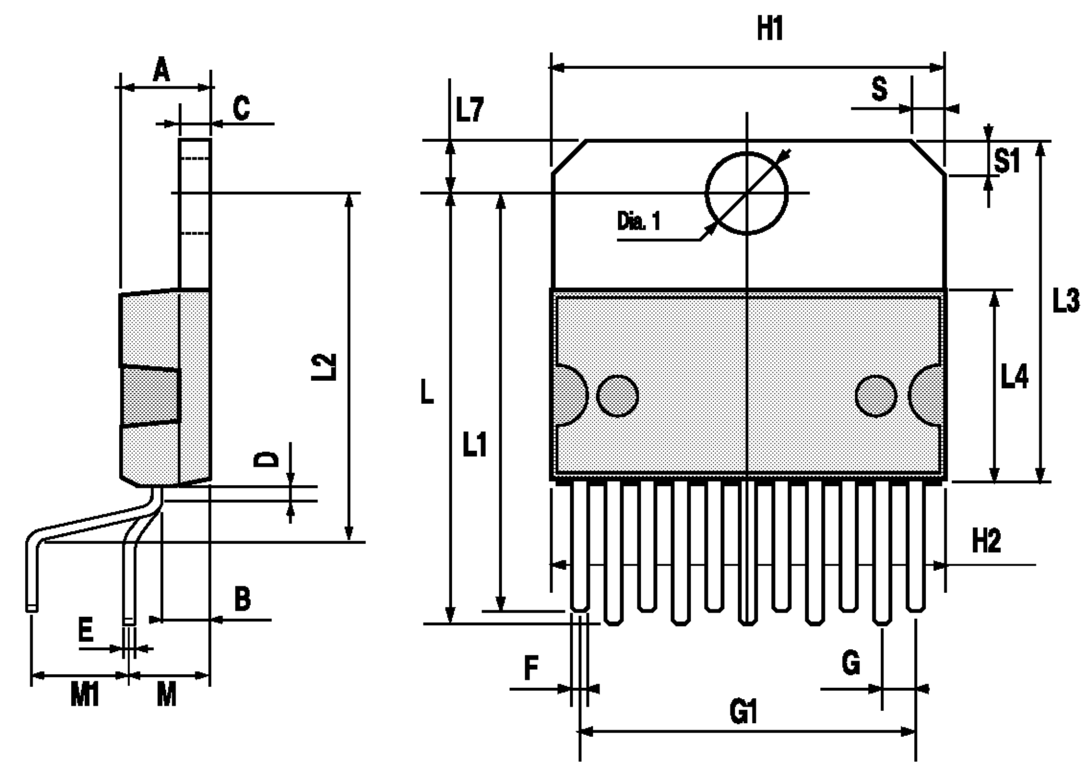
Load : L_C = 80 mH, T_C = 6 Ω
R_{max} = V_{CC}/2 mA

MAIN FEATURES

This application has the same features as the dual 2 A -12 V application.

MULTIWATT11 PACKAGE MECHANICAL DATA

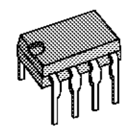
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.88		0.95	0.035		0.037
G	1.45	1.7	1.95	0.057	0.067	0.077
G1	16.75	17	17.25	0.659	0.669	0.679
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.87	0.886
L2	17.4		18.1	0.685		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.73	5.08	5.43	0.186	0.200	0.214
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152



TDE1798

0.5A INTELLIGENT POWER SWITCH

- HIGH OUTPUT CURRENT 500mA
- SHORT-CIRCUIT PROTECTION UP TO V_{CC} = +35V
- INTERNAL THERMAL PROTECTION WITH EXTERNAL RESET AND SYNCRONIZATION CAPABILITY
- OPEN GROUND PROTECTION
- OUTPUT VOLTAGE CAN BE LOWER THAN GROUND FOR FAST INDUCTIVE LOAD DE-MAGNETIZATION
- DIFFERENTIAL INPUTS FOR ANY LOGIC SYSTEM COMPATIBILITY
- INPUT VOLTAGE CAN BE HIGHER THAN V_{CC}
- LARGE SUPPLY VOLTAGE RANGE FROM 6V TO 35V
- SINK AND SOURCE ALARM OUTPUTS
- NO NEED FOR EXTERNAL CLAMPING DI-ODE FOR DEMAGNETIZATION ENERGY UP TO 150mJ
- SEVERAL DEVICES CAN BE CONNECTED IN PARALLEL



Minidip

ORDERING NUMBER: TDE1798DP

DESCRIPTION

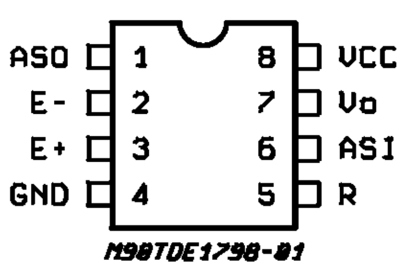
The TDE1798 is an interface circuit delivering high currents and capable of driving any type of loads.

The output is protected from short-circuits with the positive supply or ground. In addition thermal shut down is provided to keep the IC from over-heating. If internal dissipation becomes too high, the driver will shut down to prevent excessive heating. The output stays null after the overload is off, if the reset input is low. If high, the output will alternatively switch on and off until the overload is removed.

Higher current can be obtained by paralleling the outputs of several devices. In this case, the de-vices can be reactivated simultaneously after an overload if their reset input are connected in par-allel.

The device operates over a wide range of supply voltages from standard ±15 operational amplifier supplies to the single ±6V or +35V used for indus-trial electronic systems. Input voltage can be higher than the V_{CC}. The output is low in open ground conditions.

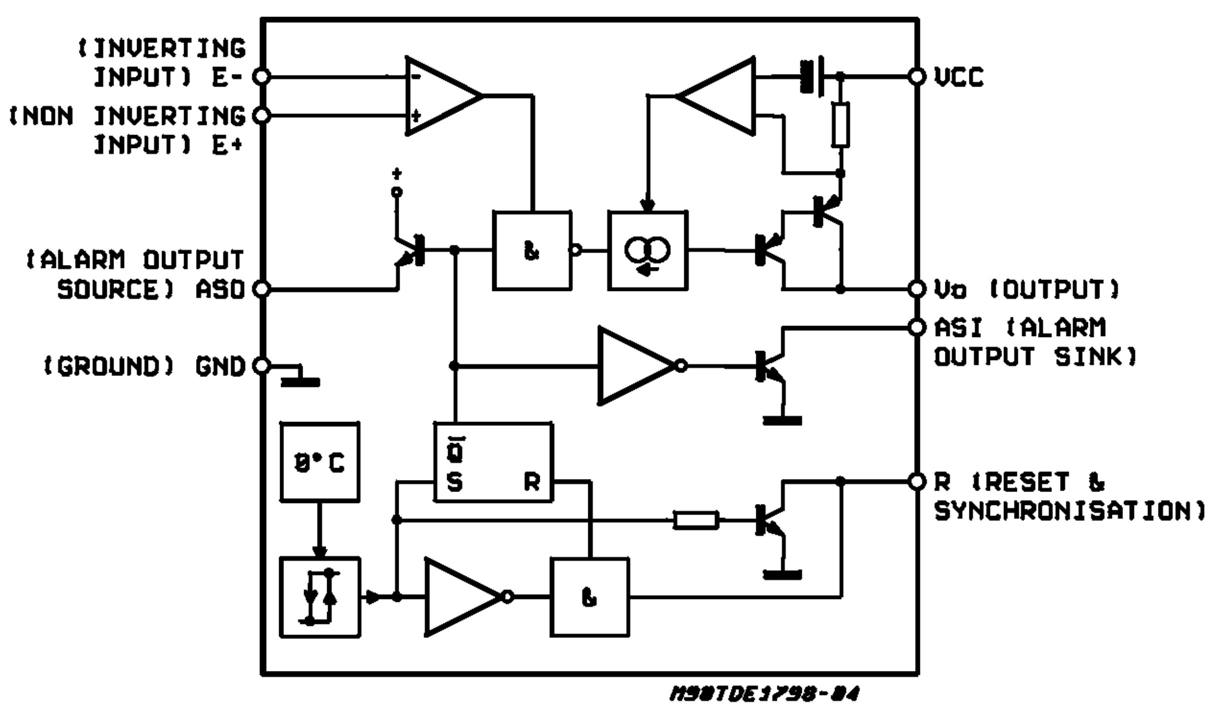
PIN CONNECTION (Top view)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Test Conditions	Unit
V_{CC}	Supply Voltage	50	V
V_{ID}	Input Differential Voltage	50	V
V_I	Input Voltage	-30 to +50	V
$V_{I(reset)}$	Reset Input Voltage	VCC -50 to V_{CC}	V
I_O	Output Current	internally limited	A
P_{tot}	Power Dissipation	Internally Limited	mW
	Reset Input Sink Current (in thermal shut-down)	15	mA
W_D	Repetitive Maximum Demagnetization Energy - 10^6 Operations	150	mJ
T_{op}	Operating Ambient Temperature Range	-25 to -85	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C
$I_{A(sink)}$	Alarm Output Sink Current	25	mA
$I_{A(source)}$	Alarm Output Source Current	12	mA

BLOCK DIAGRAM



THERMAL DATA

Symbol	Description		Value	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case (1)	max.	30	°C/W
$R_{th\ j\text{-}ambient}$	Thermal Resistance Junction-ambient (1)	max.	90	°C/W

1) Devices bounded on a 40cm^2 glass-epoxy printed circuit 0.15cm thick with 4cm^2 of copper

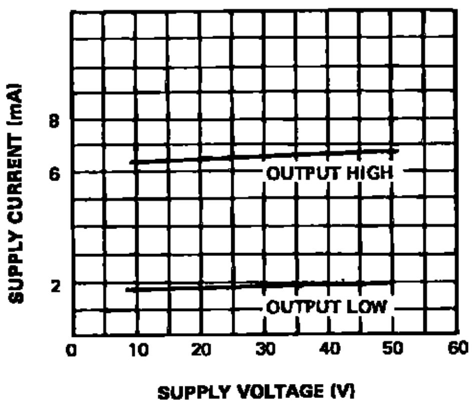
ELECTRICAL CHARACTERISTICS (note 2)

TDE -25°C ≤ T_j ≤ +85°C, 6V ≤ V_{CC} ≤ +35V, I_o ≤ 500mA (unless otherwise specified).

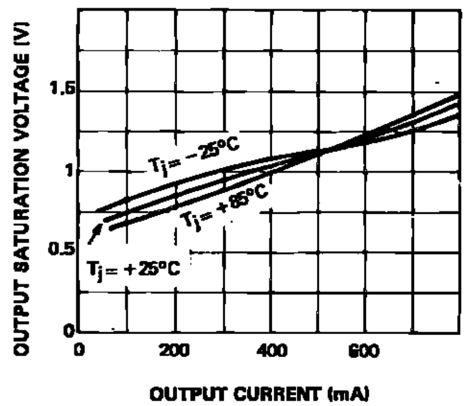
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{IO}	Input Offset Voltage	(note 3)	–	2	50	mV
I_{CC}	Power Supply Current	Output High (Tamb = +25°C, I_o = 500mA) Output Low	– –	6.5 2	8 4	mA mA
I_{IB}	Input Bias Current		–	15	40	μA
V_{ICR}	Common-mode Input Voltage Range	(note 4)	1	–	45	V
V_I	Input Voltage Range	V_{ref} > +1V, (note 4 and 5)	-25	–	45	V
I_{SC}	Short-circuit Output Current	V_{CC} = 30V, t = 10ms	0.7	0.9	1.3	A
V_{CC} - V_O	Output Saturation Voltage	I_O = 500mA (|V^+ I - V^- I|> 50mV)	–	1	1.25	V
I_{OL}	Output Low Leakage Current	T_j = +85°C (V_{CC} = 30V, V_O = 0V)	–	10	100	μA
$I_{(pin\ 1)\ source}$ $I_{(pin\ 6)\ sink}$	Available Alarm Output Current	Source ($V_{(pin\ 1)}$ = V_{CC} - 2.5V) Sink (in thermal shut-down) $V_{(pin\ 6)}$ = 2V	4 6	8 15	– –	mA mA
I_{RH} I_{RL}	Reset Input Current		– -1	15 0	40 +1	μA μA
V_{th}	Reset Threshold		0.8	1.4	2	V
I_{reset}	Reset Output Sink Current	(in thermal shut-down) for V_{reset} ≤ +0.8V	2	–	–	mA
$I_{OL(open\ GND)}$	Output Leakage Current	(open ground)	–	10	100	μA
V_{BRVEO}	Output Transistor Avalanche Volt.	V_{CC} - V_O	65	–	110	V

Notes:
2) For operating at high temperature, the TDE1798 must be derated based on a 150°C maximum junction temperature and the junction-ambient thermal resistance.
3) The offset voltage given is the maximum value of input differential voltage required to drive the output voltage within 2V of the ground or the supply voltage;
4) Input voltage range is independent of the supply voltage;
5) The reference input can be the inverting or the non-inverting one.

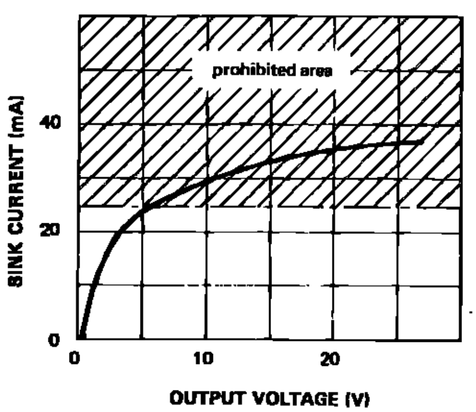
POWER SUPPLY CURRENT.



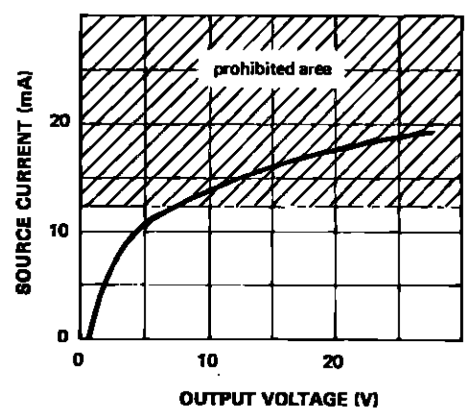
OUTPUT SATURATION VOLTAGE.



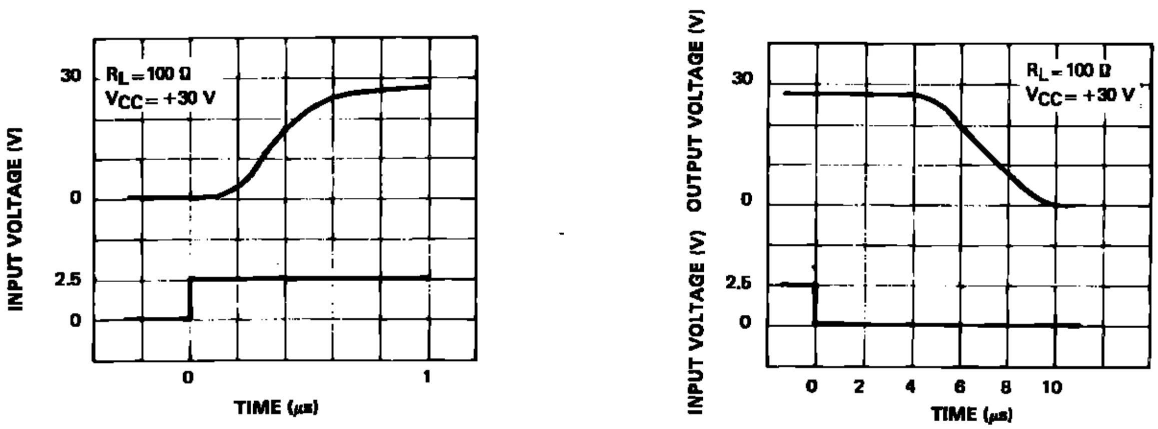
ALARM OUTPUT CURRENT SINK
(after thermal shut down).



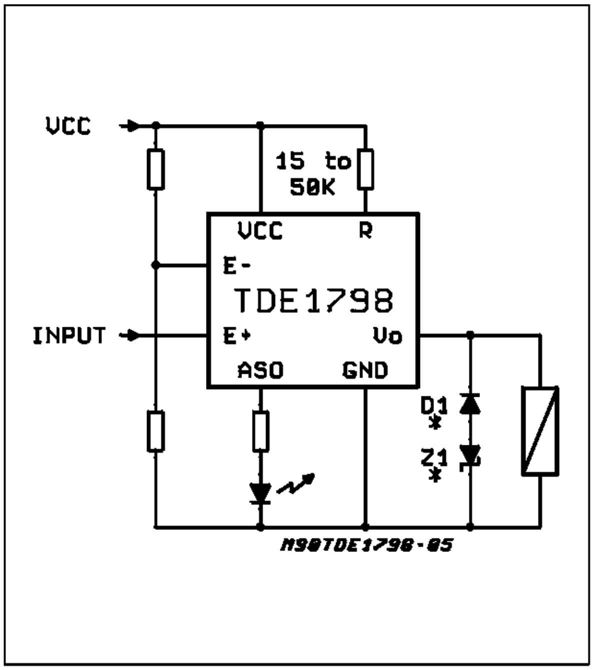
ALARM OUTPUT CURRENT SOURCE
(normal operation).



