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MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MC33218

Advance Information

Voice Switched Speakerphone with Microprocessor Interface

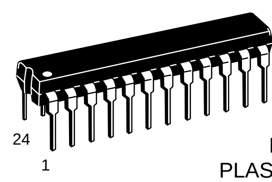
VOICE SWITCHED SPEAKERPHONE with µPROCESSOR INTERFACE

The Motorola MC33218 Voice Switched Speakerphone Circuit incorporates the necessary amplifiers, attenuators, level detectors, and control algorithm to form the heart of a high quality, hands-free speakerphone system. Included are a microphone amplifier with mute, transmit and receive attenuators, a background monitoring system for both transmit and receive paths, and level detectors for each path. An AGC system reduces the receive gain on long lines where loop current and power are in short supply. A dial tone detector prevents loss of dial tone.

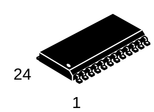
Additionally, the MC33218 has a serial data port which allows microprocessor control of various functions such as volume control, mute, attenuator range selection, and selection of receive, transmit, idle, or normal mode. The data port can be operated up to 1.0 MHz.

The MC33218 is available in a 24 pin, narrow body DIP, and a wide body SOIC package.

- Supply Voltage Range: 2.7 to 3.5 V
- Attenuator Range: 52 dB or 26 dB (Selectable)
- Background Noise Monitor for Each Path
- Microphone Amplifier with Mute Function
- Two Point Signal Sensing
- Microprocessor Port for 8-bit Serial Data Entry Controls:
  - Digital Volume Control (16 Steps)
  - Attenuator Range Selection (52 dB or 26 dB)
  - Mute Microphone Amplifier
  - Force to Receive, Transmit, Idle, or Normal Operating Mode
- Chip Deselect Pin Powers Down Entire IC

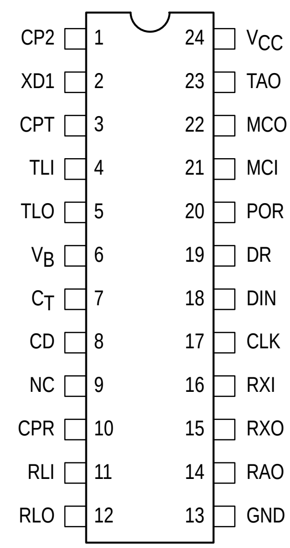


P SUFFIX
PLASTIC PACKAGE
CASE 724



DW SUFFIX
PLASTIC PACKAGE
CASE 751E
(SO-24L)

PIN CONNECTIONS

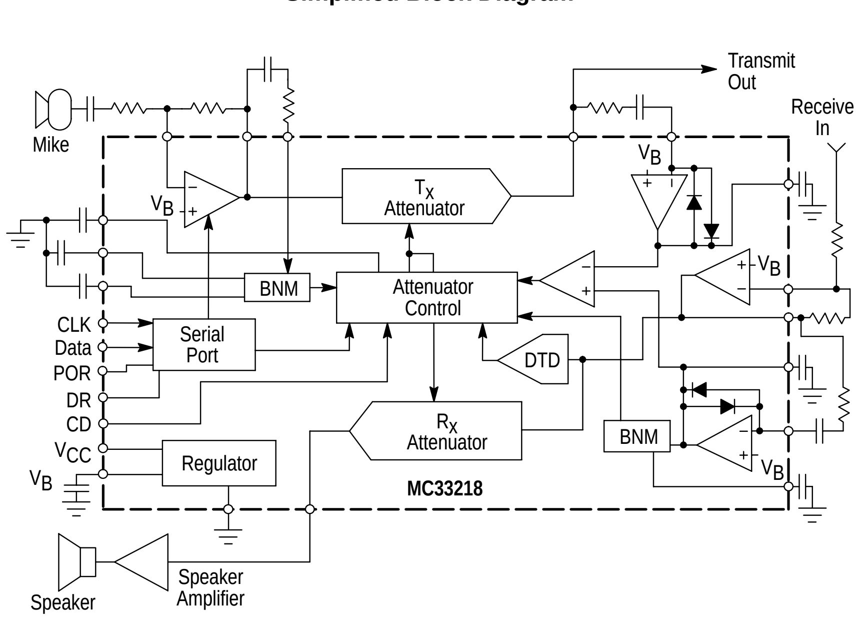


(Top View)

ORDERING INFORMATION

Device	Temperature Range	Package
MC33218DW	– 40° to + 85°C	SO-24L
MC33218P		Plastic DIP

Simplified Block Diagram



Rev 2

MAXIMUM RATINGS

Characteristic	Symbol	Min	Max	Unit
Supply Voltage	V_{CC}	– 0.5	+7.0	Vdc
Maximum Junction Temperature	T_J	—	+150	°C
Storage Temperature Range	T_{stg}	– 65	+150	°C

Devices should not be operated at or outside these values. The “Recommended Operating Limits” table provides for actual device operation.

RECOMMENDED OPERATING LIMITS

Characteristic	Symbol	Min	Typ	Max	Unit
Supply Voltage (Non-AGC Range) (AGC Range, See Text)	V_{CC}	3.5 2.7	— —	6.5 3.5	Vdc
Maximum Attenuator Input Signal	$V_{in(max)}$	—	—	350	mVrms
Clock and Data Rate (Serial Port)	F_{Data}	0	—	1.0	MHz
Operating Temperature Range	T_A	– 40	—	+ 85	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{CC} = 5.0 V, CD ≤ 0.8 V, f_{CLK} = 1.0 MHz, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
POWER SUPPLY					
Supply Current (Enabled, CD = 0) Idle Mode Receive Mode Transmit Mode	I_{CC}	 3.0 — —	 4.0 5.0 5.0	 6.0 — —	mA
Supply Current (Disabled, CD = 1)	I_{CC}	—	50	85	µA
CD Input Resistance	R_{CD}	170	250	300	kΩ
V_B Output Voltage (I_{VB} = 0)	V_B	2.1	2.2	2.3	Vdc
V_B Output Resistance	R_{OVB}	—	300	—	W
ATTENUATOR CONTROL					
C_T Voltage (Full Attenuation Range) R_X Mode Idle Mode T_X Mode	$V_{CT} – V_B$	 — — —	 +150 0 – 105	 — — —	mV
C_T Current Source (Switching to R_X Mode) Sink (Switching to T_X Mode) Idle	 I_{CTR} I_{CTT} I_{CTI}	 – 55 65 – 3.0	 – 40 85 0	 – 25 115 3.0	µA
Receive Dial Tone Detector Threshold	V_{DT}	– 40	– 20	– 8.0	mV

