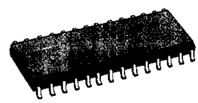
MONITOR AMPLIFIER AND RINGER

LOUDSPEAKER AMPLIFIER

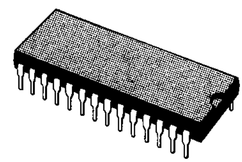
- ANTI-ACOUSTIC FEEDBACK (antilarsen)
- ANTIDISTORSION BY AUTOMATIC GAIN ADAPTATION
- PROGRAMMABLE GAIN IN STEPS OF 6 dB OR LINEARLY
- ON/OFF POSITION
- LOW VOLTAGE
- POWER : 100 mW AT 5 V

RINGER

- SWITCHING REGULATOR TO TRANSFORM HIGH INTO LOW VOLTAGE IN RING MODE
- MICROCOMPUTER SUPPLY WITH RESET, HALT AND RING DETECTION SIGNAL
- TUNE GENERATION BY MCU AND RINGING BY LOUDSPEAKER



SO-28



DIP28

ORDER CODES : TEA7031DP (DIP28)
TEA7031FP (SO-28)

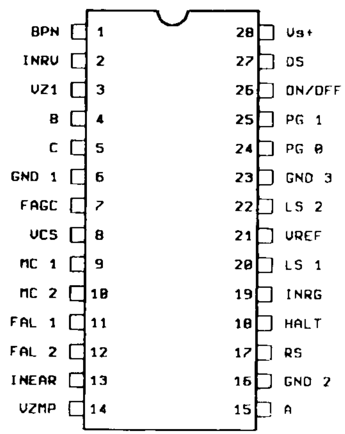
DESCRIPTION

TEA7031 is a 28-pin DIL integrated circuit providing the following facilities :

- Loudspeaker amplifier
- Anti-acoustic feed-back system (anti-Larsen system)
- Microprocessor supply and control
- Switching regulator control

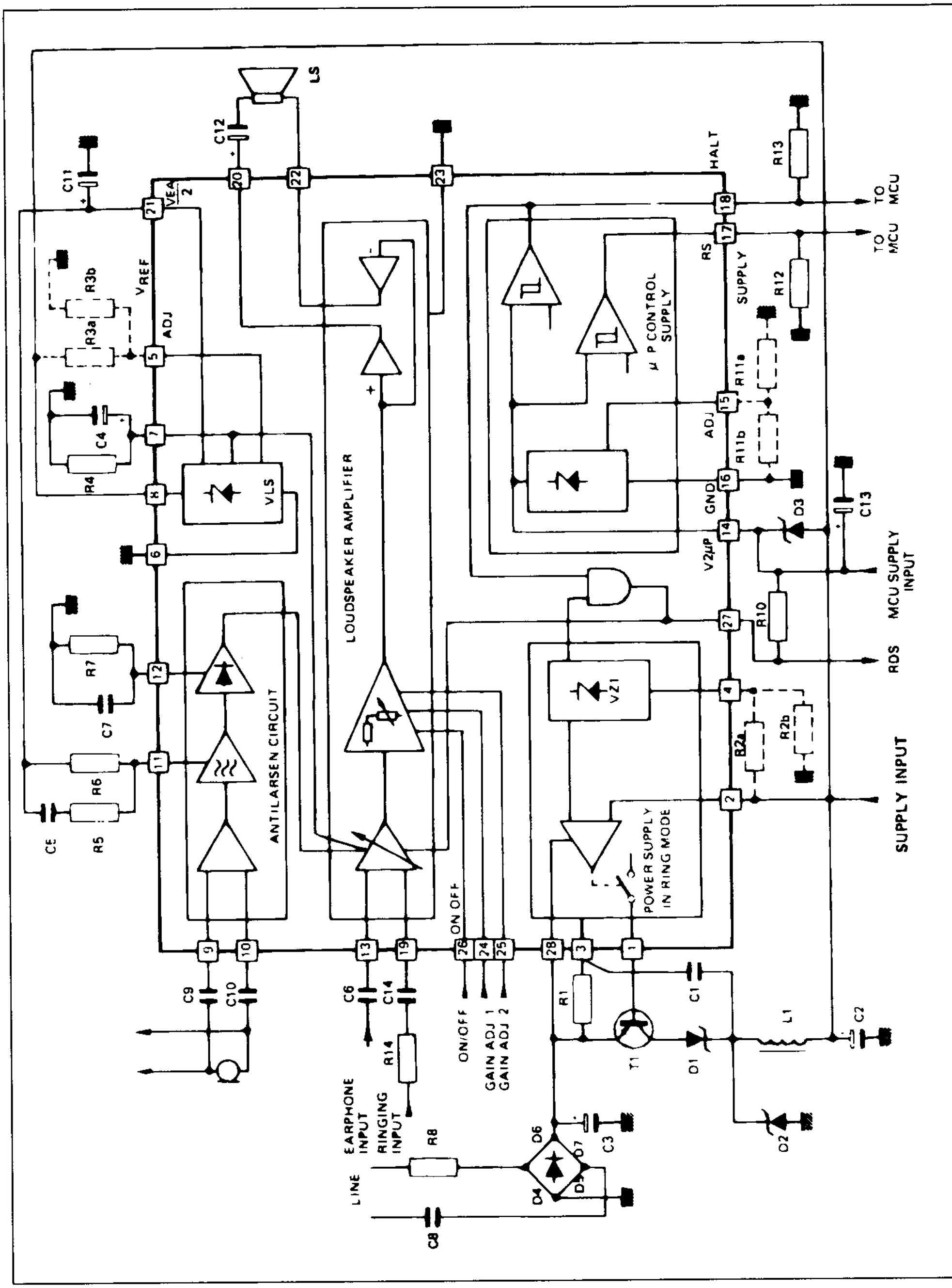
These facilities are generally electrically separated ; hence selective use of the functions provided is possible.

PIN CONNECTION (top view)



M88TEA7031-01

BLOCK DIAGRAM



PIN DESCRIPTION

Name	N°	Description
BPN	1	Base Drive to External Transistor of the Switchmode Power Supply
INRV	2	Switchmode Power Supply Regulation Input
VZ1	3	3.5 V Reference Voltage to Switchmode Power Supply
B	4	Adjust VZ1
C	5	Adjust VLS
GND 1	6	Ground
FAGC	7	Gain Control Filter
VCS	8	Supply Voltage
MC 1	9	Microphone Input 1
MC 2	10	Microphone Input 2
FAL 1	11	Antilarsen Filter 1
FAL 2	12	Antilarsen Filter 2
INEAR	13	Earphone Input
V_{ZMP}	14	Microprocessor Supply Voltage, Internally Zener Stabilized (3.3 V)
A	15	Adjust VZMP
GND 2	16	Ground
RS	17	Microprocessor Reset Output
Halt	18	Microprocessor Halt Output
INRG	19	Input Ringing Signal
LS 1	20	Loudspeaker Output
VREF	21	Internal Reference
LS 2	22	Loudspeaker Output
GND 3	23	Ground
PG 0 PG 1	24 25	Gain Level Programming
ON/OFF	26	Loudspeaker ON/OFF
DS	27	Ring Signal Indication
V_S +	28	Rectified Ring Signal Input

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{LS}	Supply Voltage (adjustable)	6	V
V_{S+}	Input Voltage Rectified Ring Signal	22	V
I_{LS}	Supply Current	90	mA
P_{tot}	Power Dissipation	360	mW
V_{ZMP}	Microprocessor Short Regulator Voltage	6	V
I_{ZMP}	Microprocessor Short Regulator Current	30	mA
T_{oper}	Operating Temperature Range	– 5 to + 45	°C
T_{STO}	Storage Temperature Range	– 55 to + 125	°C

ELECTRICAL CHARACTERISTIC (T_{amb} = 25 °C unless otherwise specified)

Symbol	Parameter	Test Conditions			Min.	Typ.	Max.	Unit
V_{LS}	Shunt Voltage Regulator	I_{LS} = 2 mA			2.65	2.8	3.2	V
		I_{LS} = 30 mA			2.7	2.9	3.4	V
V_1	Voltage Pin 1	I_{LS} = 2 mA to 30 mA				1.25		V
$I_{AGC\ off}$	Gain Control Current	I_{LS} = 30 mA (fig. 1)					1	µA
$I_{AGC\ on}$		V_{LS} = 2.6 V (fig. 2)				– 4	– 2.5	µA
G	Loudspeaker Amplifier $GAIN = \frac{V_{22} - V_{20}}{V_{13}}$	f = 300 Hz V_{OUT} = 0.8 V_{RMS} (fig. 3)						
		ON/OFF	P_{G0}	P_{G1}				
		GND	GND	GND	12	14	16	dB
		GND	GND	V_{LS}	18	20	22	dB
		GND	V_{LS}	GND	24	26	28	dB
		GND	V_{LS}	V_{LS}	30	32	34	dB
		V_{LS}	GND	GND		– 30	– 20	dB
THD	Distortion	I_{LS} = 30 mA ; V_{OUT} = 0.8 V_{RMS} f = 300 Hz to 10 kHz (fig. 3)						
		ON/OFF	P_{G0}	P_{G1}				
		GND	V_{LS}	V_{LS}			2	%
G_{RING}	Ringing Gain $GAIN = \frac{V_{22} - V_{20}}{V_{19}}$	(fig. 4)						
		ON/OFF	P_{G0}	P_{G1}				
		V_{LS}	GND	GND	12	19	16	dB
		V_{LS}	GND	V_{LS}	18	20	22	dB
		V_{LS}	V_{LS}	GND	24	26	28	dB
		V_{LS}	V_{LS}	V_{LS}	30	32	34	dB
$Z_{MIC\ IN}$	Microphone Input	Symetrical (pins 9 - 10)				4.5		kΩ
		Asymetrical (pin 10)				36		kΩ
$Z_{EAR\ IN}$	Earphone Input					2.8		kΩ
$Z_{RING\ IN}$	Ringing Input					1.2		kΩ
I_{PG0} I_{PG1} $I_{ON/OFF}$	Input Current ON State	I_{LS} = 30 mA (fig. 3) $V_{21} = V_{25} = V_{26}$ = GND			– 10 – 10 – 10	– 5 – 5 – 5		µA µA µA
I_{PG0} I_{PG1} $I_{ON/OFF}$	Input Current OFF State	I_{LS} = 30 mA (fig. 3) $V_{21} = V_{25} = V_{26} = V_{LS}$					1 1 1	µA µA µA
G_{MIC}	Microphone Gain $= \frac{V_{11}}{(V_9 - V_{10})}$	I_{LS} = 30 mA (fig. 5)			18	22	26	dB
A_{NT} RMS	Antilarsen Control $= \frac{(V_{22} - V_{20})}{V_{13}}$	I_{LS} = 30 mA (fig. 6) V_{13} = 20 mV_{RMS} V_{12} = 0.3 V_{DC} V_{12} = 0.6 V_{DC}			 20 		 – 20	 dB dB