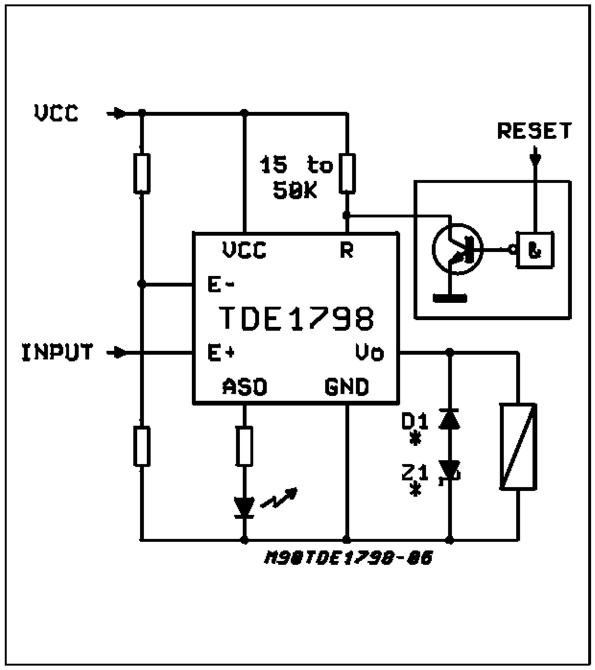
RESPONSE TIME.



TYPICAL APPLICATION AUTOMATIC RESET

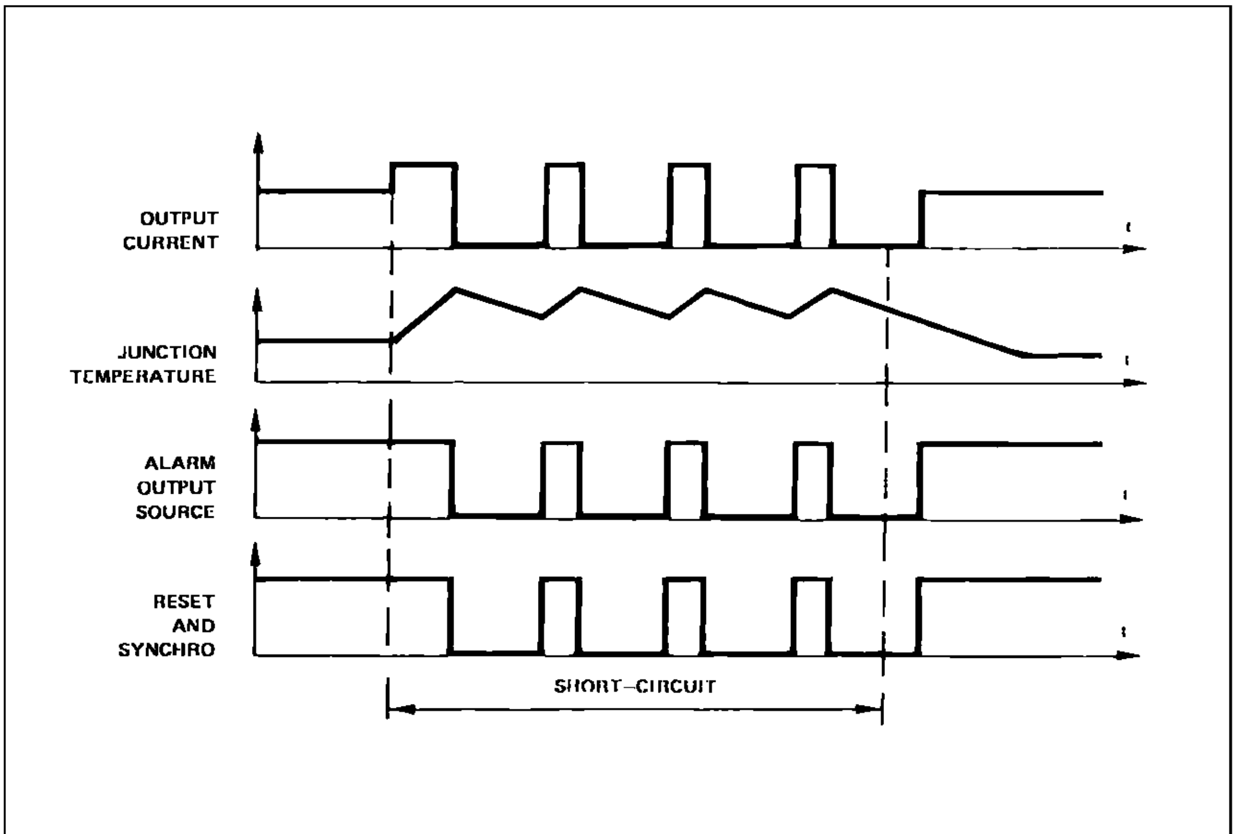


TYPICAL APPLICATION CONTROLLED RESET

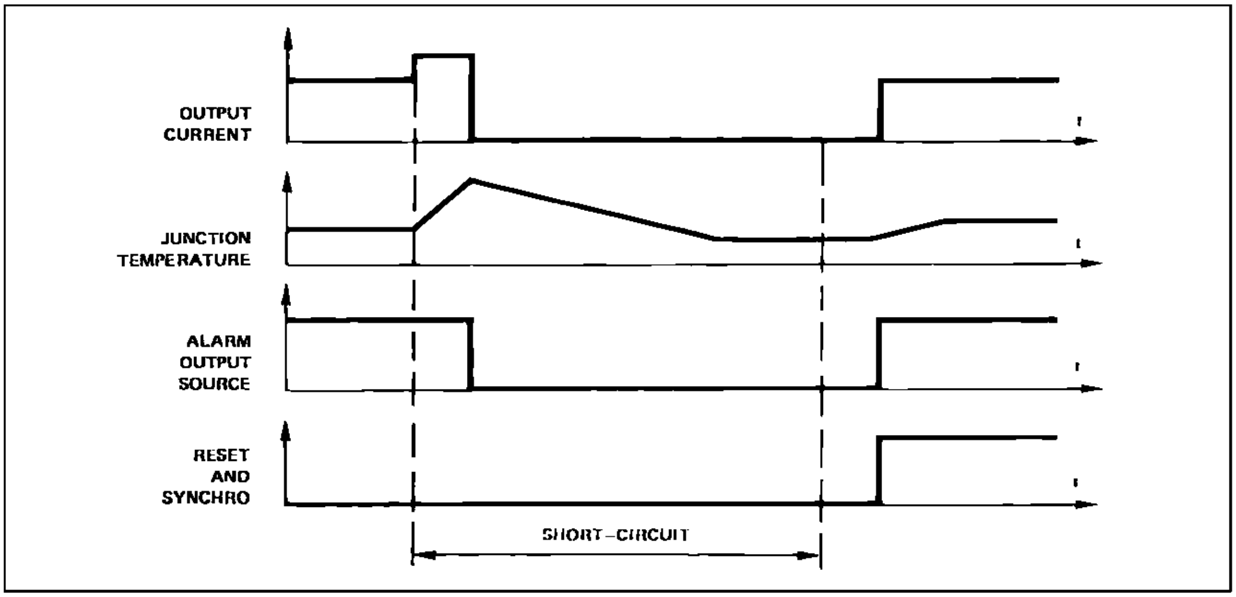


(*) D1 and Z1 needed if the demagnetization energy is higher than 150mJ

SHORT CIRCUIT CONDITIONS WITH AUTOMATIC RESET



SHORT CIRCUIT CONDITIONS WITH CONTROLLED RESET



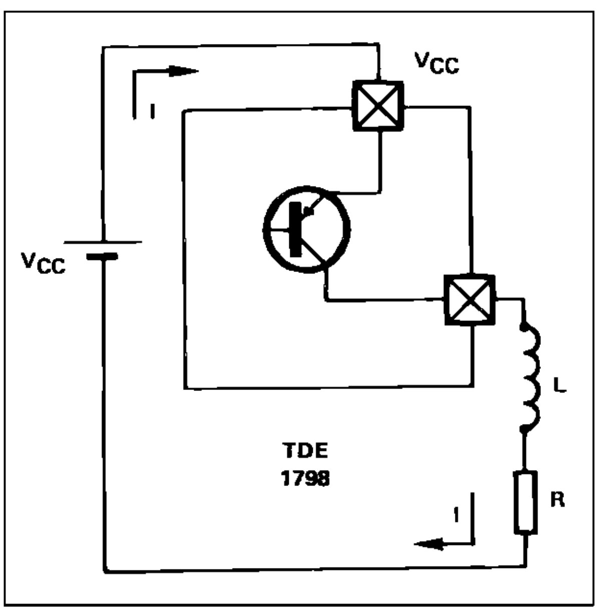
DEMAGNETIZATION OF INDUCTIVE LOADS WITHOUT EXTERNAL CLAMPING DEVICES.

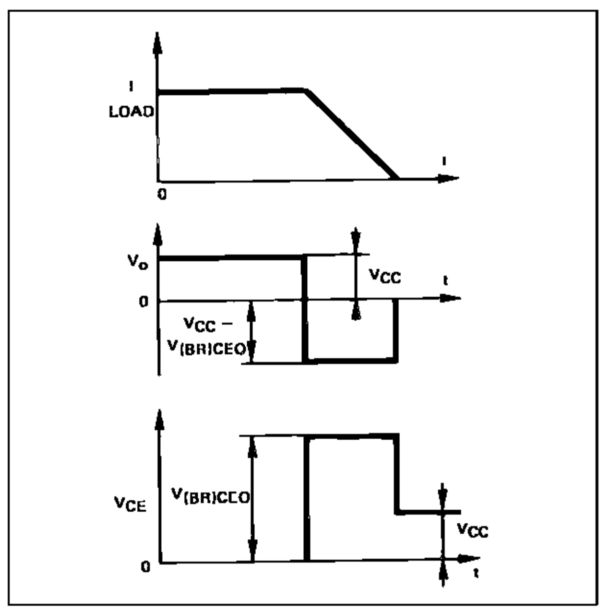
With no external clamping device, the energy of demagnetization is dissipated in the TDE1798 output stage, and the clamping voltage is the collector-emitter breakdown voltage $V_{(BR)CEO}$.

This method provides a very fast demagnetization of inductive loads and can be used up to 150 mJ.

The amount of energy W dissipated in the output stage during a demagnetization is :

$$W = V_{(BR)} \frac{L}{R} \left[I_o - \frac{V_{(BR)} - V_{CC}}{R} \operatorname{Log} \left(1 + \frac{V_{CC}}{V_{(BR)} - V_{CC}} \right) \right]$$

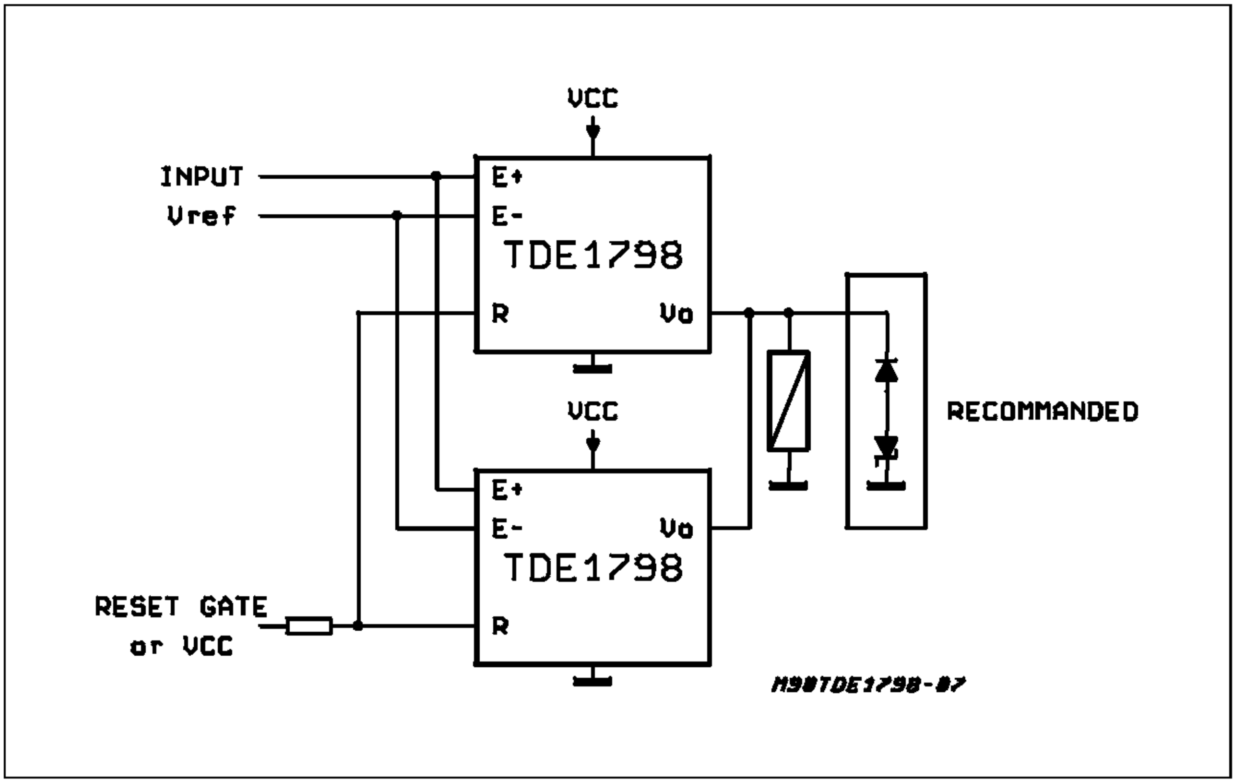




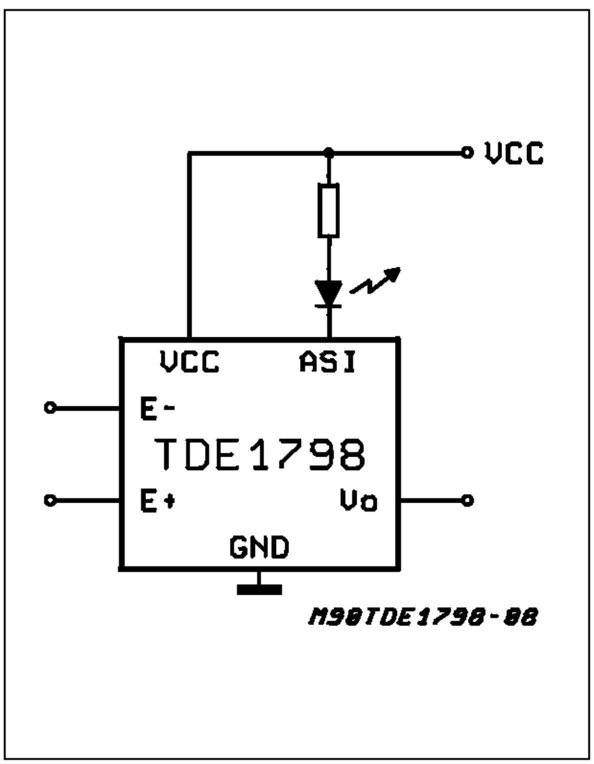
Remark 1 : This energy is dissipated inside the case, then must be included in the whole power dissipation.

Remark 2 : The use of external clamping device is recommended in case of parallel driving of loads. The dispersion of the collector-emitter breakdown voltage V(BR) would induce the circuit with the lowest V(BR) to dissipate the whole demagnetization energy (which is roughly proportionnal to I_O^2).

