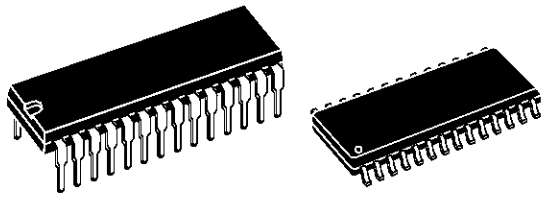
SGS-THOMSON MICROELECTRONICS

TEA7540

HANDSFREE CONTROLLER

PRELIMINARY DATA

- NOISE/SPEECH DISCRIMINATION IN EMISSION AND RECEPTION
- INTEGRATED SIGNAL GAIN COMPRESSOR IN BOTH MODES
- PROGRAMMABLE ATTENUATORS IN BOTH MODES
- ADAPTED TO ACOUSTIC PARAMETERS OF ALL CABINETS
- LOW OPERATING VOLTAGE 2.5V
- LOW OPERATING CURRENT 2.1mA
- CHIP SELECT BETWEEN HANDSFREE AND MONITORING MODES



DIP28 **SO28**

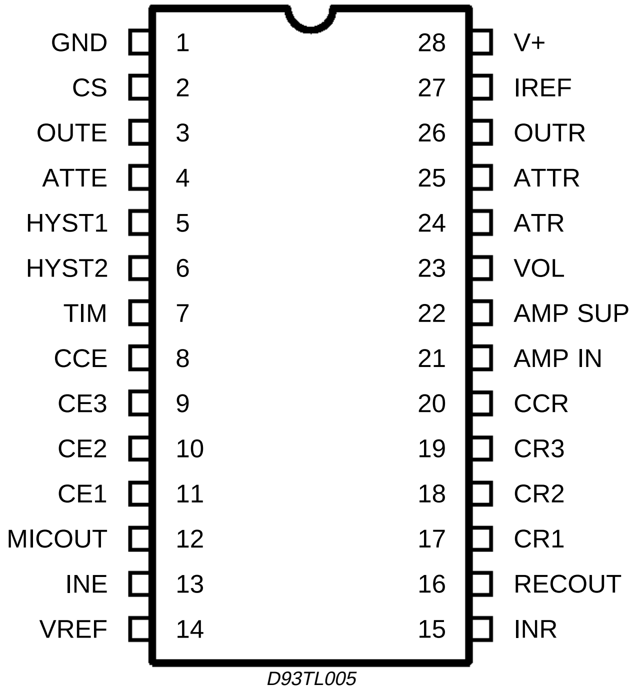
ORDERING NUMBERS:

TEA7540DP TEA7540FP

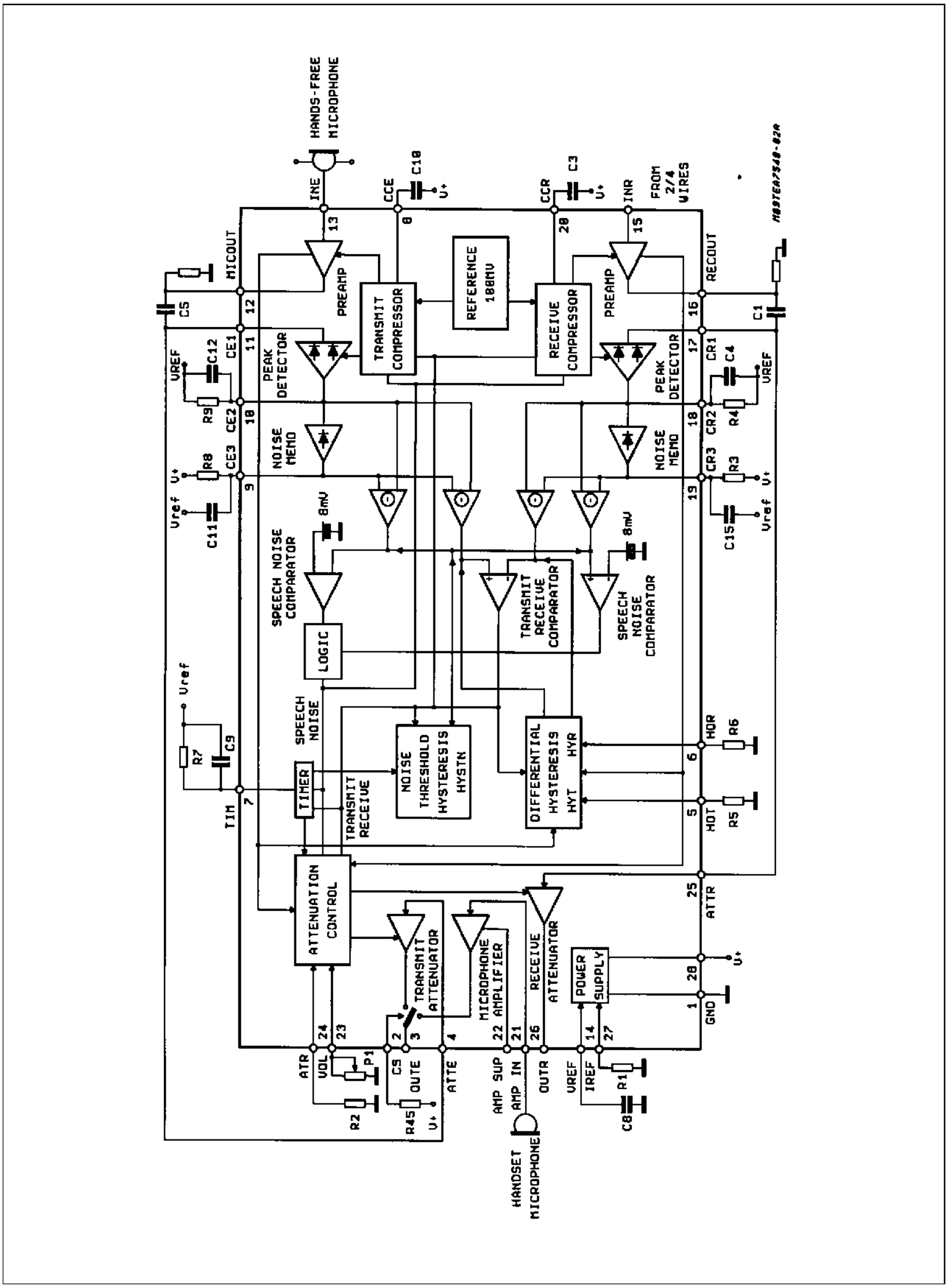
DESCRIPTION

This 28 pins IC is an innovative approach to quality handsfree telephone sets. It results from an extensive research on speech signal.

