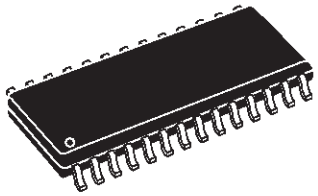
TEA7089A

LOW-RANGE PHONE DEDICATED CHIP

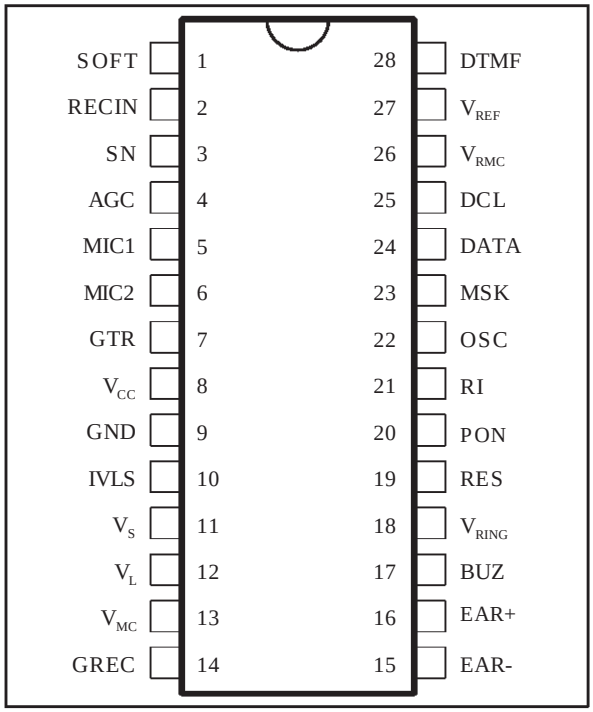
- RING
  - GENERATION OF 8 MELODY TONES (Including the 3 German Melody Tones)
  - 4 STEPS DIGITAL CONTROL ON THE AMPLIFIER OUTPUT LEVEL
- SPEECH
  - TRANSMIT GAIN EXTERNALLY ADJUSTABLE
  - RECEIVING GAIN EXTERNALLY ADJUSTABLE
  - AGC SLOPE EXTERNALLY PROGRAMMABLE
  - SOFT CLIPPING ON SENDING CHANNEL
  - RECEIVE AMPLIFIER FOR PIEZO OR ELECTRODYNAMIC TRANSDUCER
  - +6dB MODE ON RECEIVE CHANNEL
  - LINE POWER MANAGEMENT
- DIALING
  - DTMF GENERATOR
  - LOW DC MASK DURING MAKE PERIOD THROUGH MICROCONTROLLER SERIAL BUS INTERFACE
- MICROCONTROLLER INTERFACE
  - 1.79MHz CLOCK OR 3.58MHz OSCILLATOR INPUT
- MICROCONTROLLER POWER SUPPLY
- MICROCONTROLLER CONTROL INTERFACE INCLUDING SERIAL BUS
- LINE CURRENT EXTRACTOR FOR SUPPLY OF EXTERNAL PERIPHERALS



SO28
(Plastic Package)

ORDER CODE : TEA7089AFP

PIN CONNECTIONS



DESCRIPTION

The TEA7089A is a Telephone Analog Front End device, TAFE, which integrates the three basic functions of a standard telephone set :
- Speech network,
- DTMF generator,
- Ringer generator on buzzer.

A complete telephone set can be designed using TEA7089A associated with a low cost microcontroller.

SPEECH

The speech network includes :

- a low noise transmit channel suitable for any kind of microphone transducer. Softclipping on transmit line signal is provided by the chip.
- a low noise receive channel with symmetrical outputs to be compatible with both piezoceramic and electrodynamic earpiece. An additional 6dB gain can be inserted in the receive channel through software control.
- a line length gain control (AGC) with starting point of gain regulation fixed at 25mA line current ; slope of gain regulation is externally adjustable with one resistor. AGC can be removed by hardware (maximum gain flat) or by software (-2dB flat).

The phone impedance and sidetone can be tuned through external networks.

DTMF GENERATOR

The onboard DTMF generator fullfils the CEPT requirements with an external single pole filter.

RINGER

Up to 8 different tones can be generated by the TEA7089A ringer. The digital volume control of the ringer can be performed through a specific command (4 steps). A ring indication signal is provided to the microcontroller by the TEA7089A.If more tones are requested the input RM/MSK allows to inject tones generated by the microcontroller.

FURTHER ADVANTAGES

The microcontroller power supply is provided by the TEA7089A. The power supply is specifically designed to cope with a long flash or a long ground key duration.

The TEA7089A is able to supply the necessary current to an external speakerphone circuit TEA7540 and loudspeaker amplifier TEA7532 without any additional circuitry.

Line current and reset indications are provided to the microcontroller by the TEA7089A.

The microcontroller drives the TEA7089A through a 2 wires serial interface.

PIN DESCRIPTION

Name	Pin N°	Description
SOFT	1	Transmit Softclipping Time Constant
RECIN	2	Receiving Input
SN	3	Sidetone Network Input
AGC	4	Line Current Regulation Stop Value
MIC1	5	Microphone Input
MIC2	6	Microphone Input
GTR	7	Transmit Gain Adjustment
V_{CC}	8	Transmit and Receive Part Power Supply
GND	9	Ground
IVLS	10	Line Current Source Power Supply
V_S	11	Voltage Stabilizer
V_L	12	Positive Line
V_{MC}	13	Unregulated Microcontroller Power Supply
GREC	14	Receive Gain Adjustment
EAR-	15	Negative Earphone Output
EAR+	16	Positive Earphone Output
BUZ	17	Ringer Buzzer Output
VRING	18	Ring Power Supply
RES	19	Reset
PON	20	Power On
RI	21	Ring Indicator
OSC	22	Oscillator Input
MSK	23	Mask, Ring Melody Input
DATA	24	Data Input
DCL	25	Data Clock Input
V_{RMC}	26	Microcontroller Stabilized Power Supply
V_{REF}	27	Reference Voltage (V_{CC}/2)
DTMF	28	DTMF Filter

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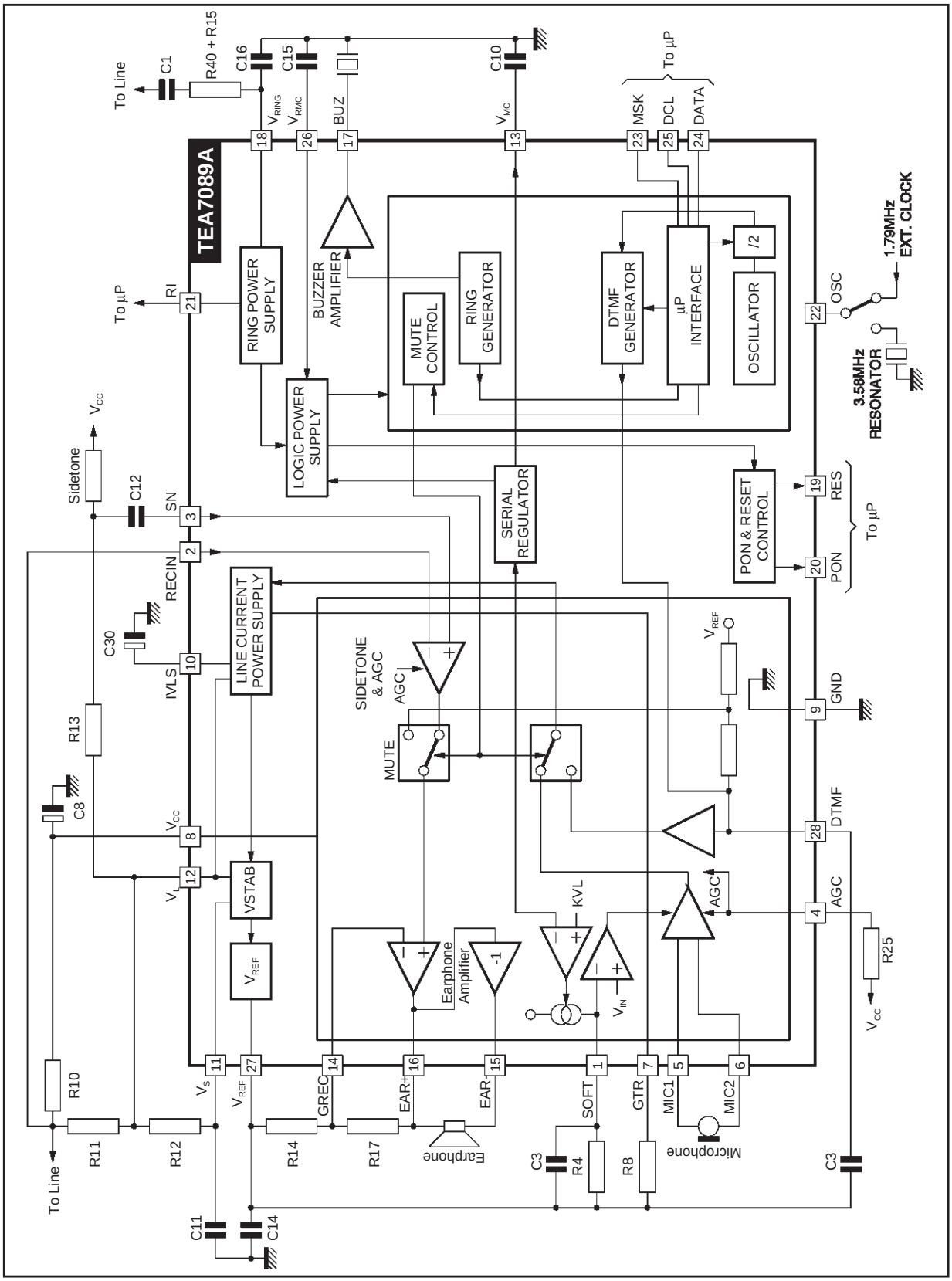
Figure 1 : Block Diagram



