

# UTC MC34118 LINEAR INTEGRATED CIRCUIT

## VOICE SWITCHED SPEAKER-PHONE CIRCUIT

### DESCRIPTION

The UTC MC34118 voice switched speaker-phone integrated circuit incorporates the necessary amplifiers, attenuators, level detectors and control algorithm to form the heart of a high quality hands-free speaker-phone system. It includes a microphone amplifier with adjustable gain and mute control. Transmit and Receive attenuators which operate in a complementary manner, level detectors at both input and output of both attenuators, and background noise monitors for both the transmit and receive channels. A dial tone detector prevents the dial tone from being attenuated by the receive background noise monitor circuit. Also two line driver amplifiers which can be used to form a hybrid network in conjunction with an external coupling transformer. A high-pass filter can be used to filter out 60Hz noise in the receive channel, or for other filtering functions. A chip disable pin permits powers down the entire circuit to conserve power on long loops where loop current is at a minimum. The UTC MC34118 may be operated from a power supply, or it can be powered from the telephone line, requiring typically 5mA. The UTC MC34118 can be interfaced directly to TIP and RING( through a coupling transformer) for stand-alone operation, or it can be used in conjunction with a handset speech network and/or other features of a feature phone.

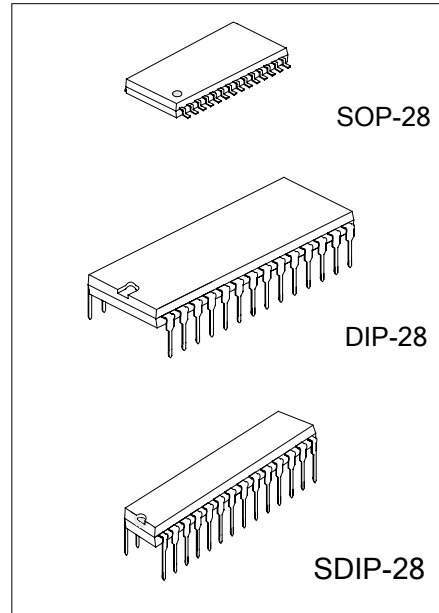
### FEATURES

\*Improved attenuator gain range: 52dB between Transmit and Receive

\*Low voltage operation for line-powered applications(3~6.5V)

\*4-point signal sensing for improved sensitivity

\*Background noise monitors for both Transmit and Receive paths



\*Pb-free plating product number: MC34118L

\*Microphone amplifier gain set by external Resistors-Mute function included

\*Chip disable for active/standby operation

\*On board filter pinned-out for user defined function

\*Dial tone detector to inhibit receive idle mode during dial tone presence

### ABSOLUTE MAXIMUM RATINGS(Ta=25°C, Voltages referred to pin 22)

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	Vcc	-1~7	V
Voltage at Pin 3	V3	-1~Vcc+1	V
Voltage at Pin 12( mute)	V12	-1~Vcc+1	V
Voltage at Pin 13( VLC)	V13	-1~Vcc+0.5	V
Voltage at Pin 9, Pin 21, and Pin 2	V9, 21, 2	-0.5~Vcc+0.5	V
Storage temperature	Tstr	-65~150	°C

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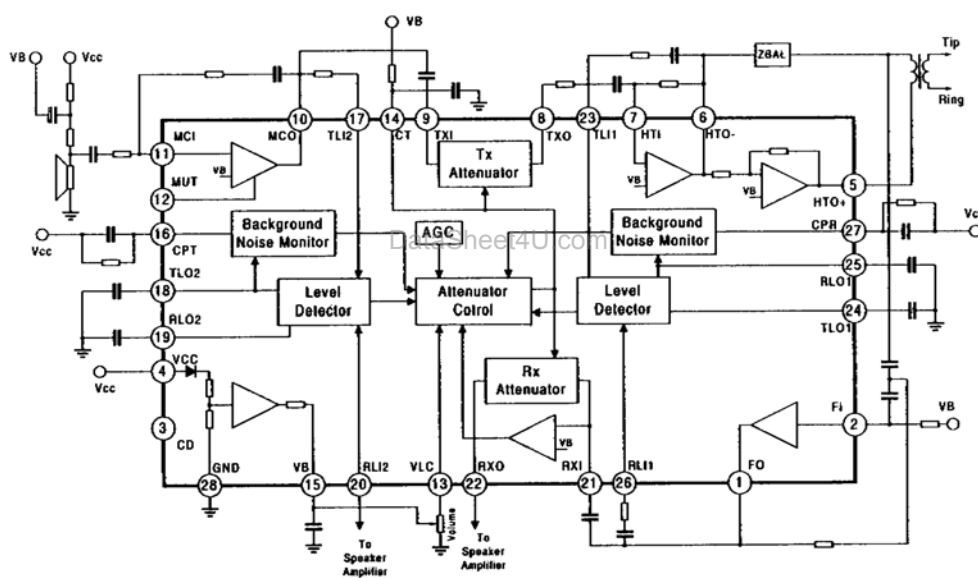
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## RECOMMENDED OPERATION CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	V4	3.5~6.5	V
Voltage at Pin 3	V3	0~Vcc	V
Voltage at Pin 12( MUTE)	V12	0~Vcc	V
Voltage at Pin 13( VLC)	V13	0.3*VB~VB	V
IVB Current( Pin 15)	IvB	500	μA
Attenuator Input Signal Voltage at Pin 9, Pin 21	V9, V21	350	mVrms
Load Current		0~+2	mA
@RXO, TXO(Pin8, Pin 22)		0~-+1	
@MCO(Pin 10)		0~-+0.5	
@HTO-, HTO+(Pin 6, Pin5)			
Ambient Operating Temperature	Topr	-20~60	°C