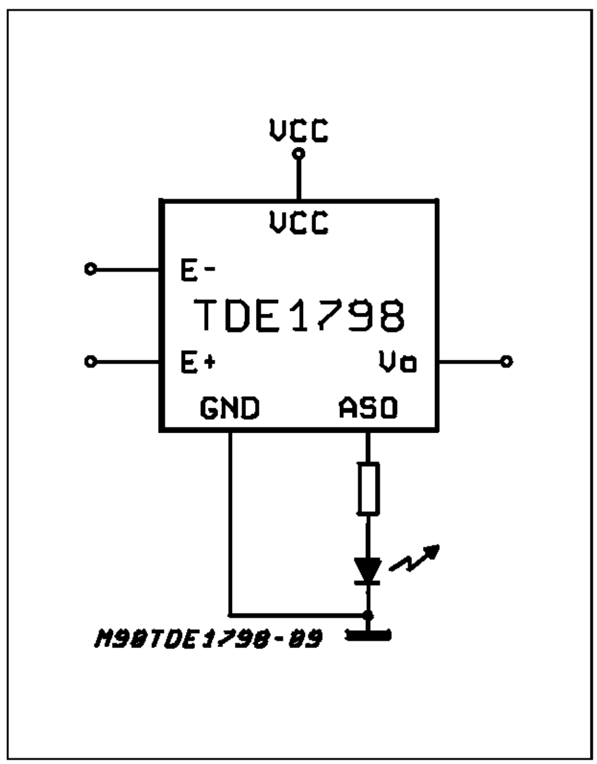
A 1 AMP. DRIVER (reset may be either automatic or controlled)



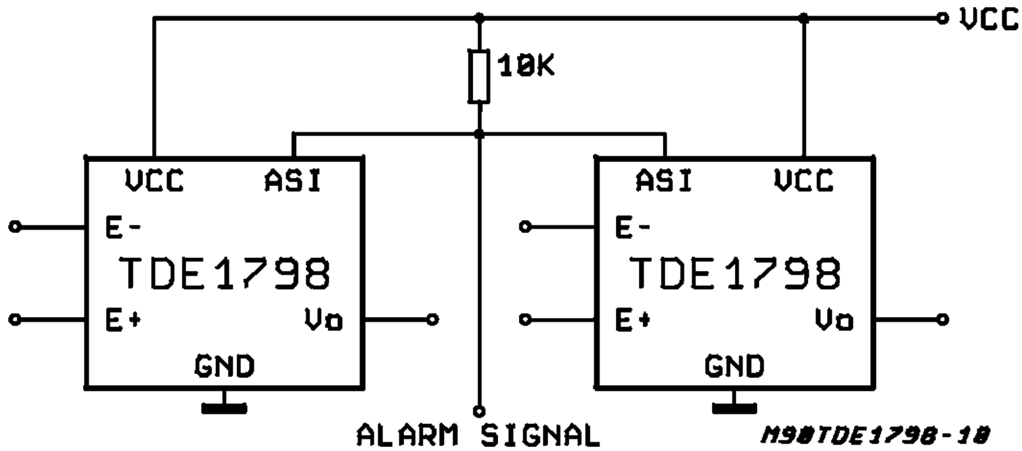
ALARM OUTPUT SINK



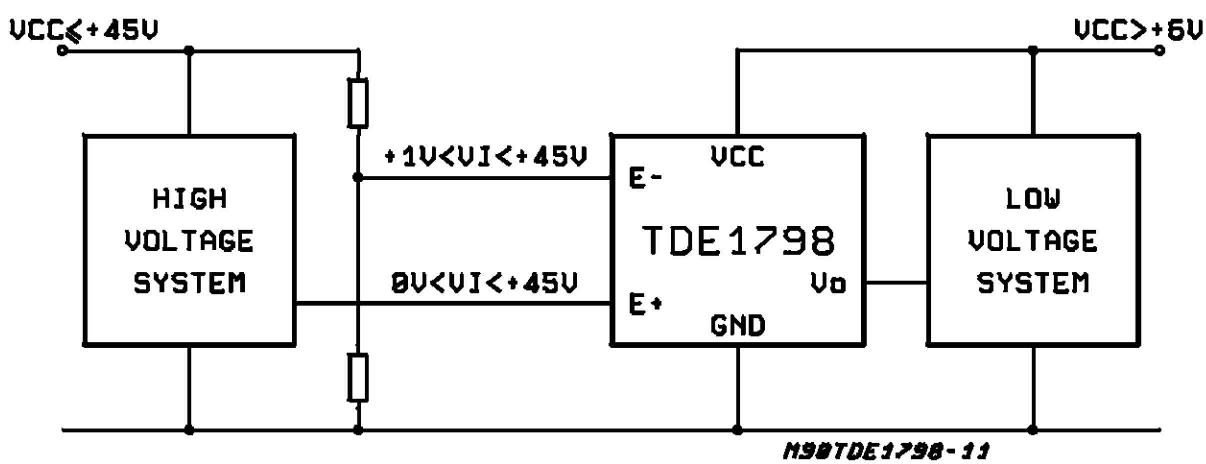
ALARM OUTPUT SOURCE



PARALLEL ALARM OUTPUTS



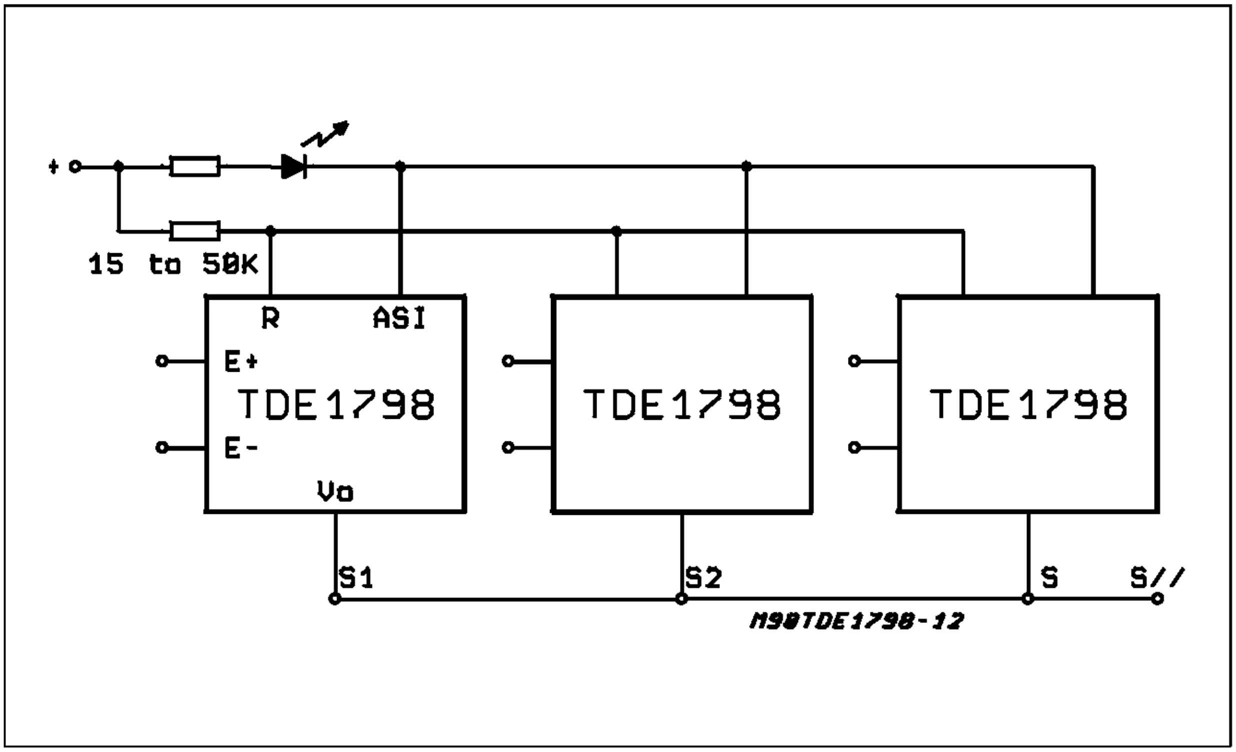
INTERFACE BETWEEN HIGH VOLTAGE AND LOW VOLTAGE SYSTEM



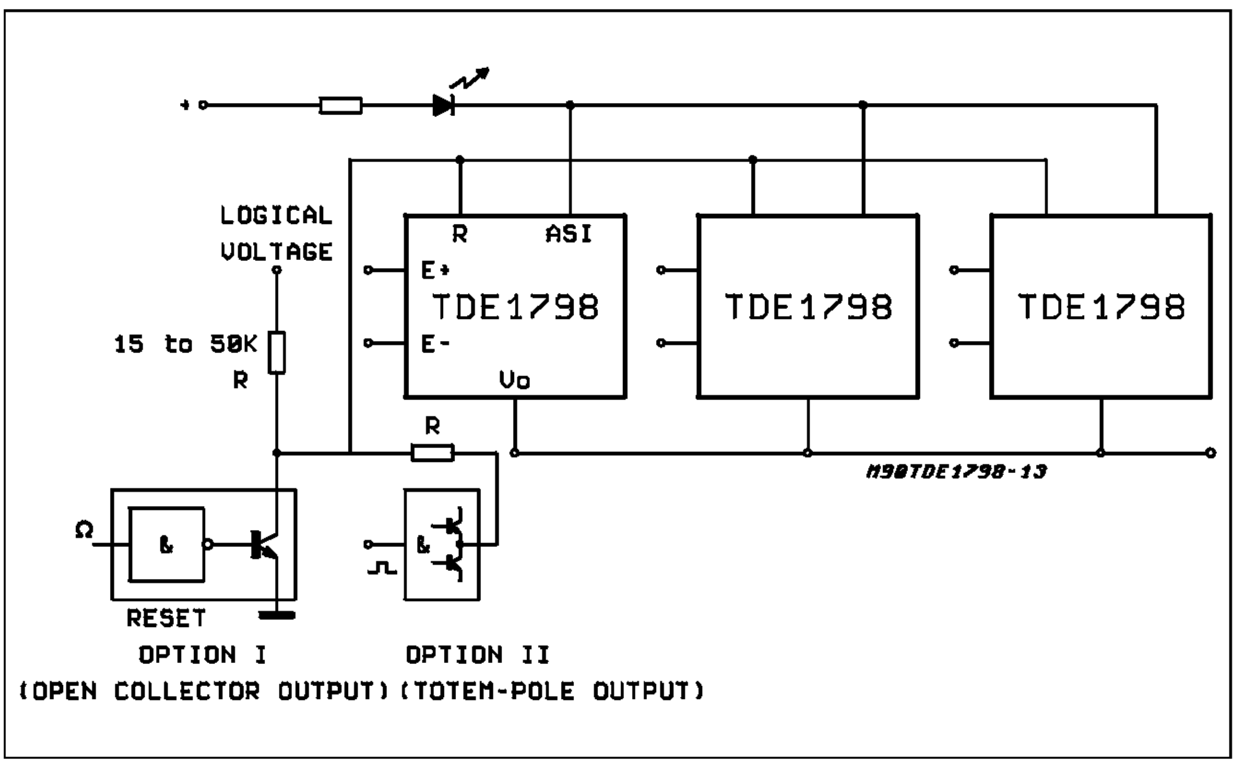
RESET AND SYNCHRONIZATION

Recommended diagram when the outputs are in parallel. After thermal disjunction a restart is possible when all the circuits are returned in operating conditions.

SYNCRONOUS AUTOMATIC RESET (parallel or independentoutputs)



SYNCHRONOUS CONTROLLED RESET (parallel or idependentoutputs)

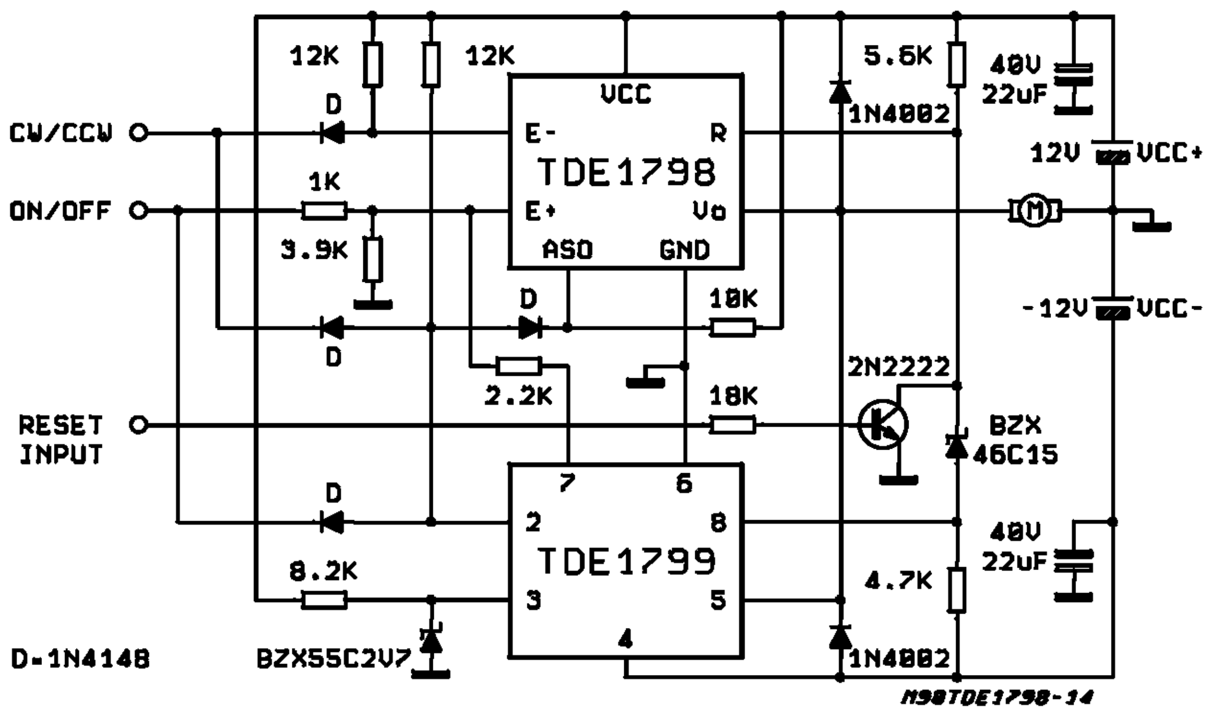


TWO QUADRANTS D.C. MOTOR DRIVE

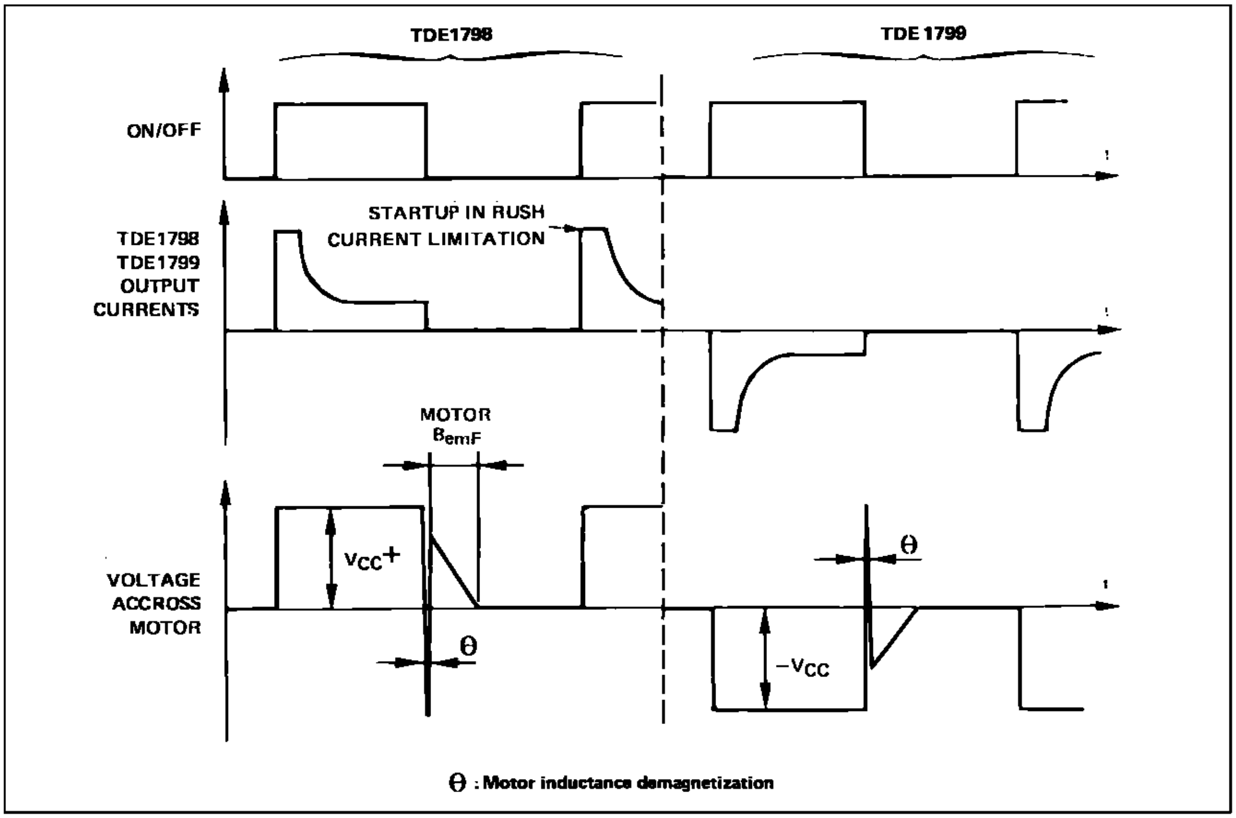
MAIN FEATURES

- V_{CC} - $V_{CC} \leq 50V$
- Maximum output current 0.5A
- Full protection against overloads and short-circuits
- No need of deadtime during rotation reversing
- TTL compatible inputs
- TDE1799 and TDE1798 input signals have the same reference
- No automatic restart after disjunction