ELECTRICAL CHARACTERISTICS

The block diagram is given in Figure 1.

The values of the different networks used in this datasheet are defined as followed :

- The return loss is adjusted by R10 of 600Ω.
- The transmit adjust gain network R8 is calculated in order to have a gain of 46dB typical with I_{LS} = 22mA.
- The sidetone network ZST is set to be lower than 20dB (Vear/Vmic) on a 600Ω load on line.
- The DC characteristics are set by a resistor of 82kΩ between V_L and V_S.

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
	Authorized Voltage on		
	Pin 2 - RECIN	13	V
	Pin 3 - SN	12	V
	Pin 8 - V_{CC}	11	V
	Pin 10 - IVLS	6	V
	Pin 12 - V_L	12	V
	Pin 13 - V_{MC}	6	V
	Pin 17 - BUZ	V_{RING} +0.3, GND -0.3	V
	Pin 18 - V_{RING}	27	V
	Pin 19 - RES	V_{RMC} +0.3, GND -0.3	V
	Pin 20 - PON	V_{RMC} +0.3, GND -0.3	V
	Pin 21 - RI	V_{RMC} +0.3, GND -0.3	V
	Pin 22 - OSC	V_{RMC} +0.3, GND -0.3	V
	Pin 23 - MSK	V_{RMC} +0.3, GND -0.3	V
	Pin 24 - DATA	V_{RMC} +0.3, GND -0.3	V
	Pin 25 - DCL	V_{RMC} +0.3, GND -0.3	V
	Pin 26 - V_{RMC}	5	V
I_{LINE}	Line Current	120	mA
I_{RING}	Ring Current	50	mA
T_{oper}	Operating Temperature	-25, +70	°C
T_{stg}	Storage Temperature	-55, +150	°C
T_j	Junction Temperature	-25, +150	°C

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DC Characteristics (T_{amb} = 25°C ; Logic in Default Mode unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_L	Line Voltage - In Speech and DTMF Mode - In Mask Mode	Test 1 I_L = 22mA I_L = 90mA I_L = 22mA	 4 6.7	 4.6 7.5	 5.2 8.3 3	 V V V
I_{VRMC}	Stabilized Supply Voltage - Output Current	Test 1, I_L = 22mA	 1.5			 mA
V_{RMC}	- Output Voltage	IRMC = 1.5mA	3.15	3.35	3.55	V
I_{VMC}	Unstabilized Supply Voltage - Start up Current - Output Current	Test 1, I_L = 22mA V_{MC} = 2.5V, I_{VRMC} = 1.5mA V_{MC} = 3.6V, I_{VRMC} = 0mA	 10	 15 3		 mA mA
I_{LS}	Line Current Source Supply	Test 1, V_{LS} = 0V ; V_{MC} = 3.6V I_L = 22mA I_L = 90mA	 10 67	 14 75	 18 82	 mA mA

The line current source supply depends of I_L :

- For I_L < 20mA : I_{LS} (mA) = 0.765 x I_L (mA) - 1.4mA
- For I_L > 20mA : I_{LS} (mA) = 0.92 x I_L (mA) - 4.5mA

On this pin the maximum output level is : $V_{10} = V_{12} - (1.2 + 10 \times I_{LS})$ and V_{10} < 6V

ELECTRICAL SPECIFICATIONS (continued)

AC Characteristics (T_{amb} = 25°C ; R_L = 600Ω ; Logic in Default Mode unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
R1	Return Loss	Test 2, I_L = 22mA f = 300/3400Hz, V_{AC} = -10dBV	17			dB

Transmit Characteristics

(T_{amb} = 25°C ; R_L = 600Ω ; f = 1kHz ; Logic in Default Mode unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Gtx	Microphone Gain	Test 3, V_m = -55dBV R8 = 1.3kΩ, R25 = 3.9kΩ				
Gtxl		I_L = 22mA	45	46	47	dB
Gtxs		I_L = 90mA	38	40	42	dB
Zmic	Microphone Input Impedance	between MIC1 & MIC2	32	40	48	kΩ
Ntx	Noise	Test 3, 2kΩ on microphone inputs, I_L = 22mA		-76		dBmp
Mmic	Microphone Mute	Test 3, V_m = -55dBV, I_L = 22mA	60			dB
	Soft Clipping	Test 3, I_L = 22mA, see Figure 2				
Dtx	- Distortion	V_m = -41dBV			2	%
V_L Max.	- Maximum Level on Line	V_m = -34dBV		1.5		Vp

Figure 2 : Softclipping

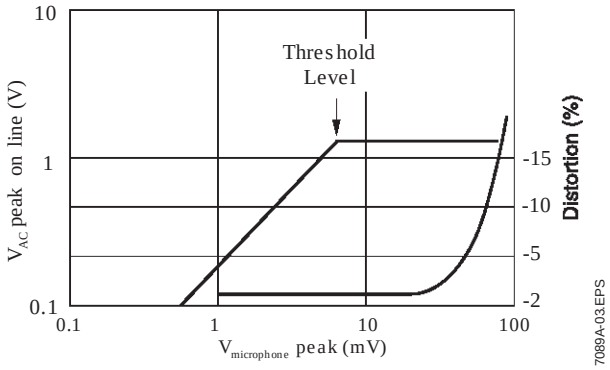
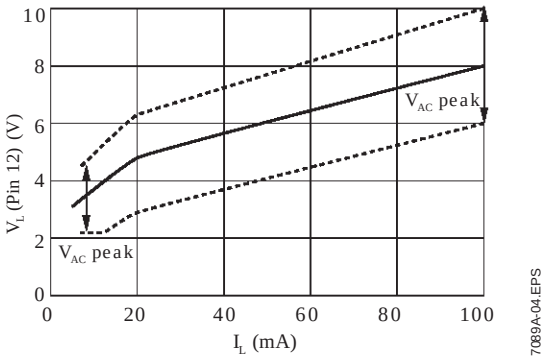


Figure 3



The maximum gain Gtl is adjustable between 44 and 56dB with R8 :

$$Gtxl = 20\log\left(820 \cdot \frac{R10 \,//\, R_L + R11}{R8 \,//\, 50k\Omega}\right)$$

The AGC variation is programmed with one resistor connected on Pin AGC. I_{SL} is the line current at which the gain must be decreased by 6dB.

$$R25\ (\Omega) = \frac{300}{I_{SL} - 5mA}\ (R25 > 2.6k\Omega)$$

For line current lower than I_{LL} or higher than I_{SL}, The transmit and receive gains have a constant value.

If no resistor or a resistor higher than 300kΩ is connected on Pin AGC, the gain is constant and equal to Gtxl and Grxl. ±0.5dB.

AGC can be inhibited also through MCU code "010100". In this case Tx and Rx gains are fixed 2dB lower than the maximum gain.

The minimum saturation voltage of the TEA7089A respect to ground is 2.2V. On long line, when the voltage over TEA7089A is low, the softclipping function automatically limits the AC dynamic to avoid to reach the 2.2V limit on TEA7089A respect to ground.