## BLOCK DIAGRAM



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## PIN CONFIGURATIONS

PIN	NAME	DESCRIPTION
1	FO	Filter Output. Output impedance is less than 50 ohms.
2	FI	Filter Input. Input impedance is greater than 1 M ohms.
3	CD	Chip Disable. A logic low (<0.8V) sets normal operation. A logic high (>2V) disable the IC to conserve power. Input impedance is nominally 90 K ohms.
4	Vcc	A supply voltage of +2.8V to +6.5V is required at 5mA. As Vcc falls from 3.5V to 2.8V, an AGC circuit reduces the receive attenuator gain by 25dB( when in the receive mode).
5	HTO+	Output of the second hybrid amplifier. The gain is internally set at -1 to provide a differential output, in conjunction with HTO-, to the hybrid transformer.
6	HTO-	Output of the first hybrid amplifier. The gain of the amplifier is set by external resistors.
7	HTI	Input and summing node for the first hybrid amplifier. DC level is about equal to VB.
8	TXO	Output of the transmit attenuator. DC level is about VB.
9	TXI	Input of the transmit attenuator. Maximum signal level is 350 mVrms. Input impedance is 10KΩ.
10	MCO	Output of the microphone amplifier. The gain of the amplifier is set by external resistors.
11	MCI	Input of the summing node of the microphone. DC level is VB.
12	MUT	Mute input. A logic low (<0.8V) sets normal operation. A logic high (>2V) mutes the microphone amplifier without affecting the rest of the circuit. Input impedance is 90 K ohms.
13	VLC	Volume control input. When VLC=VB, the receive attenuator is at maximum gain when in the receive mode. When VLC=0.3dB, the receive gain is down 35dB. Does not effect the transmit modes.
14	CT	The RC at this pin sets the response time for the circuit to switch modes.
15	VB	N output voltage=Vcc/2. This voltage is a system AC ground and biases the volume control. A filter capacitor is required.
16	CPT	The RC at this pin sets the time constant for the transmit background side.
17	TLI2	Input to the transmit level detector on the microphone/ speaker side.
18	TLO2	Output to the transmit level detector on the microphone/ speaker side, and input to the transmit background monitor.
19	RLO2	Output of the receive level detector on the microphone/ speaker side
20	RLI2	Input to the receive level detector on the microphone/ speaker side
21	RXI	Input to the receive attenuator and dial tone detector. Maximum input level is 350mVrms. Input impedance is 10KΩ.
22	RXO	Output of the receive attenuator. DC level is VB.
23	TLI1	Input to the transmit level detector on the line side.
24	TLO1	Output to the transmit level detector on the line side, and input to the transmit background monitor.
25	RLO1	Output of the receive level detector on the line side.
26	RLI1	Input to the receive level detector on the line side.
27	CPR	The RC at this pin sets the time constant for the receive background monitor.
28	GND	Ground pin for the entire IC.