PIN CONNECTION (top view)



BLOCK DIAGRAM



PIN FUNCTION

N°	Name	Function
1	GND	Ground
2	CS	Chip Select
3	OUTE	Transmit Attenuator Output
4	ATTE	Transmit Attenuator Input
5	HYST1	Transmit Channel Hysteresis
6	HYST2	Receive Channel Hysteresis
7	TIM	RC Timer
8	CCE	Time Constant of the Transmit Signal Compressor
9	CE3	Transmit Background Noise Memorization Output
10	CE2	Transmit Peak Detector Output
11	CE1	Transmit Rectifier Input
12	MICOUT	Transmit Signal Compressor Output
13	INE	Transmit Signal Compressor Input
14	V_{ref}	V+/2 - Reference Voltage
15	INR	Receive Signal Compressor Input
16	RECOUT	Receive Signal Compressor Output
17	CR1	Receive Rectifier Input
18	CR2	Receive Peak Detector Output
19	CR3	Receive Background Noise Memorization Output
20	CCR	Time Constant of the Receive Signal Compressor
21	AMP IN	Handset Preamplifier Input
22	AMP SUP	Handset Preamplifier Power Supply
23	VOL	Volume Control
24	ATR	Attenuation Value
25	ATTR	Receive Attenuator Input
26	OUTR	Receive Attenuator Output
27	I_{ref}	Reference Current Source
28	V+	

FUNCTIONAL DESCRIPTION

SWITCHED ATTENUATORS

Fig.A represents a block diagram of a handsfree subset with attenuators in signal mode. To prevent the system from howling, the total loop gain, including acoustic feedback through the housing and sidetone coupling, must be less than 0dB. For this purpose, two switched attenuators are inserted in each mode (emission and reception). The attenuation is shifted from one mode to the other, resulting from the speech level comparison between each way.

To prevent the circuit to switch continuously in one way, the operation of the IC must be fully symetrical in both ways. This involves signal comparison, attenuation value.

GAIN COMPRESSOR

In TEA7540, two signal compressors are inserted in each mode before the signal comparison, so the signal coming from each end has the same level (100mV peak), the losses in each way (for instance losses resulting from the line length in receiving mode) are compensated and the signal comparison is fully symetrical. The time constant of each signal compressor decreases 80 times more quickly than it increases to prevent from noise increasing between words. The compressing depth is 38dB.

BACKGROUND NOISE DISCRIMINATION

An additional feature provided in TEA7540 is background noise level discrimination in each way. The IC stores the background sound level with a long time constant (3 to 5 seconds depending on an external RC) and compares it with the incoming signal in order to distinguish a useful signal (speech) from the background noise. This background noise memorization is also used to compensate the noise in each mode before signal comparison: the noise level in each mode is sub-

stracted from the incoming signal before the comparison. So very high noise level in one mode cannot trouble the comparison between the useful signals.
The result of the comparison manages the attenuators in the following way:

- The maximum attenuation is switched on the mode where the speech signal is the lowest. The maximum attenuation is fixed by two external resistor (maximum 52dB).

  The time constant of the switch is fixed by the timer via an external capacitor.

- When neither party is talking both attenuators are set to a medium attenuation. Thus each mode is in idle mode. The time constant of the switch from active mode to idle mode must be long enough to prevent from switching to idle mode between two words (see fig.B). This time constant is fixed by an external RC.

