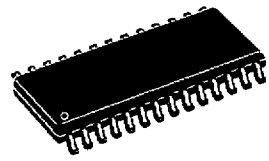
SGS-THOMSON MICROELECTRONICS

TEA7088A

LOW RANGE PHONE DEDICATED CHIP

PRELIMINARY DATA

- 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
  - SOFTCLIPPING ON SENDING CHANNEL
  - RECEIVE AMPLIFIER FOR PIEZO OR ELECTRODYNAMIC TRANSDUCER
  - +6 dB MODE ON RECEIVE CHANNEL
  - LINE POWER MANAGEMENT
- DIALLING
  - 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

ORDERING NUMBER: TEA7088AFP

DESCRIPTION

The TEA7088A 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 TEA7088A 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 contol.
- 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.
A single resonator of 3.58MHz can be used in conjunction with ST629X MCU, while a separate resonator is needed with ST729X or other MCU's.

RINGER

Up to 8 different tones can be generated by the TEA7088A 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 TEA7088A.
If more tones are requested the input RM/MSK allows to inject tones generated by the microcontroller.

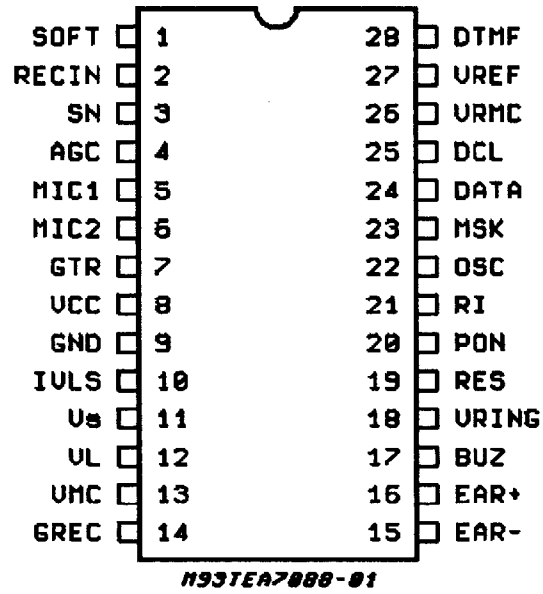
FURTHER ADVANTAGES

- The microcontroller power supply is provided by the TEA7088A. The power supply is specifically designed to cope with a long flash or a long ground key duration.
- The TEA7088A is able to supply the necessary current to an external speakerphone circuit TEA7540 and loudspeaker amplifier TEA7530 or TEA7532 without any additional circuitry.
- Line current and reset indications are provided to the microcontroller by the TEA7088A.
- The microcontroller drives the TEA7088A through a 2 wires serial interface.

PIN FUNCTIONS

N°	Name	Description
1	SOFT	Transmit softclipping time constant
2	RECIN	Receiving input
3	SN	Sidetone network input
4	AGC	Line current regulation stop value
5	MIC1	Microphone input
6	MIC2	Microphone input
7	GTR	Transmit gain adjustment
8	VCC	Transmit and receive part power supply
9	GND	Ground
10	IVLS	Line current source power supply
11	VS	Voltage stabilizer
12	VL	Positive Line
13	VMC	Unregulated microcontroller power supply
14	GREC	Receive gain adjustment
15	EAR-	Negative earphone output
16	EAR+	Positive earphone output
17	BUZ	Ringer buzzer output
18	VRING	Ring power supply
19	RES	Reset
20	PON	Power on
21	RI	Ring indicator
22	OSC	Oscillator input
23	MSK	Mask, ring melody input
24	DATA	Data Input
25	DCL	Data clock input
26	VRMC	Microcontroller stabilized power supply
27	VREF	Reference voltage (VCC/2)
28	DTMF	DTMF filter

PIN CONNECTION (Top view)