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## ELECTRICAL CHARACTERISTICS (referred to fig. 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>SUPPLY VOLTAGES</b>						
V+ Supply Current V <sub>cc</sub> =6.5V, CD=0.8V V <sub>cc</sub> =6.5V, CD=2V	I <sub>cc</sub>			5.5 600	8 800	mA μA
CD Input Resistance	R <sub>CD</sub>	V <sub>cc</sub> =V <sub>CD</sub> =6.5V	50	90		kΩ
CD Input Voltage(High)	V <sub>CDH</sub>		2		V <sub>cc</sub>	V
CD Input Voltage	V <sub>CDL</sub>				0.8	V
V <sub>B</sub> Output Voltage	V <sub>B</sub>	V <sub>cc</sub> =3.5V V <sub>cc</sub> =5V	1.8	1.3 2.1	2.4	V
V <sub>B</sub> Output Resistance	R <sub>OV<sub>B</sub></sub>	I <sub>VB</sub> =1mA		400		Ω
V <sub>B</sub> Power Supply Rejection Ratio	PSRR	C <sub>VB</sub> =220μF, f=1kHz		54		dB
<b>ATTENUATORS</b>						
Receive Attenuator Gain(f=1kHz, V <sub>Lc</sub> =V <sub>B</sub> )						
Rx Mode, RXI=150mVrms	G <sub>RX</sub>	V <sub>cc</sub> =5V	4	6	8	dB
Rx Mode, RXI=150mVrms	G <sub>RX</sub>	V <sub>cc</sub> =3.5V	4	6	8	dB
Gain Change	ΔG <sub>RX1</sub>	V <sub>cc</sub> =3.5V vs. V <sub>cc</sub> =5V	-0.5	0	+0.5	dB
AGC Gain Change	ΔG <sub>RX2</sub>	V <sub>cc</sub> =3.5V vs. V <sub>cc</sub> =5V		-25	-15	dB
Idle Mode, RXI=150mVrms	G <sub>RX1</sub>		-22	-20	-17	dB
Rx to Tx Mode Range	ΔG <sub>RX3</sub>		49	52	54	dB
Volume Control Range	V <sub>CR</sub>		27	35		dB
RXO DC Voltage	V <sub>RXO</sub>	Rx Mode		V <sub>B</sub>		V
ΔRXO DC Voltage	ΔV <sub>RXO</sub>	Rx to Tx Mode		+/-10	+/-150	mV
RXO High Voltage	V <sub>RXOH</sub>	I <sub>out</sub> =-1mA, RXI=V <sub>B</sub> +1.5V	3.7			V
RXO Low Voltage	V <sub>RXOL</sub>	I <sub>out</sub> =+1mA, RXI=V <sub>B</sub> -1V, Output Measured with Respect to V <sub>B</sub>		-1.5	-1	V
RXI Input Resistance	R <sub>RXI</sub>	RXI<350mVrs	7	10	14	kΩ
<b>TRANSMIT ATTENUATOR GAIN(f=1kHz)</b>						
Tx Mode, TXI=150mVrms	G <sub>TX</sub>		4	6	8	dB
Idle Mode, TXI=150mVrms	G <sub>TXI</sub>		-22	-20	-17	dB
Tx to Rx Mode Range	ΔG <sub>TXI</sub>		49	52	54	dB
TXO DC Voltage	V <sub>TXO</sub>	Tx		V <sub>B</sub>		V
ΔTXO DC Voltage	ΔV <sub>TXO</sub>	Tx to Rx Mode		+/-30	+/-150	mV
TXO High Voltage	V <sub>TXOH</sub>	I <sub>out</sub> =-1mA, TXI=V <sub>B</sub> +1.5V	3.7			V
TXO Low Voltage	V <sub>TXOL</sub>	I <sub>out</sub> =+1mA, TXI=V <sub>B</sub> -1V, Output Measured with Respect to V <sub>B</sub>		-1.5	-1	V
TXI Input Resistance	R <sub>TXI</sub>	TXI<350mVrs	7	10	14	kΩ

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PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Gain Tracking	GTR	GRx+GTx, @Tx, Idle, Rx		+0.1		dB
<b>ATTENUATOR CONTROL</b>						
CT Voltage( CT-V <sub>B</sub> )						
Rx Mode		V <sub>LC</sub> =V <sub>B</sub>		240		mV
Idle Mode				0		mV
Tx Mode				-240		mV
CT Source Current	I <sub>CTR</sub>	(Switching to Rx Mode)	-85	-60	-40	μA
CT Sink Current	I <sub>CTT</sub>	(Switching to Tx Mode)	+40	+60	+85	μA
CT Slow Idle Current	I <sub>CTS</sub>			0		μA
CT Fast Idle Internal Resistance	R <sub>FI</sub>		1.5	2	3.6	kΩ
VLC Input Current	I <sub>VLC</sub>			-60		nA
Dial Tone Detector Threshold	V <sub>DT</sub>		10	15	20	mV
<b>MICROPHONE AMPLIFIER( V<sub>MUT</sub>&lt; 0.8V, A<sub>VCL</sub>=31dB, unless otherwise specified)</b>						
Output Offset	M <sub>COVOS</sub>	V <sub>MCO</sub> -V <sub>B</sub> , R <sub>f</sub> =180kΩ	-50	0	50	mV
Open Loop Gain	A <sub>VOLM</sub>	F<100Hz	70	80		dB
Gain Bandwidth	G <sub>BWM</sub>			1		MHz
Output High Voltage	V <sub>MCOH</sub>	I <sub>out</sub> =1mA, V <sub>CC</sub> =5V	3.7			V
Output Low Voltage	V <sub>MCOL</sub>	I <sub>out</sub> =1mA			200	mV
Input Bias Current	I <sub>BM</sub>	@MCI		-40		nA
Muting(ΔGain)	G <sub>MT</sub>	f=1kHz, V <sub>MUT</sub> =2V 300Hz<f<10kHz	-55	-68		dB
MUT Input Resistance	R <sub>MUT</sub>	V <sub>CC</sub> =V <sub>MUT</sub> =6.5V	50	90		kΩ
MUT High Input Voltage	V <sub>MUTH</sub>		2		V <sub>CC</sub>	V
MUT Low Input Voltage	V <sub>MUTL</sub>		0		0.8	V
Distortion	TH <sub>DM</sub>	300Hz<f<10kHz		0.15		%
<b>HYBID AMPLIFIER</b>						
HTO-Offset	H <sub>VOS</sub>	V <sub>HTO-</sub> -V <sub>B</sub> , R <sub>f</sub> =51kΩ	-20	0	20	mV
HTO- to HTO+ Offset	H <sub>BVOS</sub>	R <sub>f</sub> =51kΩ	-30	0	30	mV
Open Loop Gain	A <sub>VOLH</sub>	HTI to HTO-, F<100Hz	60	80		dB
Gain Bandwidth	G <sub>BWH</sub>			1		MHz
Closed Loop Gain	A <sub>VCLH</sub>	HTO- to HTO+	-0.35	0	0.35	dB
Input Bias Current(@HTI)	I <sub>BH</sub>			-30		nA
HTO- High Voltage	V <sub>HT-H</sub>	I <sub>out</sub> =-5mA	3.7			V
HTO- Low Voltage	V <sub>HT-L</sub>	I <sub>out</sub> =+5mA			250	mV
HTO+ High Voltage	V <sub>HT+H</sub>	I <sub>out</sub> =-5mA	3.7			V
HTO+ Low Voltage	V <sub>HT+L</sub>	I <sub>out</sub> =+5mA			450	mV
Distortion	TH <sub>DM</sub>	300Hz<f<10kHz		0.3		%
<b>LEVEL DETECTORS and BACKGROUND NOISE MONITORS</b>						

