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## SPEECH AND DIALLER L3914A/16A AND ST3917A/B

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## I - INTRODUCTION OF L3914A/16A/ST3917A/B

These devices are an integrated circuit incorporating the speech and dialler circuit into one chip which are designed for USA market. By changing a few components values or by adding a few external components, it is possible to use it in several other countries.

### COMMON FEATURES

- 2 to 4 wires conversion
- Line loss compensation for long line
- Symmetrical high impedance microphone inputs suitable for dynamic, Electret or Piezoelectric transducer
- Asymmetrical earphone output suitable for dynamic transducer
- Internal muting to disable speech during dialling
- Tone/pulse dialler with 32 digits for last number redial buffer
- Pacifier tone provides audible indication of valid key press in a buzzer or/and in the earphone
- Timed pabx pause and flash initiates timed break

- Continuous tone for each digit until key release
- Uses inexpensive 3.579545MHz ceramic resonator

### L3914A/16A

- Three 18 digits one-touch memories for emergency redial and ten 18 digits two-touch memories
- Hold function for parallel phone with 400ms validation timer to prevent false release (L3914A only)
- Lighted dialled led which consume 25% of total line current (L3916A only)

### ST3917A/B

- Make/break ratio :  
40/60(ST3917A) and 33/67(ST3917B)
- 4 selectable options on flash duration, softswitch inhibition in one of the options with 100ms flash timing
- 2 selectable options : transmit mute/led keyboard illumination or led indicator for tone mode dialling

### I.1 - Speech + Dialler Family Chart

Device	M/B Ratio 40/60	M/B Ratio 33/67	Flash (ms)	Lighted Dial LED	HOLD Function
L3914A	Cp = 0, Rp = ∞	Cp=4.7μF, Rp=100kΩ	585	No	Yes
L3924A	Cp = 0, Rp = ∞	Cp=4.7μF, Rp=100kΩ	300	No	Yes
L3934A	Cp = 0, Rp = ∞	Cp=4.7μF, Rp=100kΩ	100	No	Yes
L3916A	Cp = 0, Rp = ∞	Cp=4.7μF, Rp=100kΩ	585	Yes	No
L3926A	Cp = 0, Rp = ∞	Cp=4.7μF, Rp=100kΩ	300	Yes	No
L3936A	Cp = 0, Rp = ∞	Cp=4.7μF, Rp=100kΩ	100	Yes	No
ST3917A	Yes	No	585/300/100	Yes	No
ST3917B	No	Yes	585/300/100	Yes	No

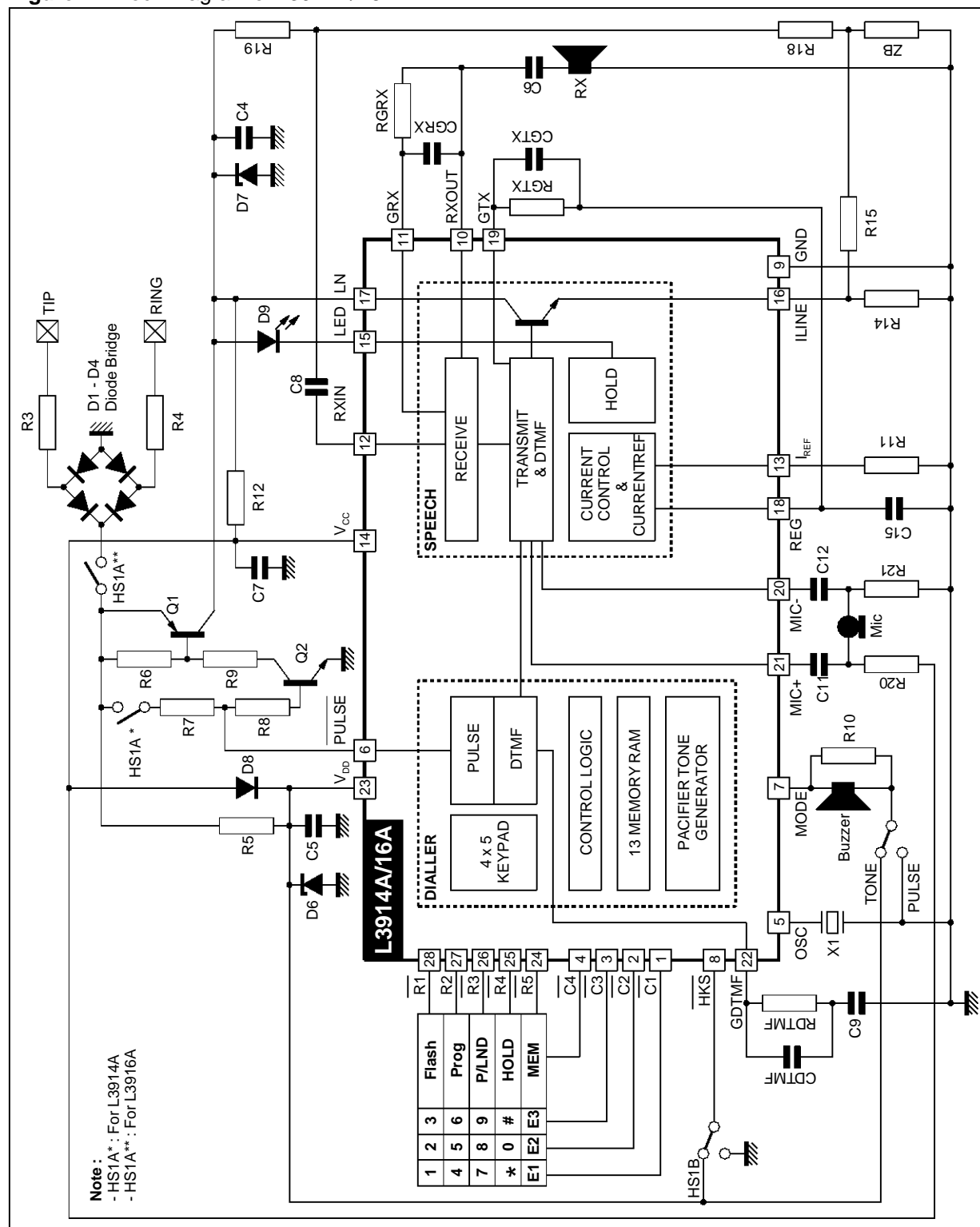
**Notes:** 1. L3924A/34A are metal mask options of L3914A with different Flash timing.  
2. L3926A/36A are metal mask options of L3916A with different Flash timing.

The descriptions in this application for L3914A and L3916A are also applied to L3924A/34A/26A/34A.

## I - INTRODUCTION OF L3914A/16A/ST3917A/B (continued)

### I.2 - Block Diagram of L3914A/16A

Figure 1 : Block Diagram of L3914A/16A

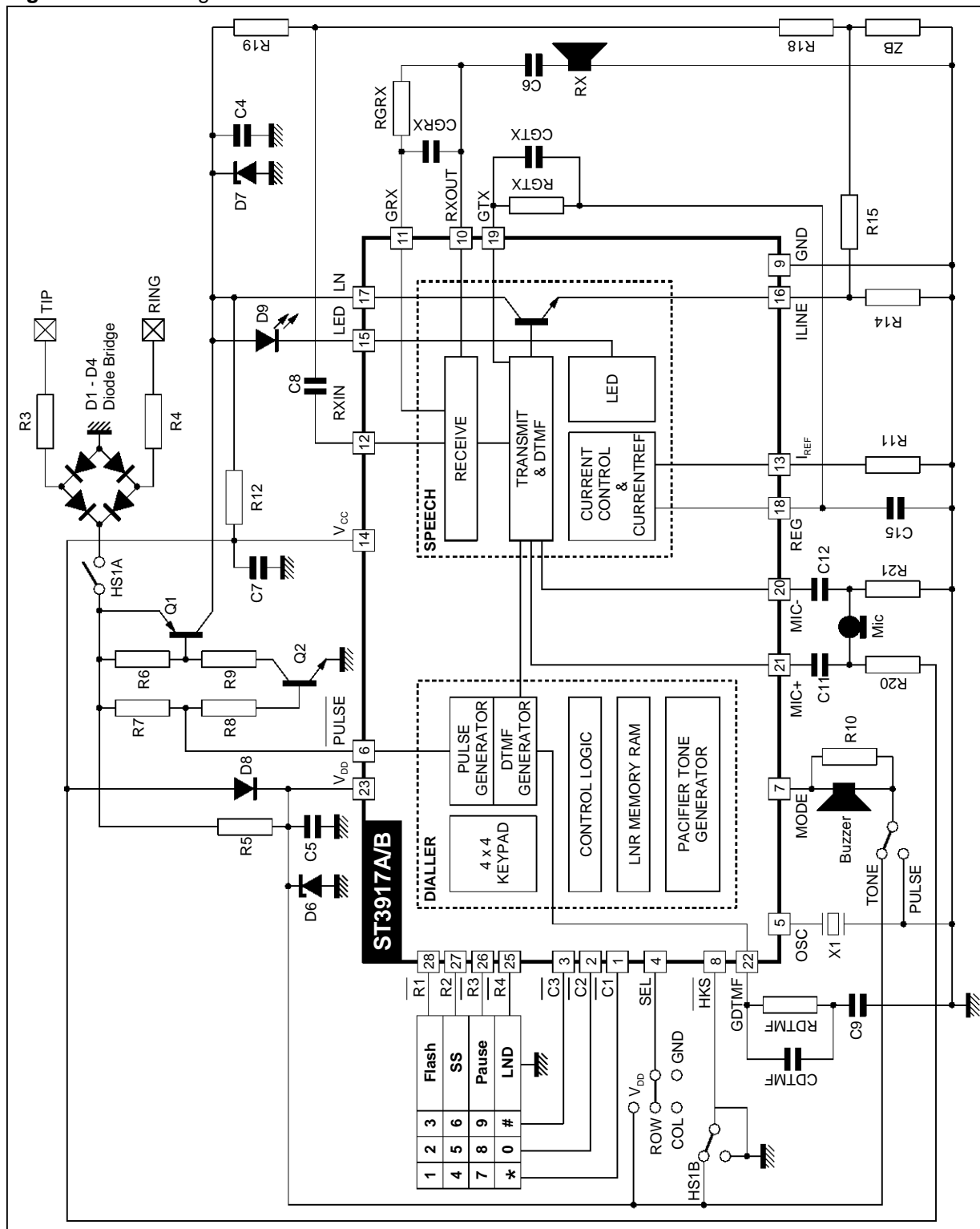


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I - INTRODUCTION OF L3914A/16A/ST3917A/B (continued)

I.3 - Block Diagram of ST3917A/B

Figure 2 : Block Diagram of ST3917A/B



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## SPEECH AND DIALLER L3914A/16A AND ST3917A/B

### I - INTRODUCTION OF L3914A/16A/ST3917A/B (continued)

#### I.4 - L3914A/16A Pins Assignment

Pin	Name	Function
1	$\overline{C1}$	Keypad Column 1
2	$\overline{C2}$	Keypad Column 2
3	$\overline{C3}$	Keypad Column 3
4	$\overline{C4}$	Keypad Column 4
5	OSC	Oscillator Pin
6	$\overline{PULSE}$	Pulse Output Pin
7	MODE	Pacifier Output and Tone/Pulse Mode Select
8	$\overline{HKS}$	Hookswitch Input
9	GND	Ground Pin for all Voltage Reference
10	RXOUT	Receive Amplifier Output
11	GRX	Receive Gain Adjustment
12	RXIN	Receive Amplifier Input
13	$I_{REF}$	Current Reference
14	$V_{CC}$	Speech Circuit Supply
15	LED	LED Output Pin
16	ILINE	Slope Adjustment
17	LN	Positive Line Terminal
18	REG	Voltage Regulator Decoupling
19	GTX	Transmit Gain Adjustment
20	MIC-	Inverting Microphone Input
21	MIC+	Non-inverting Microphone Input
22	GDTMF	DTMF Level Adjustment
23	$V_{DD}$	Dialler Positive Supply
24	$\overline{R5}$	Keypad Row 5
25	$\overline{R4}$	Keypad Row 4
26	$\overline{R3}$	Keypad Row 3
27	$\overline{R2}$	Keypad Row 2
28	$\overline{R1}$	Keypad Row 1

#### I.5 - ST3917A/B Pins Assignment

Pin	Name	Function
1	$\overline{C1}$	Keypad Column 1
2	$\overline{C2}$	Keypad Column 2
3	$\overline{C3}$	Keypad Column 3
4	SEL	Option Select Pin
5	OSC	Oscillator Pin
6	$\overline{PULSE}$	Pulse Output Pin
7	MODE	Pacifier Output and Tone/Pulse Mode Select
8	$\overline{HKS}$	Hookswitch Input
9	GND	Ground Pin for all Voltage Reference
10	RXOUT	Receive Amplifier Output
11	GRX	Receive Gain Adjustment
12	RXIN	Receive Amplifier Input
13	$I_{REF}$	Current Reference
14	$V_{CC}$	Speech Circuit Supply
15	LED	LED Output Pin
16	ILINE	Slope Adjustment
17	LN	Positive Line Terminal
18	REG	Voltage Regulator Decoupling
19	GTX	Transmit Gain Adjustment
20	MIC-	Inverting Microphone Input
21	MIC+	Non-inverting Microphone Input
22	GDTMF	DTMF Level Adjustment
23	$V_{DD}$	Dialler Positive Supply
24	MU/MFI	Transmit Mute and Tone Mode Indicator
25	$\overline{R4}$	Keypad Row 4
26	$\overline{R3}$	Keypad Row 3
27	$\overline{R2}$	Keypad Row 2
28	$\overline{R1}$	Keypad Row 1

## II - OVERVIEW OF L3914A/16A/ST3917A/B(SPEECH CIRCUIT)

The internal functional block of the L3914A/16A/ST3917A/B(for speech circuit only) is shown in Figure 3. The speech circuit can be divided into two modes : the speech mode and the dialling mode. The speech mode can be further sub-divided into two sections : the speech transmitting and the speech receiving mode.

In the speech transmitting mode, the speech signal from the microphone is being amplified by the transmit pre-amplifier (GM1). Since it is in the speech mode, the mute switch as controlled by the MUTE CONTROL will be at position 1 which enabled the speech path and disabled the DTMF path. This allows the amplified speech signal to propagate to the transmit output amplifier. The amplified speech signal will then be sent to the line.

In the speech receiving mode, the speech signal from the line is being amplified by the receive pre-amplifier (GM4). The mute switch is at position 1 and therefore the speech signal will be passed to the final receive amplifier. The amplified speech signal will then be delivered to the earphone.

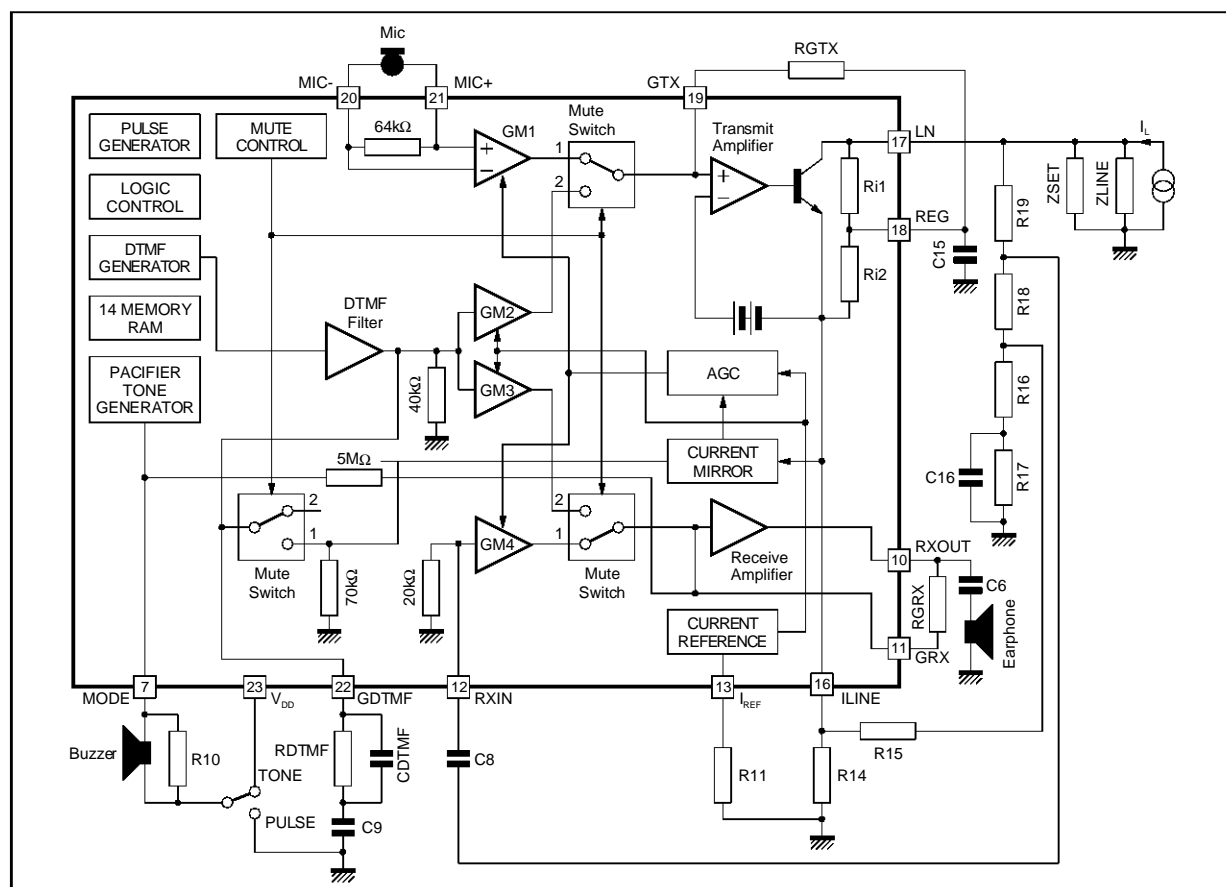
In the speech mode, the Automatic Gain Control (AGC) will regulate the gain of both the transmit and receive pre-amplifier according to the line current.

