MOTOROLA
SEMICONDUCTOR
APPLICATION NOTE

AN957

Interfacing The Speakerphone To The MC34010/11/13 Speech Networks

Prepared by
Dennis Morgan
Bipolar Analog IC Division

INTRODUCTION

Interfacing the MC34018 speakerphone circuit to the MC34010 series of telephone circuits is described in this application note. The series includes the MC34010, MC34011, MC34013, and the newer "A" version of each of those. The interface is applicable to existing designs, as well as to new designs.

FUNCTIONAL REQUIREMENTS

Figure 1 shows the basic MC34010 telephone circuit as described in the data sheet. It is a completely functional telephone meant for use with a handset, and provides the additional function of a microprocessor interface for the DTMF dialing function. The MC34011 does not have the microprocessor interface, but otherwise is identical, including the pin numbers. The MC34013 has the same speech network, dialer, and line interface circuit as the MC34010, but does not have the microprocessor interface or the tone ringer. Except for a minor difference between the speech networks of the "A" version parts and the "non-A" parts, the interface to the speakerphone circuit is virtually the same for all 6 parts.

Figure 2 shows the basic MC34018 speakerphone circuit as described in the data sheet. It is NOT a complete telephone, but provides only the speakerphone functions. It requires a speech network, such as the MC34010, to transfer the speech signals to/from the Tip & Ring lines, and to provide the required supply voltage. The four external connections — transmit output, receive input, dc line input, and chip select — are the points which must be interfaced to the speech network.

In the following text, only the MC34010 interface will be described. The interface to the other parts is the same except where noted.

When combining a speech network which operates a handset, with a speakerphone circuit, certain changes are required in the circuit operation when switching between the handset mode and the speakerphone mode, and additionally when the dialing mode is in effect. The four modes to be considered are: 1) using the handset for speech, 2) using the speakerphone for speech, 3) dialing in the handset mode, and 4) dialing in the speakerphone mode. The requirements are summarized in the following table:

Mode	MC34018	Vlr	Handset Mike	Speaker-phone Mike
Handset-Speech	Unpowered	Low	Live	N/A
Spkrphone Speech	Powered	High	Dead	Live
Handset-Dialing	Unpowered	Low	Dead	N/A
Spkrphone Dialing	Powered	High	Dead	Dead

Since the entire circuit is to be powered by the phone line, the speakerphone circuit is powered up only when it is to be used since it uses a portion of the loop current, (a significant portion on long loops). The MC34010, however, must be powered all the time since it is the interface to the phone line. The Vlr voltage mentioned in the table is the voltage across the resistor at the LR pin of the MC34010, which sets the dc characteristics of the circuit. By increasing that resistor, the dc supply voltage (and the voltage at Tip & Ring) will be increased in the speakerphone modes, where additional power is required.

The handset mike is to be functional only in the handset-speech mode. If it were functional in the speakerphone-speech mode, system oscillations and/or additional echoes could occur. Disabling the microphone is accomplished by activating the MM (Mike Mute) pin on the MC34010. On the MC34010A, activating the MM pin results in disabling the transmit amplifier, so in that case, a transistor is added to the microphone circuit as the means to disable it. In both dialing modes, muting is automatic whenever the dialer is activated, so the DTMF tones are not distorted by sounds entering the microphone.

The speakerphone mike is listed as N/A in the handset modes since the MC34018 circuit is unpowered, effectively disabling the mike. In the speakerphone dialing mode it must be non-functional for the same reason as mentioned above. That is accomplished by the fact that the MC34010 (and MC34010A) transmit amplifier is inoperative when its DTMF dialer is activated.