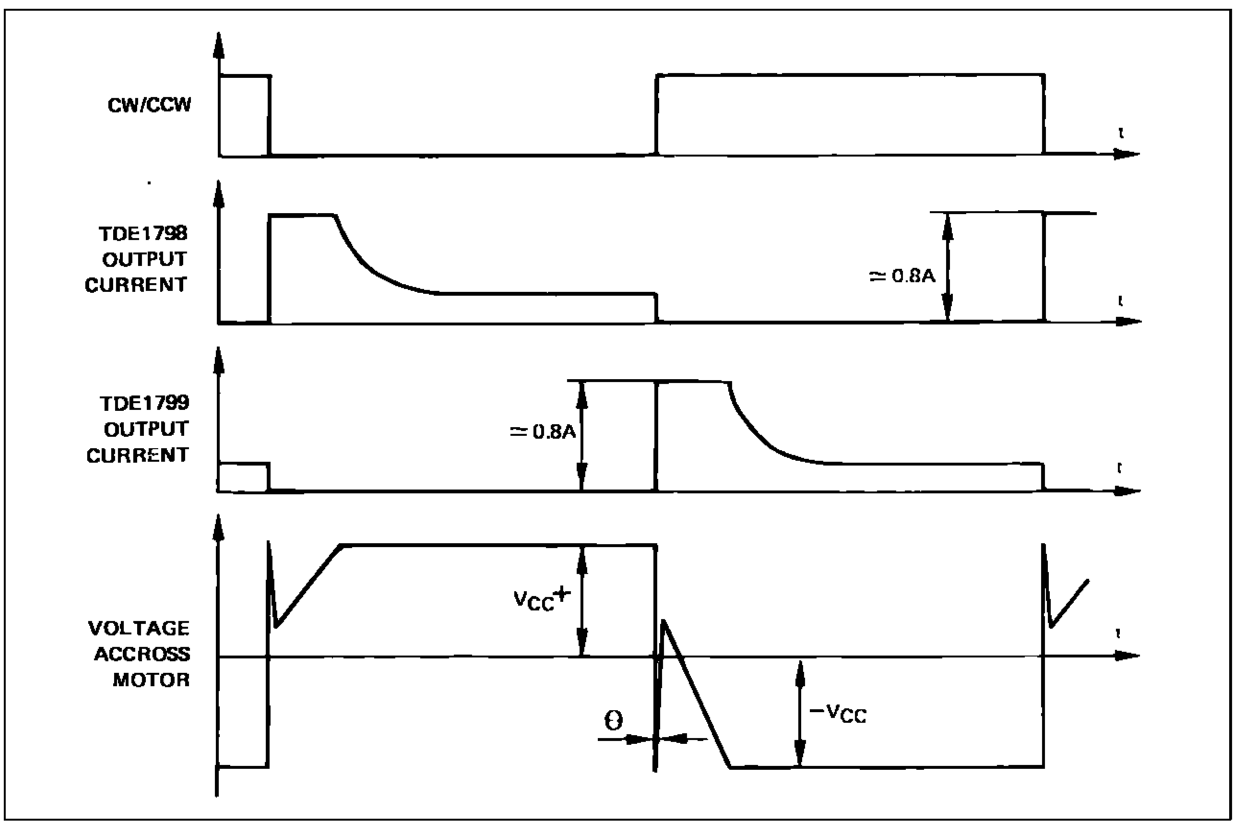
CW/CCW	ON PFF	1798	1799
0	0	OFF	OFF
0	1	ON	OFF
1	1	OFF	ON
1	0	OFF	OFF



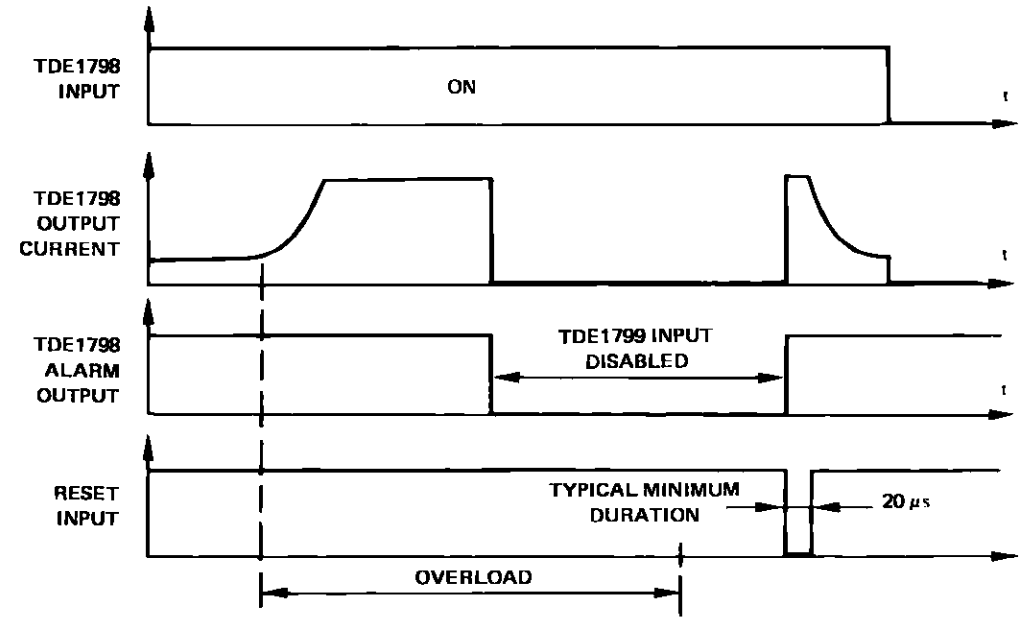
ON/OFF CYCLES



ROTATION REVERSING



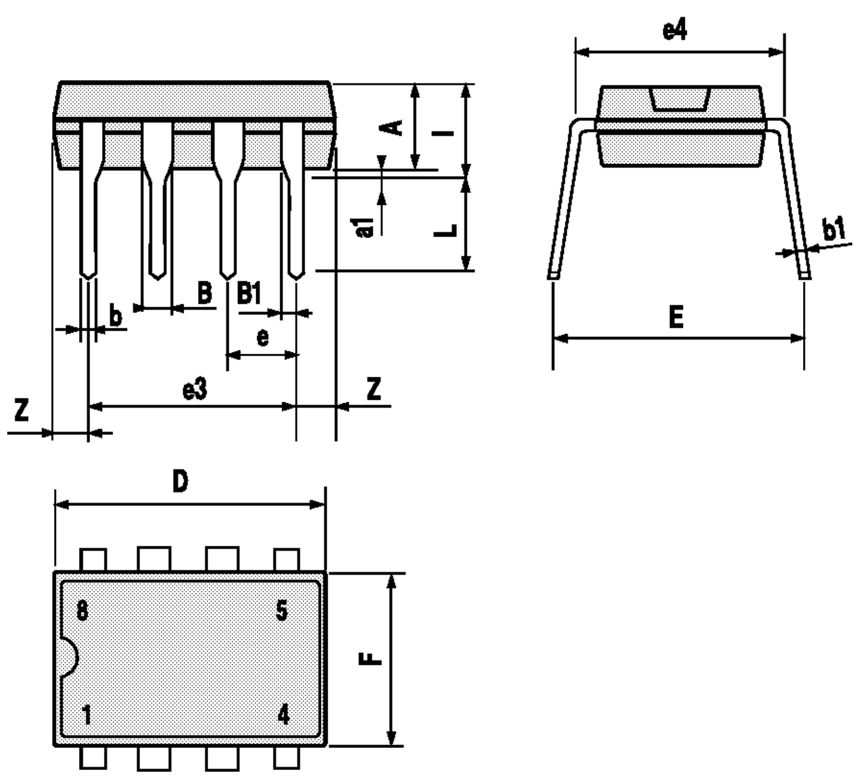
OVERLOAD CONDITIONS



* For instance overload during TDE1798 operation

MINIDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
I			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060



SGS-THOMSON Microelectronics GROUP OF COMPANIES

Australia - Brazil - France - Germany - Hong Kong - Italy - Japan - Korea - Malaysia - Malta - Morocco - The Netherlands - Singapore - Spain - Sweden - Switzerland - Taiwan - Thaliand - United Kingdom - U.S.A.

![SGS-THOMSON MICROELECTRONICS]

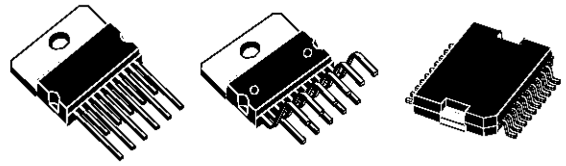
TDE1890
TDE1891

2A HIGH-SIDE DRIVER
INDUSTRIAL INTELLIGENT POWER SWITCH

PRELIMINARY DATA

- 2A OUTPUT CURRENT
- 18V TO 35V SUPPLY VOLTAGE RANGE
- INTERNAL CURRENT LIMITING
- THERMAL SHUTDOWN
- OPEN GROUND PROTECTION
- INTERNAL NEGATIVE VOLTAGE CLAMPING TO V_S - 50V FOR FAST DEMAGNETIZATION
- DIFFERENTIAL INPUTS WITH LARGE COMMON MODE RANGE AND THRESHOLD HYSTERESIS
- UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- OPEN LOAD DETECTION
- TWO DIAGNOSTIC OUTPUTS
- OUTPUT STATUS LED DRIVER

MULTIPOWER BCD TECHNOLOGY



MULTIWATT11 (In line) MULTIWATT11V PowerSO20

ORDERING NUMBERS:

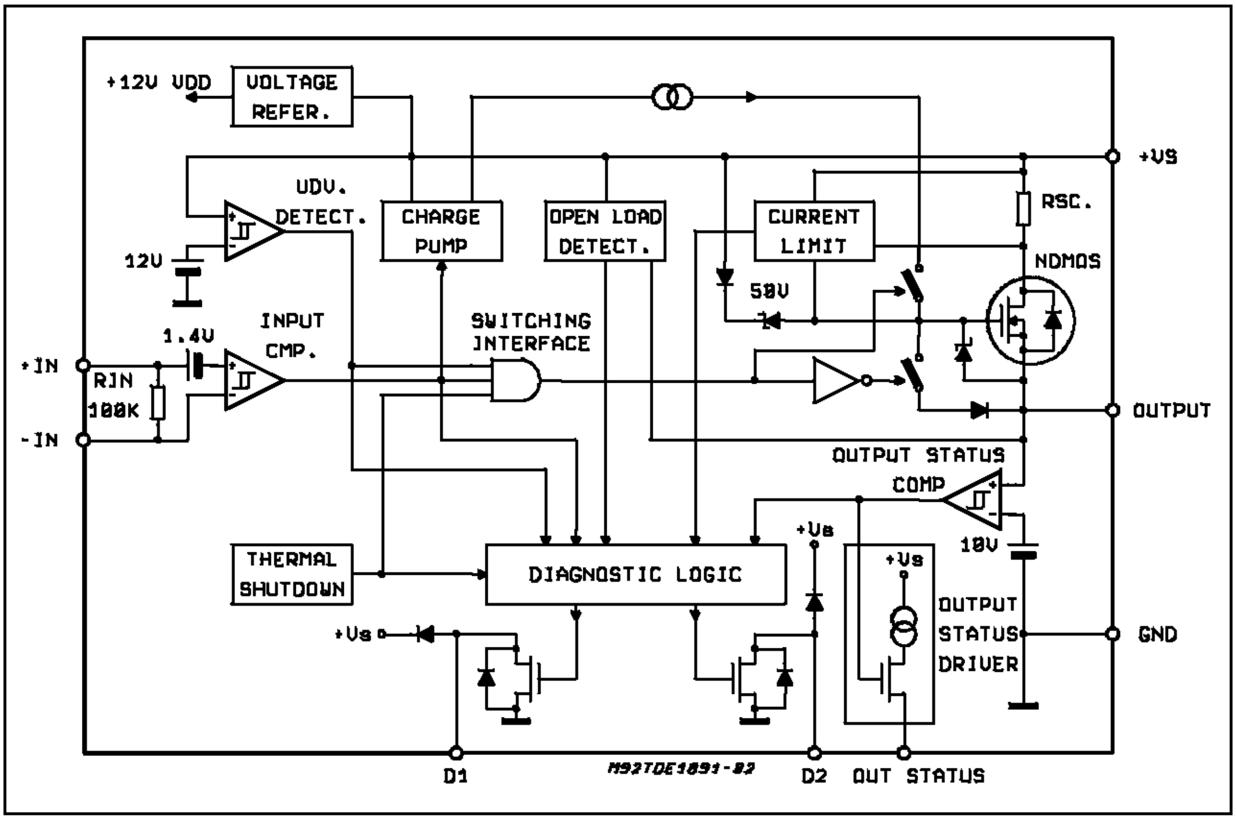
TDE1890L	TDE1890V	TDE1890D
TDE1891L	TDE1891V	TDE1891D

DESCRIPTION

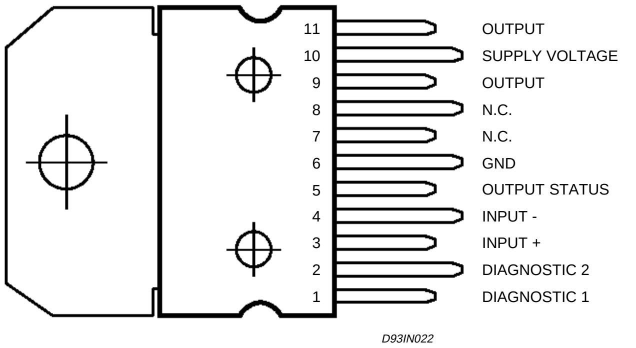
The TDE1890/1891 is a monolithic Intelligent Power Switch in Multipower BCD Technology, for driving inductive or resistive loads. An internal Clamping Diode enables the fast demagnetization of inductive loads.

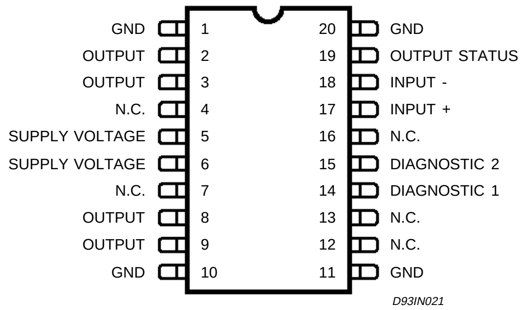
Diagnostic for CPU feedback and extensive use of electrical protections make this device extremely rugged and specially suitable for industrial automation applications.

BLOCK DIAGRAM



PIN CONNECTION (Top view)





Note: Output pins must be must be connected externally to the package to use all leads for the output current (Pin 9 and 11 for Multiwatt package, Pin 2, 3, 8 and 9 for PowerSO20 package).

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage (Pin 10) (T_W < 10ms)	50	V
$V_S – V_O$	Supply to Output Differential Voltage. See also V_{CI} (Pins 10 - 9)	internally limited	V
V_i	Input Voltage (Pins 3/4)	-10 to V_S +10	V
V_i	Differential Input Voltage (Pins 3 - 4)	43	V
I_i	Input Current (Pins 3/4)	20	mA
I_O	Output Current (Pin 9). See also ISC (Pin 9)	internally limited	A
P_{tot}	Power Dissipation. See also THERMAL CHARACTERISTICS.	internally limited	W
T_{op}	Operating Temperature Range (T_{amb})	-25 to +85	°C
T_{stg}	Storage Temperature	-55 to 150	°C
E_I	Energy Induct. Load T_J = 85°C	1	J

THERMAL DATA

Symbol	Description		Multiwatt	PowerSO20	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max.	1.5	1.5	ÉC/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	35	–	ÉC/W