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{CC} = 5.0 V, CD ≤ 0.8 V, f_{CLK} = 1.0 MHz, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ATTENUATORS					
Receive Attenuator Gain (f = 1.0 kHz)					dB
Full Volume, Full Attenuation Range					
R_X Mode	G_{RX}	3.0	6.0	9.0	
T_X Mode	G_{RXT}	– 49	– 46	– 43	
Idle Mode	G_{RXI}	– 28	– 25	– 22	
Range (R_X to T_X Mode)	ΔG_{RX}	49	52	55	
Full Volume, Half Attenuation Range					dB
R_X Mode	G_{RX}	– 10	– 7.0	– 4.0	
T_X Mode	G_{RXT}	– 37	– 34	– 31	
Idle Mode	G_{RXI}	– 28	– 25	– 22	
Range (R_X to T_X Mode)	ΔG_{RX}	23	26	29	
Volume Control Range (Rx Mode)	V_{CR}	31	37	41	dB
AGC Attenuation Range (V_{CC} = 3.5 to 2.7 V)	G_{AGC}	—	6.0	—	dB
RAO Offset Voltage With Respect to V_B	V_{RAO}				mVdc
(R_X Mode)		—	– 10	—	
(T_X Mode)		—	0	—	
Transmit Attenuator Gain (f = 1.0 kHz)					dB
Full Attenuation Range					
T_X Mode	G_{TX}	3.0	6.0	9.0	
R_X Mode	G_{TXR}	– 49	– 46	– 43	
Idle Mode	G_{TXI}	– 19	– 16	– 13	
Range (T_X to R_X Mode)	ΔG_{TX}	49	52	55	
Half Attenuation Range					
T_X Mode	G_{TX}	– 9.0	– 6.0	– 3.0	
R_X Mode	G_{TXR}	– 36	– 33	– 30	
Idle Mode	G_{TXI}	– 19	– 16	– 13	
Range (T_X to R_X Mode)	ΔG_{TX}	23	26	29	
TAO Offset Voltage With Respect to V_B	V_{TAO}				mVdc
(R_X Mode)		—	0	—	
(T_X Mode)		—	– 60	—	
RAO, TAO					Vdc
High Voltage (I_L = – 1.0 mA)	V_{TAOH}	3.7	4.1	—	
Low Voltage (I_L = +1.0 mA)	V_{TAOL}	V_B – 1.0	V_B – 1.4	V_B – 3.0	
AMPLIFIERS — Microphone Amplifier					
Output Offset with Respect to V_B	MCO_{VOS}	—	0	—	mVdc
Open Loop Gain (f < 100 Hz)	A_{VOL}	—	80	—	dB
Gain Bandwidth	GBW	—	0.8	—	MHz
Output High Voltage (I_{out} = – 1.0 mA)	V_{MCOH}	3.7	4.1	—	Vdc
Output Low Voltage (I_{out} = +1.0 mA)	V_{MCOL}	0	140	250	mVdc
Transmit Path Muting (Δ Gain) Pin 21 to Pin 23	GMT				dB
Microphone Amp (R_{Fdbk} = 300 kΩ), plus Transmit Attenuator in R_X Mode		80	125	—	
AMPLIFIERS — Receive Amplifier					
DC Voltage (R_X Mode)	V_{RXO}	—	V_B	—	Vdc
Output High Voltage (I_{out} = – 1.0 mA)	V_{RXOH}	3.7	4.0	—	Vdc
Output Low Voltage (I_{out} = +1.0 mA)	V_{RXOL}	—	100	250	mVdc

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_{CC} = 5.0 V, CD ≤ 0.8 V, f_{CLK} = 1.0 MHz, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
LEVEL DETECTORS AND BACKGROUND NOISE MONITORS					
Transmit/Receive Switching Threshold	I_{TH}	0.8	1.0	1.2	µA/µA
CPR, CPT Output Resistance	R_{CP}	—	5.0	—	W
CPR, CPT Leakage Current	I_{CPLK}	—	– 0.1	—	µA
T_X and R_X Level Detector					
Source Current	I_{LDOH}	—	– 2.6	—	mA
Sink Current	I_{LDOL}	—	2.0	—	µA
CLOCK AND DATA					
POR Input Resistance	R_{POR}	70	115	160	kΩ
Data In/Clock Input Resistance	R_{CLK}				kΩ
(High) V_{in} = 5.0 V		35	55	85	
(Low) V_{in} = 0.9 V		70	120	160	
Data Ready Input Resistance	R_{DR}				kΩ
(High) V_{in} = 5.0 V		10	20	30	
(Low) V_{in} = 0.9 V		25	45	65	
Logic Input Threshold	V_{TH}	—	1.5	—	V
SYSTEM					
R_X Mode Distortion R_X Amplifier and Attenuator (f = 1.0 kHz, V_{in} = 350 mVrms)	THD_R	—	0.3	3.0	%
T_X Mode Distortion T_X Attenuator and Microphone Amplifier (f = 1.0 kHz, V_{in} = 3.5 mVrms)	THD_T	—	0.3	3.0	

TEMPERATURE CHARACTERISTICS (V_{CC} = 5.0 V, CD ≤ 0.8 V, f_{CLK} = 1.0 MHz, unless otherwise noted.)

