

# KA8601C

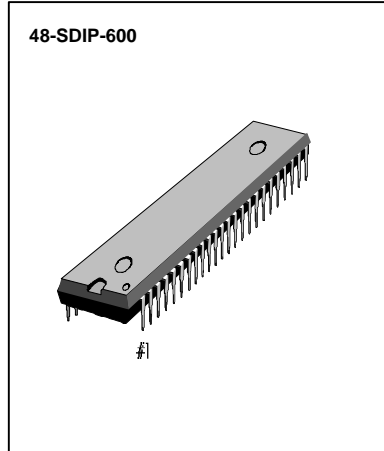
# SPEAKER PHONE WITH SPEECH NETWORK

## INTRODUCTION

The KA8601C is a monolithic integrated circuit for use in high performance speaker phone system. The KA8601C consists of speaker phone and speech network. Speaker phone includes attenuators, amplifiers, level detectors, attenuator control, hybrid amplifiers, regulator and AGC circuit. Speech network includes transmit amp, receive amp, voltage regulator for dialer, side tone control, and line equalizer.

## FEATURES

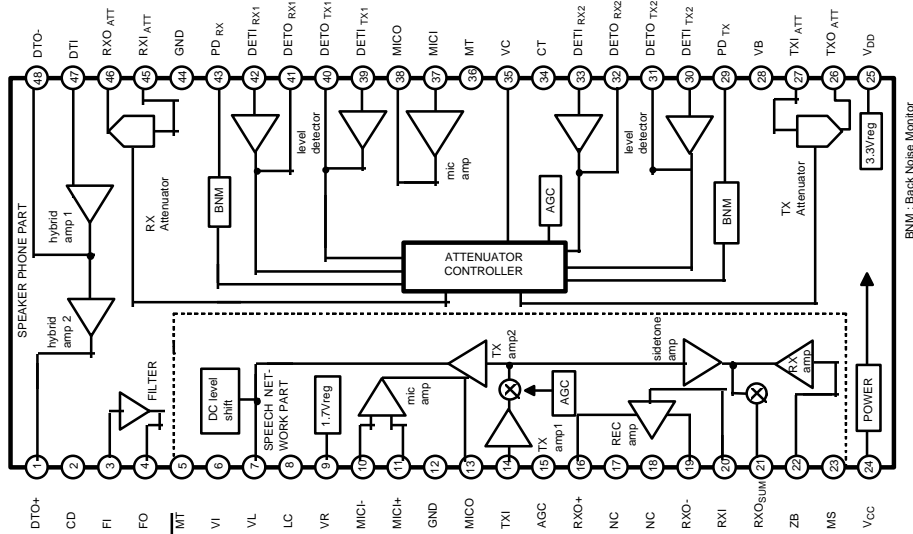
- Speaker Phone
  - Low Operating Voltage (3.0 ~ 6.5V)
  - High Attenuator Gain Range (52dB)
  - Improved Sensitivity (Four-point Signal Sensing)
  - Chip Disable for Active or Standby Operation
  - Microphone Amp Gain set by External Components
- Speech Network
  - Low Operating Voltage (1.5V : speech)
  - Regulated Voltage for Dialer (Typically 3.3V)
  - Transmit, Receive, Side Tone Gains set by External Components
  - Mute Input for DTMF Dialing