Figure A

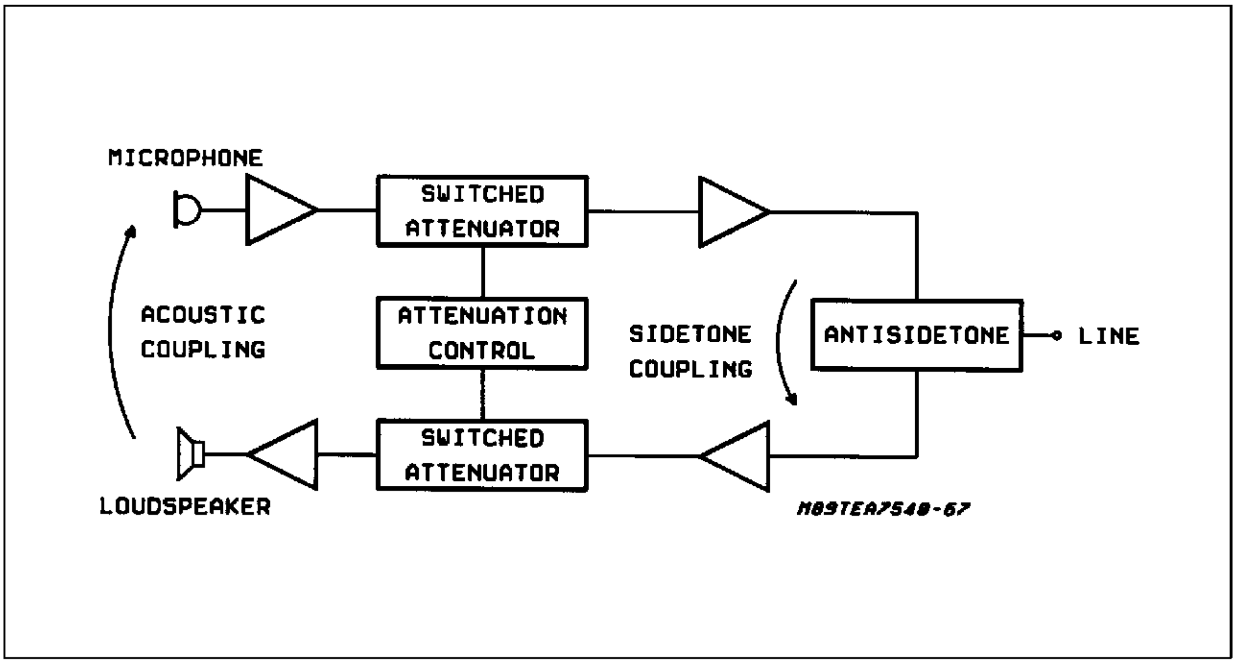
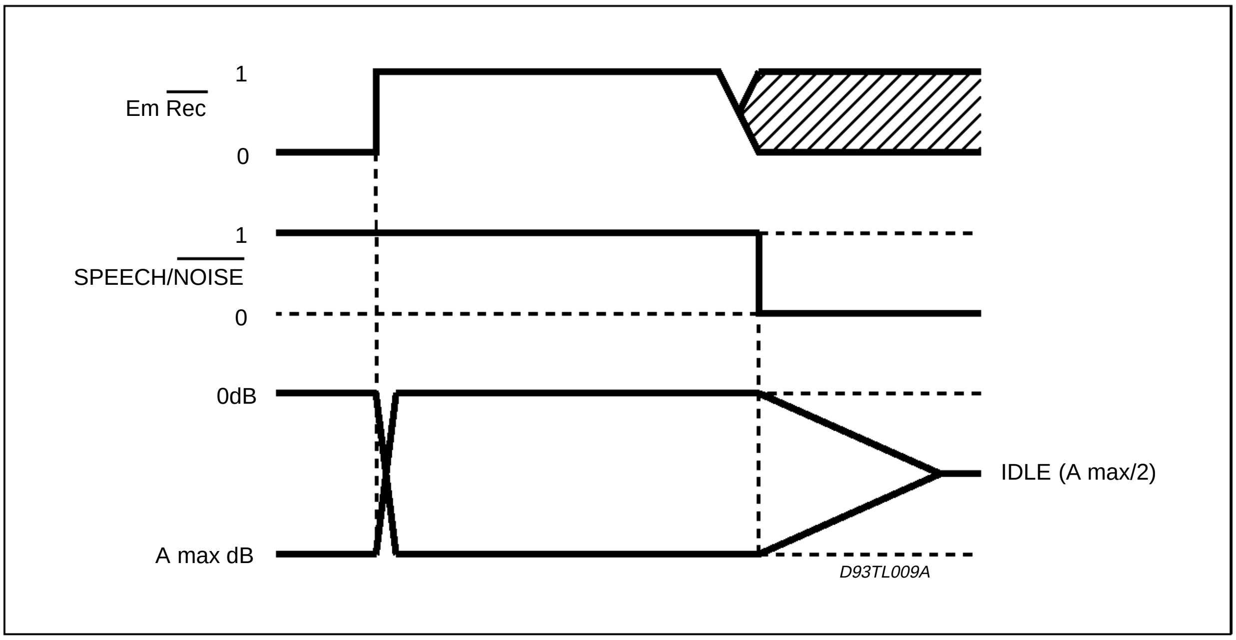


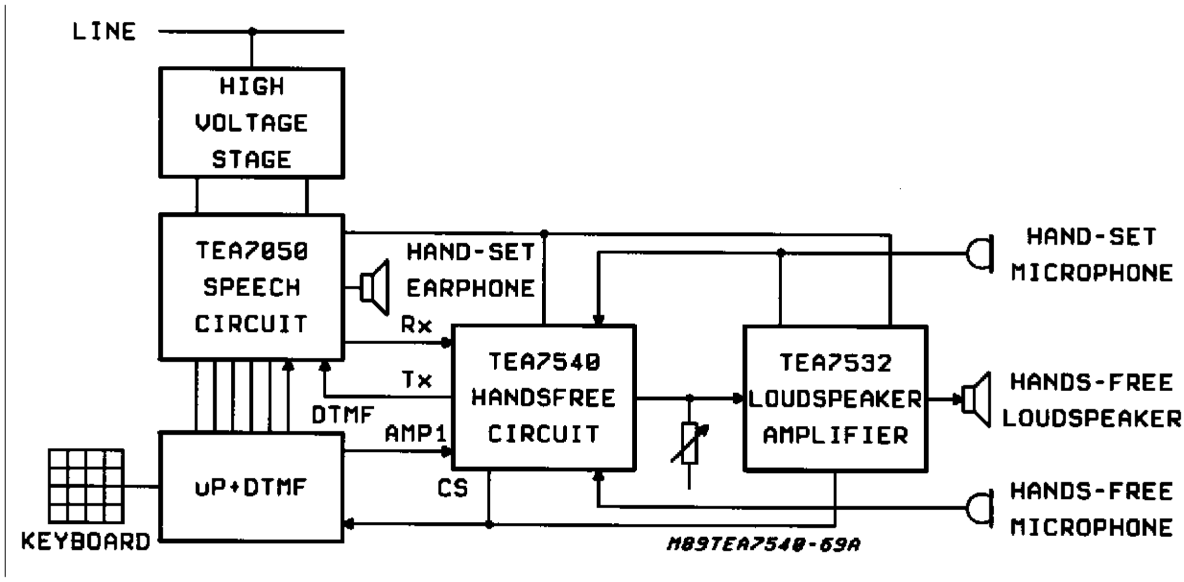
Figure B



TEA7540 OPERATION

TEA7540 is powered through an external shunt regulator (for instance the shunt regulator of the monitor amplifier TEA7532) or an external zener diode.
It can work at a very low voltage (2.5V) over the circuit and it has a low current consumption (2.1mA).
It's also possible via the chip select pin (CS) to put the handsfree function in standby to use the circuit in monitoring mode with the handset microphone.
TEA7540 is designed to work with all kind of microphone, including Electret.
TEA7540 also handles the handset microphone signal (AMP IN) when the system is set to normal conversation mode.

Figure C: Application Diagram (Example of high range telephone set using TEA7540).



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V^+	Supply Voltage	12	V
Top	Operating Temperature	-20 to 70	°C
T_{stg}	Storage Temperature Range	-65 to 125	°C

ELECTRICAL CHARACTERISTICS (Refer to test circuits, T_{amb} = 25°C; V^+ = 3V; f = 1KHz unless otherwise specified).