ELECTRICAL CHARACTERISTIC (continued)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
MICROCOMPUTER SUPPLY SECTION						
V_{ZMP1}	Supply Voltage	I_{ZMP1} = 3 mA (fig. 9)	3	3.3	3.6	V
I_{ZMP}	Supply Current	V_{ZMP} = 0.8 V_{ZMP1} (fig. 10)		0,3		mA
I_{RESET}	Reset ON	V_{17} = 0 V ; V_{14} = V_{ZMP1}			1	µA
	Reset OFF	V_{17} = 0 V ; V_{14} = 0.8 V_{ZMP1}		– 150	– 75	µA
I_{HALT}	Halt ON	V_{18} = 0 V ; V_{14} = V_{ZMP1}			1	µs
	Halt Off	V_{18} = 0 V ; V_{14} = 0.8 V_{ZMP1}		– 150	– 75	µA
SWITCH MODE SUPPLY SECTION						
V_{SA}	Maximum Input Voltage	I_{VS} = 1 mA, (fig. 7)	22			V
V_{21}	Voltage Reference	V_{S+} = 22 V ; V_{LS} = 2,8 V (fig. 7)	3,2	3,5	3,8	V
$I_{BPN\ ON}$ $I_{BPN\ OFF}$	PNP Base ON PNP Base OFF	V_{14} = 0 V ; V_2 = 3 V (fig. 8) V_{14} = 0 V ; V_2 = 4 V (fig. 8)	1	2	 1	mA µA
$V_{Z1\ ADJ}$	Adjust VZ1	V_{14} = 0 V ; V_2 = 4 V (fig. 8)		1.1		V
$I_{DS\ ON}$ $I_{DS\ OFF}$	Ring Detection ON Ring Detection OFF	V_{14} = 3.5 V (fig. 8) V_{14} = 0.8 X V_{ZMP1} (fig. 8)	0,8	14		mA µA

Figure 1 : Test VLS, VREF, I AGC, V (5).

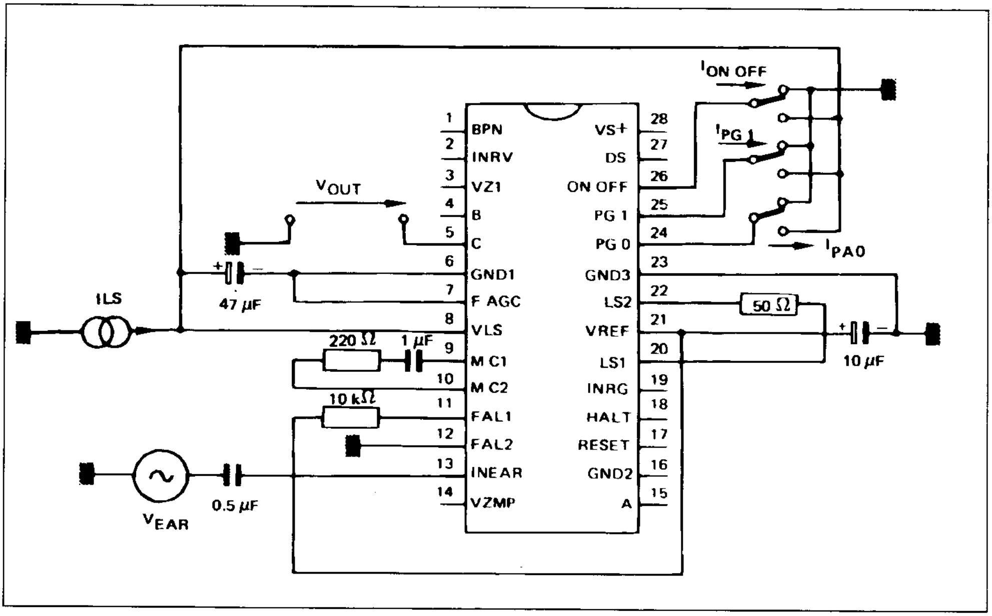


Figure 2 : Test Power Supply - ILS - I AGC.

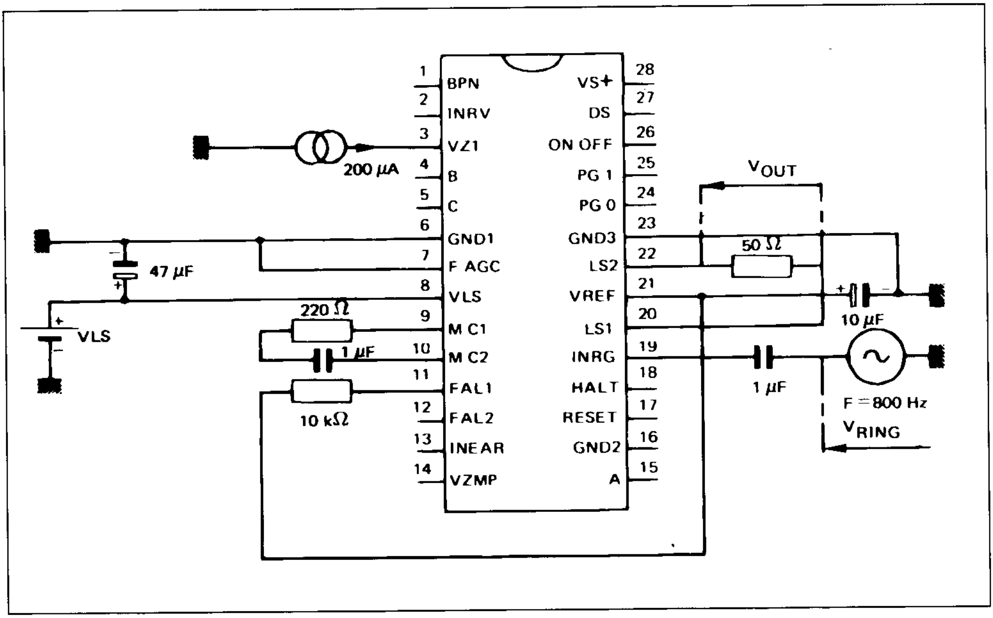


Figure 3 : Test Loudspeaker Amplifier - Gain - Distortion - ILS.

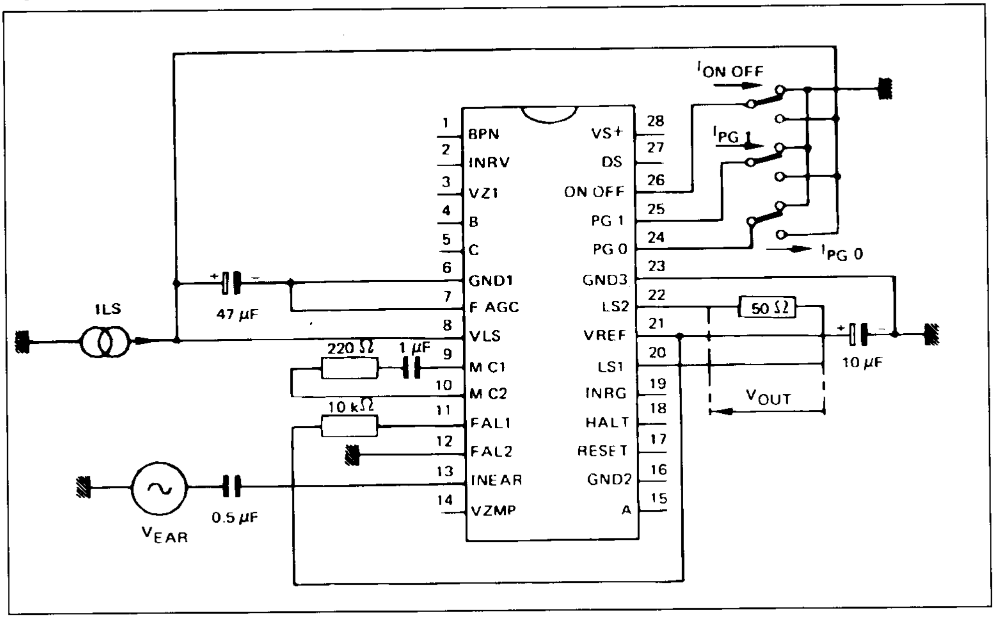


Figure 4 : Test Amplifier.

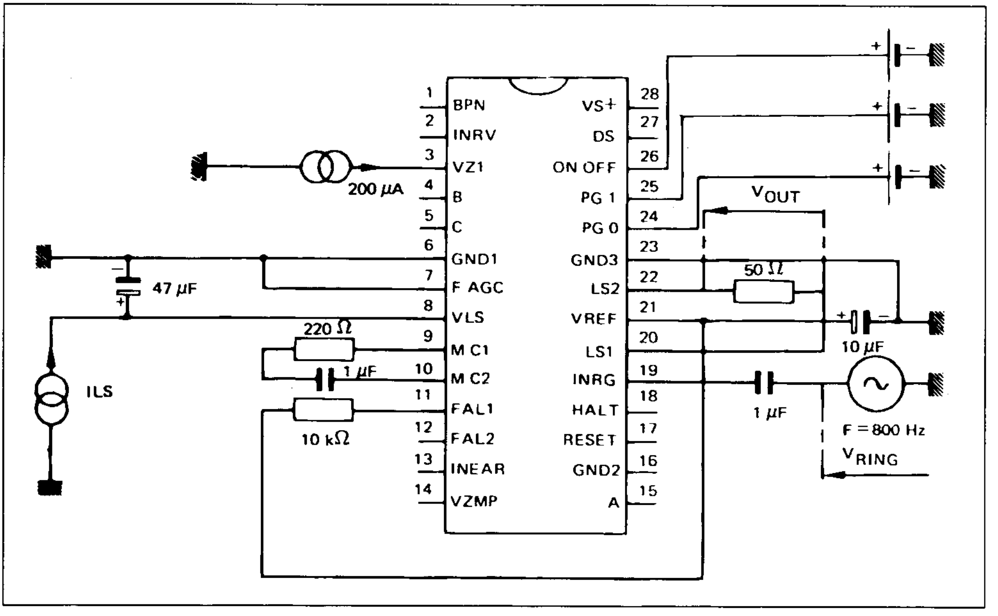


Figure 5 : Test Antiacoustic System Efficiency.

