

EM91886

COMS SINGLE CHIP TELEPHONE

WITH

LOCK,SPEAKERPHONE,HOLD MELODY

AND

LCD INTERFACE



GENERAL DESCRIPTION

The EM91886 is a CMOS integrated circuit that contains all the functions needed to form a high performance electronic telephone. The device incorporates Tone / Pulse dialer, speakerphone and a high quality of speech network circuit.

The dialer is composed of 13 set memories, Hands-free dialing and lock functions. Specially, the SDO (Serial Data Output) functions are provided in advance version. The SDO is designed to drive LCD driver and voice synthesizer. In this application, the dialing numbers can be displayed on LCD screen with EM32100 (or EM32117). The EM91886 has a special I.P.P. detect function (Illegal Parallel Phone Detect) can prevent the illegal use of the line. The I.P.P will detect the illegal user when illegal phone pickup are detected. This function will pickup the line automatically by a short cycle and send the alarm signal to the telephone line to interfere the illegal dialing. This alarm signal alert the master user by loud speaker.

For the care of disability in hearing, the EM91886 equipped the VOL key with 6 cyclic steps in off-hook/and 13 cyclic steps in on-hook speakerphone receive volume control. It no extra component required since it was internal gain controlled by receiving path of speech network.

Speech network circuits for telephone 2-wire to 4-wire converter which performs transmitting and receiving. It's capable of low powered operation. Voltage and current makes the ICs used in telephone network with good performance even connected more telephone sets in parallel .

Interior speakerphone is simple full duplex transmission equipped the VOL+/VOL- key with 13 cyclic steps volume control. EM91886 just using the less exterior components perform speakerphone than other solutions.

FEATURES

DIALER :

- Tone/Pulse selectable.
- Wide operating voltage from 2.0 V to 5.5 V (VDD pin).
- Low operating current .
- OFF-hook : 0.15 mA (Pulse) and 0.3 mA (Tone) @VDD=2.5v.
- Receiving volume control : 6 or 13 steps cyclic control. (save the cost of mechanical slide switch)
- I.P.P. detect function prevents the illegal line connection.
- SDO data format compatible with EM32xxx series LCD driver.
- SDO function supports LCD driver and voice synthesizer to indicate dialing numbers and icons (symbols) display.
- A 32-digit LNB (last number) redial memory with one key redial function.
- A 32-digit SAVE memory for second redial or notepad.
- Memory cascade dialing.
- Lock function provides conventional key lock.
- Connecting resistor on keyboard scan pin that can select the specifications, such as : tone/pulse mode, pulse rate, M/B ratio, flash time, dialing lock functions.
- Line hold function is designed for stopping conversation temporality.
- Melody generator provides music on hold function.
- 13 sets (3 sets one touch and 10 sets two touch or 13 sets one touch) repertory memory, each one can hold data up to 20 digits.
- Hands-free function provides on-hook dialing and speakerphone application.
- Pause and P-T time are fixed to 3.6 seconds.
- Tone duration and inter-tone pause time are fixed to 98 ms.
- Using 3.579545 MHz crystal or ceramic resonator.
- Auto Insert Pause(AIP) time.
- Note : I.P.P. detect = Illegal Parallel Phone Detect.

SPEECH NETWORK :

- Built-in speech network with AGC line loss compensation.
- Wide operating voltage from 2.0 V to 5.5 V (VDDA pin) : perfectly operating range from start 2.7 V to 5.5V , when voltage down to 2.0V performance reduced
- Low operating current 0.5mA @VDDA=3.0Vdc.
- Adjustable DC characteristics with external resistor.
- Adjustable transmitting gain and receiving gain with external resistor.
- Microphone first stage amplifier with high impedance for symmetrical (68K) and asymmetrical (34K).
- DTMF input with confidence tone.
- Mute for dialing (interconnection from dialer).
- Different line loss compensation (i.e. AGC) for transmitting and receiving.
- Vary large range of gain setting on microphone and ear-piece amplifiers.

SPEAKERPHONE :

- Maximum power of audio amp is 100mW @5.5V under loaded 25Ω
- 13 cyclic steps volume control by key of VOL /or“VOL+” and “VOL-“.In on-hook speakerphone mode the IC keep the last volume level status for next activation of speakerphone.
- The less exterior components.
- Easy to tune.

PACKAGES :

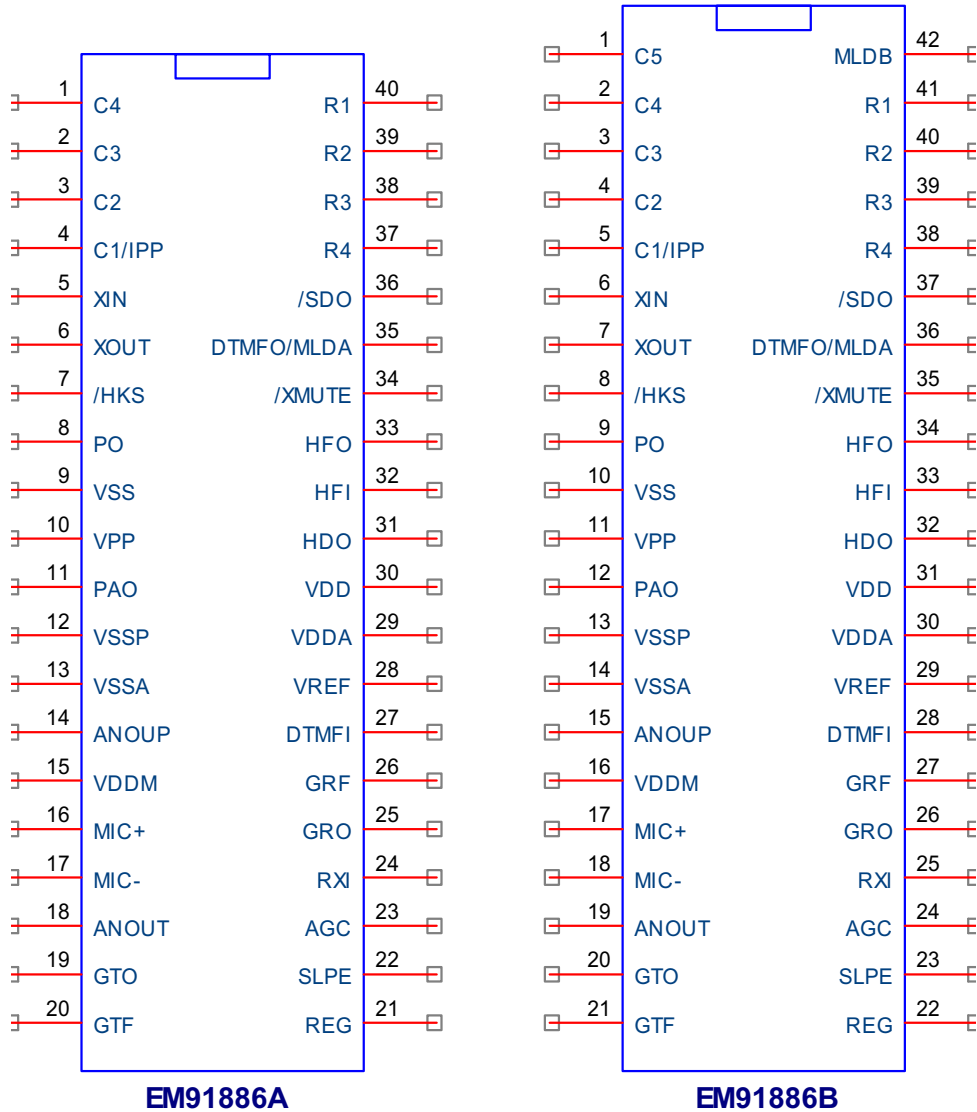
- 40 PDIP,42 SDIP.

APPLICATION

- Feature Phone/Cordless Phone/Answering Machine/FAX.

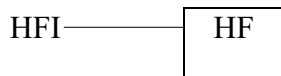
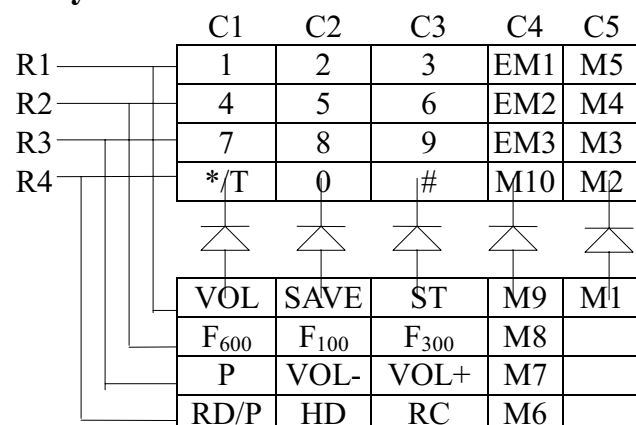


PIN ASSIGNMENT



KEYBOARD ARRANGEMENT :

Keyboard :



0~9,*,#	: Dialing digit key
M6~M10, EM1~EM3	: Memory station
ST	: Memory store
RC	: Memory recall
SAVE	: MEMO, Notepad
VOL	: Volume control
F	: Flash
P	: Pause
RD/P	: Redial/ Pause
T	: Pulse to Tone
HD	: Hold
HF	: Hand-free
VOL +/-	: Volume control up/down

R-option :

R1	Mode
R-VDD	Pulse 10 PPS
NR	Pulse 20 PPS
R-VSS	DTMF

R4	Volume aid
R-VSS	Fix
NR	Reset

R2	MBR(%)
NR	40:60
R-VSS	33:66

C2	C3	Lock number
NR	NR	None
NR	R-VDD	0
NR	R-VSS	All
R-VSS	NR	0,9
R-VSS	R-VDD	None
R-VSS	R-VSS	AIP
R-VDD	NR	0,9
R-VDD	R-VDD	9
R-VDD	R-VSS	None

R3	Redial
R-VDD	RD _{1.6S}
NR	RD/P
R-VSS	RD _{1.2S}

C4	HOLD Melody signal supply pin	
	EM91886A	EM91886B
NR	DTMFO/MLDA	DTMFO/MLDA
R-VSS	NONE	MLDB

HF key are the external trigger input.

NOTE:

1. "Fix" : keep the last receiver volume-aided level when the next off-hook goes.
2. "Reset" : Start begin the lower receiver volume-aided level when the next off-hook goes.
3. Lock "All" : All keys on keyboard matrix are inhibited.
4. Selection of VOL+/VOL- or VOL key by user 's decision R –option of R4 selection only suit for off-hook mode, at speakerphone mode volume level internally set at "Fix" mode.

at off-hook mode:

VOL : The cyclic sequences are 0dB→ 3dB→ 6dB→ 9dB→ 12dB→ 15dB→ 12dB→ 9dB→ 6dB→ 3dB→ 0dB.....

VOL+/VOL-: The gain increment by VOL+ and decrement by VOL-.

If current volume-aided level at "0dB" the cyclic sequences of VOL+ are 0→ 3→ 6→ 9→ 12→ 15→ 15(dB)(if depress still, keep the most top level) .. ,the same operation, in case of volume-aided level set at "15dB" the cyclic sequence of VOL- are 15→ 12→ 9→ 6→ 3→ 0→ 0(dB)... (if depress still, keep the most bottom level)

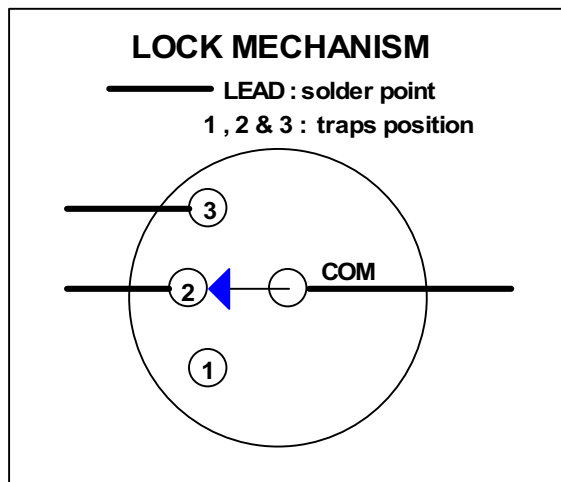
at on-hook speakerphone mode:

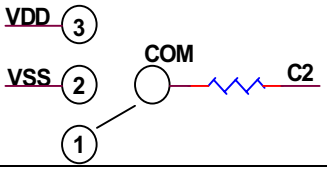
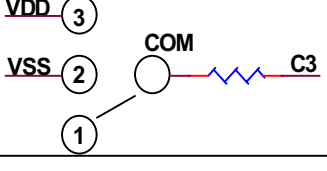
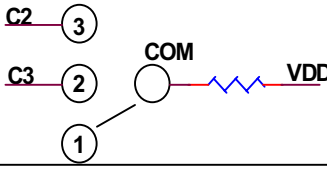
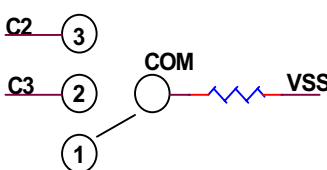
VOL: The cyclic sequences are 20→ 24.8→ 28→ 30→ 32→ 33.5→ 34.8→ 36→ 37→ 37.7→ 38.5→ 39.3 → 40 → 39.3 → 38.5 20(dB)

VOL+/VOL-: The gain increment by VOL+ and decrement by VOL-.