ABSOLUTE MAXIMUM RATINGS

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

Figure 1: Block Diagram

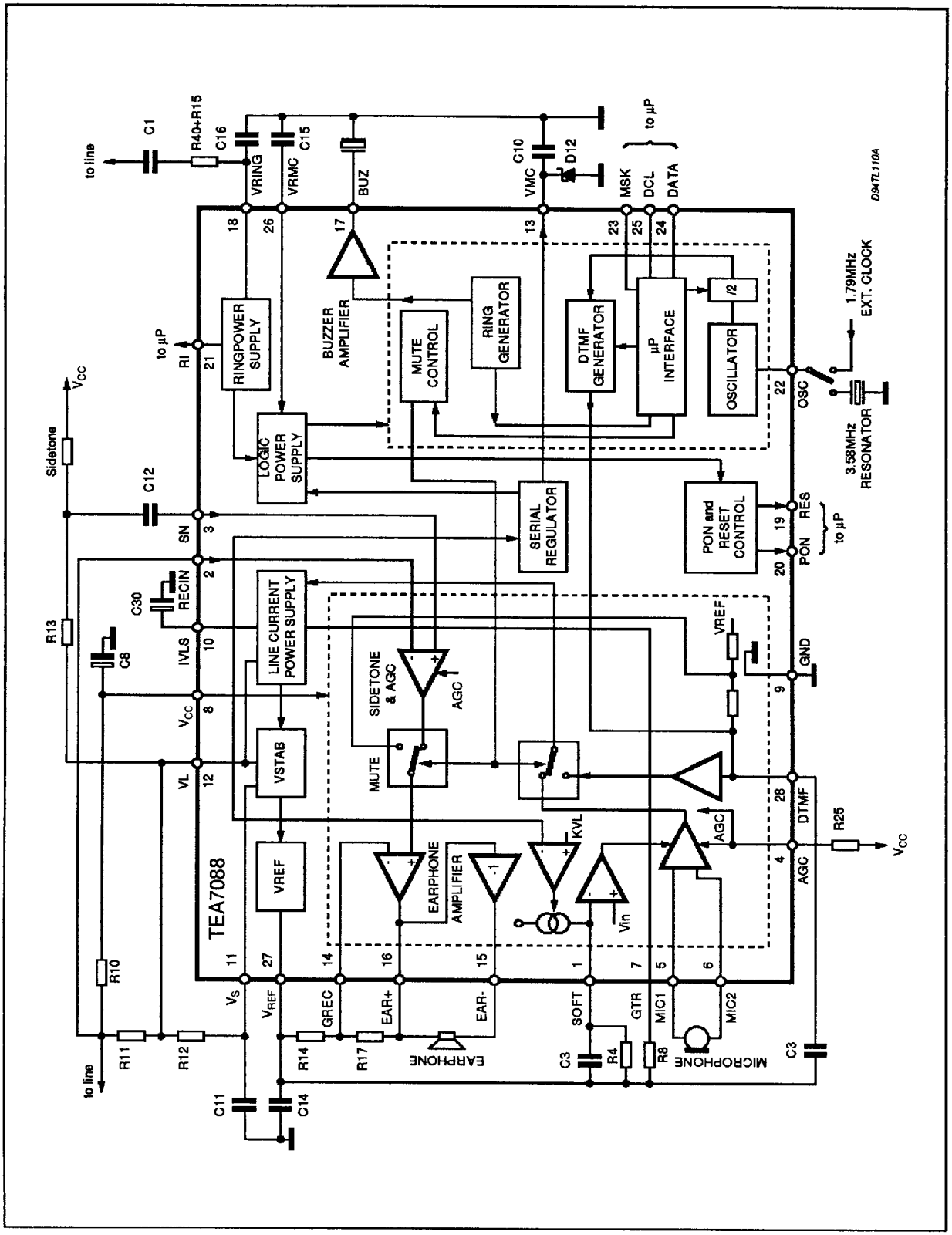
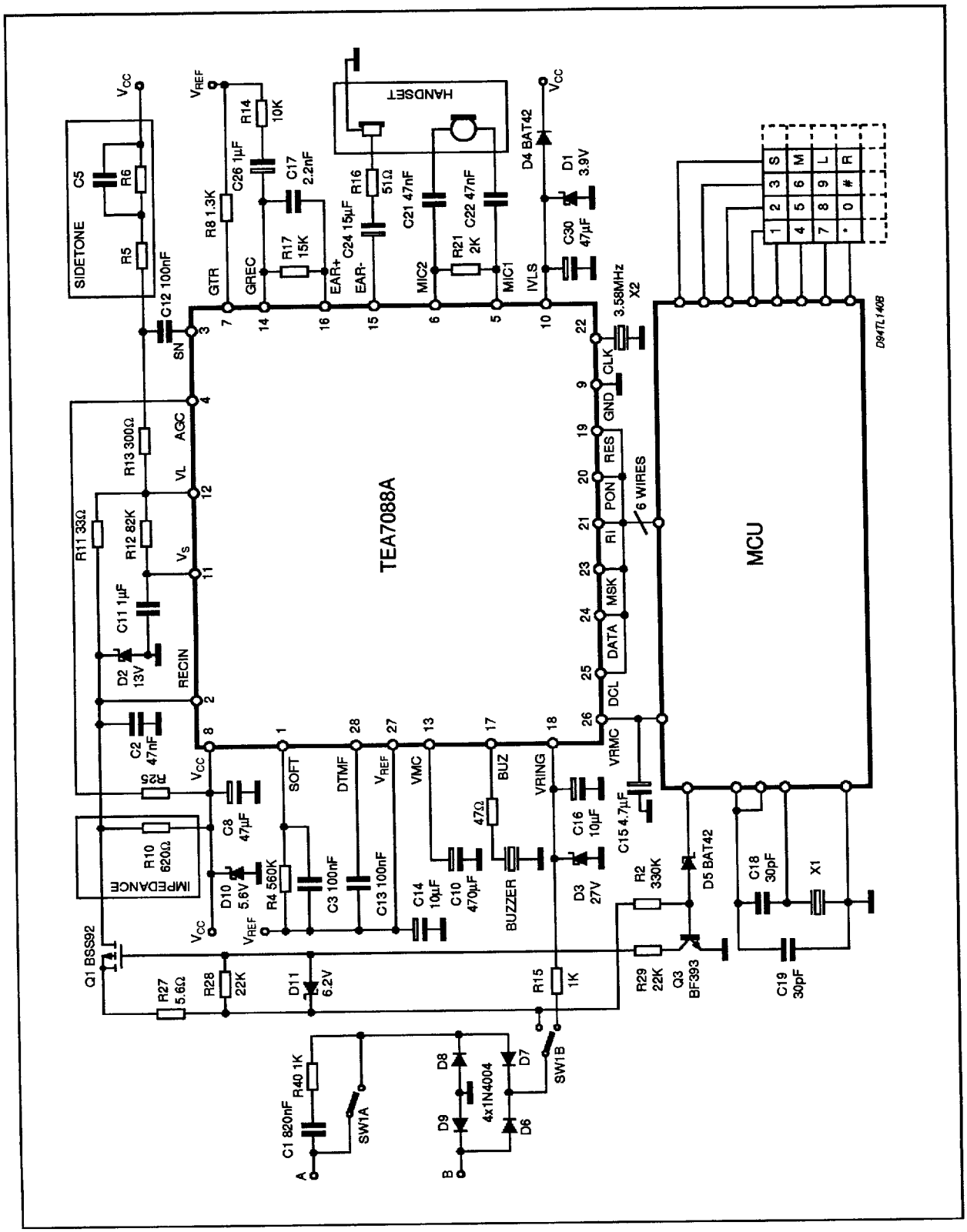


Figure 2: Typical Application



TYPICAL DIAGRAM and GENERAL CHARACTERISTICS

A typical diagram is given on Fig 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 45dB 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 82K between VL and VS

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

Symbol	Parameter	Test Condition	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 V_{MC} = 2.5V; I_{VRMC} = 1.5mA; I_L = 22mA; V_{RMC} = 3.6V; I_{VRMC} = 0mA; I_L = 22mA;	 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:
Vpin10 = Vpin12 - (1.2 + 10 x I_{LS})
and **Vpin10 < 6V**

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

Symbol	Parameter	Test Condition	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 Condition	Min.	Typ.	Max.	Unit
Gtx Gtxl Gtxs	Microphone Gain	Test 3 V_m = -55dBV; R8 = 1.3KΩ R25 = 3.9K Ω I_L = 22mA I_L = 90mA	 45 38	 46 40	 47 42	 dB 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
 Dtx VLmax	Soft Clipping - Distortion - Maximum Level on Line	Test 3; I_L = 22mA See Fig. 2; V_m = -41dBV V_m = -34dBV		 1.5	 2	 % Vp

Figure 3: Softclipping

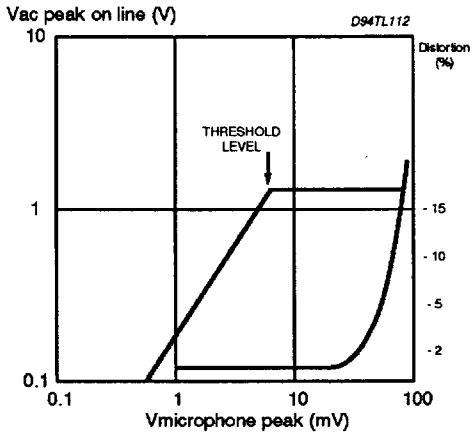
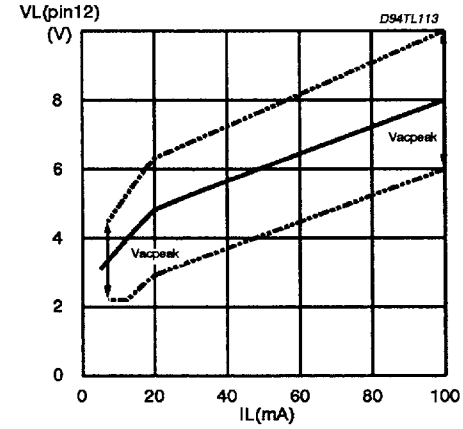


Figure 4



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

$$Gtxl = 20\log\left(820 \cdot \frac{R10 // RL + R11}{R8 // 50K}\right)$$

The AGC variation is programmed with one resistor connected on pin AGC. ISL is the line current at which the gain must be decreased by 6dB.

$$R25\Omega = \frac{300}{ISL - 5mA} \quad (R25 > 2.6K\Omega)$$

For line current lower than ILL or higher than ISL, 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 then maximum gain.