ELECTRICAL CHARACTERISTICS (V_S = 24V; T_{amb} = –25 to +85°C, unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{smin}	Supply Voltage for Valid Diagnostics	I_{diag} > 0.5mA ; V_{dg1} = 1.5V	9		35	V
V_s	Supply Voltage (operative)		18	24	35	V
I_q	Quiescent Current $I_{out} = I_{os} = 0$	V_{il} V_{ih}		3 5	7 8	mA mA
V_{sth1}	Undervoltage Threshold 1	(See fig. 1), Tamb = 0 to +85°C	11			V
V_{sth2}	Undervoltage Threshold 2				15.5	V
V_{shys}	Supply Voltage Hysteresis			1		V
I_{sc}	Short Circuit Current	V_S = 18 to 35V; $R_L = 2\Omega$	2.6		5	A
V_{don}	Output Voltage Drop	I_{out} = 2.0A T_j = 25°C T_j = 125°C I_{out} = 2.5A T_j = 25°C T_j = 125°C		360 575 440 700	500 800 575 920	mV mV mV mV
I_{oslk}	Output Leakage Current	$V_i = V_{il}$; V_o = 0V			500	µA
V_{ol}	Low State Out Voltage	$V_i = V_{il}$; $R_L = \infty$		0.8	1.5	V
V_{cl}	Internal Voltage Clamp (V_S - V_O)	I_O = 1A Single Pulsed: Tp = 300µs	48	53	58	V
I_{old}	Open Load Detection Current	$V_i = V_{ih}$; T_{amb} = 0 to +85°C	0.5		9.5	mA
V_{id}	Common Mode Input Voltage Range (Operative)	V_S = 18 to 35V, V_S - V_{id} < 37V	–7		15	V
I_{ib}	Input Bias Current	V_i = –7 to 15V; –In = 0V	–250		250	µA
V_{ith}	Input Threshold Voltage	V+In > V–In	0.8	1.4	2	V
V_{iths}	Input Threshold Hysteresis Voltage	V+In > V–In	50		400	mV
R_{id}	Diff. Input Resistance	0 < +In < +16V ; –In = 0V –7 < +In < 0V ; –In = 0V		400 150		KΩ KΩ
I_{ilk}	Input Offset Current	V+In = V–In +Ii 0V < V_i <5.5V –Ii	–20 –75	 –25	+20	µA µA
		–In = GND +Ii 0V < V+In <5.5V –Ii	 –250	+10 –125	+50	µA µA
		+In = GND +Ii 0V < V–In <5.5V –Ii	–100 –50	–30 –15		µA µA
V_{oth1}	Output Status Threshold 1 Voltage	(See fig. 1)			11.5	V
V_{oth2}	Output Status Threshold 2 Voltage	(See fig. 1)	8.5			V
V_{ohys}	Output Status Threshold Hysteresis	(See fig. 1)		0.7		V
I_{osd}	Output Status Source Current	$V_{out} > V_{oth1}$; V_{os} = 2.5V	2		4	mA
V_{osd}	Active Output Status Driver Drop Voltage	$V_S - V_{os}$; I_{os} = 2mA T_{amb} = -25 to +85°C			5	V
I_{oslk}	Output Status Driver Leakage Current	$V_{out} < V_{oth2}$; V_{os} = 0V V_S = 18 to 35V			25	µA
V_{dgl}	Diagnostic Drop Voltage	D1 / D2 = L ; I_{diag} = 0.5mA D1 / D2 = L ; I_{diag} = 3mA			250 1.5	mV V
I_{dglk}	Diagnostic Leakage Current	D1 / D2 =H ; 0 < Vdg < V_s V_S = 15.6 to 35V			25	µA
V_{fdg}	Clamping Diodes at the Diagnostic Outputs. Voltage Drop to V_S	Idiag = 5mA; D1 / D2 = H			2	V

Note $V_{il} \leq 0.8V$, $V_{ih} \geq 2V$ @ (V+In > V–In)

SOURCE DRAIN NDMOS DIODE

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{fsd}	Forward On Voltage	@ Ifsd = 2.5A		1	1.5	V
I_{fp}	Forward Peak Current	t = 10ms; d = 20%			6	A
t_{rr}	Reverse Recovery Time	If = 2.5A di/dt = 25A/µs		200		ns
t_{fr}	Forward Recovery Time			100		ns

THERMAL CHARACTERISTICS

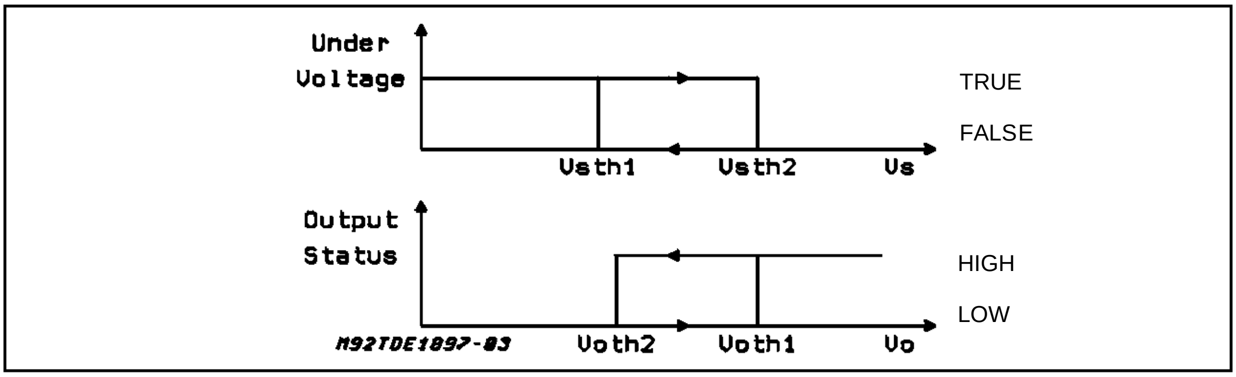
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Ø Lim	Junction Temp. Protect.		135	150		°C
T_H	Thermal Hysteresis			30		°C

SWITCHING CHARACTERISTICS (V_S = 24V; R_L = 12Ω)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
t_{on}	Turn on Delay Time				200	µs
t_{off}	Turn off Delay Time				40	µs
t_d	Input Switching to Diagnostic Valid				200	µs

Note Vil ≤ 0.8V, Vih ≥ 2V @ (V+In > V–In)

Figure 1



DIAGNOSTIC TRUTH TABLE

Diagnostic Conditions		Input	Output	Diag1	Diag2
Normal Operation		L H	L H	H H	H H
Open Load Condition ($I_o < I_{old}$)		L H	L H	H L	H H
Short to V_S		L H	H H	L L	H H
Short Circuit to Ground ($I_O = I_{SC}$) (**)	**TDE1891**	H	<H (*)	H	L
	TDE1890	H	H L	H H	H H
Output DMOS Open		L H	L L	H L	H H
Overtemperature		L H	L L	H H	L L
Supply Undervoltage ($V_S < V_{sth2}$)		L H	L L	L L	L L

(*) According to the intervention of the current limiting block.
(**) A cold lamp filament, or a capacitive load may activate the current limiting circuit of the IPS, when the IPS is initially turned on. TDE1891 uses Diag2 to signal such condition, TDE1890 does not.

APPLICATION INFORMATION

DEMAGNETIZATION OF INDUCTIVE LOADS

An internal zener diode, limiting the voltage across the Power MOS to between 50 and 60V (V_{cl}), provides safe and fast demagnetization of inductive loads without external clamping devices.

The maximum energy that can be absorbed from an inductive load is specified as 1J (at $T_j = 85°C$).

To define the maximum switching frequency three points have to be considered:

1) The total power dissipation is the sum of the On State Power and of the Demagnetization Energy multiplied by the frequency.
2) The total energy W dissipated in the device during a demagnetization cycle (figg. 2, 3) is:

$$W = V_{cl} \frac{L}{R_L}\left[I_o - \frac{V_{cl} - V_s}{R_L} \log\left(1 + \frac{V_s}{V_{cl} - V_s}\right)\right]$$

Where:
V_{cl} = clamp voltage;
L = inductive load;
R_L = resistive load;
Vs = supply voltage;
$I_O = I_{LOAD}$

3) In normal conditions the operating Junction temperature should remain below 125°C.

If the demagnetization energy exceeds the rated value, an external clamp between output and $+V_S$ must be externally connected (see fig. 5).

The external zener will be chosen with V_{zener} value lower than the internal V_{cl} minimum rated value and significantly (at least 10V) higher than the voltage that is externally supplied to pin 10, i.e. than the supply voltage.

Alternative circuit solutions can be implemented to divert the demagnetization stress from the TDE1890/1, if it exceeds 1J. In all cases it is recommended that at least 10V are available to demagnetize the load in the turn-off phase.

A clamping circuit connected between ground and the output pin is not recommended. An interruption of the connection between the ground of the load and the ground of the TDE1890/1 would leave the TDE1890/1 alone to absorb the full amount of the demagnetization energy.

Figure 2: Inductive Load Equivalent Circuit

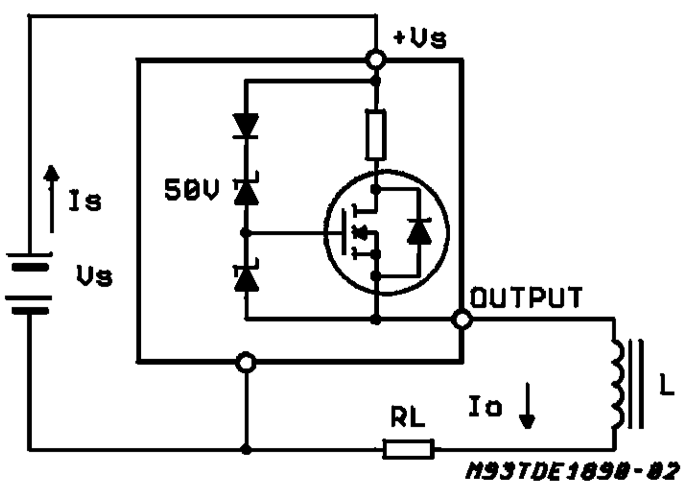


Figure 3: Demagnetization Cycle Waveforms

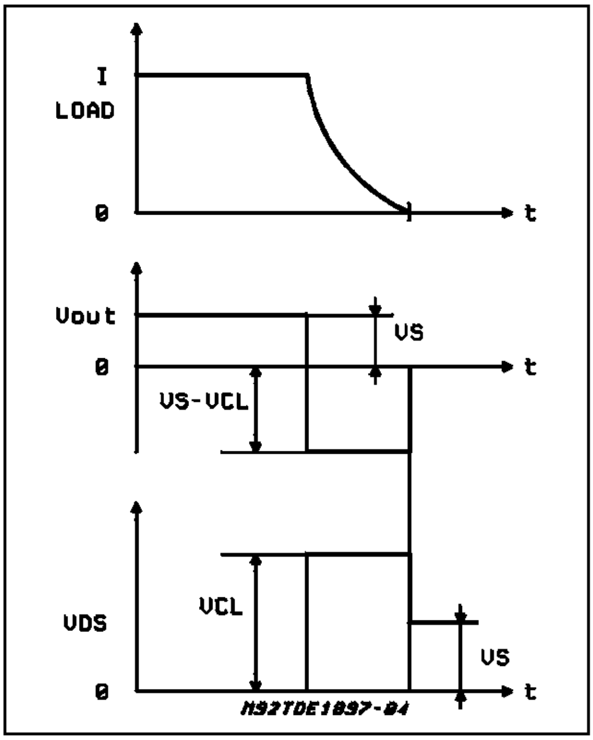


Figure 4: Normalized R_{DSON} vs. Junction Temperature

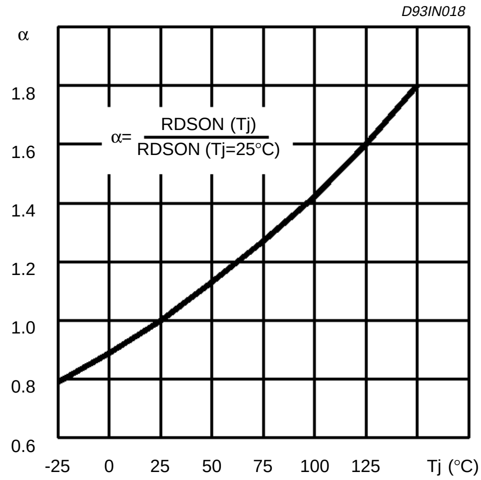
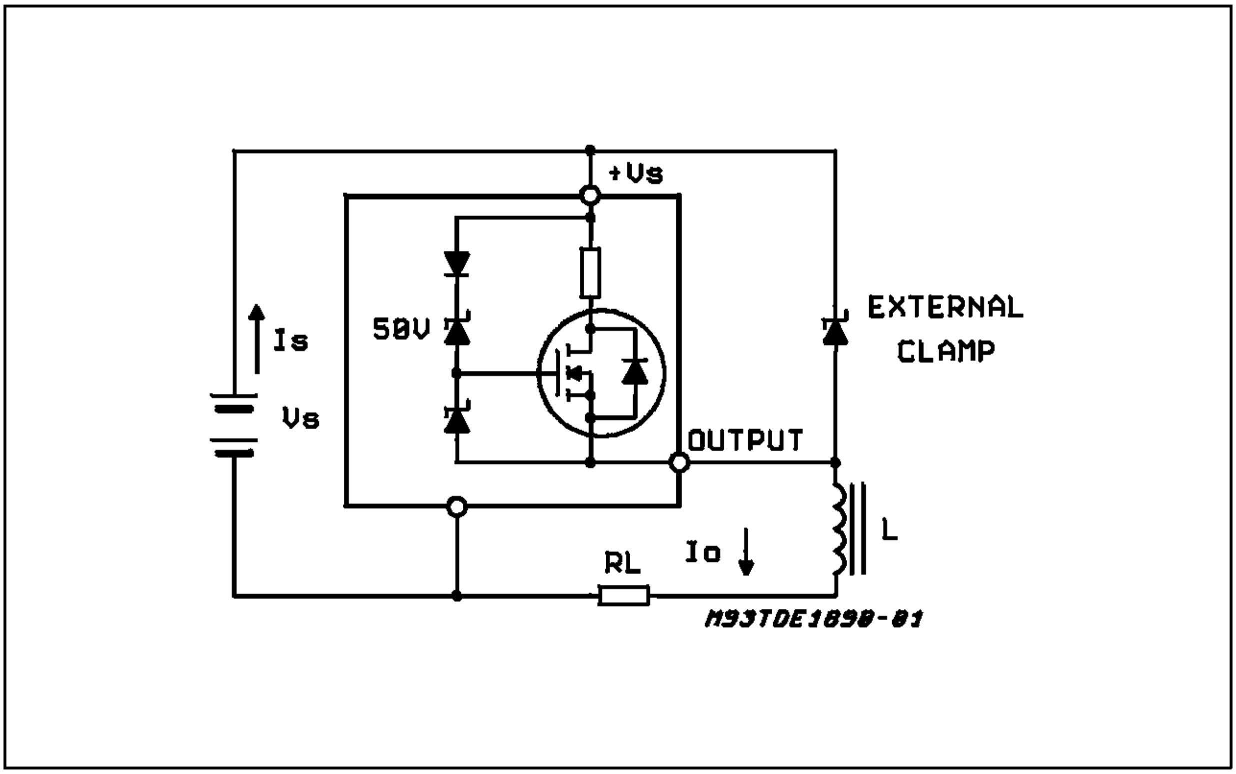


Figure 5.



WORST CONDITION POWER DISSIPATION IN THE ON-STATE

In IPS applications the maximum average power dissipation occurs when the device stays for a long time in the ON state. In such a situation the internal temperature depends on delivered current (and related power), thermal characteristics of the package and ambient temperature.

At ambient temperature close to upper limit (+85°C) and in the worst operating conditions, it is possible that the chip temperature could increase so much to make the thermal shutdown procedure untimely intervene.

Our aim is to find the maximum current the IPS can withstand in the ON state without thermal shutdown intervention, related to ambient temperature. To this end, we should consider the following points:

1) The ON resistance R_{DSON} of the output NDMOS (the real switch) of the device increases with its temperature.
   Experimental results show that silicon resistivity increases with temperature at a constant rate, rising of 60% from 25°C to 125°C.
   The relationship between R_{DSON} and temperature is therefore:

   $$R_{DSON} = R_{DSON0} (1 + k)^{(T_j \pm 25)}$$

   where:
   T_j is the silicon temperature in °C
   R_{DSON0} is R_{DSON} at T_j=25°C
   k is the constant rate ($k = 4.711 \cdot 10^{\pm 3}$)
   (see fig. 4).

2) In the ON state the power dissipated in the device is due to three contributes:

a) power lost in the switch:
   $P_{out} = I_{out}^{2} \cdot R_{DSON}$ (I_{out} is the output current);

b) power due to quiescent current in the ON state Iq, sunk by the device in addition to I_{out}: $P_q = I_q \cdot V_s$ (V_s is the supply voltage);

c) an external LED could be used to visualize the switch state (OUTPUT STATUS pin). Such a LED is driven by an internal current source (delivering I_{os}) and therefore, if V_{os} is the voltage drop across the LED, the dissipated power is: $P_{os} = I_{os} \cdot (V_s \pm V_{os})$.

   Thus the total ON state power consumption is given by:

$$P_{on} = P_{out} + P_q + P_{os} \qquad (1)$$

In the right side of equation 1, the second and the third element are constant, while the first one increases with temperature because R_{DSON} increases as well.

3) The chip temperature must not exceed ΘLim in order do not lose the control of the device.
   The heat dissipation path is represented by the thermal resistance of the system device-ambient (R_{th}). In steady state conditions, this parameter relates the power dissipated P_{on} to the silicon temperature T_j and the ambient temperature T_{amb}:

$$T_j \pm T_{amb} = P_{on} \cdot R_{th} \qquad (2)$$

From this relationship, the maximum power P_{on} which can be dissipated without exceeding ΘLim at a given ambient temperature T_{amb} is:

$$P_{on} = \frac{\Theta Lim \pm T_{amb}}{R_{th}}$$

Replacing the expression (1) in this equation and solving for I_{out}, we can find the maximum current versus ambient temperature relationship:

$$I_{outx} = \sqrt{\frac{\frac{\Theta Lim \pm T_{amb}}{R_{th}} \pm P_q \pm P_{os}}{R_{DSONx}}}$$

where R_{DSONx} is R_{DSON} at T_j=ΘLim. Of course, I_{outx} values are top limited by the maximum operative current I_{outx} (2A nominal).
From the expression (2) we can also find the maximum ambient temperature T_{amb} at which a given power P_{on} can be dissipated:

$$T_{amb} = \Theta Lim \pm P_{on} \cdot R_{th} =$$
$$= \Theta Lim \pm (I_{out}^{2} \cdot R_{DSONx} + P_q + P_{os}) \cdot R_{th}$$

In particular, this relation is useful to find the maximum ambient temperature T_{ambx} at which I_{outx} can be delivered:

$$T_{ambx} = \Theta Lim \pm (I_{outx}^{2} \cdot R_{DSONx} + P_q + P_{os}) \cdot R_{th} \qquad (4)$$

Referring to application circuit in fig. 6, let us consider the worst case:

- The supply voltage is at maximum value of industrial bus (30V instead of the 24V nominal value). This means also that I_{outx} rises of 25% (2.5A instead of 2A).

