Dedicated IC-optocoupler CNR50

FEATURES

- A cost effective optocoupler with integrated additional functions
- A wide body DIL 8 encapsulation with a pin distance of 10.16 mm
- A clearance of 9.6 mm minimum and a creepage of 10 mm minimum
- High degree of AC and DC insulation (5000 V (RMS) and 7070 V (DC))
- Maximum permissible voltage of 8000 V (peak) and maximum operating isolation voltage of 1000 V (RMS) in accordance with VDE 0884.

DESCRIPTION

The CNR50 is an optocoupler specifically designed for use as a cost-effective integrated feed-back loop element in Self Oscillation Power Supplies (SOPS).

It consists of an infra-red emitting GaAlAs diode and an integrated photodetector circuit in an 8-pin dual-in-line (DIL) SOT271 wide body envelope, providing high isolation voltage, creepage and clearance distances.

The photodetector circuit incorporates a low-current initialization circuit, an under-voltage detection comparator and a starting current generator.

The CNR50 can operate in SOPS circuits either using discrete components, or with a dedicated control IC : TDA8385.

APPROVALS

STANDARD	REFERENCE
UL	Covered under UL component recognition FILE E90700
BSI	Certification in accordance with BS415:1990; BS7002:1989; BS5301:1982 for class II applications
NORDIC	Tested for applications (reinforced isolation); Class II applications for pluggable apparatus in normal tight execution
SETI	In accordance with IEC 65, 380, 950 & 335
SEMKO	In accordance with IEC 65, 380, 950 & 335
NEMKO	In accordance with IEC 65, 380, 950 & 335
DEMKO	In accordance with IEC 65, 380, 950 & 335
VDE	VDE 0884/0804/0860/0805/0806/750-1/IEC 950

Dedicated IC-optocoupler | CNR50

PINNING - SOT271

PIN	DESCRIPTION
1	not connected
2	anode
3	cathode
4	not connected
5	ground
6	V_{OUT}
7	V_{IN}
8	V_{CC}

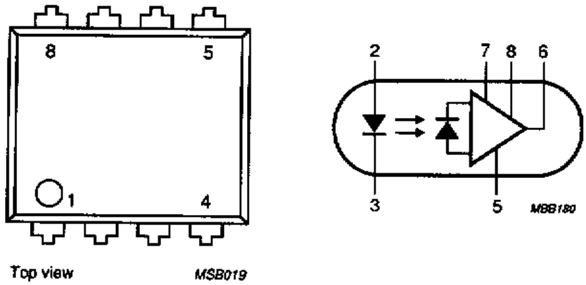


Fig.1 Simplified outline and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
Diode					
I_F	forward current	DC value	–	60	mA
V_R	reverse voltage	DC value	–	5	V
Photodetector					
I_{OUT}	output current	$t_p = 3\ \mu s$; $\delta = 0.1$	–	2	A
V_{CC}	supply voltage		–	18	V
Optocoupler					
V_{IO}	isolation voltage	(UL/IEC/BSI)			
		DC value	–	7.07	kV
		RMS value	–	5	kV
V_{Tr}	maximum permissible overvoltage	peak value (VDE 0884)	8000	–	V
V_{IORM}	maximum operating isolation voltage	RMS value (VDE 0884)	–	1000	V
SWITCHING TIMES					
t_{PHL}	propagation switching time from high to low level output		–	0.5	µs
t_{PLH}	propagation switching time from low to high level output		–	1	µs

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
Diode					
I_F	forward current	DC value	–	60	mA
V_R	reverse voltage	DC value	–	5	V
P_{tot}	total power dissipation	T_{amb} = 25 °C	–	200	mW
Photodetector					
I_{OUT}	output current range (output transistor on)	DC value	0	100	mA
		peak value; t_p = 3 µs; δ = 0.1	0	2	A
V_{CC}	supply voltage range	V_{source}	–0.5	18	V
V_{OUT}	output voltage range		–0.5	18	V
V_{IN}	input voltage range (input undervoltage)	V_{IN} - V_{CC} < = 0.5 V	–0.5	18	V
Optocoupler					
T_{stg}	storage temperature range		–55	150	°C
T_{amb}	ambient operating temperature range		0	70	°C
T_{sld}	soldering temperature up to the seating plane	T_{sld} < 10 s	–	260	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	MAX.	UNIT
Diode			
$R_{th\ j\text{-}a}$	from junction to ambient in free air	500	K/W
$R_{th\ j\text{-}a}$	from junction to ambient when mounted on PCB	400	K/W
Transistor			
$R_{th\ j\text{-}a}$	from junction to ambient in free air	500	K/W

ISOLATION RELATED VALUES

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
L(IO1)	external air gap (clearance)	between input and output terminals	9.6	–	–	mm
L(IO2)	external tracking path(creepage distance)	between input and output terminals	10	–	–	mm
	internal plastic gap (clearance)	isolation thickness between emitter and receiver	1	–	–	mm
C_{io}	capacitance input to output	V_{IO} = 0; f = 1 MHz	–	0.4	0.6	pF

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
R_{IO}	insulation resistance input to output	V_{IO} = ±500 V at 25 °C	10^{12}	10^{13}	–	Ω
		V_{IO} = ±500 V at 100 °C	10^{11}	–	–	Ω
		V_{IO} = ±500 V at 150 °C (T_{si} max.)	10^{9}	–	–	Ω
V_{IO}	isolation voltage (for UL 1577, IEC, BSI)	DC value; t = 1 min (note 1)	7.07	–	–	kV
		RMS value; t = 1 min (note 1)	5	–	–	kV
V_{IORM}	maximum operating isolation voltage	RMS value; VDE 0884	1000	–	–	V
V_{Pr}	partial discharge test voltage	RMS value; VDE 0884; V_{Pr} = 1.6 x V_{IORM} for t_p = 1 s; P_d < 5 pC (note 2, Fig.10, procedure 'b')	1600	–	–	V
		RMS value VDE 0884; V_{Pr} = 1.2 x V_{IORM} for t_p = 60 s; P_d < 5 pC (note 3, Fig.11, procedure 'a')	1200	–	–	V
V_{Tr}	maximum permissible overvoltage	peak value; VDE 0884; t_{Tr} = 10 s (note 3, Fig.11, procedure 'a')	8000	–	–	V
Maximum safety ratings (maximum permissible in case of fault) (Note 4 and Fig.9)						
T_{si}	package temperature		–	–	150	°C
I_{si}	input current I_F	P_{si} = 0	–	–	400	mA
P_{si}	total power dissipation		–	–	700	mW

Notes

1. Every product is tested by applying an isolation test voltage of 6000 V (RMS) for 2 seconds, between all shorted input side leads and all shorted output side leads, with a detection current of approximately 1 µA. Test at 5000 V (RMS) for 1 min is performed by sampling.
2. Every product is tested by applying a partial discharge test voltage of 1600 V (RMS) for 1 second, between all shorted input side leads and all shorted output side leads, with a maximum partial discharge of 5 pC (see test procedure 'b', Fig.10)
3. Test procedure 'a' is performed by sampling (see Fig.11)
4. Isolation characteristics are guaranteed only within the maximum ratings that must be ensured by protective circuits in application.