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PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Transmit-Receive Switching Threshold( Ratio of Current at RLI1+RLI2 to 20 $\mu$ A at TLI1+TLI2 to Switch from Tx to Rx)	ITH		0.8	1	1.2	mA
Source Current at RLO1, RLO2, TLO1, TLO2	ILSO			-2		mA
Sink Current at RLO1, RLO2, TLO1, TLO2	ILSK			4		$\mu$ A
CPR, CPT Output Resistance	R <sub>CPT</sub>	I <sub>out</sub> =1.5mA		35		$\Omega$
CPR, CPT Leakage Current	I <sub>CPLK</sub>			-0.2		$\mu$ A
Filter						
Voltage Offset at FO	Fovos	V <sub>FO</sub> -V <sub>B</sub> , 220k $\Omega$ from VB to FI	-200	-90	0	mV
FO Sink Current	I <sub>FO</sub>		150	260	400	$\mu$ A
FI Bias Current	I <sub>FI</sub>			-50		nA
SYSTEM Distortion(f=1kHz)						
Rx Mode	THDR	from FI to RXO, FO connected to RXI		0.5	3	%
Tx Mode	THD	from MCI to HTO-/HTO+, includes TX attenuator		0.8	3	%

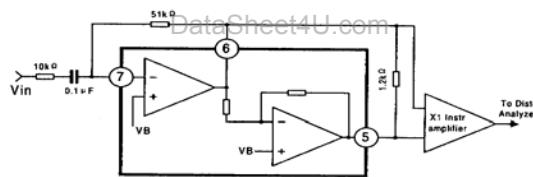


Fig.1 Hybrid Amplifier Distortion Test

## TEMPERATURE PARAMETERS

PARAMETER	TYP VALUE (Ta=25°C)	TYP CHANGE	UNIT
Vcc Supply Current(CD=0.8V)	5mA	-0.3	%/°C
Vcc Supply Current(CD=2V)	400 $\mu$ A	-0.4	%/°C
VB Output Voltage(Vcc=5V)	2.1V	+0.8	%/°C
Attenuator Gain(Max Gain)	6	0.0008	dB/°C
Attenuator Gain(Max Attenuation)	-46dB	0.004	dB/°C
Attenuator Input resistance	10k $\Omega$	0.6	%/°C
Dial Tone Detector Threshold	15mV	20	$\mu$ V/°C
CT Source, Sink Current	+60 $\mu$ A	-0.15	%/°C
Microphone, Hybrid Amplifier Offset	0mV	+4	$\mu$ V/°C
Transmit-Receive Switching Threshold	1	+0.02	%/°C
Sink Current at RLO1, RLO2, TLO1, TLO2	4 $\mu$ A	-10	nA/°C
Closed Loop Gain( HTO- to HTO+)	0dB	0.001	%/°C