- All electrical parameters of the device, concerning the calculation, are at maximum values.
- Thermal shutdown threshold is at minimum value.

Therefore:

V_s = 30V, R_{DSON0} = 0.23Ω, I_q = 8mA, I_{os} = 4mA @ V_{os} = 2.5V, ΘLim = 135°C

$R_{thj\text{-}amb}$ = 35°C/W

It follows:

I_{outx} = 2.5A, R_{DSONx} = 0.386Ω, P_q = 240mW, P_{os} = 110mW

From equation 4 we can see that, without any heatsink, it is not possible to operate in the ON steady state at the maximum current value. A derating curve for this case is reported in fig. 7. Using an external heatsink, in order to obtain a total R_{th} of 15°C/W, we obtain the derating curve reported in fig. 8.

Figure 6: Application Circuit

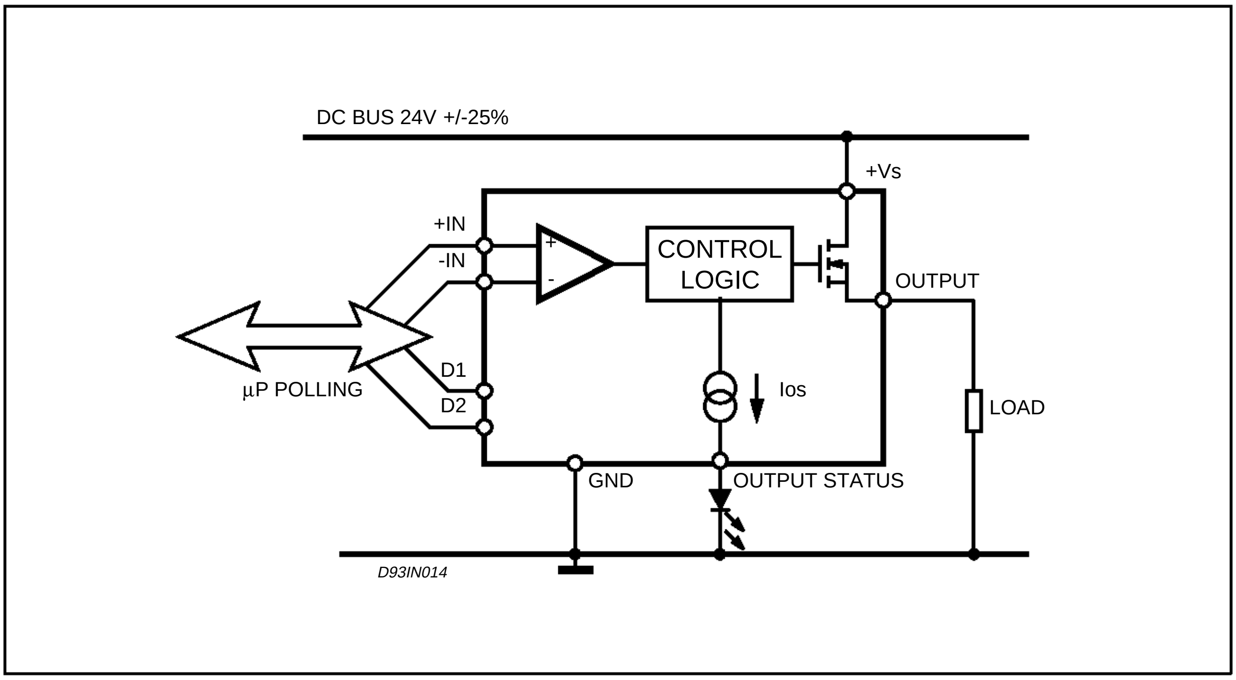


Figure 7: Max. Output Current vs. Ambient Temperature (Multiwatt without heatsink, $R_{th\ j\text{-}amb}$ = 35°C/W)

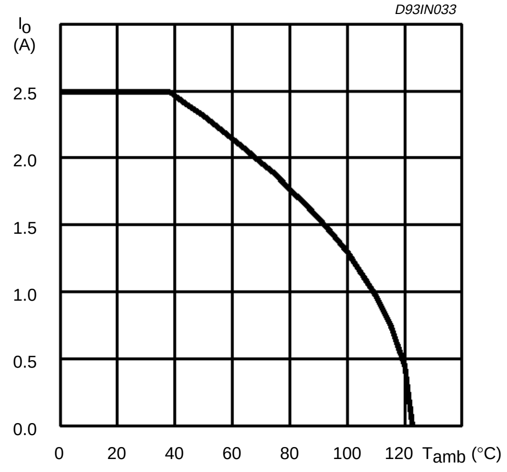
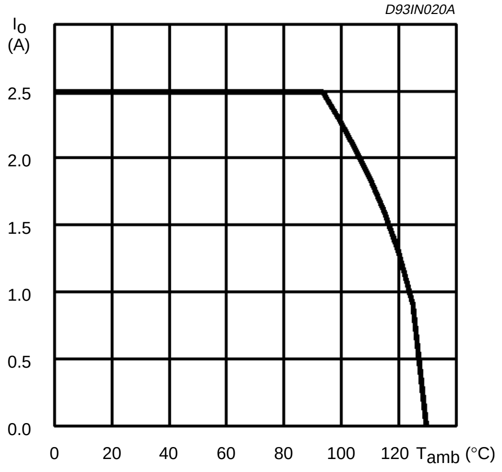
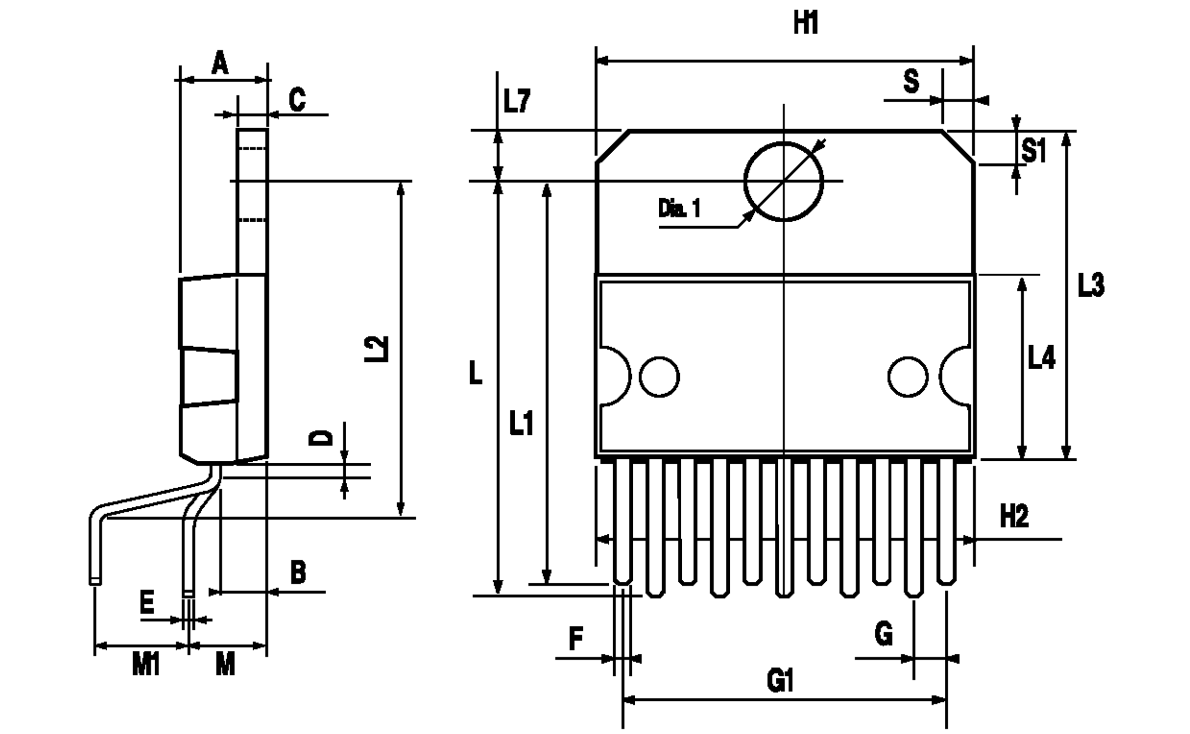


Figure 8: Max. Output Current vs. Ambient Temperature (Multiwatt with heatsink, $R_{th\ j\text{-}amb}$ = 15°C/W)



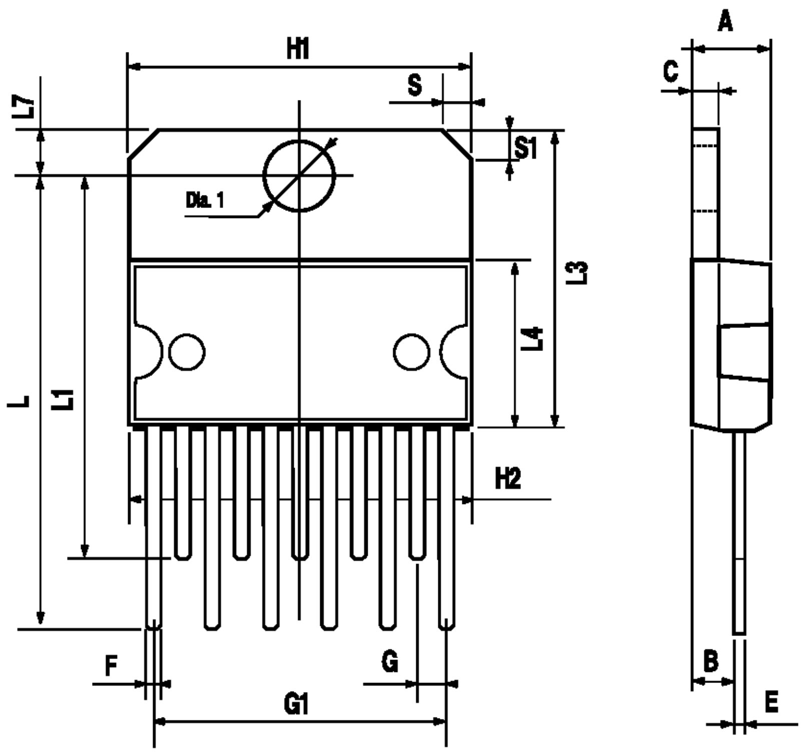
MULTIWATT11 (Vertical) PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.88		0.95	0.035		0.037
G	1.57	1.7	1.83	0.062	0.067	0.072
G1	16.87	17	17.13	0.664	0.669	0.674
H1	19.6			0.772		
H2			20.2			0.795
L	21.5		22.3	0.846		0.878
L1	21.4		22.2	0.843		0.874
L2	17.4		18.1	0.685		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.1	4.3	4.5	0.161	0.169	0.177
M1	4.88	5.08	5.3	0.192	0.200	0.209
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152



MULTIWATT11 (In line) PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
E	0.49		0.55	0.019		0.022
F	0.88		0.95	0.035		0.037
G	1.57	1.7	1.83	0.062	0.067	0.072
G1	16.87	17	17.13	0.664	0.669	0.674
H1	19.6			0.772		
H2			20.2			0.795
L	26.4		26.9	1.039		1.059
L1	22.35		22.85	0.880		0.900
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

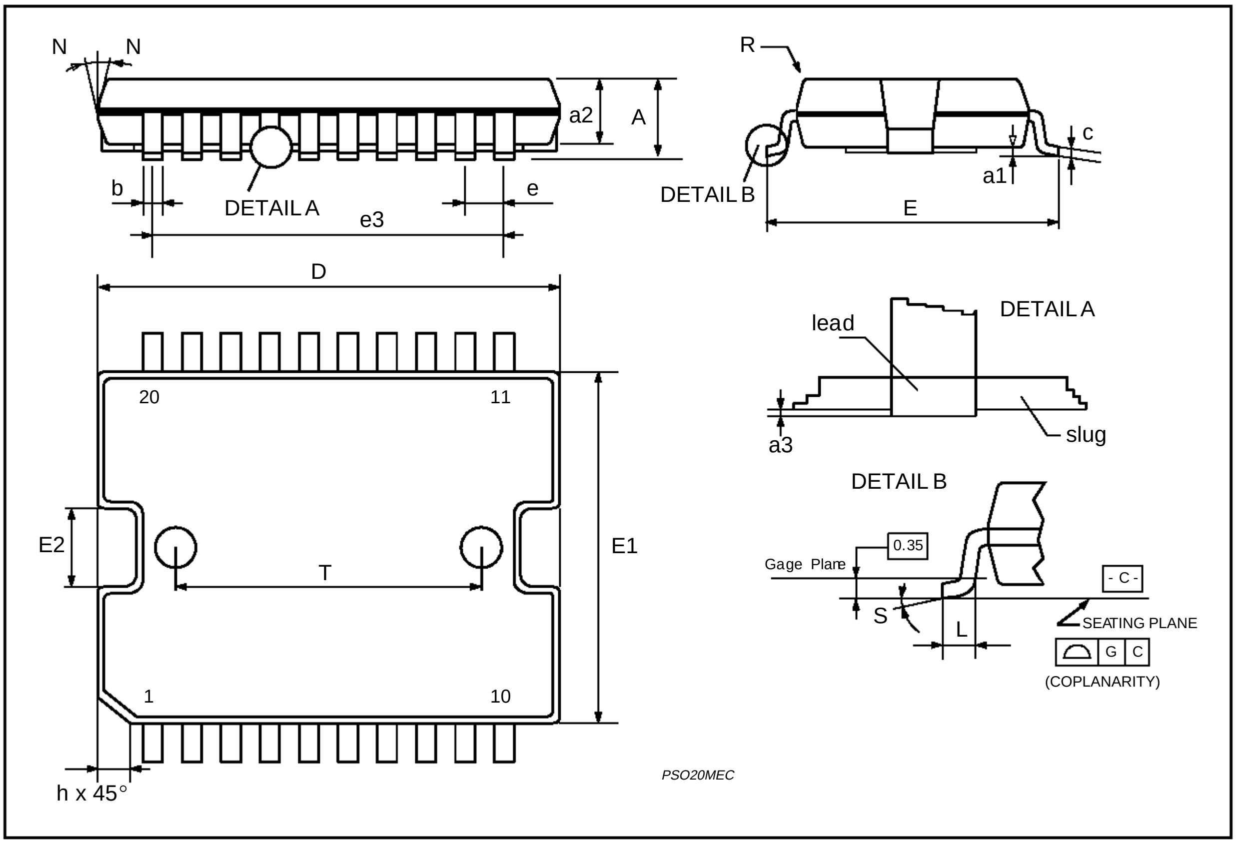


SGS-THOMSON MICROELECTRONICS

PowerSO20 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			3.60			0.1417
a1	0.10		0.30	0.0039		0.0118
a2			3.30			0.1299
a3	0		0.10	0		0.0039
b	0.40		0.53	0.0157		0.0209
c	0.23		0.32	0.009		0.0126
D (1)	15.80		16.00	0.6220		0.6299
E	13.90		14.50	0.5472		0.570
e		1.27			0.050	
e3		11.43			0.450	
E1 (1)	10.90		11.10	0.4291		0.437
E2			2.90			0.1141
G	0		0.10	0		0.0039
h			1.10			
L	0.80		1.10	0.0314		0.0433
N	10° (max.)					
S	8° (max.)					
T		10.0			0.3937	

(1) ”D and E1” do not include mold flash or protrusions
- Mold flash or protrusions shall not exceed 0.15mm (0.006”)



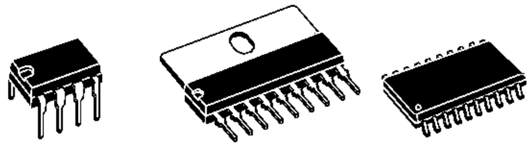
TDE1897R
TDE1898R

0.5A HIGH-SIDE DRIVER
INDUSTRIAL INTELLIGENT POWER SWITCH

PRELIMINARY DATA

- 0.5A OUTPUT CURRENT
- 18V TO 35V SUPPLY VOLTAGE RANGE
- INTERNAL CURRENT LIMITING
- THERMAL SHUTDOWN
- OPEN GROUND PROTECTION
- INTERNAL NEGATIVE VOLTAGE CLAMPING TO V_S - 45V FOR FAST DEMAGNETIZATION
- DIFFERENTIAL INPUTS WITH LARGE COMMON MODE RANGE AND THRESHOLD HYSTERESIS
- UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- OPEN LOAD DETECTION
- TWO DIAGNOSTIC OUTPUTS
- OUTPUT STATUS LED DRIVER