If current volume-aided level at "20dB" the cyclic sequences of VOL+ are 20→ 24.8→ ... 39.3 → 40 → 40(dB)(if depress still, keep the most top level) .. ,the same operation, in case of volume-aided level set at "40dB" the cyclic sequences of VOL- are 40→ 39.3→ 38.5→ ...→ 20→ 20(dB)... (if depress still, keep the most bottom level)

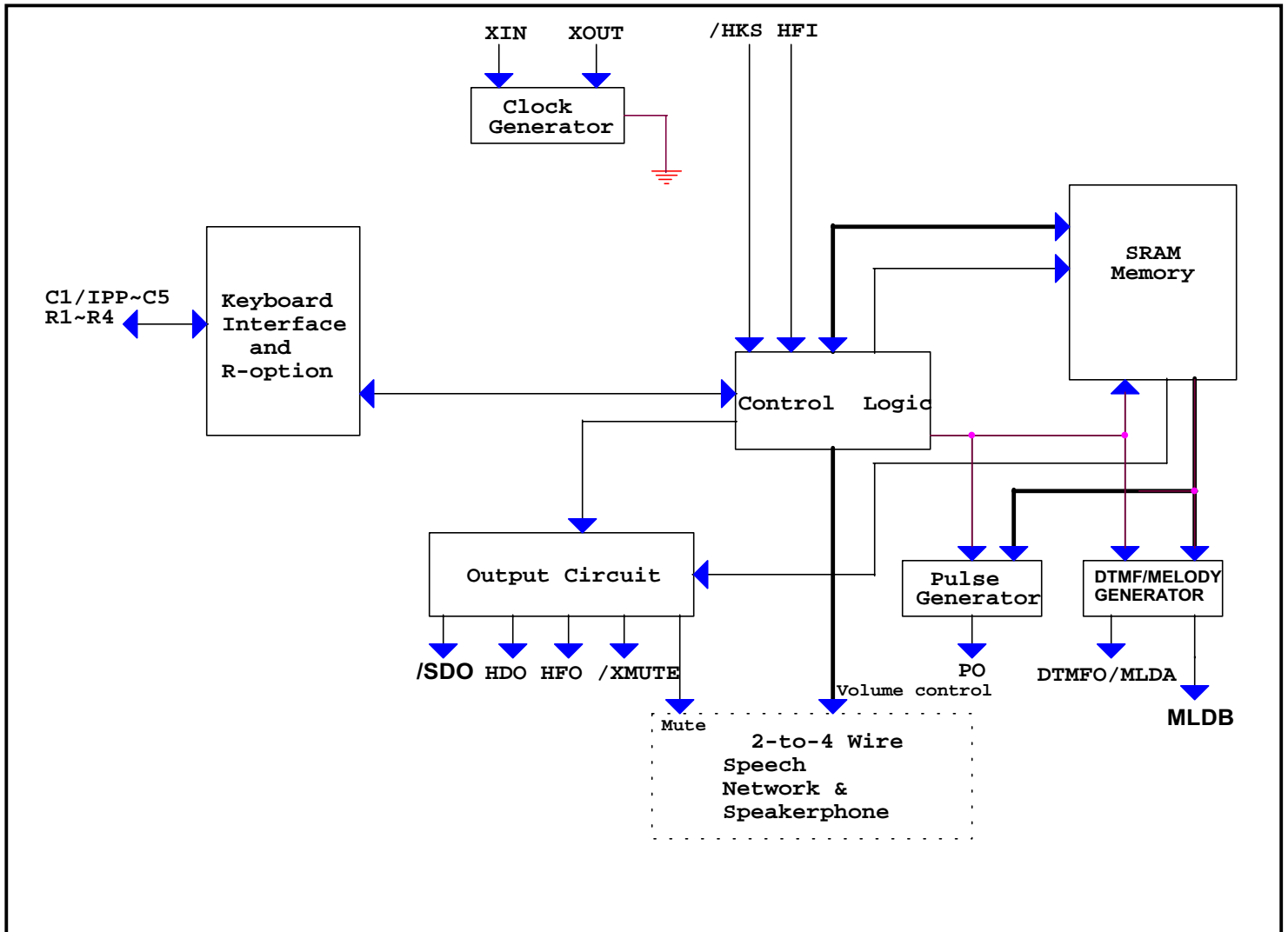
5. When the different matrix block and same column two keys are pressed at the same time, the upper matrix key would be processed .
6. "RD1.6S" or "RD1.2S": Redial break time duration are 1.6sec or 1.2 sec waiting for dial tone.
7. "AIP": Auto Insert Pause time.
8. The following schematics show setting the lock function.



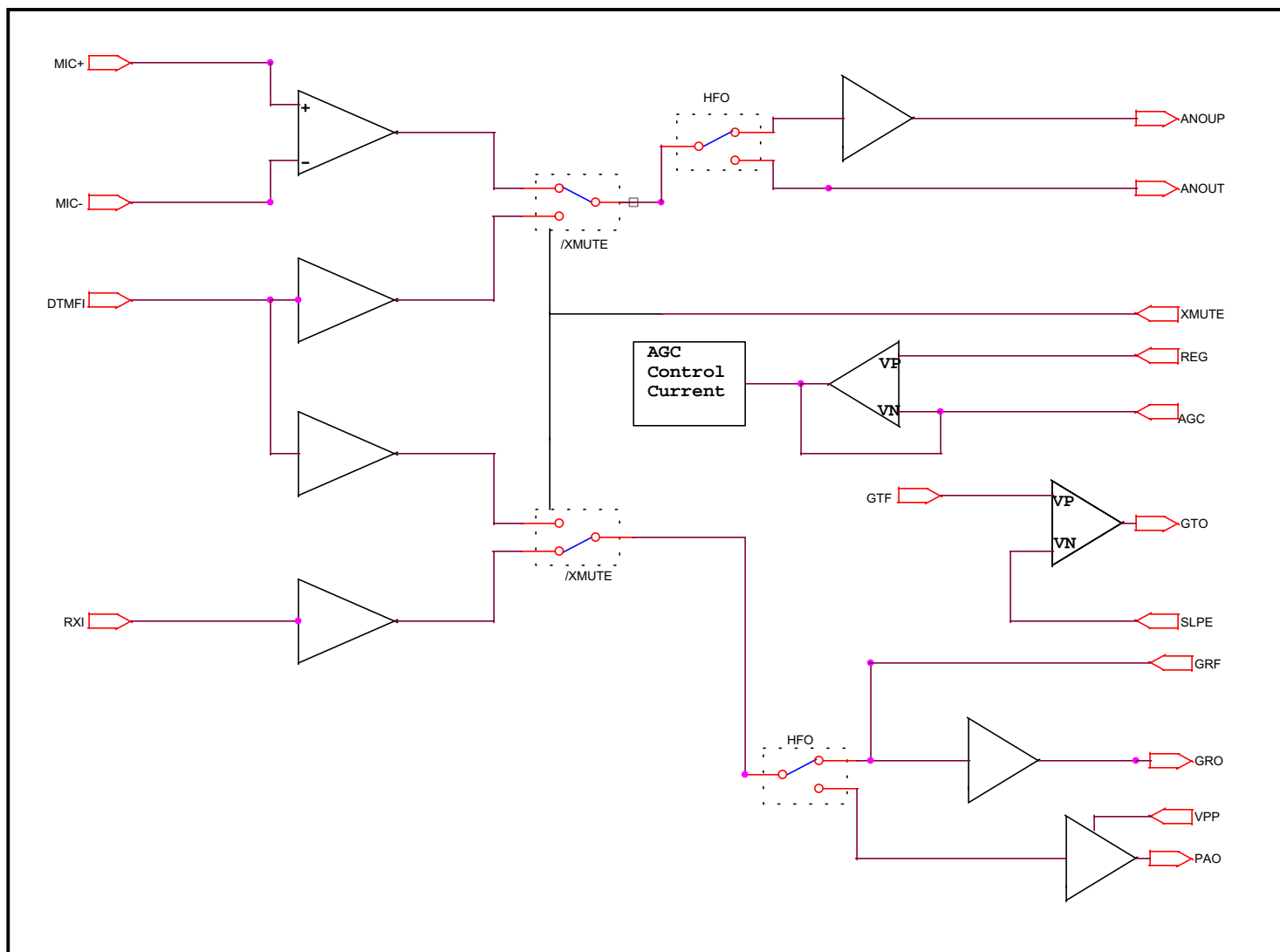
	ATTACH	C3=NR			C3=R-VDD			C3=R-VSS		
	POSITION	1	2	3	1	2	3	1	2	3
	LOCK	NONE	0,9	0,9	0	NONE	9	ALL	AIP	NONE
	ATTACH	C2=NR			C2=R-VDD			C3=R-VSS		
	POSITION	1	2	3	1	2	3	1	2	3
	LOCK	NONE	ALL	0	0,9	NONE	9	0,9	AIP	NONE
	ATTACH									
	POSITION	1	2	3						
	LOCK	NONE	0	0,9						
	ATTACH									
	POSITION	1	2	3						
	LOCK	NONE	ALL	0,9						

FUNCTION BLOCK DIAGRAM

DIALER :



SPEECH NETWORK & SPEAKERPHONE :



PIN DESCRIPTIONS

DIALER :

Symbol	I/O	Active	Description
VDD, VSS	---	---	Digital power supply pins. Positive and negative power supply input pins. Recommended operating voltage from 2.0Vdc to 5.5Vdc. The VDD also supply power to internal ringer while ringing.
XIN, XOUT	---	---	Oscillator input and output pins. A 3.579545 MHz crystal or ceramic resonator must be crossed connection to XIN and XOUT pins which generate system clock.
R1~R4, C1/IPP~ C5	I/O	---	Two 4x4 matrix keyboard scan pins. These pins are provided to two 4x4 matrix keyboard scan. In idle state (/HKS is high and HFO, HDO is Low), these pins stay high impedance level to prevent power consumption. Otherwise, pin R1~R4 switch to high level and C1~C5 switch to low level for detecting keyboard entry. The keyboard scan signal is 600 Hz. For two 4x4 matrix scanning, the first 4x4 matrix is direct connection to R1~R4 and C1~C5, the column of extension 4x4 matrix are needed 4 DIODE forward from extension column connecting to C1~C5 respectively (refer to keyboard arrangement). The keyboard scan pins are also provided to select the dialing SPEC. with connecting a resistor to VSS or not, called R-option. In addition, the C1/IPP pin acts as the Illegal Parallel Phone detect (called IPP function) during ON-hook. See the description of IPP function for more detail. The IPP detection of C1/IPP pin is a Schmitter trigger input structure.
/HKS	I	L	Hook detect input pin. When handset was left from cradle, this pin must be connected to low level, called OFF hook. Otherwise, this pin must be connected to high level, called ON hook. The /HKS pin is a general Schmitter trigger input structure.
DTMFO/ MLDA	O	---	Dual Tone Multi-Frequency and hold melody signal output pin. Normally, this pin stays low level. In Tone dialing mode, this pin will output DTMF signal that is corresponding to keyboard 0 .. 9, * and # keys. The DTMF signals are connected to DTMFI pin of speech network by the way of attenuation circuit. In hold mode melody signal sent from this pin.or not selected by C4 R-option.



Symbol	I/O	Active	Description
MLDB	O	---	Hold melody signal output pin at 42-pin package which output level is stronger than DTMFO/MLDA signal for louder hold melody application.
PO	O (P.P)	L	Pulse signal outputs pin. Normally, ON-hook state this pin stays high impedance. In Pulse dialing mode, this pin will output pulse trains signal that is corresponding to keyboard 0 .. 9 keys. It also outputs low to break line while flash time and one key redial break time. In IPP state, this pin change the structure from open drain to push pull and outputs high.
/XMUTE	O (O.D)	L	Dialing mute output pin. The /XMUTE pint is a open drain structure for external other controls. The mute control are internal connected to speech network for dialing mute. The EM91886 provide this output pin to control another application of telephone design.
/SDO	O (O.D)	L	Serial Data Output pin. It is an NMOS open-drain structure. When a valid entry on keyboard, this pin will output a serial data. This serial data designed to interfaced the EMC LCD driver to display dialing number and icons (symbols) on LCD screen or interfaced to the EMC voice synthesizer for dialing number announcing.
HDO	O (P.P)	H	Hold key / Line hold control output. When HD key on keyboard pressed HDO pin toggle and DTMFO output melody signal. In some applications, the HDO pin outputs high to enable “the extended phone pickup” detection circuit and this circuit output a low pulse to R1 pin to release the hold function. The hold releasing can be done by the way of turns on hands-free or off-hook. The HDO output high while line holding, it also can drive the LED , or enable the LCD driver.
HFI, HFO	I (P.D) O (P.P)	H H	Hand-free key input / Hand-free control output. The HFI pin detects the HF key trigger, each high input will toggle HFO pin. In some applications, the HFO pin outputs high to enable the amplifier of loud speaker. The hand-free releasing can be done by the way of turns on hold or off-hook. The HFO output high, it also can drive the LED for speak enable indication. The HFI pin is a Schmitter trigger input structure.

NOTE :

P.P : Push-Pull

P.D : Pull-Down

I/O : Input / Output

O.D : Open-Drain

I : Input

none : None pull-up or pull-down

P.U : Pull-Up

O : Output

SPEECH NETWORK & SPEAKERPHONE :

Symbol	I/O	Description
VDDA, VSSA	---	Speech network analog power supply pins. These pins supply the power to internal speech network and reference from line. Recommended operating voltage from 2.0Vdc to 5.5Vdc.
VPP VSSP	---	Speakerphone audio amplifier power supply pins.
VDDM	---	Off-hook mode microphone bias voltage supply pin routed from VDDA through an interior switch.
MIC+, MIC-	I	Non-inverting/inverting microphone amplifier inputs, it meet the use of any magnetic, electret and piezo-electric type.
ANOUT	O	Analog signal amplifier output. Analog signal output processed from microphone and DTMFI.
ANOUP	O	Microphone amplifier output, typically it is internally set at 34dB under speakerphone mode
DTMFI	I	Dual-tone multi-frequency input.
AGC	---	Changing of the range of transmitting and receiving gain to compensate line loss by adjusting external resistor.
VREF	---	Reference voltage point should connected a capacitor to ground for stable operation.
REG		Voltage regulator de-coupling.
GRF, GRO	---	Receiving gain control by adjusting the external resistor.
RXI	I	Receiving signal input.
GTF, GTO	---	Transmitting gain control by adjusting the external resistor.
SLPE	I	DC (slope) resistance adjustment. Feedback the line voltage to compensate the line loss.
PAO	O	Single end output of audio amplifier

FUNCTION DESCRIPTIONS

DIALER :

All operating timing diagrams are listed at FIG 1 thru FIG 15 of item 12

• Dialing signal selection

The EM91886 series incorporated a special keyboard scanning function that is connecting a resistor (typical 560K ohms) on keyboard scan pin to select the dialing specifications. The specifications are described as follows :

R1	Mode
R-VDD	Pulse 10 PPS
NR	Pulse 20 PPS
R-VSS	DTMF

R4	Volume aid
R-VSS	Fix
NR	Reset

R2	MBR(%)
NR	40:60
R-VSS	33:66

C2	C3	Lock number
NR	NR	None
NR	R-VDD	0
NR	R-VSS	All
R-VSS	NR	0,9
R-VSS	R-VDD	None
R-VSS	R-VSS	AIP
R-VDD	NR	0,9
R-VDD	R-VDD	9
R-VDD	R-VSS	None

R3	Redial
R-VDD	RD _{1.6S}
NR	RD/P
R-VSS	RD _{1.2S}

C4	HOLD Melody signal supply pin	
	EM91886A	EM91886B
NR	DTMFO/MLDA	DTMFO/MLDA
R-VSS	NONE	MLDB

• Normal dialing

Directly keying digital key on keyboard which number can be dialing output and stored in LNB memory automatically. Operating procedure described as follows :

1. To select Pulse or Tone mode.
2. Off-hook or turn on HF function.
3. Keying d1, d2, .. , dn. The "d" expressed digital keypad that included 1~9, *, 0, #, P, and P→T keys. The "n" expressed unlimited.