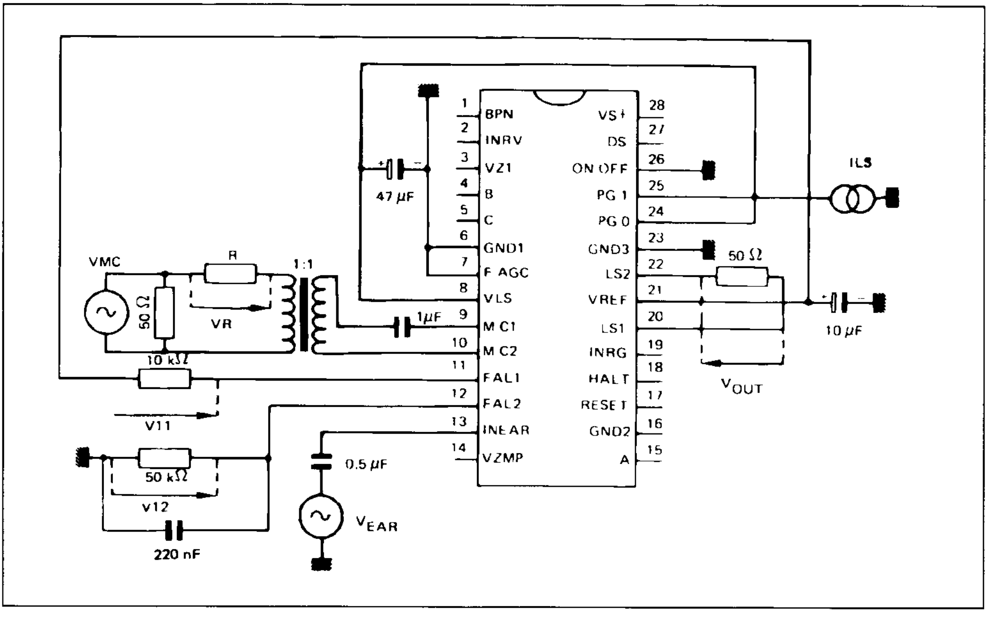


Figure 6 : Test Antiacoustic System Efficiency.

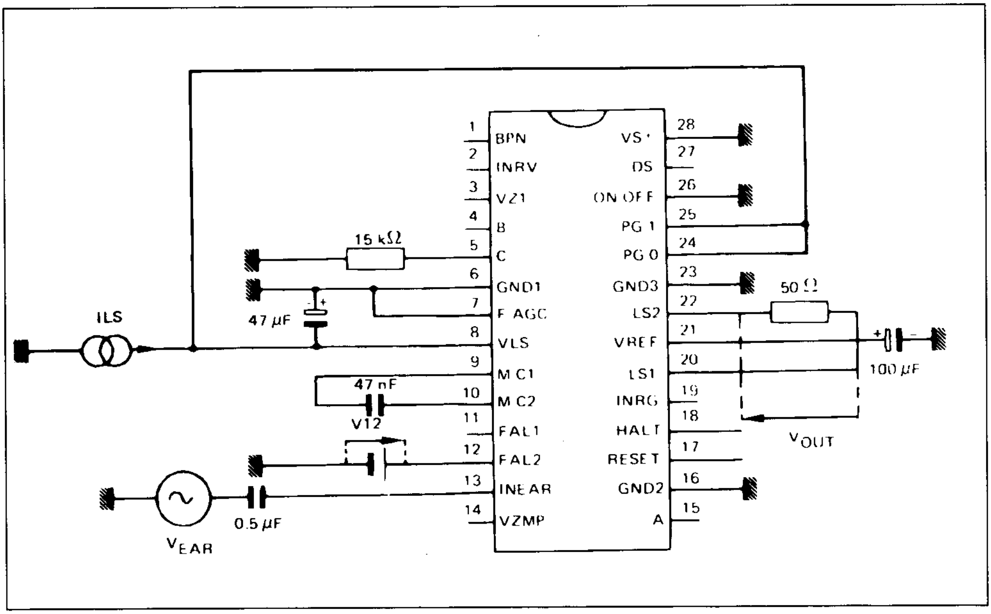


Figure 7 : Test Power Supply in Ring Mode - VZ1 - IBPN - IDS.

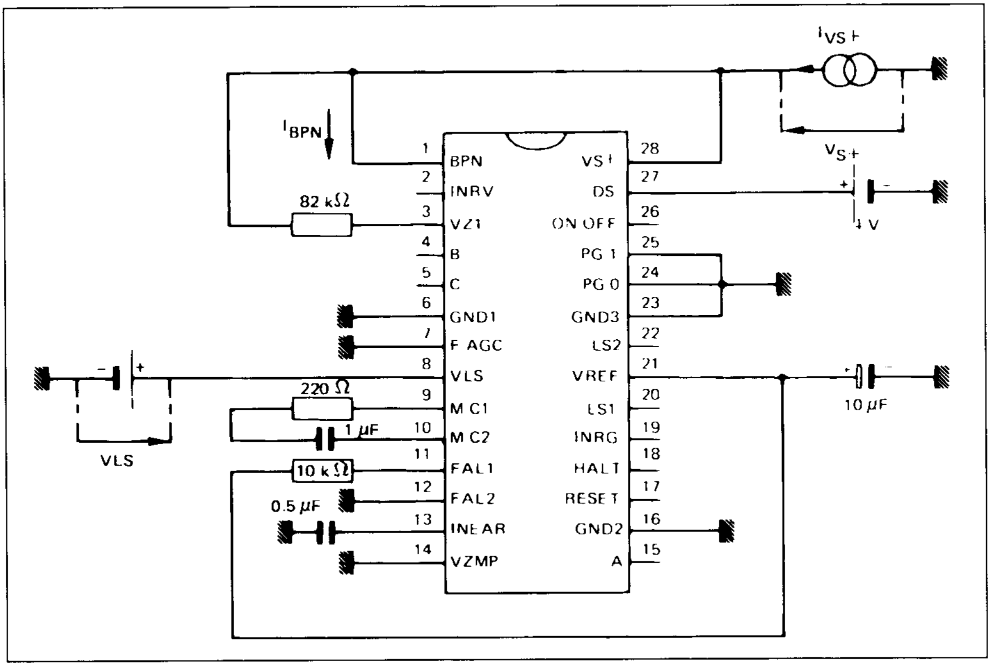
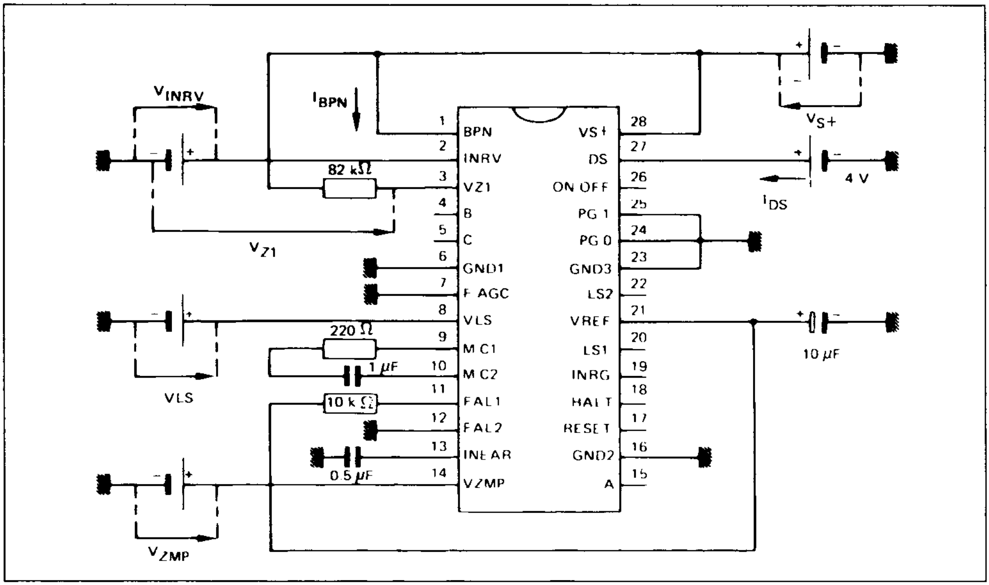


Figure 8 : Test Power Supply in Ring Mode - VB + MAX.



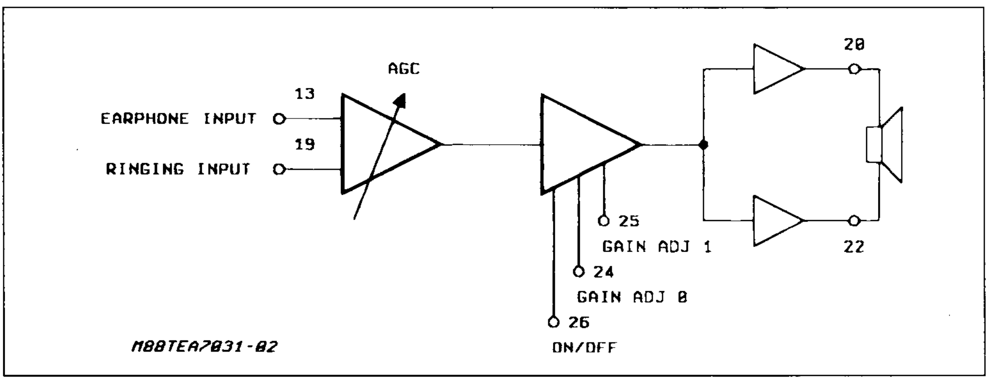
CIRCUIT DESCRIPTION

TEA7031 is a 28-pin DIL integrated circuit providing the following facilities :

- Loudspeaker amplifier
- Anti-acoustic feed-back system (anti-Larsen system)
- Microprocessor supply and control
- Switching regulator control

These facilities are generally electrically separated ; hence selective use of the functions provided is possible.

Figure 9 : Loudspeaker Amplifier.



1.1 LOUDSPEAKER AMPLIFIER

The amplifier is divided into 3 main sections :

a) Automatic Gain Control (AGC)
b) Preamplifier
c) Push-pull amplifier (bridge structure).