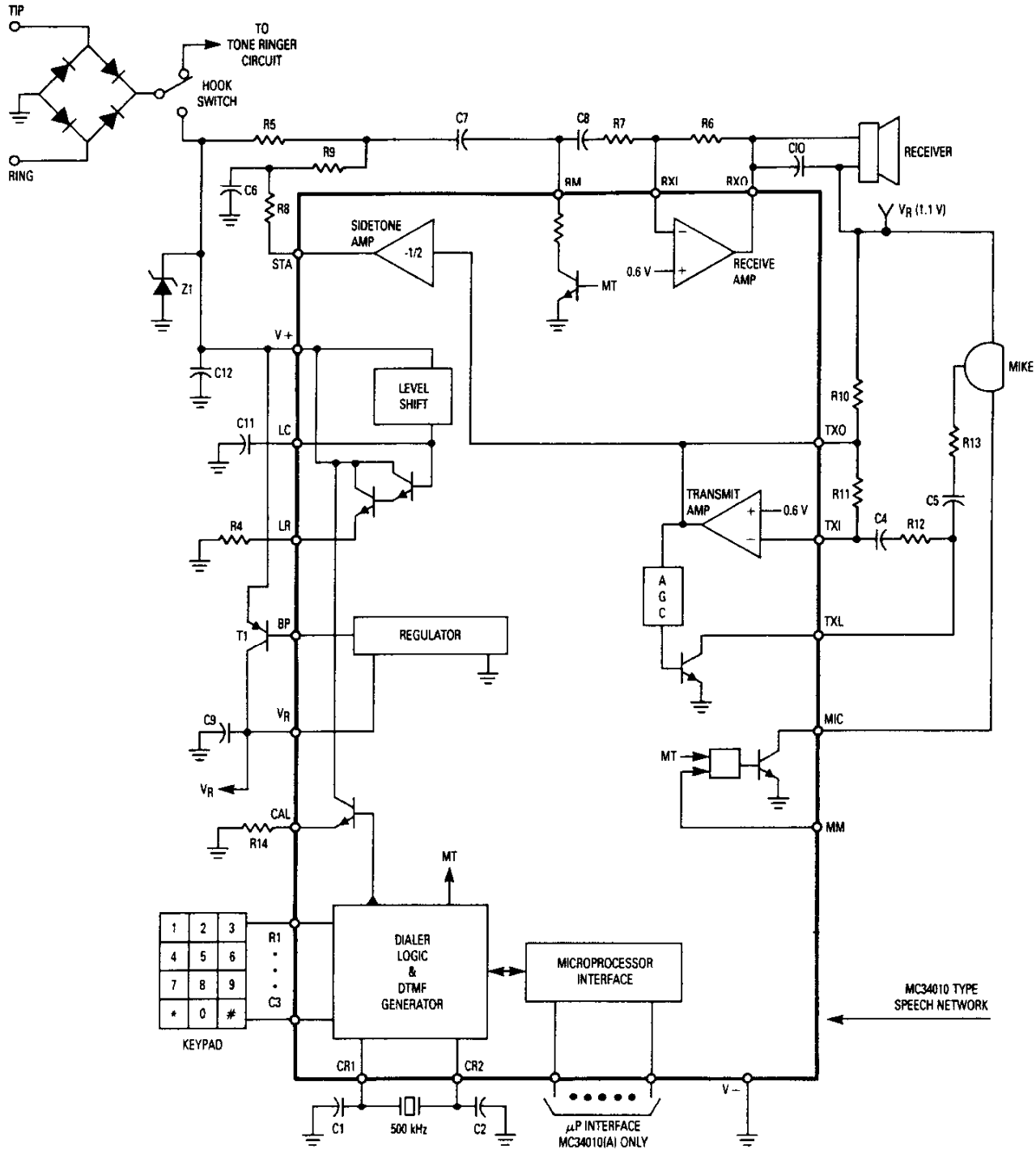


Figure 1. Basic MC34010 Type Telephone

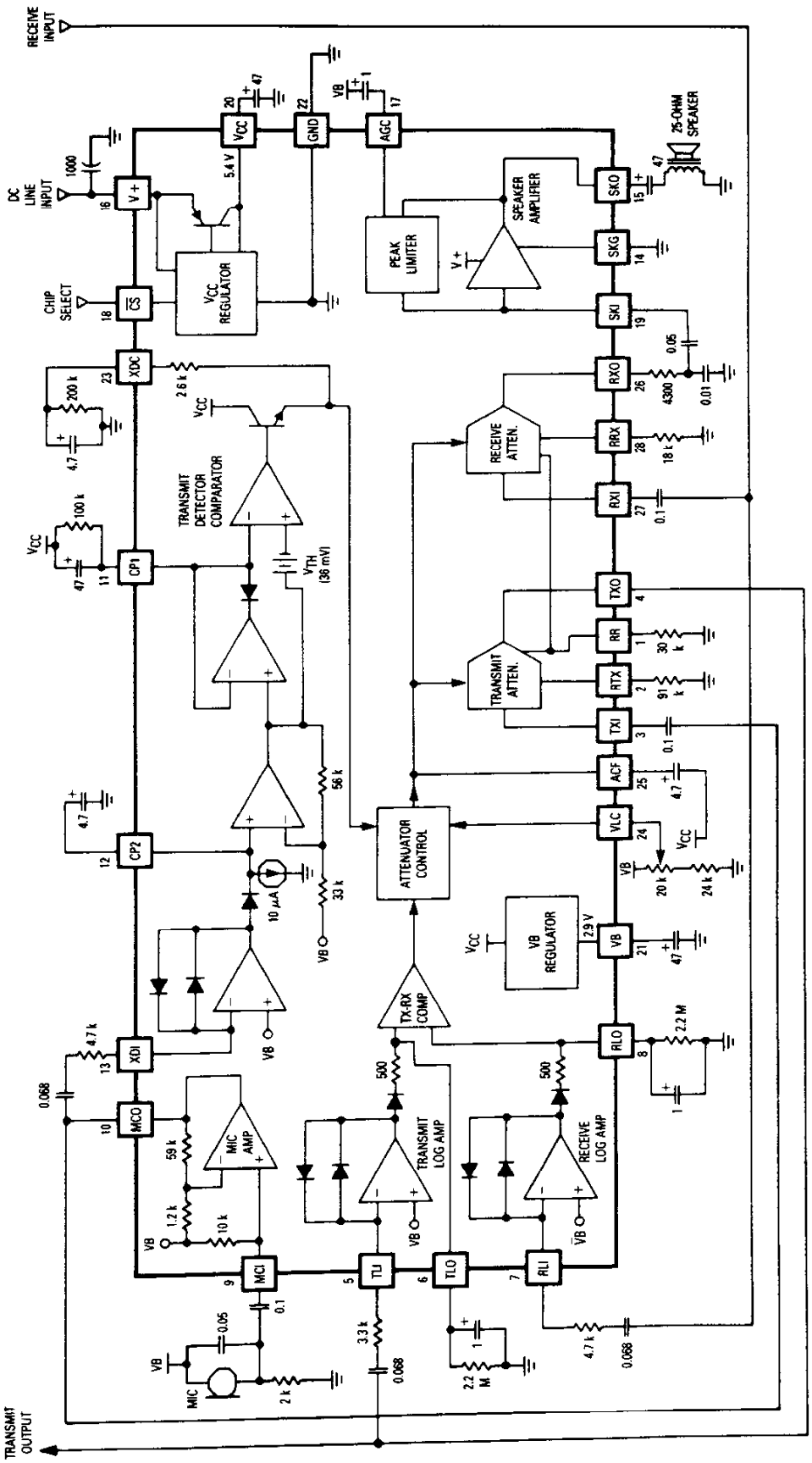


Figure 2. MC34018 Speakerphone Circuit

CIRCUIT DESCRIPTION

SWITCHING ARRANGEMENT

Figure 3 indicates the switching arrangement for going off-hook in either the handset mode or speakerphone mode, and for switching between them. S1 (a two pole switch) is the normal hook switch activated by lifting the handset. S2 (a two pole switch) is a manually operated switch which activates the speakerphone.

Whenever the handset is off-hook, and S2 is in the off position, power from Tip & Ring is applied to the MC34010 through the diode bridge and S1A. S1B's position is of no consequence in this mode. Should S2 be switched on while the handset is off-hook, power is then applied to the speakerphone IC through S2B. However, since S1B is open, the MC34018's $\overline{CS}$ pin (Chip Select) is taken high through R33, disabling the IC.