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## FUNCTIONAL DESCRIPTION

### INTRODUCTION

The fundamental difference between operation of a speakerphone and a handset is that of half-duplex versus full-duplex. The handset is full duplex since conversation can occur in both directions (transmit and receive) simultaneously. A speakerphone has higher gain levels in both paths, and attempting to converse full duplex results in oscillatory problems due to the loop that exists within the system. The loop is formed by the receive and transmit paths, the hybrid, and the acoustic coupling (speaker to microphone). The only practical and economical solution used to date is to design the speakerphone to function in a half duplex mode- ie. only one person speaks at a time, while the other listens. To achieve this requires a circuit which can detect who is talking, switch on the appropriate path (transmit or receive), and switch off (attenuate) the other path. In this way, the loop gain is maintained less than unity, when the talkers exchange function, the circuit must quickly detect this, and switch the circuit appropriately. By providing speech level detectors, the circuit operates in a "hands-free" mode, eliminating the need for a "push-to-talk" switch. The handset, by the way, has the same loop as the speakerphone. But since the gains are considerably lower, and since the acoustic coupling from the ear piece to the mouthpiece is almost non-existent (the receiver is normally held against a person's ear), oscillations do not occur. The UTC MC34118 provides the necessary level detectors, attenuators, and switching control for a properly operating speakerphone. The detection sensitivity and timing are externally controllable. Additionally, the UTC MC34118 provides background noise monitors which make the circuit insensitive to room and line noise, hybrid amplifier for interfacing to Tip and Ring, the microphone amplifier, and other associated functions. Please refer to the Block Diagram when reading the following sections.

### ATTENUATORS

The transmit and receive attenuators are complementary in function, ie. when one is at maximum gain (+6dB), the other is at maximum attenuation (-46dB), and vice versa. They are never both fully on or both fully off. The sum of their gains remains constant (within a nominal error band of  $\pm 0.1$ dB) at a typical value of -40dB (see Figure 10). Their purpose is to control the transmit and receive paths to provide the half-duplex operation required in speakerphone. The attenuators are non-inverting, and have a -3dB (from max gain) frequency of  $\sim 100$ kHz. The input impedance of each attenuator (TXI and RXI) is nominally  $10k\Omega$ , and the input signal should be limited to 350 mVrms (990mvp-p) to prevent distortion. That maximum recommended input signal is independent of control setting. The diode clamp on the inputs limits the input swing, and therefore the maximum negative output swing. This is the reason for VRXOL and VTXOL specification being defined as they are in the Electrical Characteristics. The output impedance is  $< 10\Omega$  until the output current limit (typically 2.5mA) is reached.

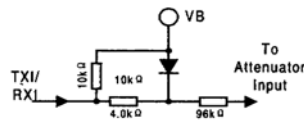


Fig.2 Attenuator Input stage

The attenuators are controlled by the signal output of the Control Block, which is measurable at the CT pin (pin 14). When the CT pin is at +240mV with respect to VB, the circuit is in the receive mode (receive attenuator is at +6dB). The circuit is in an idle mode when the CT voltage is equal to VB causing the attenuators' gains to be halfway between their fully on and fully off positions (-20 dB each). Monitoring the CT voltage (with respect to VB) is the most direct method of monitoring the circuit's mode. The inputs to the Control Block are 7: 2 from the comparators operated by the level detectors, 2 from the background noise monitors, the volume control, the dial-tone detector, and the AGC circuit. These 7 inputs are described below.

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## LEVEL DETECTORS

There are four level detectors—two on the receive side and two on the transmit side. Refer to Figure 3—the terms in parentheses form one system, and the other terms form the second system. Each level detector is a high amplifier with back-to-back diodes in the feedback path, resulting in non-linear gain, which permits operation over a wide dynamic range of speech levels. The sensitivity of each level detector is determined by the external resistor and capacitor at each input (TLI1, TLI2, RLI1, and RLI2). Each output charges an external capacitor through a diode and limiting resistor, thus providing a DC representation of the input AC signal level. The outputs have a quick rise time (determined by the capacitor and an internal  $350\Omega$  resistor), and a slow decay time set by an internal current source and the capacitor. The capacitors on the four outputs should have the same value (+10%) to prevent timing problems. Referring to the Block Diagram, on the receive side, one level detector (RLI1) is at the receive input receiving the same signal as at Tip and Ring, and the other (RLI2) is at the output of the speaker amplifier. On the transmit side, one level detector (TLI2) is at the microphone amplifier, while the other (TLI1) is at the hybrid output. Outputs RLO1 and TLO1 feed a comparator, the output of which goes to the attenuator Control Block. Likewise, outputs RLO2 feed a second comparator which also to the attenuator Control Block. The truth table for the effects of the level detectors on the Control Block is given in the section describing the Control Block.