4. The numbers d1, d2, .. , dn will be dialed out in Pulse or Tone mode as selection.

- **LNB redial memory**

Storing :

In normal dialing mode, every digital key was entry which number will be stored in LNB memory automatically. If entry digits are more than 32 digits, the redial function of LNB memory will be disabled (no Trdb and Trdp in one key redial). Otherwise, these numbers stored in LNB memory can be redial output.

Redialing (one key redial) :

The redial function are designed for a convenient operation (called one key redial). When a dial sequence busy, pressed RD key directly then the last dial number will dial out after a automatic line break (Trdb) and pause time (Trdp). Key entry is valid during redial pause.

The other redial is keying F key (or On-Off hook again) and keying RD key (no automatic line break and pause). The numbers that are stored into LNB memory will be dialed output.

Example :

Dial : (select Pulse mode) 1, 2, 3, */T, 4, 5, 6,RD

These numbers will be dialed out and redial out as following sequence:

1, 2, 3, Tp, 4, 5, 6

(pulse mode) ... (tone mode)

The LNB buffered the number 1, 2, 3, */"T", 4, 5, 6.

- **SAVE redial memory**

The SAVE memory is designed in EM91886 series to support 32 digits capacity buffer for second redial(memo or notepad), pager memory dialing and other system applications.

SAVE Store :

EM91886 series support two operating methods to store numbers into SAVE redial memory.

Method 1

1. To select Pulse or Tone mode.
2. Off-hook (or turn on HF function), push d1, d2, .. , dn. The numbers d1, d2, .. , dn will be dialed out in Pulse or Tone mode as selection.
3. After dn had been dialed out completely and push [ST], SAVE key. If the keying numbers are more than 32 digits that content of SAVE memory can not be updated. Otherwise, these numbers will be stored into SAVE memory.

The [] key allows to be omitted.

Method 2

Off-hook (or turn on HF function), push ST, d1, d2, .. , dn, [ST], SAVE. If the keying numbers are not over 32 digits, the numbers d1, d2, .. , dn will be stored in SAVE redial memory automatically.

SAVE recall :

1. To select Pulse or Tone mode.
2. Off-hook (or turn on HF function), push [RC], SAVE key. The numbers stored in SAVE memory will be dialed out in Pulse or Tone mode as selection.

The [] key allows to be omitted.

- **Repertory memory**

The EM91886 series incorporated several sets repertory memory and each one can store number up to 20 digits. In memory storing, if stored numbers are more than 20 digits that only the previous 20 digits can be stored into specific memory. Otherwise, these numbers can be stored entirely.

Direct (one-touch) memory store :

Off-hook (or turn on HF function), push (ST, d1, d2, .. , dn [ST], EM1~EM3 or M1~M10.) The numbers d1, d2, .. , dn will be stored into memory location EM1~EM3 or M1~M10.

The [] key allows to be omitted.

Indirect (two-touch) memory store :

Off-hook (or turn on HF function), push (ST, d1, d2, .. , dn, ST, n.) The numbers d1, d2, .. , dn will be stored into memory location “n”. The “n” expressed digital key from 1 to 9 and 0 which map to M1~M10.

Direct (one-touch) memory recall :

1. To select Pulse or Tone mode.
2. Off-hook (or Turn on HF function), push [RC], Mn (or EM1~EM3) key. The numbers that are stored in direct memory location ”Mn (or EM1~EM3)” will be dialed out in Pulse or Tone mode as selection. The ‘n’ expressed digital number from 1~10 decided by dialers’ memory sets.

The [] key allows to be omitted.

Indirect (two-touch) memory recall :

1. To select Pulse or Tone mode.
2. Off-hook (or Turn on HF function), push RC, n key. The numbers that are stored in indirect memory location ‘n’ will be dialed out in Pulse or Tone mode as selection. The ‘n’ expressed digital key from 0 to 9.

• **Cascade Dialing**

1. Pressed the d1, d2 Dn, EM1, ...EMm, M1, M2, ...Mn, all the sequence and memory contents can be dialed out with quick entry, and buffered in LNB.
2. Pressed the RD, d1, d2, EM1, M1, M2, all the sequence and memory contents can be dialed out with quick entry, and buffered in LNB.

The sequences buffered in LNB is 32 digits, each sequences more than 32 digits dialing will inhibit the redial at next OFF-hook.

- **Auto Insert Pause Time function**

EM91886 Provides a new function – Auto Insert Pause Time after dial CO(Central Office)line access digit “0” or “9” – for PABX system user . In PABX system , we usually use a special number to identify the phone want dial out or just a internal phone . So between the first and second number , the PABX system will switch to central office , that will be few second switch time . The auto insert pause time function will auto insert the pause time between first and second digit in redialing mode . This function are provide a pause time to wait PABX switch to Central Office . In fact , the pause time are record the waiting time of last dialing between the first and second digit . The auto insert pause minimum duration are equal 0 second , maximum duration are equal 3.1 second , and pause duration scale are 0.1 second . So , if the time during user keying first and second digit are longer than 3.1 second , then the auto insert pause time will be limited at 3.1 second . By this function , we can dial the correct number out in PABX system .AIP selected by R-option of C2 & C3.

- **Pause (P) key operation**

The Pause (P) key is designed to support pause operation in dialing duration. “P” key can be stored in memory and it will occupy one digital position.

To select Pulse or Tone mode.

1. Off-hook (or turn on HF function), push (d1, d2, .. , dn, P, k1, k2, .. , kn.)

These numbers will be dialed out as following sequence:

d1, d2, .. , dn, Tp, k1, k2, .. , kn.

- **Pulse to Tone (* /T) and # key operation**

The Pulse to Tone (* /T) key is designed to support toll dialing (long distance call) or PABX system operation. The “* /T” key can be stored in memory and it will occupy one digital position.

1. To select Pulse mode.
2. Off-hook (or turn on HF function).
3. Press #, #, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, * /T, 1, 2, 3, 4, 5, 6, 7, 8, 9, “*” /T, 0, #. (key entry rapidly)

These numbers will be dialed out as following sequence:

1, 2, 3, 4, 5, 6, 7, 8, 9, 0, P-T, 1, 2, 3, 4, 5, 6, 7, 8, 9, *, 0, #.

(pulse mode).....Tp.....(tone mode)

Select Tone mode, then press RD.

These numbers will be redialed out as following sequence:

#, #, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, P-T, 1, 2, 3, 4, 5, 6, 7, 8, 9, *, 0, #.

(tone mode).....Tp.....(tone mode)

• Flash (F) key operation

The Flash (F) key is designed to break telephone line temporarily. After F100/or F300/or F600 key is depressed, this dialer will send a flash signal to break line a flash time as R3 R-option selected. During the break time, the key entry inhibited but entry available at flash pause. The flash function like a ON/OFF hook once.

Example :

Dial : d1, d2 dn, F, c1, c2,..... cn

The F key pressed will interrupt the dial sequence d1~dn while d1~dn is dialing out. All of the operations were done. The LNB buffered the number c1, c2,cn.

Dial : (select Pulse mode) 1, 2, 3, */T, 4, 5, 6, (select Tone mode), F, 7, 8, 9

These numbers will be dialed out as following sequence:

1, 2, 3, Tp,4, 5, 6,Tf, 7, 8, 9

(pulse mode)...(tone mode)..... (pulse mode)

The LNB buffered the number 7, 8, 9.

• Hands-free (HF) function

The hands-free function is designed to support on-hook dialing and loudspeaker application which can be turn 'on' or 'off' with rising edge signal from HFI pin. During hand-free function is executed, the HFO pin is switched to 'high'. Otherwise the HFO pin stays 'low' level. One of the following operations can turn off Hands-free function (HFO pin return to 'low').

1. On-off hook once.
2. Trigger HFI pin with rising edge signal.
3. Turn on Hold (HD) function. (HDO pin switched to 'high')

- **Hold (HD) function ,DTMFO/MLDA and MLDB**

The Hold function is designed to stop conversation temporarily. In off-hook state (or HF function is turned on), to press HD key on the keyboard, the hold function can be turned 'on' (HDO pin switched to 'high') and melody sent from DTMFO-MLDA pin/or MLDB. One of the following operations can turn off Hold function (HDO pin switched to 'low').

1. On-off hook once.
2. To press HD key again (or a low pulse detected from extension phone pickup).
3. Turn on Hand-free (HF) function. (HFO pin switched to 'high')

DTMFO/MLDA and MLDB are able to be selected by R-option C4 for different use, where the output levels of MLDB are stronger than MLDA

- **IPP detect function**

The EM91886 series provide the I.P.P. function to prevent illegal connect. I.P.P means Illegal Parallel Phone. When the ON-HOOK condition and HF turn off, the C1/IPP pin detected low input. The EM91886 will turn on Hand-free and hold function, then send the alarm signal to telephone line. During the alarm, DTMFO pin will send the cyclic “#”, “8” “8” signal. The DTMF signal will interfere the illegal user until the illegal user hang up the phone and the C1/IPP pin detect “high” again. The I.P.P function can also design to allow the legal extension phone in same line. (see I.P.P Application circuit).

- **LOCK function**

The EM91886 series provide the LOCK function to inhibit toll dialing operation. Connecting a resistor on C2 and C3 to select the lock function enable or not and lock number.

1. Off hook (or turn on HF function)
2. Keying : d1 , d2 , .. , dn .

If the first number (d1) is the same with the lock number that optioned in table, then all entry numbers can not be dialed out and keyboard will be inhibited until on to off hook once again.

If the first number is not equal to lock number, all the entry numbers will be dialed out.

Note : A 300 ms delay time (Tdly) at the first Off-Hook or turn on Hands-free that is a

special designed to avoid a rapid key entry (dummy number) in this time duration ,and a long distance call number follows. For example,

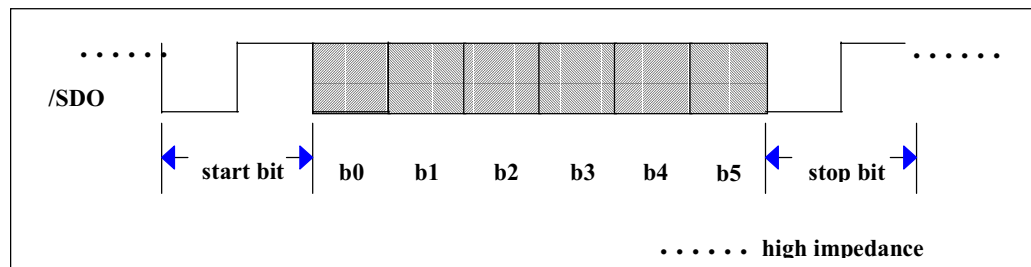
Off-Hook , “3” ,..... , “0” ,1,2,3..... first “3” is dummy key, the ‘0’is lock umber. The dummy number “3” is not detected by the centered office or PABX ,but the following numbers “0” ,1,2,3...long distance call can be dialed out normally since the leading number “3” is not the lock-number in defined.

To prevent the unavoidable long distance call, then EM91886 inhibits the key entry during Tdly. When C2, C3 “none lock” selected , then no Tdly timing at first OFF-hook.

• SDO (Serial Data Output) function

The SDO is serial data output which format is same as UART protocol. SDO function is designed to drive LCD driver and voice synthesizer. So that the dialing numbers and icons (symbols) can be display on LCD screen with EMC LCD driver. The SDO signal consists of two start bits, six data bits and two stop bits. Each bit time is about 3.9 ms (256 Hz)

and output sequences are following by start bits, data bits (LSB to MSB) and stop bits.