CLASSIFICATION CATEGORIES

Installation category for rated line voltages ≤600 V (RMS)	DIN VDE 0109, Dec. 83, tab 1: I-IV
Installation category for rated line voltages ≤1000 V (RMS)	DIN VDE 0109, Dec. 83, tab 1: I-III
IEC climatic category	DIN IEC 68, part 1/0980: 55/100/21
Pollution degree	DIN VDE 0109, Dec. 83: 2
Comparative tracking index (CTI)	DIN IEC 112/VDE 0303, part 1: 175
Material group	DIN VDE 0109: IIIa

FUNCTIONAL DESCRIPTION (Fig.2)

The CNR50 provides the turn-off pulses to the power switching transistor of the SOPS. Under normal operation conditions, these turn-off pulses are controlled by the diode forward current.

The IC-photodetector comprises:

1. An internal supplies block:

   This block provides internally stabilized voltage/current supplies to the other blocks.

2. An initialization block:

   As the circuit is intended to be used on the primary side of the power supply, it should be supplied by a take-over winding on the transformer.

   To initialize the operation, a high ohmic resistor between the rectified mains voltage and the supply (V_{CC}) connection of the IC will slowly charge the capacitor connected to this pin. When the voltage exceeds the initialization level of typically 15.3 V, the circuit starts up.

   When the voltage on the V_{CC} pin drops below typically 3.9 V, the circuit abruptly shuts down.

   During the initialization phase (1.5 V < V_{CC} < 15.3 V), the optocoupler is in "output on" state.

3. A photodetector block:

   When current (5 mA minimum) is fed into the infra-red emitter; the light produced is transformed into a current through the photodiode. This current is then fed into a transimpedance amplifier.

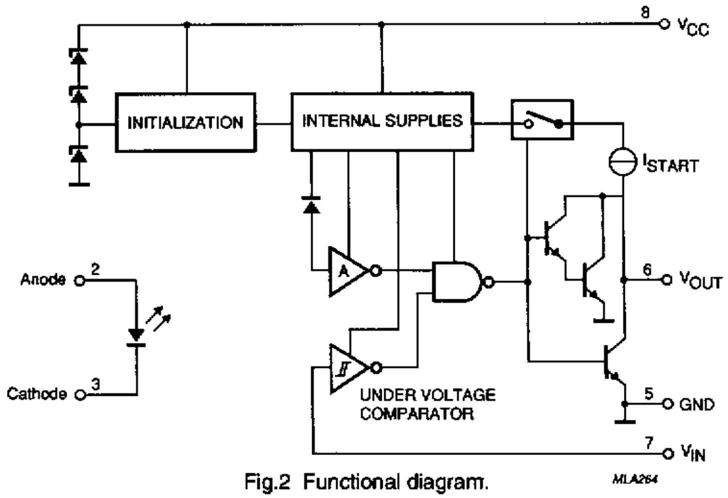


Fig.2 Functional diagram.

The collector output of the IC is turned on when the infra-red emitter is conducting.

4. An under voltage comparator:

The V_{IN} voltage is fed into a Schmitt trigger. When V_{IN} becomes lower than typically 2.35 V, the output of the IC is turned on. The output is switched off again when V_{IN} exceeds typically 2.9 V.

If V_{IN} is below 2.9 V during the initializing phase, the output will remain "on" after initialization, unless V_{IN} rises above 2.9 V.

5. An ISTART block:

A starting current of min. 1 mA is fed to the output, to enable the start up of the SOPS after the initializing phase.

If the output is active (on), the starting current will be blocked.

6. An output stage:

The output stage comprises a Darlington in parallel with a transistor. This configuration enables a high current capability together with a low saturation voltage for low output currents.

During the initialization phase $V_{CC} \geq 1.5$ V, the output stage will be active (on).

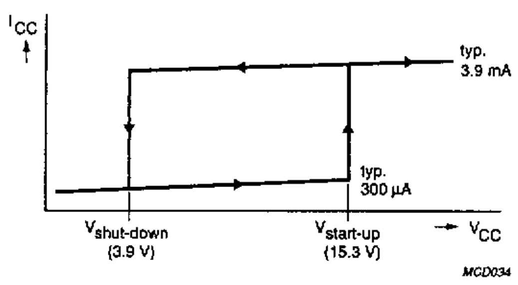


Fig.3 Initialization waveform.

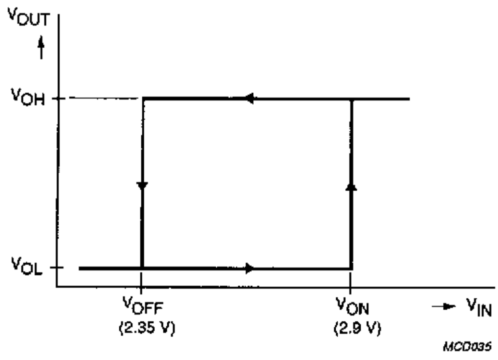


Fig.4 Comparator waveform.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Diode						
V_F	forward voltage	I_F = 10 mA	1.2	1.5	1.9	V
		I_F = 5 mA	–	1.45	–	V
I_R	reverse current	V_R = 5 V	–	–	10	µA
C_d	diode capacitance	V_D = 0; f = 1 MHz	–	200	–	pF
Initialization/supply						
V_{START}	start-up voltage		13.5	15.3	15.5	V
V_{STOP}	shut-down voltage		3.4	3.9	4	V
V_{START}/V_{STOP}	start/stop ratio		3.6	3.95	4.4	V
$I_{CC\ off}$	supply current (shut off)	V_{CC} = 10 V	–	170	220	µA
$I_{CC\ start}$	supply current at start-up	$V_{CC} = V_{START} - \delta V$ note 1	–	300	350	µA
$I_{CC\ on}$	supply current (started)	V_{CC} = 10 V; $V_{IN} \leq 2$ V	–	3.9	5	mA
$I_{START\ on}$	starting current (started)	V_{CC} = 10 V; $V_{IN} \geq 3.2$ V	1	1.5	–	mA
Undervoltage Schmitt trigger						
V_{ON}	turn-on voltage	I_F = 0; V_{CC} = 10 V; V_{OUT} = 0.2 V	2.85	2.9	3	V
V_{OFF}	turn-off voltage	I_F = 0; V_{CC} = 10 V; V_{OUT} = 0.2 V	2.27	2.35	2.42	V
I_{IN}	input current	V_{CC} = 10 V; V_{IN} = 3.2 V	–	12	30	µA

Note

1. $V_{CC\ start}$ is an unstable point for the current variation, so the measurement is made at a very close and stable point, (e.g. δV = 10 mV).