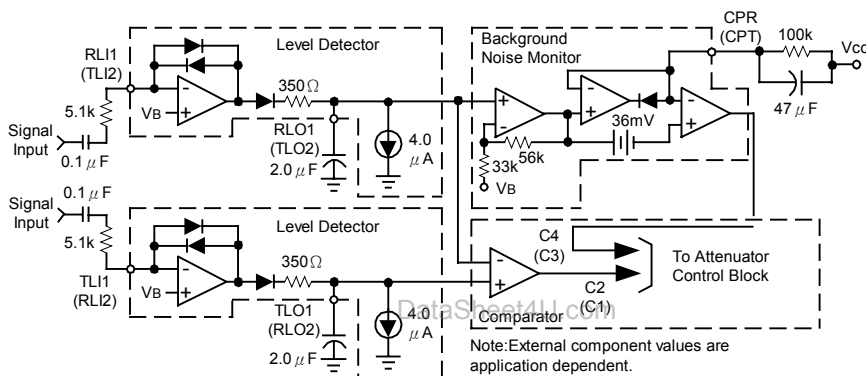


FIGURE 3 LEVEL DETECTORS

## BACKGROUND NOISE MONITORS

The purpose of the background noise monitors is to distinguish speech (which consists of bursts) from background noise (a relatively constant signal level). There are two background noise monitors—one for the receive path and one for the transmit path. Referring to Figure 3, the receive background noise monitor is operated on by the RLI1-RLO1 level detector, while the transmit background noise monitor is operated on by the TLI2-TLO2 level detector. They monitor the background noise by storing a DC voltage representative of the respective noise levels in capacitors at CPR and CPT. The voltage at these pins has slow rise times (determined by the external RC), but fast decay times. If the signal at RLI1 (or TLI2) changes slowly, the voltage at CPR (or CPT) will remain more positive than the voltage at the non-inverting input of the monitor's output comparator. When speech is present, the voltage on the non-inverting input of the comparator will rise quicker than the voltage at the inverting input (due to the burst characteristic of speech), causing its output to change. This output is sensed by the attenuator Control Block. The 36 mV offset at the comparator's input keeps the comparator from changing state unless the speech level exceeds the background noise by ~4dB. The time constant of the external RC (~4.7 seconds) determines the response time to background noise variations.

## VOLUME CONTROL

The volume control input at VLC (pin 13), is sensed as a voltage with respect to VB. The volume control affects the attenuators only in the receive mode. It has no effect in the idle or transmit modes. When in the receive mode, the gain of the receive attenuator will be +6dB, and the gain of the transmit attenuator will be -4dB, only when VLC is equal to VB. As VLC is reduced below VB, the gain of the receive attenuator is reduced, and the gain of the transmit

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attenuator is increased, such that their sum remains constant. Changing the voltage at VLC changes at CT( see the attenuator Control Block section), which in turn controls the attenuators. The volume control setting does not affect the maximum attenuator input signal at which noticeable distortion occurs. The bias current at VLC is typically 60 nA out of the pin, and does not vary significantly with the VLC voltage or with VCC.

### DIAL TONE DETECTOR

The dial tone detector is a comparator with one side connected to the receive input(RXI) and the other input connected to VB with a 15mV offset( see Figure 4). If the circuit is in the receive mode, and the incoming signal is greater than 15mV(10 mVrms). The comparator's output will change, disabling the receive idle mode. The receive attenuator will then be at a setting determined solely by the volume control.

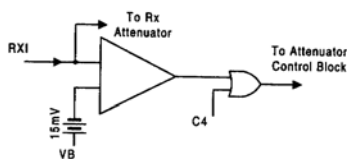


Fig.4 Dial Tone detector

The purpose of this circuit is to prevent the dial tone( which would be considered as continuous noise) from fading away as the circuit would have the tendency to switch to the idle mode. By disabling the receive idle mode, the dial tone remains at the normally expected full level.

### AGC

The AGC circuit affects the circuit only in the receive mode, and only when the supply voltage( Vcc) is less than 3.5 volts. As Vcc falls below 3.5 volts., the transmit path attenuation changes such that the sum of the transmit and receive gains remains constant. The purpose of this feature is to reduce the power( and current) used by the speaker when a line-powered speakerphone is connected to a long line, where the available power is limited. By reducing the speaker power, the voltage sag at Vcc is controlled, preventing possible erratic operation.

### ATTENUATOR CONTROL BLOCK

The Attenuator control block has the seven inputs described below:

- \*The output of the comparator operated by RLO2 and TLO2( microphone/ speaker side), designated C1.
- \*The output of the comparator operated by RLO1 and TLO1( Tip/ Ring side), designated C2.
- \*The output of the transmit background noise monitor, designated C3.
- \*The output of the receive background noise monitor, designated C4.
- \* The volume control
- \* The dial tone detector
- \* The AGC circuit

The single output of the control block controls the two attenuators. The effect of C1~C4 is as follows:

INPUTS				OUTPUT MODE
C1	C2	C3	C4	
Tx	Tx	1	X	Transmit
Tx	Rx	Y	Y	Fast Idle
Rx	Tx	Y	Y	Fast Idle
Rx	Rx	X	1	Receive
Tx	Tx	0	X	Slow Idle
Tx	Rx	0	0	Slow Idle
Rx	Tx	0	0	Slow Idle
Rx	Rx	X	0	Slow Idle