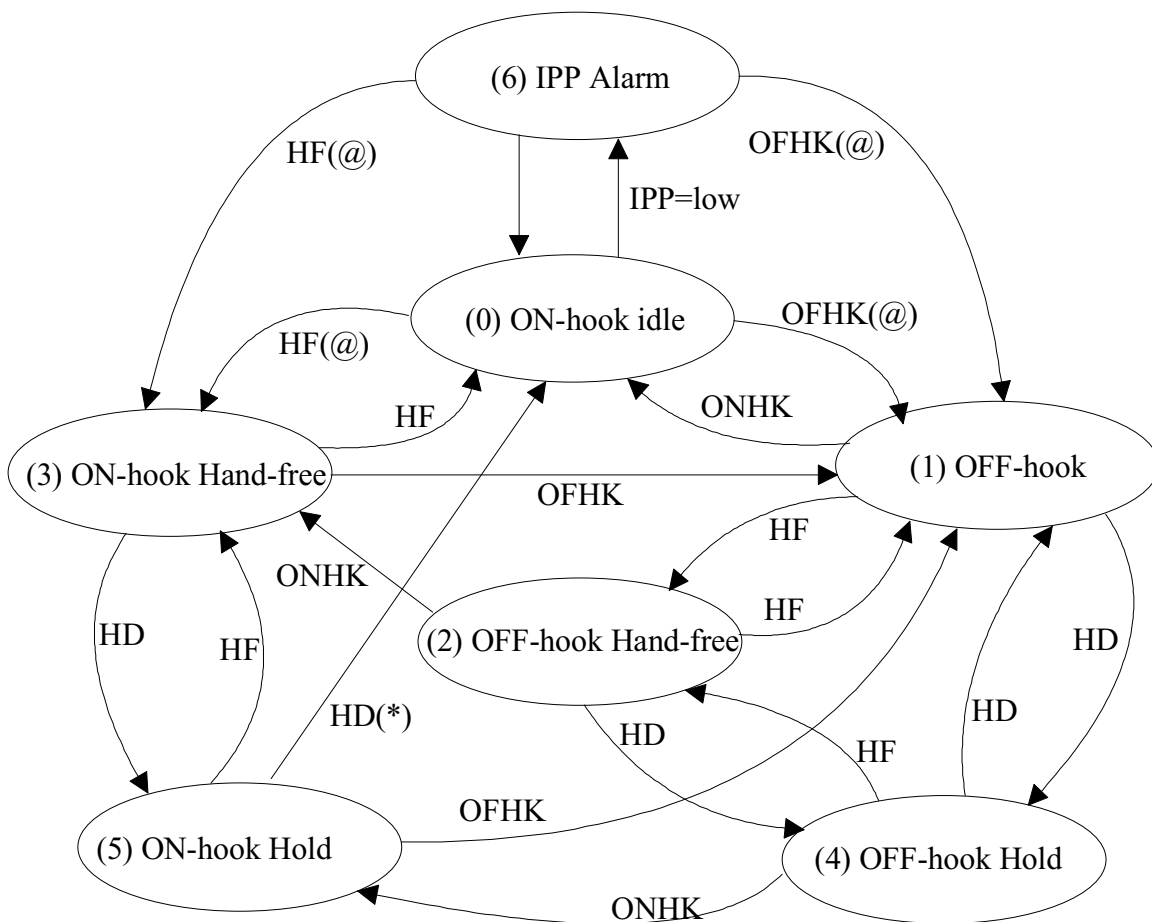
• SDO Keypad Encoded table

b5	b4	b3~b0	Keypad	Display	b5	b4	b3~b0	Keypad	Display
0	0	0001	1	1	1	0	0000	ST	STORE
0	0	0010	2	2	1	0	0001	(Lock state)	LOCK
0	0	0011	3	3	1	0	1000	HD	HOLD
0	0	0100	4	4	1	0	1010	HF	SPEAKER
0	0	0101	5	5	1	0	1110	RC	RECALL
0	0	0110	6	6	1	0	1111	F	clear screen

0	0	0111	7	7	1	1	1100	EM1~EM3	MEMORY
0	0	1000	8	8	1	1	1101	RD	REDIAL
0	0	1001	9	9	reserved				
0	0	1010	0	0					
0	0	1011	“*”/T	L					
0	0	1100	#	J					
0	0	1101	P	P					
0	0	1110	*/”T”	┘					

1. All of the undefined data are reserved and act as no function.
2. The “Display” is a pattern of recommendation and the field display of “b5,b4=00” are the characters with the form of 7-segment and others are icons (symbols).
3. The display pattern is referred to EM32xxx LCD driver.

OPERATING DIAGRAM



ONHK : ON-hook.

HD : Hold.

OFHK : OFF-hook.

@ : Fetch R-option.

HF : Hand-free.

* : Extension Phone pick up.



IPP: pin C1/IPP.

H : high. L : Low.

Z : High Impedance

State Operation	Input / Output Level						
	/HKS	PO	C1/IPP	Keyboard	HFO	HDO	DTMFO
(0) ON-hook idle	H	Z	H	Z	L	L	L
(1) OFF-hook	L	Z	L	H/L detect	L	L	L
(2) OFF-hook Hand-free	L	Z	L	H/L detect	H	L	L
(3) ON-hook Hand-free	H	Z	L	H/L detect	H	L	L
(4) OFF-hook Hold	L	Z	L	H/L detect	L	H	L
(5) ON-hook Hold	H	Z	L	H/L detect	L	H	L
(6) IPP Alarm	H	H	L	Z	H	L	active

RECEIVING VOLUME CONTROL

The receive gain can be changed by pressing the VOL(or VOL+/VOL- key, by application) key while in-use. The dynamic range of volume gain setting is 15 dB maximum. The gain is reset/fix by next OFF-hook selected by R4. The volume gain changed are shown as follows:

Operation	Volume gain	Note
OFF-hook (or Hand-free)	0 dB	from idle to operation
Press VOL key	3dB	
Press VOL key again	6dB	
The 3-rd VOL key pressed	9dB	
The 4-th VOL key pressed	12dB	
The 5-th VOL key pressed	15dB	max. level
The 6-th VOL key pressed	12 dB	
The 7-th VOL key pressed	9dB	
The 8-th VOL key pressed	6dB	
The 9-th VOL key pressed	3dB	
The 10-th VOL key pressed	0dB	
ON-hook	---	go to idle

The cyclic sequence is 0→3→6→9→12→15→12→9....(dB), it make the volume change smoothing.

Volume control is valid only under no dialer operations activated.

at on-hook **speakerphone** mode:

The cyclic sequence is 20→ 24.8→ 28→ 30→ 32→ 33.5→ 34.8→ 36→ 37→ 37.7→ 38.5→ 39.3 → 40 (dB)
 (see page 7 for details)

SEECH NETWORK :

For further understanding, the following descriptions please refer to the FIG 23 to FIG 25 and EM91886 application circuit.

• Power system and regulation---VDDA, VSSA,VDDM, REG and VREF

All interior amplifiers and references powered feeding from R45 which also is responsible for AC impedance and return loss. For stable supply, the external capacitor

C19,C20,and C25 are needed. Microphone bias voltages are strongly recommended to connect to VDDM for muting under on-hook speakerphone mode.
(see FIG 16 and FIG 18)

- **DC load resistor--- SLPE**

When telephone line is in-use the voltage across TIP and RING determined by external resistor R49,R54(12K)and R55, which attached to emitter transistor Q12. The components stated above are outer IC selected by designer. In normal use the value of R55 would be 22Ω 1/2Watt. $V_{in}=1.26(1+(R49/R54))+I_{in}*R55$.
(see FIG 17)

- **ANOUT pin**

The analog signal processed output is from microphone (MIC+, MIC-) and DTMFI. These signals are AC coupling to final output stage for line driving.

- **Microphone signal processing---MIC+,MIC-, GTO and GTF**

To suit widely uses, input of MIC+ and MIC- are connected to symmetrical or asymmetrical circuit and Its impedance is $68K\Omega$ or $34K\Omega$.

Transmitting signal should be ac-coupled from pin ANOUT to GTF. Frequency response are determinable by R46,C22,R52,and R54. The total gain of microphone amplifier can be adjusted up to 52dB(@ $I_{line}=15mA$), its proportional to the value of R54 connected between LINE and REG. Different combination of input types e.g. magnetic, electret and piezoelectric are available.

(see FIG 18)

- **Receiving signal processing--- RXI, GRO and GRF**

RXI is receiving signal input. In normal use anti-sidetone network attenuation combined together for optimized result. For easy match up to low cost ear-piece and widely range to control the receiving volume up to 26.5dB(@ $I_{line}=15mA$) by adjusting R58 connected between GRO and GRF. The higher value of R58, the greater receiving gain.

After the default gain (0 dB) are designed by the receiving path, we also can change the

receiving volume by VOL key. The dynamic range of VOL key gain setting is 9dB maximum.

(see FIG 19)

- **Dual-tone multi-frequency input ---DTMFI**

The /XMUTE pin (it interconnect from dialer) performs speech to dialing switching. If /XMUTE activated, the GTO send dual-tone multi-frequency signals (from DTMFI) to telephone line. Interior IC the gain of first amplifier of DTMFI to line is up to 26dB and appears in GRO pin is -23dB(i.e. called DTMF sidetone). To meet the different specifications between DTMFO and DTMFI may be applied a attenuator R30,R32,and C15 .

(see FIG 20)

- **Automatic gain control---AGC**

Line loss compensation performed by interior ICs AGC circuit. It can vary the gain of microphone amplifier and the gain of the receiving amplifier which making the transmitting and receiving signals appropriately. The range of line loss compensation is up to -6 dB within Iline 20mA to 60mA. The R62 attached between AGC pin and VSSA which is according to different configuration of feeding bridge.

(see FIG 21)

SPEAKERPHONE :

Audio amplifier power supply ---VPP & VSSP

For stable audio amplifier operation ,the extra power supply pins VPP and VSSP are need. In general use, a diode should be applied between VPP and VDDA and a big value(1000uF above) of capacitor across VPP and VSSP.

Microphone output ---ANOUP

Microphone signal from this pin to line via exterior output buffer, the gain between

MIC+(or MIC-) and ANOUP is internally set at 34dB

Single end audio amplifier output --- PAO

PAO to load should be an AC-coupled by a capacitor(10uF above).The max output power is 100mw under loaded 25Ω and VPP is 5.5VDC. Volume controlled by pressing VOL+ and VOL- key with 8 cyclic steps that the gain vary from 20dB to 40dB. (see FIG 22)

ABSOLUTE MAXIMUM RATING

Parameter	Symbol	Condition	Rating
Supply voltage	VDD ,VDDA &VPP		-0.5V to 5.5V
Input voltage	Vin		-0.5V to VDD(or VDDA)+0.5V
Output voltage	Vo	Except open-drain	-0.5V to VDD(or VDDA)-0.5V
Power dissipation	Pd	Topr=75°C off-hook mode	300 mW
		Topr=75°C on-hook speakerphone mode	1.4W
Operating temperature	Topr		0 °C to 70 °C
Storage temperature	Tstg		-40 °C to 125 °C

RECOMMENDED OPERATING CONDITIONS

Operating Voltage	2.5 < VDD < 4.5
	2.5 < VDDA < 5
	3.0 < VPP < 5.5
Operating Temperature	10°C < Top < 50°C
Oscillator Frequency	3.58MHz (resonator : Murata CSA 3.58M G300FGA)

DC ELECTRICAL CHARACTERISTICS

DIALER :

(Ambient temperature is 25°C, VDD=2.5v, VSS=0v, unless otherwise noted,
Fosc=3.579545MHz)

Parameter	Sym.	Condition	Min.	Typ.	Max.	Unit
Operating Voltage	Vdd	unload.	2.0	---	5.5	V
Operating Current	Pulse	Idd /HKS=0, dialing with 8 option resistors.	---	0.15	0.3	mA
	Tone		---	0.3	0.5	
Standby current	/HKS=1	Istb with 8 option resistors.	---	---	0.1	uA
	/HKS=0	unload.	---	1	10	uA
	/HKS=0	with 8 option resistors.	---	10	30	uA
Memory Retention Current	Imrt	idle mode, Vdd=1.0v	---	---	0.1	uA
Input Voltage	ViH	pin /HKS, HFI, /HDI,	0.8Vdd	---	Vdd	V
	ViL		VSS		0.2Vdd	
Input Voltage	ViH	pin C1/IPP	0.7Vdd	---	Vdd	V
	ViL		VSS		0.3Vdd	
Output Current (1)	sink	IoL Vo=0.5v, pin PO, HFO, HDO, /SDO, /XMUTE	+0.2	---	---	mA
		IoH Vo=2.0v, pin HFO, HDO	-0.2	---	---	
	source	Vo=2.0v, pin PO at alarm	-0.2	---	---	
Output Current (2)	sink	IoL Vo=VSS+0.5, pin C1/IPP~C4, R1~R4	+200	+400	+800	uA
	source	IoH Vo=Vdd-0.5, pin C1/IPP~C4, R1~R4	-2	-10	-30	
Leakage Current	Ilk	Vpin=Vdd, open drain output pin	---	---	±0.001	uA
Input Current	Ii	Vpin=Vdd or VSS, all input pin except pull-up/down	---	---	±0.001	
Input Resistance	Rpd	Vpin=Vdd, pin HFI	100	200	---	KΩ
	Rup	Vpin=VSS, pin /HDI, chip enable	100	200	---	
	Rup	Vpin=VSS, pin /HDI, chip idle	2.0	2.5	---	MΩ
Keyboard Resistance	Rkey	Row, Column contact resistance	---	---	10	KΩ

The sign “+” means that current follow into device and sign “-” means that

current follow out the device.

SPEECH NETWORK :

(Ambient temperature is 25°C, VDDA=3V , & VSSA=0V under Iline=15mA, R45=620, R49=20K, R54=12K, R55=22Ω)

Parameter	Symbol	Description	Min	Typ.	Max	Unit
Minimum operating voltage	VDDA	No load	2	---	5.5	V
Maximum operating current	Idda	No load, off hook VDDA=3V	---	---	0.8	mA
		No load, on hook speakerphone mode VDDA=5VDC, VPP=5.5VDC	---	---	0.4	
Line regulation		VIn-Vslpe	3.2	3.4	3.6	V
GTO drive current	Igto	β of Q12 must greater than 150	---	1	---	mA
Microphone input resistance	Ri	Symmetrical Asymmetrical	---	68K 34K	---	Ω
DTMF input resistance	Ri		---	20K	---	Ω
Receiving input resistance	Ri		---	20K	---	Ω
Receiving output resistance	Ro		---	4	---	Ω
Receiving output loading	Rrl		100	150	---	Ω

SPEAKERPHONE :

(Ambient temperature is 25°C, R45=620, VPP=5.5V, VSSP=0V, VDDA=5V, & VSSA=0V)

Parameter	Symbol	Description	Min	Typ	Max	Unit
Maximum operating voltage	VPP	No load	3	---	5.5	V
Maximum operating current	Ipp	No load, VDDA = 5VDC VOL at MAX(40dB) RXI = 16mVrms @1Khz	---	---	2	mA
Quiescent current	Ippq	VOL at Min(20dB) RXI = Vref(0.4VDD)	---	---	2	mA
MIC Amp source current	Ioa	ANOUP = Vref	---	50	---	uA
Short circuit current	Isht	pin PAO to GND	---	---	250	mA
Audio AMP output loading	Rpao		16	25	---	Ω

AC ELECTRICAL CHARACTERISTICS:

DIALER :

(Ambient temperature is 25°C, VDD=2.5v, VSS=0v, unless otherwise noted,
Fosc=3.579545MHz)