Likewise for the dialling mode, there are two sections: the DTMF transmit and the Dial-Pulse transmit.

In the DTMF dialling mode, the DTMF signal generated from the DTMF generator is filtered and then amplified by the transmit pre-amplifier (GM2). The filtered DTMF signal is also attenuated by the receive pre-amplifiers (GM3). The mute switch in this case will be at position 2 which disabled the speech path and enabled the DTMF path. The DTMF signal will be amplified by the final transmit amplifier and sent to the line. In addition, the DTMF signal will also be amplified by the final receive amplifier and delivered to the earphone.

In the Dial-Pulse mode, the speech mode will be disabled. No DTMF signal will be generated. However, a pacifier tone generated by the Pacifier Tone Generator will be sent to the final receive amplifier. The amplified signal will then be sent to the earphone. The pacifier tone is also delivered to an optional external buzzer at the mode pin.

**Figure 3 : Internal Block Diagram of Speech Circuit**



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## III - FUNCTIONAL DESCRIPTION

### III.1 - DC Characteristics

This device provides a two slope DC characteristics curves. The steeper slope is for line current from 4mA to 10mA. The flatter slope is for line current from 10mA onwards so as to limit the power dissipation for short loop application.

#### III.1.1 - Basic Formula without RA & RB

$$V_{LN} = R14 \times [I_{LINE} - (I_{CC} + I_{DD})] + \left( \frac{Ri2 + Ri1}{Ri2} \right) \times V_1 + (Ri1 \times I_1)$$

with  $V_1 = 1.4V$ ,  $Ri1 = 16.9k\Omega$ ,  $Ri2 = 39k\Omega$  and  $I_{CC} + I_{DD} = 2mA$ .

@  $I_L = 5mA$ ,  $I_1 = 12\mu A$

@  $I_L = 10mA$ ,  $I_1 = 70\mu A$

@  $I_L = 100mA$ ,  $I_1 = 98\mu A$

Where  $V_{LN}$  is the line voltage at Pin 17 (LN) without RA or RB.

Changing the values of R14 will change the second slope of the DC curve which has a line current ranging from 10mA to 120mA. This will affect the microphone gain, DTMF gain, sidetone, maximum output swing on LN and the DC Characteristics (especially at lower voltage). For this reason, it is recommended to maintain R14 at 20Ω.

As shown in Figure 4, by connecting RA and RB it is possible to shift the DC curve up and down with respect to the line current. This is illustrated in Figure 5.

#### III.1.2 - DC Mask Change with RA and RB

1) RA between LN and REG pins

$$\delta V = \left( \frac{-Ri1^2}{Ri1 + RA} \right) \times \left( \frac{V_1}{Ri2} + I_1 \right)$$

Therefore,  $V_{LNA} = V_{LN} + \delta V$ .

**Note :** RA value cannot be lower than 9.1kΩ, otherwise this will affect the return loss.

2) RB between REG and ILINE pins

$$\delta V = V_1 \times \frac{Ri1}{RB}$$

Therefore,  $V_{LNB} = V_{LN} + \delta V$ .

### III.2 - Balance Return Loss

The AC impedance of the circuit is mainly determined by R9, R12 and C4.

Values of these components are chosen in such a way that a compromise is made between balance return loss and the frequency curve of the sending amplifier.

For real impedance, Z12 and Z14 are real, i.e. resistive load :

$$Z12 = R12 ; Z14 = R14.$$

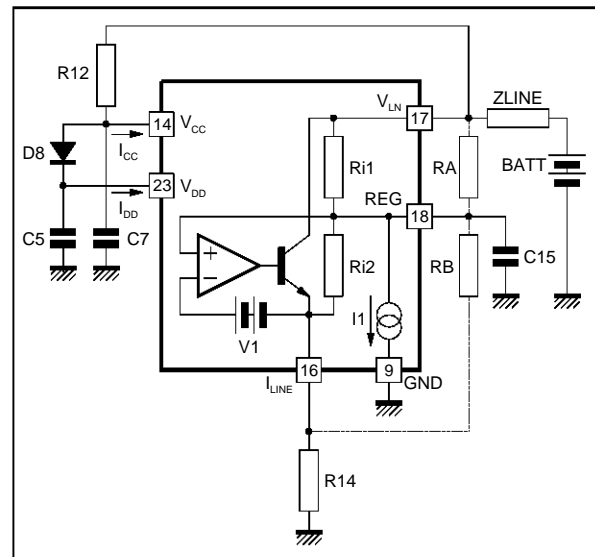
For complex impedance, Z12 and Z14 are complex, i.e. :

$$Z12 = R12 + R22//C17$$

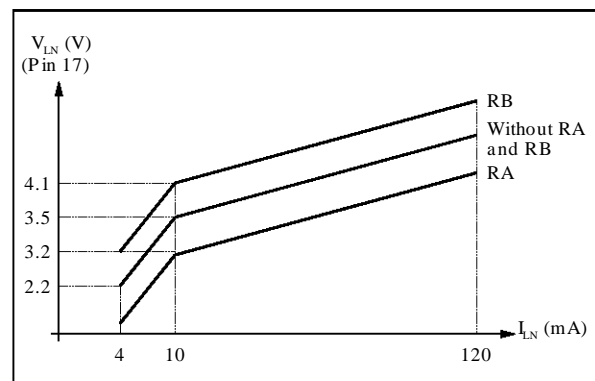
$$Z14 = R14 + R23//C18$$

The AC impedance of the speech circuit for both real and complex impedances is shown in Figures 6 and 7.

**Figure 4 : Block Diagram of DC Regulator**



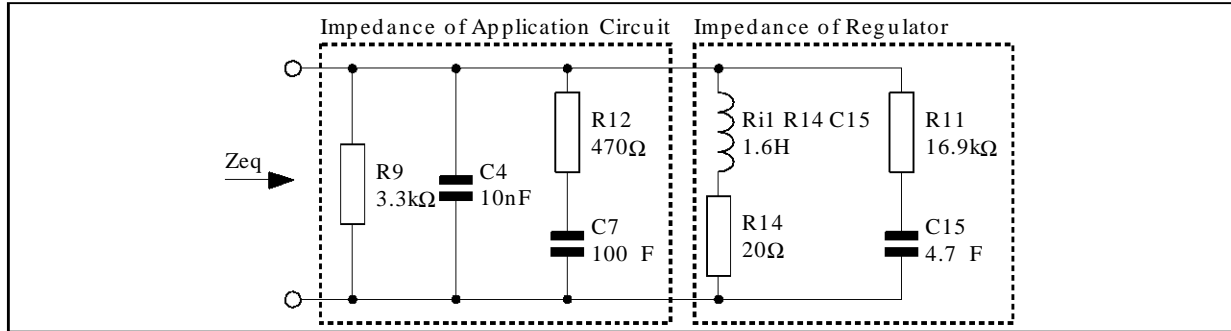
**Figure 5 : DC Characteristics**





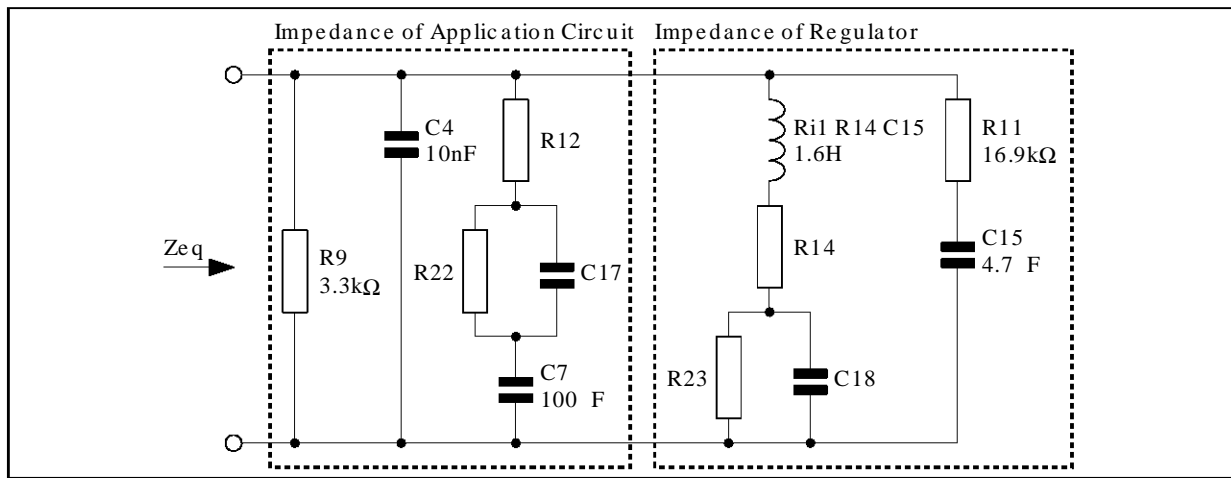
### III - FUNCTIONAL DESCRIPTION (continued)

**Figure 6 : Real AC Impedance of the Speech Circuit**



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**Figure 7 : Complex AC Impedance of the Speech Circuit**



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#### III.3 - Two to Four Wires Conversion

The device performs the two to four wires conversion by means of Sidetone configuration (refer to Figure 8) or bridge configuration (refer to Figure 9). The two wires are connected to the Tip and Ring of the telephone line and the four wires are connected to the transmitting signal from MIC+, MIC- and the receiving signal from the earphone and ground.

- In transmitting mode :

The AC signal from the microphone is sent to one diagonal of the bridge across pins 16 and 17. Major portion of the signal will be sent to the line, but small portion will be lost on ZB.

- In receiving mode :

The AC signal coming from the line input to the diagonal of the bridge across Pin 12 and 9. After amplification, it will be applied to the receiver.

##### III.3.1 - Sidetone Configuration

To optimize the balancing of the bridge :

$$\frac{ZB}{ZB + R15} = \frac{ZLINE}{ZLINE + ZSET}$$

where :

- ZSET =  $R9 // R12 / C4$ .
- ZLINE is the line impedance between Tip and Ring of telephone line.
- ZB is a complex impedance function of the line length. The values chosen for ZB should be for an average value of the line length.

**Note :** the application diagrams described in this application note are using this Sidetone configuration.

##### III.3.2 - Bridge Configuration

To optimize the balancing of the bridge :

$$\frac{ZB}{ZSET // ZLINE} = \frac{R18}{R14}$$

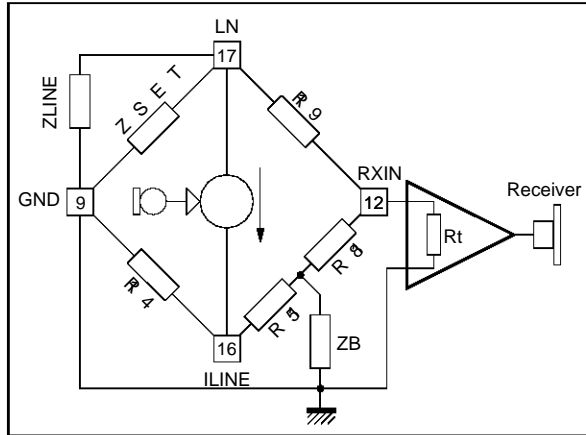
where :

- ZSET =  $R9 // R12 / C4$ .
- ZLINE is the line impedance between Tip and Ring of the telephone line.

**Note :** Refer to Appendix E in Section VIII.5 for the typical application circuit.

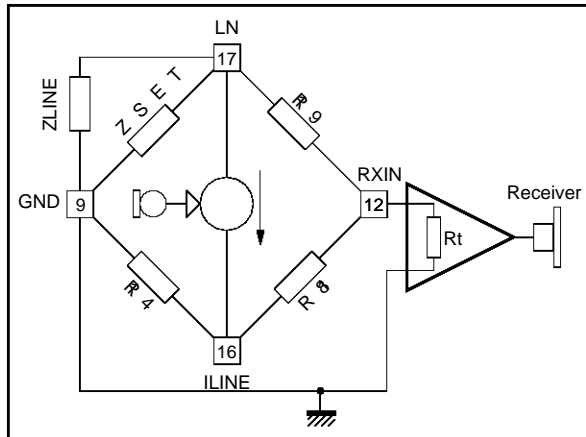
### III - FUNCTIONAL DESCRIPTION (continued)

**Figure 8 : Sidetone Configuration**



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**Figure 9 : Bridge Configuration**



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#### III.4 - Sidetone

However, the balancing condition is only an ideal case because there is always a portion of the transmitted signal, called SIDETONE, present at the receiver.

##### III.4.1 - Sidetone Suppression

Suppression of the transmitted signal in the earpiece is obtained by the Sidetone network comprising ZLINE//ZSET, R19, R18, R15, R14 and ZB (refer to Figure 8). Maximum compensation is obtained when the following conditions are fulfilled :

a)  $R14 \times R19 = ZSET \times [R18 + (R15/ZB)]$

b)  $\frac{ZB}{ZB + R15} = \frac{ZLINE}{ZLINE + ZSET}$

If fixed values are chosen for ZSET, R19, R18 and R14, then condition a) is always fulfilled provided  $|R15/ZB| \ll R18$ .

To obtain optimum sidetone suppression, condition b) has to be fulfilled, resulting in :

$$ZB = \frac{R15}{ZSET} \times ZLINE = k \times ZLINE$$

where k is a scale factor ;  $k = \frac{R15}{ZSET}$ .

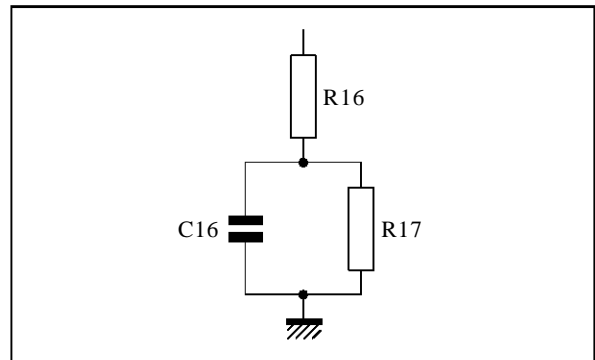
The scale factor k (value of R15) is chosen to meet the following criteria :

- $|ZB/R15| \ll R18$  to fulfill condition a) and thus ensure correct Sidetone bridge operation.
- $|ZB + R15| \gg R14$  to avoid influencing the transmit gain.

In practice ZLINE varies considerably with line length and line type. Therefore, the values chosen for ZB should be for an average line length giving satisfactory sidetone suppression with short and long lines.

The suppression also depends on the accuracy of the matching between ZB and the impedance of the average line.

**Figure 10 : Sidetone Network, ZB**



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##### III.4.2 - Optimization of Sidetone Network

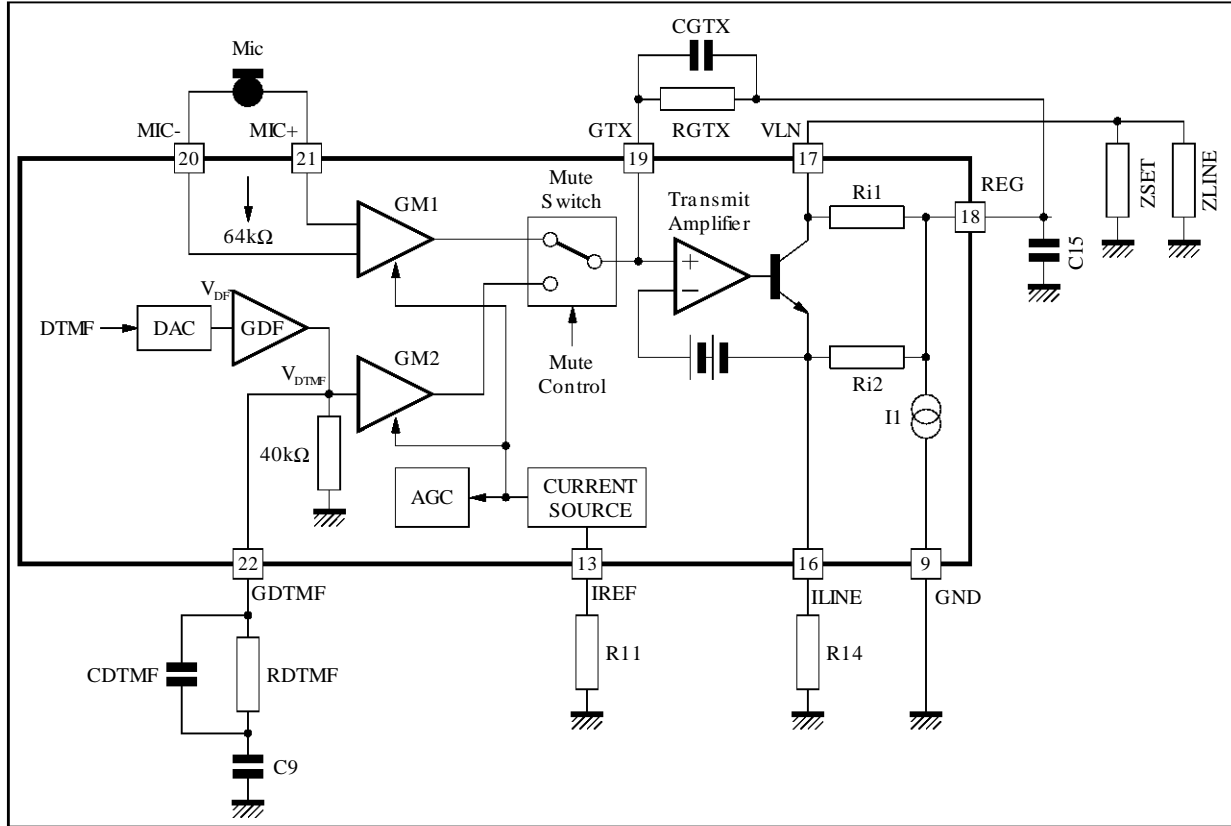
The practical procedures to adjust the component values of ZB :

- Replace R16 + R17 by a 1kΩ trimmer and send a 100Hz signal at the microphone input. Adjust the trimmer so that the 100Hz signal is at its minimum value at the earphone output.
- Fix R16 to 1/3 of the trimmer value.
- Replace R17 by a 1kΩ trimmer and C16 by a variable capacitor and send a 1kHz signal at the microphone input.
- Adjust the trimmer and the variable capacitor so that the 1kHz signal is at its minimum at the earphone.
- Fix R17 and C16 with the final values of the trimmer and variable capacitor.