The minimum saturation voltage of the TEA7088A respect to ground is 2.2V. On long line, when the voltage over TEA7088A is low, the softclipping function automatically limits the AC dynamic to avoid to reach the 2.2V limit on TEA7088A respect to ground.

RECEIVE CHARACTERISTICS (T_{amb} = 25°C; R_L = 660Ω; f = 1KHz)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
E_{ff}	Sidetone Eff = (Vear$^+$ - Vear$^-$) /Vm	Test 3 Vm = -55dBV; I_L = 22mA; R14 = 10KΩ; R17 = 15KΩ			22.5	dB
G_{RXX} G_{RXl} 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 Condition	Min.	Typ.	Max.	Unit
Gtp	Transmit Gain	Test 3 & Test 4; I_L = 22 to 90mA Code: 010100 V_m = -55dBV	Gtxl -3	Gtxl -2	Gtxl -1	dB
Grp	Receive Gain	V_L = -14.5dBV	Grxl -3	Grxl -2	Grxl -1	dB

RING CHARACTERISTICS (T_{amb} = 25°C)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{Thri\ ON}$	- Ringing Threshold Voltage	Test 5 a/b RI high (see fig. 5)	15		20	V
$V_{Thri\ OFF}$		RI low (see fig. 5)	5		9	V
I_{CRing}	Internal Consumption in Ring Mode	VRING = 10V		1	1.2	mA
V_{RMC}	Microprocessor Supply Voltage		3.45	3.75	4.05	V
t_{ron}	- Rise time	Iring = 10mA			100	ms
V_{Ring}	- Internal Zener Voltage		27			V
Vbout	- Buzzer V_{out}	Vring = 27Vzener (see fig. 6)				
	Freq = 1312Hz	Level Code (011111)	23.5	25	27	Vpp
	Freq. Code 001111	Level Code (011110)	8.5	10.5	13	Vpp
		Level Code (011101)	3.5	5.0	6.5	Vpp
		Level Code (011100)	0.2	1.5	3.0	Vpp

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Amf	- Tone Frequency Accuracy	Test 6 fclock = 1.79MHz (or code	- 0.4		0.4	%
Llf	- Low Frequncy Group line level	"101000" and Quartz 3.58MHz);	-10	-8.5	-7	dBm
Lhf	- High Freq. Group line level	C13 =100nF; I_L = 22mA	-8	-6.5	-5	dBm
Pmf	- Preemphasis HF/LF		+1	+2	+3	dB
Tdon	- Rise Time				5	ms
Tdoff	- Decay Time				5	ms
Cmf	- DTMF Confidence tone:					
	Earphone level (low freq.)		13	17	21	mV
	Earphone level (high freq.)		17	22	27	mV
–	- Unwanted Harmonics level	(see Fig 7)	–	–	–	–

Figure 5: Ringer Hysteresis Ringer

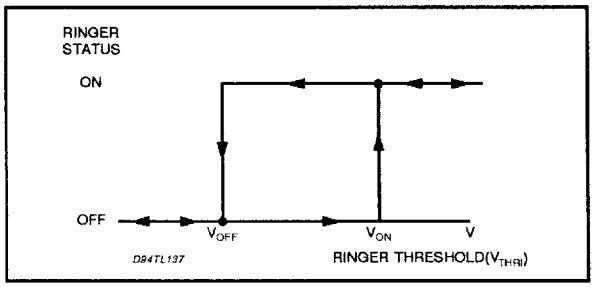


Figure 6: Ringer Output Waveform

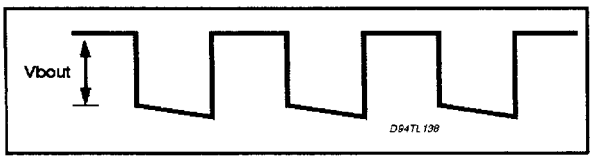


Figure 7: Unwanted Harmonics level in DTMF

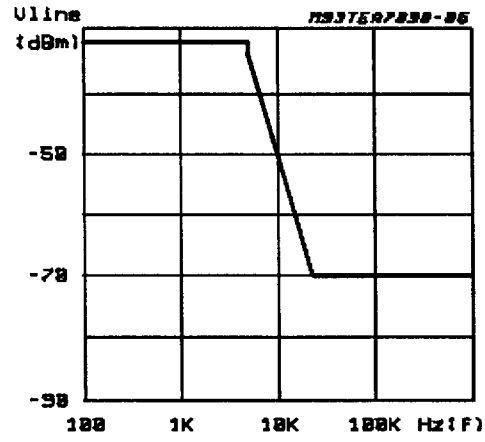
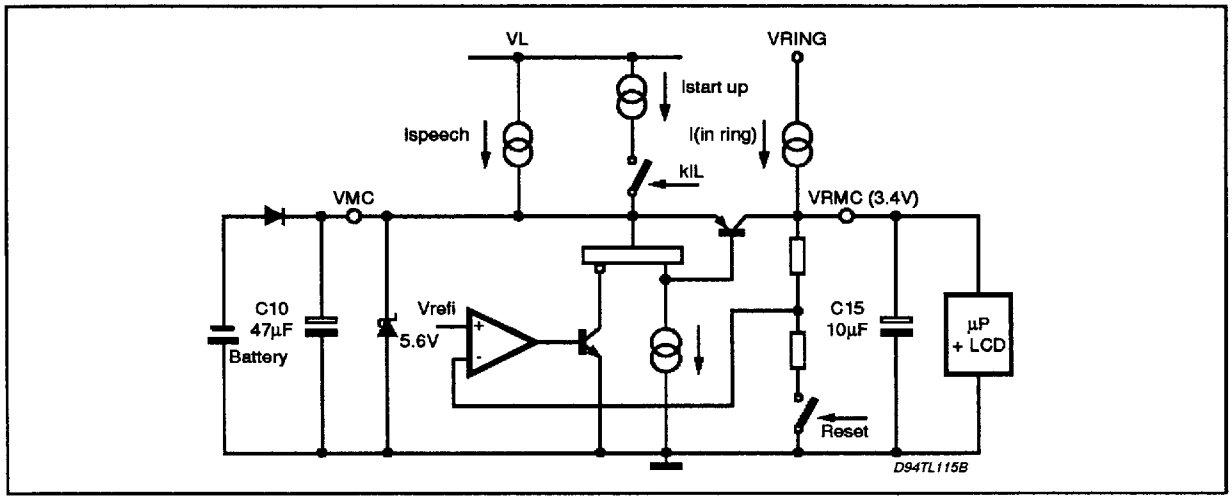


Figure 8: Microcontroller Interface



MICROCONTROLLER INTERFACE WITH TEA7088A

All inputs can be driven by a Low level max. of 0.1 x VRMC and a high level min. of 0.9 x VRMC. 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 (VRMC) and by an unregulated power supply (VMC).
The two supplies are connected through a serial regulator. The unregulated power supply (VMC) has a DC voltage equal to: Vpin12 - 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 VRMC to supply a LCD driver.
The current consumption on the serial regulator has a typical value of 60µA.