Parameter	Sym.	Condition	Min.	Typ.	Max.	Unit
Keyboard debounce time	Tdb	Key pressed	---	20	---	ms
HD key release hold function debunce time	Thdrdb		---	93	---	ms
OFF-hook delay time	Tdly	From idle to operation.	---	300	---	ms
SDO bit time	Tbit	pin /SDO and dialing.	3.8	3.9	4.1	ms
Minimum tone duration	Td	Tone mode speed dialing.	96	98	100	ms
Inter-Tone Pause	Titp	Tone mode speed dialing.	96	98	100	ms
Inter-Digit Pause	Tidp	20 PPS pulse dialing.	---	500	---	ms
		10 PPS pulse dialing.	---	800	---	
Pulse Rate	PPS	R1=R-VDD	---	10	---	pps
		R1=NR	---	20	---	
Make/Break reatio	MBR	R2=R-VSS, Tm/Tb	---	33:66	---	%
		R2=NR, Tm/Tb	---	40:60	---	
Flash time	Tf	KEY F600	---	600	---	ms
		KEY F100	---	100	---	
		KEY F300	---	300	---	
Flash Pause time	Tfp		---	300	---	ms
Auto Insert Pause time	Taip		0	---	3100	ms
Puase (or P→T wait)time	Tp	Dial P or */"T" key	---	3.6	---	sec
One key redial break time	Trdb	R3=R-VDD	---	1.6	---	sec
		R3=R-VSS		1.2		sec
One key redial pause time	Trdp		---	600	---	ms
C1/IPP pin IPP debounce	Tipp	ON-hook, pin C1/IPP=VSS,	41	43	45	ms
IPP Alarm duration	Talm	DTMF active	---	250	---	ms
IPP Alarm pause	Talp		---	250	---	ms
IPP Alarm cycle time	Talc		---	1.5	---	sec

DTMF ELECTRICAL CHARACTERISTICS :

(Ambient temperature is 25°C, VDD=2.5v, VSS=0v, unless otherwise noted,

Fosc=3.579545MHz)

Parameter	Sym.	Condition	Min.	Typ.	Max.	Unit
DTMFO/MLDA Sink current	IoL	Vpin=0.5v	+0.2	---	---	mA
DTMFO/MLDA DC level	Vdc	Vdd=2.0v~5.5v	0.5	---	0.75	Vdd
DTMFO/MLDA AC level	Vac	Row group	142	160	180	mVrms
Pre-emphasis (twist)	Twist	Column group-Row group	1	2	3	dB
Total Harmonics distortion	THD	RL=5KΩ loaded	---	-30	-23	dB
DTMF frequency						
Keypad position	CCITT standard (Hz)		Actual (Hz)		Deviation (%)	
R1 (FL1)	697		699.1		0.30	
R2 (FL2)	770		766.2		0.49	
R3 (FL3)	852		847.4		-0.53	
R4 (FL4)	941		947.9		0.73	
C1 (FH1)	1209		1215.8		0.56	
C2 (FH2)	1336		1331.6		-0.32	
C3 (FH3)	1477		1471.8		-0.35	

Distortion in dB defined as : $THD = 20 \log \frac{\sqrt{v_1^2 + v_2^2 + \dots + v_n^2}}{\sqrt{v_l^2 + v_h^2}}$

where v_1, \dots, v_n are the unwanted frequency components (BW=300~3500Hz), v_l is the low frequency tone, v_h is the high frequency tone.

MELODY ELECTRICAL CHARACTERISTICS :

(Ambient temperature is 25°C, VDD=2.5v, VSS=0v, unless otherwise noted,

Fosc=3.579545MHz)

Parameter	Sym.	Condition	Min.	Typ.	Max.	Unit
Melody tone ac level main-tone sub-tone	Vmtac	VDD=2.0V~5.5V from	48	53	58	mV-rms
	Vstac	DTMFO/MLDA pin	37	42	47	
	Vmatc	VDD=2.0V~5.5V from MLDB pin ,	180	202	229	
	Vstac	C4=R-VSS @ 42 SDIP	142	160	180	
MLDB pin Sink current	IoL	Vpin=0.5v	+0.2	---	---	mA
MLDB pin DC level	Vdc	Vdd=2.0v~5.5v	0.5	---	0.75	Vdd
Total Harmonics distortion	THD	RL=5KΩ loaded	---	-30	-23	dB

SPEECH NETWORK :

(Ambient temperature is 25°C, under Iline=15mA, R45=620, R55=22Ω, R54=12K, R49=20K; VDDA=3V, & VSSA=0V)

Parameter	Symbol	Description	Min	Typ.	Max	Unit
Microphone amplifier voltage gain from MIC+ or MIC- to LINE	Gv	R46// R52=110K	50.5	52	53.5	dB
Receiving amplifier voltage gain from RXI to GRO	Gv	R58=82KΩ	25	26.5	28	dB
DTMF voltage gain from DTMFI to LINE	Gvt	R46// R52=110KΩ	24.5	26	27.5	dB
DTMF voltage gain from DTMFI to GRO	Gvr	R58=82KΩ	---	-23	---	dB
Auto gain control from 20mA to 60mA	ΔGvT	R62=68KΩ	---	-6	---	dB

NOTE :

- R45 = Resistor across between “LINE” and “VDDA”
- R46 = Resistor across between “ANOUT” and “VREF”
- R49 = Resistor across between “LINE” and “REG”
- R52= Resistor across between “GTF” and “REG”
- R54= Resistor across between “REG” and “SLPE”
- R55 = Resistor across between “SLPE” and “VSS”
- R58 = Resistor across between “GRF” and “GRO”

SPEAKERPHONE :

(Ambient temperature is 25°C, R45=620, VPP=5.5V, VSSP=0V, VDDA=5V, & VSSA=0V)

Parameter	Symbol	Description	Min	Typ.	Max	Unit
Microphone amplifier voltage gain from MIC+ or MIC- to ANOUP	Gv		33	34	35	dB
Receiving amplifier voltage gains from RXI to PAO (see “NOTE” for details)	Gv	13 cyclic gain setting by VOL+/VOL-key	20	---	40	dB
DTMF voltage gain from DTMFI to ANOUP	Gv		13	14	15	dB
DTMF voltage gain from DTMFI to PAO	Gv	no volume aid	---	-23	---	dB



PAO max output voltage swing	Vpao	load = $25\ \Omega$ VOL at MAX level (40dB) RXI = 16 mVrms	---	4.5	---	VP-P
Open loop unity gain Band width	BW	unload	---	1	---	MHZ
Total harmonic distortion	THD	load= $25\ \Omega$ VOL at level 34dB, PAO output swing = 3.16Vp-p @1khz	---	0.5	1	%
Output power	Ppao	THD=2%	---	100	---	mW

NOTE:

1. Volume control steps are gradually increased as 20→ 24.8→ 28→ 30→ 32→ 33.5→ 34.8→ 36→ 37→ 37.7→ 38.5→ 39.3 → 40 (dB) by pressing of key VOL+, otherwise , backward control by key VOL-.
2. Initial volume level gain from RXI to PAO is internally set at 20dB.
3. Speakerphone use “Fix” volume control only regardless of R-OPTION of R4.

APPLICATION CIRCUIT

(see FIG 23~25)