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
SUPPLY SECTION							
V^+	Supply Voltage		2.5		7.0	V	1
I_C	Current Consumption	Vcs = 0 Handsfree mode Vcs= N.C. Monitoring mode		2.1 1.1	3.0 1.5	mA mA	1
TRANSMIT SECTION							
COMPRESSOR							
Rine	Compressor input impedance	PIN13	7.5	10.0	14.5	KΩ	1
C_R	Compressor Range			16.5		dB	
G_{1max}	Maximum Gain		40.5	41.5	42.5	dB	2
G_{1min}	Minimum Gain		24.0	25.0	26.0	dB	3
V_O	Output Voltage	PIN12 compressing range	160	200	240	mVpp	4
T_{dh}	Transmit Distortion				3.0	%	4
I_{cce1}	Compressor dacay time current	Increasing gain	1.0	1.25	1.5	µA	5
I_{cce2}	Compressor rise time current	Decreasing gain	65	85	105	µA	6
V_{cce1}	Voltage drop PIN8 V_{cce} = Vref - Vpin8	G1max		0	20	mV	2
V_{cce2}		G1min	175	225	275	mV	3
PEAK DETECTOR							
R_{inpd}	Input impedance PIN11		7.5	10.0	14.5	KΩ	1
I_{ce2}	Rise time current		16	20	24	µA	7
NOISE MEMORIZATION							
V1	Max voltage drop on pin 9		33	36	45	mV	8
ATTENUATOR							
R_{ina}	Input impedance PIN4		7.5	10	14.5	KΩ	1
ATE-	Attenuation= 20log(Voute/Vatte) Mode: Inactive Tx, Rx Comp. Max Gain	Rpin24 = 11KΩ Rpin24 = 15KΩ		46 58		dB dB	9
ATE-active	Mode: Active	Rpin24 = 11KΩ	0	1.5	3	dB	10
ATE-IDLE	Mode: Noise Tx, Rx Comp. Max Gain	Rpin24 = 11KΩ		23		dB	11
RECEIVE SECTION							
COMPRESSOR							
R_{inr}	Input impedance	PIN15	7.5	10.0	14.5	KΩ	1
C_R	Compressor Range			20.5		dB	
G_{2max}	Maximum Gain		35.5	36.5	37.5	dB	2
G_{2min}	Minimum Gain		15.0	16.0	17.0	dB	3
V_{micout}	Compressor output voltage	PIN16 compressing range	160	200	240	mVpp	4
R_{dh}	Receive Distortion				3.0	%	4
I_{ccr1}	Compressor decay time current	Increasing gain	1.0	1.25	1.5	µA	5
I_{ccr2}	Compressor rise time current	Decreasing gain	65	85	105	µA	6
V_{ccr1}	Voltage drop PIN20 Vccr = Vref - Vpin20	G2max		0	20	mV	2
V_{ccr2}		G2min	175	225	275	mV	3
Symbol	**Parameter**	**Test Condition**	**Min.**	**Typ.**	**Max.**	**Unit**	**Fig.**

ELECTRICAL CHARACTERISTICS (continued)

PEAK DETECTOR							
R_{inpd}	Input impedance	PIN17	7.5	10	14.5	KΩ	1
I_{cr2}	Rise time current		16	20	24	µA	7
NOISE MEMORIZATION							
V1	Max voltage drop on PIN 19		33	36	45	mV	8
ATTENUATOR							
Rina	Input impedance	PIN25	7.5	10	14.5	KΩ	1
ATR-	Attenuation= 20lg(Voutr/Vatte) Mode: Inactive RX, TX Comp. Max Gain	Rpin24 = 11KΩ Rpin24 = 15KΩ		46 58		dB dB	9
ATR-active	Mode: Active	Rpin24 = 11KΩ	0	1.5	3	dB	10
ATR-IDLE	Mode: Noise RX, TX Comp. Max Gain	Rpin24 = 11KΩ		23		dB	11
ATTENUATION CONTROL SECTION							
V_{TIME}	Tx Mode Att.Voltage		190	250	325	mV	12
I_{TIME}	TX Mode Att.Current		40	50	70	µA	12
V_{TIMR}	RX Mode Att.Voltage		-325	-250	-190	mV	13
I_{TIMR}	RX Mode Att.Current		40	50	70	µA	13
ATRVOL	Volume Control		29	32	35	dB	14
MICROPHONE PREAMPLIFIER							
R_{amp}	Imput impedance	PIN21	35	50	70	KΩ	
G_{mic}	V_{mic} = Voute-Vamp in	V_{cs} open	19	20	21	dB	
G_{2off}	Compressor Gain Monitoring Mode G2 = V_{recout}/V_{inr}	Rext between PINs 2 - 28 Rext = open Rext = 40KΩ		 36.5 16		 dB dB	

Figure 1: Basic Configuration

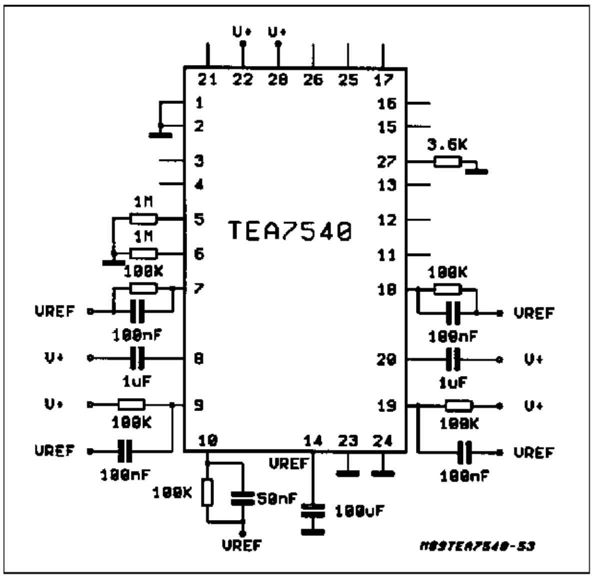
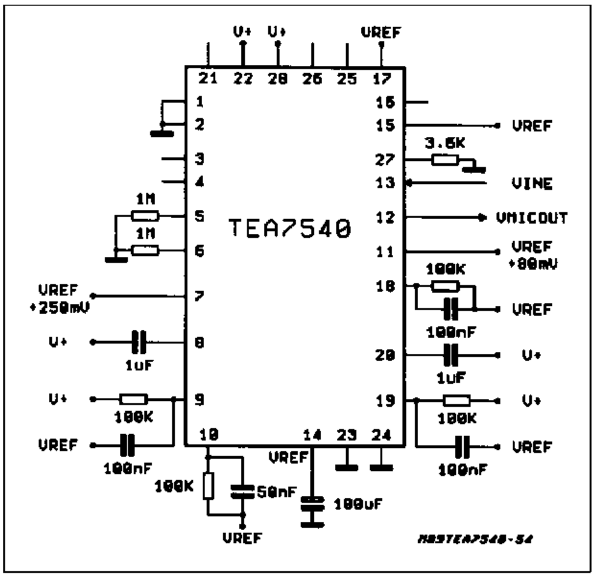