Parameter	Typical Value @ – 40°C	Typical Value @ + 25°C	Typical Value @ + 85°C	Unit
V_{CC} Supply Current				
Idle Mode (Enabled, CD = 0)	4.7	4.2	3.7	mA
All Modes (Disabled, CD = 1)	60	50	75	µA
V_B	2.1	2.2	2.3	V
Receive Attenuator Range (f = 1.0 kHz) Full Volume				dB
Full Attenuation Range	52	52	53	
Half Attenuation Range	26	26	27	
Transmit Attenuator Range (f = 1.0 kHz)				dB
Full Attenuation Range	52	52	53	
Half Attenuation Range	26	26	27	
Transmit Path Muting (Δ Gain, Pin 21 to 23)				dB
Microphone Amp (R_{Fdbk} = 300 kΩ), plus Transmit Attenuator in R_X Mode	128	127	128	
Volume Control Range (R_X Mode)	34	36	40	dB

PIN FUNCTION DESCRIPTION

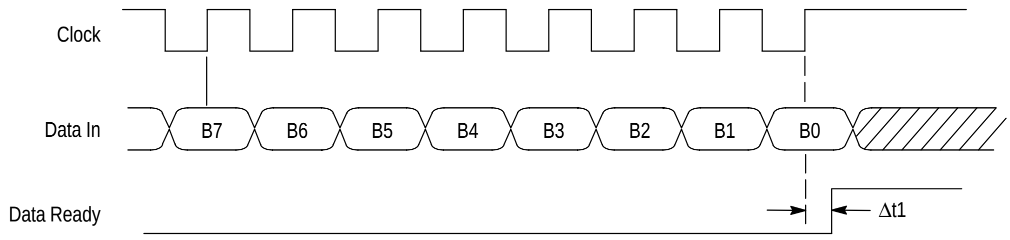
Name	Pin No.	Description
CP2	1	A capacitor at this pin stores a voltage representing the transmit background noise level.
XDI	2	Input to the transmit background noise monitor.
CPT	3	An RC sets the time constant for the transmit background noise monitor.
TLI	4	Input to the transmit level detector.
TLO	5	Output of the transmit level detector.
V_B	6	A reference voltage, and analog ground for the amplifiers.
C_T	7	An RC sets the response time to switch among the various modes.
CD	8	Chip deselect (Logic input). When low, the IC is active. When high, the entire IC is powered down and non-functional.
NC	9	No internal connection.
CPR	10	An RC sets the time constant for the receive background noise monitor.
RLI	11	Input to the receive level detector.
RLO	12	Output of the receive level detector.
GND	13	Ground pin for the entire IC.
RAO	14	Output of the receive attenuator.
RXO	15	Output of the receive path input amplifier, and input of the receive attenuator.
RXI	16	Inverting input of the receive path input amplifier.
CLK	17	Serial Port Clock. 1.0 MHz maximum, data is entered on clock's rising edge.
D_{IN}	18	Serial Port Data Input. Enter an 8-bit word, B7 first, B0 last.
DR	19	Serial Port Data Ready. Taking this line high latches new data in the registers.
POR	20	Power On Reset. Upon power up and/or enabling, all bits are set to 0.
MCI	21	Inverting input of the microphone amplifier.
MCO	22	Output of the microphone amplifier, and input of the transmit attenuator.
TAO	23	Output of the transmit attenuator.
V_{CC}	24	Power Supply pin. Operating range is 2.5 V to 6.5 Vdc.

Bits	Code	Function
B7, B6	00 01 10 11	Normal voice switched operation. Force to receive mode. Force to idle mode. Force to transmit mode.
B5	0 1	Attenuator range is 52 dB. Attenuator range is 26 dB.

Bits	Code	Function
B4	0 1	Microphone amplifier is active. Microphone amplifier is mute.
B3 – B0*	0000 1111	Maximum receive volume. Minimum receive volume.

*Bit B0 is the LSB for the volume control.

Figure 1. Serial Port Timing Diagram



NOTES:
1. Maximum clock and data rate is 1.0 MHz. There is no required minimum rate.
2. B7 is to be entered first, B0 last.
3. Data is entered on the clock rising edge.
4. Clock can continue to toggle after B0 is entered if Data Ready goes high before the clock's next rising edge.
5. Clock-to-data setup and hold times, and minimum Δt1 to be determined.
6. Upon power up, all bits are internally set to logic 0.