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Optocoupler						
I_{OUT}	output current	I_F = 5 mA; V_{CC} = 10 V; V_{IN} = 3.2 V; V_{OUT} = 0.2 V	10	10.5	–	mA
		I_F = 5 mA; V_{CC} = 10 V; V_{IN} = 3.2 V; V_{OUT} = 1 V; t_p = 3 μs; δ = 0.1	0.75	0.80	–	A
		I_F = 0; V_{CC} = 3 V; V_{OUT} = 0.3 V	1	2.5	–	mA
		I_F = 0; V_{CC} = 3 V; V_{OUT} = 1.5 V; t_{on} = 10 μs	0.9	1.05	–	A
V_{OUT}	output voltage	I_F = 5 mA; V_{CC} = 10 V; V_{IN} = 3.2 V; I_{OUT} = 2 A; t_p = 3 μs; δ = 0.1	–	1.39	1.45	V
Switching times (see Figs 5 and 6)						
t_{PHL}	propagation switching time from high to low level output	I_F = 5 mA; V_{IN} = 3.2 V; R_L = 4.7 Ω; V_{CC} = 10 V started	–	0.3	0.5	μs
t_{PLH}	propagation switching time from low to high level output	I_F = 5 mA; V_{IN} = 3.2 V; R_L = 4.7 Ω; V_{CC} = 10 V started	–	0.4	1	μs
Switching times on the initialization curve (see Figs 7 and 8)						

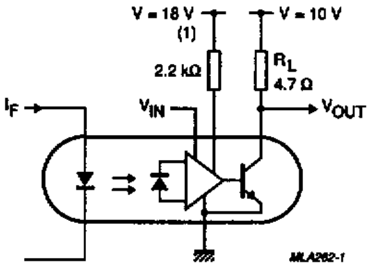
t_{HL}	switching time from high to low level output	I_F = 0;
		V_{IN} = 3.2 V;
		R_L = 50 Ω;
		start-up V_{CC} = 16 V;
		shut-down V_{CC} = 3.4 V;
			–	1.8	–	μs

t_{LH}	switching time from low to high level output	I_F = 0;
		V_{IN} = 3.2 V;
		R_L = 50 Ω;
		start-up V_{CC} = 16 V;
		shut-down V_{CC} = 3.4 V;
			–	0.9	–	μs

CAUTION

It is advised that normal static precautions have to be taken in the handling and assembling of these components, to prevent damage and/or degradation which may be induced by ESD (Electrostatic Discharge).

The partial discharge test according to VDE 0884 is performed after all the other high voltage tests.



(1) V_{CC} = 10 V after start.

Fig.5 Switching times test circuit.

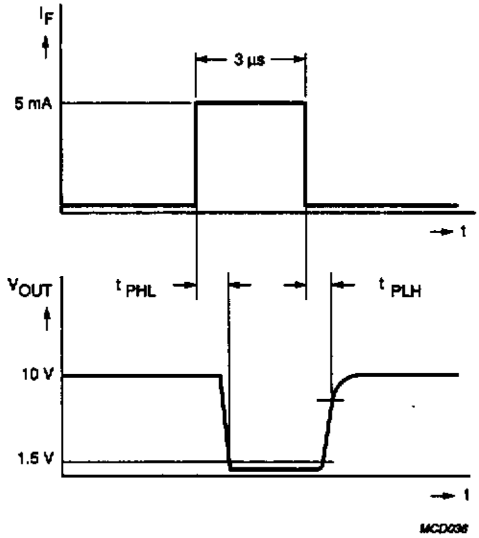


Fig.6 Switching times waveform.

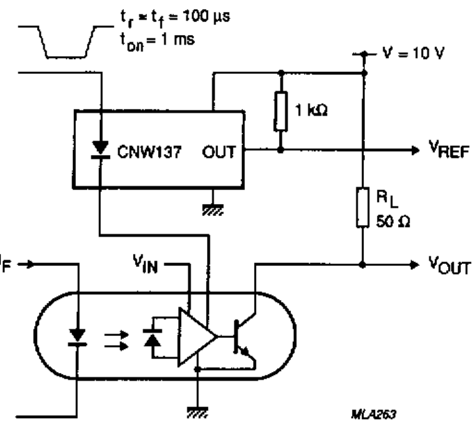


Fig.7 Switching times (on the initialization curve) test circuit.

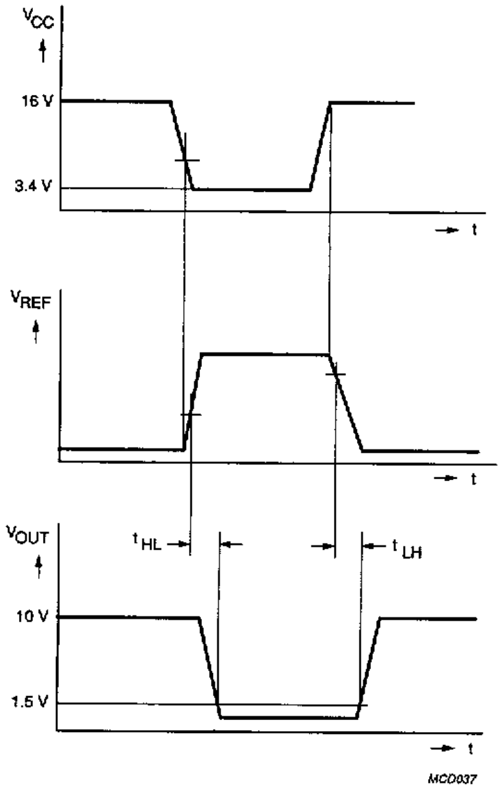


Fig.8 Switching times (on the initialization curve) waveforms.