Power ON (PON)

The TEA7088A generates a power on signal (PON) as soon as the voltage on VRMC pin is higher than 2.6V (0.75 x VRMC 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 Cpin8 = 47µF, Cpin11 = 1µF, Cpin27 = 10µF).

Reset

The TEA7088A generates a rise edge Reset signal as soon at the logic power supply is higher than 2.6V (0.75 x VRMC final) and the line current is present.

RESET is active in speech mode on the first positive edge of PON or VRMC and then remains high until VRMC decreases below 2.5V or the RESET control code is received. In Ring, RESET is identical to RI output.

Only positive edge PON, derived on opening and closing the line, is forcing the default mode again. This code is only active in speech configuration.

Serial Bus Interface (Data and Clock)

The serial bus uses 6 bits. A standard 8 bit bus can be used, where bits a6 and a7 are not considered. Different types of codes are used:

a) The Ring Control Code

- Ring start up
- Output level codes

b) The Operating Code:

- Speech
- Dialling
- Microphone mute
- Earphone/Microphone mute

c) The Data Codes (DTMF, ring frequencies)

Those data codes are stored inside the TEA7088A 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 +6 dB.

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 the proper code.

e) The RESET Code

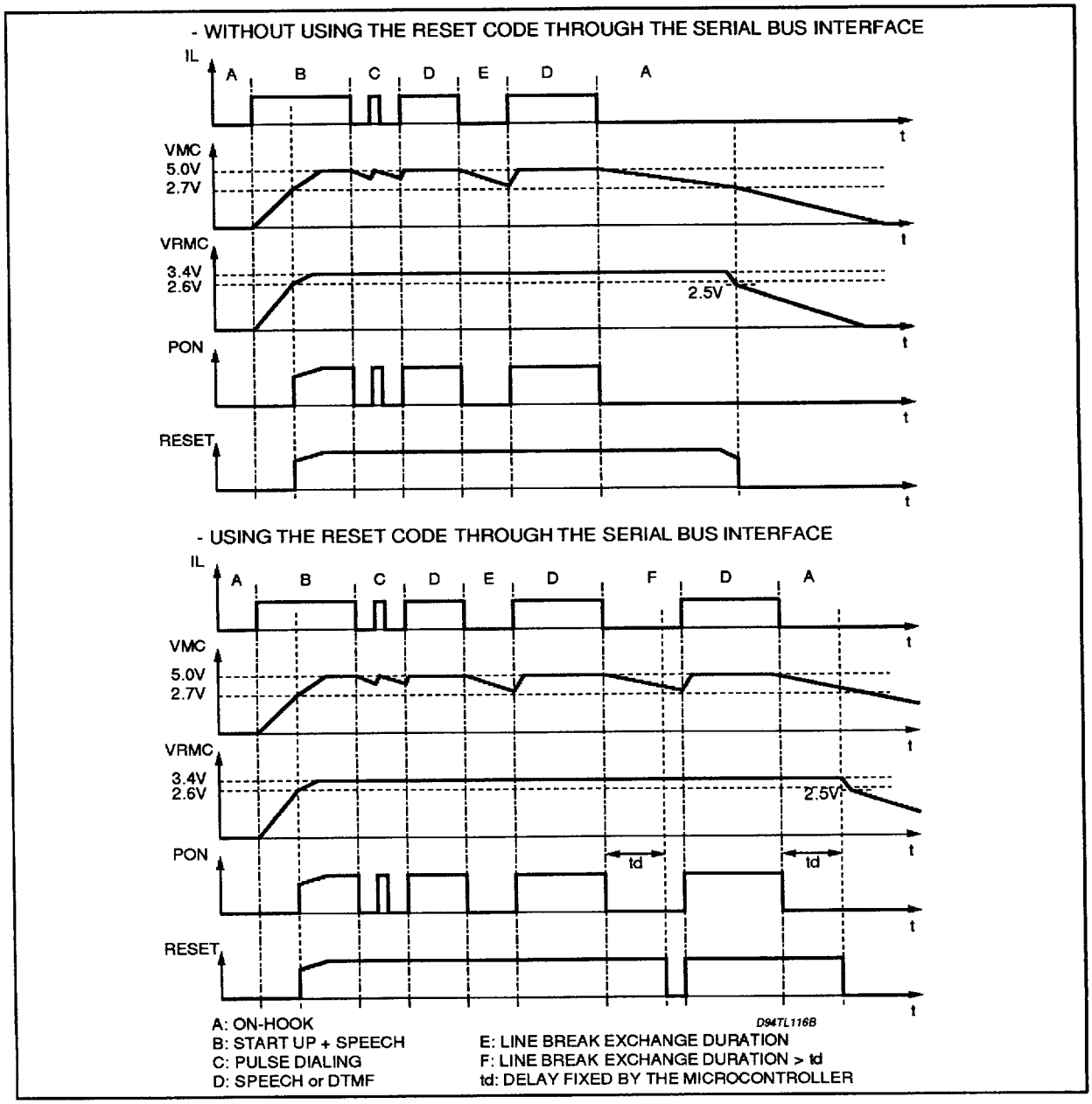
Reset code from the MCU will reset internal logic of TEA7088A to default mode and will induce TEA7088A to generate a "RESET" status "low" to the MCU on pin19.

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 TEA7088A to default mode, but the TEA7088A will not generate reset command to the MCU on Pin 19.