ELECTRICAL SPECIFICATIONS (continued)

Receive Characteristics (T_{amb} = 25°C ; R_L = 660Ω ; f = 1kHz)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
E_{ff}	Sidetone Eff = ($Vear^+$ - $Vear^-$) /Vm	Test 3, V_m = -55dBV, I_L = 22mA, R14 = 10kΩ, R17 = 15kΩ			22.5	dB
 G_{RXI} G_{RXs}	Gain in Symmetric Mode Grx = ($Vear^+$ - $Vear^-$) / V_L	Test 6, V_L = -14.5dBV, R14 = 10kΩ, R17 = 15kΩ, R25 = 3.9kΩ I_L = 22mA I_L = 90mA	 0.7 -6	 1.7 -4	 2.7 -2	 dB dB
Dr	Distortion	Test 4, Rear = 300Ω, I_L = 22mA Vear = -12dBV Vear = -8dBV			 2 5	 % %
Nr	Noise	Test 4, I_L = 22mA		-76		dBmp
Vear (010010)	Earphone Mute	I_L = 22mA, V_L = -14.5dBV	60			dB
Zout	Output Impedance				20	Ω

Automatic Gain Control Inhibition (T_{amb} = 25°C ; R_L = 660Ω ; f = 1kHz no AGC mode selected)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
 Gtp Grp	 Transmit Gain Receive Gain	Test 3 & Test 4, I_L = 22 to 90mA Code : 010100 V_m = -55dBV V_L = -14.5dBV	 Gtxl -5 Grxl -5	 Gtxl -4 Grxl -4	 Gtxl -3 Grxl -3	 dB dB

Ring Characteristics (T_{amb} = 25°C)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{Thri\ ON}$ $V_{Thri\ OFF}$	Ringing Threshold Voltage	Test 5 a/b RI high (see Figure 4) RI low (see Figure 4)	 15 5		 20 9	 V V
I_{CRing}	Internal Consumption in Ring Mode	V_{RING} = 10V		1	1.2	mA
V_{RMC}	Microprocessor Supply Voltage		3.45	3.75	4.05	V
t_{RON}	Rise Time	I_{RING} = 10mA			100	ms
V_{RING}	Internal Zener Voltage		27			V
V_{bout}	Buzzer V_{out} Freq = 1312Hz Freq. Code 001111	VRING = 27Vzener (see Figure 5) Level Code (011111) Level Code (011110) Level Code (011101) Level Code (011100)	 12 4.4 2.2 1	 13 5.6 2.8 1.4	 13.5 6.7 3.4 1.8	 V_{RMS} V_{RMS} V_{RMS} V_{RMS}

Figure 4 : Ringer Hysteresis Ringer

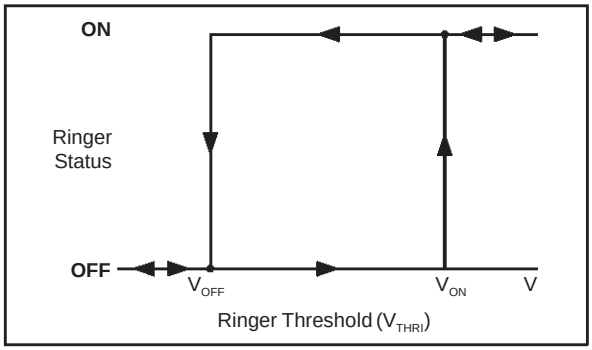
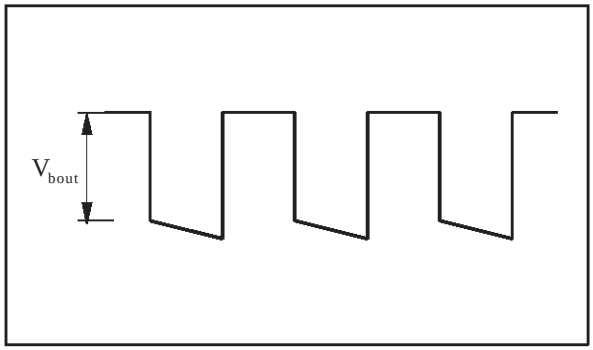


Figure 5 : Ringer Output Waveform



ELECTRICAL SPECIFICATIONS (continued)

DTMF Generator (T_{amb} = 25°C ; R_L = 660Ω)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Amf	Tone Frequency Accuracy	Test 6 Pin Osc fclock = 1.79MHz oscillator off or Resonator : 3.58MHz oscillator on C13 =100nF, I_L = 22mA	- 0.4		0.4	%
Llf Lhf	Low Freq. Group Line Level High Freq. Group Line Level		-10 -8	-8.5 -6.5	-7 -5	dBm dBm
Pmf	Preemphasis HF/LF		+1	+2	+3	dB
t_{DON} t_{DOFF}	Rise Time Decay Time				5 5	ms ms
Cmf	DTMF Confidence Tone : Earphone level (low freq.) Earphone level (high freq.)		 13 17	 17 22	 21 27	 mV mV
–	- Unwanted Harmonics Level	(see Figure 6)	–	–	–	–

Figure 6 : Unwanted Harmonics Level in DTMF

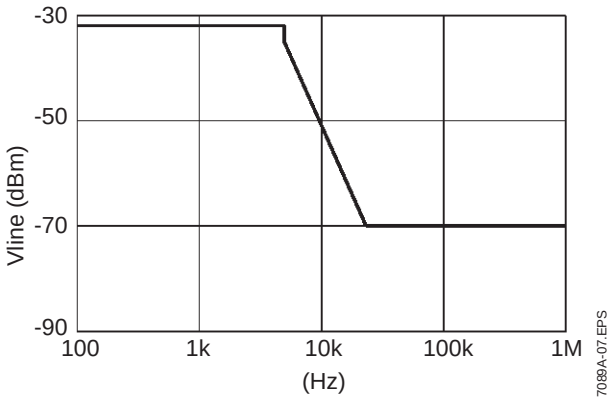
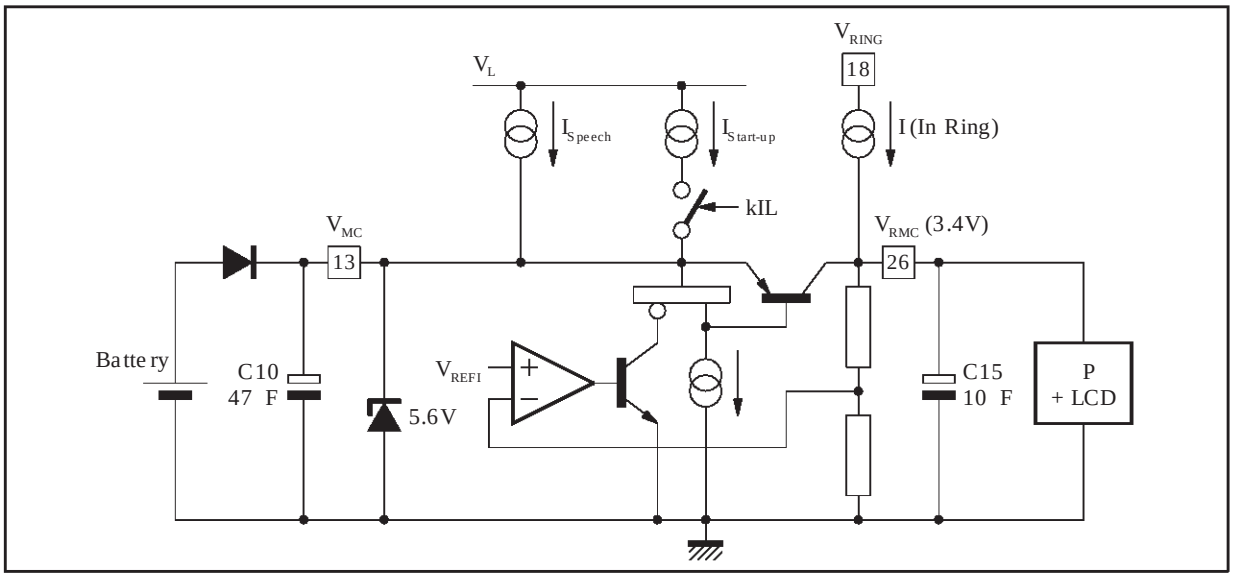


Figure 7 : Microcontroller Interface



MICROCONTROLLER INTERFACE WITH TEA7089A

All inputs can be driven by a Low level max. of 0.1 x V_{RMC} and a high level min. of 0.9 x V_{RMC}.

Inputs MSK, DCL and DATA have internal pull-up resistors of 120kΩ and input OSC has a internal pull up of 240kΩ.

All outputs can drive a ±1mA typical.

Power Supply

The microcontroller is power supplied by a 3.4V regulated supply (V_{RMC}) and by an unregulated power supply (V_{MC}).

The two supplies are connected through a serial regulator. The unregulatedpower supply (V_{MC}) has a DC voltage equal to: V_{12} - 0.6V and must be lower than 6V. It is also possible to connect a battery at Pin V_{MC} and use the regulated output at Pin V_{RMC} to supply a LCD driver.