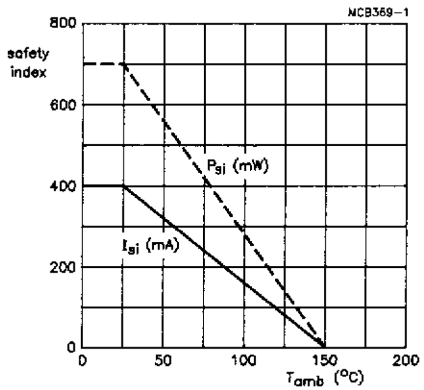
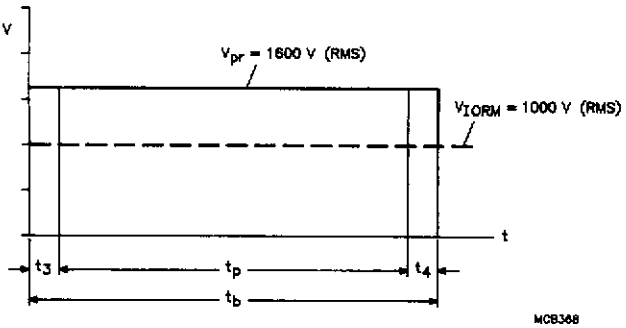
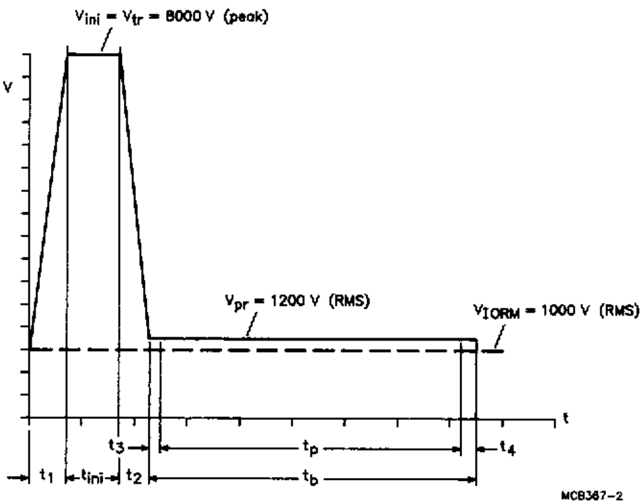


Fig.9 Dependence of safety maximum ratings with ambient temperature.



t_p = 1 s.
t_b = 1.2 s.
$t_3 = t_4$ = 0.1 s.
T_{amb} = 15 to 35 °C/(23±1) °C in case of dispute.
RH = 45 to 75/(50±2)% in case of dispute.
Partial discharge test limit q_c = 5 pC (during t_p).

Fig.10 Partial discharge measurement procedure 'b', according to VDE 0884 non destructive test for 100% inspection.



t_{ini} = 10 s.
$t_1 = t_2$ = 100 V/s to 1000 V/s.
t_p = 60 s.
$t_3 = t_4$ = 1 s.
T_{amb} = 15 to 35 °C/(23±1) °C in case of dispute.
RH = 45 to 75/(50±2)% in case of dispute.
Partial discharge test limit q_c = 5 pC (during t_p).

Fig.11 Partial discharge measurement procedure 'a', according to VDE 0884 destructive test for qualification and sampling tests.

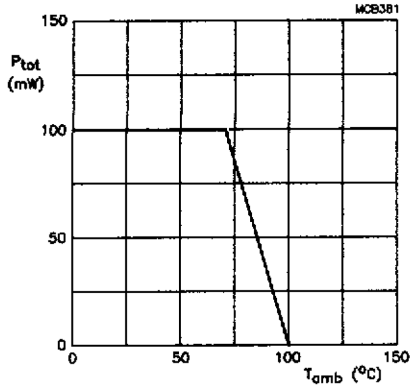
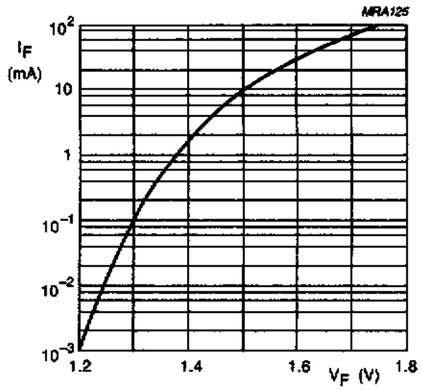
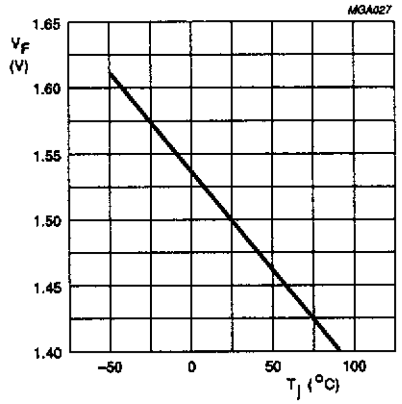


Fig.12 Total power dissipation as a function of ambient temperature.



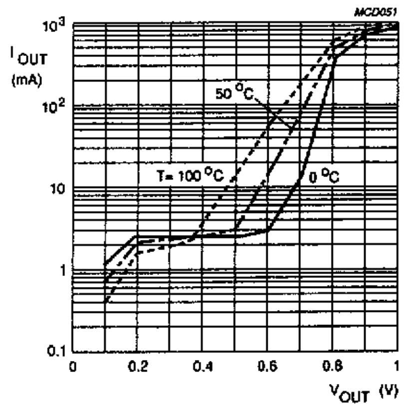
T_{amb} = 25 °C.

Fig.13 Forward current as a function of forward voltage; typical values.



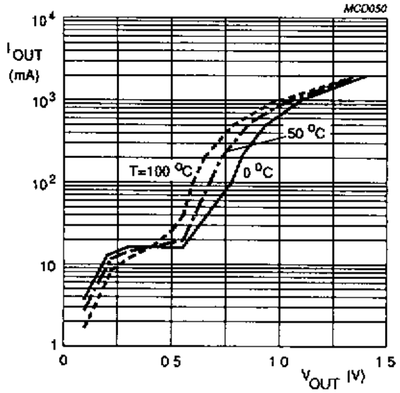
I_F = 10 mA.

Fig.14 Forward voltage as a function of junction temperature, typical values.



$V_{CC\ off}$.

Fig.15 Output stage as a function of temperature, measured at V_{CC} = 10 V.



$V_{CC\ on}$.

Fig.16 Output stage as a function of temperature, measured at V_{CC} = 10 V.