Figure 2. Typical Application

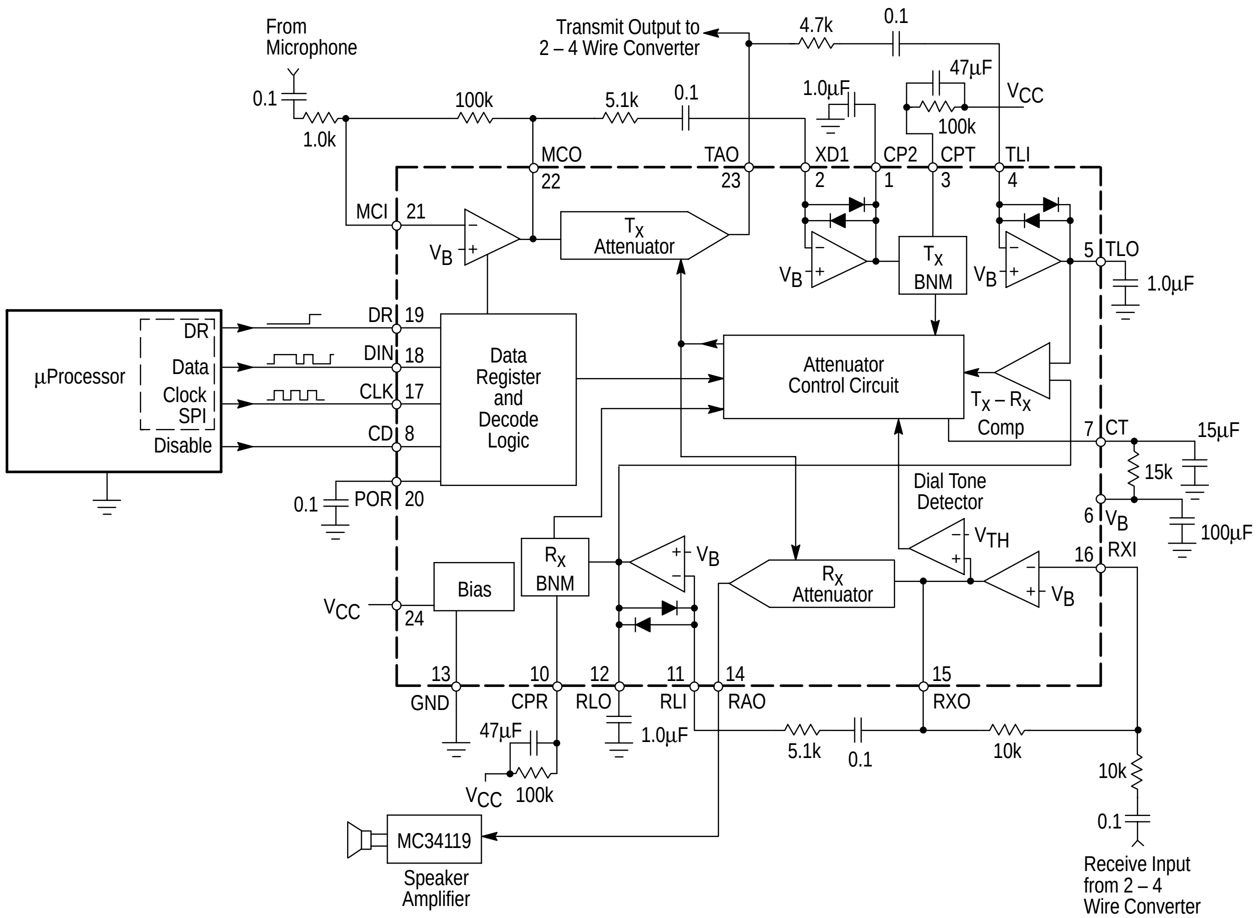


Figure 3. Attenuator Gain versus V_{CT}

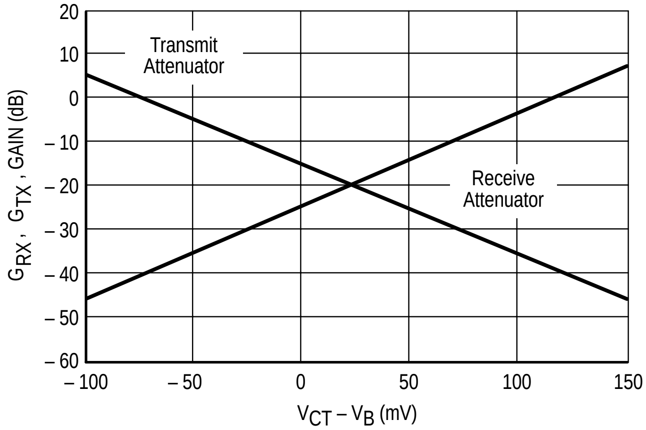


Figure 4. Attenuator Gain versus V_{CT} (Half Attenuation Range)