TIMING DIAGRAM

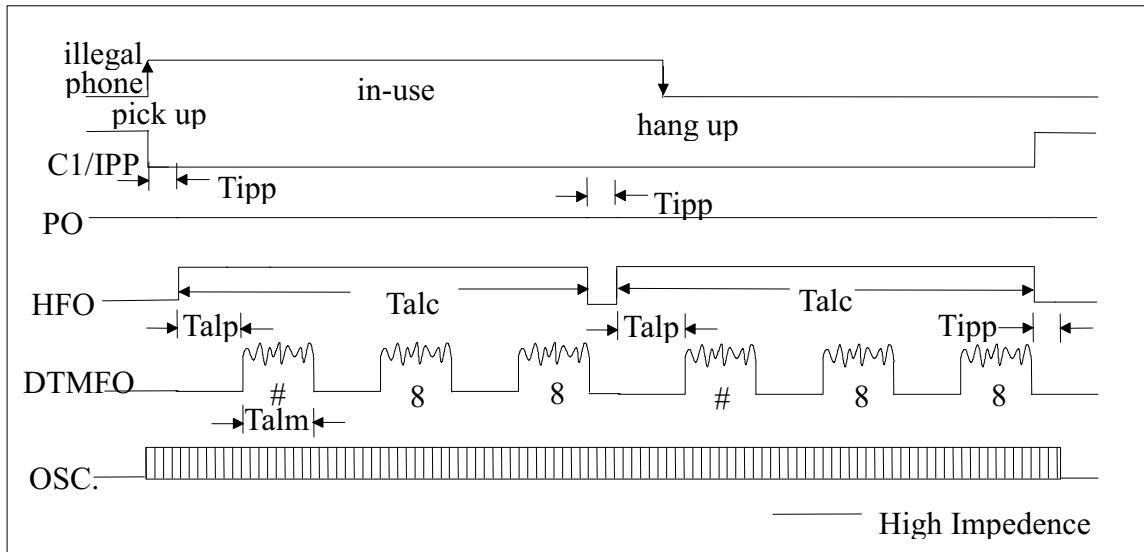


Figure 1 IPP detect and alarm

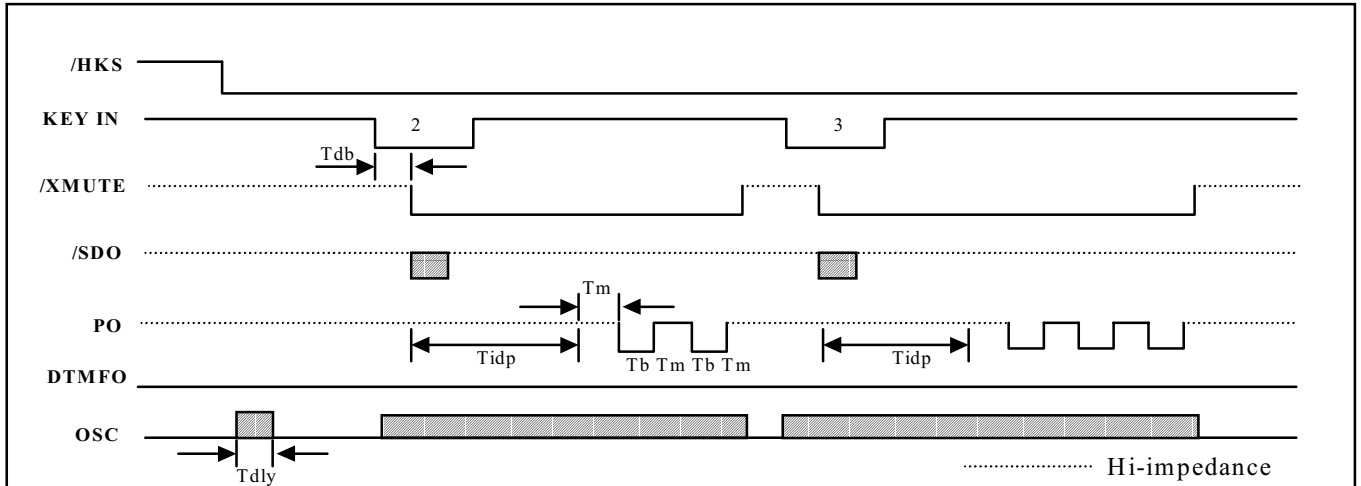


FIG 2 PULSE MODE OPERATING TIMING

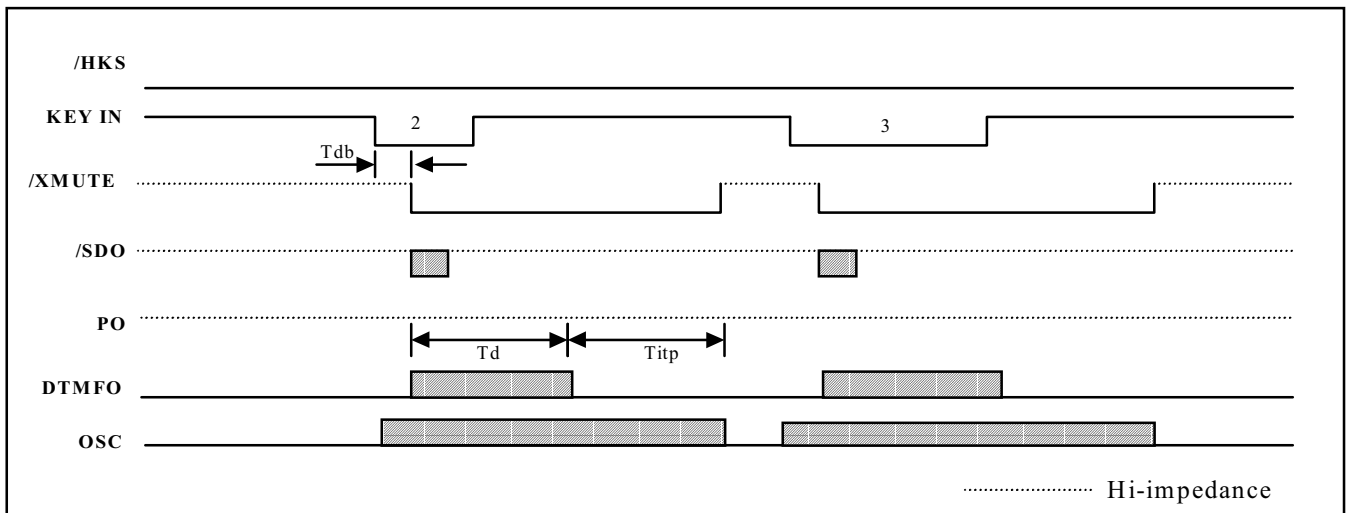


FIG 3 DTMF MODE OPERATING TIMING

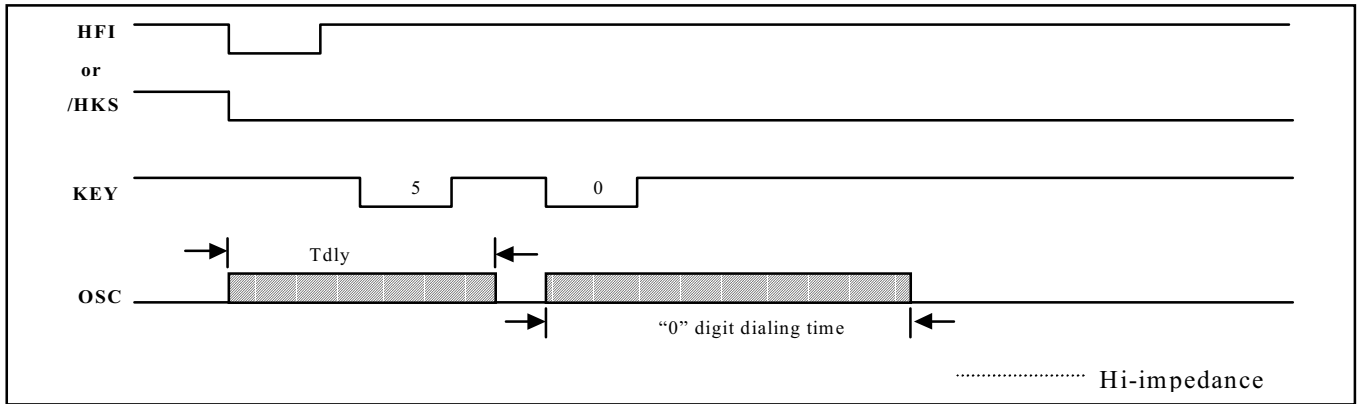


FIG 4 OFF-HOOK DELAY TIME

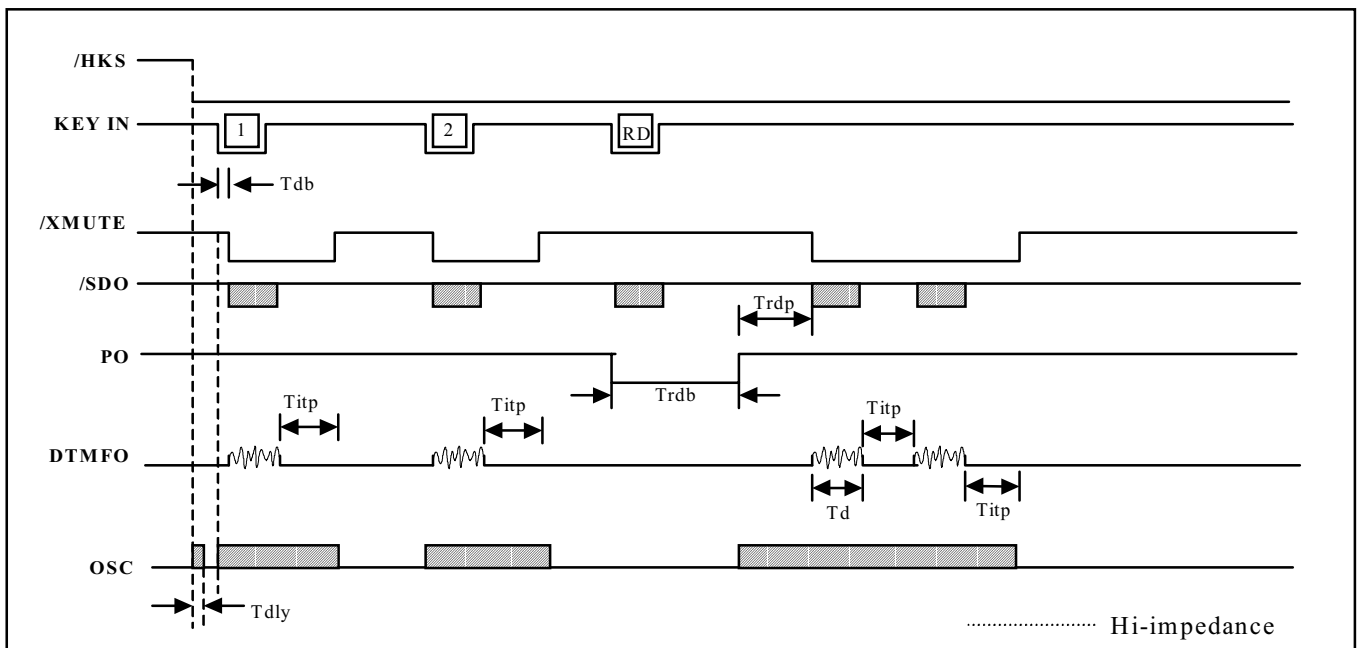


FIG 5 TONE MODE ONE KEY REDIAL