MULTIPOWER BCD TECHNOLOGY



Minidip	SIP9	SO20

ORDERING NUMBERS:

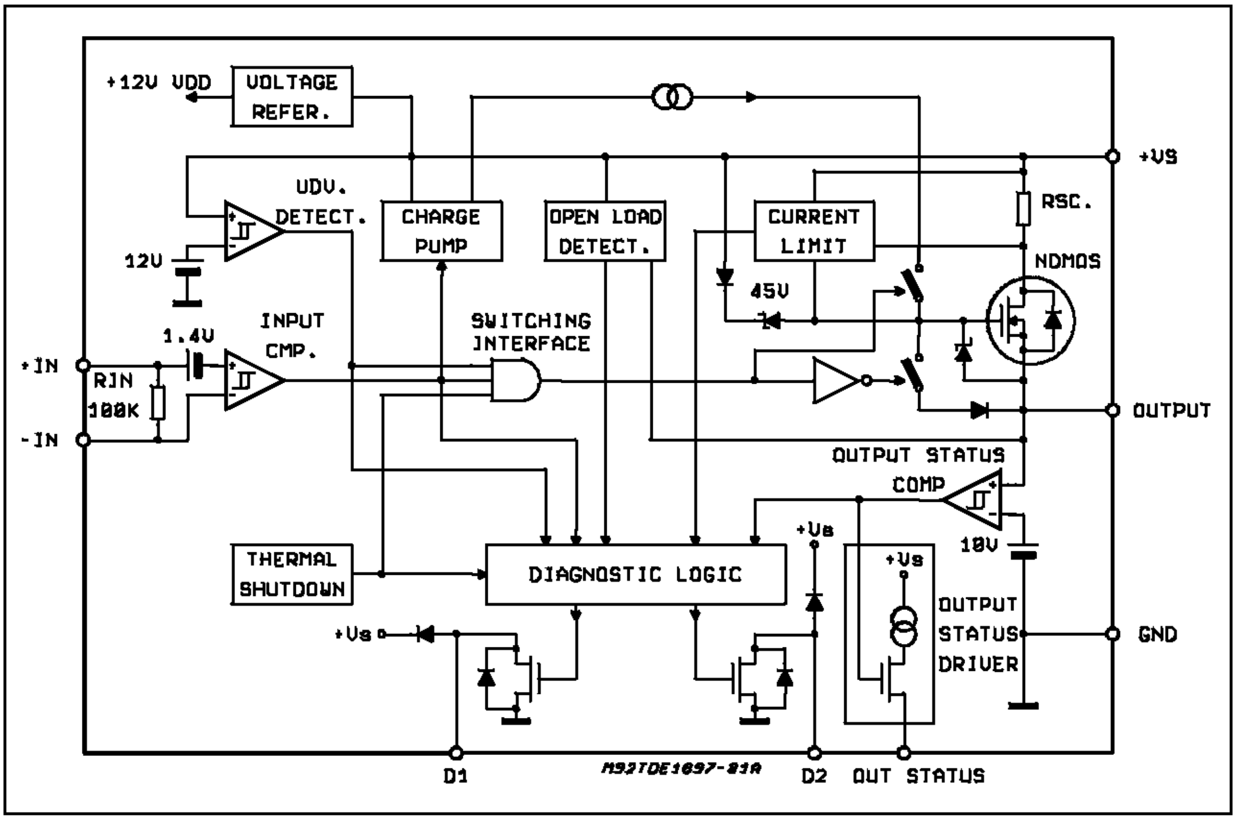
TDE1897RDP	TDE1898RSP	TDE1897RFP
TDE1898RDP		TDE1898RFP

DESCRIPTION

The TDE1897R/TDE1898R is a monolithic Intelligent Power Switch in Multipower BCD Technology, for driving inductive or resistive loads. An internal Clamping Diode enables the fast demagnetization of inductive loads.

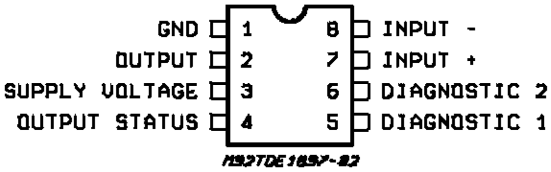
Diagnostic for CPU feedback and extensive use of electrical protections make this device inherently indistructible and suitable for general purpose industrial applications.

BLOCK DIAGRAM

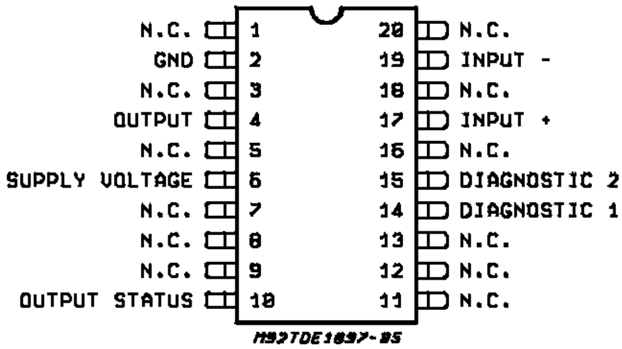


PIN CONNECTIONS (Top view)

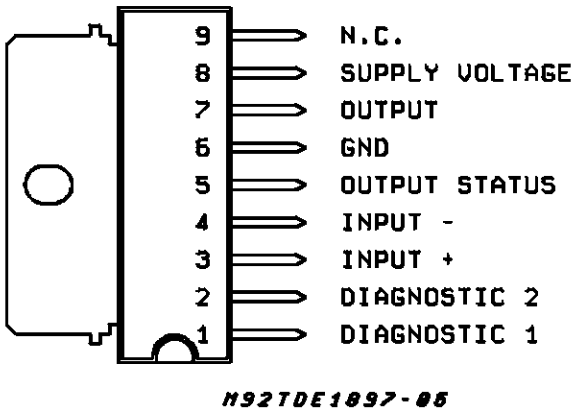
Minidip



SO20



SIP9



ABSOLUTE MAXIMUM RATINGS (Minidip pin reference)

Symbol	Parameter	Value	Unit
V_S	Supply Voltage (Pins 3 - 1) (T_W < 10ms)	50	V
$V_S - V_O$	Supply to Output Differential Voltage. See also V_{Cl} 3-2 (Pins 3 - 2)	internally limited	V
V_i	Input Voltage (Pins 7/8)	-10 to V_S +10	V
V_i	Differential Input Voltage (Pins 7 - 8)	43	V
I_i	Input Current (Pins 7/8)	20	mA
I_O	Output Current (Pins 2 - 1). See also ISC	internally limited	A
E_I	Energy from Inductive Load (T_J = 85°C)	200	mJ
P_{tot}	Power Dissipation. See also THERMAL CHARACTERISTICS.	internally limited	W
T_{op}	Operating Temperature Range (T_{amb})	-25 to +85	°C
T_{stg}	Storage Temperature	-55 to 150	°C

THERMAL DATA

Symbol	Description		Minidip	Sip	SO20	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	Max.		10		°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	100	70	90	°C/W

ELECTRICAL CHARACTERISTICS (V_S = 24V; T_{amb} = –25 to +85°C, unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{smin} 3	Supply Voltage for Valid Diagnostics	I_{diag} > 0.5mA @ V_{dg1} = 1.5V	9		35	V
V_s 3	Supply Voltage (operative)		18	24	35	V
I_q 3	Quiescent Current I_{out} = I_{os} = 0	V_{il} V_{ih}		2.5 4.5	4 7.5	mA mA
V_{sth1}	Undervoltage Threshold 1	(See fig. 1); T_{amb} = 0 to +85°C	11			V
V_{sth2} 3	Undervoltage Threshold 2	(See fig. 1); Tamb = 0 to +85°C			15.5	V
V_{shys}	Supply Voltage Hysteresis	(See fig. 1); T_{amb} = 0 to +85°C	0.4	1	3	V
I_{sc}	Short Circuit Current	V_S = 18 to 35V; R_L = 1Ω	0.75		1.5	A
V_{don} 3-2	Output Voltage Drop	@ I_{out} = 625mA; T_j = 25°C @ I_{out} = 625mA; T_j = 125°C		250 400	425 600	mV mV
I_{oslk} 2	Output Leakage Current	@ V_i = V_{il} , V_o = 0V			300	µA
V_{ol} 2	Low State Out Voltage	@ V_i = V_{il}; R_L = ∞		0.8	1.5	V
V_{cl} 3-2	Internal Voltage Clamp (V_S - V_O)	@ I_O = -500mA	45		55	V
I_{old} 2	Open Load Detection Current	V_i = V_{ih}; T_{amb} = 0 to +85°C	0.5		9.5	mA
V_{id} 7-8	Common Mode Input Voltage Range (Operative)	V_S = 18 to 35V, V_S - V_{id} 7-8 < 37V	–7		15	V
I_{ib} 7-8	Input Bias Current	V_i = –7 to 15V; –In = 0V	–700		700	µA
V_{ith} 7-8	Input Threshold Voltage	V+In > V–In	0.8	1.4	2	V
V_{iths} 7-8	Input Threshold Hysteresis Voltage	V+In > V–In	50		400	mV
R_{id} 7-8	Diff. Input Resistance	@ 0 < +In < +16V; –In = 0V @ –7 < +In < 0V; –In = 0V		400 150		KΩ KΩ
I_{ilk} 7-8	Input Offset Current	V+In = V–In +Ii 0V < V_i <5.5V –Ii	–20 –75	 –25	+20	µA µA
		–In = GND +Ii 0V < V+In <5.5V –Ii	 –250	+10 –125	+50	µA µA
		+In = GND +Ii 0V < V–In <5.5V –Ii	–100 –50	–30 –15		µA µA
V_{oth1} 2	Output Status Threshold 1 Voltage	(See fig. 1)			12	V
V_{oth2} 2	Output Status Threshold 2 Voltage	(See fig. 1)	9			V
V_{ohys} 2	Output Status Threshold Hysteresis	(See fig. 1)	0.3	0.7	2	V
I_{osd} 4	Output Status Source Current	V_{out} > V_{oth1}, V_{os} = 2.5V	2		4	mA
V_{osd} 3-4	Active Output Status Driver Drop Voltage	V_s – V_{os} @ I_{os} = 2mA; T_{amb} = -25 to 85°C			5	V
I_{oslk} 4	Output Status Driver Leakage Current	V_{out} < V_{oth2} , V_{os} = 0V V_S = 18 to 35V			25	µA
V_{dgl} 5/6	Diagnostic Drop Voltage	D1 / D2 = L @ I_{diag} = 0.5mA D1 / D2 = L @ I_{diag} = 3mA			250 1.5	mV V
I_{dglk} 5/6	Diagnostic Leakage Current	D1 / D2 =H @ 0 < V_{dg} < V_s V_S = 15.6 to 35V			25	µA
V_{fdg} 5/6-3	Clamping Diodes at the Diagnostic Outputs. Voltage Drop to Vs	@ I_{diag} = 5mA; D1 / D2 = H			2	V

Note Vil ≤ 0.8V, Vih ≥ 2V @ (V+In > V–In); Minidip pin reference.
All test not dissipative.

SOURCE DRAIN NDMOS DIODE

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_{fsd} 2-3	Forward On Voltage	@ I_{fsd} = 625mA		1	1.5	V
I_{fp} 2-3	Forward Peak Current	t = 10ms; d = 20%			2	A
t_{rr} 2-3	Reverse Recovery Time	I_f = 625mA di/dt = 25A/µs		200		ns
t_{fr} 2-3	Forward Recovery Time			50		ns

THERMAL CHARACTERISTICS (*)

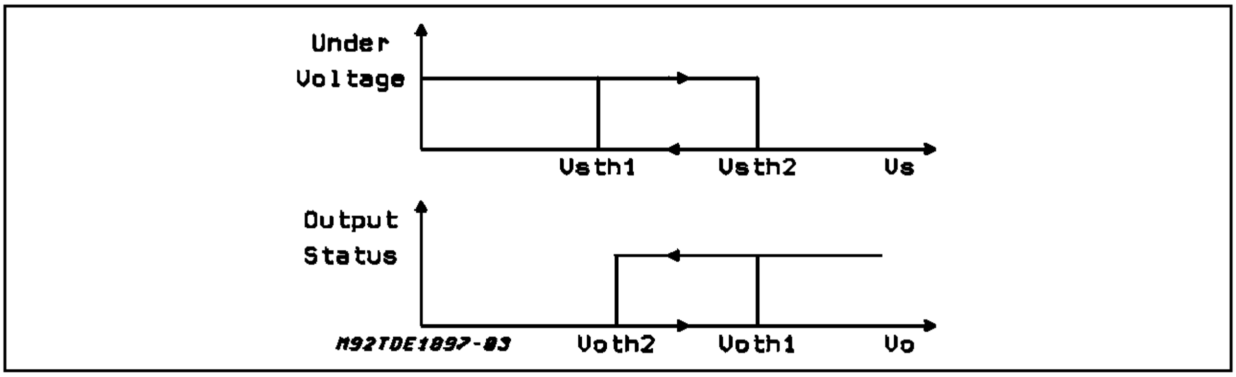
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Θ Lim	Junction Temp. Protect.		135	150		°C
T_H	Thermal Hysteresis			30		°C

SWITCHING CHARACTERISTICS (V_S = 24V; R_L = 48Ω) (*)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
t_{on}	Turn on Delay Time				100	µs
t_{off}	Turn off Delay Time				20	µs
t_d	Input Switching to Diagnostic Valid				100	µs

Note Vil ≤ 0.8V, Vih ≥ 2V @ (V+In > V–In); Minidip pin reference. (*) Not tested.

Figure 1



DIAGNOSTIC TRUTH TABLE

Diagnostic Conditions		Input	Output	Diag1	Diag2
Normal Operation		L H	L H	H H	H H
Open Load Condition (I_o < I_{old})		L H	L H	H L	H H
Short to V_S		L H	H H	L L	H H
Short Circuit to Ground (I_O = I_{SC}) (**)	**TDE1897R**	H	<H (*)	H	L
	TDE1898R	H	H L	H H	H H
Output DMOS Open		L H	L L	H L	H H
Overtemperature		L H	L L	H H	L L
Supply Undervoltage (V_S < V_{sth1} in the falling phase of the supply voltage; V_S < V_{sth2} in the rising phase of the supply voltage)		L H	L L	L L	L L

(*) According to the intervention of the current limiting block.
(**) A cold lamp filament, or a capacitive load may activate the current limiting circuit of the IPS, when the IPS is initially turned on. TDE1897 uses Diag2 to signal such condition, TDE1898 does not.

APPLICATION INFORMATION

DEMAGNETIZATION OF INDUCTIVE LOADS

An internal zener diode, limiting the voltage across the Power MOS to between 45 and 55V (V_{cl}), provides safe and fast demagnetization of inductive loads without external clamping devices.

The maximum energy that can be absorbed from an inductive load is specified as 200mJ (at T_j = 85°C).

To define the maximum switching frequency three points have to be considered:

1) The total power dissipation is the sum of the On State Power and of the Demagnetization Energy multiplied by the frequency.

2) The total energy W dissipated in the device during a demagnetization cycle (figg. 2, 3) is:

$$W = V_{cl}\ \frac{L}{R_L}\left[I_o - \frac{V_{cl} - V_s}{R_L}\ \log\left(1 + \frac{V_s}{V_{cl} - V_s}\right)\right]$$

Where:
V_{cl} = clamp voltage;
L = inductive load;
R_L = resistive load;
Vs = supply voltage;
$I_O = I_{LOAD}$

3) In normal conditions the operating Junction temperature should remain below 125°C.