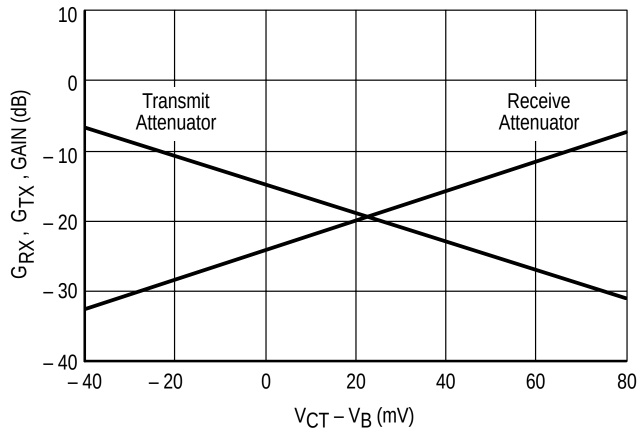


Figure 5. Level Detector DC Transfer Characteristics

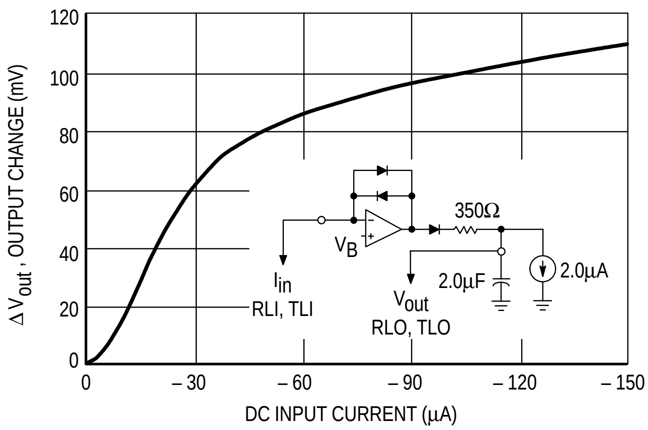


Figure 6. Level Detector AC Transfer Characteristics

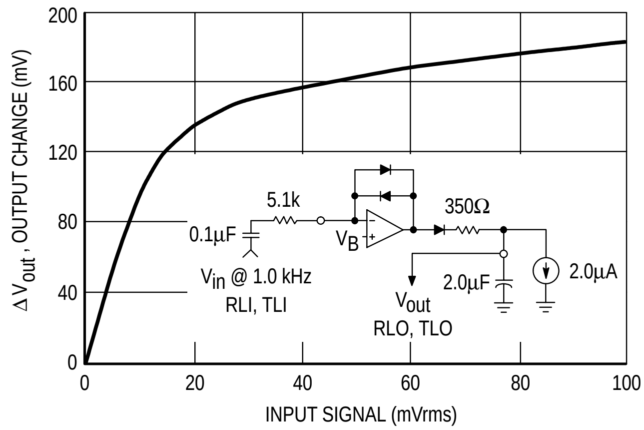


Figure 7. Level Detector AC Transfer Characteristic versus Frequency

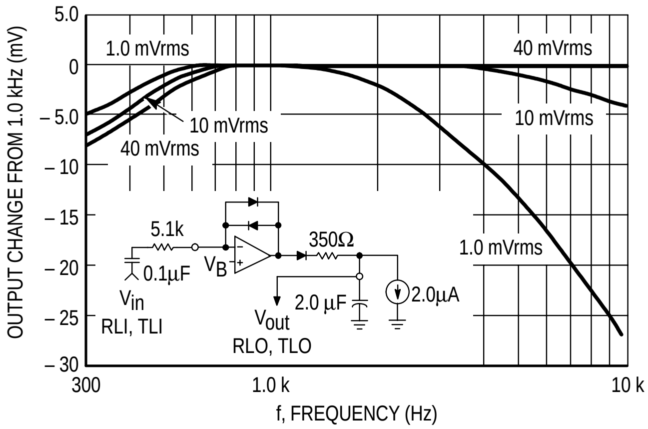


Figure 8. Receive Gain versus Volume Setting

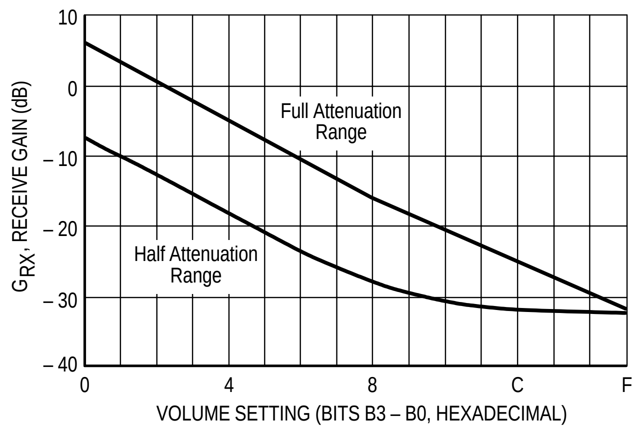


Figure 9. Supply Current versus Supply Voltage

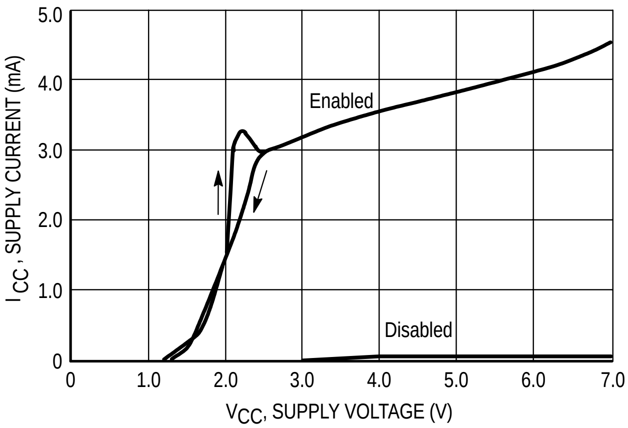


Figure 10. CD Input Characteristics

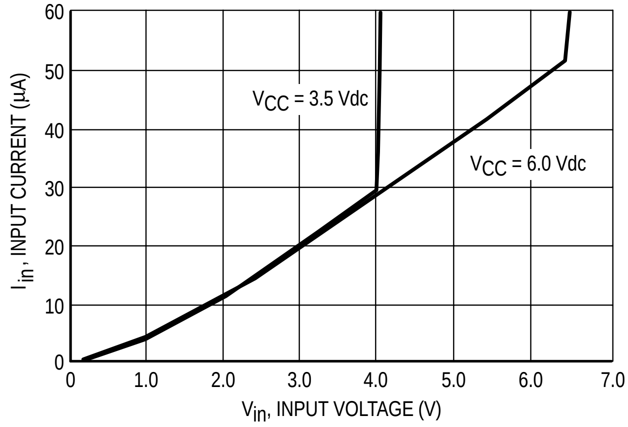


Figure 11. V_B Output Characteristics

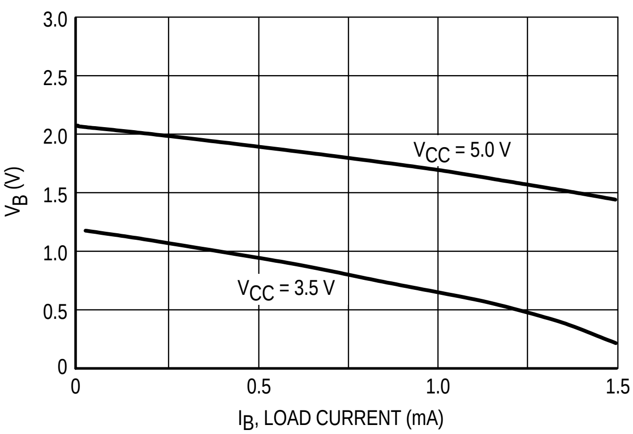


Figure 12. Typical Output Swing versus V_{CC}

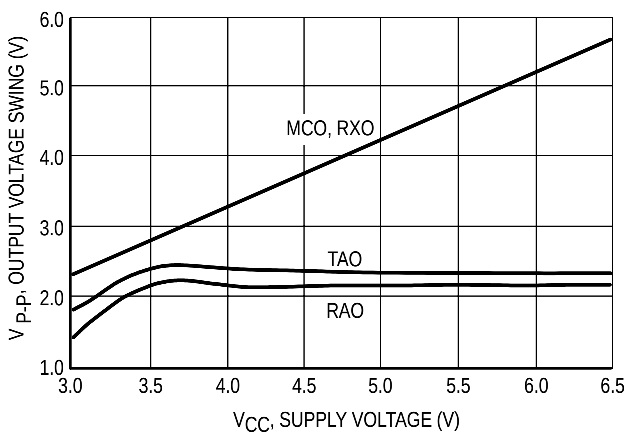


Figure 13. V_B Power Supply Rejection versus Frequency

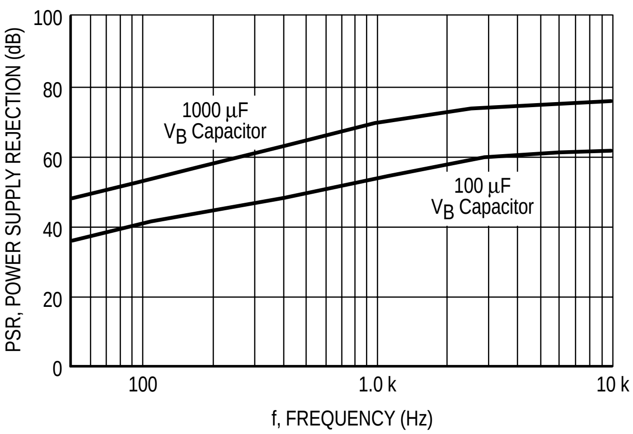


Figure 14. Data Ready, Data In, and Clock Input Characteristics

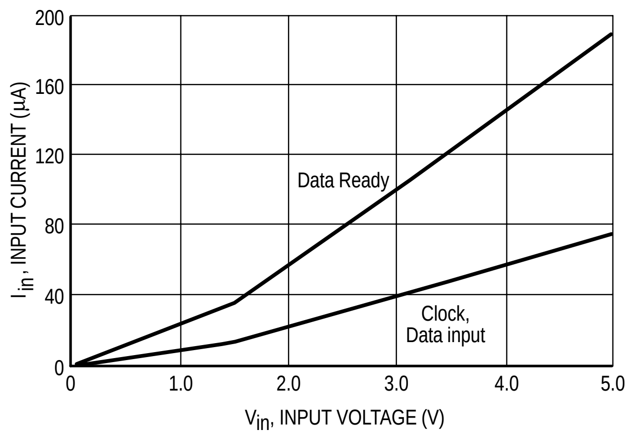
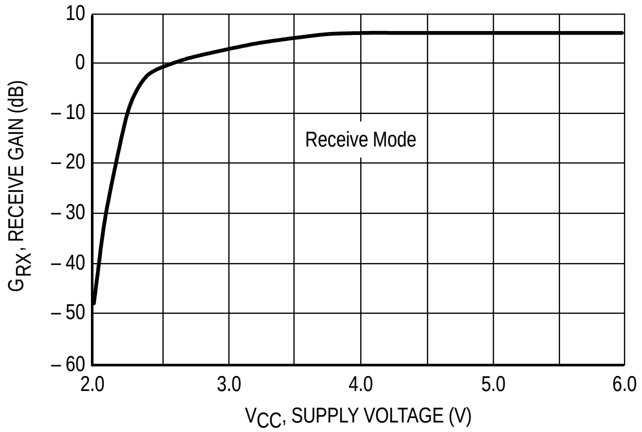


Figure 15. Receive Attenuator Gain versus V_{CC}



APPLICATIONS INFORMATION

Introduction

The MC33218 provides the necessary circuitry to perform a voice switched, half duplex, speakerphone function. The half duplex function is necessary to prevent oscillation resulting from the high gain and acoustic coupling. It includes transmit and receive attenuators, preamps, level detectors, and background noise monitors. An attenuator control circuit automatically adjusts the gain of the transmit and receive attenuators based on the microprocessor inputs and/or the relative strengths of the voice signals present.

Power Supply, V_B, and Chip Disable

The power supply voltage at Pin 24 is to be between 3.5 and 6.5 V for normal operation, with reduced operation possible down to 2.7 V (see AGC section).

The output voltage at V_B (Pin 6) is approximately equal to (V_{CC} – 0.7)/2, and provides the AC ground for the system. The output impedance at V_B is approximately 300 Ω (see Figure 9), and in conjunction with the external capacitor at V_B, forms a low pass filter for power supply rejection. The choice of V_B capacitor is application dependent based on whether the circuit is powered by the telephone line or a power supply.

The Chip Disable (Pin 8) permits powering down the IC for power conservation. With CD between 0 and 0.8 V, normal operation is in effect. With CD between 2.0 V and V_{CC}, the IC is powered down. When the IC is re-enabled, the speakerphone should return to normal mode (bits B0 – B7 equal to 0).

Transmit and Receive Attenuators

The transmit and receive attenuator sections are complementary, performing a log-antilog function. When one is at maximum gain, the other is at maximum attenuation; they are never both fully on or fully off. Both attenuators are controlled by a single output from the attenuator control which ensures the sum of their gains will remain constant at a typical value of – 40 dB. Their purpose is to provide the half-duplex operation required in a speakerphone. They are identical, and consist of a pre-amp, an input clamp, an attenuator, and a current to voltage converter. An internal control voltage determines the gain of each attenuator.