Figure 9: Reset and Power ON



The Start up Conditions of the TEA7088A:

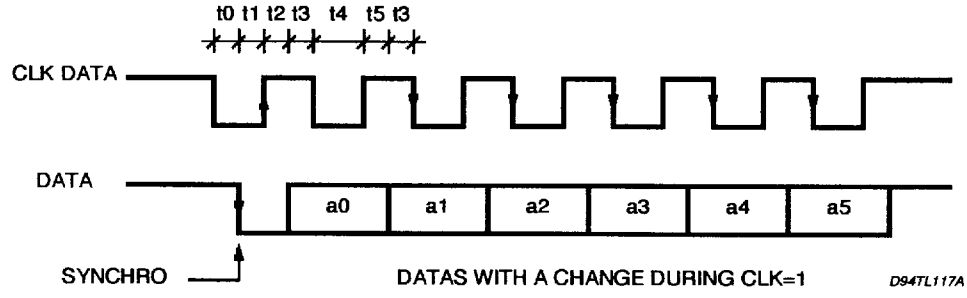
As soon as RESET is high and before sending any code the circuit is in the following default configuration:

- 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.

Figure 10: DATA/CLOCK TIMING



Codes						Keyboard	Remarks	
a5	a4	a3	a2	a1	a0			
0	0	0	0	0	0	"2"	1336 Hz + 697 Hz	IN DTMF DIALLING
0	0	0	0	0	1	"1"	1209 Hz + 697 Hz	
0	0	0	0	1	0	"A"	1633 Hz + 697 Hz	
0	0	0	0	1	1	"3"	1477 Hz + 697 Hz	
0	0	0	1	0	0	"8"	1336 Hz + 852 Hz	
0	0	0	1	0	1	"7"	1209 Hz + 852 Hz	
0	0	0	1	1	0	"C"	1633 Hz + 852 Hz	
0	0	0	1	1	1	"9"	1477 Hz + 852 Hz	
0	0	1	0	0	0	"5"	1336 Hz + 770 Hz	
0	0	1	0	0	1	"4"	1209 Hz + 770 Hz	
0	0	1	0	1	0	"B"	1633 Hz + 770 Hz	
0	0	1	0	1	1	"6"	1477 Hz + 770 Hz	
0	0	1	1	0	0	"0"	1336 Hz + 941 Hz	
0	0	1	1	0	1	"*"	1209 Hz + 941 Hz	
0	0	1	1	1	0	"D"	1633 Hz + 941 Hz	
0	0	1	1	1	1	"#"	1477 Hz + 941 Hz	
0	0	0	0	0	0		822 Hz ring signal	IN RING MODE
0	0	0	0	0	1		744 Hz ring signal	
0	0	0	0	1	0		1005 Hz ring signal	
0	0	0	0	1	1		909 Hz ring signal	
0	0	1	1	0	0		1187 Hz ring signal	
0	0	1	1	0	1		1074 Hz ring signal	
0	0	1	1	1	0		1451 Hz ring signal	
0	0	1	1	1	1		1312 Hz ring signal	
0	1	0	0	0	0		Speech mode	
0	1	0	0	0	1		Dialling 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)	

DTMF Dialling

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

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

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

Pulse Dialling

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

The "MAKE" voltage over the TEA7088A during dialling can be reduced by sending the MASK code 0010101. To recover the normal speech voltage at the end of dialling the mask code must be sent again.

If the MASK code is not used the voltage over the TEA7088A during dialling is the same as in speech mode.

Ring Indicator (RI)

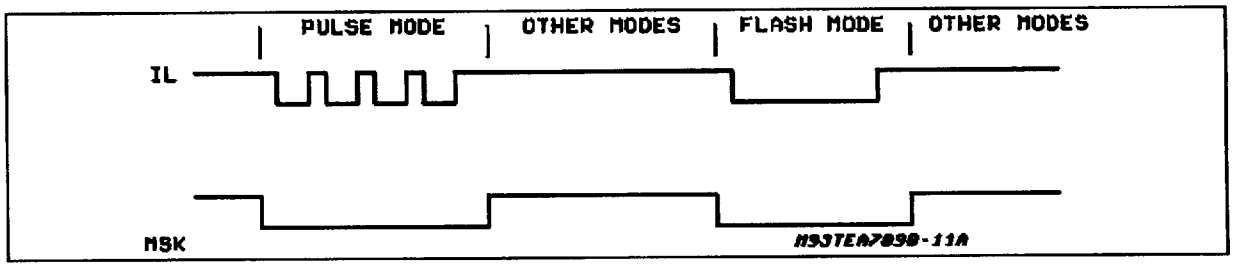
In ring mode TEA7088A generates a high logic level on pin RI as soon as the voltage on pin VRING is higher than V_{THRJ} ON (19V typ.), and the voltage on VRMC is higher than 3.4V.
When the voltage on VRMC becomes higher than 2.6V, RESET signal becomes also high.

Mask input (MSK)

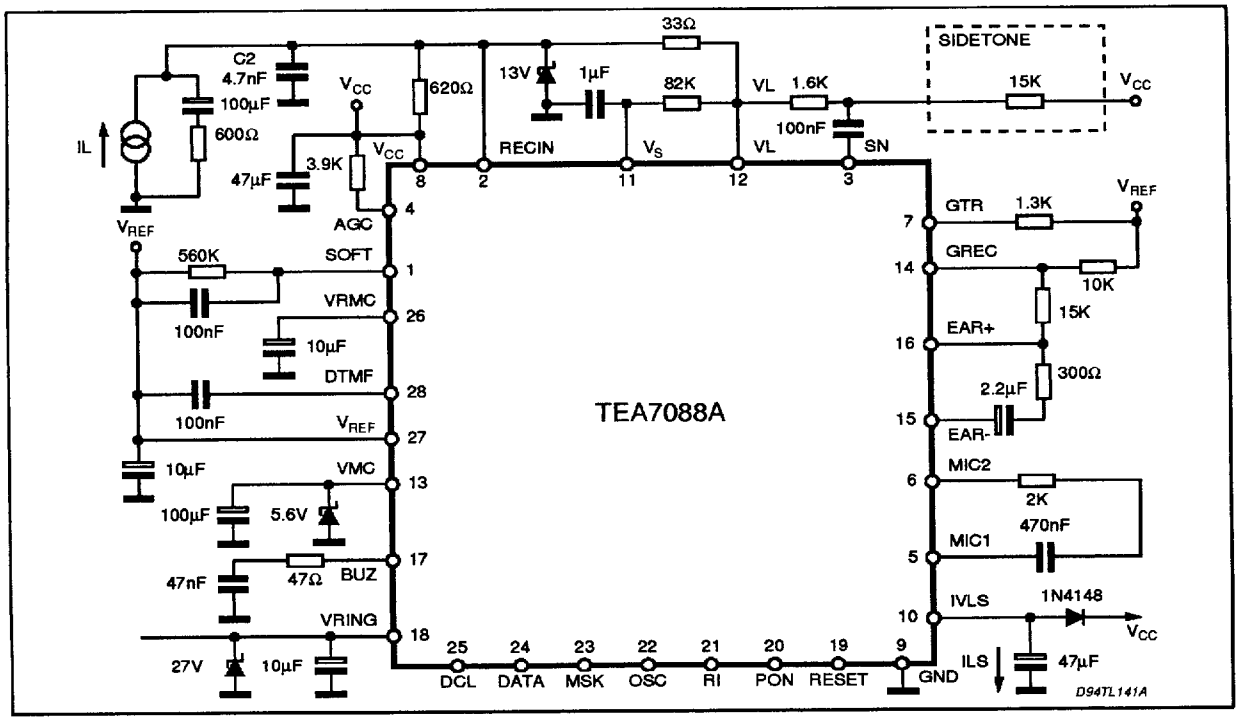
MSK input must be high by default (fig. 11).
In speech configuration forcing MSK input to low level will have same functionality than the MASK code.