## ORDERING INFORMATION

Device	Package	Operating Temperature
KA8601C	48-SDIP-600	- 25°C ~ + 75°C

## BLOCK DIAGRAM



PIN CONFIGURATION

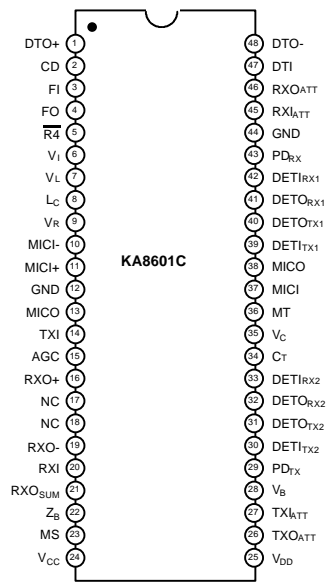


Fig. 2

PIN DESCRIPTION

Pin No	Symbol	Description
1	DTO+	Output of the second hybrid amplifier.
2	CD	Chip Disable. A logic low (<0.8V) sets normal operation.
3	FI	Filter input.
4	FO	Filter output.
5	$\overline{MT}$	Mute input. A logic "1" sets normal speech mode.
6	V <sub>I</sub>	A resistor connected from this pin to V <sub>SS</sub> sets the AC terminating impedance.
7	V <sub>L</sub>	Power supply for the speech network. Supply voltage is derived from loop current. T <sub>x</sub> amp output operates on this pin.
8	L <sub>C</sub>	Resistor at this pin set the DC characteristics of the circuit.
9	V <sub>R</sub>	A 1.7 volt regulated output which can be used to bias the mic.
10	MICI-	Inverting differential input to the mic amp.
11	MICI+	Non-inverting differential input to the mic amp.
12	GND	Ground pin for the speech network.
13	MICO	Mic amp output.
14	TXI	Input to the T <sub>x</sub> amp from the Mic amp.
15	AGC	Loop current sensing input.

## PIN DESCRIPTION (continued)

Pin No	Symbol	Description
16	RXO+	R <sub>X</sub> amp non-inverting differential output.
17	NC	No connection.
18	NC	No connection.
19	RXO-	R <sub>X</sub> amp inverting differential output.
20	RXI	Input to the R <sub>X</sub> amp.
21	RXO <sub>SUM</sub>	Summed output of the R <sub>X</sub> current amp.
22	Z <sub>B</sub>	Input to the R <sub>X</sub> current amp.
23	MS	Mode select input. A logic "1" → pulse dialing, A logic "0" → tone (DTMF) dialing.
24	V <sub>CC</sub>	A supply voltage pin for the speaker phone part.
25	V <sub>DD</sub>	A regulated 3.3 volt output for an external dialer.
26	TXO <sub>ATT</sub>	Output of the T <sub>X</sub> attenuator.
27	TXI <sub>ATT</sub>	Input to the T <sub>X</sub> attenuator.
28	V <sub>B</sub>	This voltage is a system AC ground, and biases the volume control. A filter cap is required.
29	PD <sub>TX</sub>	An RC at this pin sets the time constant for the T <sub>X</sub> background monitor.
30	DETI <sub>TX2</sub>	Input to the T <sub>X</sub> level detector on the mike/speaker side.
31	DETO <sub>TX2</sub>	Output of the T <sub>X</sub> level detector on the mike/speaker side.
32	DETO <sub>RX2</sub>	Output of the R <sub>X</sub> level detector on the mike/speaker side.
33	DETI <sub>RX2</sub>	Input to the R <sub>X</sub> level detector on the mike/speaker side.
34	C <sub>T</sub>	This pin sets the response time for the circuit to switch modes.
35	V <sub>C</sub>	Volumn control input.
36	MT	Mute input. A logic low (<0.8V) sets normal operation. A logic high (>2.0V) mutes the mic amp.
37	MICI	Input and summing node of the mic amp.
38	MICO	Output of the mic amp is set by external resistors.
39	DETI <sub>TX1</sub>	Input to the T <sub>X</sub> level detector on the line side.
40	DETO <sub>TX1</sub>	Output of the T <sub>X</sub> level detector on the line side.
41	DETO <sub>RX1</sub>	Output of the R <sub>X</sub> level detector on the line side.
42	DETI <sub>RX1</sub>	Input to the R <sub>X</sub> level detector on the line side.
43	PD <sub>RX</sub>	A RC at this pin sets the time constant for the R <sub>X</sub> background monitor.
44	GND	Ground pin for the speaker phone part.
45	RXI <sub>ATT</sub>	Input to the R <sub>X</sub> attenuator and dial tone detector.
46	RXO <sub>ATT</sub>	Output of the R <sub>X</sub> attenuator.
47	DTI	Input and summing node of the mic amp.
48	DTO -	Output of the first hybrid amplifier.