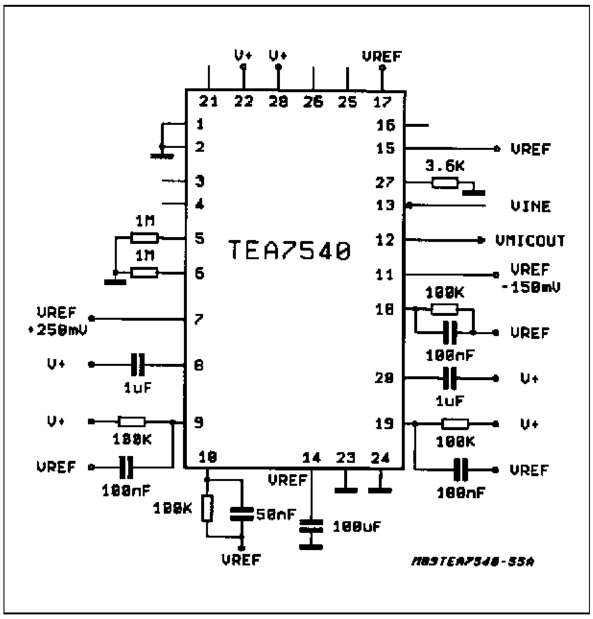
Figure 2: Test Configuration



V^+ = 3V
pin 7 is forced to transmit mode
pin 11 is forced to max gain
Input signal on pin 13 VINE = 1.5mVpp
output voltage VMICOUT measured on pin 12

G1max = 20log (VMICOUT / VINE)

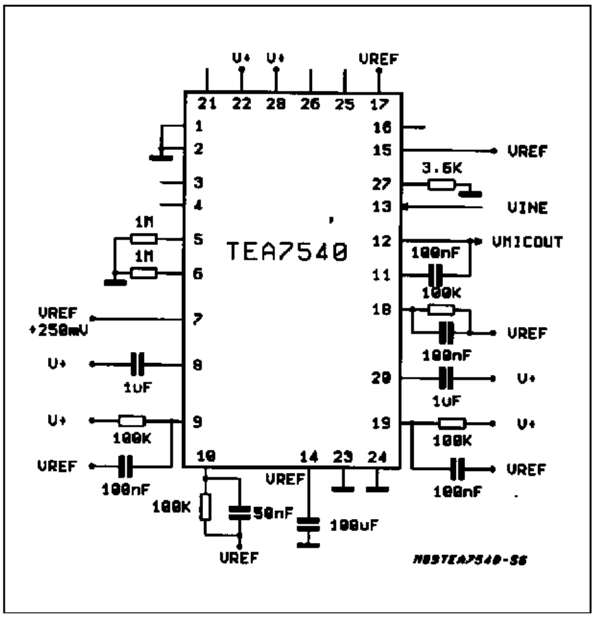
Figure 3: Test Configuration



$V^+ = 3V$
pin 7 is forced to transmit mode
pin 11 is forced to minimum gain
Input signal on pin 13 VINE = 1.5mVpp
output voltage VMICOUT measured on pin 12

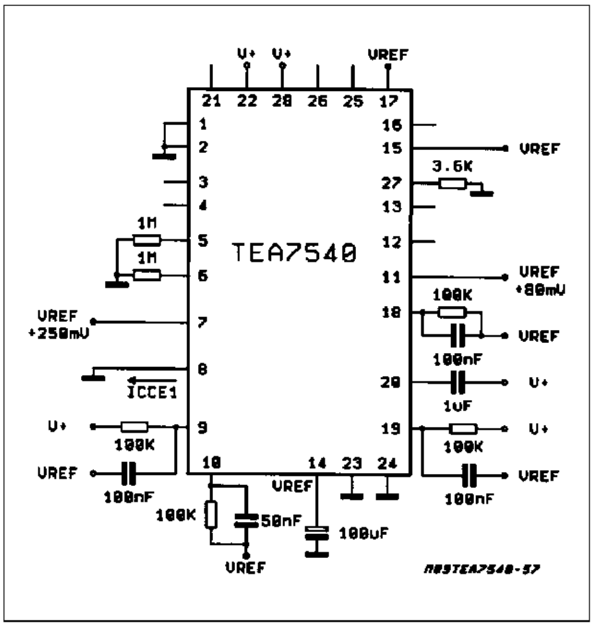
G1min = 20log (VMICOUT / VINE)

Figure 4: Test Configuration



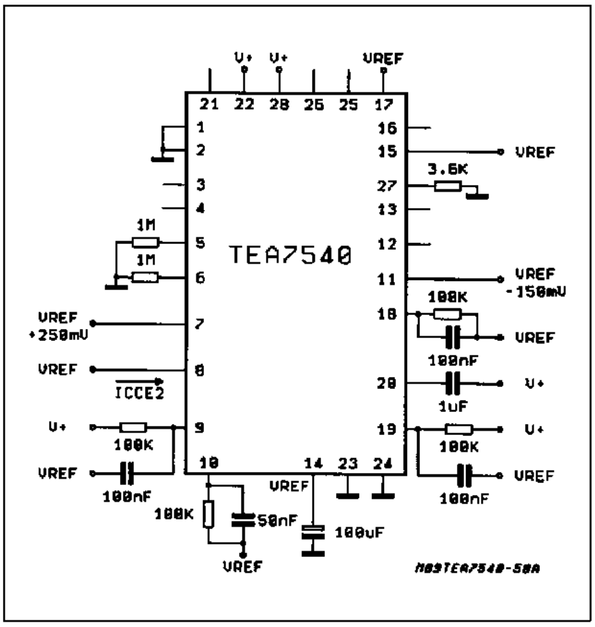
$V^+ = 3V$
pin 7 is forced to transmit mode
Input signal on pin 13 VINE in the compressing range (5mVpp for example)
output voltage VMICOUT measured on pin 12