The inputs to the attenuators should not exceed 400 mVrms to prevent distortion.

Attenuator Control Section

There are five inputs to the attenuator control section: one each from the transmit/receive level comparator, dial tone detector, control logic block and transmit and receive background noise monitors. A single output sets the gain of both the transmit and receive attenuators.

A DC feedback loop samples the output current of the attenuator that is at full gain and compares it to a reference current. The resultant error current then drives an external resistor and capacitor at the C_T pin which corrects the control voltage, maintaining the desired attenuator gain. The external RC on the C_T pin determines the response time of the speakerphone.

Background Noise Monitors

The purpose of background noise monitors is to distinguish speech (which consists of bursts) from background noise (a relatively constant level). There are two background noise monitors — one for the receive path and one for the transmit path. Each is operated on by a level detector, which provides a DC voltage representative of the noise level. The voltages at the CPT and CPR pins have slow rise times (determined by an external RC), but fast decay times. When speech is present, the voltage on the non-inverting input of an internal comparator will rise faster 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 time constant of the external RCs (Pins 3 and 10) determine the response time to background noise variations.

Dial Tone Detector

Since the dial tone is considered continuous noise, the background noise monitor would tend to force the attenuators back to idle mode. The dial tone detector prevents the IC from changing to idle mode, thus preventing the dial tone from fading away. The dial tone detector is a comparator with one side connected to the input of the receive attenuator and the other input connected to V_B with a 15 mV offset. If the circuit is in the receive mode and the incoming signal is greater than 15 mV, the comparator's output will change, disabling the receive idle mode. The receive attenuator gain will then be determined solely by the volume control.

AGC

In the receive mode, the AGC circuit decreases the gain of the receive attenuator when the supply voltage at V_{CC} falls below 3.5 V to prevent the speaker from clipping or distorting. 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 telephone line, where the available power is limited. Reducing the speaker power controls the voltage sag at V_{CC} and prevents clipping and distortion on the speaker output.