## ABSOLUTE MAXIMUM RATINGS

Characteristic		Symbol	Value	Unit
Speaker Phone	Supply Voltage	$V_{CC}$	- 1.0 ~ + 7.0	V
	Voltage at $V_C$	$V_{I(VC)}$	- 1.0 ~ $V_{CC} + 0.5$	V
	Voltage at CD,MT	$V_{I(CM)}$	-1.0 ~ $V_{CC} + 1.0$	V
	Voltage at $T_X$ , $R_X$ , HFI	$V_{I(TRH)}$	- 0.5 ~ $V_{CC} + 0.5$	V
Speech Network	Supply Voltage	$V_{CC}$	- 1.0 ~ + 12	V
	Supply Voltage for dialer	$V_{DD}$	- 1.0 ~ + 6.0	V
	Voltage at $MT_S$ , MS	$V_{I(MS)}$	- 1.0 ~ $V_{DD} + 0.5$	V
	Current Through $V_L$ , $L_C$	$I_{I(VL, LC)}$	130	mA
	Current into $Z_B$	$I_{I(ZB)}$	3	mA
Operating Temperature		$T_{OPR}$	- 25 ~ + 75	°C
Storage Temperature		$T_{STG}$	- 65 ~ + 150	°C

## ELECTRICAL CHARACTERISTICS (Ta = 25°C)

Characteristic	Symbol	Test Conditions		Min	Typ	Max	Unit
<b>SPEECH NETWORK (Ta = 25°C, unless otherwise noted)</b>							
Line Voltage	$V_L$	Speech Mode	$I_L = 30mA$	3.0	3.9	4.7	V
		Pulse Mode	$I_L = 120mA$	8	9.8	11.5	
		Tone Mode	$I_L = 30mA$	4.4	5.1	6.5	
$V_R$ Voltage	$V_R$	$I_L = 30mA$	Speech Mode	1.55	1.7	1.85	V
MF Operating Voltage	$V_{DD(MF)}$	$V_L = 4.5V$	Tone Mode	3.0	3.3	3.8	V
			$I_{DD} = 1.6mA$	3.0	3.3	3.8	
MF Operating Current (Max)	$I_{DD(MF(MAX))}$	$I_L = 30mA$	Speech Mode	0.5	1.1	2.0	mA
			Pulse Mode	2	2.8	4	
			Tone Mode	2	2.8	4	
MICO Bias Voltage	$V_{BIAS(MPO)}$	$I_L = 30mA$	Speech Mode	0.8	1.08	1.4	V
TXI Bias Voltage	$V_{BIAS(TXTs)}$	$I_L = 30mA$	Speech Mode	0.04	0.086	0.2	V
MIC Amp Gain	$G_V(MIC)$	$I_L = 30mA$	Speech Mode	27	30	33	dB
MIC Common Mode Rejection Ratio	$CMRR_{(MIC)}$	-		30	64	-	dB
MIC Gain Reduction	$\Delta G_V(MIC)$	$MT = 0V$		-10	-60	-	dB
$T_X$ Gain	$G_V(TX)$	Speech Mode	$I_L = 30mA$	30	34.8	60	dB
			$I_L = 80mA$	28	31	34	
$T_X$ Distortion	$THD_{TX}$	$I_L = 30mA$	Speech Mode	-	-	2	%
$R_X$ Gain	$G_V(RX)$	Speech Mode	$I_L = 30mA$	-15	-10.5	-2	dB
			$I_L = 80mA$	-17	-14	-10	
$R_X$ Distortion	$THD_{RX}$	$I_L = 30mA$	Speech Mode	-	-	2	%
Side Tone Gain	$G_V(ST)$	$I_L = 30mA$	Speech Mode	-	10	15	dB

## ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Test Condition		Min	Typ	Max	Unit
Side Tone Rejection	RST			20	25	-	dB
MUTE Input Impedance	$Z_{I(MUTE)}$			-	60	-	K $\Omega$
MUTE Input Low Voltage	$V_{IL(MUTE)}$			-		1.0	V
MUTE Input High Voltage	$V_{IH(MUTE)}$			$V_{DD}$ -0.3		-	
MS Input Low Voltage	$V_{IL(MS)}$			-		0.8	V
MS Input High Voltage	$V_{IH(MS)}$			2.0		-	
$L_C$ Level Shift	$\Delta V_{LC}$	$I_L = 30mA$	Speech Mode	2.1	2.9	3.5	V
			Pulse Mode	2.1	2.9	3.5	
			Tone Mode	3.4	4.3	5.2	
<b>SPEAKER PHONE</b> ( $T_a = 25^\circ C$ , $V_{CC} = 5.0V$ , unless otherwise noted)							
Operating Current	$I_{CC}$	$V_{CC} = 6.5V$	CD = 0.8V	-	5.5	8.0	mA
			CD = 2V	-	0.6	0.8	
Reference Voltage	$V_{REF}$		$I_L = 1.0mA$	1.8	2.1	2.4	V
				$V_{CC} = 3.5V$	-	1.3	
$R_X$ Attenuator Gain	$G_{ATT(RX)}$	$V_C = V_B$	$V_{CC} = 3.5V, V_C = V_B$	4.0	6.0	8.0	dB
			$V_{CC} = 2.8V, V_C = V_B$	-	-19	-11	
			$V_{CC} = 3.5V, V_C = V_B$	-0.5	0	+0.5	
$R_X$ Attenuator Gain Change	$\Delta G_{ATT(RX)}$	$V_{CC} = 3.5V$ , to 5.0V					dB
$R_X$ Attenuator AGC Gain Change	$\Delta G_{ATT AGC(RX)}$	$V_{CC} = 2.8V$ , to 5.0V					dB
$R_X$ Attenuator Gain (Idle Mode)	$G_{ATT(RX)(IM)}$	$V_C = V_B$					dB
$R_X$ Attenuator Gain Range	$G_{ATT(RX)}$	$V_C = V_B$ ( $R_X$ to $T_X$ Mode)					dB
$R_X$ Volume Control Range	$G_{VCTL(RX)}$	$V_C = 0.1V_B$					dB
$R_X$ DC Output Voltage	$V_{O(RX)}$						V
$R_X$ DC Output Voltage Change	$\Delta V_{O(RX)}$	$R_X$ to $T_X$ Mode					mV
$R_X$ DC Output High Voltage	$V_{OH(RX)}$	$V_{RXI} = 3.5V$					V
$R_X$ DC Output Low Voltage (with respect to $V_B$ )	$V_{OL(RX)}$	$V_{RXI} = 1V$					V
$R_X$ Mode Distortion	THD <sub>RX</sub>						%
$C_T$ Voltage (with respect to $V_B$ )	$V_{CT}$		$R_X$ Mode	-	+240	-	mV
			Idle Mode	-	0	-	
			$T_X$ Mode	-	-240	-	
Dial Tone Detector Threshold	$V_{TH(DET)}$	$V_C = V_B, V_{RXI} = 3.0V$					mV
$T_X$ Attenuator Gain	$G_{ATT(TX)}$						dB
$T_X$ Attenuator Gain Range	$G_{ATT(TX)}$						dB
$T_X$ Output DC Voltage	$V_{O(TX)}$						V
$T_X$ Output DC Voltage Change	$\Delta V_{O(TX)}$						mV

## ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
T <sub>X</sub> Output High Voltage	V <sub>OH(TX)</sub>	V <sub>TXI</sub> = 3.5V	3.7	-	-	V
T <sub>X</sub> Output Low Voltage	V <sub>OL(TX)</sub>	V <sub>TXI</sub> = 1.0V	-	0.5	1	V
T <sub>X</sub> Mode Distortion	THD <sub>TX</sub>		-	0.8	3	%
MIC Voltage Gain	G <sub>V(MIC)</sub>		70	80	-	dB
MIC Output Offset Voltage	V <sub>OO(MIC)</sub>		-50	0	+50	mV
MIC Output High Voltage	V <sub>OH(MIC)</sub>	V <sub>MIC</sub> = 1.0V	3.7	-	-	V
MIC Output Low Voltage	V <sub>OL(MIC)</sub>	V <sub>MIC</sub> = 3.0V	-	-	200	mV
MIC Input Bias Current	I <sub>BIAS(MIC)</sub>		-	-40	-	nA
Muting (Gain)	G <sub>V(MUTE)</sub>	V <sub>MT</sub> = 2V, f = 1KHz	-55	-	-	dB
MIC Amp Distortion	THD <sub>MIC</sub>		-	0.15	-	%
MUTE Input High Voltage	V <sub>IH(MUTE)</sub>	0.3KHz ≤ f ≤ 10KHz	2.0	-	V <sub>CC</sub>	V
MUTE Input Low Voltage	V <sub>IL(MUTE)</sub>		0	-	0.8	V
Open Loop Gain (Hybrid Amp)	G <sub>V(HA)</sub>		60	80	-	dB
DTO-Output High Voltage	V <sub>OH(DTO-)</sub>		3.7	-	-	V
DTO-Output Low Voltage	V <sub>OL(DTO-)</sub>		-	-	250	mV
DTO+Output High Voltage	V <sub>OH(DTO+)</sub>	I <sub>O</sub> = -5mA	3.7	-	-	V
DTO+Output Low Voltage	V <sub>OL(DTO+)</sub>	I <sub>O</sub> = 5mA	-	-	250	mV
DTO Distortion	THD <sub>DTO</sub>	I <sub>O</sub> = -5mA	-	0.3	-	%
Filter Offset Voltage	V <sub>IO(F)</sub>	I <sub>O</sub> = 5mA	-22	-90	0	mV
Filter Input Bias Current	V <sub>BIAS(F)</sub>		0	-50	-	mA