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A definition of the above terms:

1. "Transmit" means the transmit attenuator is fully on( +6dB). And the receive attenuator is at max. attenuation ( -46dB).
2. "Receive" means both attenuators are controlled by the volume control. At max. volume the receive attenuator is fully on( +6dB), and the transmit attenuator is at max.attenuation( -46dB).
3. "Fast Idle" means both transmit and receive speech are present in approximately equal levels. The attenuators are quickly switched(30 ms) to idle until one speech level dominates the other.
4. "Slow Idle" means speech has ceased in both transmit and receive paths. The attenuators are then slowly switched(1 second) to the idle mode.
5. Switching to the full transmit or receive from any other mode is at the fast rate(~30 ms).

A summary of the truth table is as follows:

1. The circuit will switch to transmit if: (A) both transmit level detectors sense signals relative to the respective receive level detectors( TLI1 versus RLI1, TLI2 versus RLI2) and (B) the transmit background noise monitor indicates the presence of speech.
2. The circuit will switch to receive if: (A) both receive level detectors sense higher signal levels relative to the respective transmit level detectors and (B) the receive background noise monitor indicates the presence of speech.
3. The circuit will switch to the fast Idle mode if the level detectors disagree on the relative strengths of the signal levels, and at least one of the background noise monitor indicates speech. For example, referring to the Figure 2, if there is sufficient signal at the microphone amp. Output(TLI2) to over-ride the speaker signal(RLI2), and there is sufficient signal at the receive input(RLI1) to over-ride the signal at the hybrid output(TLI1), and either or both background noise monitors indicates speech, then the circuit will be in the fast idle mode. Two conditions which can cause the fast idle mode to occur are : (A) when both talkers are attempting to gain control of the system by talking at the same time. And (B) when one talker is in a very noisy environment, forcing the other to continually over-ride that noise level. In general, the fast idle mode will occur infrequently.
4. The circuit will switch to the slow idle mode when: (A) both talkers are quiet( no speech present) or (B) when one talker's speech level is continuously over-ride, by noise at the other speaker's location. The time required to switch the circuit between transmit, receive, fast idle, and slow idle is determined in part by the components at the CT pin( pin14), (see the section on switching timers for a more complete explanation of the switching time components A schematic of the CT circuitry is shown in Figure 5, and operates as follows:  
 \*RT is typically 120k $\Omega$ , and CT is typically 5 $\mu$ F.  
 \*To switch to the receive mode, I1 is turned on( I2 is off), charging the external capacitor to +240mV above VB( An internal clamp prevents further charging of the capacitor).  
 \*To switch to the transmit mode, I2 is turned on( I1 is off), bringing down the voltage on the capacitor to -240mV with respect VB.  
 \*To switch to idle quickly(fast idle), the current sources are turned off, and the internal 2k $\Omega$  resistor is switched in, discharging the capacitor to VB with a time constant= 2k $\Omega$  x CT.  
 \*To switch to idle slowly(slow idle), the current sources are turned off, the switch at the 2k $\Omega$  resistor is open, and the capacitor discharges to VB through the external resistor RT with a time constant=RT x CT.

## UTC MC34118 LINEAR INTEGRATED CIRCUIT

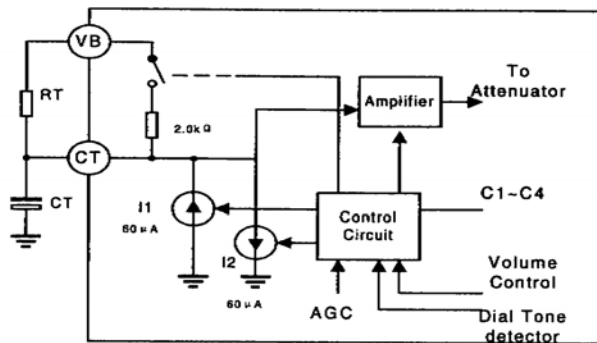


Fig. 5. CT Attenuator control block circuit

### MICROPHONE AMPLIFIER

The microphone amplifier( Pins 10, 11) has the non-inverting input internally connected to VB while the inverting input and the output are pinned out. Unlike most op-amps., the amplifier has an all-NPN output stage, which maximizes phase margin and gain bandwidth. This feature ensures stability at gains less than unity, as wide range of reactive loads. The open loop gain is typically 80dB( $f < 100\text{Hz}$ ), and the gain bandwidth is typically 1MHz. The maximum p-p output swing is typically 1 volt. less than  $V_{cc}$  with an output impedance of  $< 10\Omega$  until current limiting is reached( typically 1.5mA). Input bias current at MCI is typically 40nA out of the pin. The muting function( Pin 12), when activated, will reduce the gain of the amplifier to  $\sim -39\text{dB}$ ( with  $R_{MI}=5.1\text{k}\Omega$ ) by shorting the range of ground and  $V_{cc}$ . If the mute function is not used, the pin should be grounded.