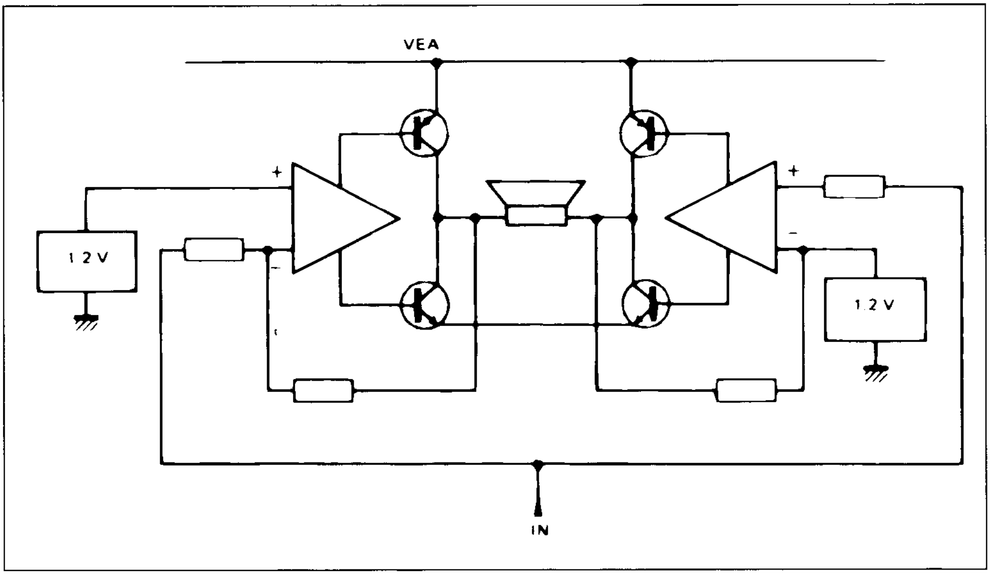
a) The AGC section is used for the anti-Larsen and anti-distortion system.

- When used in a telephone set to avoid Larsen effect the AGC automatically decreases loudspeaker amplifier gain.
- When the required output level exceeds the capabilities of the available current, the AGC decreases the loudspeaker amplifier gain to avoid distorsion.

b) The preamplifier permits step control of amplifier gain in steps of 6 dB, using pins GAIN ADJ 1 and 2, which may be controlled using switches or by a microprocessor.
The amplifier may be muted using the ON/OFF control signal (pin 26).

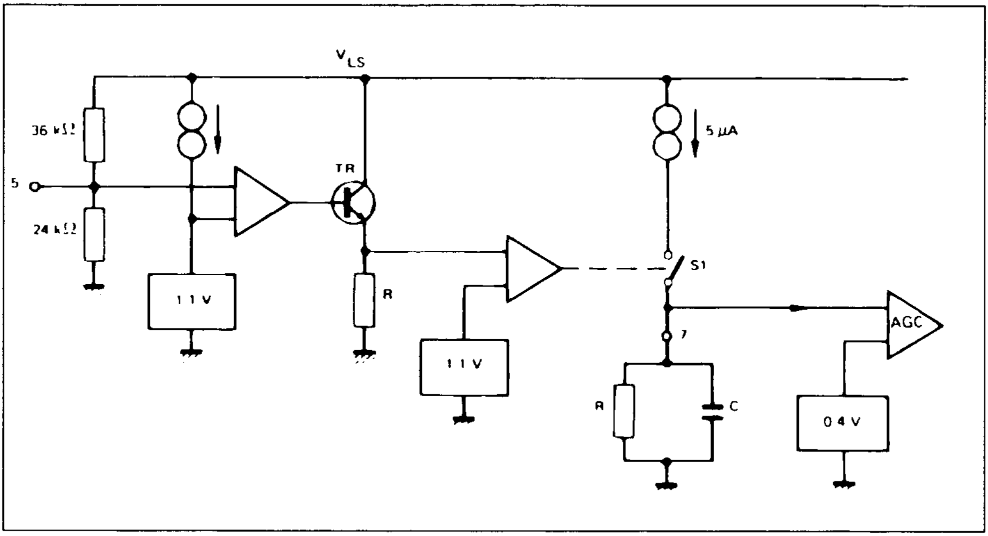
c) The output amplifier uses a double push-pull configuration (H bridge) to get maximum dynamic range under limited supply conditions.

Figure 10 : Output Stage.



Amplifier DC Supply.
In transmission mode, the supply voltage is controlled by the internal shunt DC regulator. For this reason, the TEA7031 should be supplied from a current source (see : supply considerations).
An anti-distortion system is embodied which provides AGC control to avoid loudspeaker distortion under current-limited conditions.

Figure 11.



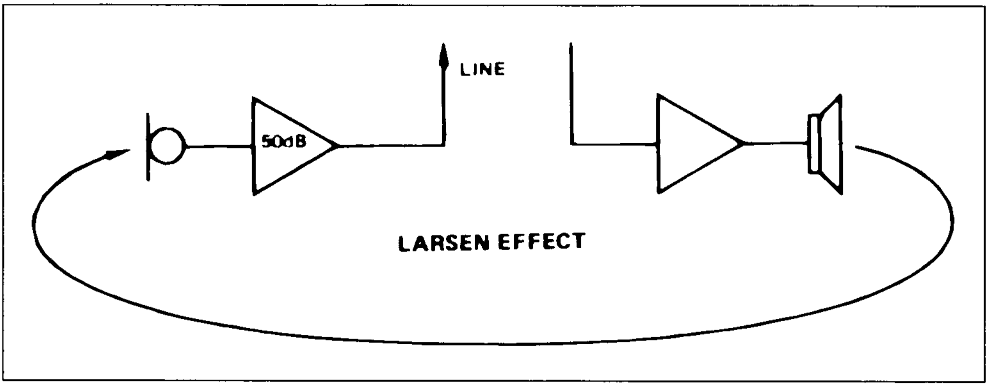
Circuit action.
When the supply voltage is unsufficient, the voltage at pin 5, falls below the reference voltage 1.1 V, resulting in transistor (TR) being switched off, resulting in zero current flow in resistor R. This state enables the gain control system. Under these conditions, the shunt DC supply will switch at a rate determined by the time constant of the RC network on pin 7.

This switching action accomodates normal speech characteristics under low supply conditions.

1.2 . ANTIACOUSTIC FEEDBACK SYSTEM (antilarsen system).

The purpose of this system is to control AGC action, in order to avoid acoustic feedback between the loudspeaker and the microphone, when used in a telephone set.

Figure 12.



Principle of Operation.
When examining, the spectral density of the voice area and the Larsen area, it may be seen that the dominant features of each exist in different frequency bands.

To extract the Larsen component, the microphone signal is first filtered by a second order filter (formed by two first order filters), then amplified and rectified in order to produce the AGC control signal.

Figure 13.

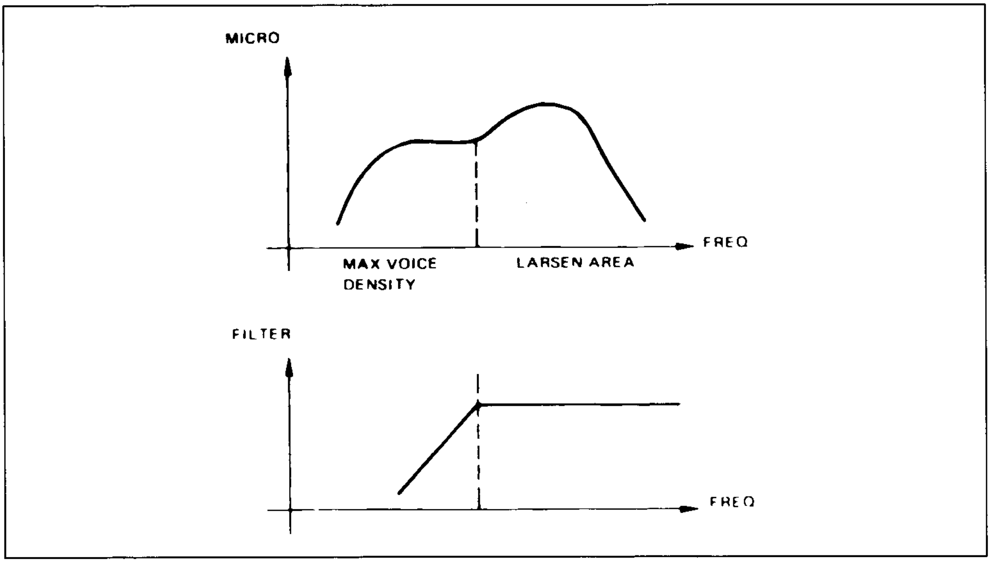
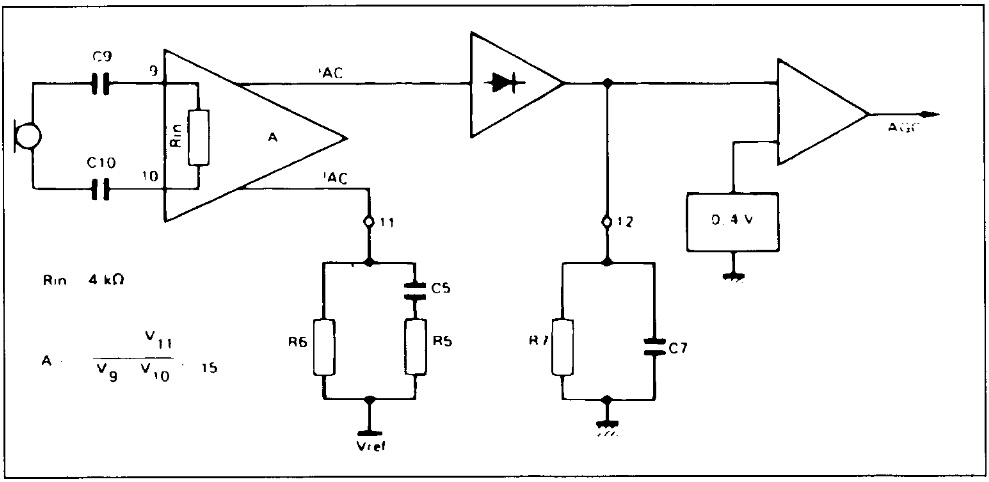


Figure 14.