## APPLICATION INFORMATION

### FUNCTION DESCRIPTION

#### SPEECH NETWORK

##### 1. MICROPHONE AMPLIFIER

This microphone amplifier is equipped with a fixed gain (30dB). Its basic configuration is shown in figure 3.

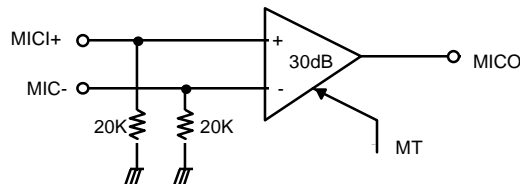


Fig .3

This amplifier has a mute function. If a mute signal from the dialer is inputted when the speech network is in the mute mode, the microphone amplifier will be muted.

##### 2. VOLTAGE REGULATOR (DIALER INTERFERENCE)

This voltage regulator has a minimum output voltage of 3.1 volts. When the dialer is not in motion, its minimum current is 1.0mA, whereas when the dialer is moving the minimum current is 2.2mA.

##### 3. VOLTAGE REFERENCE

Generally when in the voltage reference mode, the microphone's bias voltage is used, but when in the TX<sub>IATT</sub> mode, DC bias voltage is used. The output voltage of the voltage reference is a minimum of 1.6 volts.

#### SPEAKER PHONE

##### 1. MICROPHONE AMPLIFIER

This device amplifies outside microphone signals, which are inputted while in the inverting mode. As it alters elements, the microphone amplifier allows for them to be modulated. Its open loop gain is 80dB, while the band width is typically 1.0KHz. It has a mute function, and when operating in the mute mode at least 2.0V, the microphone amplifier gain is reduced to around 40dB. If the mute mode is not used, it must be connected with the ground.

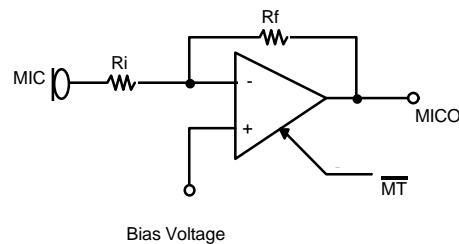


Fig. 4

**2. VOLUME CONTROL**

The volume control can only be applied in the receive mode. If the voltage of the  $V_C$  mode is the same as the  $V_B$ , the receive attenuator gain is maximized and the transmit gain is minimized. At the same time, if the  $V_C$  mode voltage is less than the  $V_B$ , the receive attenuator gain is reduced.