### III - FUNCTIONAL DESCRIPTION (continued)

#### III.5 - Transmit

Figure 11 : Block Diagram of Transmit Amplifier



##### III.5.1 - Transmit Characteristics

The Figure 11 shows the internal block diagram of the transmit amplifier section.

The transmit signal (VMIC) from the microphone passes through the pre-amplifier (GM1) to the line driver circuit which is the same circuit used by the DC line interface.

This is to provide a better dynamic and lower line current operation.

##### III.5.2 - Transmit Gain Adjustment

The maximum transmit gain between Pin 21 (MIC+), Pin 20 (MIC-) and pin 20 (LN) is :

$$GTX = \frac{V_{LN}}{V_{MIC}} = 1.386 \times \frac{RGTX}{R11} \times \frac{ZLINE/ZSET}{R14}$$

where : ZSET = R12//R9//C4

and ZLINE is the line impedance between Tip and Ring of telephone line.

RGTX minimum value : 20kΩ (41.4dBat GTX max.)

RGTX maximum value : 82kΩ (53.6dBat GTX max.)

The Figures 12 and 13 shows the transmit gain as a function of line current ILN and transmit gain as a function of RGTX.

##### III.5.3 - Transmit Response Curve

The overall telephone set transmit gain and the response curve depend on the type of microphone used.

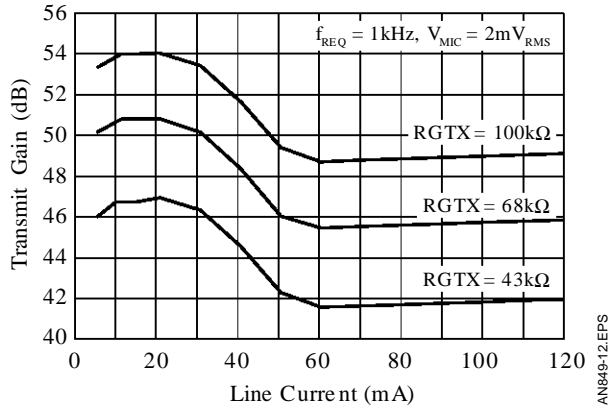
C10, C11, C12, R13, RGTX, CGTX, R20 and R21 are used to fix these parameters whenever a electret microphone is used. RGTX is used to fix the internal transmit gain.

C11, C12, R13 are used to fix the slope for low frequency.

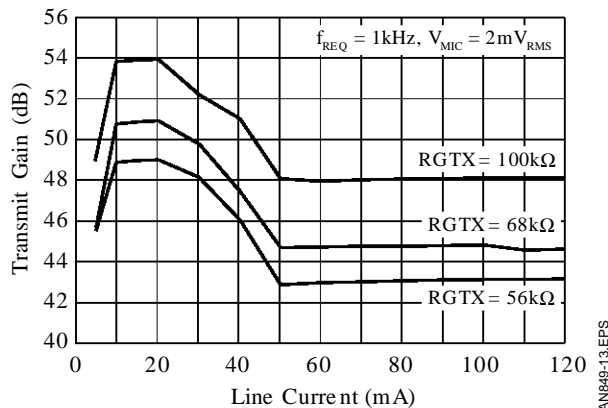
C10 and CGTX are used to fix the high frequency rolloff. R20 and R21 are used to fix the gain of the microphone.

## III - FUNCTIONAL DESCRIPTION (continued)

**Figure 12 :** Transmit Gain versus Line Current of L3914A/16A



**Figure 13 :** Transmit Gain versus Line Current of ST3917A/B



### III.6 - DTMF Gain Adjustment and Confidence Tone

The absolute value of the DTMF gain is modified through the new RDTMF, CDTMF connected on Pin 22 (GDTMF) and the resistor RGTX.

The GDTMF input impedance is equal to 40kΩ.

- DTMF level (VDTMF) at Pin 22 (see Figure 14) is given by :

$$VDTMF = GDF \cdot VDF$$

$$\text{where : } GDF = 0.09 \cdot \frac{RDTMF // CDTMF // 40k\Omega}{R11}$$

and VDF is the DTMF level of approximately 150mV<sub>RMS</sub> generated internally.

- The gain of DTMF at pin 17 (LN) with respect to Pin 22 (GDTMF) is :

$$GDTMF = \frac{V_{17}}{V_{22}}$$

$$GDTMF = 0.347 \cdot \frac{RGTX}{R11} \cdot \frac{ZSET // ZLINE}{R14}$$

- Confidence tone level available to earphone (see Figure 14).

During DTMF dialing, the internal muting control will disable the speech circuit. The DTMF signal will pass through the pre-amplifier to the earphone.

This acts as a feedback signal to the user.

The confidence tone attenuation between Pin 10 (RXOUT) and pin 22 (GDTMF) can be obtained as follows :

$$CRDTMF = \frac{V_{10}}{V_{22}} \Rightarrow CRDTMF = 0.095 \cdot \frac{RGRX}{R11}$$

where RGRX and R11 are in kΩ.

The confidence tone level between Pin 10 (RXOUT) and pin 17 (LN) is obtained as follows :

$$CDTMF = \frac{V_{10}}{V_{17}} = \frac{V_{10}}{V_{22}} \cdot \frac{V_{22}}{V_{17}} \Rightarrow CDTMF = \frac{CRDTMF}{GDTMF}$$

- Components setting of DTMF transmit level and confidence tone.

Higher DTMF gain can be adjusted with higher value of RDTMF at pin 22. But RDTMF should not be larger than 7kΩ because this will affect the AGC decoupling at speech mode.

If RDTMF is set, CDTMF should be selected such that the cutoff frequency for DTMF filtering is about 4kHz.

$$f_{CUTOFF} = \frac{1}{2\pi CDTMF \times RDTMF}$$

A higher confidence tone level can be achieved by connecting a resistor and capacitor (20kΩ + 100nF) between Pin 22 (GDTMF) and Pin 11 (GRX), refer to Figure 14. However, we need to re-adjust the DTMF network, RDTMF and CDTMF, to achieve the proper level if the extra network is connected.

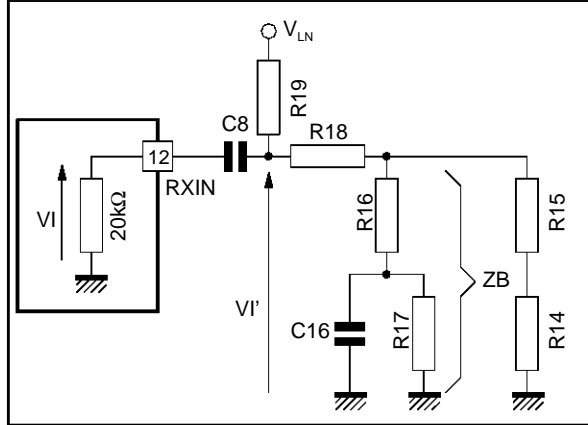


## III - FUNCTIONAL DESCRIPTION (continued)

### III.7.2 - Receive Gain Adjustment

The equivalent circuit of the first stage of the receive amplifier can be simplified as shown in Figure 16.

**Figure 16 :** Equivalent Circuit of First Stage of Receive Amplifier



The gain of the first stage of the receive amplifier can be obtained as follows :

$$VI' = V_{LN} \cdot \frac{R18 + ZB // (R15 + R14)}{R19 + [R18 + ZB // (R15 + R14)]} \quad (1)$$

$$\text{and } VI = VI' \cdot \frac{20k\Omega}{\frac{1}{j\omega C8} + 20k\Omega} \quad (2)$$

Substituting equation (1) into (2), we can obtain the first stage of receive gain, GRX1 :

$$GRX1 = \frac{VI}{V_{LN}}$$

$$GRX1 = \frac{R18 + ZB // (R15 + R14)}{R19 + [R18 + ZB // (R15 + R14)]} \cdot \frac{20k\Omega}{\frac{1}{j\omega C8} + 20k\Omega}$$

The absolute value of the receive gain is modified through the resistor RGRX connected between Pin 11 (GRX) and Pin 10 (RXOUT).

The maximum receive gain, GRX2 between Pin 12 (RXIN) and Pin 10 (RXOUT) can be obtained as follows :

$$GRX2 = \frac{V_{OUT}}{V_I} = 1.386 \times \frac{RGRX}{R11}$$

where RGRX and R11 are in kΩ.

and the gain, GRX between Pin 17 (LN) and Pin 10 (RXOUT) is :

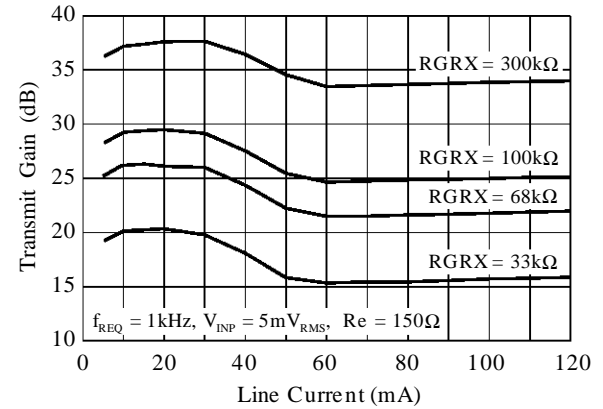
$$GRX = \frac{V_{OUT}}{V_{LN}} = GRX1 \times GRX2$$

where GRX should take in account the attenuation due to the sidetone network interface, the decoupling capacitor, C8 connected on Pin 12 (RXIN) and the 20kΩ input impedance of Pin 12 (RXIN) (see Figure 16).

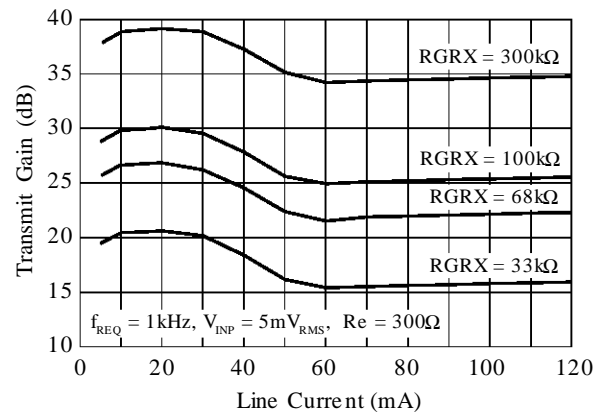
RGRX minimum value : 33kΩ (21.4dBat GRX max.)  
RGRX maximum value : 330kΩ (41.4dBat GRX max.)

Figures 17 and 18 show the effect of L3914A/16A receive gain as a function of line current, I<sub>LN</sub> and as a function of RGRX.

**Figure 17 :** L3914A/16A Receive Gain versus Line Current at Re = 150Ω



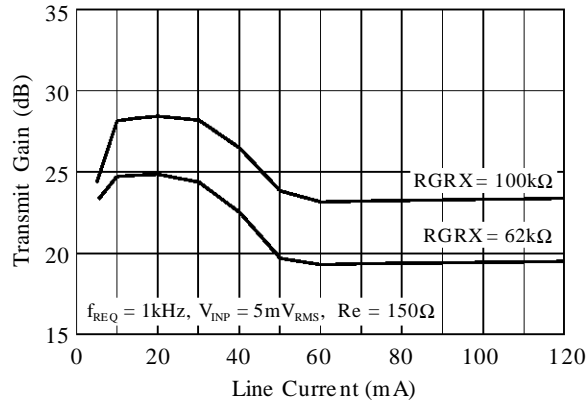
**Figure 18 :** L3914A/16A Receive Gain versus Line Current at Re = 300Ω



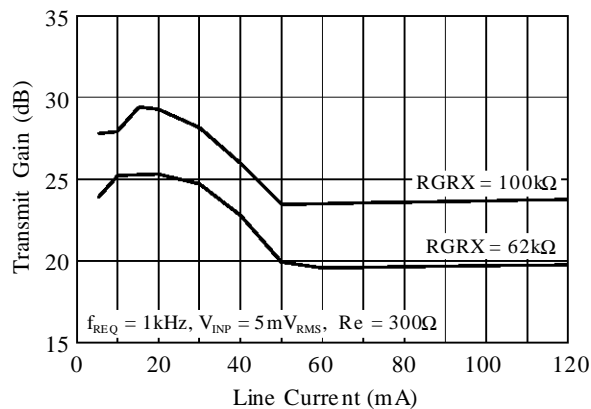
### III - FUNCTIONAL DESCRIPTION (continued)

Figures 19 and 20 show the effect of ST3917A/B receive gain as a function of line current,  $I_{LN}$  and as a function of RGRX.

**Figure 19 :** ST3917A/B Receive Gain versus Line Current at  $R_e = 150\Omega$



**Figure 20 :** ST3917A/B Receive Gain versus Line Current at  $R_e = 300\Omega$



#### III.7.3 - Receive Response Curve

If it is necessary to compensate the response curve of the transducer, it is possible to put a capacitor in parallel with RGRX or to adjust C6 and C8 values.

#### III.8 - Pacifier Tone

The Figure 21 shows the pacifier tone and mode detection circuit during pulse mode.

The mode detection circuit is to detect the Tone/Pulse mode at off-hook.

The pacifier tone circuit is to provide audible tone from dialler's circuit through the internal MOS switch and resistor RP to the earphone to indicate valid key press during pulse dialling and non-DTMF key press in Tone mode.

There have 2 solutions to achieve higher pacifier tone :

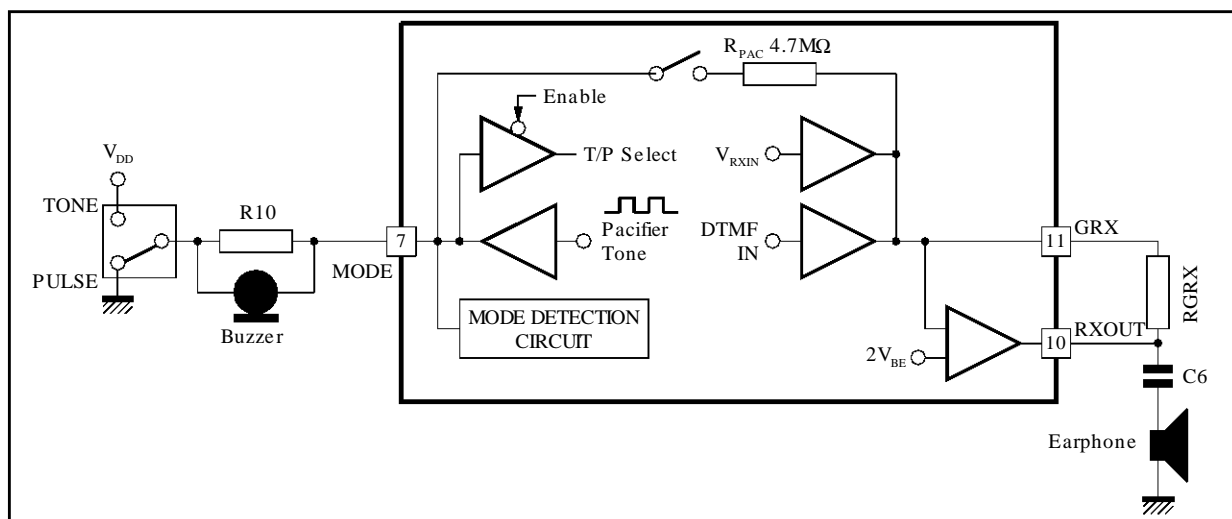
- Put a resistor RP across Pin 7 (MODE) and Pin 11 (GRX) as mentioned in data sheet, @  $I_L = 15mA$ ,  $RP = \infty$  ; typical level is  $60mV_{RMS}$   
 $RP = 430k\Omega$  ; typical level is  $600mV_{RMS}$
- Add external component at Pin 7 (MODE) as shown in Figures 22 and 23.

Because the output impedance at Pin 10 (RXOUT) is  $35\Omega$ , it is recommended that a series resistor (R) should be added to Pin 10 to avoid the loading effect to pacifier tone generated at Pin 7 (MODE). However, this will cause a 6dB loss at receiving.

Nominal value of earphone is about  $150\Omega$ , so R works as a potential divider in order to decide the tone level available at earphone.