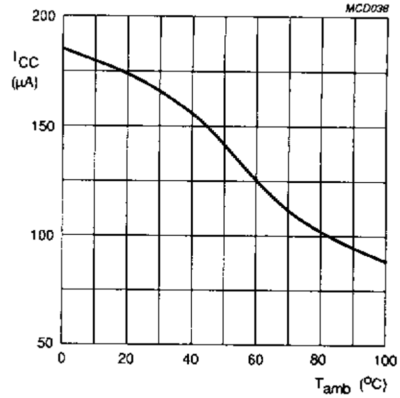


Fig.17 $I_{CC\ off}$ as a function of temperature.

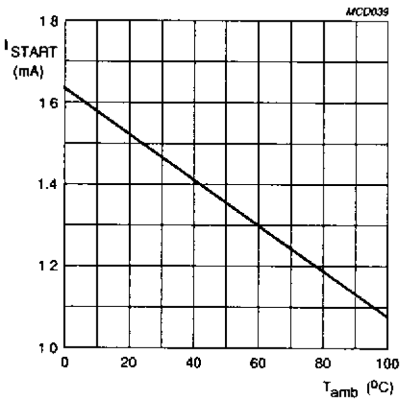


Fig.18 I_{START} as a function of temperature.

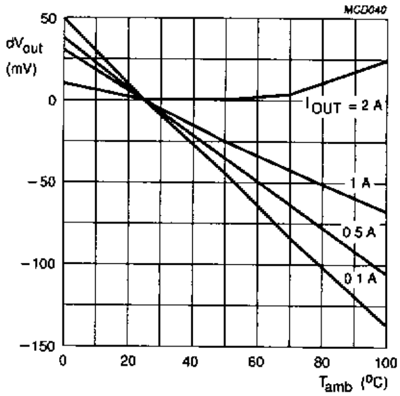


Fig.19 Output voltage variation (dV_{OUT}) as a function of temperature.

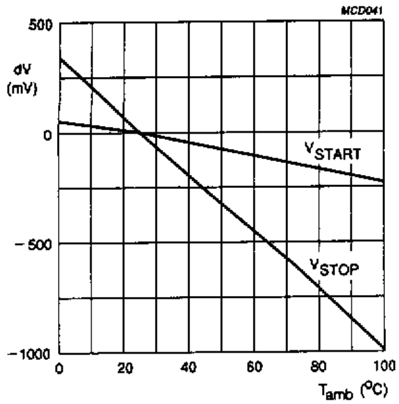


Fig.20 Voltage variations (dV_{START} and dV_{STOP}) as functions of temperature.

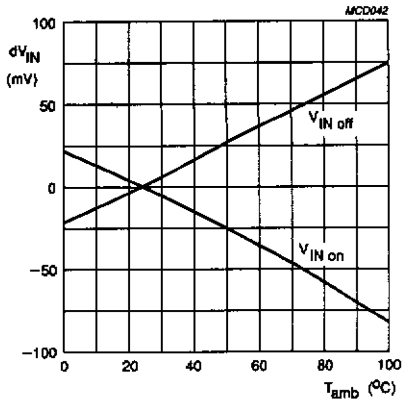


Fig.21 Input voltage variation (dV_{IN}) as a function of temperature.

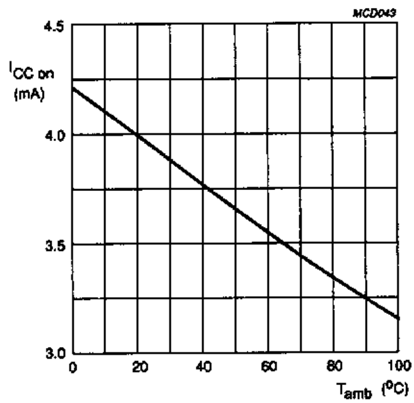


Fig.22 Supply 'on' current ($I_{CC\ on}$) as a function of temperature.

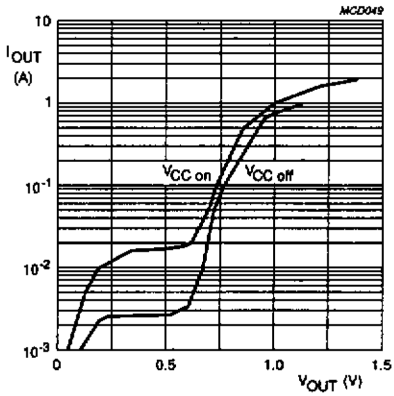


Fig.23 Output stage: output current as a function of output voltage, measured at V_{CC} = 10 V.

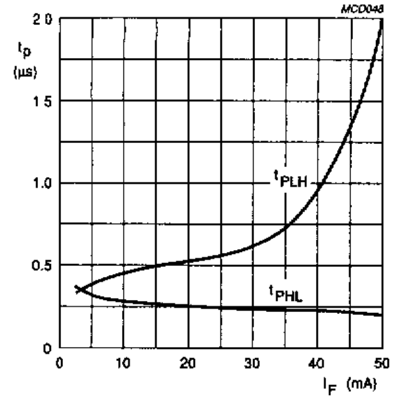


Fig.24 Propagation delay times as functions of forward current.

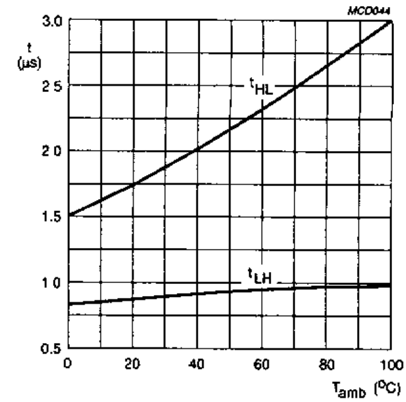


Fig.25 Switching times as functions of temperature.

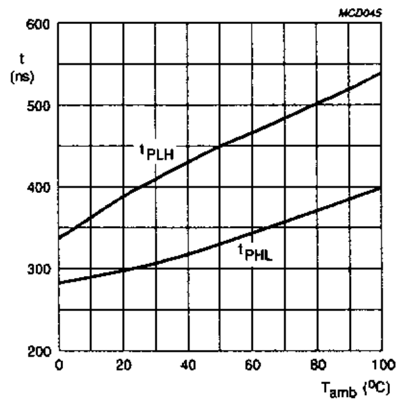


Fig.26 Propagation delay times as functions of temperature.

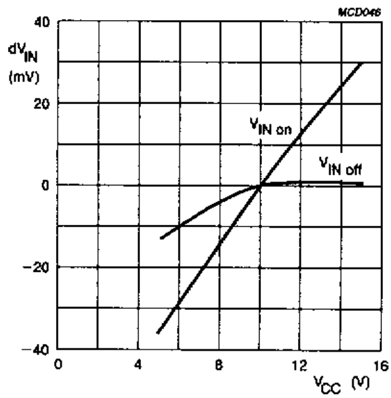


Fig.27 Input voltage variation (dV_{IN}) as a function of supply voltage.