Anytime the handset is on-hook, and S2 is on (both poles closed), power is applied to both the MC34010 and the MC34018. Since S1B is closed, $\overline{CS}$ is taken low, enabling the speakerphone circuit. Anytime the handset is taken off-hook the circuit will revert back to the handset mode.

The 1.0 Henry inductor isolates the speech signals at Tip & Ring from the V+ pin of the MC34018, preventing an oscillatory loop from forming. The diode bridge, B2, is added for the tone ringer circuit of the MC34010(A), or MC34011(A), to keep the switches S1 and S2 from requiring 3 poles each.

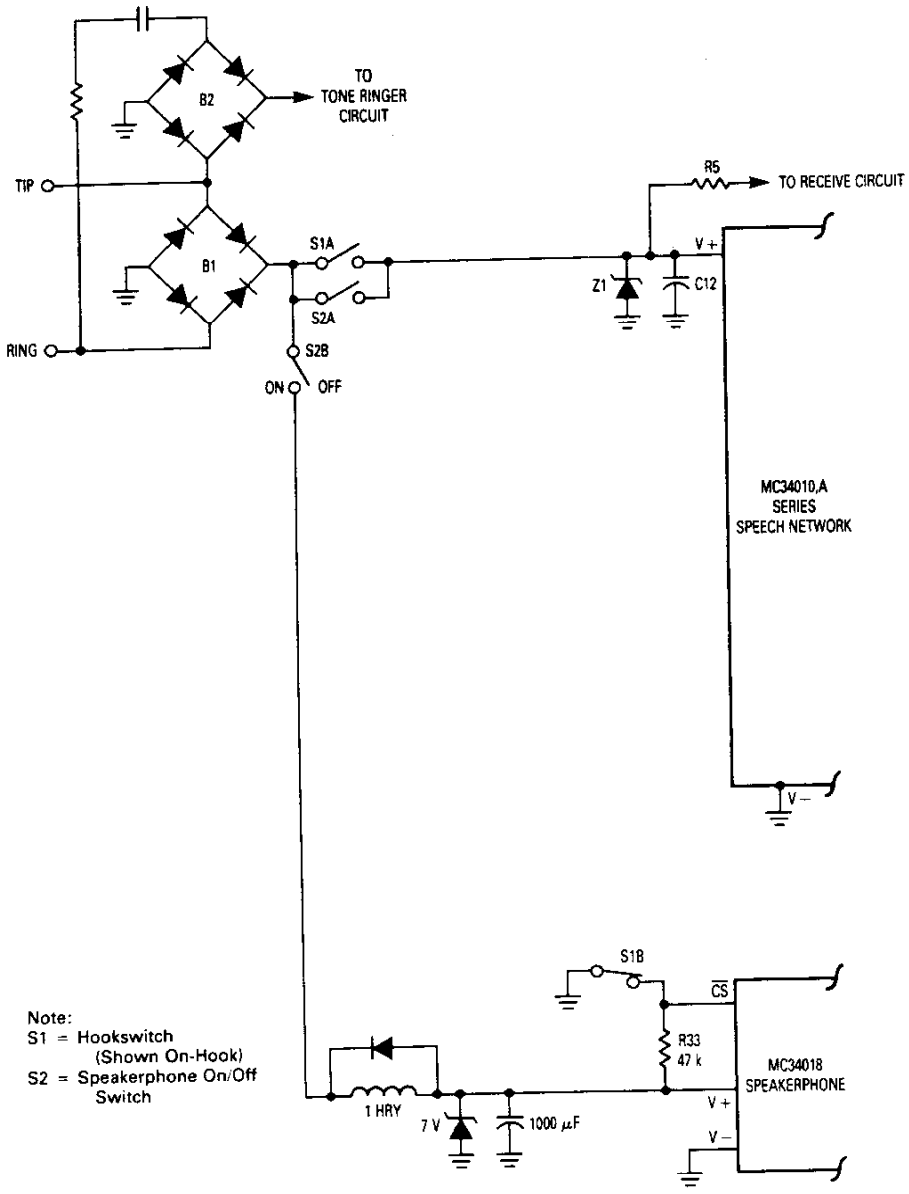


Figure 3. Handset/Speakerphone Power Switching

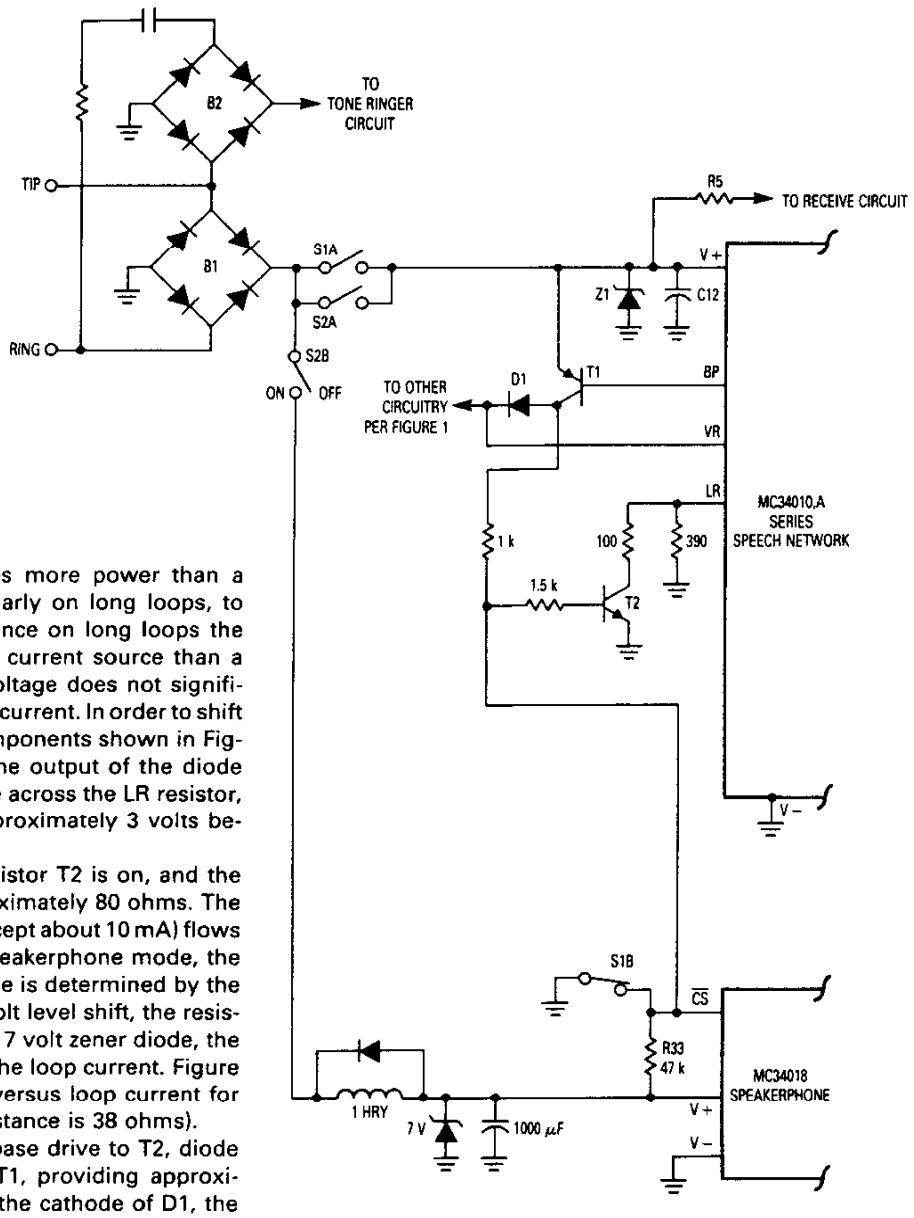


Figure 4. DC Level Shift

VIr SHIFT

Since a speakerphone requires more power than a handset, it is necessary, particularly on long loops, to increase the Tip-Ring voltage. Since on long loops the Tip & Ring lines act more like a current source than a voltage source, increasing the voltage does not significantly decrease the available loop current. In order to shift the dc voltage, the additional components shown in Figure 4 are used. The voltage at the output of the diode bridge (B1) is equal to the voltage across the LR resistor, plus an internal level shift of approximately 3 volts between V+ and LR.