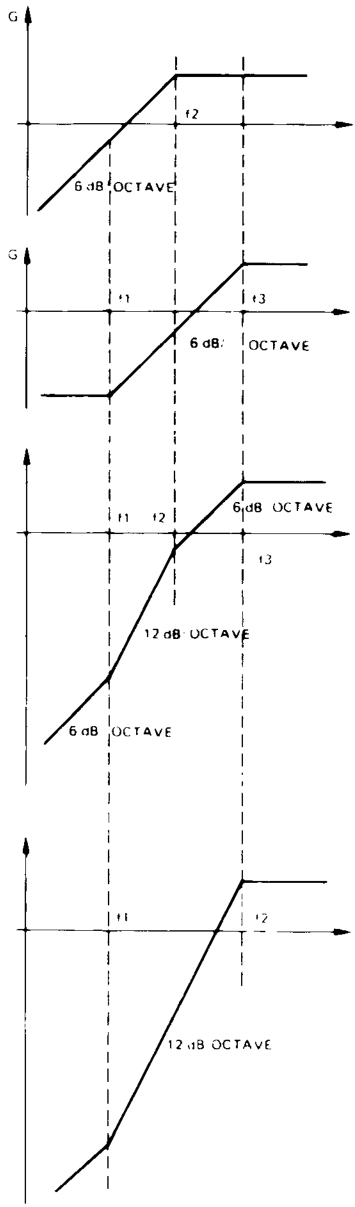


$$i_{AC} = \frac{V_{pin\ 11}}{Z_{pin\ 11}} \quad \text{with} \quad \frac{1}{Z_{pin\ 11}} = \frac{1}{R6} + \frac{1}{R5 + \frac{1}{C5j\omega}}$$

$$V_{DC\ pin\ 12} = \frac{i_{AC}\ (RMS) \cdot 2\sqrt{2}}{\pi}\ R7$$

The first filter is generated by the capacitors on pins 9 and 10 and the input resistor Rin ; the second filter by the RC network on pin 11.

Figure 15.



- Filter on pins 9-10 :

$$f2 = \frac{C9 + C10}{2\pi . Zin.C9.C10}$$

- Filter on pin 11 :

$$f1 = \frac{1}{2\pi (R6 + R5)\ C5}$$

$$f2 = \frac{1}{2\ R5\ C5}$$

- Anti-Larsen system filter response.

- Theoretical result.

If f2 = f3 the anti-Larsen system filter is equivalent to a second order filter.

f2 = f3

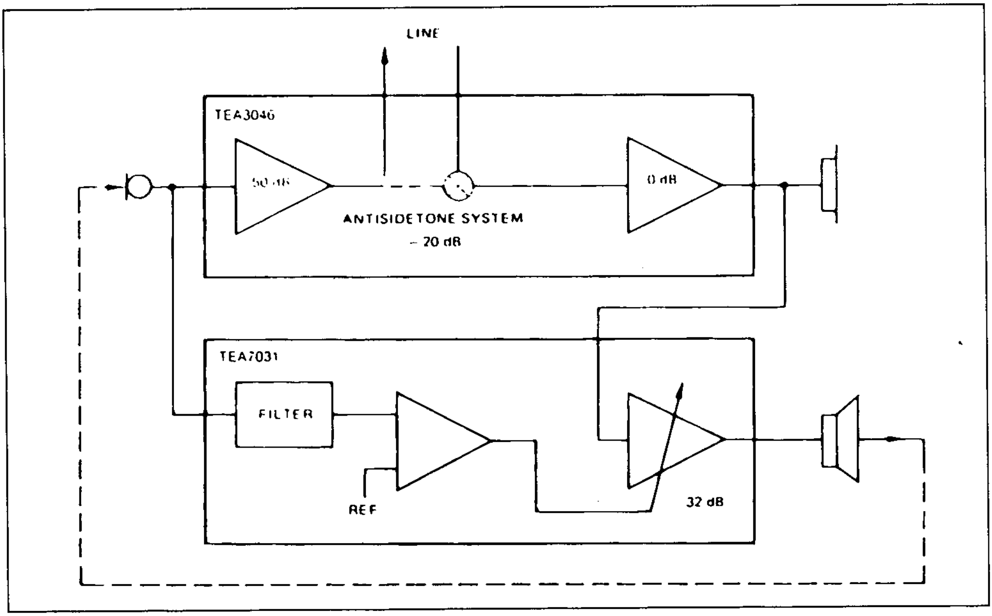
$$\frac{C9 + C10}{2\ \pi . Zim.C9.C10} = \frac{1}{2\ \pi\ R5\ C5}$$

A complete telephone set has two anti-Larsen systems :

- one in the transmission circuit (for example : TEA7050) antisidetone network ;
- one in the loudspeaker amplifier (for example: TEA7031).

Together these form a high efficiency anti-Larsen system.

Figure 16.



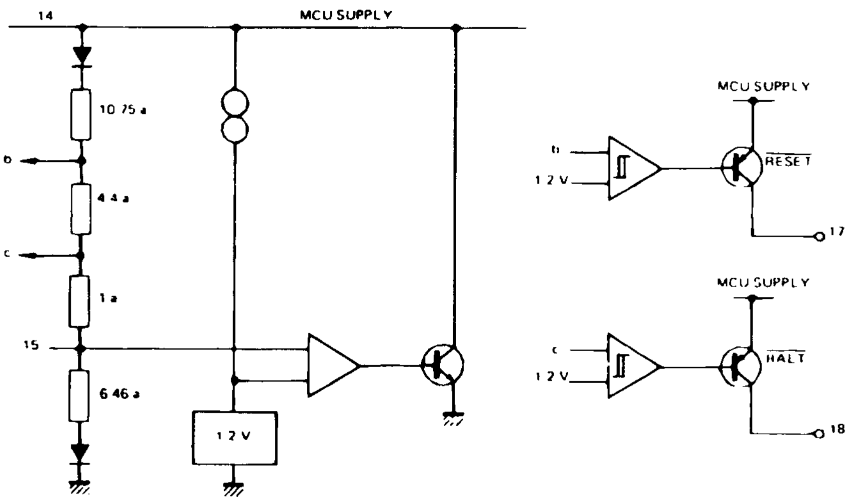
1.3 . MICROPROCESSOR CONTROL.

TEA7031 provides the following signals for an associated microprocessor :

- halt and reset signal,
- a regulated supply.

The MCU shunt supply voltage is internally fixed at 3.2 V but can be adjusted via pin 15.

Figure 17.



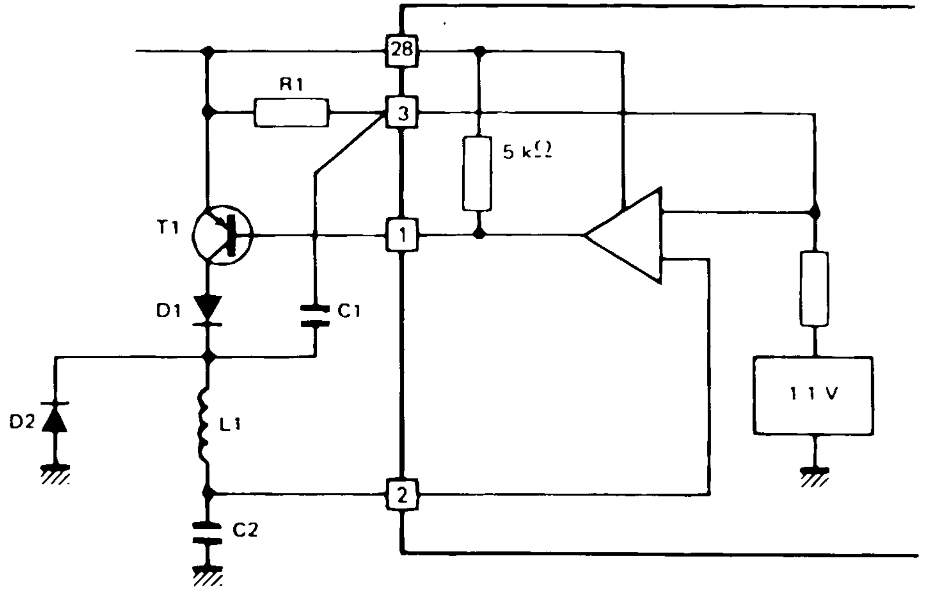
$2\ k\Omega < a < 8\ k\Omega$.

Note : Reset and Halt outputs, which are open collector outputs, require external resistors to zero volt.

1.4 . SWITCHING CONVERTER.

Under ringing conditions the line supply available has a high voltage (~ 22 V), low current (~ 6 mA) characteristic. In order to be used by the I.C., this supply has to be converted to a low voltage (~ 3.5 V) and higher current (15 – 20 mA), using a switching converter.

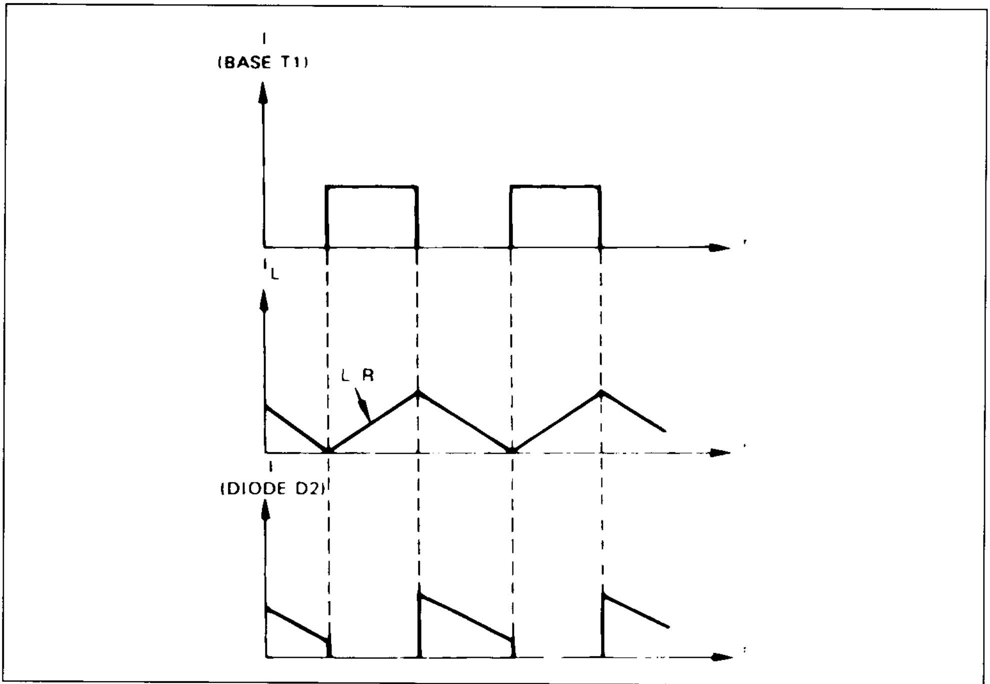
Figure 18.