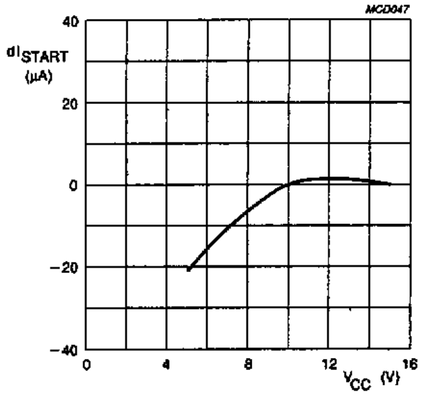


Fig.28 Starting current variation (dI_{START}) as a function of supply voltage.

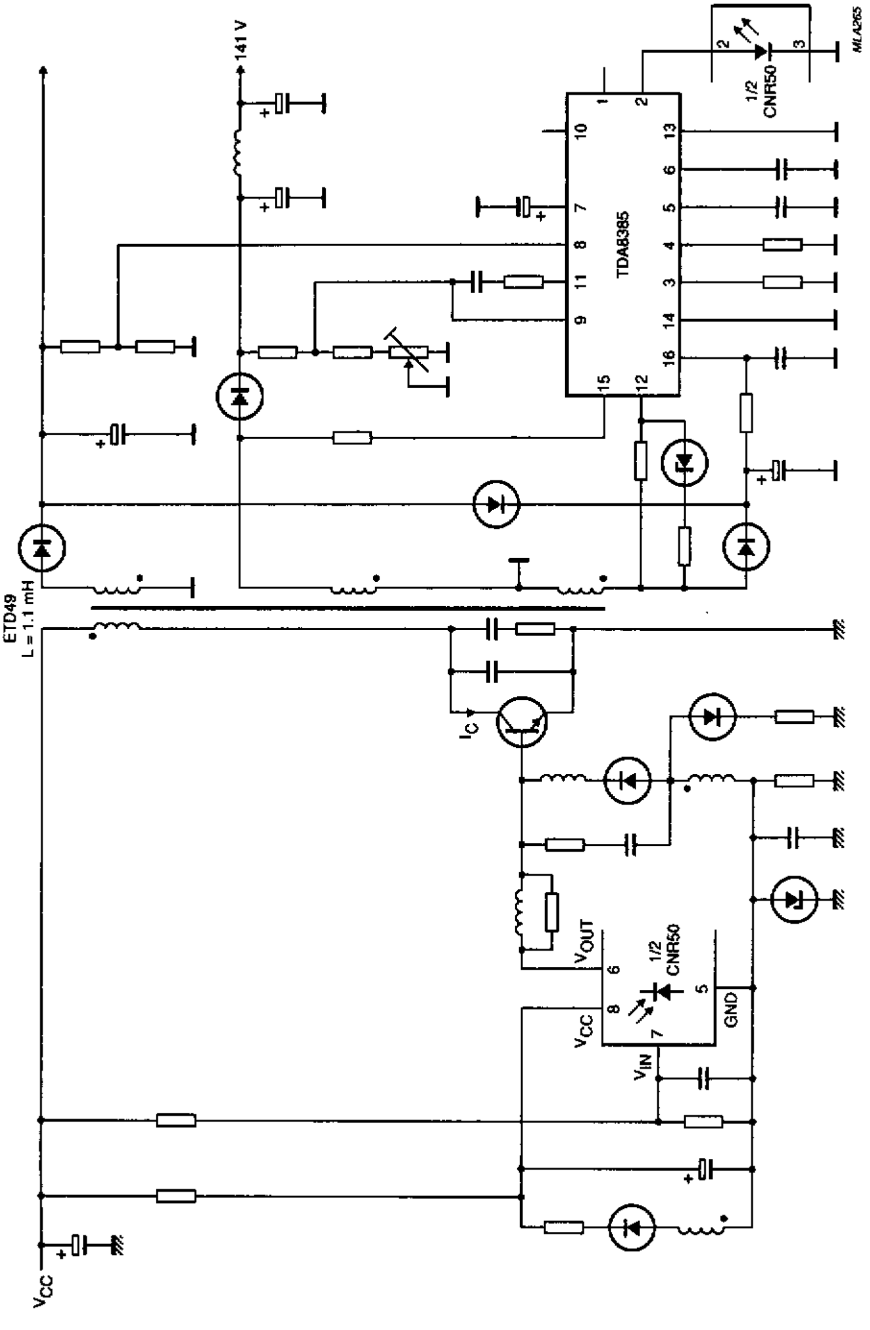


Fig.29 Typical application circuit with bipolar switch.