Microprocessor Control

The data register and decode logic are used to interface the data from the serial port to the required internal circuitry. This enables microprocessor control of the following functions:

Volume Control (16 levels)
Microphone Mute
Attenuator Range (52 dB or 26 dB)
Mode Select: Normal, Transmit, Receive, Idle

The logic inputs should not exceed V_{CC}, and they should never be allowed to go below ground. The maximum clock frequency is 1.0 MHz.

On power up, the internal registers are reset to all zeros (normal mode). An internal capacitor on the Power-on-Reset pin prevents the registers from accepting data input before the supply voltage has stabilized.

Volume Control

The volume control enables the receive attenuator gain to be increased or decreased in 16 equal 2.5 dB steps, independent of temperature, by microprocessor control. On power up, the volume control will be reset to maximum (bits B3 – B0 will be 0000). Bit B0 is the least significant bit (LSB), and bit B3 is the most significant bit (MSB). The transmit attenuator gain will be varied in a complementary manner.

Microphone Amplifier Mute

When activated by the microprocessor by pulling bit B4 high, it reduces the gain of the amplifier by approximately – 75 dB. For additional muting, force the Mode Select (bits B6 and B7) to receive during mute. This will ensure the transmit attenuator is at 46 dB of attenuation (in full range) and will provide a combined attenuation of 120 dB in the transmit path.

Attenuator Range Selection

Bit B5, the Attenuator Range Selector, provides a choice of 52 dB attenuation range (– 46 dB to + 6.0 dB, nominally) or 26 dB range (– 32 db to – 6.0 dB). At half attenuation, the volume control range will be reduced to approximately 26 dB (see Figure 6).

Mode

The MC33218 can be forced to transmit, receive, or idle mode by microprocessor input by using bits B7 and B6. The attenuators will be in the transmit mode for a (V_{CT}–V_B) of – 105 mV and the receive mode for a (V_{CT}–V_B) of + 150 mV. At idle mode, (V_{CT}–V_B) is approximately zero. The mode selection provides manual or remote control for testing, to overcome noise on the line, or to increase the transmit path attenuation during mute.

RFI Interference

Potential radio frequency interference (RFI) problems should be addressed early in the electrical and mechanical design of the speakerphone. RFI may enter the circuit through Tip and Ring, through the microphone wiring to the microphone amplifier, or through any of the PC board traces. The most sensitive pins on the MC33218 are the inputs to the level detectors (RLI, TLI) since, when there is no speech present, the inputs are high impedance and these op amps are in a near open loop condition. The board traces to these pins should be kept short, and the resistor and capacitor for each of these pins should be physically close to the pins. Any other high impedance input pin should also be considered sensitive to RFI signals.

In the Final Analysis

Proper operation of a speakerphone is a combination of proper mechanical (acoustic) design as well as proper electronic design. The acoustics of the enclosure must be considered early in the design of a speakerphone. In general, electronics cannot compensate for poor acoustics, low speaker quality, or any combination of the two. Proper acoustic separation of the speaker and microphone is essential. The physical location of the microphone, along with the characteristics of the selected microphone, will play a large role in the quality of the transmitted sound. The microphone and speaker vendors can usually provide additional information on the use of their products.

In the final analysis, the circuit shown in this data sheet will have to be fine tuned to match the acoustics of the enclosure, the specific hybrid, and the specific speaker and microphone selected. The components shown in this data sheet should be considered as starting points only. The gains of the transmit and receive paths are easily adjusted at the microphone and speaker amplifiers, respectively. The switching response can then be fine tuned by varying (in small steps) the components at the level detector inputs until satisfactory operation is obtained for both long and short lines.

For additional information on speakerphone design, please refer to the data sheet for the MC34118 Speakerphone IC.

GLOSSARY

AGC – *Automatic gain control*. In the speakerphone, the gain of the attenuators is reduced as the supply voltage decreases to prevent clipping or distortion on the output.

Attenuation – A decrease in magnitude of a communication signal, usually expressed in dB.

Bandwidth – The range of information carrying frequencies of a communication system.

C-Message Filter – A frequency weighting which evaluates the effects of noise on a typical subscriber's system.

Channel Separation – The ability of one circuit to reject outputting signals which are being processed by another circuit. Also referred to as *crosstalk*, it is usually expressed in dB.

dB – A power or voltage measurement unit, referred to another power or voltage. It is generally computed as:

$$10 \times \log (P1/P2) \text{ for power measurements, and}$$
$$20 \times \log (V1/V2) \text{ for voltage measurements.}$$

dBm – An indication of signal power. 1.0 mW across 600 Ω, or 0.775 Vrms, is typically defined as 0 dBm for telecom applications. Any voltage level is converted to dBm by:

$$\text{dBm} = 20 \times \log (\text{Vrms}/0.775)\text{, or}$$
$$\text{dBm} = [20 \times \log (\text{Vrms})] + 2.22.$$

dBmp – Indicates dBm measurement using a psophometric weighting filter.

dBrn – Indicates a dBm measurement relative to 1.0 pW power level into 600 Ω. Generally used for noise measurements, 0 dBrn = – 90 dBm.

dBrnC – Indicates a dBrn measurement using a C-message weighting filter.

DTMF – *Dual Tone Multi Frequency*. It is the “tone dialing” system based on outputting two non-harmonic related frequencies simultaneously to identify the number dialed. Eight frequencies have been assigned to the four rows and four columns of a typical keypad.

Four-Wire Circuit – The portion of a telephone or central office, which operates on two pairs of wires. One pair is for the Transmit path (generally from the microphone), and one pair is for the Receive path (generally from the receiver).

Full-Duplex – A transmission system which permits communication in both directions simultaneously. The standard handset telephone is full-duplex.

Gain – The change in signal amplitude (increase or decrease) after passing through an amplifier, or other circuit stage. Usually expressed in dB, an increase is a positive number, and a decrease is a negative number.

Half-Duplex – A transmission system which permits communication in one direction at a time. CB radios, with “push-to-talk” switches, and voice activated speakerphones, are half-duplex.

Hookswitch – A switch which connects the telephone circuit to the subscriber loop. The name derives from old telephones where the switch was activated by lifting the receiver off and onto a hook on the side of the phone.

Hybrid – Another name for a two-to-four wire converter.