In the handset mode, the transistor T2 is on, and the equivalent LR resistance is approximately 80 ohms. The majority of the loop current (all except about 10 mA) flows through the LR resistor. In the speakerphone mode, the transistor is off, and the dc voltage is determined by the 390 ohm resistor, the internal 3 volt level shift, the resistance of the 1 Henry inductor, the 7 volt zener diode, the current draw of the two ICs, and the loop current. Figure 5 indicates the Tip-Ring voltage versus loop current for the two modes (the inductor resistance is 38 ohms).

To facilitate the design of the base drive to T2, diode D1 is added to the collector of T1, providing approximately 1.8 volts at that point. At the cathode of D1, the voltage is still regulated at 1.1 volts.

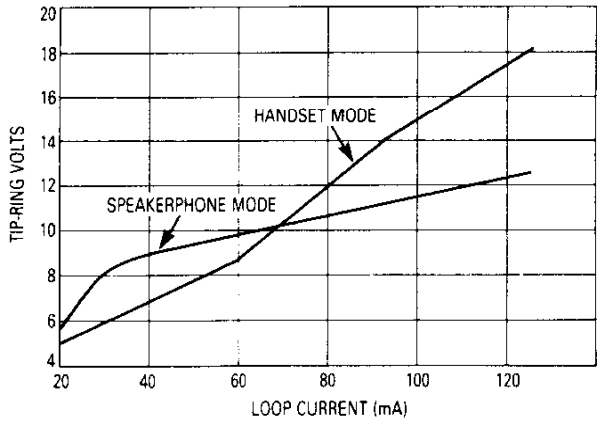


Figure 5. Tip-Ring Voltage versus Loop Current

MICROPHONE CONTROLS

To mute the handset microphone when the speakerphone speech mode is in effect, the circuit of Figure 6 is used for the MC34010 (MC34011, MC34013), and the circuit of Figure 7 is used for the MC34010A (MC34011A, MC34013A).

In Figure 6, when the handset mode is in effect, S1B takes the MM pin low, enabling the handset microphone by turning on the MIC pin (to ground). When the speakerphone mode is in effect, MM is taken high through R32, disabling the handset microphone (MIC pin is open).