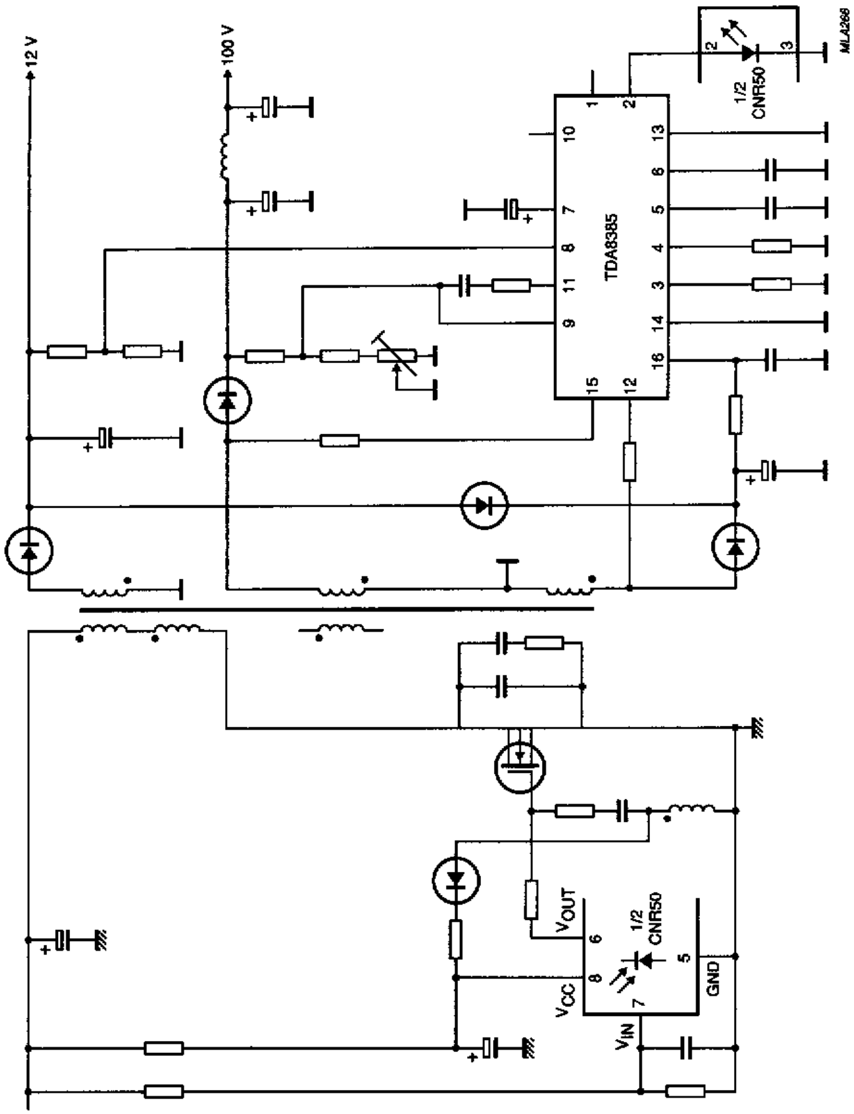


Fig.30 Typical application circuit with MOS switch.

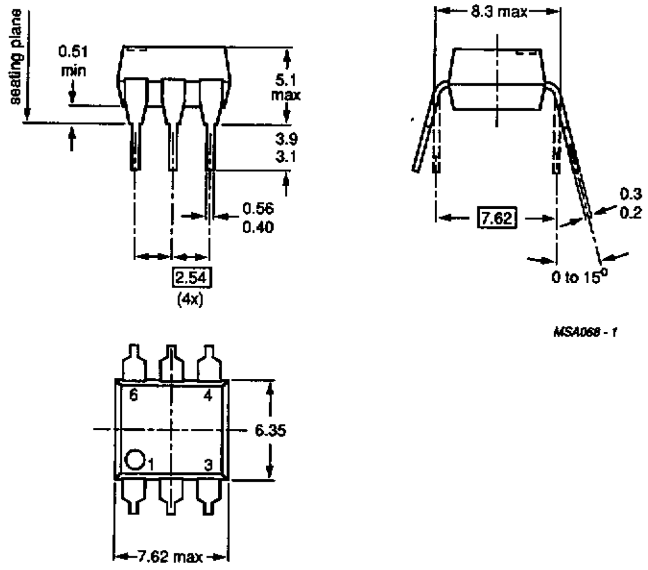


Fig.1 SOT90B.

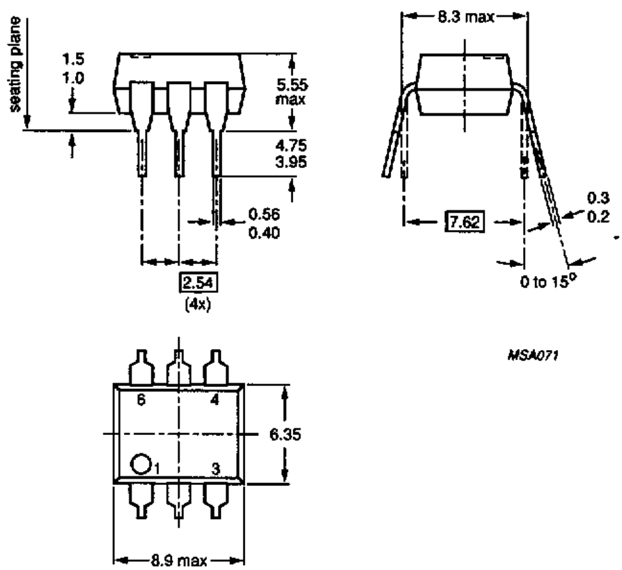


Fig.2 SOT229B.

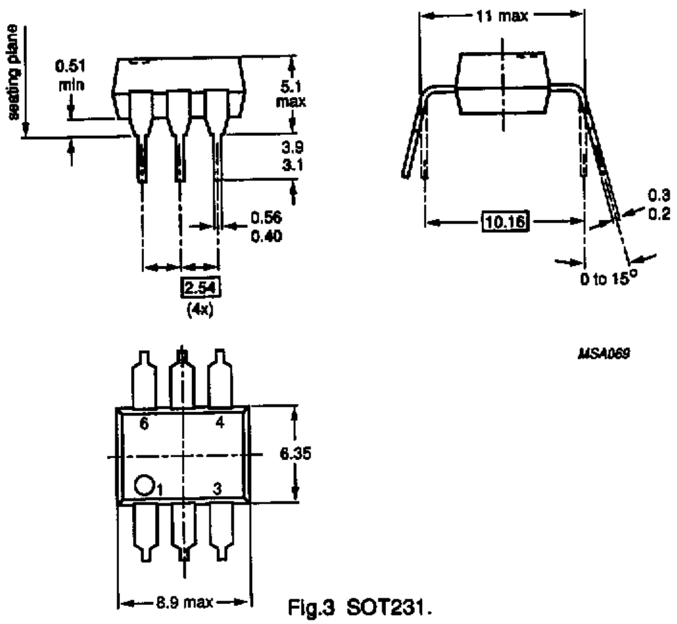


Fig.3 SOT231.

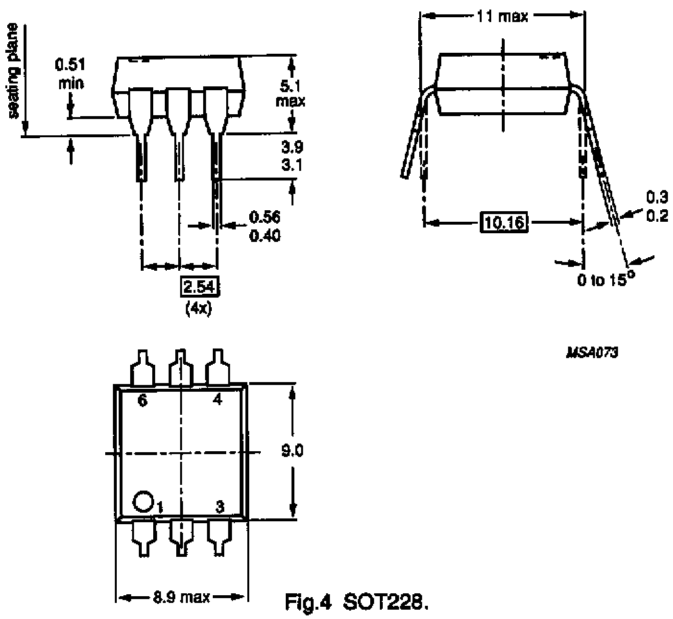


Fig.4 SOT228.