Figure 3: Demagnetization Cycle Waveforms

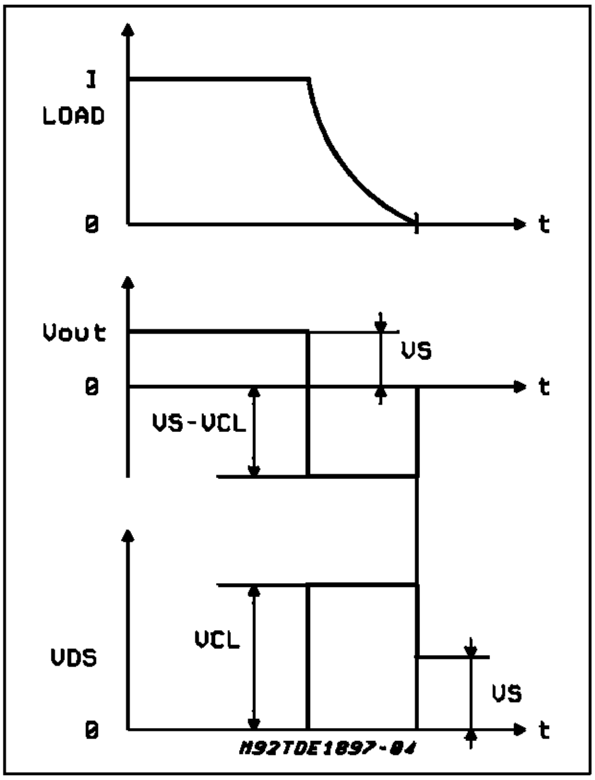


Figure 2: Inductive Load Equivalent Circuit

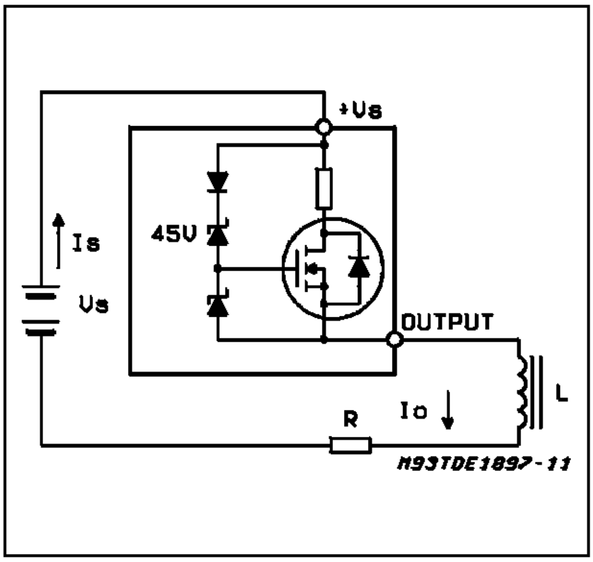
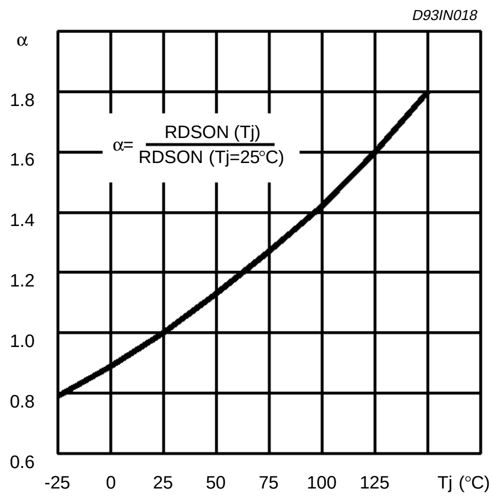


Figure 4: Normalized R_{DSON} vs. Junction Temperature



WORST CONDITION POWER DISSIPATION IN THE ON-STATE

In IPS applications the maximum average power dissipation occurs when the device stays for a long time in the ON state. In such a situation the internal temperature depends on delivered current (and related power), thermal characteristics of the package and ambient temperature.

At ambient temperature close to upper limit (+85°C) and in the worst operating conditions, it is possible that the chip temperature could increase so much to make the thermal shutdown procedure untimely intervene.

Our aim is to find the maximum current the IPS can withstand in the ON state without thermal shutdown intervention, related to ambient temperature. To this end, we should consider the following points:

1) The ON resistance R_{DSON} of the output NDMOS (the real switch) of the device increases with its temperature.
Experimental results show that silicon resistivity increases with temperature at a constant rate, rising of 60% from 25°C to 125°C.
The relationship between R_{DSON} and temperature is therefore:

$$R_{DSON} = R_{DSON0}\,(1 + k)^{(T_j \pm 25)}$$

where:
T_j is the silicon temperature in °C
R_{DSON0} is R_{DSON} at T_j=25°C
k is the constant rate ($k = 4.711 \cdot 10^{\pm 3}$)
(see fig. 4).

2) In the ON state the power dissipated in the device is due to three contributes:

a) power lost in the switch:
$P_{out} = I_{out}^{\,2} \cdot R_{DSON}$ (I_{out} is the output current);

b) power due to quiescent current in the ON state Iq, sunk by the device in addition to I_{out}: $P_q = I_q \cdot V_s$ (V_s is the supply voltage);

c) an external LED could be used to visualize the switch state (OUTPUT STATUS pin). Such a LED is driven by an internal current source (delivering I_{os}) and therefore, if V_{os} is the voltage drop across the LED, the dissipated power is: $P_{os} = I_{os} \cdot (V_s \pm V_{os})$.

Thus the total ON state power consumption is given by:

$$P_{on} = P_{out} + P_q + P_{os} \qquad (1)$$

In the right side of equation 1, the second and the third element are constant, while the first one increases with temperature because R_{DSON} increases as well.

3) The chip temperature must not exceed ΘLim in order do not lose the control of the device.
The heat dissipation path is represented by the thermal resistance of the system device-board-ambient (R_{th}). In steady state conditions, this parameter relates the power dissipated P_{on} to the silicon temperature T_j and the ambient temperature T_{amb}:

$$T_j \pm T_{amb} = P_{on} \cdot R_{th} \qquad (2)$$

From this relationship, the maximum power P_{on} which can be dissipated without exceeding ΘLim at a given ambient temperature T_{amb} is:

$$P_{on} = \frac{\Theta Lim \pm T_{amb}}{R_{th}}$$

Replacing the expression (1) in this equation and solving for I_{out}, we can find the maximum current versus ambient temperature relationship:

$$I_{outx} = \sqrt{\frac{\dfrac{\Theta Lim \pm T_{amb}}{R_{th}} \pm P_q \pm P_{os}}{R_{DSONx}}}$$

where R_{DSON}x is R_{DSON} at T_j=ΘLim. Of course, I_{outx} values are top limited by the maximum operative current I_{outx} (500mA nominal).
From the expression (2) we can also find the maximum ambient temperature T_{amb} at which a given power P_{on} can be dissipated:

$$T_{amb} = \Theta Lim \pm P_{on} \cdot R_{th} =$$
$$= \Theta Lim \pm (I_{out}^{\,2} \cdot R_{DSONx} + P_q + P_{os}) \cdot R_{th}$$

In particular, this relation is useful to find the maximum ambient temperature T_{ambx} at which I_{outx} can be delivered:

$$T_{ambx} = \Theta Lim \pm (I_{outx}^{\,2} \cdot R_{DSONx} + P_q + P_{os}) \cdot R_{th} \qquad (4)$$

Referring to application circuit in fig. 5, let us consider the worst case:

- The supply voltage is at maximum value of industrial bus (30V instead of the 24V nominal value). This means also that I_{outx} rises of 25%

(625mA instead of 500mA).

- All electrical parameters of the device, concerning the calculation, are at maximum values.
- Thermal shutdown threshold is at minimum value.
- No heat sink nor air circulation (R_{th} equal to $R_{thj-amb}$).

Therefore:

V_s = 30V, R_{DSON0} = 0.6Ω, I_q = 6mA, I_{os} = 4mA @ V_{os} = 2.5V, ΘLim = 135°C

$R_{thj-amb}$ = 100°C/W (Minidip); 90°C/W (SO20); 70°C/W (SIP9)

It follows:

I_{outx} = 0.625mA, R_{DSONx} = 1.006Ω, P_q = 180mW, P_{os} = 110mW

From equation 4, we can find:

T_{ambx} = 66.7°C (Minidip);
73.5°C (SO20);
87.2°C (SIP9).

Therefore, the IPS TDE1897/1898, although guaranteed to operate up to 85°C ambient temperature, if used in the worst conditions, can meet some limitations.

SIP9 package, which has the lowest $R_{thj-amb}$, can work at maximum operative current over the entire ambient temperature range in the worst conditions too. For other packages, it is necessary to consider some reductions.

With the aid of equation 3, we can draw a derating curve giving the maximum current allowable versus ambient temperature. The diagrams, computed using parameter values above given, are depicted in figg. 6 to 8.

If an increase of the operating area is needed, heat dissipation must be improved (R_{th} reduced) e.g. by means of air cooling.

Figure 5: Application Circuit.

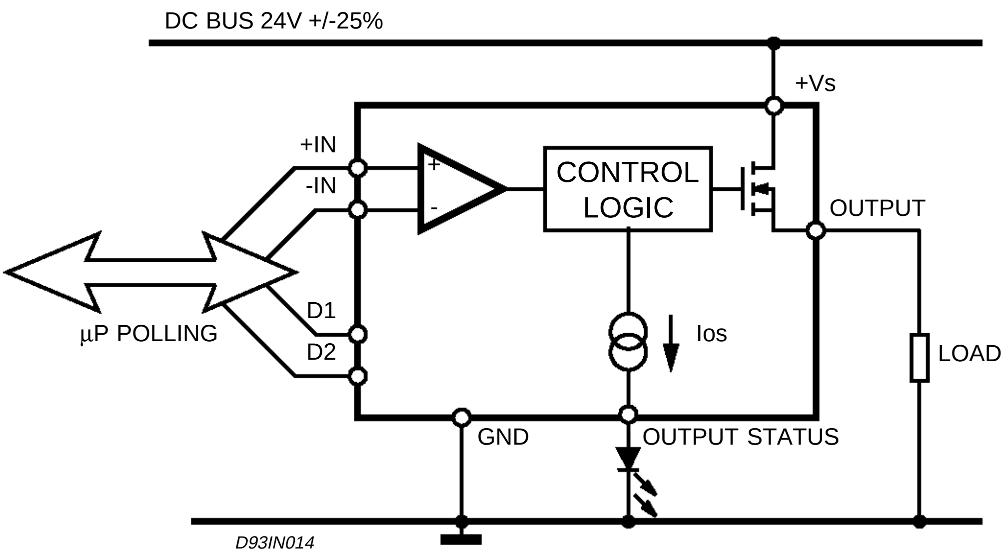


Figure 6: Max. Output Current vs. Ambient Temperature (Minidip Package, $R_{th\ j\text{-}amb}$ = 100°C/W)

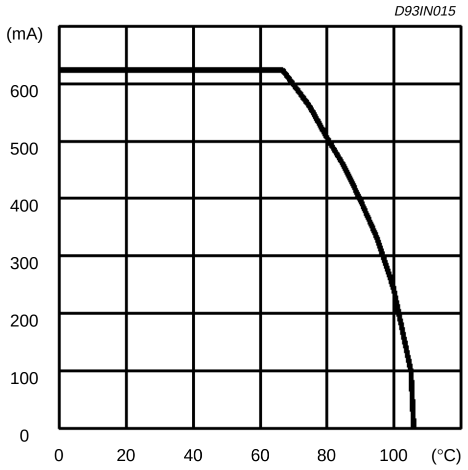


Figure 7: Max. Output Current vs. Ambient Temperature (SO20 Package, $R_{th\ j\text{-}amb}$ = 90°C/W)

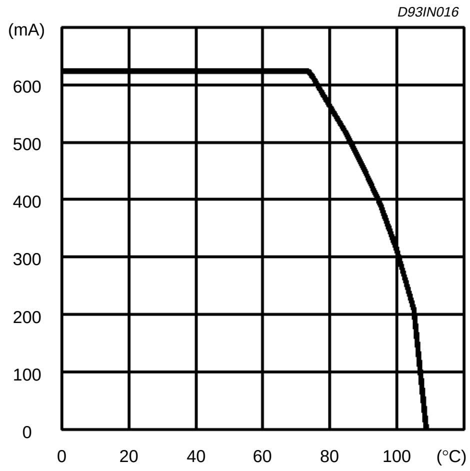
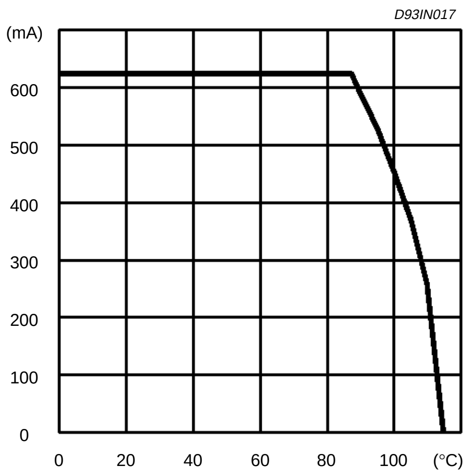
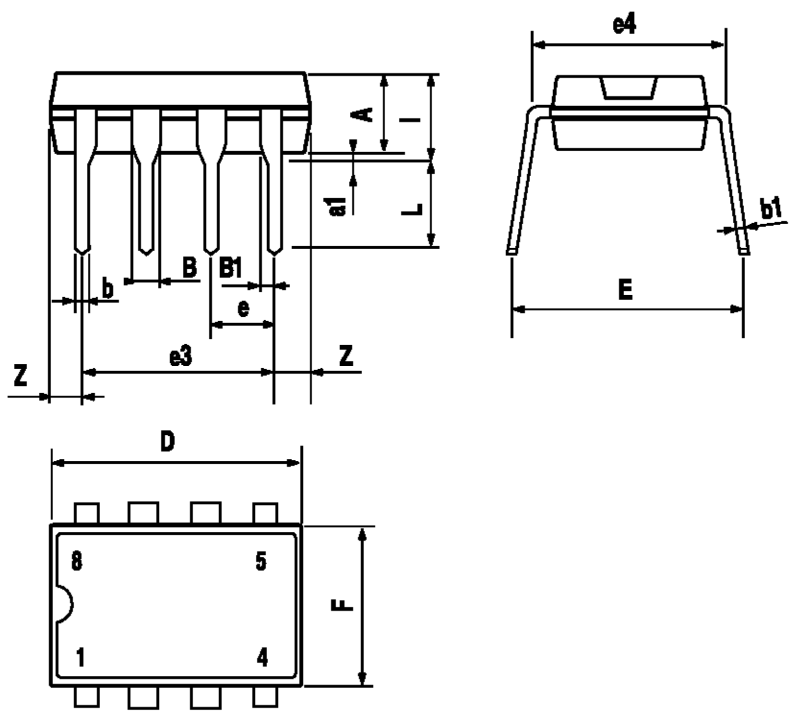


Figure 8: Max. Output Current vs. Ambient Temperature (SIP9 Package, $R_{th\ j\text{-}amb}$ = 70°C/W)



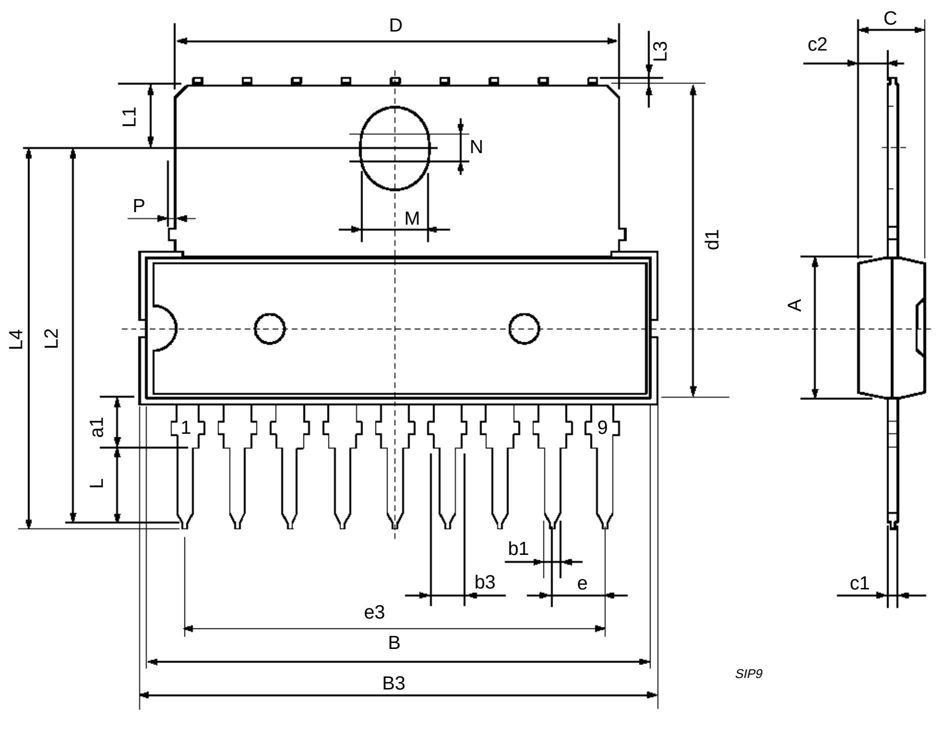
MINIDIP PACKAGE MECHANICAL DATA

DIM	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060



SIP9 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			7.1			0.280
a1	2.7		3	0.106		0.118
B			23			0.90
B3			24.8			0.976
b1		0.5			0.020	
b3	0.85		1.6	0.033		0.063
C		3.3			0.130	
c1		0.43			0.017	
c2		1.32			0.052	
D			21.2			0.835
d1		14.5			0.571	
e		2.54			0.100	
e3		20.32			0.800	
L	3.1			0.122		
L1		3			0.118	
L2		17.6			0.693	
L3			0.25			0.010
L4	17.4		17.85	0.685		0,702
M		3.2			0.126	
N		1			0.039	
P			0.15			0.006



SGS-THOMSON MICROELECTRONICS

SO20 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			2.65			0.104
a1	0.1		0.2	0.004		0.008
a2			2.45			0.096
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.013
C		0.5			0.020	
c1	45° (typ.)					
D	12.6		13.0	0.496		0.510
E	10		10.65	0.394		0.419
e		1.27			0.050	
e3		11.43			0.450	
F	7.4		7.6	0.291		0.300
L	0.5		1.27	0.020		0.050
M			0.75			0.030
S	8° (max.)