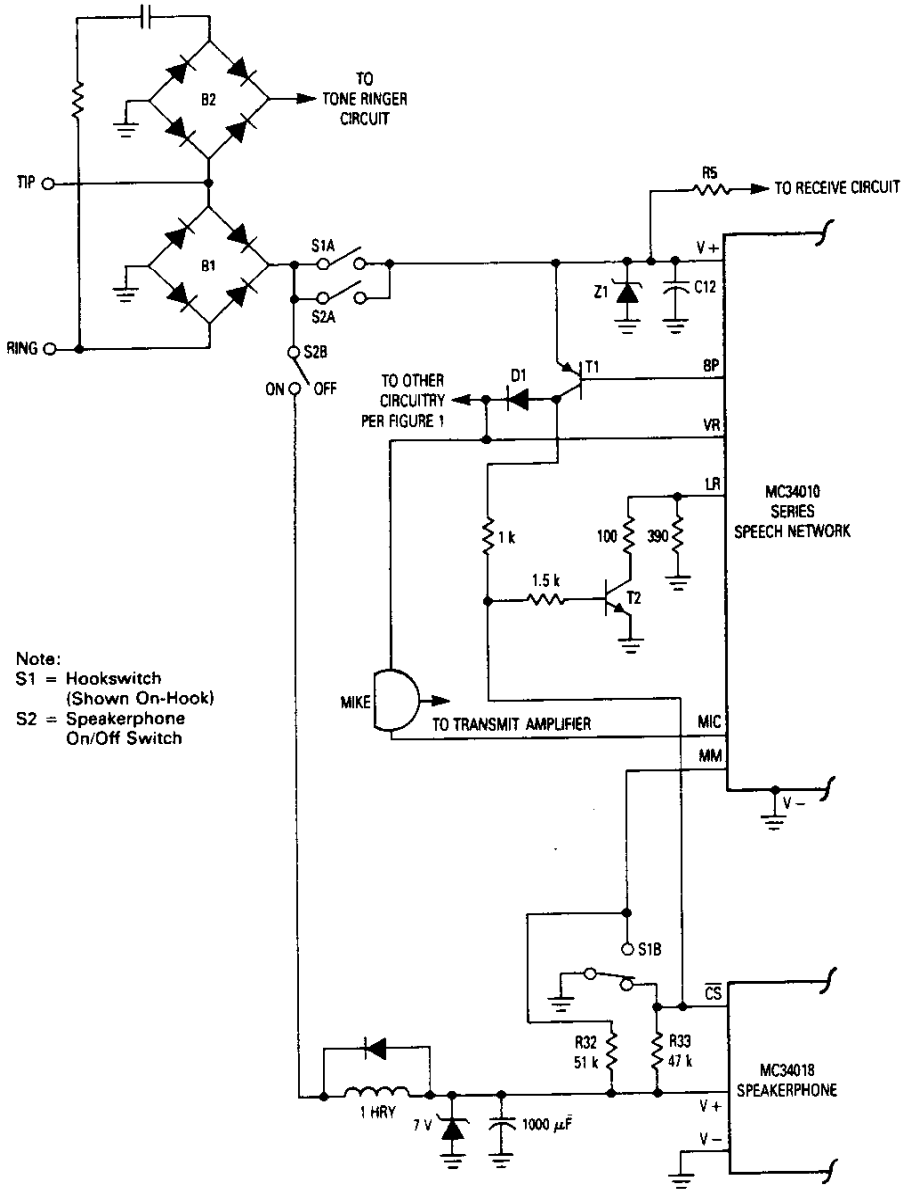


Figure 6. Microphone Muting — MC34010 Series

In Figure 7, in the handset mode, S1B is open, T3 is on, and the microphone bias current flows through the MIC pin. In the speakerphone mode, S1B is closed, turning off T3, disabling the microphone. T3 is required for disabling the microphone with the "A" series speech networks since the transmit amplifier is disabled when the MM pin is taken high.

In both the "non-A" and the "A" version circuits, the handset microphones are muted during dialing due to the fact that the MIC pin is opened by the dialer circuit.

SPEECH SIGNALS

Referring to the complete schematics (Figures 8, 9, 10, and 11) the receive signals coming in on Tip & Ring are sent to the handset receiver (at RXO) and to the speakerphone circuit's "receive input" path by the MC34010's hybrid function. It is not necessary to mute the handset receiver during speakerphone operation.

The transmit signals from the handset microphone are put onto the Tip & Ring lines through the MC34010's hybrid function, with a gain determined by resistors R27–R30. In the speakerphone mode, the transmit output signals (at TXO of the MC34018) are attenuated by R35 before being applied to the MC34010's transmit amplifier. The level of the speakerphone transmit signals at Tip & Ring can be adjusted by varying R35.