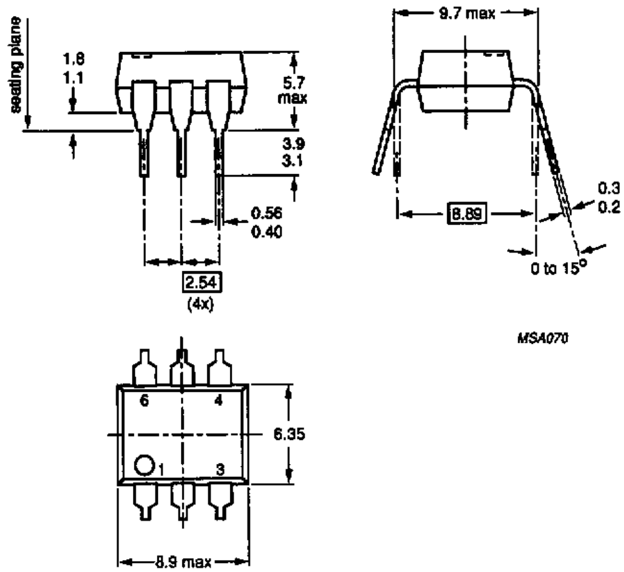


Fig.5 SOT230.

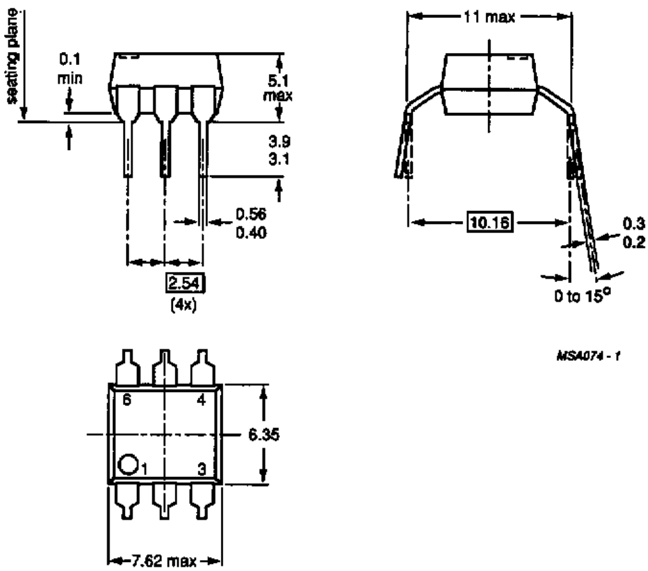


Fig.6 SOT212.

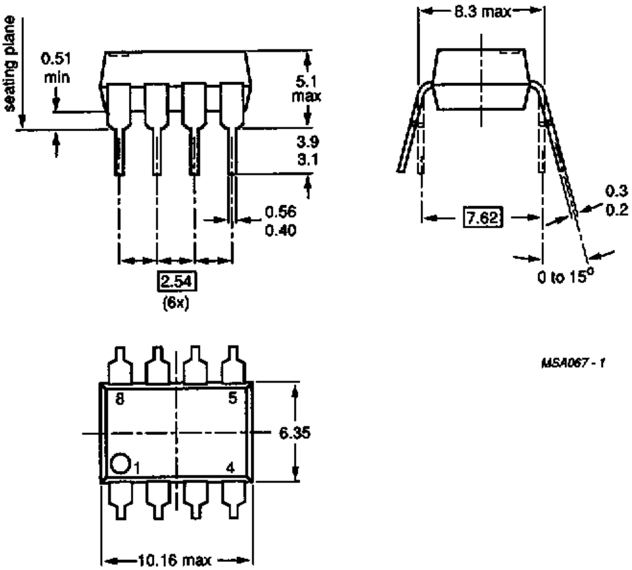


Fig.7 SOT97F.

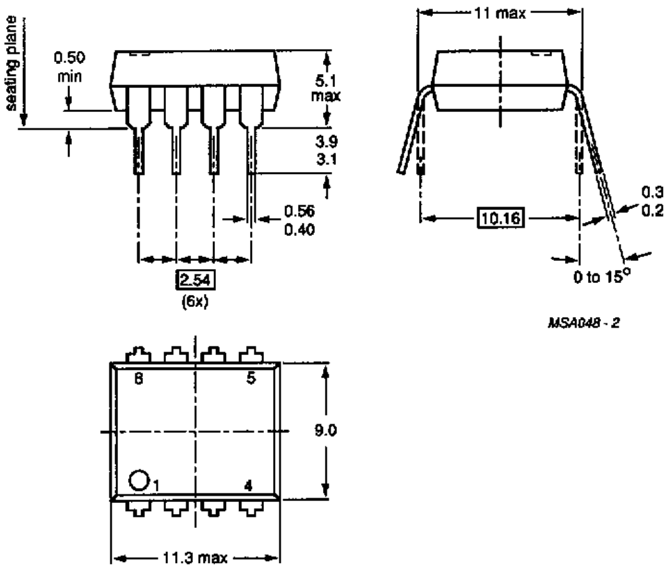


Fig.8 SOT271.

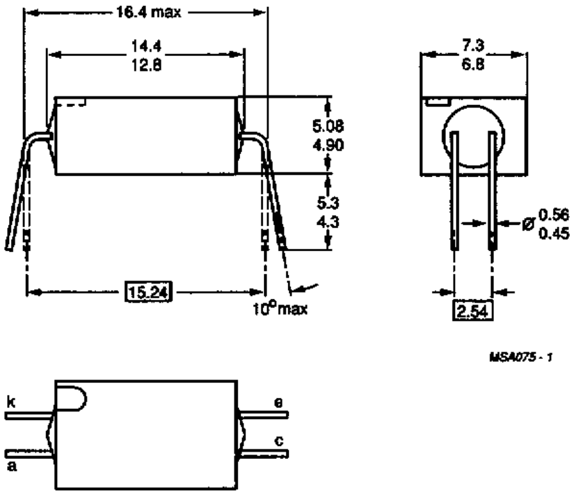

16.4 max
14.4
12.8
5.08
4.90
5.3
4.3
15.24
10° max
7.3
6.8
Ø 0.56
0.45
2.54
MSA075 - 1
k
e
c
a

Fig.9 SOT211.