Transistor T1 is switched either ON/OFF via pin 1 in accordance with the result of a comparison between an internal reference voltage and the I.C. supply voltage (pin 2). When transistor T1 is off, the diode D2 provides a return current path for L1.

Under speech conditions, the switching converter has to be isolated from the main supply VLS by D1, to prevent reverse current.

Figure 19.



Internal conditions during switching converter operation :

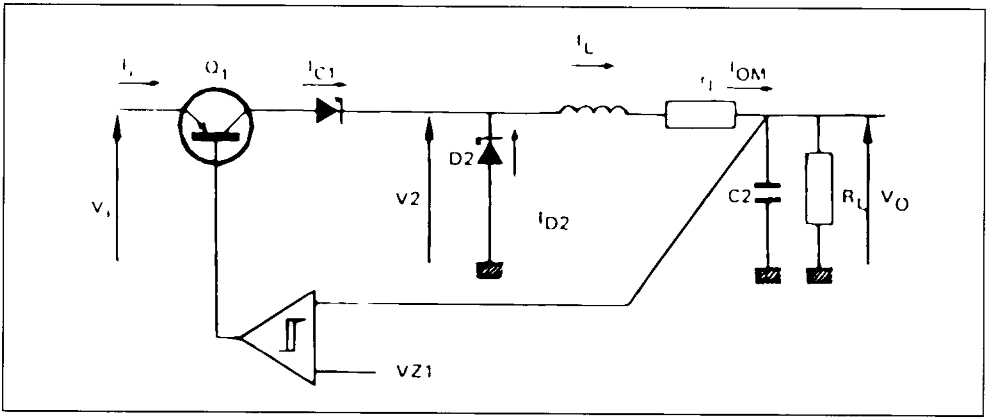
- the internal zener diodes VLS, MCU supply are automatically disconnected,
- the Earphone input is OFF and ringing input is ON.

Note : For better converter efficiency, it is advisable to use schottky diodes for D1 and D2.

SWITCHING POWER SUPPLY EFFICIENCY.

Contribution of external components

Figure 20.

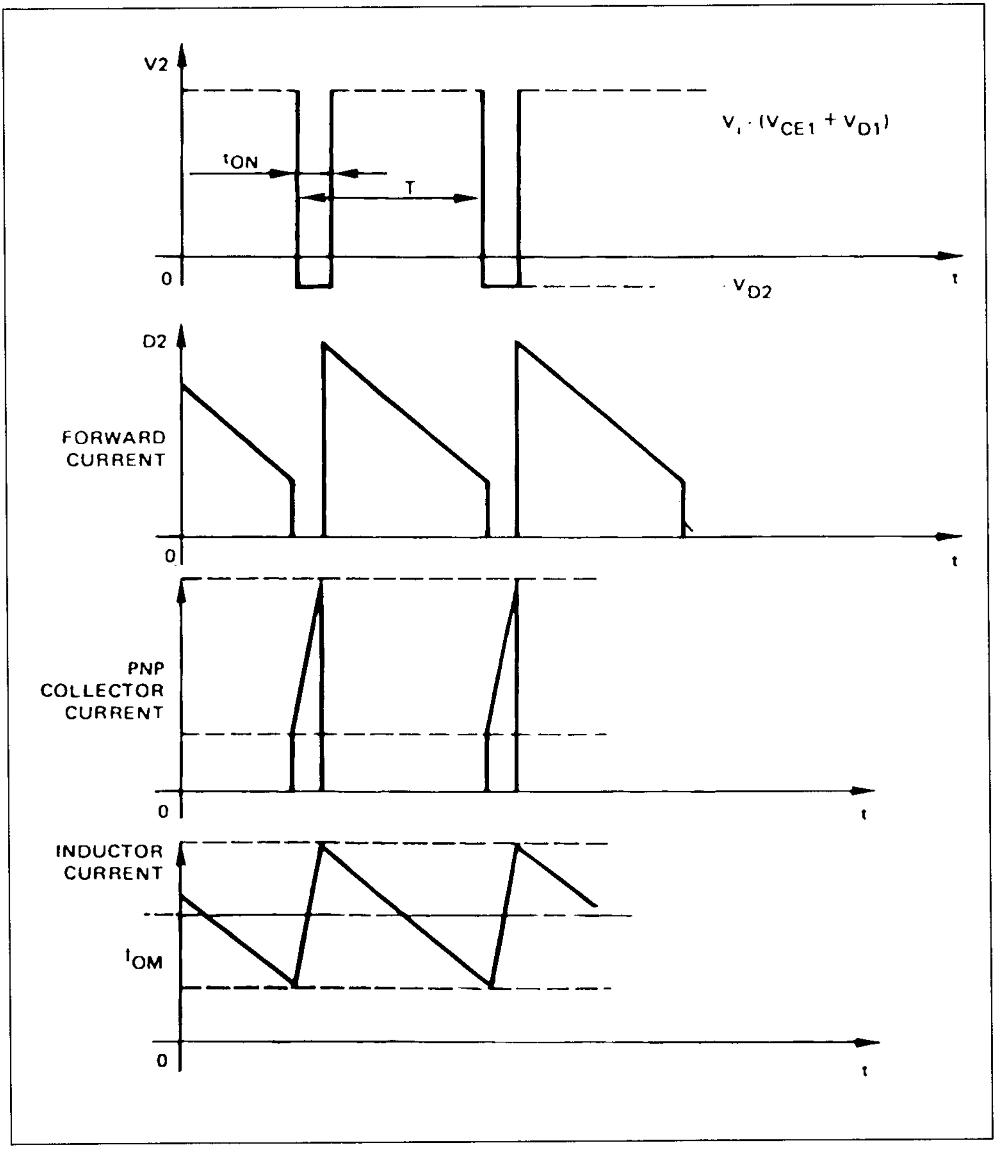


EQUIVALENT DRAWING :

Efficiency calculation hypotheses :

- I_{OM} average output current
- $R_L \cdot C_2 > T$. T = switching period
- Duty cycle $\tau r = \frac{t_{on}}{T}$
- Be careful that resonance frequency of $L.C_2$ must be lower than switching frequency.

Figure 21.



If Po = load output power
Pe = input power

If Ppo = dissipated power in D2 and L
Ppe = dissipated power in Q1 and D1
Po = Pe – Ppo – Ppe

The efficiency is $o = \frac{Po}{Pe} = 1 - \frac{Ppo + Ppe}{Pe}$

Dissipated power in D2 and L
$Ppo \,.\, (V_{D2} + r\,o \,.\, I_{OM}) \,.\, I_{OM}\,(1 - \tau_r)$
V_{D2} = forward voltage of D2

Dissipated power in Q1 and D1
$Ppe = (V_{D1} + V_{CES1}) \,.\, I_{OM} \,.\, \tau_r$
V_{D1} = forward voltage of D1

V_{CES1} = Saturation voltage (at $I_C = I_{OM}$) of Q1

Relation between o and τ_r

$$\tau_r = \frac{Vo}{Vi} \cdot \frac{1}{e} \quad \text{detail} \left\{ \begin{array}{l} Po = o \cdot Po \\ Vo,\ I_{OM} = o \cdot I_{OM}\ V_i \cdot \tau_r \end{array} \right.$$

$$\rho = \frac{Vo}{V_i} = \frac{Vi - (V_{D1} + V_{CES1}) + V_{D2} + r\,o \cdot I_{OM}}{Vo + V_{D2} + ro \cdot I_{OM}}$$

2 . PIN FUNCTIONS

PIN 1 : SWITCHING CONVERTER DRIVE OUTPUT :

Base drive output for the external PNP switching transistor in the switching converter. This switching transistor should have the following characteristics :

$V_{CEO} > 30$ V ; $I_C > 200$ mA ; $G_{min} > 100$; $f_T \geq 1$ MHz.

PIN 2 : SWITCHMODE POWER SUPPLY REGULATION INPUT :

This input provides the voltage sensing feedback input to the switching converter.

PIN 3 : VZ1 : REF. VOLTAGE TO SWITCHING CONVERTER COMPARATOR :

With pin 4 open circuit, VZ1 is internally stabilized at 3.5 V.

PIN 4 : ADJUST VZ1 :

This pin is used to adjust the switching converter power supply reference voltage.

PIN 5 : ADJUST VLS :

This pin is used to adjust the I.C. supply voltage.

PINS 6 - 16 - 23 : GROUND :

These pins have to be connected together.

PIN 7 : AUTOMATIC GAIN CONTROL FILTER :

The anti-distortion system response is adjusted by the RC network on this pin.

PIN 8 : CIRCUIT SUPPLY VOLTAGE :

With pin 5 open circuit, VLS is internally stabilized at 2.8 V.

When the TEA7031 is under AGC control, the voltage on this pin varies slightly (due to AGC action).

PIN 9/10 : MICROPHONE INPUTS :

These are used for anti-Larsen control.

PIN 11 : ANTI-LARSEN FILTER 1

The second filter of the anti-Larsen system (1 st filter : pins 9-10) is formed by the RC network R5C5. In order to obtain a second order filter for the anti-Larsen system, the cut-off frequency defined at this pin, should be the same as that chosen for the first filter.

For correct TEA7031 operation R6 and R5 should be fixed at 10 kΩ and 1 kΩ respectively.

PIN 12 : ANTI-LARSEN FILTER 2 :

The gain and the response of the anti-Larsen system can be adjusted respectively by the resistor and the capacitor on this pin, according to the acoustic characteristics of the telephone set.

The value of the resistor should not exceed 390 kΩ. When the voltage on this pin exceeds the threshold voltage of 0.4 V, the AGC system is enable.

PIN 13 : EARPHONE INPUT.

Input for loudspeaker signal. This input is only active in transmission mode, but not in ringing mode ; in ringing mode, input pin 19 should be used for amplification of ringing tones. In transmission mode no signal should applied on pin 19, for a proper working of the I.C.

PIN 14 : MICROPROCESSOR SUPPLY VOLTAGE.

With pin 15, open circuit, MCU supply is internally stabilized at 3.3 V, and is available for microprocessor supply purposes.