The current consumption on the serial regulator has a typical value of 60µA.

Power ON (PON)

The TEA7089Agenerates a power on signal (PON) as soon as the voltage on Pin V_{RMC} is higher than 2.6V (0.75 x V_{RMC} final) and the line current is present.

Note : During the break period in the loopdisconndect and Flash mode and during the exchange line break, the power ON signal goes to low level. Maximum delay for Pon decay edge after I_{Line} goes to zero is 50ms (with C8 = 47µF, C11 = 1µF, C27 = 10µF).

Reset

The TEA7089A generates a rise edge Reset signal as soon as the logic power supply is higher than 2.6V (0.75 x V_{RMC} final).

RESET remains high until V_{RMC} decreases below 2.5V or the RESET control code is received. In Ring, RESET is identical to RI output.

Only new positive edge PON, derived on opening and closing the line, is forcing the default mode again. The Reset control code is only active in speech mode.

Serial Bus Interface (Data and Clock)

The serial bus uses 6 bits. A standard 8 bit bus can be used, bits a6 and a7 are not take in account by the TEA7089A. Different types of codes are used :

a) The Ring Control Code :
- Ring start up
- Output level codes

b) The Operating Code :
- Speech
- Dialing
- Microphone mute
- Earphone/Microphone mute

c) The Data Codes (DTMF, ring frequencies) **:**
Those data codes are stored inside the TEA7089A and are used as soon as the dialing code or the ring start code is received.

d) The Configuration Code :
- AGC / no AGC (toggle)
- No mask / mask (Low DC in ”make”) (toggle)
- Normal gain / normal gain +6dB, on receive channel (toggle)
- 1.79MHz external clock / 3.58MHz internal oscillator (toggle)

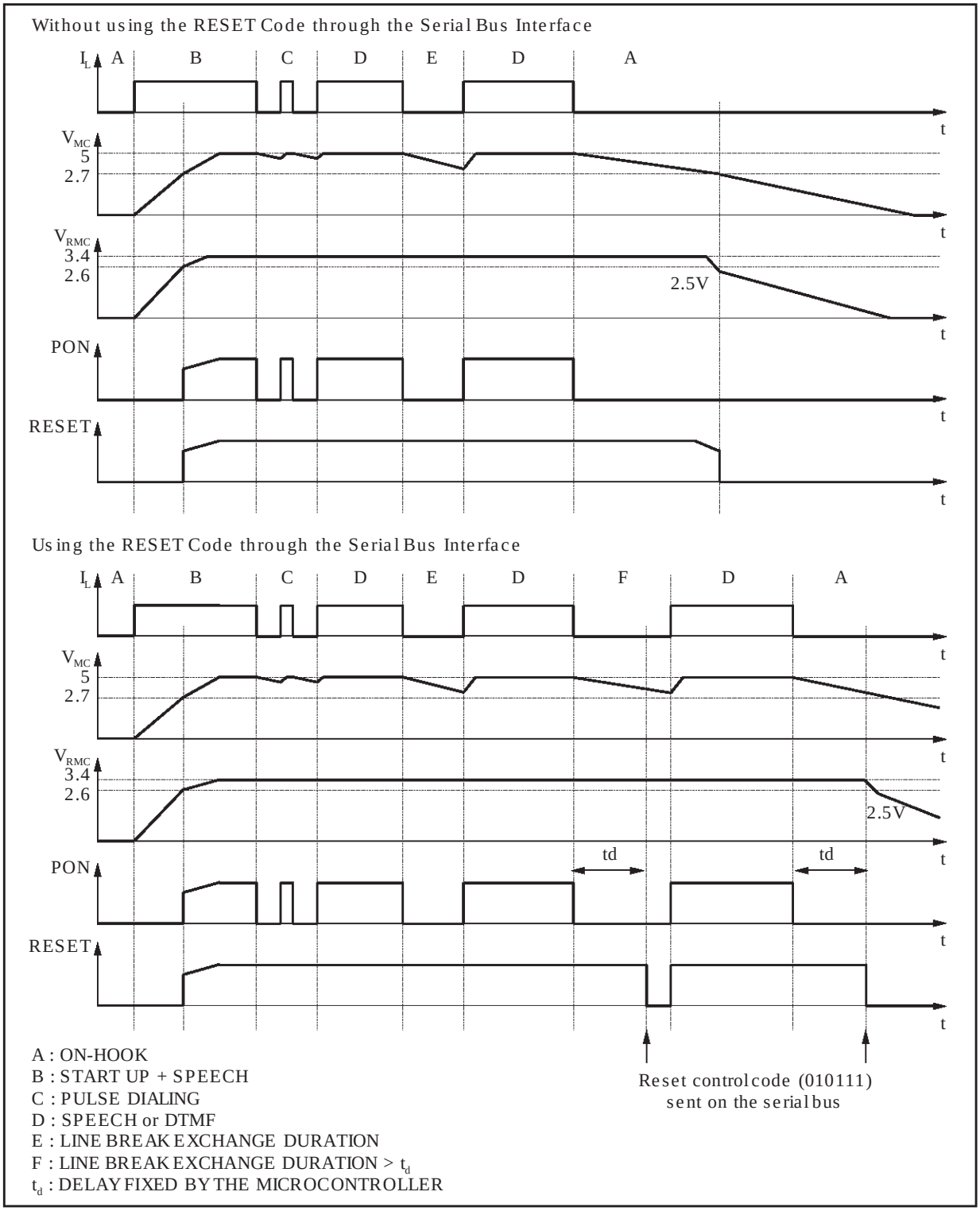
Those configuration codes are ”Flip-Flop” codes.
For instance : The first time that the+6dB code is sent, the receive gain increases of +6dB.
If the same code is sent again, the receive gain goes back to normal value. In the same way the 3.58MHz internal oscillator can be switched OFF with a second transmission of the proper code.

e) The RESET Code :
Reset code from the MCU will reset internal logic of TEA7089A to default mode and will induce TEA7089A to generate a ”RESET” status ”low” to the MCU on Pin 19.
Warning : the ”RESET” code deactivates the serial bus interface which is reactivated only after a ”ON-HOOK/OFF-HOOK” sequence**.**

f) The INITIALIZATION Code :
Initialization code from the MCU will reset the internal logic of TEA7089A to default mode, but the TEA7089A will not generate reset command to the MCU on Pin 19.

MICROCONTROLLER INTERFACE WITH TEA7089A (continued)

Figure 8 : Reset and Power ON



MICROCONTROLLER INTERFACE WITH TEA7089A (continued)

The Start Up Conditions of the TEA7089A

As soon as RESET is high and before sending any code the circuit is in the following default configuration :

- Speech
- No mask
- AGC ON in transmit and receive channels
- Normal gain on receive channel
- 1.79MHz input clock (oscillator in stand by)

6 bit Codes

Between two DTMF or ring frequencies, introducing a Mute or speech code implies to wait 1ms to end the sinewave or square period.

DTMF Dialing

To dial in DTMF the following sequence of codes must be sent :

DTMF Frequency code : 00XXXX
Dialing Mode code : 010001
Mute or SPEECH code : 010010 or 010000

The duration of the DTMF signal is fixed by the delay between Dialing mode code and MUTE or SPEECH code.

Pulse Dialing

The pulse dialing function is performed by the microcontroller through the high voltage stage.

The "MAKE" voltage over the TEA7089A during dialing can be reduced by sending the mask code 0010101. To recover the normal speech voltage at the end of dialing the mask code must be sent again.

If the mask code is not used the voltage over the TEA7089A during dialing is the same as in speech mode.

Ring Indicator (RI)

In ring mode TEA7089A generates a high logic level on Pin RI as soon as the voltage on Pin V_{RING} is higher than V_{THRI} ON (19V Typ.), and the voltage on V_{RMC} is higher than 3.4V.

When the voltage on V_{RMC} becomes higher than 2.6V, RESET signal becomes also high.

Mask Input (MSK)

MSK input must be high by default (Figure 10).

In speech configuration forcing MSK input to low level will have same functionality than the MASK code.

For ring mode when it is necessary to send other frequencies than the 8 basic ones, this input allows to drive the buzzer output.