Line Length Compensation – Also referred to as *loop compensation*, it involves changing the gain of the transmit and receive paths, within a telephone, to compensate for different signal levels at the end of different line lengths. A short line (close to the CO) will attenuate signals less, and therefore less gain is needed. Compensation circuits generally use the loop current as an indication of the line length.

Loop – The loop formed by the two subscriber wires (Tip and Ring) connected to the telephone at one end, and the central office (or PBX) at the other end. Generally it is a floating system, not referred to ground or AC power.

Loop Current – The DC current which flows through the subscriber loop. It is typically provided by the central office or PBX, and ranges from 20 to 120 mA.

Off-Hook – The condition when the telephone is connected to the phone system, permitting the loop current to flow. The central office detects the DC current as an indication that the phone is busy.

On-Hook – The condition when the telephone is disconnected from the phone system, and no DC loop current flows. The central office regards an on-hook phone as available for ringing.

Power Supply Rejection Ratio – The ability of a circuit to reject outputting noise, or ripple, which is present on the power supply lines. PSRR is usually expressed in dB.

Pulse Dialing – A dialing system whereby the loop current is interrupted a number of times in quick succession. The number of interruptions corresponds to the number dialed, and the interruption rate is typically 10 times per second. The old rotary phones, and many new pushbutton phones, use pulse dialing.

Receive Path – Within the telephone, it is the speech path from the phone line to the earpiece.

Ring – One of the two wires connecting the central office to a telephone. The name derives from the ring portion of the plugs used by operators (in older equipment) to make the connection. Ring is traditionally negative with respect to Tip.

Sidetone – The sound fed back to the receiver as a result of speaking into the microphone. It is a natural consequence of the 2-to-4 wire conversion system. Sidetone was recognized by Alexander Graham Bell as necessary for a person to be able to speak properly while using a handset.

Signal to Noise Ratio – The ratio of the desired signal to unwanted signals (noise) within a defined frequency range. The larger the number, the better.

Speech Network – A circuit which provides 2-to-4 wire conversion, i.e. connects the microphone and receiver (or the transmit and receive paths) to the Tip and Ring phone lines. Additionally, it provides sidetone control, and in many cases, the DC loop current interface.

Tip – One of the two wires connecting the central office to a telephone. The name derives from the tip of the plugs used by operators (in older equipment) to make the connection. Tip is traditionally positive with respect to Ring.

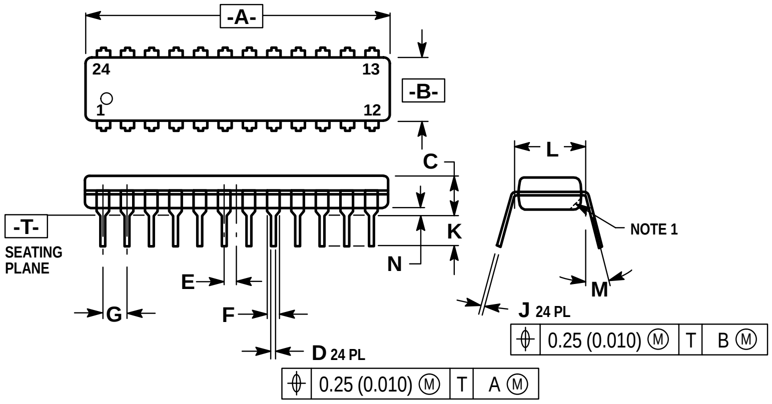
Transmit Path – Within the telephone, it is the speech path from the microphone to the phone line.

Two-to-Four Wire Converter – A circuit which has four wires (on one side); two (signal and ground) for the outgoing signal, and two for the incoming signal. The outgoing signal is sent out differentially on the two-wire side (the other side), and incoming differential signals received on the two-wire side are directed to the four-wire side. Additional circuitry within cancels the reflected outgoing signal to keep it separate from the incoming signal.

Voiceband – That portion of the audio frequency range used for transmission across the telephone system. Typically, it is 300 to 3400 Hz.

OUTLINE DIMENSIONS

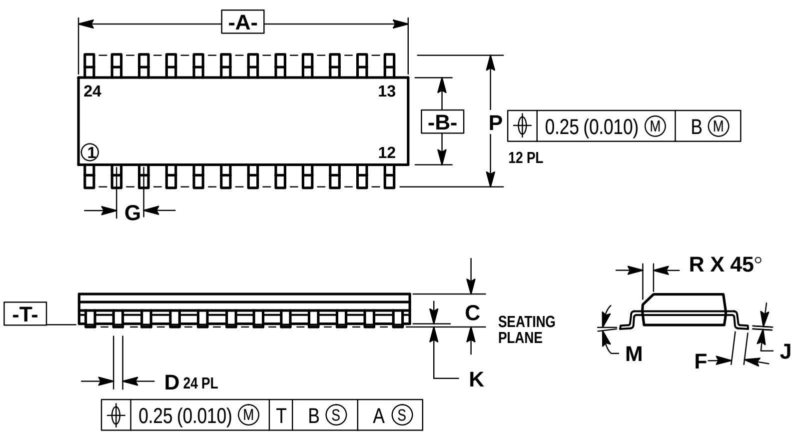
P SUFFIX
PLASTIC PACKAGE
CASE 724-03



NOTES:
1. CHAMFERRED CONTOUR OPTIONAL.
2. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.
4. CONTROLLING DIMENSION: INCH.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	31.25	32.13	1.230	1.265
B	6.35	6.85	0.250	0.270
C	3.69	4.44	0.145	0.175
D	0.38	0.51	0.015	0.020
E	1.27 BSC		0.050 BSC	
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
J	0.18	0.30	0.007	0.012
K	2.80	3.55	0.110	0.140
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.01	0.020	0.040

DW SUFFIX
PLASTIC PACKAGE
CASE 751E-03
(SO-24L)



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. 751E-01 AND -02 OBSOLETE, NEW STANDARD 751E-03.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	15.25	15.54	0.601	0.612
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.41	0.90	0.016	0.035
G	1.27 BSC		0.050 BSC	
J	0.229	0.317	0.0090	0.0125
K	0.127	0.292	0.0050	0.0115
M	0°	8°	0°	8°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029