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

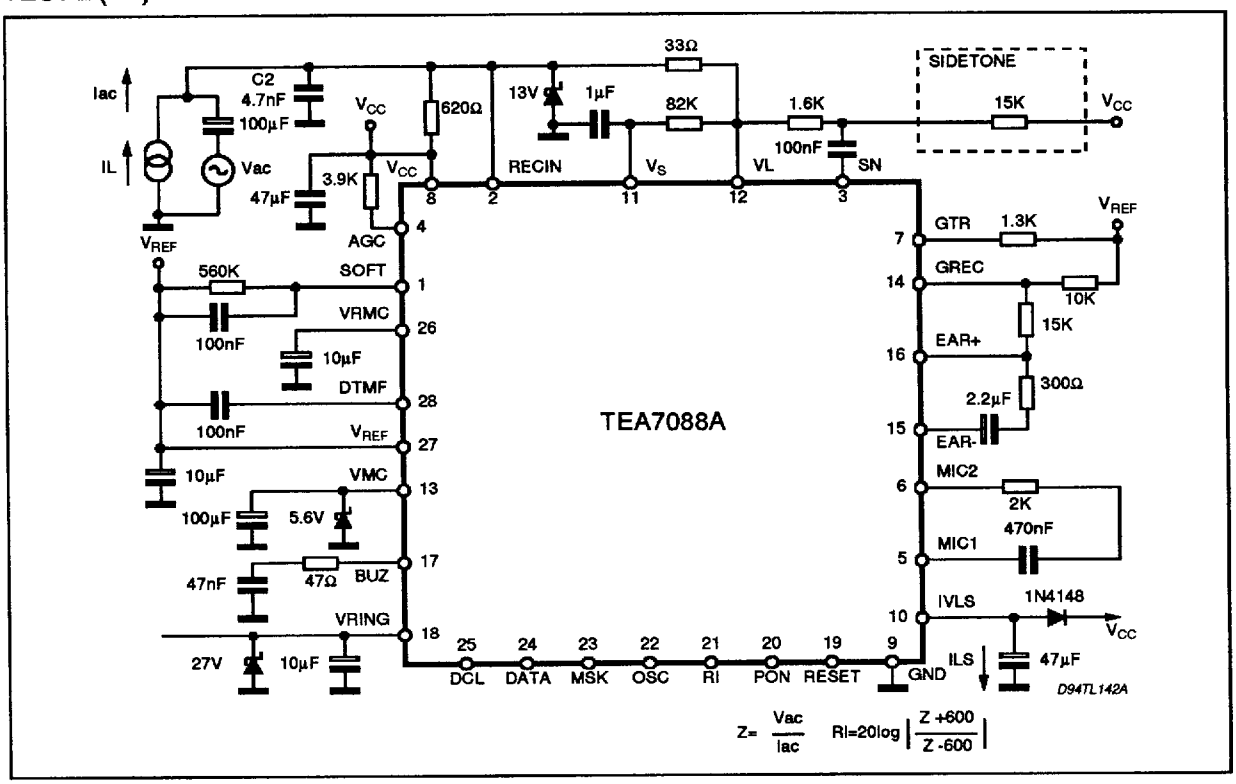
Figure 11: MASK Timing.



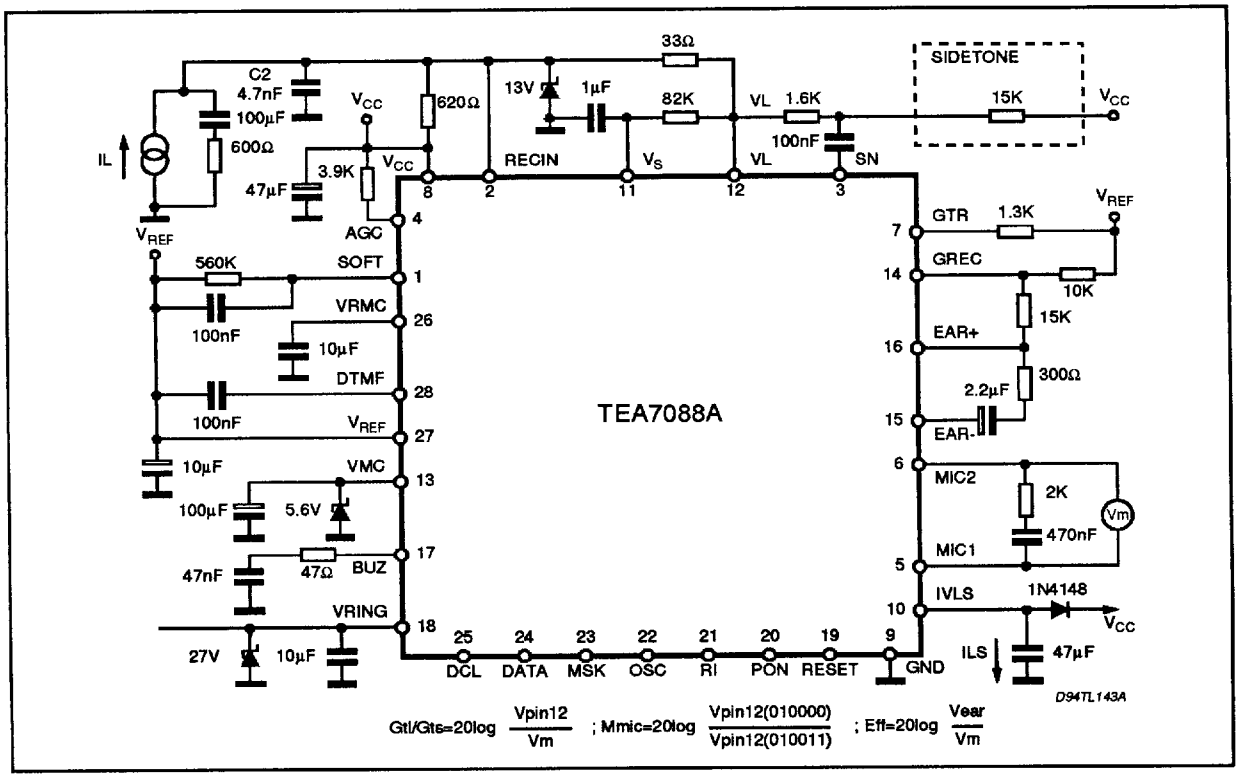
TEST CIRCUITS - Test 1 (VL / VRMC / VMC / IVMC / ILS)