Figure 9 : DATA/CLOCK Timing

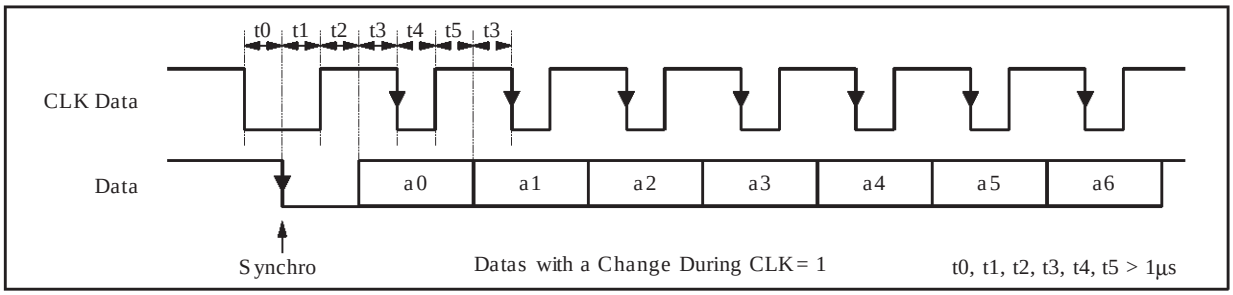
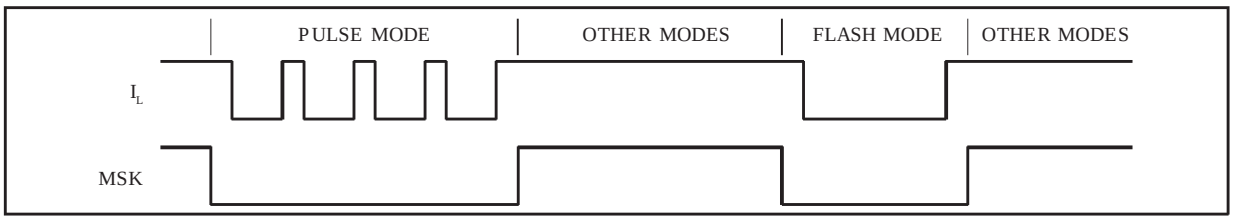


Figure 10 : MASK Timing



MICROCONTROLLER INTERFACE WITH TEA7089A (continued)

Codes						Keyboard	Remarks	
a5	a4	a3	a2	a1	a0			
0	0	0	0	0	0	”2”	1336Hz + 697Hz	In DTMF Dialing
0	0	0	0	0	1	”1”	1209Hz + 697Hz	
0	0	0	0	1	0	”A”	1633Hz + 697Hz	
0	0	0	0	1	1	”3”	1477Hz + 697Hz	
0	0	0	1	0	0	”8”	1336Hz + 852Hz	
0	0	0	1	0	1	”7”	1209Hz + 852Hz	
0	0	0	1	1	0	”C”	1633Hz + 852Hz	
0	0	0	1	1	1	”9”	1477Hz + 852Hz	
0	0	1	0	0	0	”5”	1336Hz + 770Hz	
0	0	1	0	0	1	”4”	1209Hz + 770Hz	
0	0	1	0	1	0	”B”	1633Hz + 770Hz	
0	0	1	0	1	1	”6”	1477Hz + 770Hz	
0	0	1	1	0	0	”0”	1336Hz + 941Hz	
0	0	1	1	0	1	”*”	1209Hz + 941Hz	
0	0	1	1	1	0	”D”	1633Hz + 941Hz	
0	0	1	1	1	1	”#”	1477Hz + 941Hz	
0	0	0	0	0	0		822Hz Ring Signal	In Ring Mode
0	0	0	0	0	1		744Hz Ring Signal	
0	0	0	0	1	0		1005Hz Ring Signal	
0	0	0	0	1	1		909Hz Ring Signal	
0	0	0	1	0	0		1187Hz Ring Signal	
0	0	0	1	0	1		1074Hz Ring Signal	
0	0	0	1	1	0		1451Hz Ring Signal	
0	0	0	1	1	1		1312Hz Ring Signal	
0	1	0	0	0	0		Speech Mode	
0	1	0	0	0	1		Dialing Mode or Ring Start	
0	1	0	0	1	0		Earphone & Microphone Mute	
0	1	0	0	1	1		Microphone Mute	
0	1	0	1	0	1		Mask/No Mask	
0	1	0	1	1	0	”+6dB”	Normal/+6dB on Receive Channel	
0	1	0	1	1	1		Reset Pin Control	
1	1	1	0	1	0		Initialization Code	
0	1	0	1	0	0		AGC / No AGC	
1	0	1	0	0	0		1.79MHz Ext Clock & Oscillator Stand by / 3.58MHz Ceramic (toggle)	
0	1	1	1	0	0		Minimum Ring Level (level 1)	
0	1	1	1	0	1		Intermediate Low Ring Level (level 2)	
0	1	1	1	1	0		Intermediate High Ring Level (level 3)	
0	1	1	1	1	1		Maximum Ring Level (level 4)	

7089A-03.TBL

Figure 11 : Test Circuits - Test 1 (V_L / V_{RMC} / V_{MC} / IVMC / I_{LS})

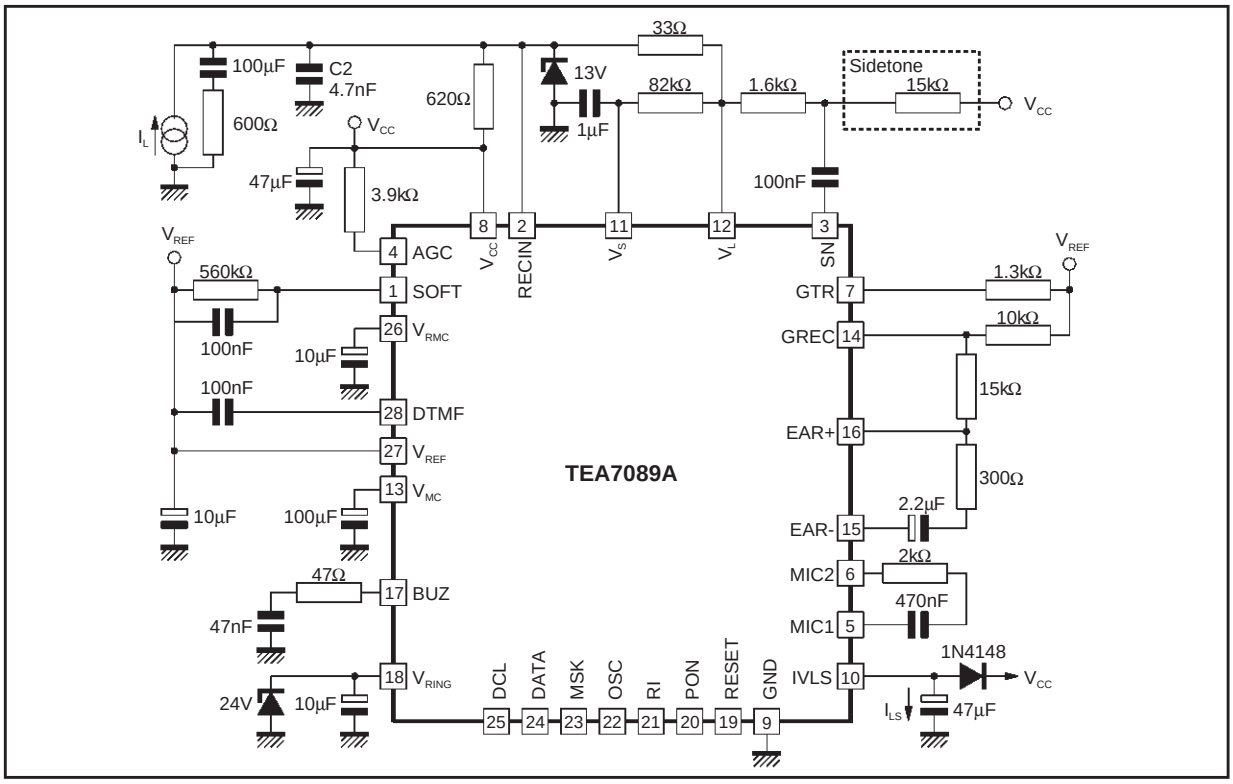


Figure 12 : Test 2 (R1)