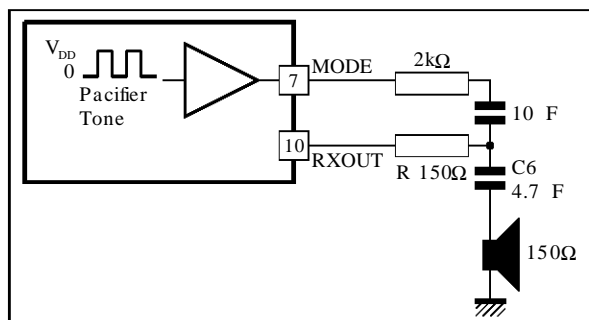
With a typical  $V_{DD} = 3V$ , the pacifier tone level at earphone will be about  $110mV_{PP}$ .

**Figure 21 :** Block Diagram of Pacifier Tone Generator

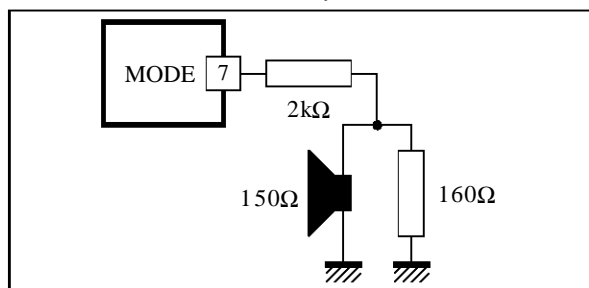


## III - FUNCTIONAL DESCRIPTION (continued)

**Figure 22 :** Connection of RC Network between



**Figure 23 :** Connection of a resistor between Pin 7 and earphone



### III.9 - AGC Control for Line Loss Compensation

The AGC control block regulates the current that must be sent to the transmit and receive preamplifiers which in turn adjust the gain of the amplifier according to the line length.

The AGC function is implemented internally in the device.

The AGC range is fixed with a gain control ranging from 0 to 6dB.

For :

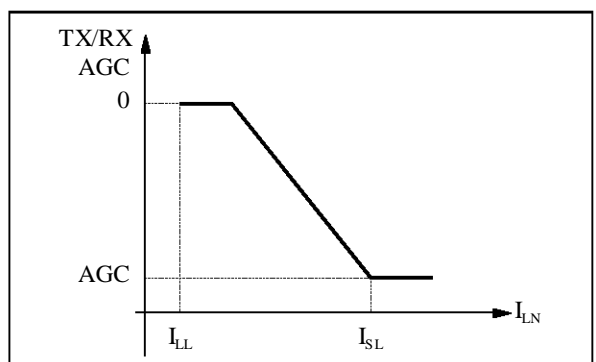
$I_L \leq 20\text{mA}$ , AGC = 0dB

$I_L \geq 60\text{mA}$ , AGC = -5dB (L3914A/16A)

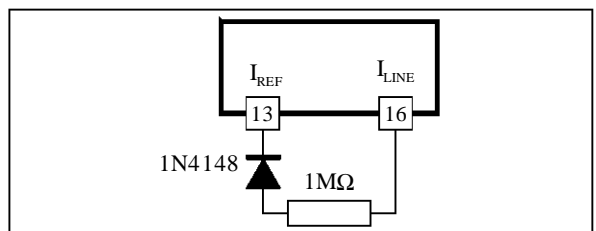
$I_L \geq 60\text{mA}$ , AGC = -6dB (ST3917A/B)

To achieve a higher AGC, connect a diode and a resistor between Pin 13 ( $I_{REF}$ ) and Pin 16 ( $I_{LINE}$ ). (see Figure 25).

**Figure 24**



**Figure 25**





#### **IV - DIALLER**

The common features available are :

- 32 digits for Last Number Redial
- Provide Tone/Pulse switchable dialling
- Pacifier tone for audible indication of valid key pressed in a Buzzer or/and in the Earphone
- Timed PABX Pause
- Flash initiates Time Break
- Continuous tone for each digit until key release

##### **L3914A/16A**

The L3914A/16A provide manual dialling of an infinite number of digits, but if more than 32 digits are dialled, it would wrap around in the LNR.

Other features include :

- Three 18 digits one-touch memories for emergency redial and ten 18 digits two-touch memories.
- HOLD function for parallel phone with 400ms validation timer to prevent false release (L3914A).
- Lighted dialled LED which consume 25% of total line current (L3916A).

##### **ST3917A/B**

- Last number redial inhibition for dialling of greater than 32 digits.
- Cascading Last number redial.
- Make/Break ratio : 40/60(ST3917A) and 33/67(ST3917B).
- 4 selectable options on Flash duration, softswitch inhibition in one of the option with 100ms Flash timing.
- 2 selectable options : Transmit mute/LED keyboard illumination or LED indicator for tone mode indicator.

The timing diagram for Tone and Pulse mode dialling for L3914A/16A and ST3917A/B are shown in the Figures 26, 27, 28, 29, 30 and 31.

#### **IV.1 - Make/break Ratio Adjustment**

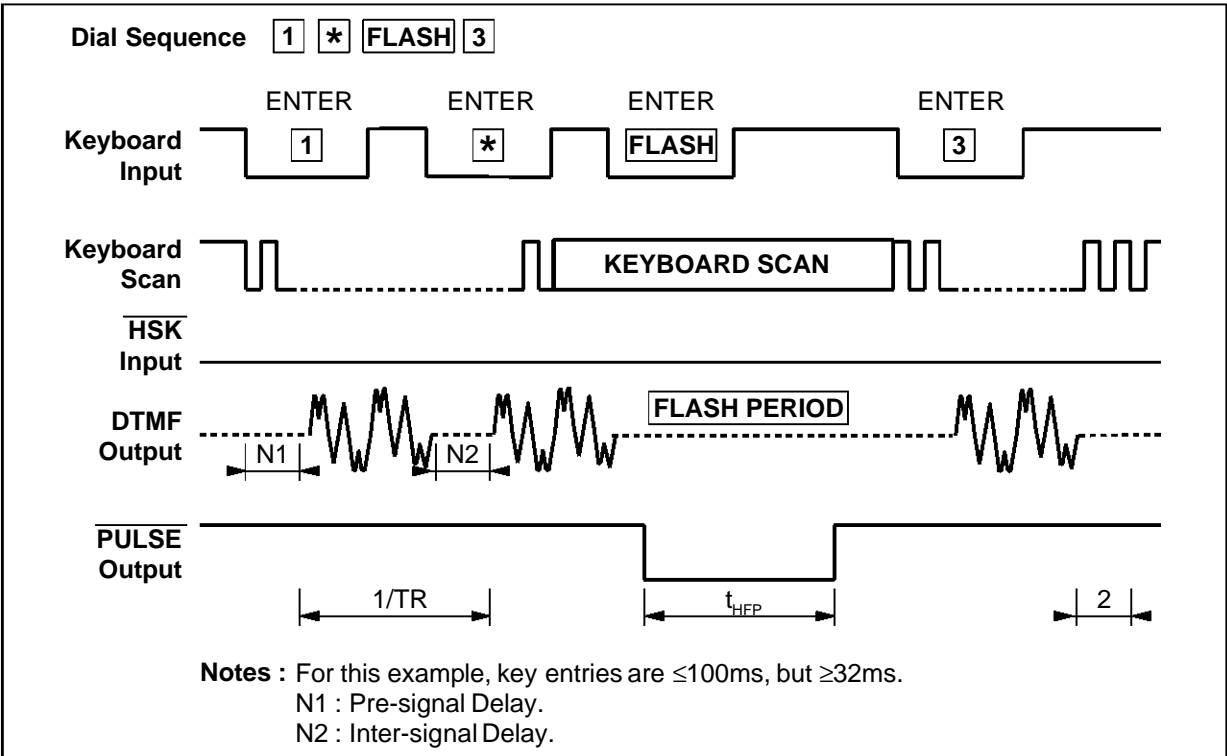
By adding a capacitor  $C_p$  on the pulse output (Pin 6) and the  $R_p$  between the base of Q2 and the LN input (Pin 17) of L3914A/16A, the make/break ratio can be changed from 40/60 to 33/67.

Refer to the typical application circuit in Appendix A of Section VIII.1.

IV - DIALLER (continued)

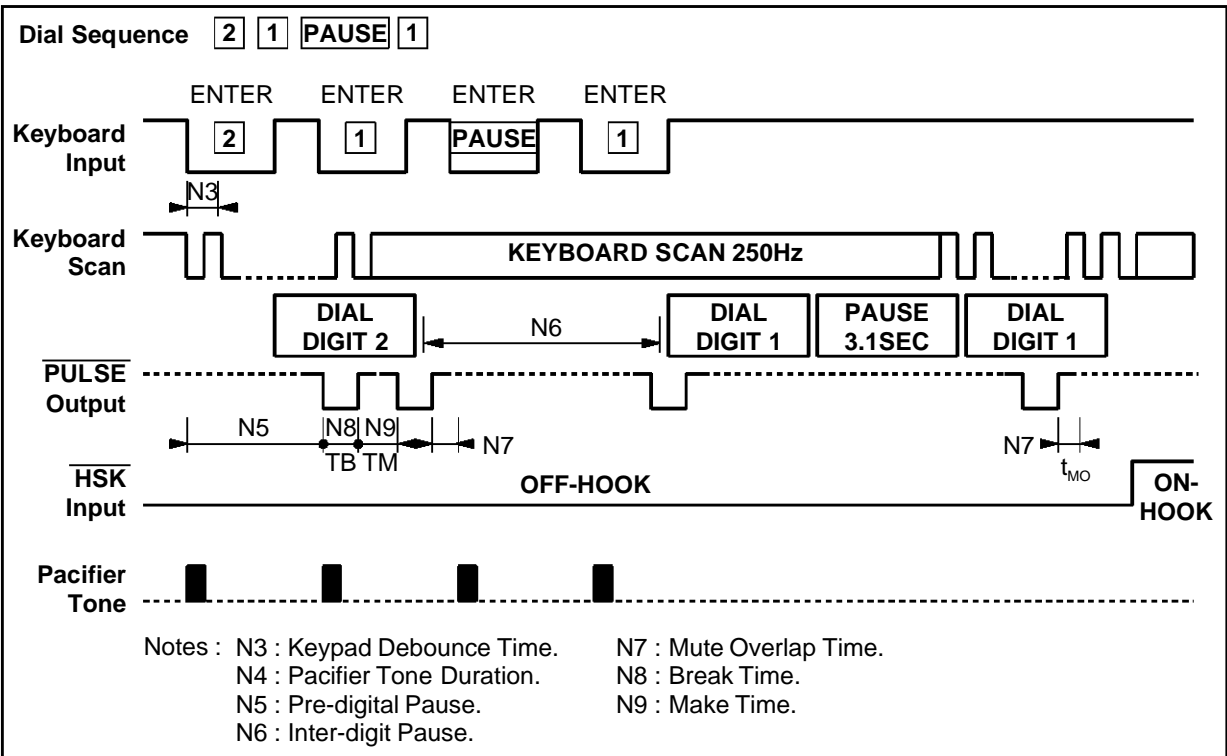
IV.2 - Timing Diagram for L3914A/16A

Figure 26 : Tone Mode Timing



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Figure 27 : Pulse Mode Timing

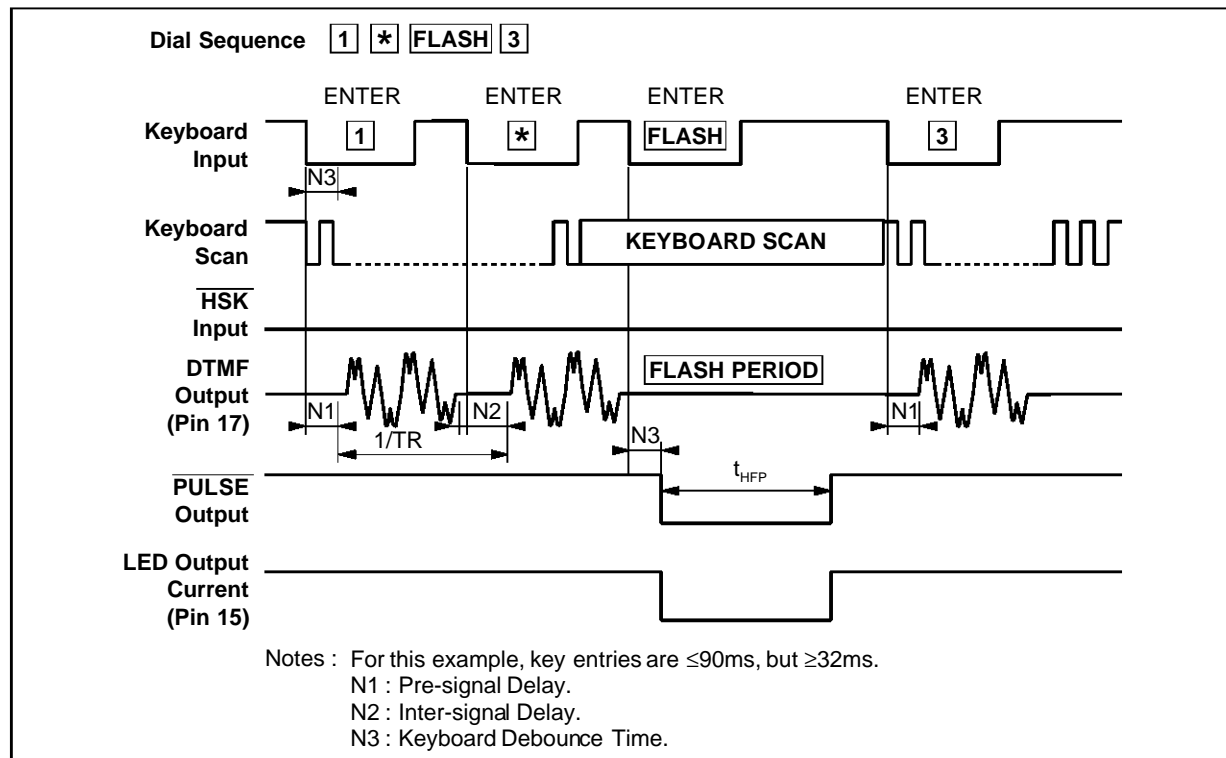


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IV - DIALLER (continued)

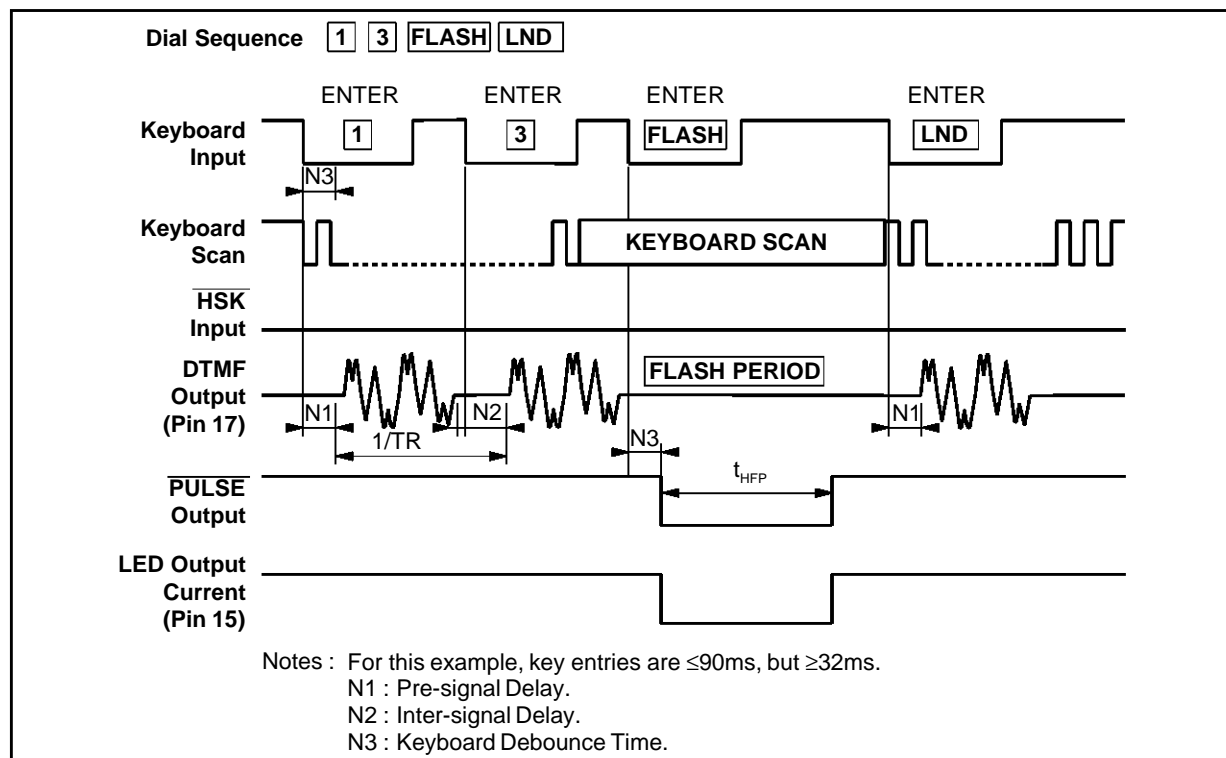
IV.3 - Timing Diagram for ST3917A/B

Figure 28 : Tone Mode Timing with Lighted Dial LED (Pin 24 to V<sub>DD</sub> or GND)



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Figure 29 : Tone Mode Timing with Tone Indicator (pin 24 to any row)