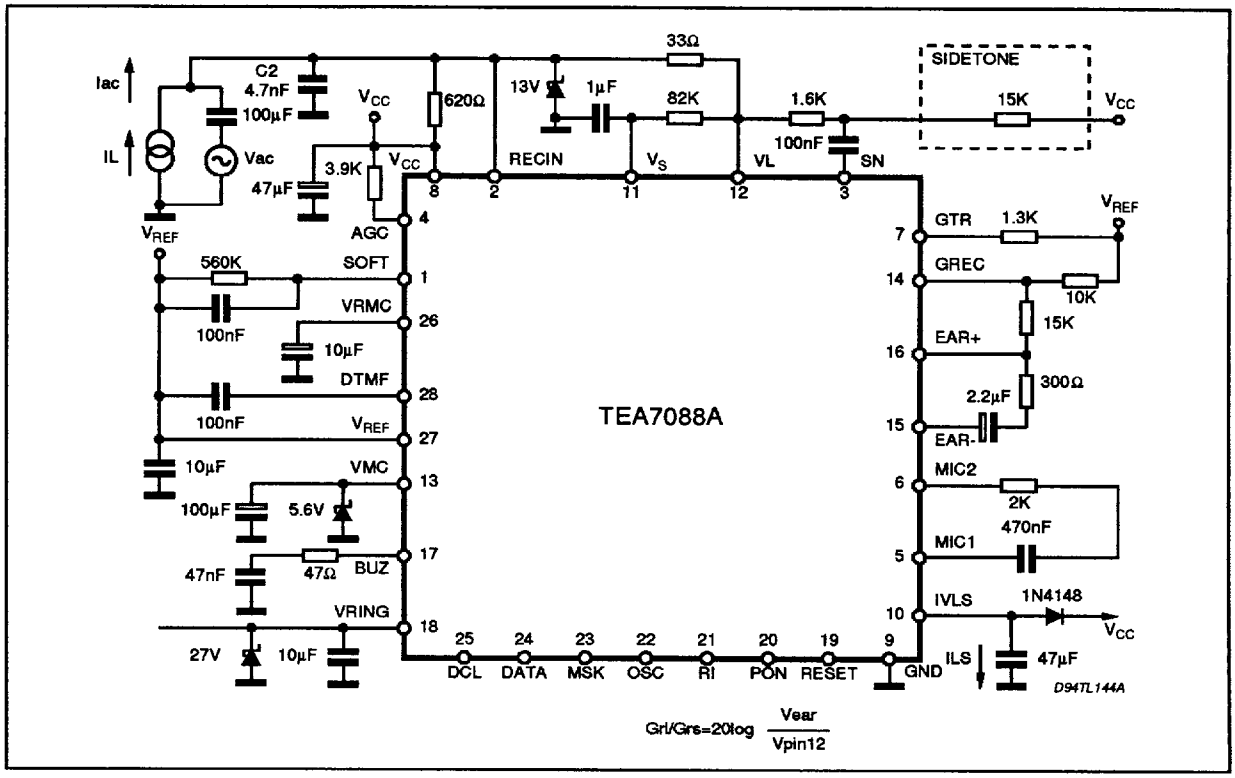
TEST 2 (R1)



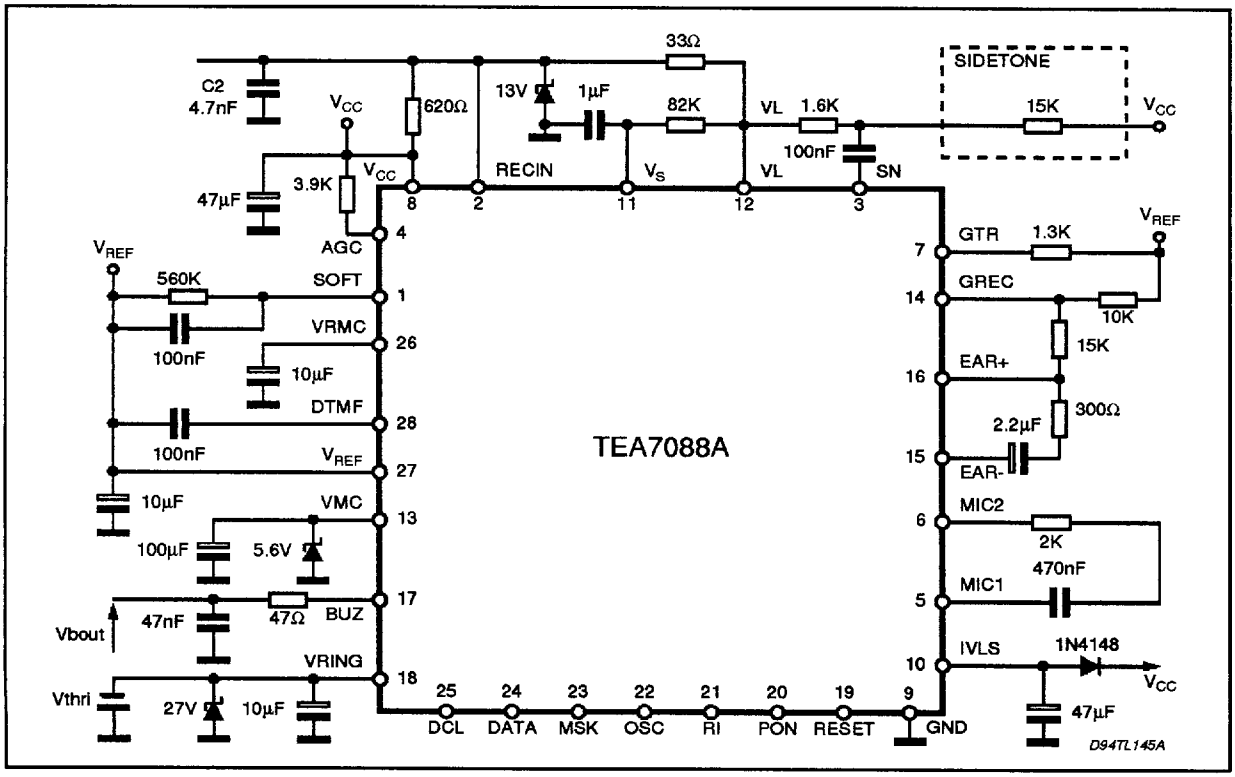
Test 3 (Gtl / Gts / Zmic / Nt / Mmic / Dt / Vlmax / Eff)