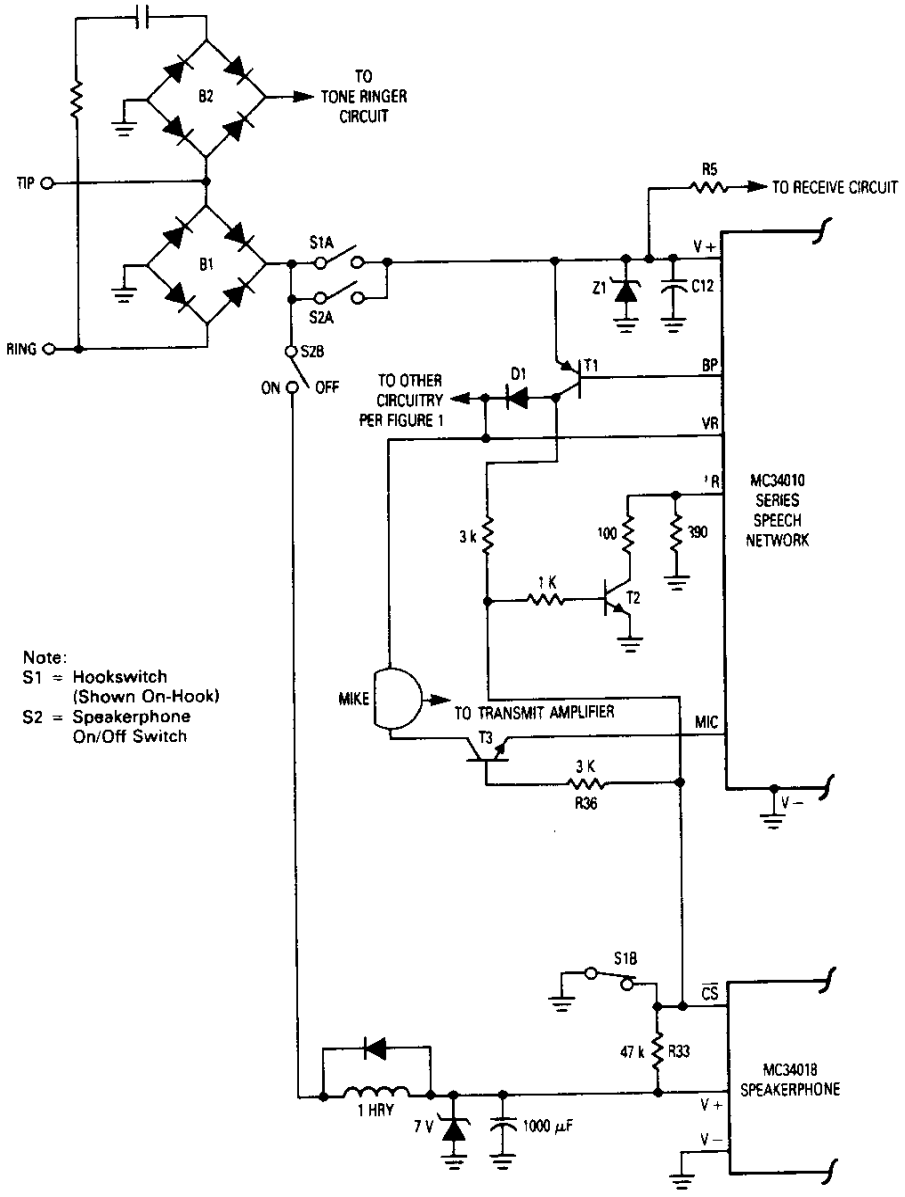
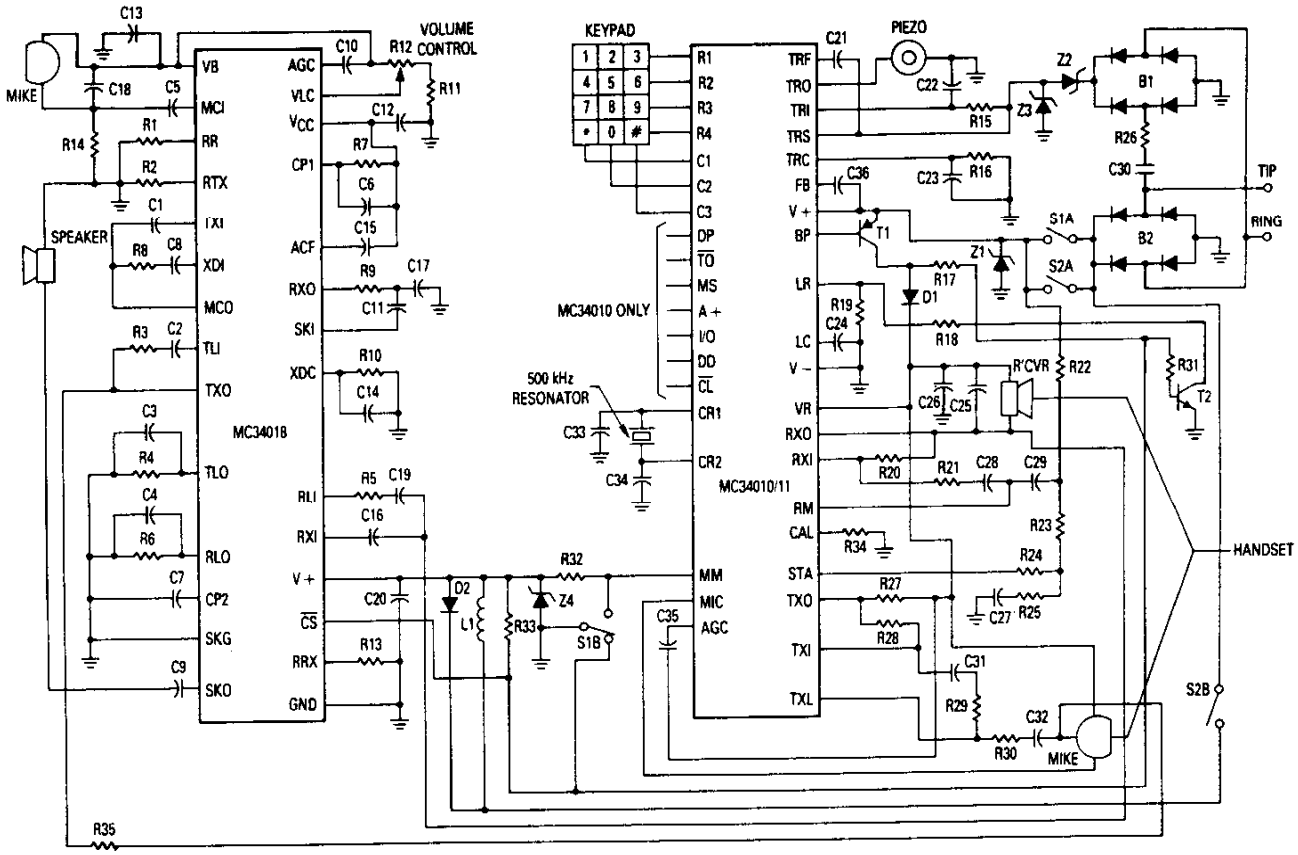


Figure 7. Microphone Muting — MC34010A Series



MC34010/11 and MC34018 COMPONENT VALUES

R1 — 30 k
R2 — 91 k
R3 — 3.3 k
R4 — 1 M
R5 — 4.7 k
R6 — 1 M
R7 — 100 k
R8 — 4.7 k
R9 — 4.3 k
R10 — 200 k
R11 — 24 k
R12 — 20 k
R13 — 18 k
R14 — 2 k
R15 — 1.8 k
R16 — 200 k
R17 — 1 k
R18 — 100
R19 — 390
R20 — 200 k
R21 — 56 k
R22 — 150 k
R23 — 56 k
R24 — 1.5 k
R25 — 1.5 k
R26 — 6.8 k
R27 — 270
R28 — 200 k
R29 — 4.7 k
R30 — 4.7 k
R31 — 1.5 k
R32 — 51 k
R33 — 47 k
R34 — 36
R35 — 33 k

C1 — 0.1
C2 — 0.068
C3 — 2.2 μF
C4 — 2.2 μF
C5 — 0.1
C6 — 47 μF
C7 — 4.7 μF
C8 — 0.068
C9 — 47 μF
C10 — 1 μF
C11 — 0.05
C12 — 47 μF
C13 — 47 μF
C14 — 4.7 μF
C15 — 4.7 μF
C16 — 0.05
C17 — 0.01
C18 — 0.05
C19 — 0.1
C20 — 1000 μF
C21 — 1 μF
C22 — 4.7 μF
C23 — 620 pF
C24 — 0.01
C25 — 0.01 μF
C26 — 2.2 μF
C27 — 0.1
C28 — 0.05
C29 — 0.05
C30 — 1 μF, NP
C31 — 0.1
C32 — 0.1
C33 — 100 pF
C34 — 100 pF
C35 — 1 μF
C36 — 0.1