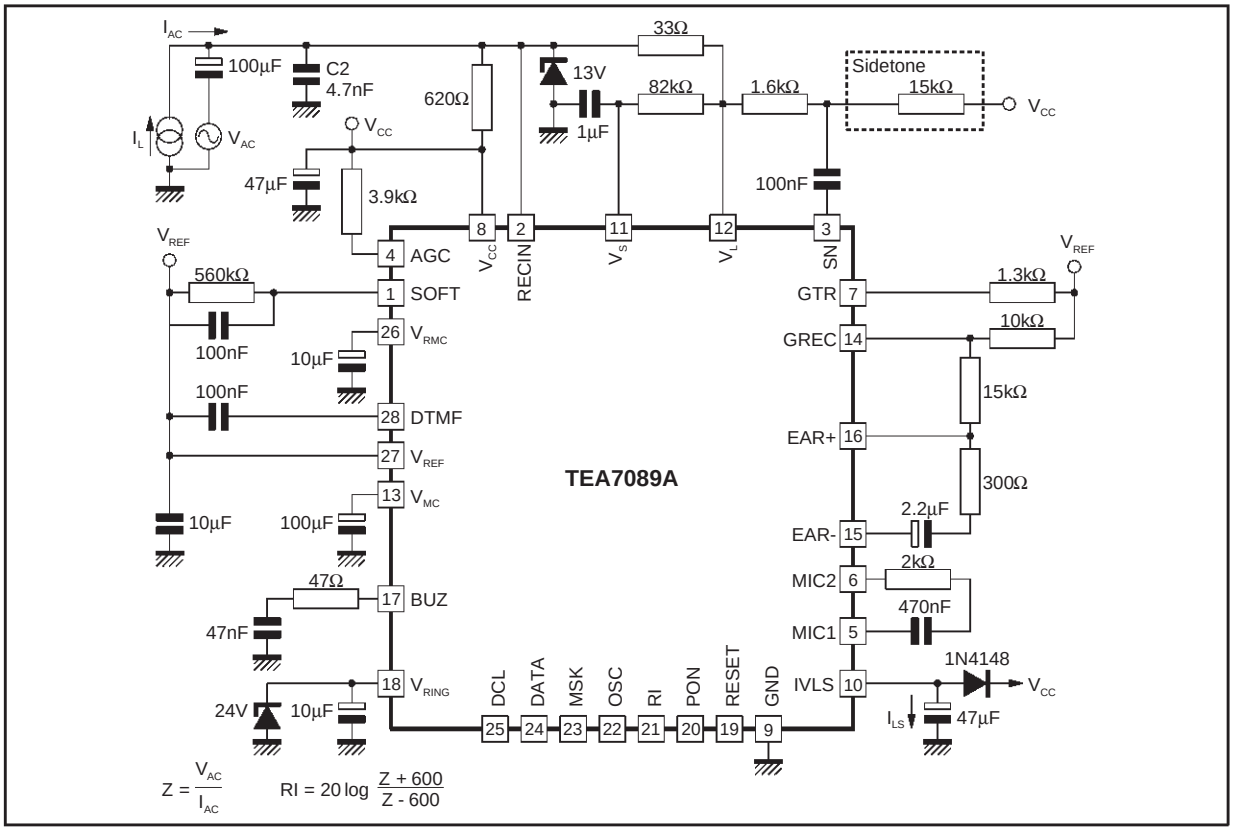


Figure 13 : Test 3 (Gtl / Gts / Zmic / Nt / Mmic / Dt / Vlmax / Eff)

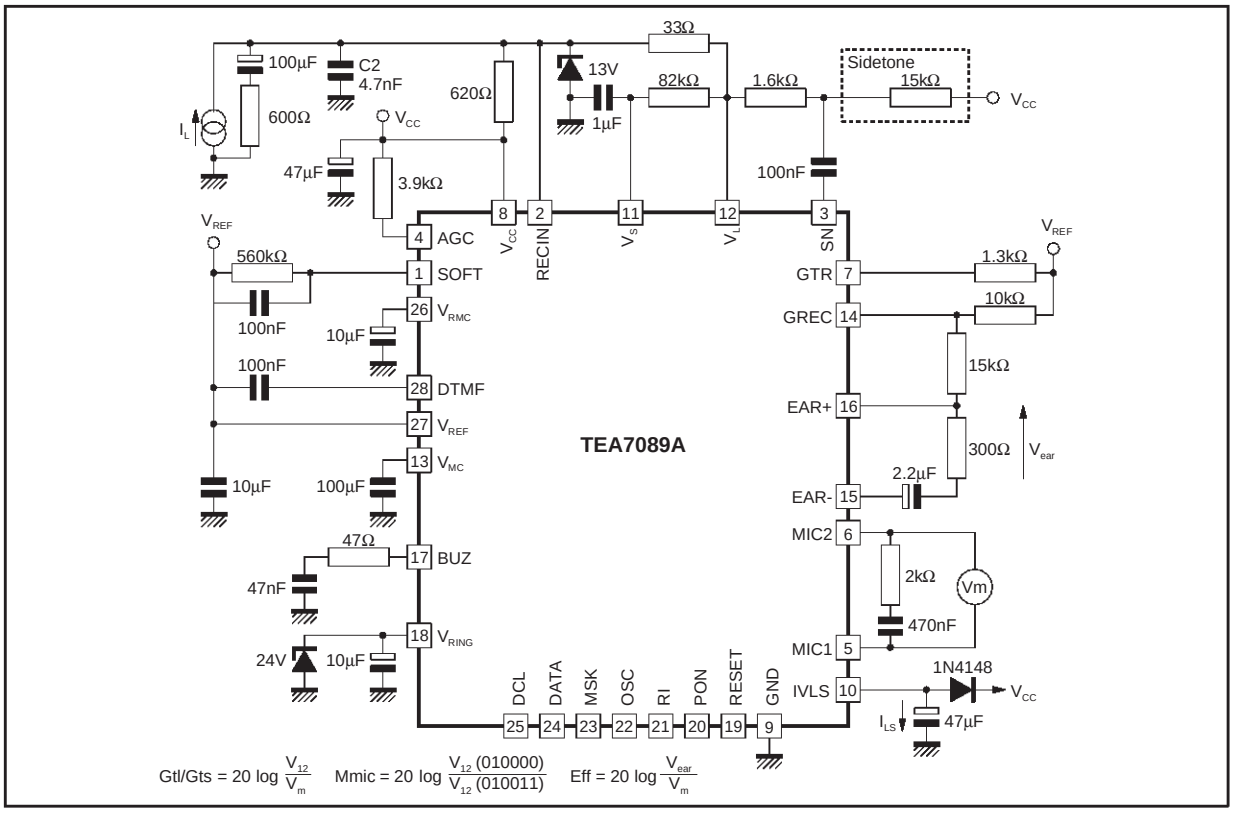


Figure 14 : Test 4 (Grl / Grs / Dr / Mear / Nr)

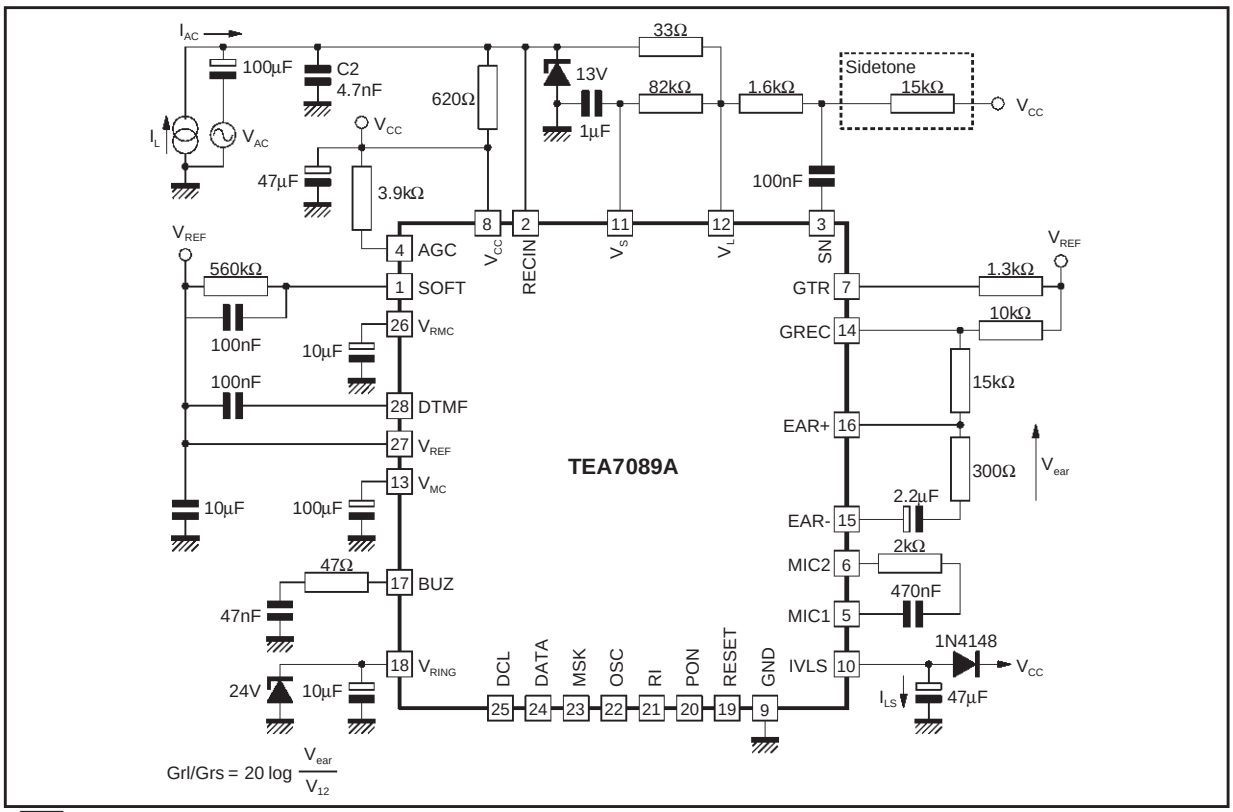


Figure 15 : Test 5a (V_{thri})