PIN 15 : MCU SUPPLY ADJUST.

This pin is used to adjust the microprocessor supply voltage.

PIN 17 : MICROPROCESSOR RESET OUTPUT.

This output is an open collector output which delivers a reset signal for a microprocessor.

PIN 18 : MICROPROCESSOR HALT OUTPUT.

This output is an open collector output with delivers a halt signal for a microprocessor.

PIN 19 : SQUARE WAVE RINGING MELODY SIGNAL INPUT.

Input for loudspeaker signal.

This input is only active in ringing mode (when supplied by the switching supply). In transmission mode (when supplied by the shunt DC supply), input 13 should be used and no signal should be applied on pin 19. In ringing mode, it could be used, for example, to generate the microprocessor melody.

PINS 20-22 : LOUDSPEAKER OUTPUTS.

Outputs to be connected to a 50 Ω impedance loudspeaker.
Output voltage : Vpp = 2 VLS – 2.5 Volts (with a gain of 32 dB).
Maximum current : depending of the supply voltage.

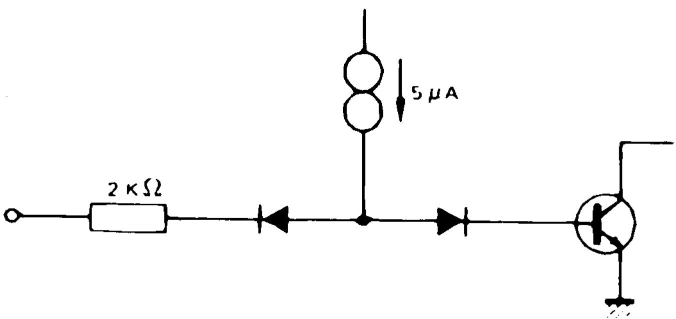
PIN 21 : V_{ref} : INTERNAL REFERENCE.

Output which provides an internally regulated reference voltage.
V_{ref} : 1.1 V typical.

Maximum available current : 5 µA.

PINS 24-25 : GAIN ADJUSTMENT INPUTS.

These pins are used to adjust the loudspeaker amplifier gain. Four steps of 6 dB/step are available (pin open circuit = high level).



GAIN ADJUSTEMENT INPUTS

GAIN ADJ 0	GAIN ADJ 1	
1	1	G_{MAX}
1	Ø	G_{MAX} – 6 dB
Ø	1	G_{MAX} – 12 dB
Ø	Ø	G_{MAX} – 18 dB

PIN 26 : LOUDSPEAKER MUTING.

This pin is used to mute the loudspeaker. Pin open-circuit = high level = loudspeaker muted. Pin low level = loudspeaker enabled.

PIN 27 : RING SIGNAL INDICATION.

This NPN open collector output provides ready status when in ringing condition.

DS is ON (low-level) when the switching converter is established in the running state and when the microprocessor supplies are stabilized. The DS signal is validated by "Halt".

It may be used to cause an associated microprocessor to generate the ringing tones.

PIN 28 : RECTIFIED RING SIGNAL INPUT.

High voltage input for the switching converter.

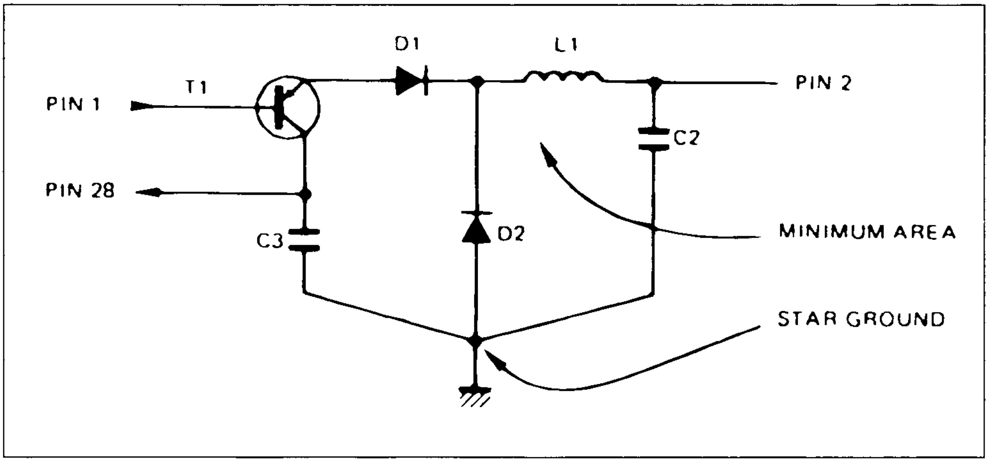
Maximum voltage : 22 V.

3 . SUPPLY CONSIDERATIONS

3.1 . SWITCHING SUPPLY LAY-OUT.

To avoid switching-noise, C2, C3, D2 should be tied together as close as possible.

Figure 23.



3.2 . TEA7031 SUPPLY.

As the I.C. has a zener characteristic, it should be supplied by a current source.

Constant voltage supply :

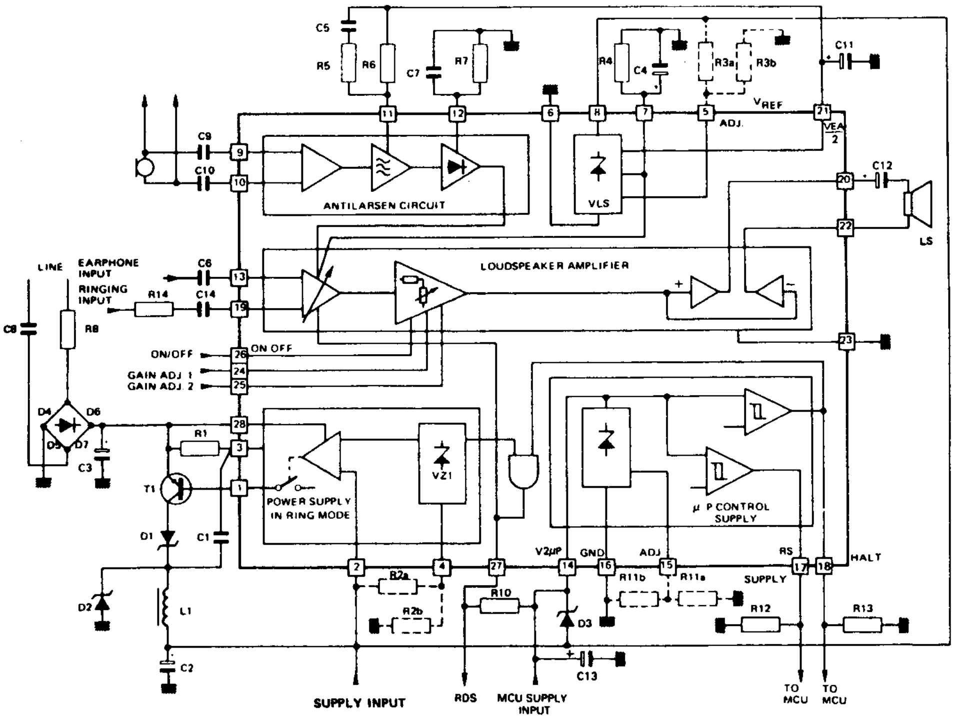
The TEA7031 can be supplied by an external constant voltage on condition :

To set the zener voltages at a level higher than the supply voltage.

To tie the automatic gain control pin (pin 7) to the ground (otherwise the I.C. will always be in AGC mode).

Note : The maximum loudspeaker level is depending of the supply voltage.

Figure 24 : Typical Application.



LIST OF COMPONENTS

RESISTORS :

R1 : 22 kΩ	R2 :
R3 :	R4 : 470 kΩ
R5 : 1 kΩ	R6 : 10 kΩ
R7 : 330 kΩ	R8 : 1 kΩ/1 W
R9 : (5 kΩ)	R10 : 100 kΩ
R11 :	R12 : 100 kΩ
R13 : 100 kΩ	R14 : 47 kΩ

CAPACITORS :

C1 : 22 pF	C2 : 220 μF/10 V
C3 : 10 μF/35 V	C4 : 10 μF/10 V
C5 : 68 nF	C6 : 220 nF
C7 : 470 nF	C8 : 1 μF/250 V
C9 : 33 nF	C10 : 33 nF
C11 : 33 μF/10 V	C12 : 22 μF
C13 : 33 μF/10 V	C14 : 1.5 nF

DIODES :

D1 : BAT43	D2 : BAT43
D3 : BAT43	D4 : 1N4004
D5 : 1N4004	D6 : 1N4748-BZX 85C (22 V)
D7 : 1N4748-BZX 85C (22 V)	

INDUCTOR :

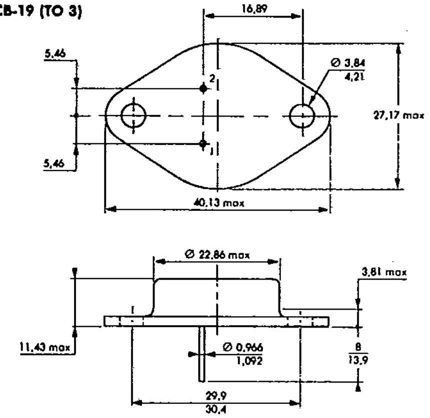
L1 : 470H - 680 H

TRANSISTOR :

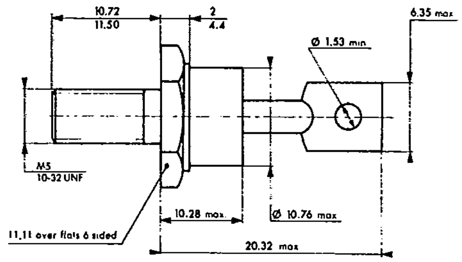
T1 : BCW93 - BCW92

case outlines

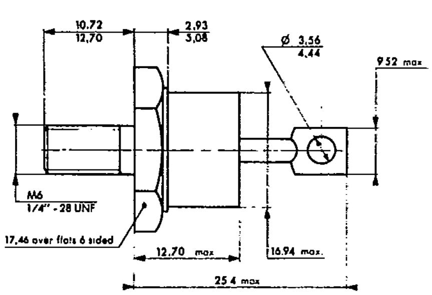
CB-19 (TO 3)



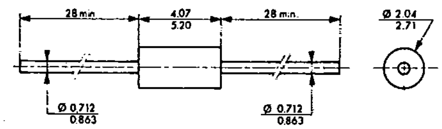
CB-33 (DO 4)