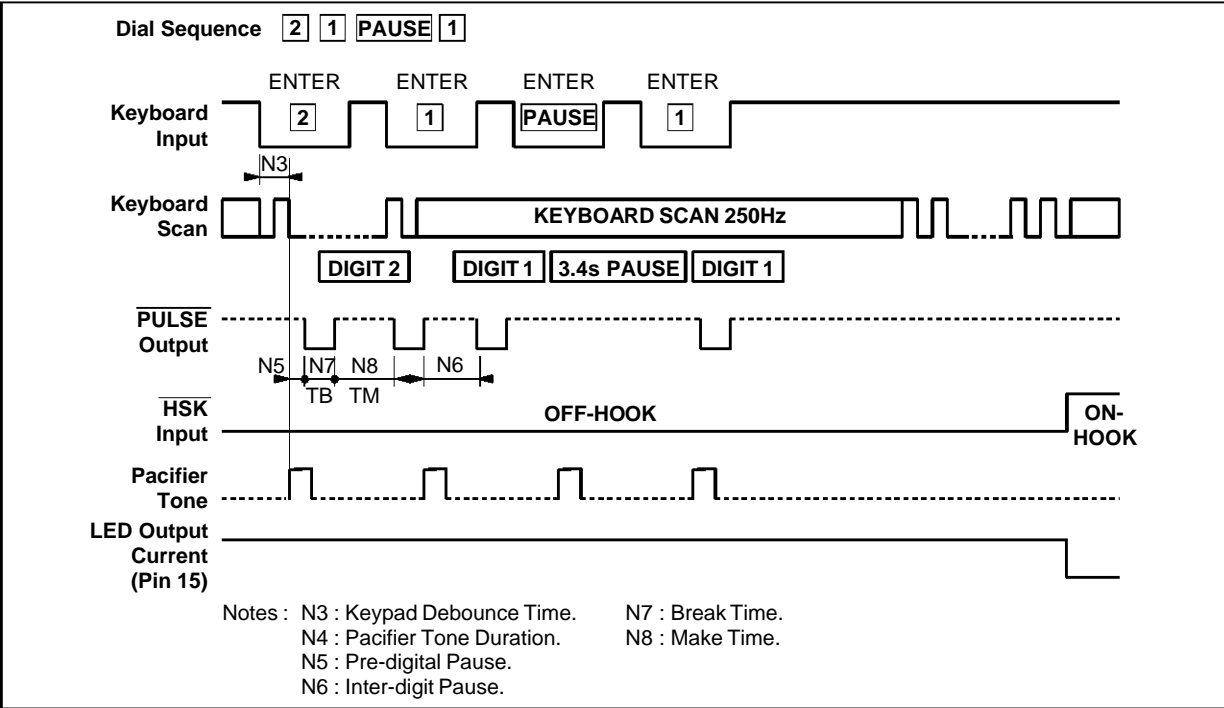


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IV - DIALLER (continued)

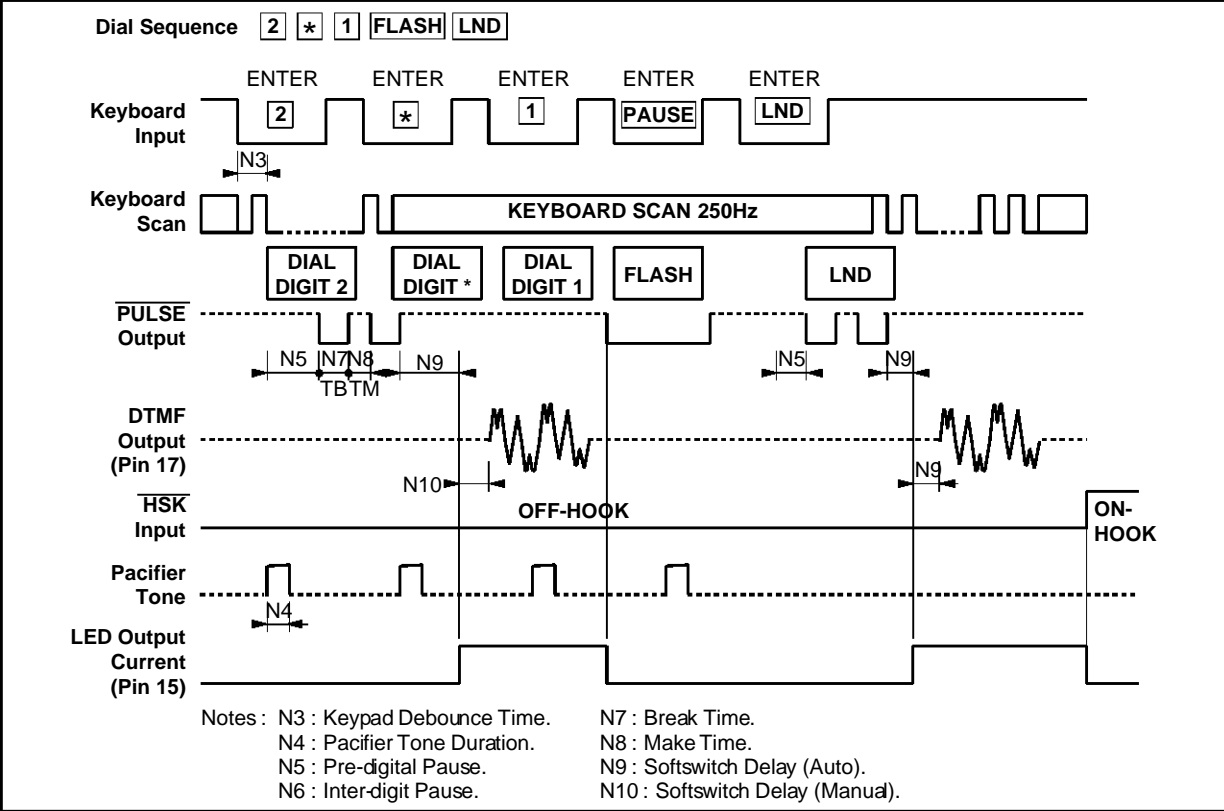
IV.3 - Timing Diagram for ST3917A/B (continued)

Figure 30 : Pulse Mode Timing with Lighted Dial LED (Pin 24 to V<sub>DD</sub> or GND)



AN849-30.EPS

Figure 31 : Pulse Mode Timing with Tone Indicator using "\*" or "TONE" Key



AN849-31.EPS

#### IV - DIALLER (continued)

#### IV.4 - Functional Tests Procedure for L3914A/16A

##### IV.4.1 - Programming and Repertory Dialing

Procedure	Sequence			Data in E1	TIP/RING Output
	Hook	Dial	Keypress		
Step 1	OFF	PROG	1, 2, 3, E1	1, 2, 3	
Step 2	ON			1, 2, 3	
Step 3	OFF		E1	1, 2, 3	1, 2, 3

##### IV.4.2 - Pause/Last Number Redialed

Procedure	Sequence			Data in E1	TIP/RING Output
	Hook	Dial	Keypress		
Step 1	OFF	1, 2, 3 .. 0		1, 2, 3 .. 0	1, 2, 3 .. 0
Step 2	ON			1, 2, 3 .. 0	
Step 3	OFF		LNR	1, 2, 3 .. 0	1, 2, 3 .. 0
Step 4	ON			1, 2, 3 .. 0	
Step 5	OFF	1, PSE, 2		1, PSE, 2	
Step 6	ON			1, PSE, 2	
Step 7	OFF		LNR	1, PSE, 2	1, PSE, 2

**Note:** PSE key would provide a 3.1s (Tone) or 3.4s (Pulse) delay into the dialling sequences.

##### IV.4.3 - 32 Digits Buffer for LNR

Procedure	Sequence			Data in E1	TIP/RING Output
	Hook	Dial	Keypress		
Step 1	OFF	32 Digits		32 Digits	32 Digits
Step 2	ON			32 Digits	
Step 3	OFF		LNR	32 Digits	32 Digits

#### IV.5 - Functional Tests Procedure for ST3917A/B

##### IV.5.1 - Cascading Last Number Redialed

Procedure	Sequence			Data in E1	TIP/RING Output
	Hook	Dial	Keypress		
Step 1	OFF	1, 2, 3 .. 0		1, 2, 3 .. 0	1, 2, 3 .. 0
Step 2	ON			1, 2, 3 .. 0	
Step 3	OFF		LNR	1, 2, 3 .. 0	1, 2, 3 .. 0
Step 4	OFF	4, 5, 6		1, 2, 3 .. 0, 4, 5, 6	4, 5, 6
Step 5	ON			1, 2, 3 .. 0, 4, 5, 6	
Step 6	OFF		LNR	1, 2, 3 .. 0, 4, 5, 6	1, 2, 3 .. 0, 4, 5, 6

##### IV.5.2 - LNR Inhibition if more than 32 Digits are Stored

Procedure	Sequence			Data in E1	TIP/RING Output
	Hook	Dial	Keypress		
Step 1	OFF	32 Digits		32 Digits	32 Digits
Step 2	ON			32 Digits	
Step 3	OFF		LNR	32 Digits	32 Digits
Step 4	OFF	1, 2, 3			1, 2, 3
Step 5	ON				
Step 6	OFF		LNR		

## V - THE DIFFERENT FEATURE BETWEEN L3914A, L3916A & ST3917A/B

### V.1 - Auto-release Hold (only for L3914A)

The AUTO-RELEASE HOLD FUNCTION is completely integrated on the chip.

The line is seizing, when the HOLD key is pressed, L3914A maintains the telephone line closed, mutes the conversation and the ON-HOLD LED starts to blink. The LED continues blinking at the rate of 1Hz when the user hang up the phone and intended to take the call from another parallel telephone.

The telephone line current is then precisely measured and stored in digital mean inside the chip. By detecting the change in line current, L3914A automatically releases the telephone line as soon as the parallel phone is picked up for more than 400ms. It is controlled by an internal timer to prevent fault trigger caused by noise and to tolerate short line break signals (example : Call waiting signalling) sent by the main telephone exchange or PABX equipment during HOLD period.

This feature can also be used to mute the telephone conversation temporarily (without hanging the phone).

To resume the conversation, simply press the HOLD key again.

The threshold of parallel phone release is 4.5mA +5% of line current.

### V.2 - Transmit Mute Function and Tone Mode Dialling Indicator (only for ST3917A/B)

When Pin 24 (MU/MFI) is connected to GND, the transmit amplifier of the speech circuit is disabled and hence the speech transmitting path is muted. Under such mode, the LED is used as a lighted dial indicator as in L3916A. However, if Pin 24 (MU/MFI) is tied to any row of the dialler circuit, the LED functions as a Tone mode dialling indicator. In this case, there will be no mute function.

The LED for Tone mode dialling indicator is used in the following conditions :

- At Tone mode, LED will light up at off-hook. The LED will turn off only when the telephone goes on-hook.

Examples : Tone mode

- 1) Off-hook (LED turns on)  $\Rightarrow$  <Tone> D1, D2, D3  $\Rightarrow$  On-hook (LED turns off)
- 2) Off-hook (LED turns on)  $\Rightarrow$  <Tone>LND  $\Rightarrow$  On-hook (LED turns off)

- At Pulse mode after off-hook, LED is off during pulse dialling. When dialling is followed by the "\*" or "TONE" softswitch key depressed, the LED will light up immediately at the softswitch after pulse dialling is completed to indicate the signalling mode change from pulse to tone.

After returning to on-hook and back to off-hook, the device will be in pulse mode and then LED is turned off. Redialling from LND memory buffer will repeat the softswitch, i.e. mixed mode redialling, the LED will light up to indicate the switch to tone mode or tone dialling. The LED will turn off only when the telephone goes on-hook or is resetted by the Flash key.

Examples : Pulse mode

- 1) Off-hook (LED is off)  $\Rightarrow$  <Pulse>D1, D2 (LED remains off), \*<Tone> (LED turns on), D3, D4  $\Rightarrow$  On-hook or Flash (LED turns off)
- 2) Off-hook (LED is off)  $\Rightarrow$  <Pulse>LND  $\Rightarrow$  <Pulse>D1, D2 (LED remains off), <Tone>(LED turns on) D3, D4  $\Rightarrow$  On-hook or Flash (LED turns off)

- At pulse mode, after off-hook, LED is off during pulse dialling. When switching the Tone/Pulse mechanical switch to Tone mode, LED will turn on.

Example : Pulse mode

- 1) Off-hook (LED is off)  $\Rightarrow$  <Pulse>D1, D2  $\Rightarrow$  Switch "Tone/Pulse" mechanical switch to Tone mode (LED turns on)  $\Rightarrow$  <Tone>D3, D4  $\Rightarrow$  On-hook (LED turns off)

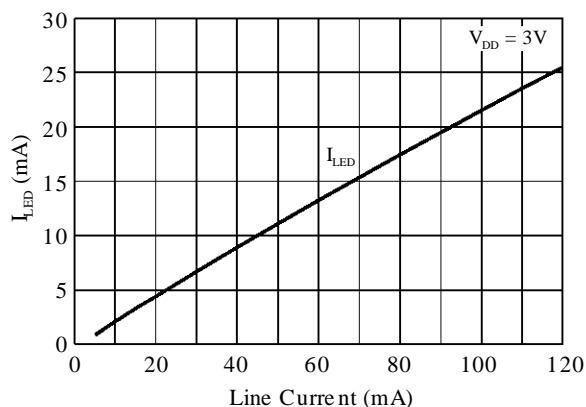
The function of the LED for Tone mode indicator is described in the timing waveform in Section IV.3.

For line current up to 20mA, the  $I_{LN-I_{CC}}$  is sourced into the LED with a maximum current limit of 19mA. For line current greater than 20mA, this sourced current is limited at 20mA(typical).

### V.3 - Lighted Dialling Led (only for L3916A)

The indication is activated in off-hook mode, consuming 25% of the line current flows into the LED. If the LED is not connected, the Pin 15 (LED) should be connected to Pin 17 (LN).

**Figure 32 :** Lighted Dial LED Current versus Line Current

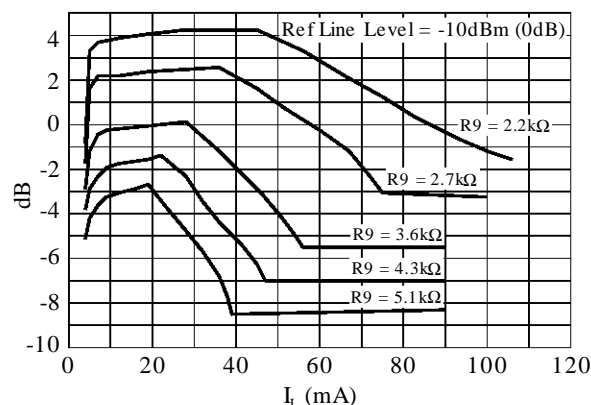


## VI - PINS DESCRIPTION

### I.1 - Pins Description for L3914A/16A

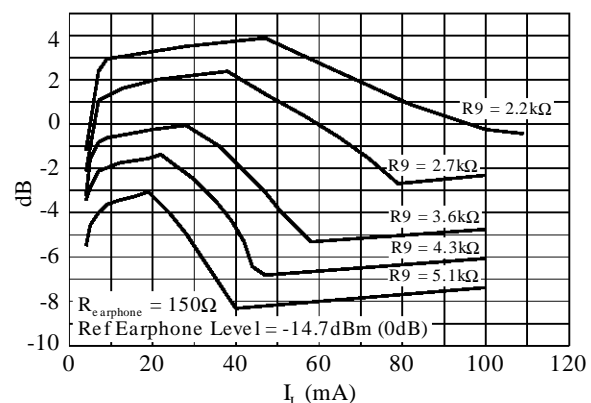
- Pin 1 *Column 1 of keypad*  
 Pin 2 *Column 2 of keypad*  
 Pin 3 *Column 3 of keypad*  
 Pin 4 *Column 4 of keypad*  
 Pin 5 *OSCILLATOR PIN*  
 Ceramic resonator = 3.579545MHz.  
 Pin 6 *PULSE OUTPUT*  
 This pin drives the line break transistors in order to send Break/Make pulses in loop disconnect mode.  
 The number of pulses depends on the key depressed.  
 Pin 7 *MODE/PACIFIER TONE*  
 This pin selects the TONE/PULSE mode and provide a Pacifier Tone during Pulse mode.  
 A logic '1' selects the Tone mode.  
 A logic '0' selects the Pulse mode.  
 Pin 8 *HKS/HOOKSWITCH*  
 This pin is connected to the Hookswitch. This pin detects the ON and OFF Hook condition.  
 Pin 9 *GND/GROUND*  
 This is the ground pin for the device. All voltages are referenced to this pin.  
 Pin 10 *RXOUT/RECEIVE OUT*  
 Earphone output  
 Output impedance : 35Ω  
 Pin 11 *GRX/RECEIVE GAIN ADJUST*  
 Pin 12 *RXIN/RECEIVE IN*  
 Input impedance = 20kΩ  
 Pin 13 *I<sub>REF</sub>*  
 A 3.6kΩ resistor, R11 is connected to set the internal current level. The line currents where the AGC turns on and off points can be modified by changing the value of R11. Refer to Figures 33 and 34 for the transmit and receive AGC curves versus R11 respectively.  
 Pin 14 *V<sub>CC</sub>/SPEECH CIRCUIT SUPPLY*  
 Supply for the speech circuit. A 100μF capacitor is connected to this pin to provide DC decoupling.  
 Recommended value is 100μF/16V. Too large capacitor would have longer turn on time (see Figure 35).  
 Pin 15 *LED INPUT PIN*  
 A LED is connected for OFF-HOOK INDICATION. This current in the LED is equal to 25% of the line current.