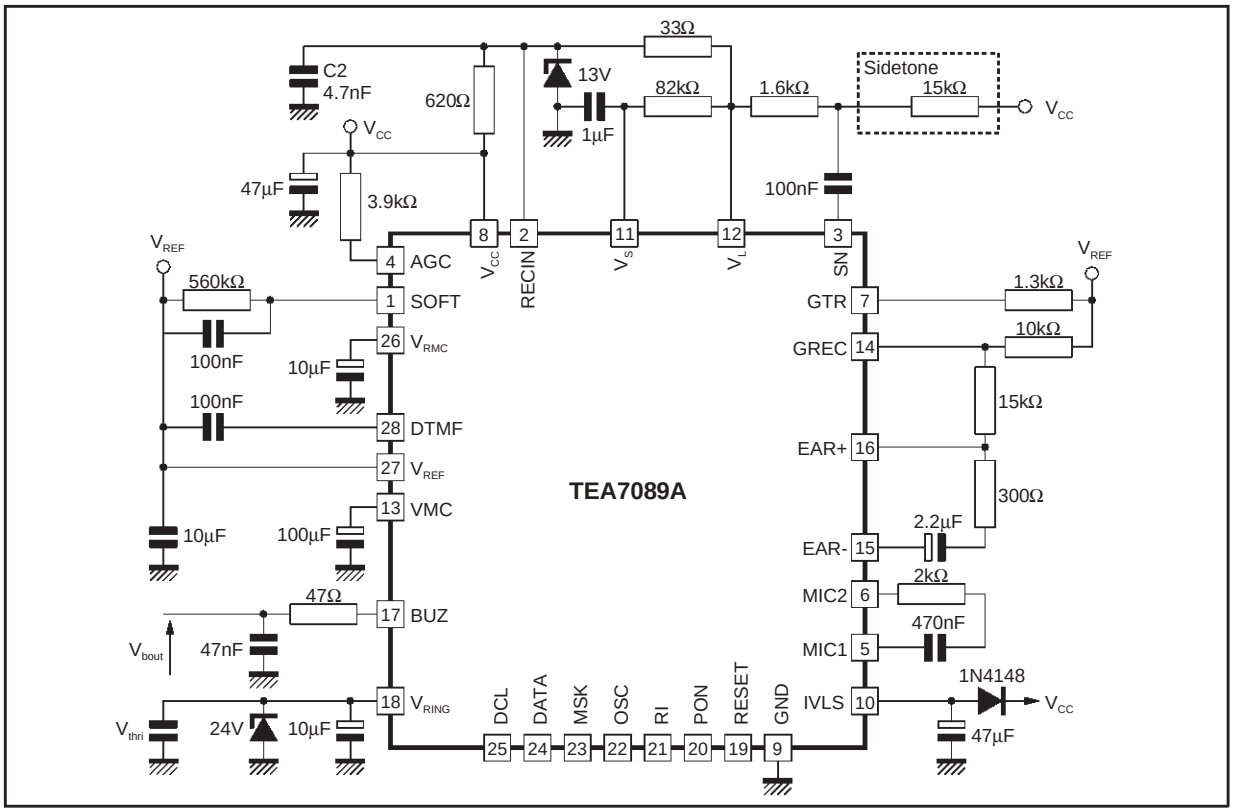


Figure 16 : Test 5b (V_{bout})