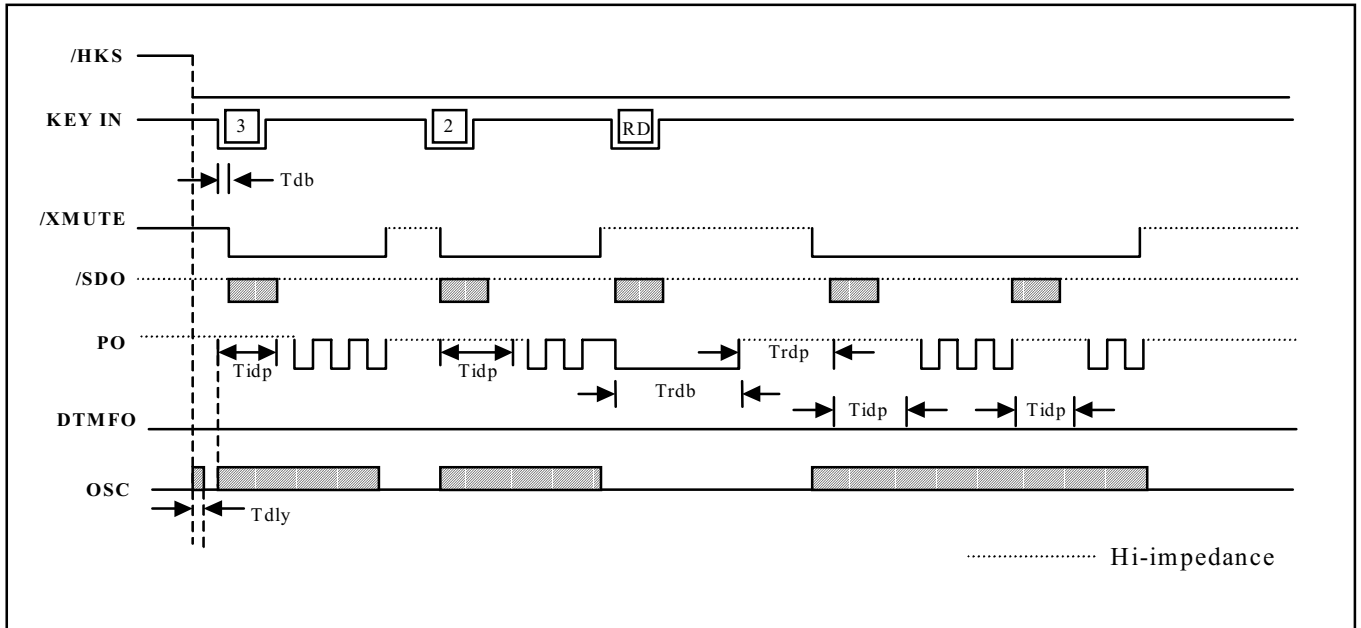


FIG 6 PULSE MODE ONE KEY REDIAL

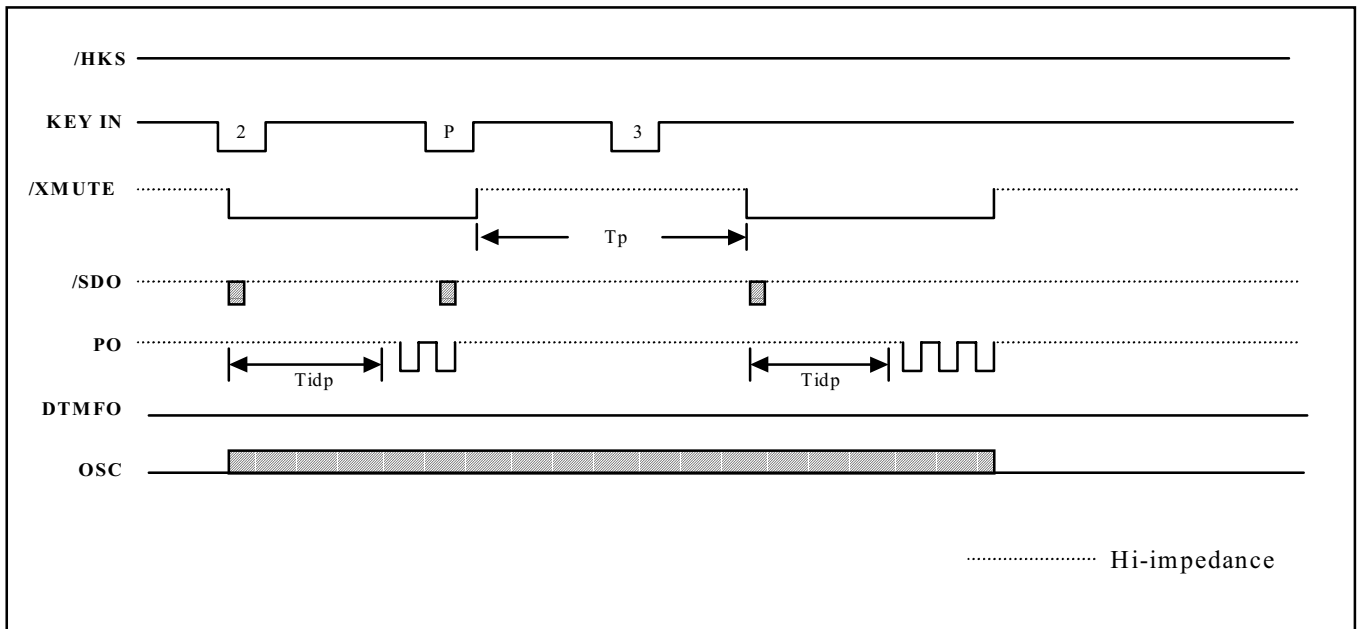


FIG 7 PAUSE KEY OPERATING TIMING

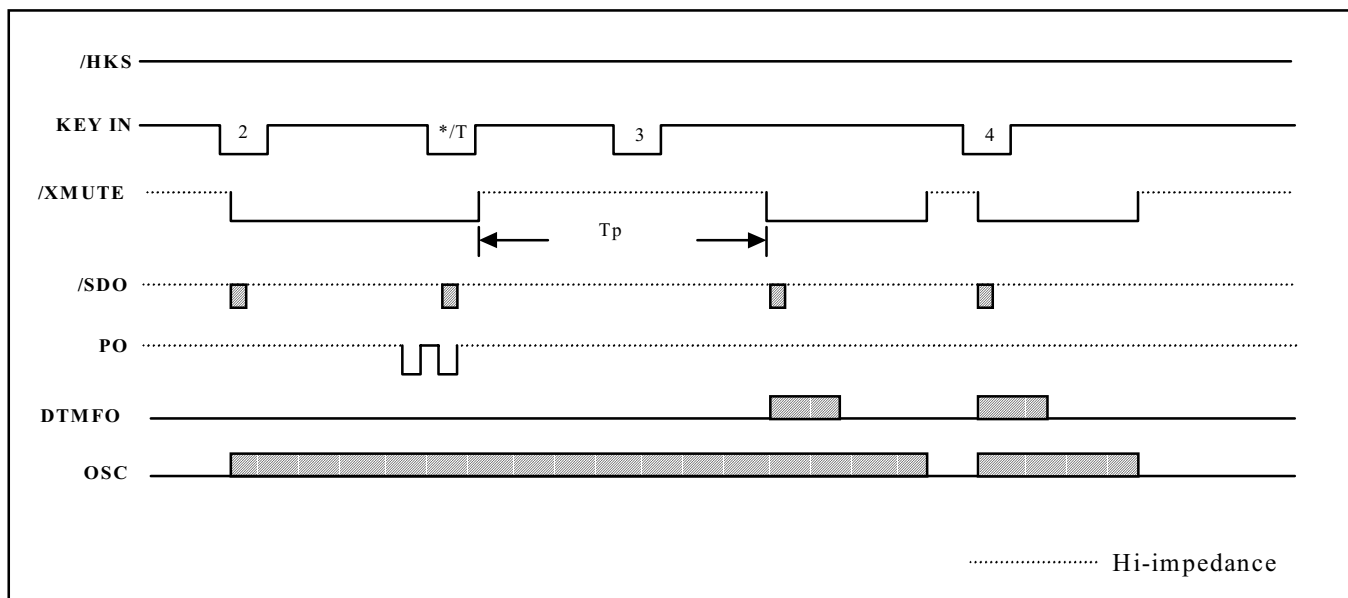


FIG 8 PULSE TO TONE(P→T) OPERATING TIMING

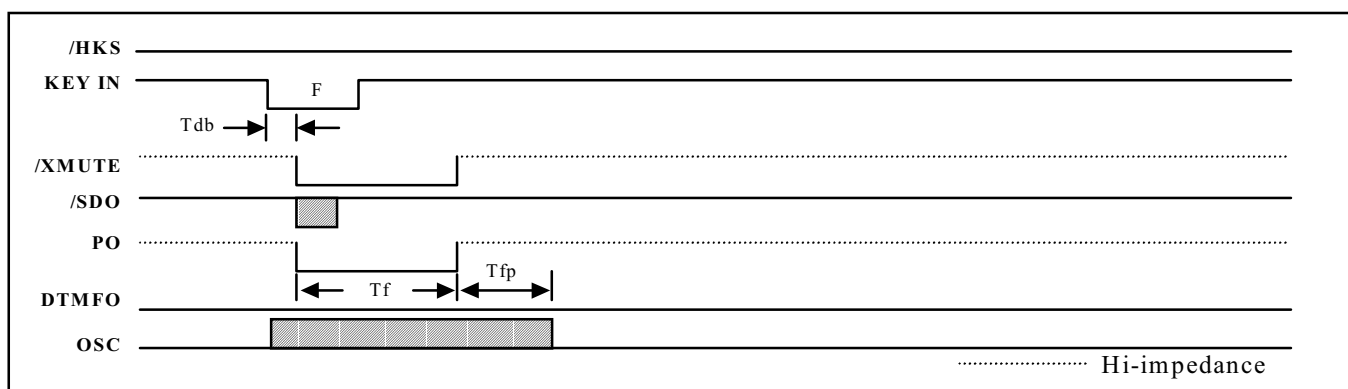
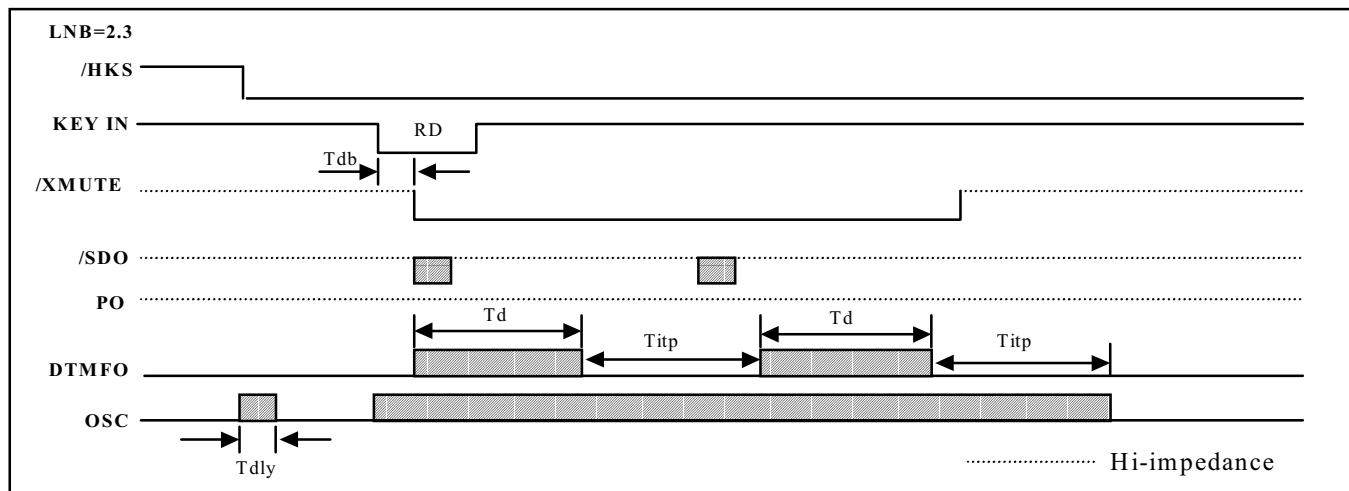
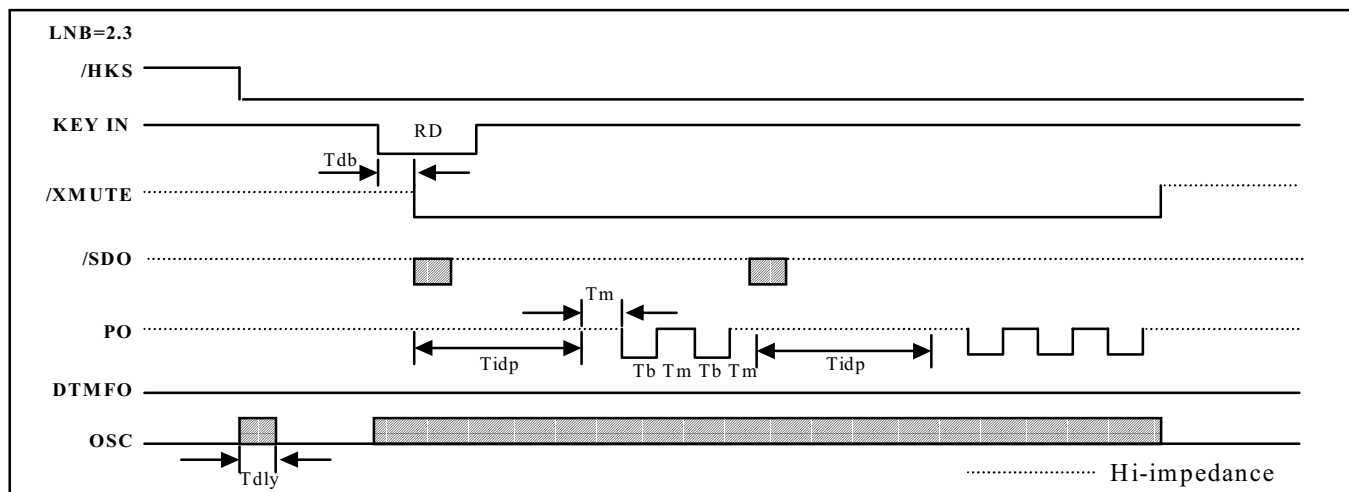