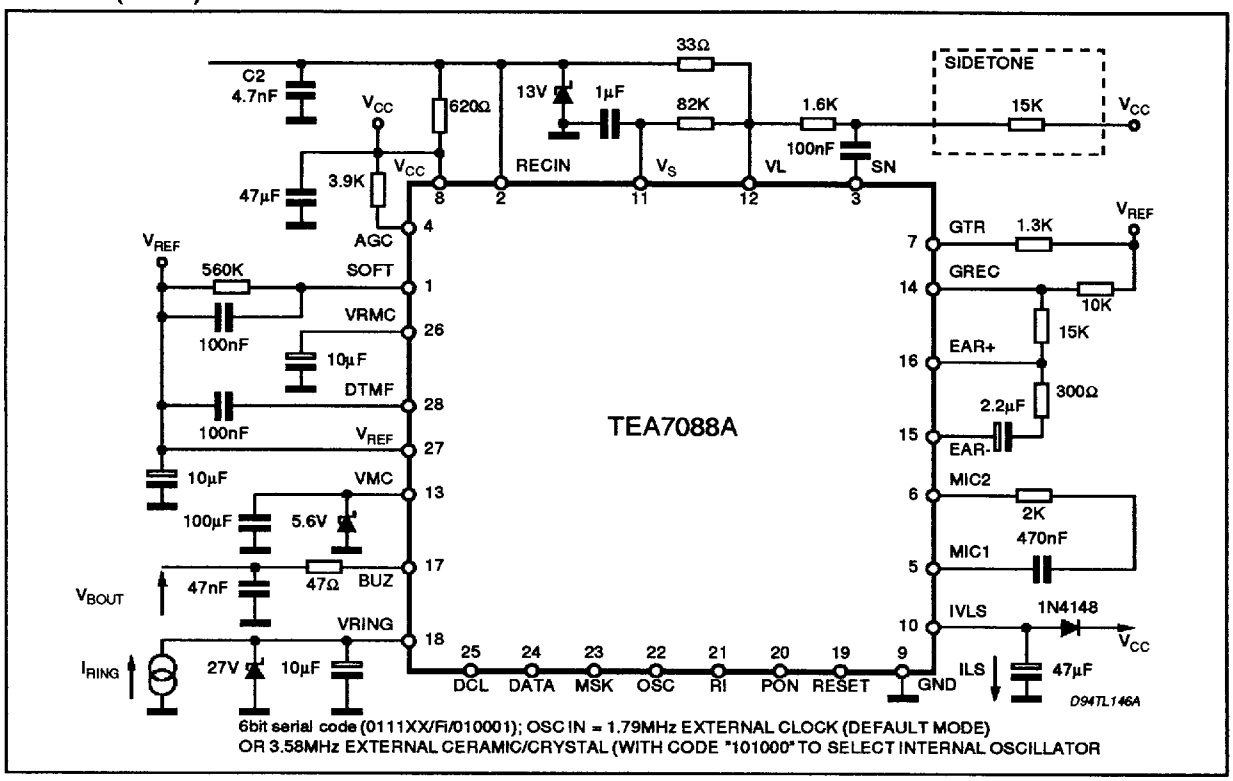
TEST 4 (Grl / Grs / Dr / Mear / Nr)



TEST 5a (Vthri)

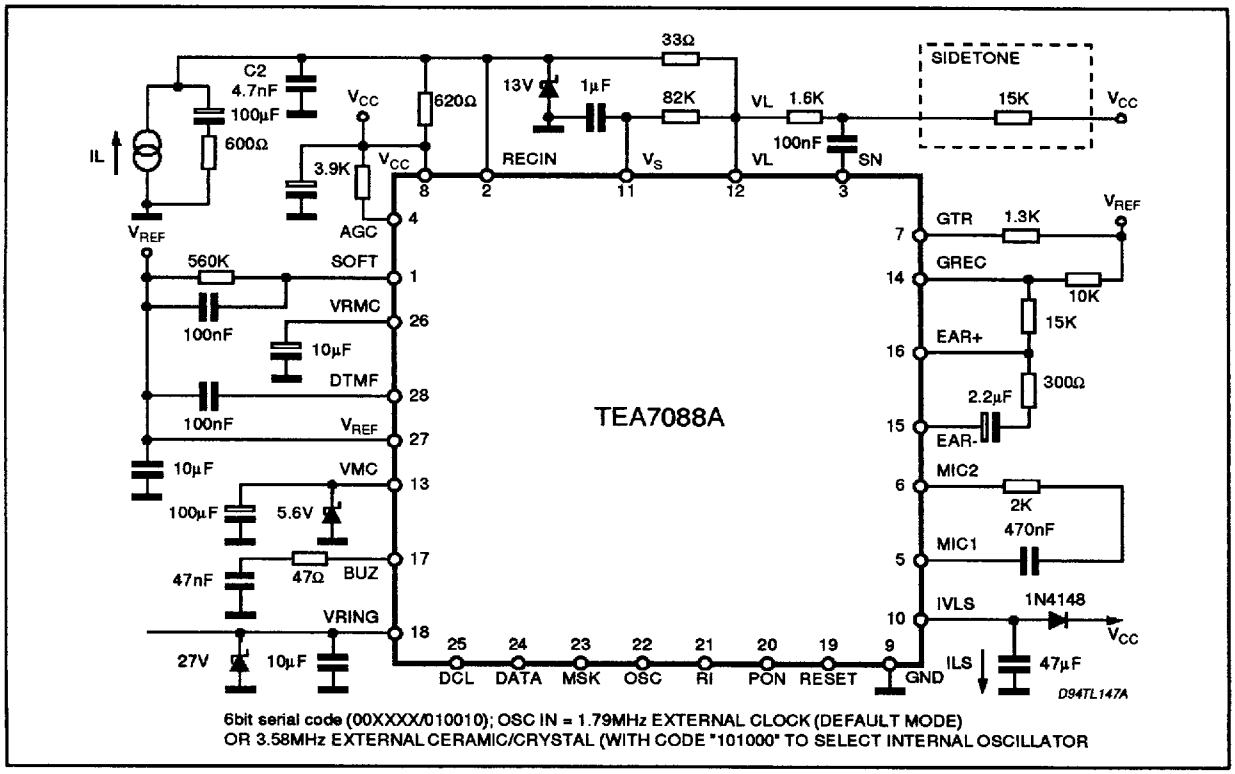


TEST 5b (Vbout)



6bit serial code (0111XX/Fi/010001); OSC IN = 1.79MHz EXTERNAL CLOCK (DEFAULT MODE)
OR 3.58MHz EXTERNAL CERAMIC/CRYSTAL (WITH CODE "101000" TO SELECT INTERNAL OSCILLATOR

TEST 6 (DTMF)



6bit serial code (00XXXX/010010); OSC IN = 1.79MHz EXTERNAL CLOCK (DEFAULT MODE)
OR 3.58MHz EXTERNAL CERAMIC/CRYSTAL (WITH CODE "101000" TO SELECT INTERNAL OSCILLATOR

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.)