### HYBRID AMPLIFIER

The two hybrid amplifiers( at HTO+, HTO-, and HTI), in conjunction with an external transformer, provide the two-to-four wire converter for interfacing to the telephone line. The gain of the first amplifier( HTI to HTO-) is set by external resistors( gain =  $-R_{HF}/R_{HI}$  in Block Diagram), and its output drives the second amplifier, the gain of which is internally set at -1. Unlike most op-amps., the amplifiers have an all- NPN output stage, which maximizes phase margin and gain-bandwidth. This feature ensures stability at gains less than unity, as with a wide range of reactive loads. The open loop gain of the first amplifier is typically 80dB, and the gain-bandwidth of each amplifier is  $\sim 1\text{MHz}$ . The maximum p-p output swing is typically 1.2 volts. less than  $V_{cc}$  with an output impedance of  $< 10\Omega$  until current limiting is reached( typically 8mA). The output current capability is guaranteed to be a minimum of 5mA. The bias current at HTI is typically 30nA out of the pin. The connections to the coupling transformer are shown in the Block Diagram. The block labeled ZBal is the balancing network necessary to match the line impedance.

### FILTER

The operation of the filter circuit is determined by the external components. The circuit within the UTC MC34118, from pins FI to FO is a butter with a high input impedance( $> 1\text{M}\Omega$ ), and a low output impedance( $< 50\Omega$ ). The configuration of the external components determines whether the circuit is a high-pass filter( as shown in Block Diagram), a low-pass filter, or a band-pass filter. As a high-pass filter, with the components shown in Figure 6, the filter will keep out 60Hz( and 120Hz) hum which can be picked up by the external telephone lines. As a low-pass filter, with the components shown in Figure 7, it can be used to roll off the high end frequencies in the receive circuit, which aids in protecting against acoustic feedback problems, with an appropriate choice of an input coupling capacitor to the low-pass filter, a band pass filter is formed.

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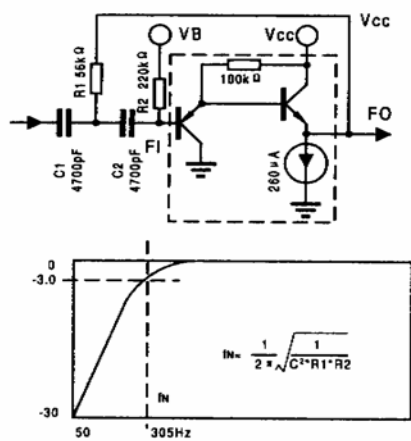


Fig.6 High Pass Filter

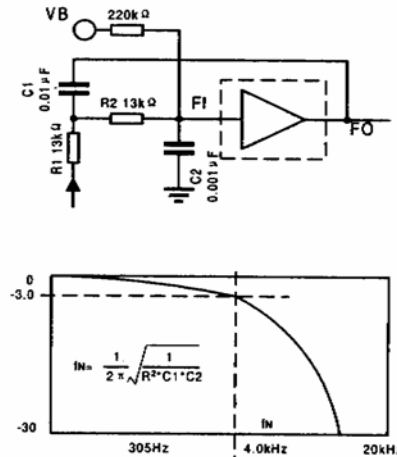


Fig 7. Low Pass Filter

### POWER SUPPLY, VB, and CHIP DISABLE

The power supply voltage at Vcc (Pin 4) is to be between 3.5 and 6.5 volts, for normal operation, with reduced operation possible down to 2.8 volts. The output voltage at VB (Pin 15) is  $\sim(V_{cc}-0.7)/2$ , and provides the AC ground for the system. The output impedance at VB is  $\sim 400\Omega$  and in conjunction with the external capacitor at VB, forms a low pass filter for power supply rejection. The choice of capacitor is application dependent based on whether the circuit is powered by the telephone line or power supply. Since VB biases the microphone and hybrid amplifiers, the amount of supply rejection at their outputs is directly related to the rejection at VB, as well as their respective gains. The Chip Disable (Pin 3) permits powering down the IC to conserve power and/or for muting purposes. With  $CD < 0.8$  volts., normal operation is in effect. With  $CD > 2$  volts. and  $< V_{cc}$ , the IC is powered down. In the powered down mode, the microphone and the hybrid amplifiers are disabled, and their outputs go to a high impedance state. Additionally, the bias is removed from the level detectors. The bias is not removed from the filter (Pin 1, 2), the attenuators (Pin 8, 9, 21, 22), or from Pins 13, 14, and 15 (the attenuators are disabled, however, and will not pass a signal impedance at CD is typically  $90k\Omega$ , has a threshold of  $\sim 1.5$  volts., and the voltage at this pin must be kept within the range of ground and Vcc). If CD is not used, the pin should be grounded.

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