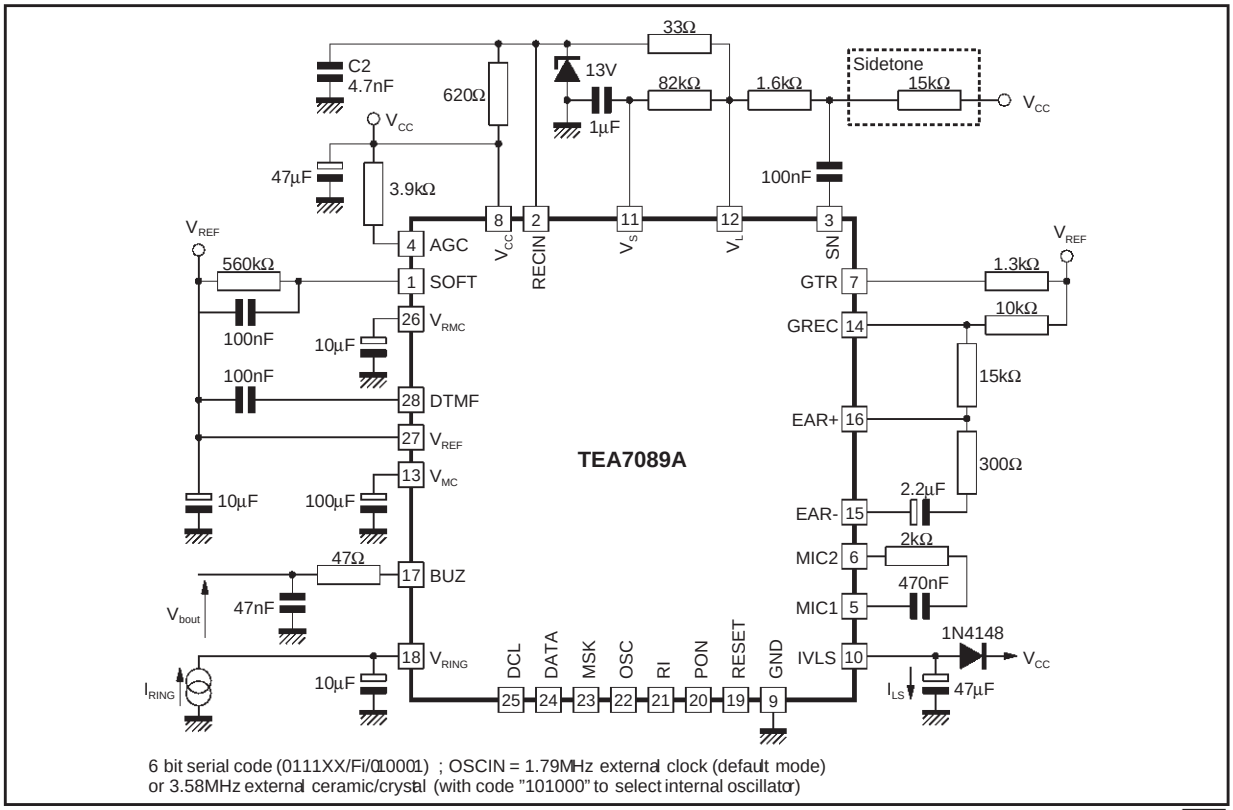
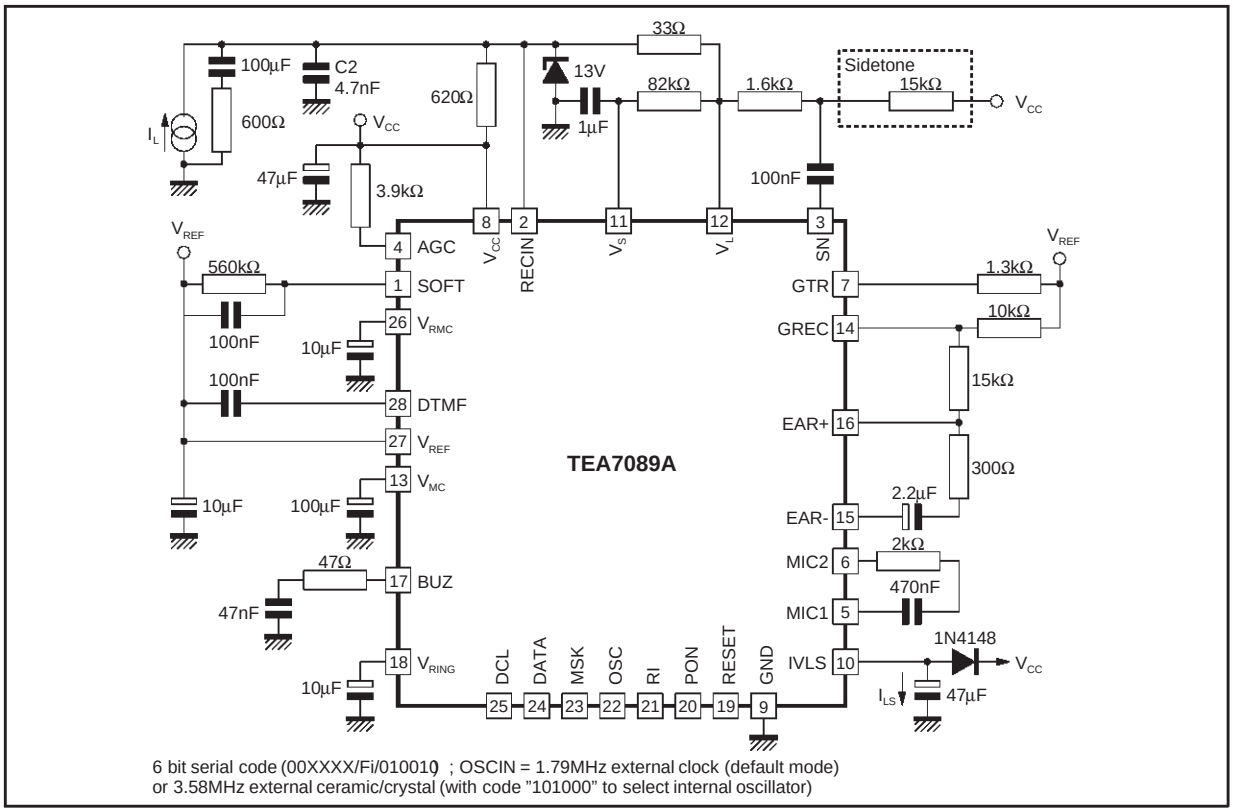
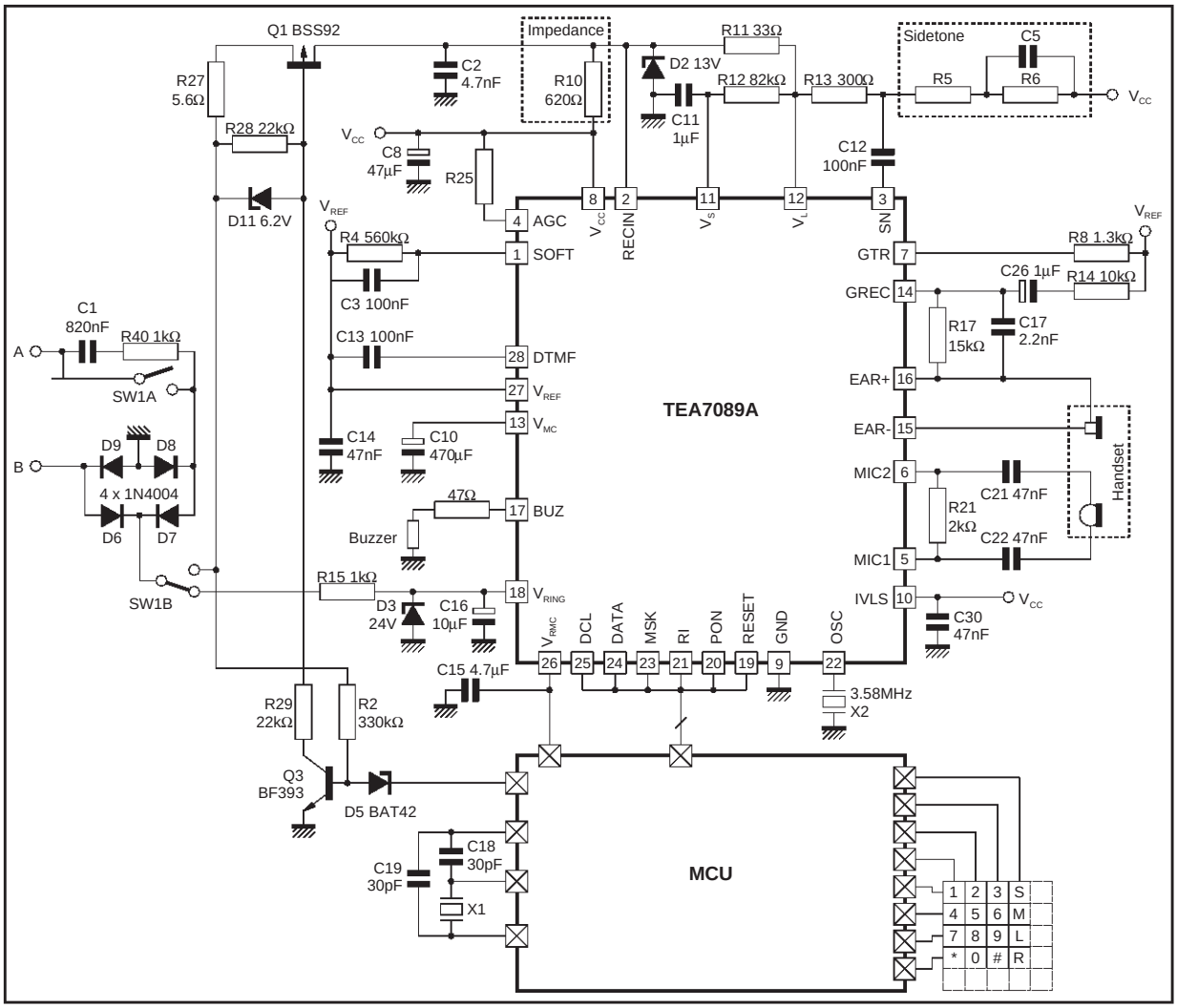


Figure 17 : Test 6 (DTMF)

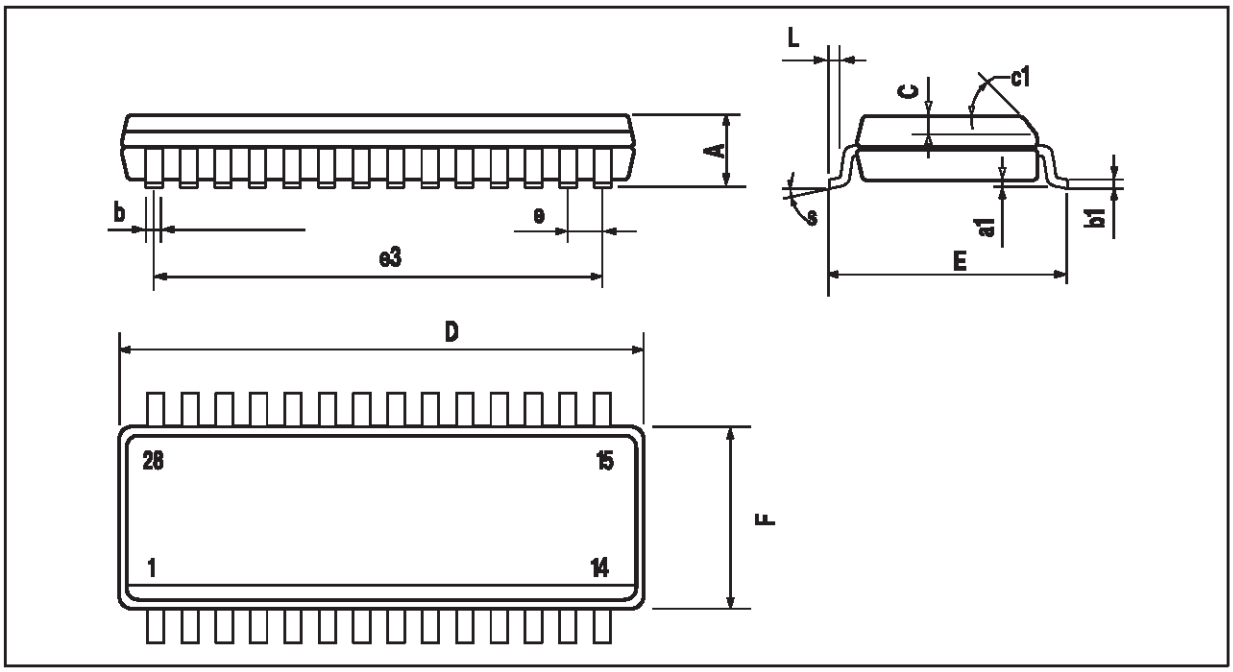


TYPICAL APPLICATION



PACKAGE MECHANICAL DATA

28 PINS - PLASTIC PACKAGE



PM-SO28.EPS

Dimensions	Millimeters			Inches		
	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.)					

SO28.TBL