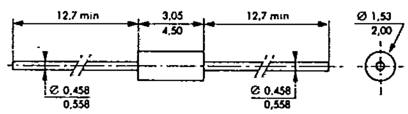
CB-34 (DO 5)



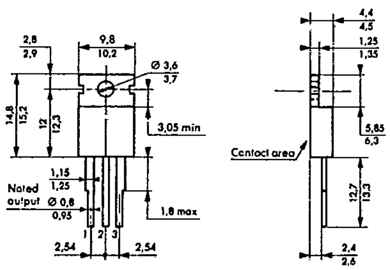
CB-101 (DO 41)



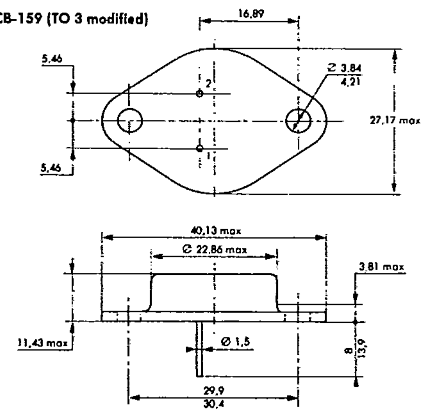
CB-102 (DO 35)



CB-117 (TO 220 AB) for power transistors

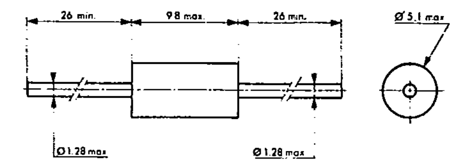


CB-159 (TO 3 modified)

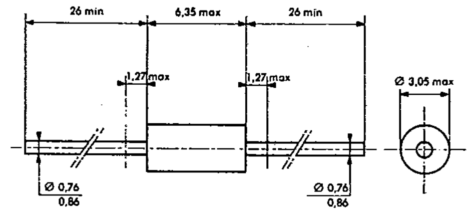


case outlines

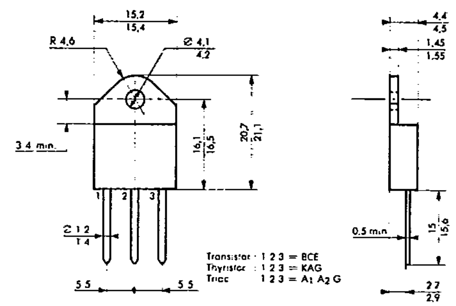
CB-197 (DO 27 A)



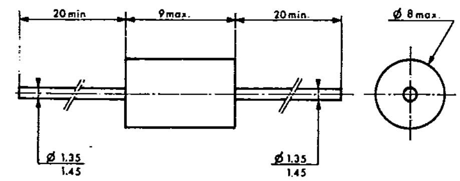
CB-210 (F 126)



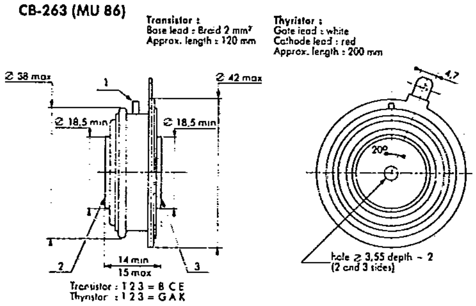
CB-244 (TO 218 - TOP 3)



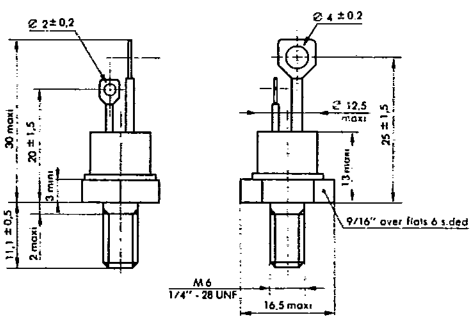
CB-257 (AG)



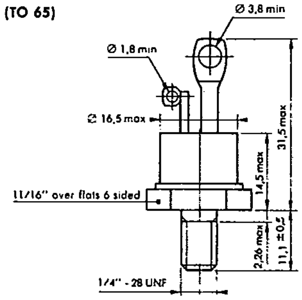
CB-263 (MU 86)



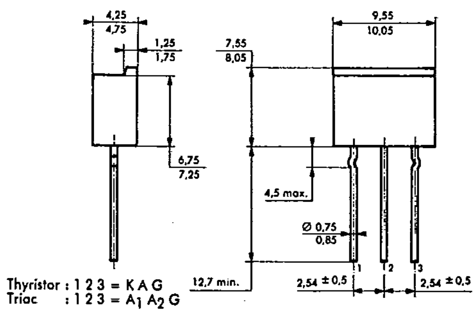
CB-267 (TO 48)



CB-269 (TO 65)



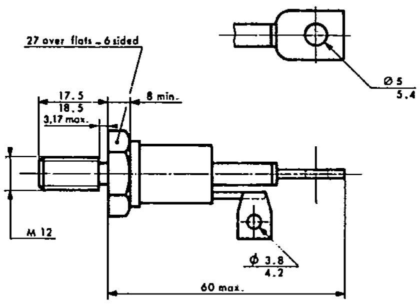
CB-274 (TL)



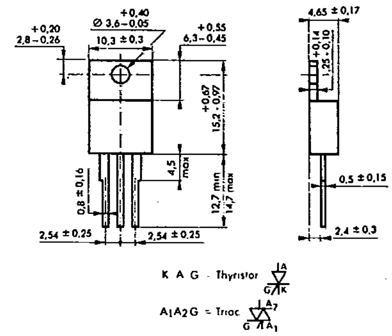
Thyristor : 1 2 3 = K A G
Triac : 1 2 3 = A_1 A_2 G

case outlines

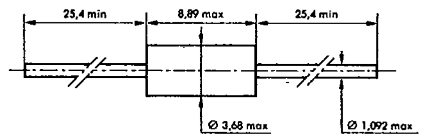
CB-338 (TO 83)



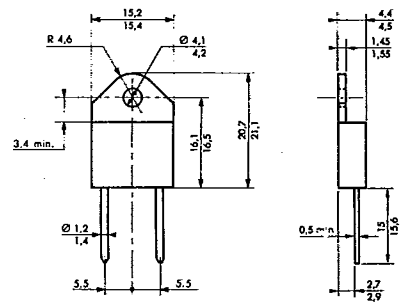
CB-415 (TO 220 AB) for thyristors and triacs



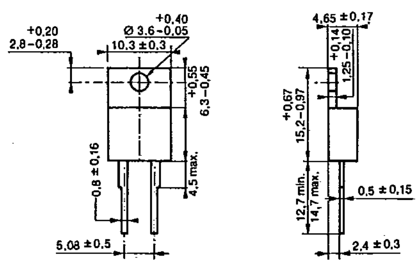
CB-417



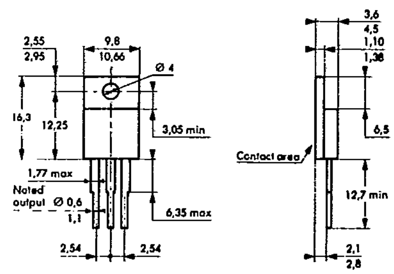
CB-425 (DOP 3)



CB-426 (DO 220 AB) for insulated types



CB-428 (TO 220 AB) for duo diodes

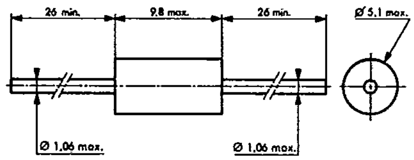


THOMSON COMPONENTS MOSTEK

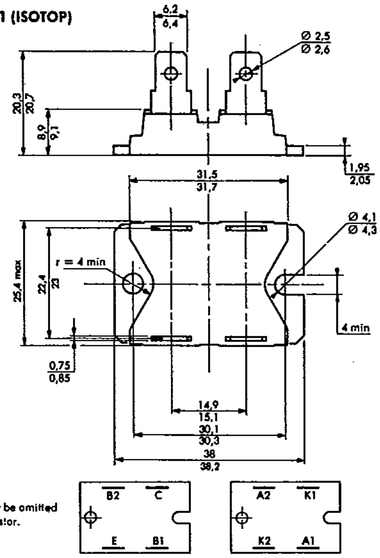
87D 09188 D T-75-11-33

case outlines

CB-429

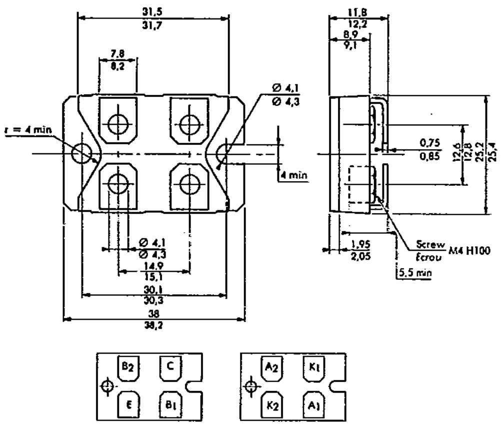


CB-451 (ISOTOP)



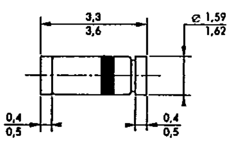
Pin B2 may be omitted for a transistor.

CB-452 (ISOTOP)

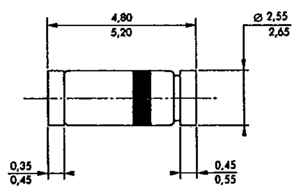


Pin B2 may be omitted for a transistor.

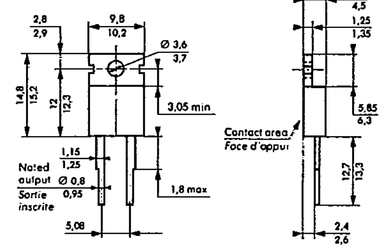
CB-465 (MINIMELF)



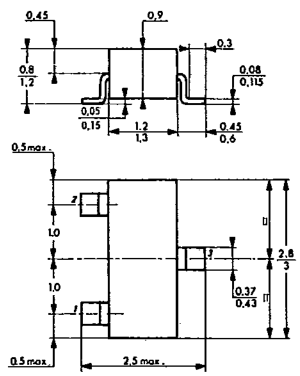
CB-466 (MELF)



CB-468 (DO 220 AB) for uninsulated types



CB-474



Dimensions in millimeters