**Figure 33 :** Transmit AGC versus R11 of L3914A/16A



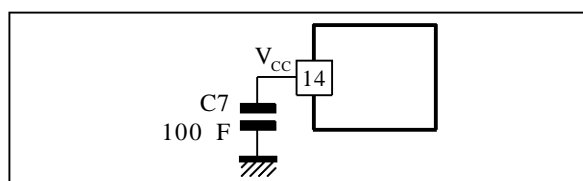
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**Figure 34 :** Receive AGC versus R11 of L3914A/16A



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**Figure 35**



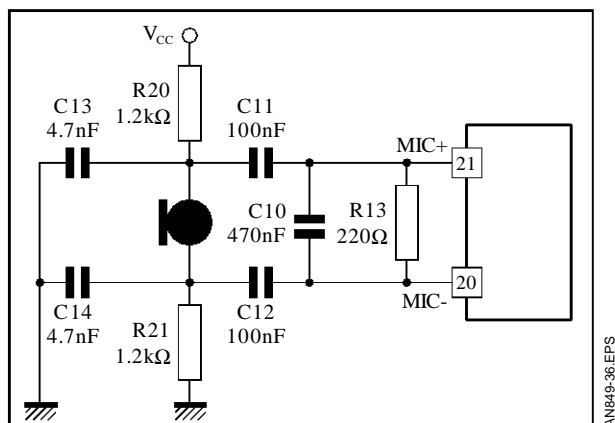
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- Pin 16 *I<sub>LINE</sub>*  
 A 20Ω resistor is connected to set the DC slope.  
 Pin 17 *LN/POSITIVE LINE TERMINAL*  
 Positive line terminal of the device. The transmit and DTMF signal are sent to the line through this pin.  
 Pin 18 *REG*  
 The capacitor C15 connected to this pin regulates the LN voltage and gives a high AC impedance for the transmit output stage.

## VI - PINS DESCRIPTION (continued)

- Pin 19 **GTKX/TRANSMIT GAIN ADJUSTMENT**  
The RGTKX resistor connected to this pin adjusts the transmit gain between 43.5dB and 51.5dB.
- Pin 20 **MIC- MICROPHONE INPUT INVERTING**
- Pin 21 **MIC+ MICROPHONE INPUT NON-INVERTING**  
The microphone has an input impedance of 64kΩ differential input and 32kΩ for asymmetrical input.  
R20 and R21 are microphone bias resistors.  
C10, C11, C12 and R13 adjust the gain and the bandwidth to be compatible with the IC's gain. C13 and C14 are used for RFI suppression.

Figure 36



- Pin 22 **GDTMF/DTMF GAIN ADJUSTMENT**  
RDTMF and CDTMF fix the DTMF level on line and the cutoff frequency for DTMF filter. The value of CDTMF and RDTMF are chosen such that :  
$$\frac{1}{2\pi RDTMF \times CDTMF} = 4\text{kHz}$$
where 4kHz is the low pass frequency for the DTMF signal.
- Pin 23 **VDD DIALLER POSITIVE SUPPLY**  
Supply for the dialling circuit. It is supplied from Vcc via a diode. The Zener diode D6 protects the dialling circuit in on-hook mode. The capacitor C5 and the resistor R5 are required for memory retention during on-hook.
- Pin 24 **Row 5 of keypad**
- Pin 25 **Row 4 of keypad**
- Pin 26 **Row 3 of keypad**
- Pin 27 **Row 2 of keypad**
- Pin 28 **Row 1 of keypad**

## VI.2 - Pins Description for ST3917A/B

- Pin 1 **Column 1 of keypad**
- Pin 2 **Column 2 of keypad**
- Pin 3 **Column 3 of keypad**
- Pin 4 **OPTIONSELECT FOR FLASH DURATION**  
This pin is used to select various Flash durations by connecting it either to a row, column, VDD or GND. The four options are summarized as follow :

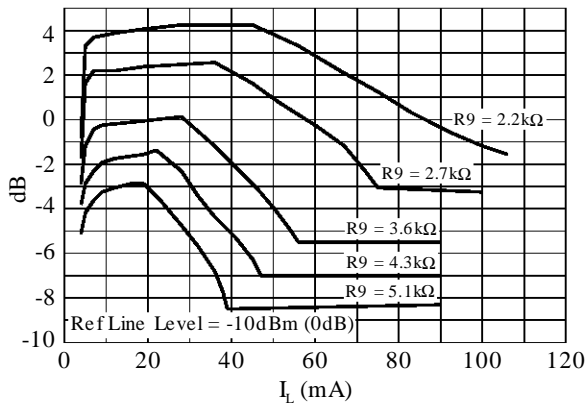
Options	SEL	Flash (ms)	Softswitch
1	VDD	100	Inhibited
2	GND	600	Enabled
3	Row	300	Enabled
4	Column	100	Enabled

- Pin 5 **OSCILLATOR PIN**  
Ceramic resonator = 3.579545MHz
- Pin 6 **PULSE OUTPUT**  
This pin drives the line break transistors in order to send Break/Make pulses in loop disconnect mode.  
The number of pulses depends on the key depressed.
- Pin 7 **MODE/PACIFIER TONE**  
This pin selects the TONE/PULSE mode and provide a Pacifier Tone during Pulse mode.  
A logic '1' selects the Tone mode.  
A logic '0' selects the Pulse mode.
- Pin 8 **HKS/HOOKSWITCH**  
This pin is connected to the hookswitch. This pin detects the on-hook and off-hook condition.
- Pin 9 **GND/GROUND**  
This is the ground pin for the device. All voltages are referenced to this pin.
- Pin 10 **RXOUT/RECEIVE OUT**  
Earphone output. Output impedance is 35Ω.
- Pin 11 **GRX/RECEIVE GAIN ADJUST**  
The RGRX resistor connected to this pin adjusts the receive gain between 21dB and 41dB.
- Pin 12 **RXIN/RECEIVE IN**  
Input impedance = 20kΩ
- Pin 13 **IREF**  
A 3.6kΩ resistor is connected to set the internal current level. The line currents where the AGC turns on and off points can be modified by changing the value of R11. Refer to Figures 37 and 38 for the transmit and receive AGC curves versus R11 respectively.

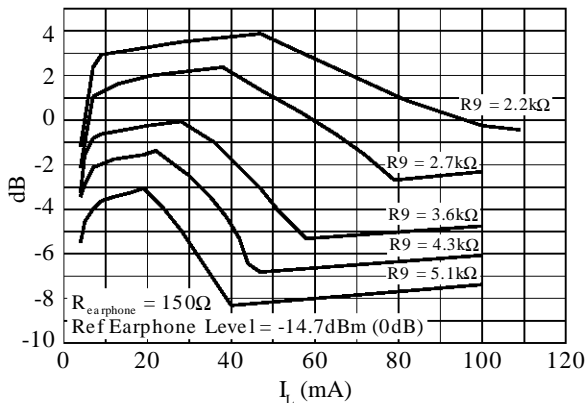


## VI - PINS DESCRIPTION (continued)

**Figure 37 : Transmit AGC versus R11**



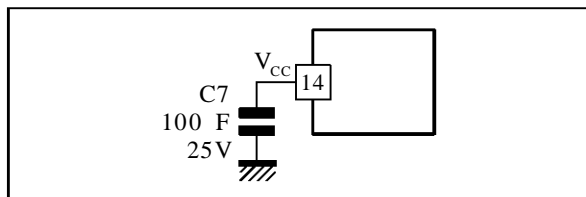
**Figure 38 : Receive AGC versus R1**



### Pin 14 *V<sub>CC</sub>/SPEECH CIRCUIT SUPPLY*

Supply for the speech circuit. A 100μF capacitor is connected to this pin to provide DC decoupling.  
Recommended value is 100μF/16V. Too large capacitor would have longer turn on time.

**Figure 39**



### Pin 15 *LED OUTPUT PIN*

When the MU/MFI pin is connected to either V<sub>DD</sub> or GND, the LED is used for keyboard illumination or off-hook indication. When the MU/MFI pin is connected to any row, it functions as a Tone mode indicator. For line current up to 20mA, the maximum LED current is 19mA. For line current more than 20mA, the LED current is 20mA (typical).

### Pin 16 *ILINE*

A 20Ω resistor is connected to set the DC slope.

### Pin 17 *LN/POSITIVE LINE TERMINAL*

Positive line terminal of the device. The transmit and DTMF signals are sent to the line through this pin.

### Pin 18 *REG*

The capacitor C15 connected to this pin regulates the LN voltage and gives a high AC impedance for the transmit output stage.

### Pin 19 *GTX/TRANSMIT GAIN ADJUSTMENT*

The RGTX resistor connected to this pin adjusts the transmit gain between 43.5dB and 51.5dB.

### Pin 20 *MIC- MICROPHONE INPUT INVERTING*

### Pin 21 *MIC+ MICROPHONE INPUT NON-INVERTING*

The microphone has an input impedance of 64kΩ differential input and 32kΩ for asymmetrical input.

### Pin 22 *GDTMF/DTMF GAIN ADJUSTMENT*

RDTMF and CDTMF fix the DTMF level on line and the cutoff frequency for DTMF filter. The value of CDTMF and RDTMF are chosen such that :

$$\frac{1}{2\pi RDTMF \times CDTMF} = 4\text{kHz}$$

where 4kHz is the low pass frequency for the DTMF signal.

### Pin 23 *V<sub>DD</sub> DIALER POSITIVE SUPPLY*

Supply for the dialling circuit. It is supplied from VCC via a diode. The zener diode D6 protects the dialling circuit in on-hook mode. The capacitor C5 and the resistor R5 are required for memory retention during on-hook.

### Pin 24 *TRANSMIT MUTE AND TONE INDICATOR SELECTION*

By connecting this pin to GND will disable the transmit amplifier of the speech circuit. By connecting this pin to any row will disable the transmit mute function and the Tone indicator mode is selected. The table below summarized the logic of MU/MFI functions :

MU/MFI	Transmit Muting	LED
Open	Active	Lighted Dial Indicator
GND	Muted	Lighted Dial Indicator
Row	Not Available	Tone Mode Indicator

### Pin 25 *Row 4 of keypad*

### Pin 26 *Row 3 of keypad*

### Pin 27 *Row 2 of keypad*

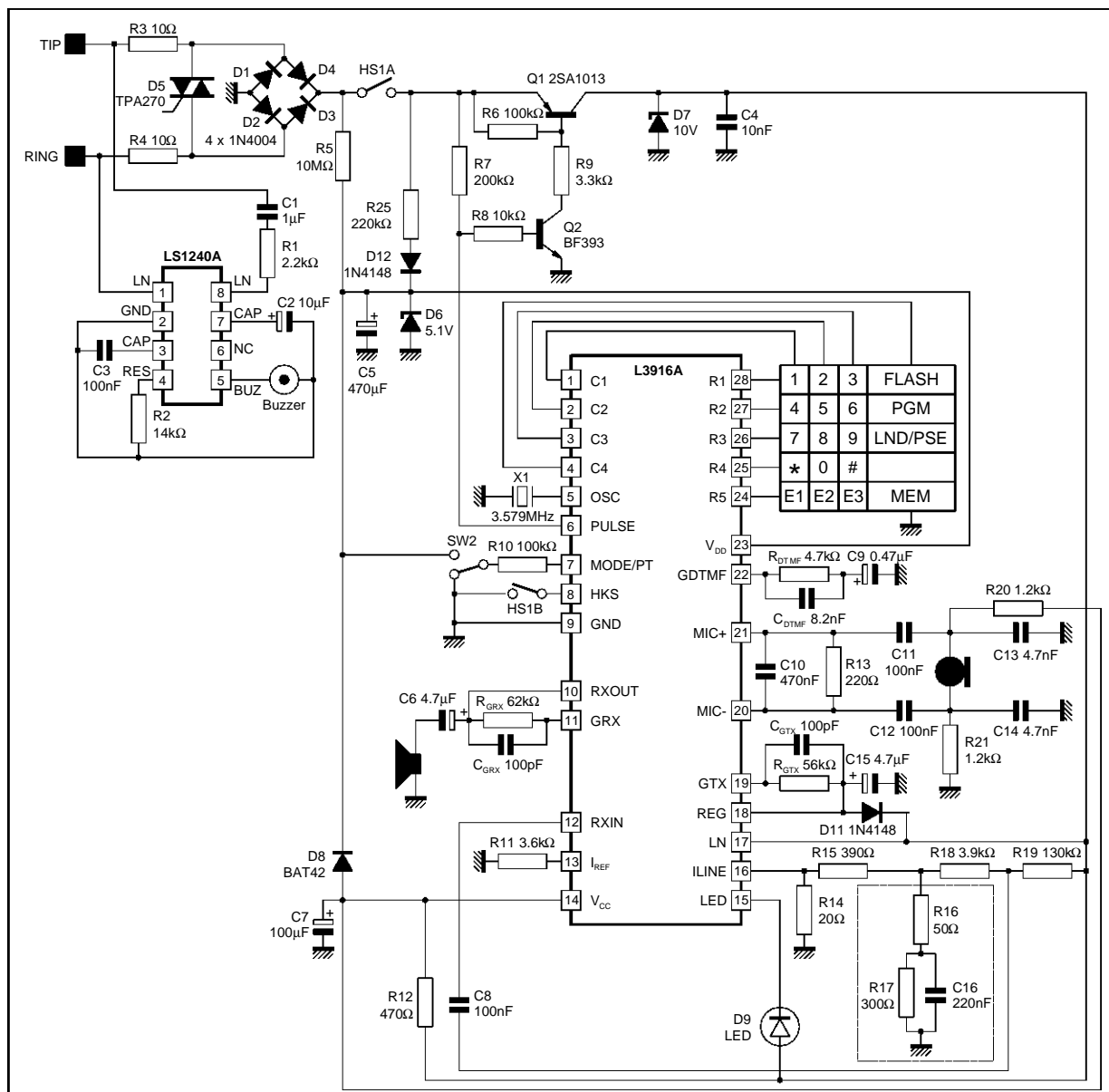
### Pin 28 *Row 1 of keypad*

## SPEECH AND DIALLER L3914A/16A AND ST3917A/B

### VII - APPLICATION FOR USA

#### VII.1 - Schematic Diagram

Figure 40 : Application Circuit for EIA Standard



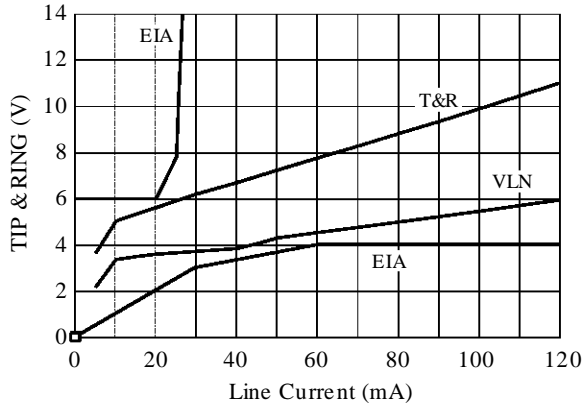
#### VII.2 - Brief Description

A complete telephone application circuit comprising only two chips, L3914A/16A (Speech and 14 memories dialler) or ST3917A (Speech and dialler with LNR only) and a ringer IC. The application circuit has been optimized for EIA-standard based on L3916A. All measurement results are enclosed as follows.