FIG 9 FLASH KEY OPERATING TIMING



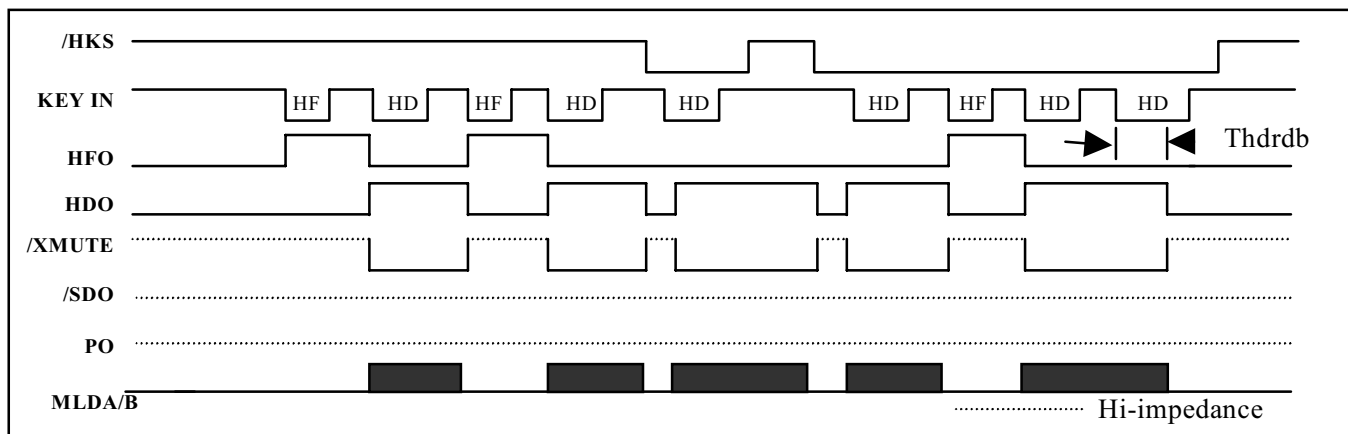


FIG 12 HF AND HD OPERATING TIMING

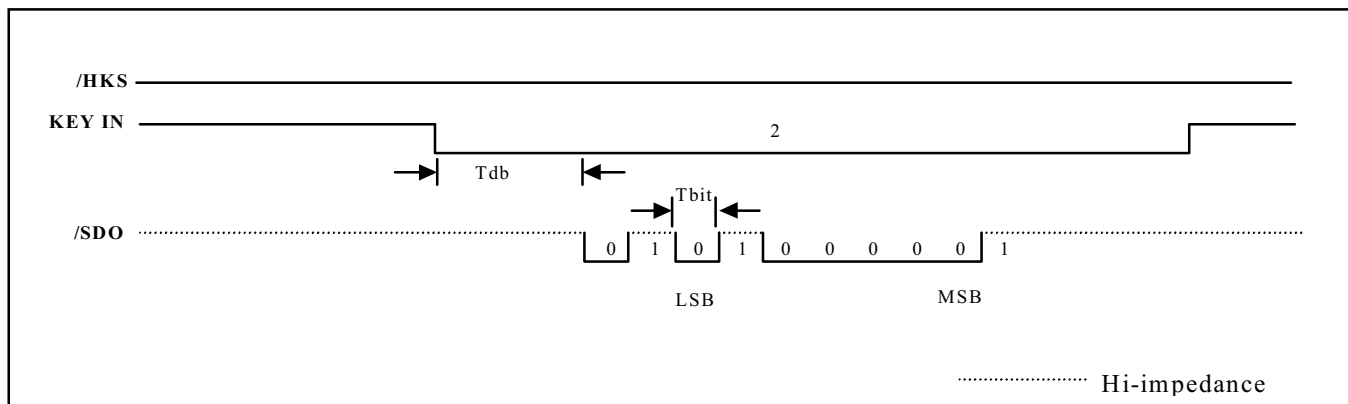


FIG 13 SDO OPERATING TIMING

Redial with Auto Insert Pause timing

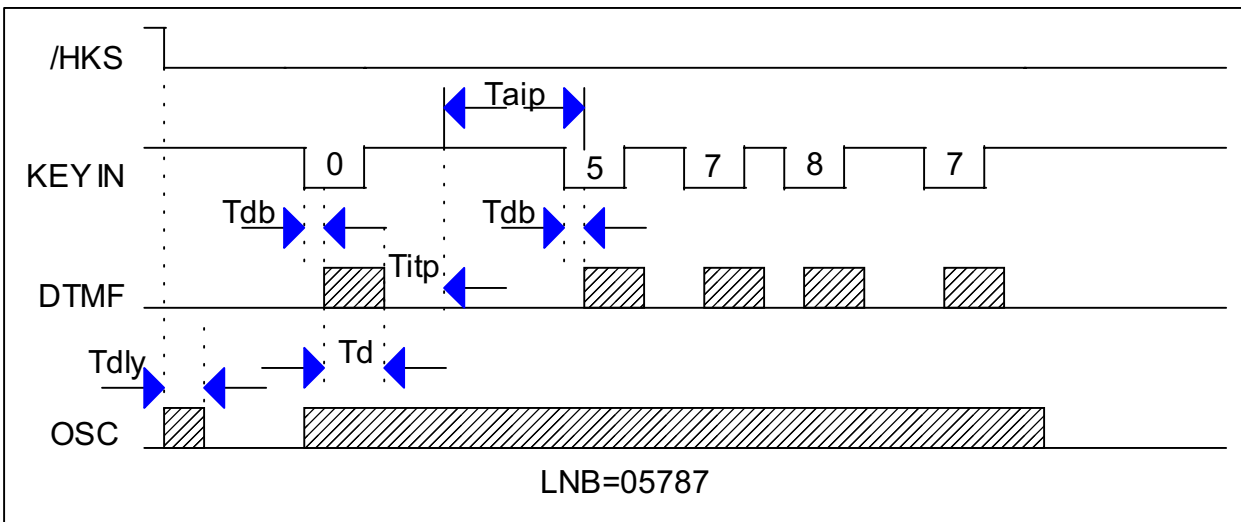


FIG 27 AIP Dialing

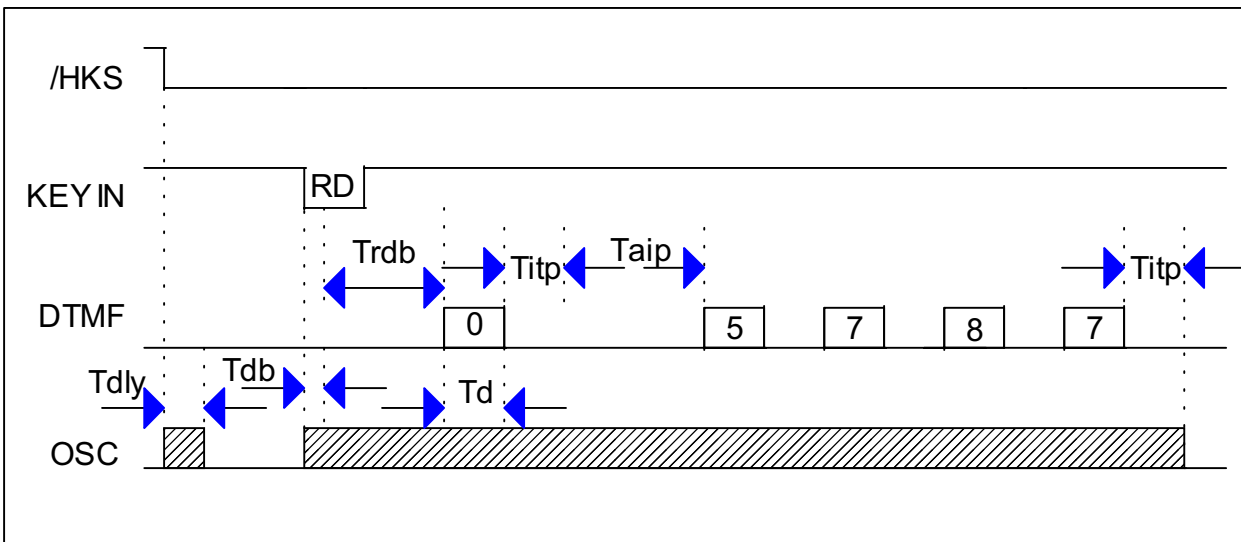
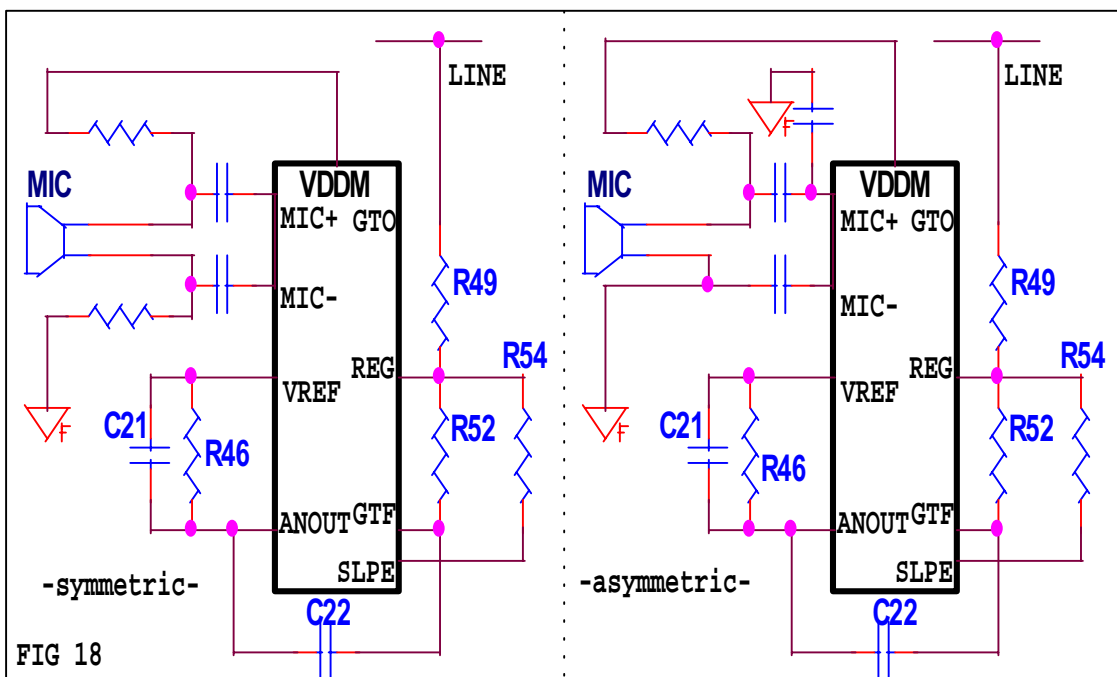
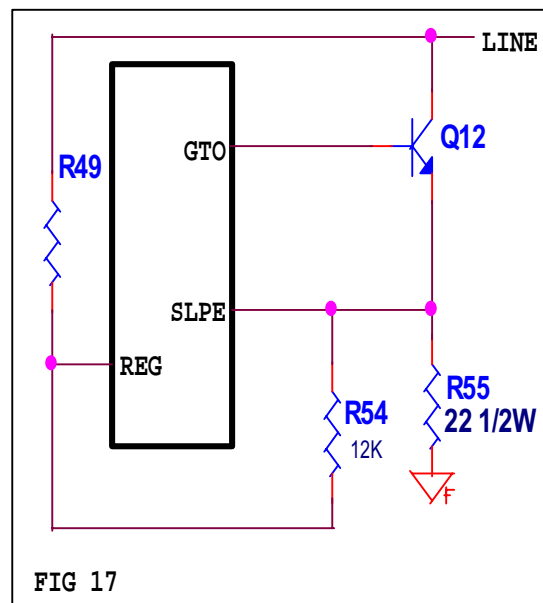
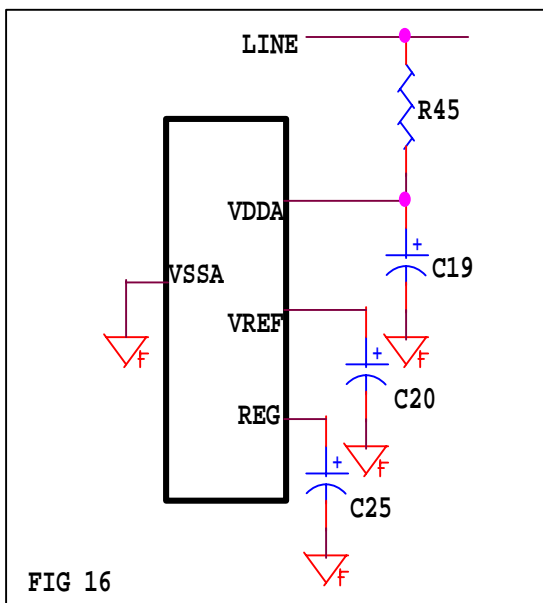
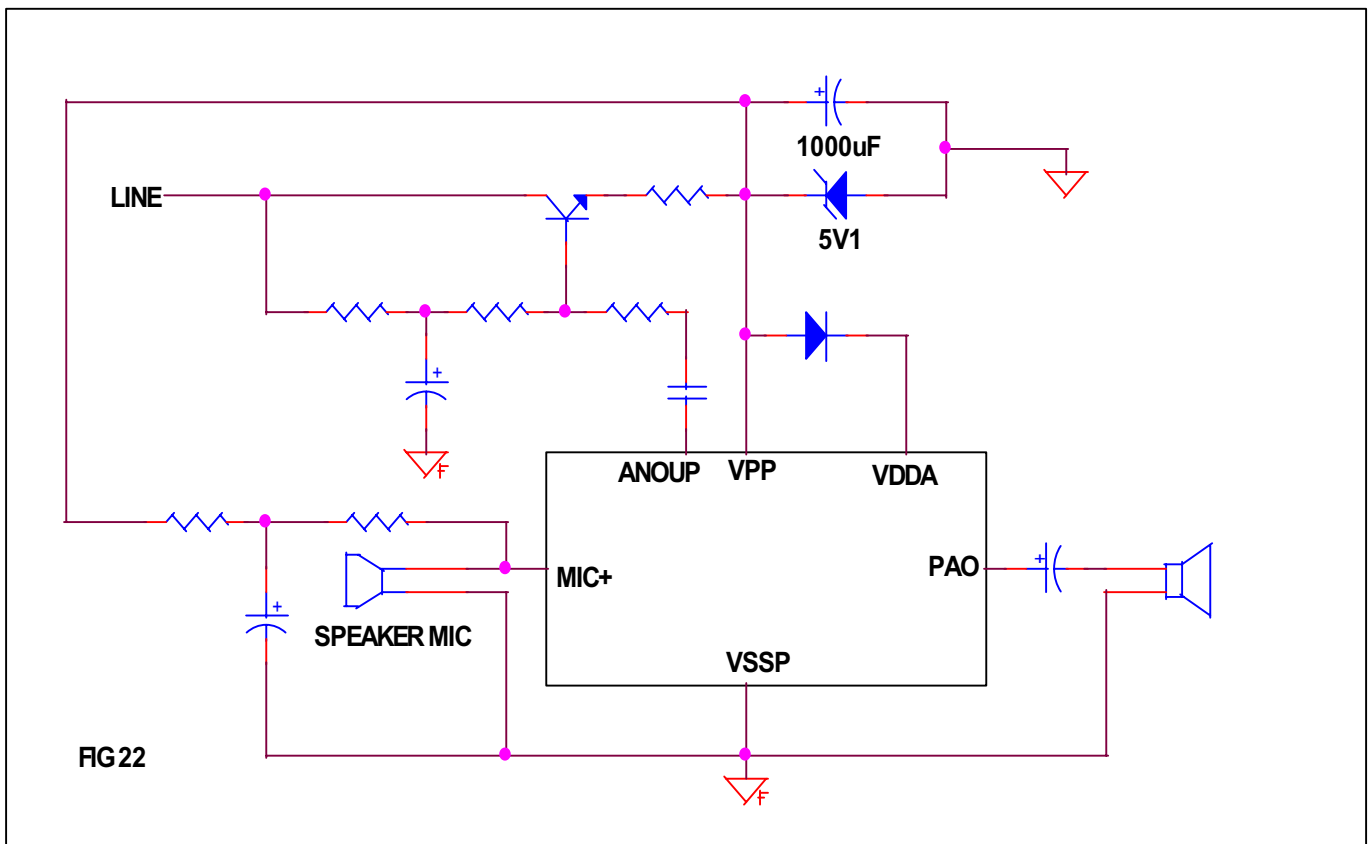
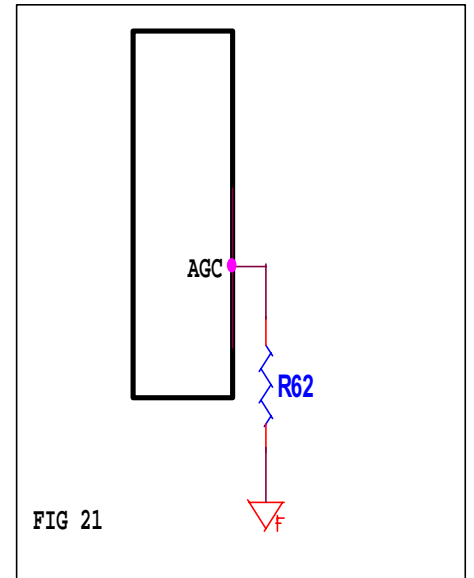
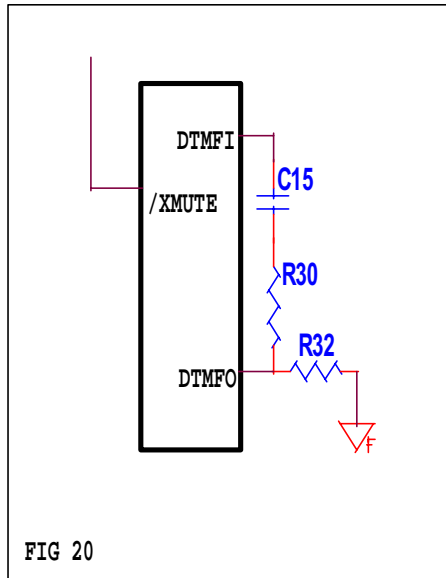
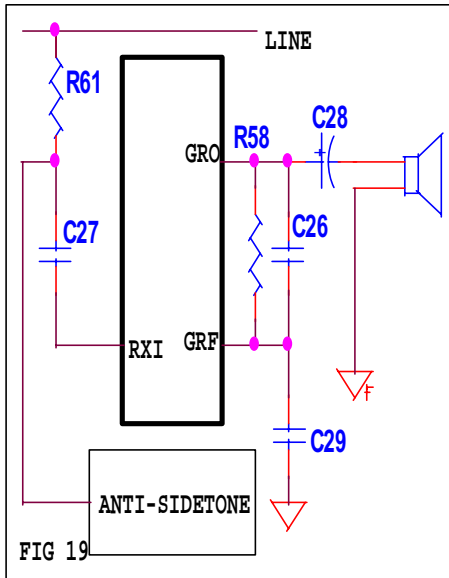
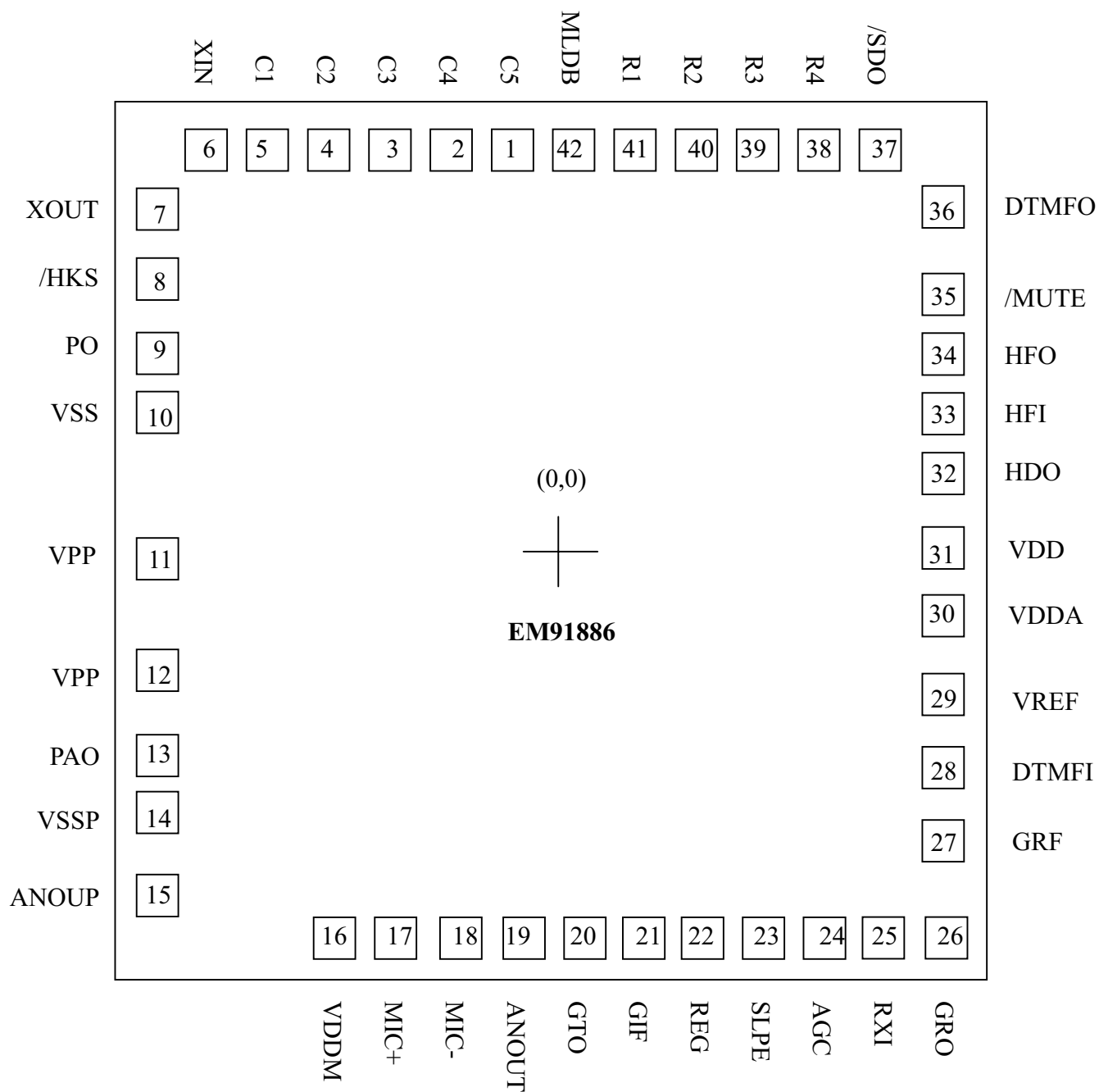


FIG 28 AIP Redialing





PAD DIAGRAM





Pin NO.	Symbol	X	Y	Pin NO.	Symbol	X	Y
1	C5	-86.9	1022.5	22	REG	347.0	-1020.7
2	C4	-206.9	1022.5	23	SLPE	467.0	-1020.7
3	C3	-336.9	1022.5	24	AGC	590.7	-1020.7
4	C2	-456.9	1022.5	25	RXI	710.7	-1020.7
5	C1	-586.9	1022.5	26	GRO	840.1	-1020.7
6	XIN	-712.9	1022.5	27	GRF	835.0	-812.5
7	XOUT	-835.0	876.5	28	DTMFI	835.0	-639.1
8	/HKS	-835.0	696.7	29	VREF	835.0	-462.7
9	PO	-835.0	523.3	30	VDDA	835.0	-238.4
10	VSS	-835.0	357.8	31	VDD	835.0	-68.2
11	VPP	-835.0	-61.5	32	HDD	835.0	156.1
12	PAO	-835.0	-391.2	33	HFI	835.0	328.5
13	VSSP	-835.0	-611.1	34	HFO	835.0	501.9
14	VSSA	-835.0	-751.7	35	/XMUTE	835.0	674.3
15	ANOUT	-835.0	-976.0	36	DTMFO	835.0	899.7
16	VDDM	-376.7	-1020.7	37	/SDO	682.1	1022.5
17	MIC+	-253.0	-1020.7	38	R4	562.1	1022.5
18	MIC-	-133.0	-1020.7	39	R3	432.1	1022.5
19	ANOUT	-13.0	-1020.7	40	R2	312.1	1022.5
20	GTO	107.0	-1020.7	41	R1	182.1	1022.5
21	GTF	227.0	-1020.7	42	MLDB	50.7	1022.5

Chip size : 1990 * 2420 um

For PCB layout, IC substrate must be connected to Vss.