L1 — 1 Hry, < 100 Ω

Z1 — 18 V
Z2 — 4.7 V
Z3 — 30 V
Z4 — 7 V
D1, D2 — 1N4001

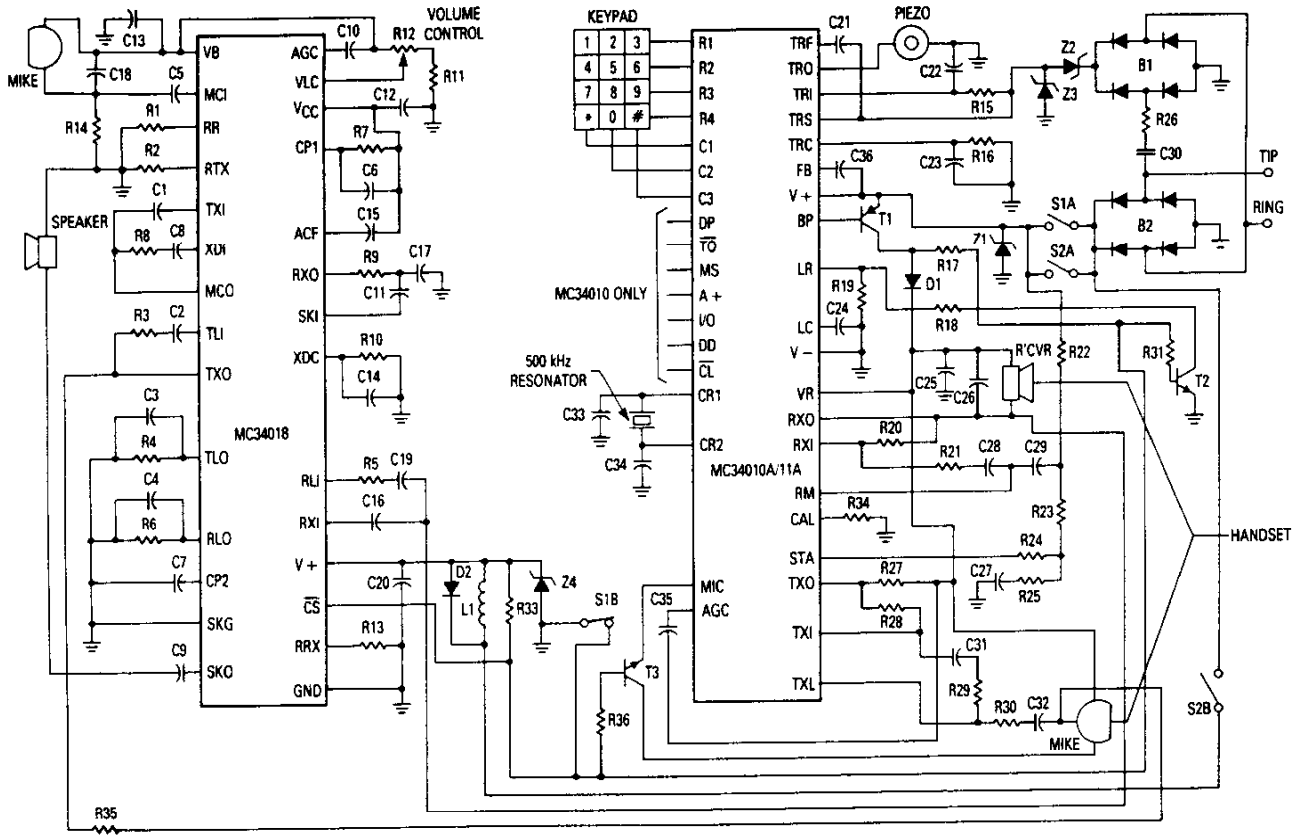
T1 — 2N4126
T2 — 2N2222A

B1 — 1N4004's
B2 — 1N4004's

S1 — DPDT (Hookswitch)
S2 — DPST (Speakerphone switch)

Handset R'cvr — 300 Ω
Handset Mike — Electret
Spkr'phone Speaker — 25 Ω, 0.3 W
Spkr'phone Mike — Electret

Figure 8. Handset/Handsfree System Using the MC34010/11 and MC34018



MC34010A/11A and MC34018
COMPONENT VALUES

R1 — 30 k
R2 — 91 k
R3 — 3.3 k
R4 — 1 M
R5 — 4.7 k
R6 — 1 M
R7 — 100 k
R8 — 4.7 k
R9 — 4.3 k
R10 — 200 k
R11 — 24 k
R12 — 20 k
R13 — 18 k
R14 — 2 k
R15 — 1.8 k
R16 — 200 k
R17 — 3 k
R18 — 100
R19 — 390
R20 — 200 k
R21 — 56 k
R22 — 150 k
R23 — 56 k
R24 — 1.5 k
R25 — 1.5 k
R26 — 6.8 k
R27 — 270
R28 — 200 k
R29 — 4.7 k
R30 — 4.7 k
R31 — 1 k
R33 — 47 k
R34 — 36
R35 — 33 k
R36 — 3 k

C1 — 0.1
C2 — 0.068
C3 — 2.2 μF
C4 — 2.2 μF
C5 — 0.1
C6 — 47 μF
C7 — 4.7 μF
C8 — 0.068
C9 — 47 μF
C10 — 1 μF
C11 — 0.05
C12 — 47 μF
C13 — 47 μF
C14 — 4.7 μF
C15 — 4.7 μF
C16 — 0.05
C17 — 0.01
C18 — 0.05
C19 — 0.1
C20 — 1000 μF
C21 — 1 μF
C22 — 4.7 μF
C23 — 620 pF
C24 — 0.1
C25 — 2.2 μF
C26 — 0.01
C27 — 0.1
C28 — 0.05
C29 — 0.05
C30 — 1 μF, NP
C31 — 0.1
C32 — 0.1
C33 — 100 pF
C34 — 100 pF
C35 — 1 μF
C36 — 0.1