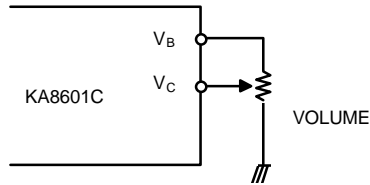


Fig. 5

**3. VOICE DETECTION FUNCTION**

The voice detection function compares the microphone amplifier output level with the outside audio amplifier level and the transmit attenuator output level with the receive attenuator input level, after which they are inputted into the control box. The block diagram of the voice detection function is as follows:

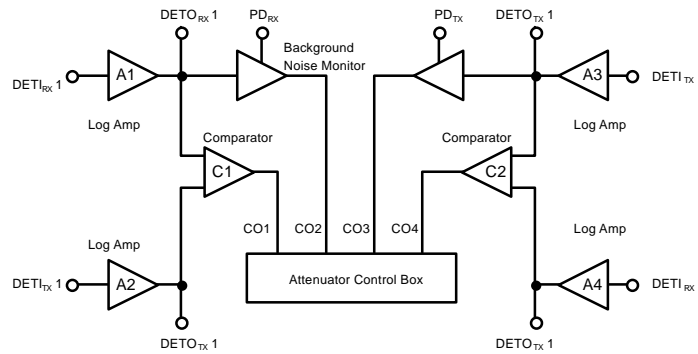


Fig. 6

It is useful to use a background noise monitor when high background noise occurs. When the input signals to the background noise monitor are increased, voltage for the  $PD_{RX}$  ( $PD_{TX}$ ) mode is stably increased. The increase time is determined by  $100K\Omega$  and  $47\mu F$ .

**4. ATTENUATOR CONTROL BOX**

In figure 6, each signal coming into the log amplifier is amplified and then inputted into the comparator (C1, C2). The comparator compares the amplified signal levels, after which they are inputted into the attenuator control box. The attenuator control box processes these signals (CO1, CO2, CO3, CO4) as logic signals, and which are put into one of the following modes:



1. Receive Mode
2. Transmit Mode
3. Slow Idle Mode
4. Fast Idle Mode

Which of the above modes is to be determined depending on the following conditions:

**1) Receive Mode**

$DETO_{TX1} < DETO_{RX1}$ ,  $DETO_{TX2} < DETO_{RX2}$ ,  $PD_{TX}$ , X,  $PD_{RX}$  : 1

**2) Transmit Mode**

$DETO_{TX1} > DETO_{RX1}$ ,  $DETO_{TX2} > DETO_{RX2}$ ,  $PD_{TX}$  : 1,  $PD_{RX}$  : X

**3) Slow Idle Mode**

$DETO_{TX1} > DETO_{RX1}$ ,  $DETO_{TX2} > DETO_{RX2}$ ,  $PD_{TX}$  : 0,  $PD_{RX}$  : X  
 $DETO_{TX1} < DETO_{RX1}$ ,  $DETO_{TX2} < DETO_{RX2}$ ,  $PD_{TX}$  : 0,  $PD_{RX}$  : X  
 $DETO_{TX1} < DETO_{RX1}$ ,  $DETO_{TX2} > DETO_{RX2}$ ,  $PD_{TX}$  : 0,  $PD_{RX}$  : X  
 $DETO_{TX1} > DETO_{RX1}$ ,  $DETO_{TX2} < DETO_{RX2}$ ,  $PD_{TX}$  : 0,  $PD_{RX}$  : X

**4) Fast Idle Mode**

$DETO_{TX1} > DETO_{RX1}$ ,  $DETO_{TX2} < DETO_{RX2}$ ,  $PD_{TX}$  : 0,  $PD_{RX}$  : 0  
 $DETO_{TX1} < DETO_{RX1}$ ,  $DETO_{TX2} > DETO_{RX2}$ ,  $PD_{TX}$  : Y,  $PD_{RX}$  : Y  
\* "<" and ">" refer to voltage level : "X" refers to "It doesn't matter" : "Y" is not zero

**5. SWITCHING TIME**

The switching time of the speaker phone is determined by the  $C_T$  and  $R_T$  of the outside elements.

1. Idle Mode →  $R_X$  or  $T_X$  Mode  
 $ST = 4,000 \times C_T$
2.  $T_X$  or  $R_X$  Mode → Fast Idle Mode  
 $ST = 2,000 \times C_T$
3.  $T_X$  or  $R_X$  Mode → Slow Idle Mode  
 $ST = R_T \times C_T$

\*  $C_T$ ,  $R_T$  refer to the capacitor and resistor between Pin 34 and  $V_{CC}$ .

# KA8601C

# SPEAKER PHONE WITH SPEECH NETWORK

## APPLICATION CIRCUIT