Figure 5: Test Configuration



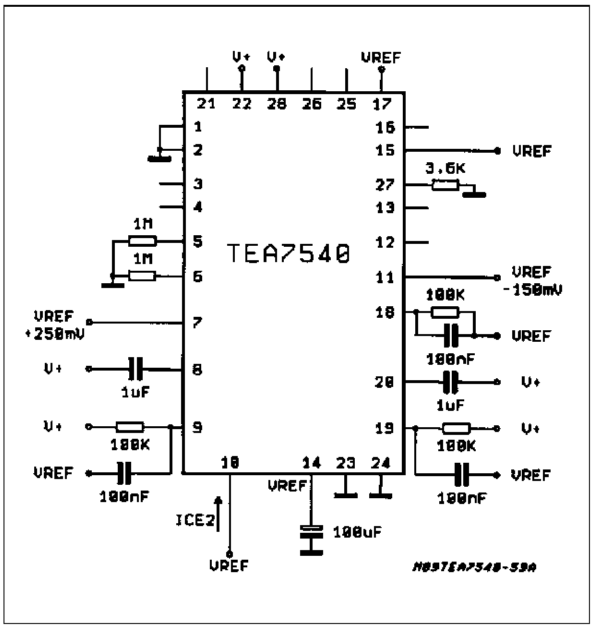
$V^+ = 3V$
pin 7 is forced to transmit mode
pin 11 is forced to maximum gain

Figure 6: Test Configuration



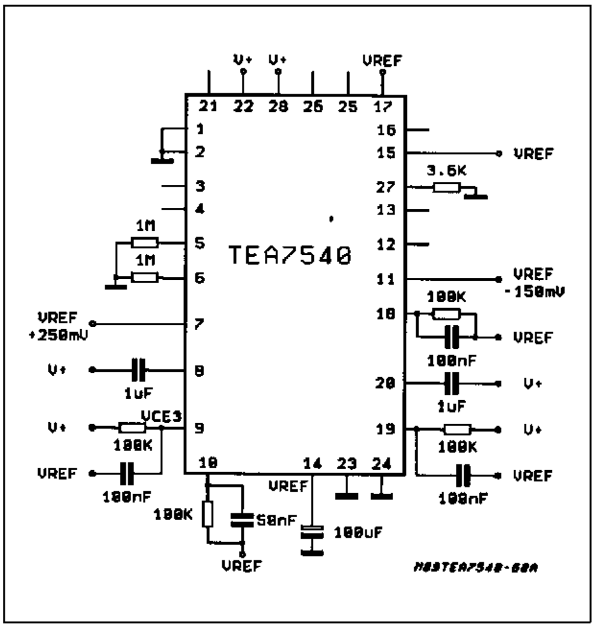
$V^+ = 3V$
pin 7 is forced to transmit mode
pin 11 is forced to minimum gain

Figure 7: Test Configuration



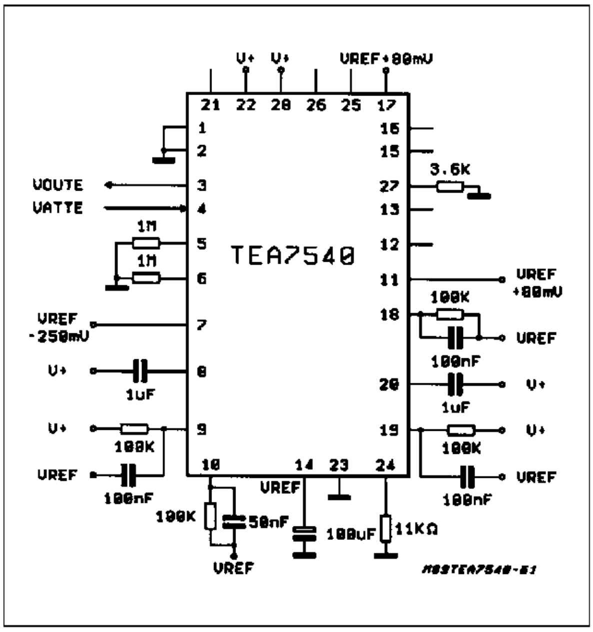
$V^+ = 3V$
pin 7 is forced to transmit mode
pin 11 is forced to minimum gain

Figure 8: Test Configuration



$V^+ = 3V$
pin 7 is forced to transmit mode
pin 11 is forced to minimum gain

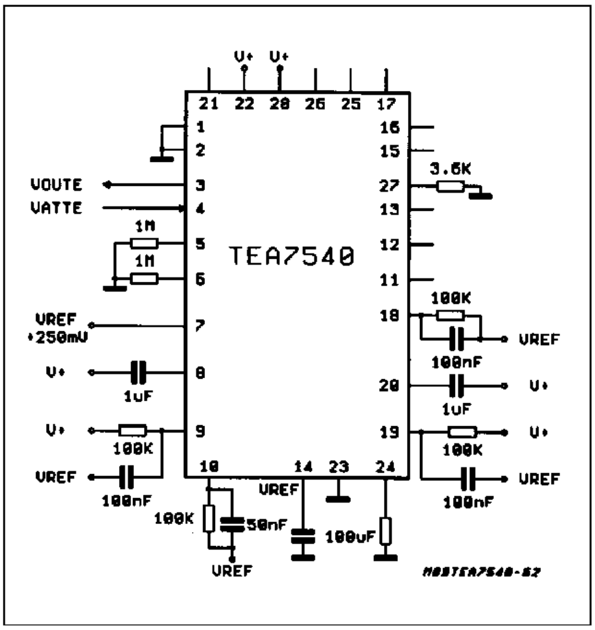
Figure 9: Test Configuration



$V^+ = 3V$
pin 7 is forced to receive mode
pin 11 and pin 17 are forced to maximum gain
Input signal on pin 4 VATTE = 200mVpp