VII - APPLICATION FOR USA (continued)

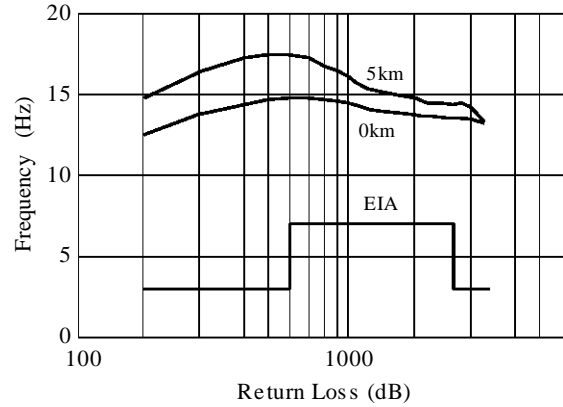
VII.3 - Measurements Results (L3916A)

Figure 41 : DC Characteristics



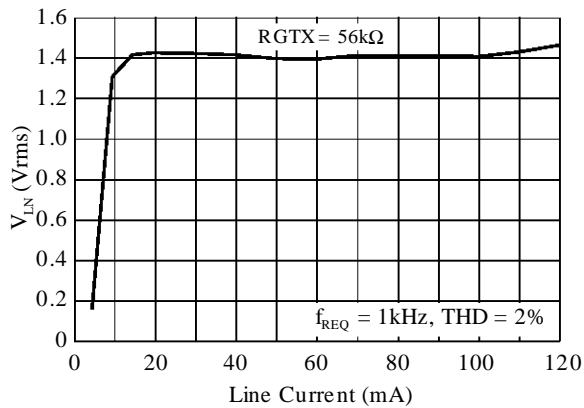
AN849-41.EPS

Figure 42 : Return Loss



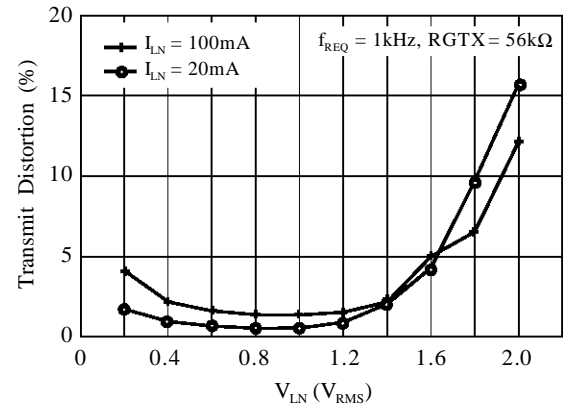
AN849-42.EPS

Figure 43 : Transmit Dynamic



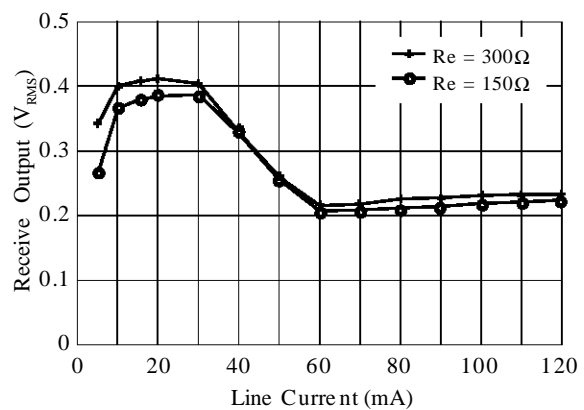
AN849-43.EPS

Figure 44 : Transmit Distortion



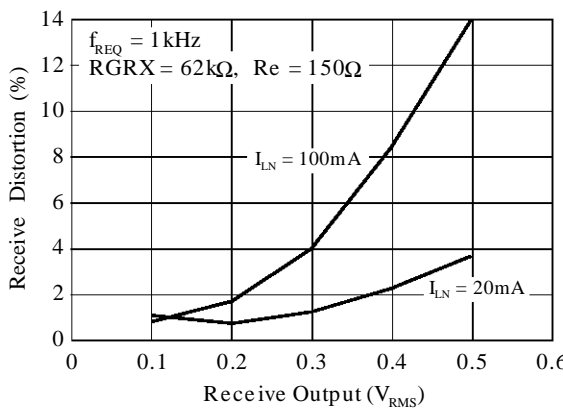
AN849-44.EPS

Figure 45 : Receive Dynamic



AN849-45.EPS

Figure 46 : Receive Distortion with  $Re = 150\Omega$



AN849-46.EPS

VII - APPLICATION FOR USA (continued)

VII.3 - Measurements Results (L3916A) (continued)

Figure 47 : Receive Distortion with Re = 300Ω

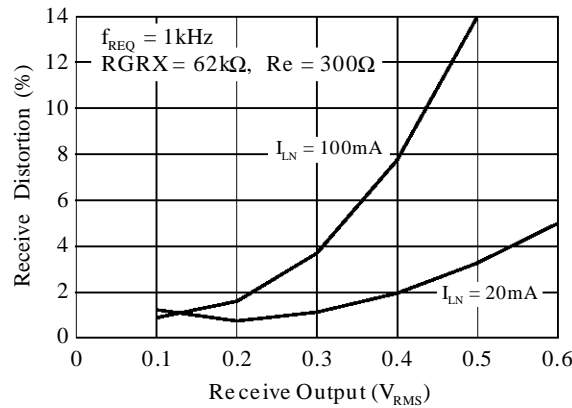


Figure 48 : DTMF Output Level

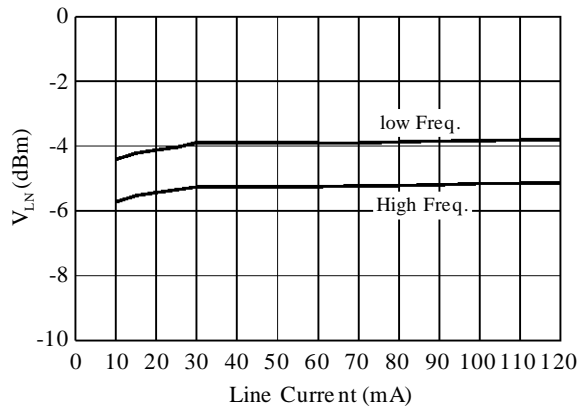
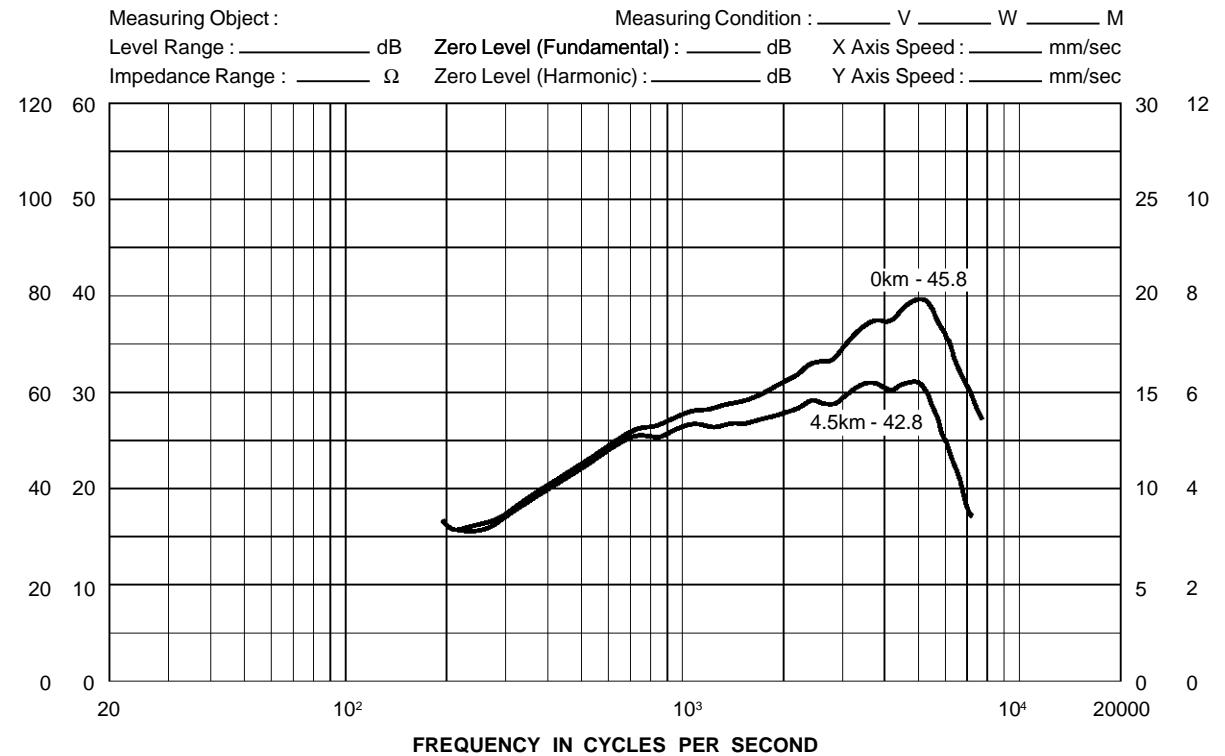


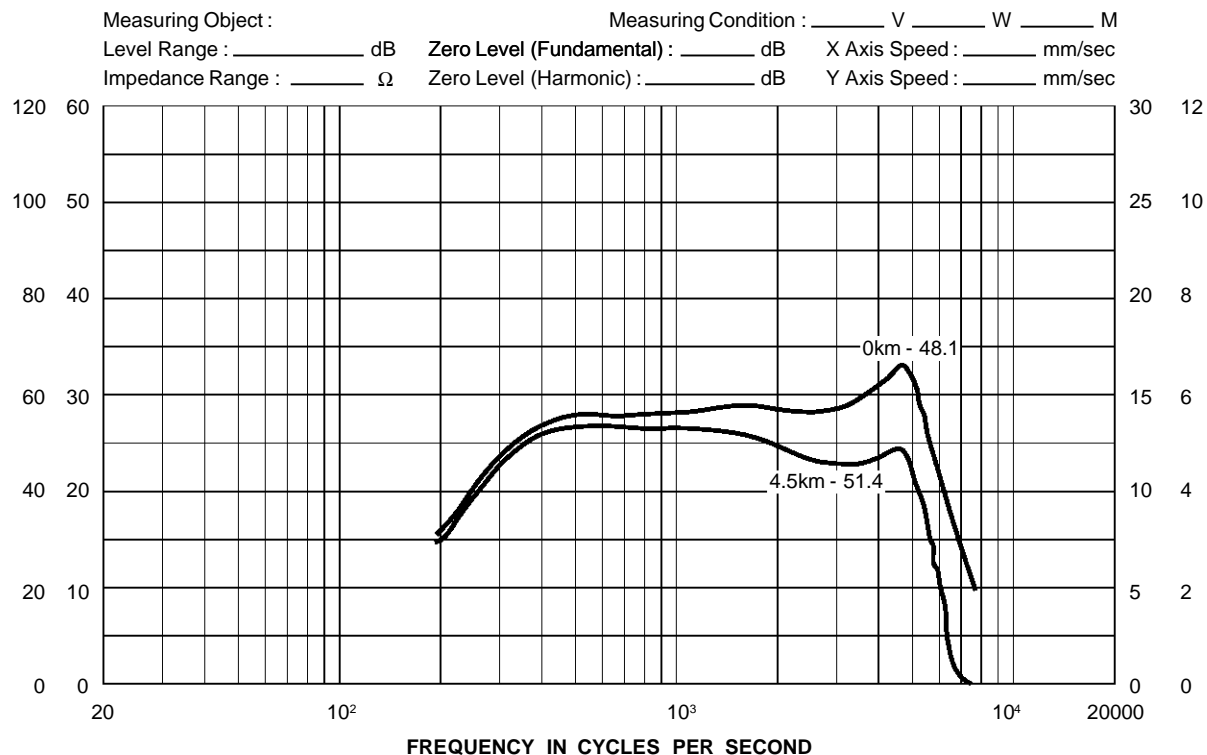
Figure 49 : Transmit Frequency Response at 0 & 4.5km



**VII - APPLICATION FOR USA (continued)**

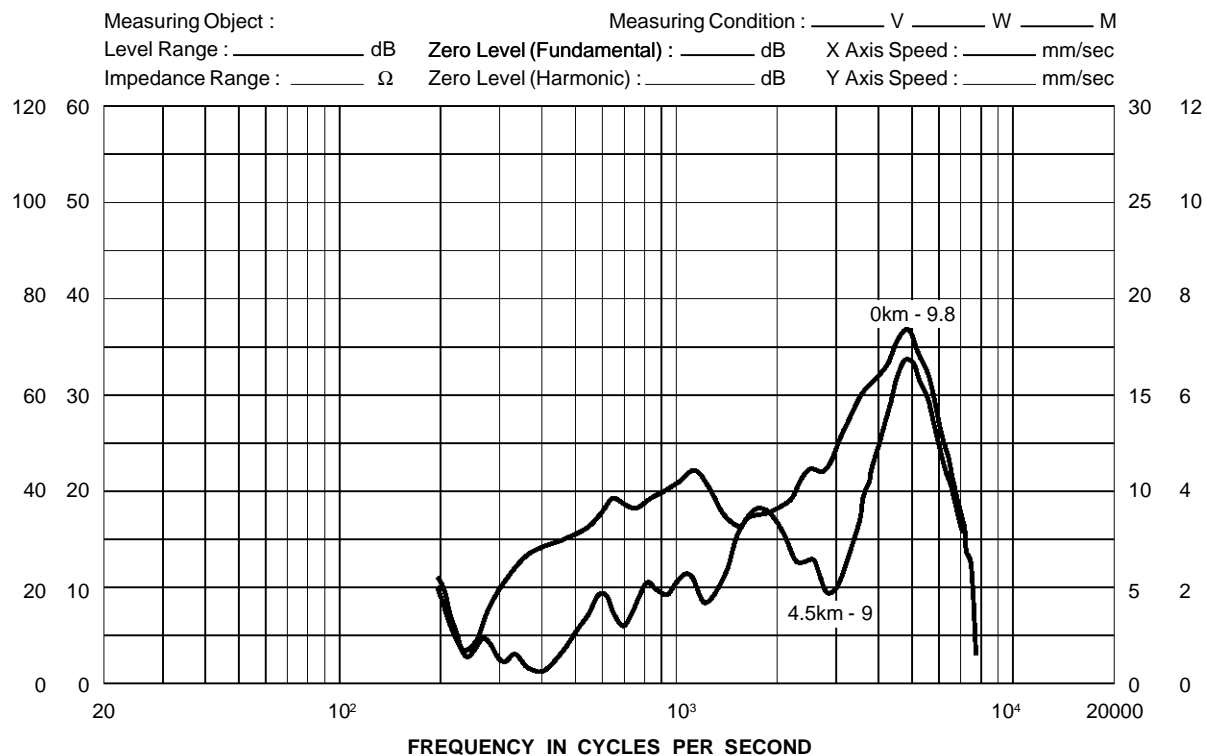
**VII.3 - Measurements Results (L3916A) (continued)**