ATE2 = 20log (VOUTE / VATTE) with Rpin24 = 11KΩ

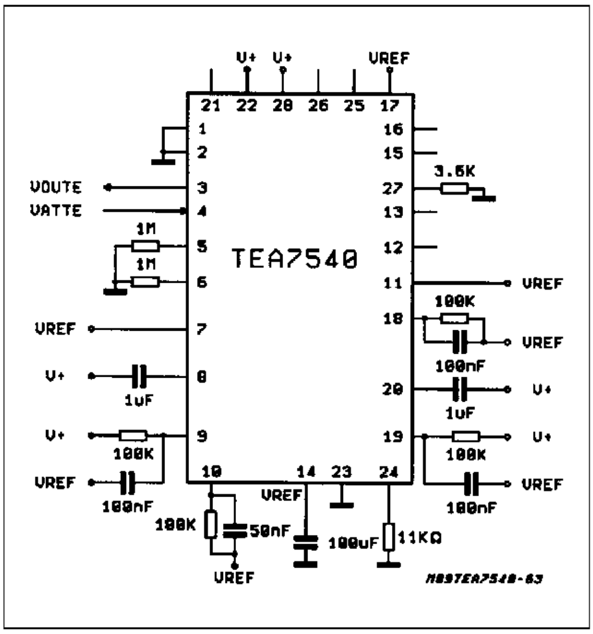
Figure 10: Test Configuration



$V^+ = 3V$
pin 7 is forced to transmit mode
Input signal on pin 4 VATTE = 200mVpp

ATE = 20log(VOUTE / VATTE)

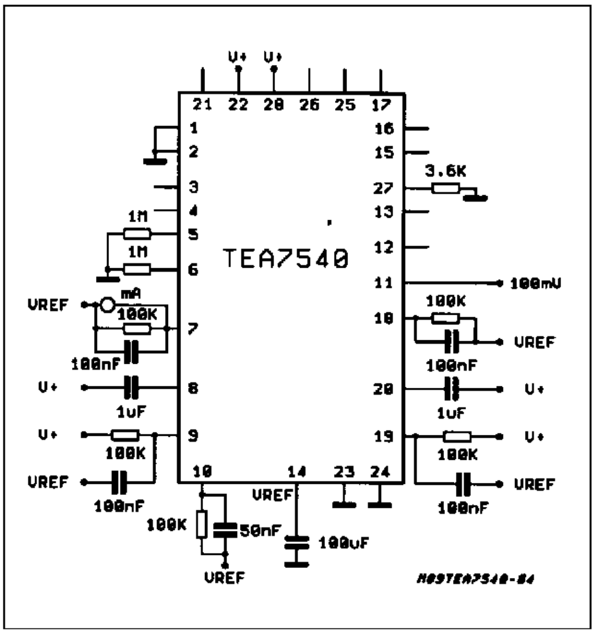
Figure 11: Test Configuration



V+ = 3V
pin 7 is forced to idle mode after that the two compressor have been forced at maximum gain by V11 and V17
Input signal on pin 4 VATTE = 200mVpp
Rpin24 = 11KΩ

ATE6 = 20log(VOUTE / VATTE)

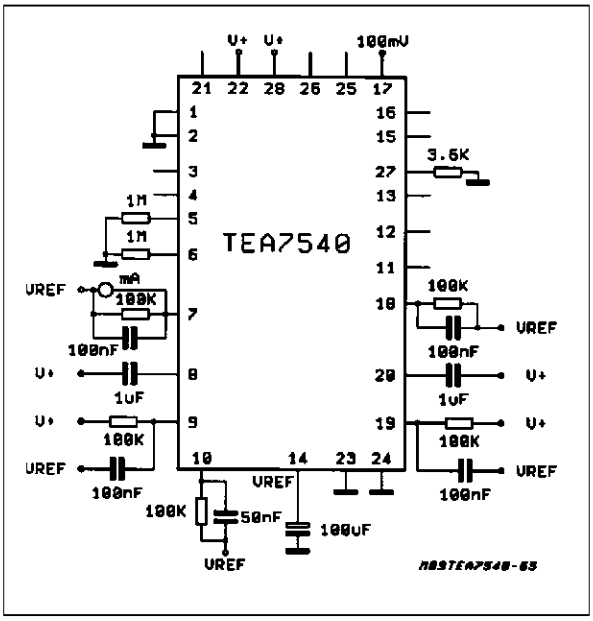
Figure 12: Test Configuration



V+ = 3V
pin 11 is forced to 100mV to force the transmit mode

VTIM_E voltage on pin 7
ITIM_E current through the mA

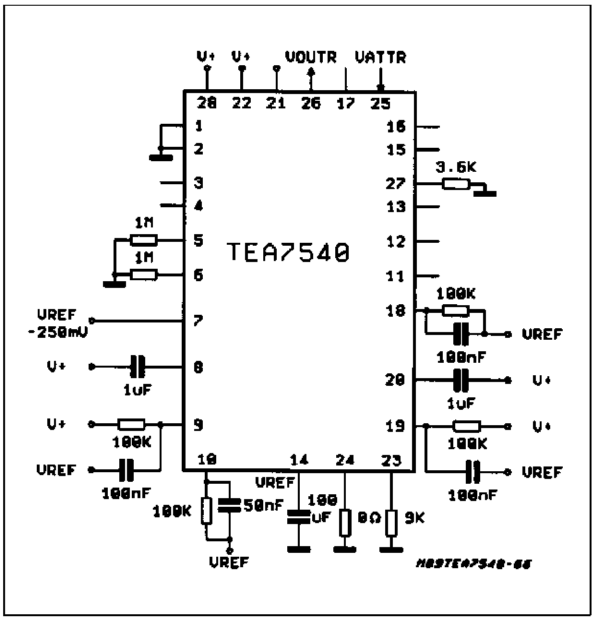
Figure 13: Test Configuration



V+ = 3V
pin 17 is forced to 100mV to force the receive mode

VTIM_R voltage on pin 7
ITIM_R current through the mA

Figure 14: Test Configuration

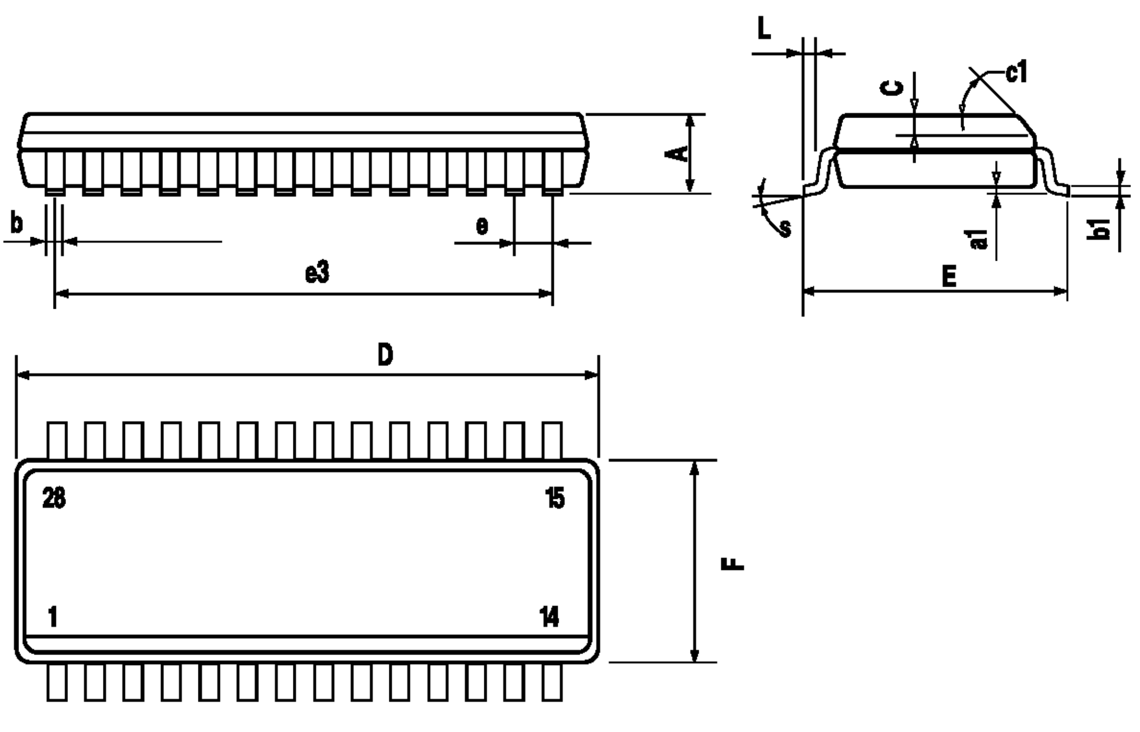


V+ = 3V
pin 7 is forced to receive mode
Input signal pin 25: VATTR = 200mVpp
Rpin23 = 9KΩ

ATRVOL = 20log(VOUTR / VATTR)

SO28 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			2.65			0.104
a1	0.1		0.3	0.004		0.012
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	17.7		18.1	0.697		0.713
E	10		10.65	0.394		0.419
e		1.27			0.050	
e3		16.51			0.65	
F	7.4		7.6	0.291		0.299
L	0.4		1.27	0.016		0.050
S	8° (max.)					



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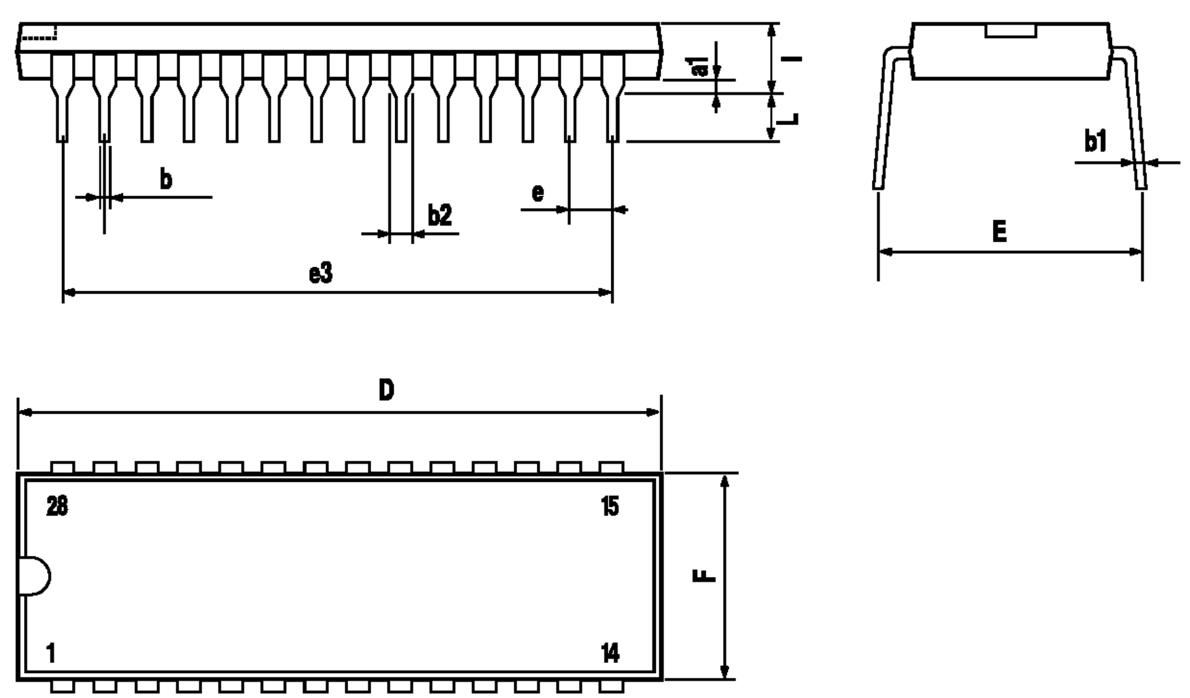
DIP28 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1		0.63			0.025	
b		0.45			0.018	
b1	0.23		0.31	0.009		0.012
b2		1.27			0.050	
D			37.34			1.470
E	15.2		16.68	0.598		0.657
e		2.54			0.100	
e3		33.02			1.300	
F			14.1			0.555
I		4.445			0.175	
L		3.3			0.130	



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