**Figure 50 : Receive Frequency Response at 0 & 4.5km**



AN849-50.EPS

**Figure 51 : Sidetone Frequency Response at 0 & 4.5km**



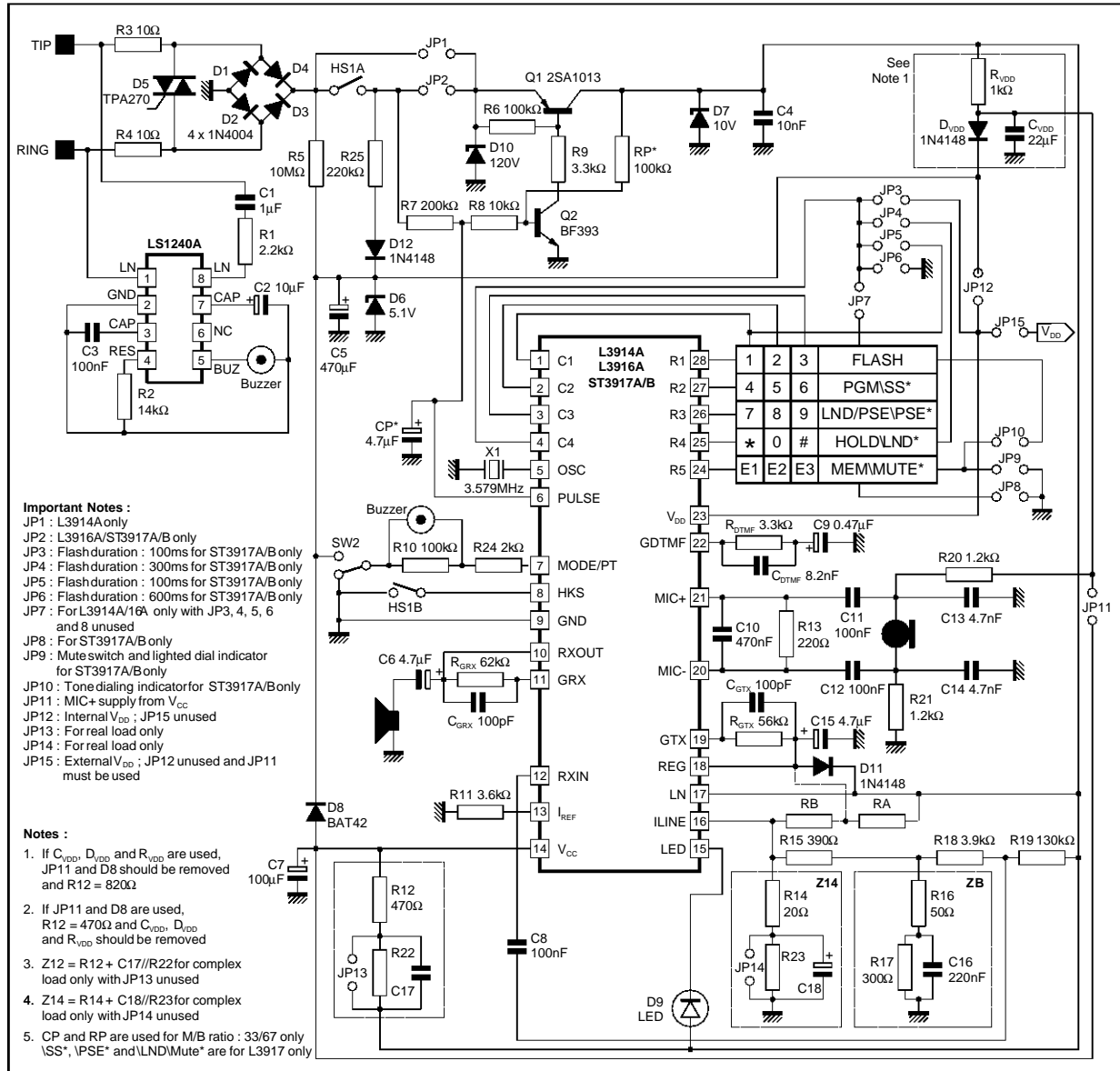
AN849-51.EPS

# SPEECH AND DIALLER L3914A/16A AND ST3917A/B

## VIII - APPENDIX

### VIII.1 - Appendix A - Demoboard for Multi Country Application by Jumper Selection

Figure 52 : Demoboard Schematic

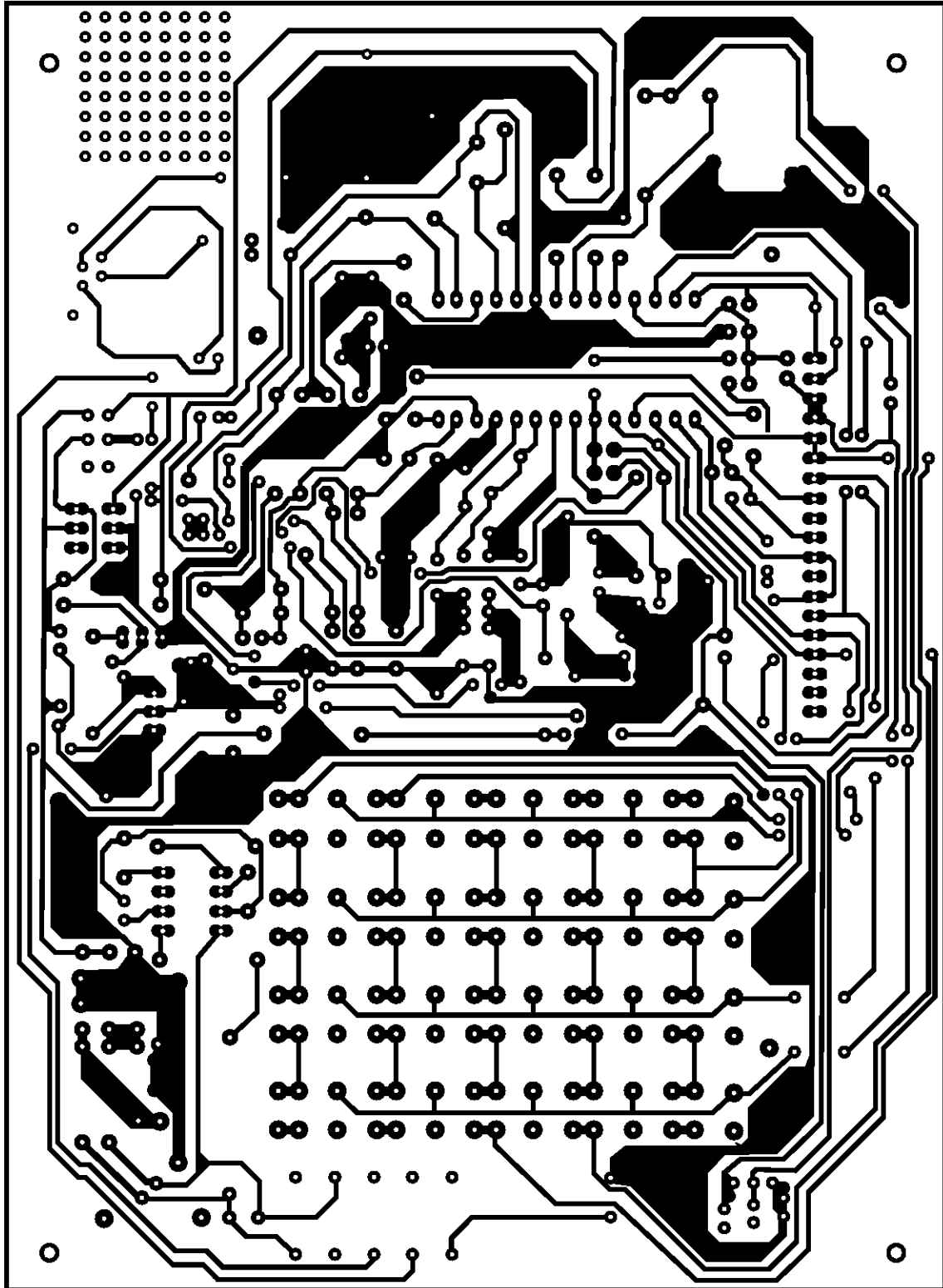


AN649-52.EPS

VIII - APPENDIX (continued)

VIII.2 - Appendix B - PCB Layout

Figure 53 : PCB Layout

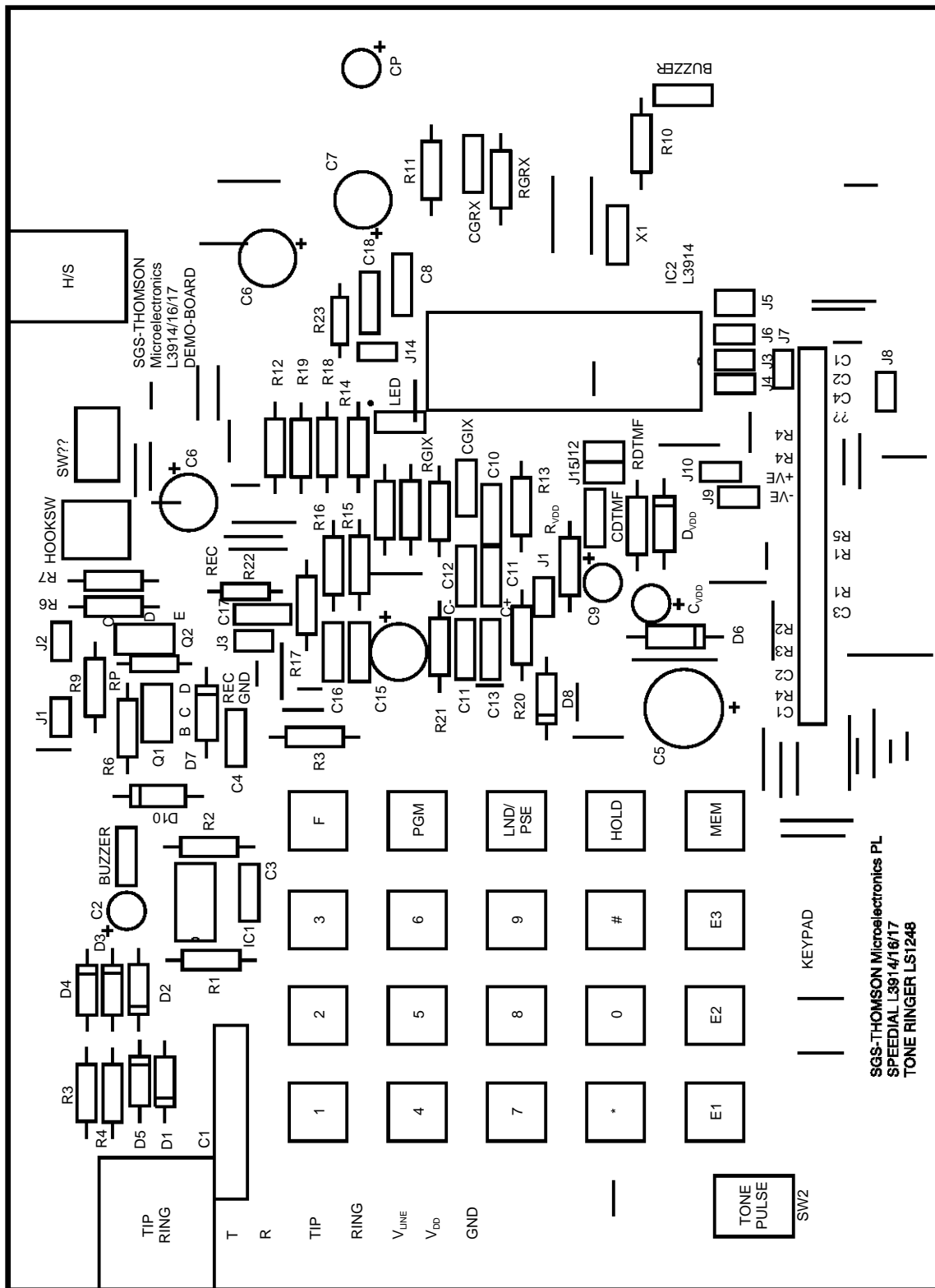


AN849-53.EPS

## VIII - APPENDIX (continued)

### VIII.3 - Appendix C - Component Layout

Figure 54 : Component Layout





**VIII - APPENDIX (continued)**

**VIII.4 - Appendix D - Component Lists**

Designation	Value	Comments
<b>RINGER</b>		
R1	2.2k $\Omega$	Impedance in Ring Mode
R2	14k $\Omega$	Output Frequency Control
C1	1 $\mu$ F/250V	Impedance in Ring Mode & AC Decoupling
C2	10 $\mu$ F/35V	Rectifier Cap
C3	100nF	Sweep Rate Control
<b>LINE INTERFACE</b>		
Q1	2SA1013	Pulse Interface
Q2	BF393	Pulse Interface
R3	10 $\Omega$	Line Current Protection
R4	10 $\Omega$	Line Current Protection
R6	100k $\Omega$	Pulse Interface
R7	200k $\Omega$	Pulse Interface
R8	10k $\Omega$	Pulse Output Current Limiter
R9	3.3k $\Omega$	Pulse Interface
D1-D4	1N4004	Rectifier Bridge
D5	TPA270	Line Protection
D10	120V ZENER	Line Protection
<b>SPEECH CIRCUIT</b>		
R5	10M $\Omega$	Memory Supply in On-hook Mode
R10	100k $\Omega$	Mode Input Pull-up
R11	3.6k $\Omega$	Internal Bias Current
R12	470 $\Omega$	Impedance Network
R13	220 $\Omega$	Transmit Response Curve Adjustment
R14	20 $\Omega$	DC Slope
R15	390 $\Omega$	Sidetone Bridge
R16	50 $\Omega$	Sidetone Network
R17	300 $\Omega$	Sidetone Network
R18	3.9k $\Omega$	Sidetone Bridge and Receive Interface
R19	130k $\Omega$	Sidetone Bridge and Receive Interface
R20	1.2k $\Omega$	Electret mic Power Supply
R21	1.2k $\Omega$	Electret mic Power Supply
R22	Optional	Complex Impedance Network
R23	Optional	Tx Response Curve Compensation if Complex Impedance used
R24	Optional	Isolation for Mode Pin R24 = 2k $\Omega$ if External Buzzer is Used else R24 = Short Circuit
R25	220k $\Omega$	V <sub>DD</sub> Dialler Power Supply in Pulse Mode
RGTX	56k $\Omega$	Transmit and DTMF Gain Adjustment
RGRX	62k $\Omega$	Receive Gain Adjustment
RDTMF	4.7k $\Omega$	DTMF Output Level Adjustment
RP	100k $\Omega$ optional	Make/Break Ratio Adjustment - L3914A/16A Only
RVDD	1k $\Omega$ Optional	Separate Microelectret Power Supply
RA	Optional	Line DC Level Adjustment, to reduce it
RB	Optional	Line DC Level Adjustment, to increase it
C4	10nF	RFI Protection
C5	470 $\mu$ F/10V	V <sub>DD</sub> Dialler Power Supply Decoupling
C6	4.7 $\mu$ F/6V	Output Receive Path Decoupling

## SPEECH AND DIALLER L3914A/16A AND ST3917A/B

### VIII - APPENDIX (continued)

#### VIII.4 - Appendix D - Component Lists (continued)

Designation	Value	Comments
SPEECH CIRCUIT (continued)		
C7	100 $\mu$ F/16V	V <sub>CC</sub> Speech Power Supply Decoupling
C8	100nF	Input Receive Path Decoupling
C9	0.47 $\mu$ F/16V	DTMF Input Decoupling
C10	470nF	Transmit Response Curve Adjustment
C11	100nF	Transmit Response Curve Adjustment
C12	100nF	Transmit Response Curve Adjustment
C13	4.7nF	RFI Protection
C14	4.7nF	RFI Protection
C15	4.7 $\mu$ F/16V	Internal Regulator Decoupling
C16	220nF	Sidetone Network
C17	Optional	Complex Impedance Network
C18	Optional	Tx Response Curve Compensation if Complex Impedance used
CGTX	100pF	Transmit Output Decoupling
CGRX	100pF	Receive Output Decoupling
CDTMF	8.2nF	DTMF Filter Adjustment
CP	4.7 $\mu$ F/6V Optional	Make/break Ratio Adjustment - L3914A/16A Only
CVDD	22 $\mu$ F/16V Optional	Separate Microelectret Power Supply Decoupling
D6	5.1V Zener	V <sub>DD</sub> Protection in On-hook Mode
D7	10V Zener	L3914A/16A/ST3917A/B Protection
D8	BAT42	V <sub>CC</sub> /V <sub>DD</sub> Isolation in Pulse Mode
D9	LED	Off-hook Indicator or Tone Mode Dialing Indicator for ST3917A/B
D11	1N4148	Transient Protection
D12	1N4148	V <sub>DD</sub> Dialler Power Supply in Pulse Mode
DVDD	1N4148-Optional	V <sub>CC</sub> /V <sub>DD</sub> Isolation in Pulse Mode
X1	3.5795MHz	Ceramic Resonator

#### JUMPER CONNECTION

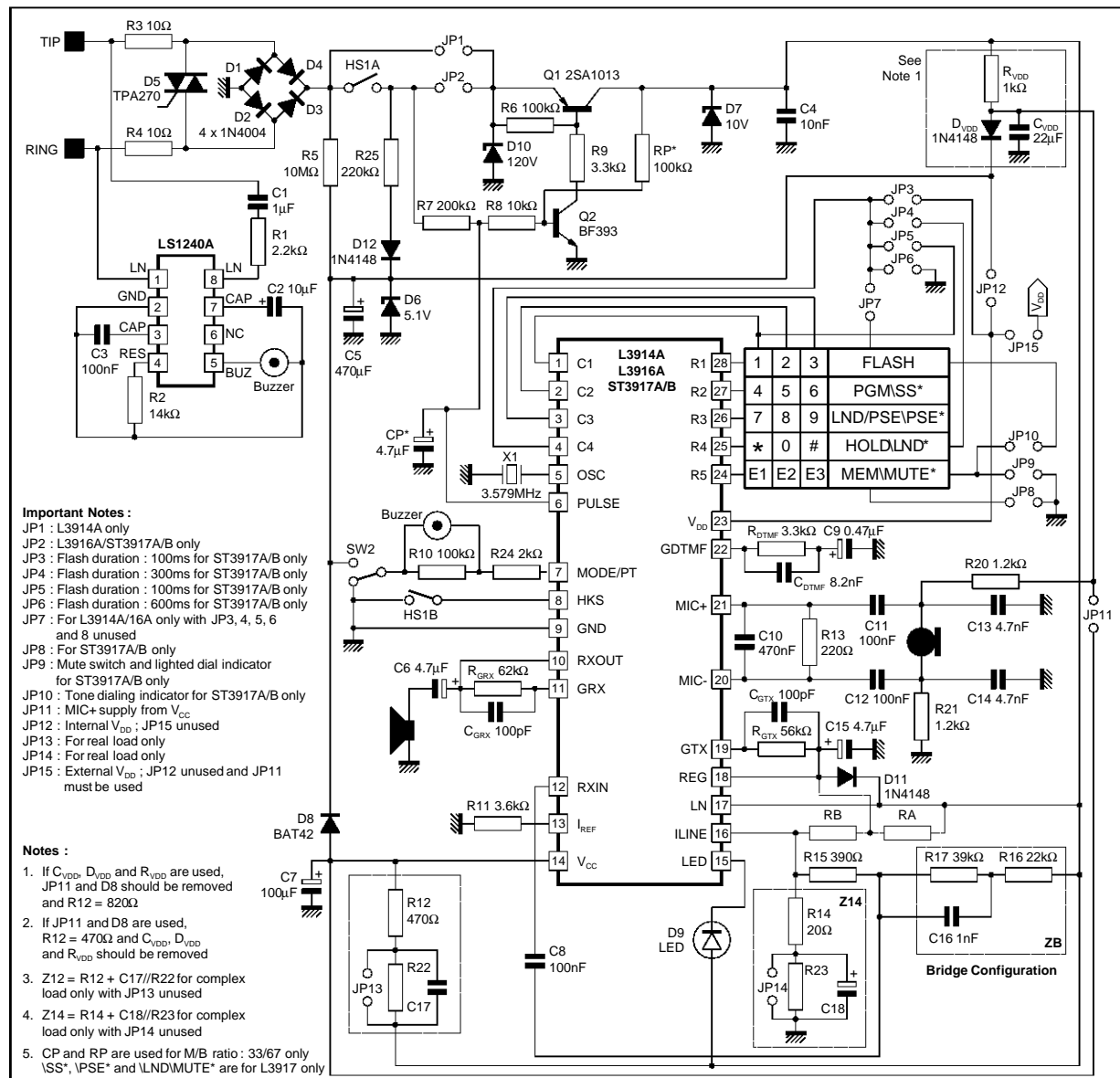
JP1		For L3914A Only
JP2		For L3916A/ST3917A/B
JP3		Flash Duration of 100ms with Softswitch Inhibition for ST3917A/B Only
JP4		Flash Duration of 300ms for ST3917A/B Only
JP5		Flash Duration of 100ms for ST3917A/B Only
JP6		Flash Duration of 600ms for ST3917A/B Only
JP7		For L3914A/16A Only with JP3, 4, 5, 6 & 8 Removed
JP8		For ST3917A/B Only
JP9		Transmit Mute and Lighted Dial Indicator for ST3917A/B Only. If JP9 is Connected, JP10 should be Removed and Vice Versa.
JP10		Tone Mode Dialling Indicator for ST3917A/B Only
JP11		Electret Mic Power Supply from V <sub>CC</sub>
JP12		V <sub>DD</sub> Dialer Power Supply from V <sub>CC</sub> with JP15 Removed
JP13		For Real Load Only
JP14		For Real Load Only
JP15		External V <sub>DD</sub> Dialer Power Supply with JP12 Removed

- Notes :**
1. If CVDD, DVDD and RVDD are used, D8 and JP11 should be removed and R12 should be 820 $\Omega$ .
  2. If D8 and JP11 are used, CVDD, DVDD and RVDD should be removed and R12 should be 470 $\Omega$ .
  3. For complex load, Z12 = R12 + R22//C17 with JP13 NOT connected.
  4. For complex load, Z14 = R14 + R23//C18 with JP14 NOT connected.
  5. For real load, Z12 = R12 and Z14 = R14 with JP13 and JP14 connected.
  6. CP and RP are only used for Make/Break ratio of 33/67 only.

# VIII - APPENDIX (continued)

## VIII.5 - Appendix E - Typical Application Circuit with Bridge Configuration

Figure 55 : Typical Application Circuit with Bridge Configuration



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