L1 — 1 Hry, < 100 Ω

Z1 — 18 V
Z2 — 4.7 V
Z3 — 30 V
Z4 — 7 V

D1, D2 — 1N4001

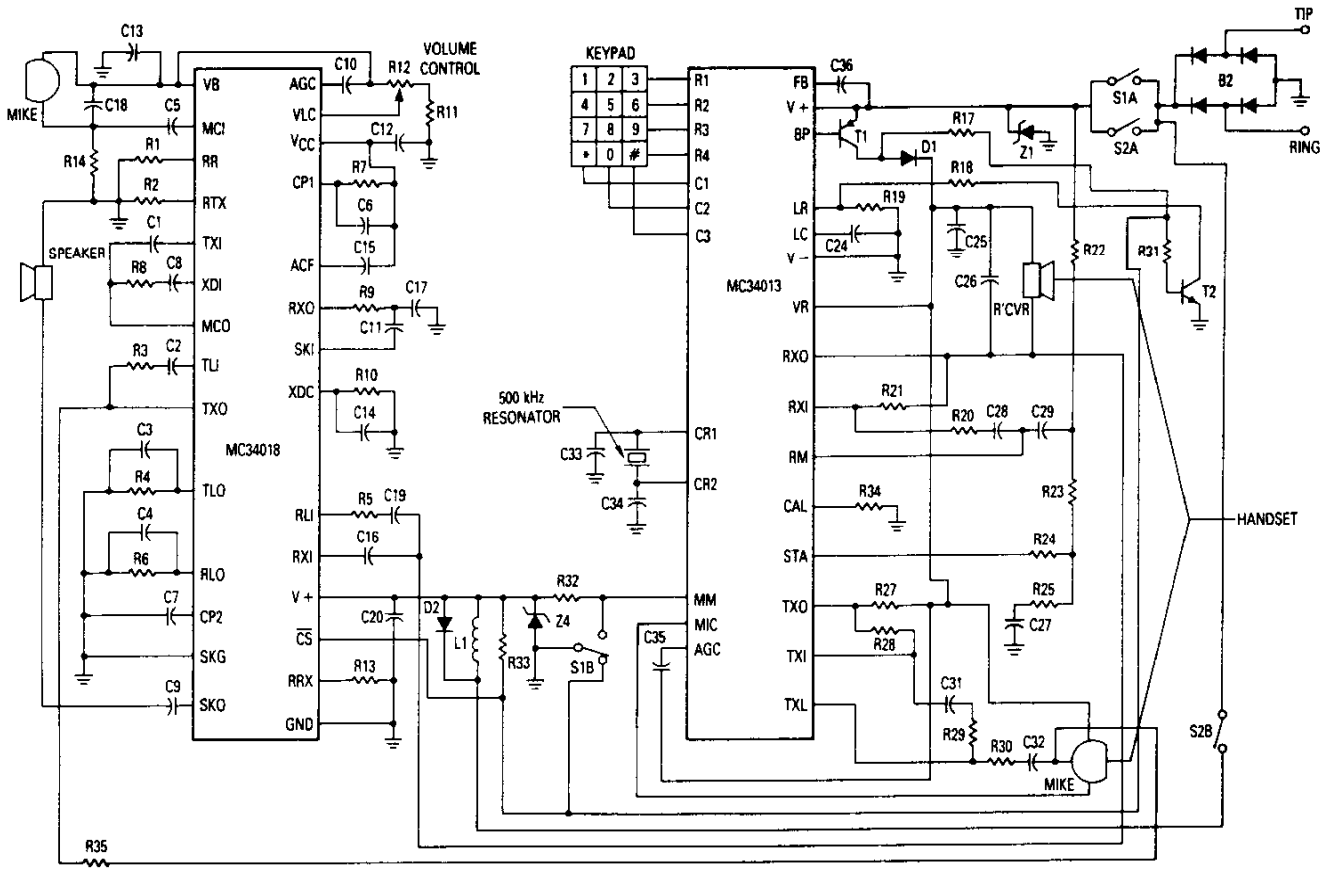
T1 — 2N4126
T2, T3 — 2N2222A

B1 — 1N4004's
B2 — 1N4004's

S1 — DPDT (Hookswitch)
S2 — DPST (Speakerphone switch)

Handset R'cvr — 300 Ω
Handset Mike — Electret
Spkr'phone Speaker — 25 Ω, 0.3 W
Spkr'phone Mike — Electret

Figure 9. Handset/Handsfree System Using the MC34010A/11A and MC34018



MC34013 and MC34018
COMPONENT VALUES

R1 — 30 k
R2 — 91 k
R3 — 3.3 k
R4 — 1 M
R5 — 4.7 k
R6 — 1 M
R7 — 100 k
R8 — 4.7 k
R9 — 4.3 k
R10 — 200 k
R11 — 24 k
R12 — 20 k
R13 — 18 k
R14 — 2 k
R17 — 1 k
R18 — 100
R19 — 390
R20 — 56 k
R21 — 200 k
R22 — 150 k
R23 — 56 k
R24 — 1.5 k
R25 — 1.5 k
R27 — 270
R28 — 200 k
R29 — 4.7 k
R30 — 4.7 k
R31 — 1.5 k
R32 — 51 k
R33 — 47 k
R34 — 36
R35 — 33 k

C1 — 0.1
C2 — 0.068
C3 — 2.2 μF
C4 — 2.2 μF
C5 — 0.1
C6 — 47 μF
C7 — 4.7 μF
C8 — 0.068
C9 — 47 μF
C10 — 1 μF
C11 — 0.05
C12 — 47 μF
C13 — 47 μF
C14 — 4.7 μF
C15 — 4.7 μF
C16 — 0.05
C17 — 0.01
C18 — 0.05
C19 — 0.1
C20 — 1000 μF
C24 — 0.1
C25 — 2.2 μF
C26 — 0.01
C27 — 0.1
C28 — 0.05
C29 — 0.05
C31 — 0.1
C32 — 0.1
C33 — 100 pF
C34 — 100 pF
C35 — 1 μF
C36 — 0.1

L1 — 1 Hry, < 100 Ω

Z1 — 18 V
Z4 — 7 V

D1, D2 — 1N4001

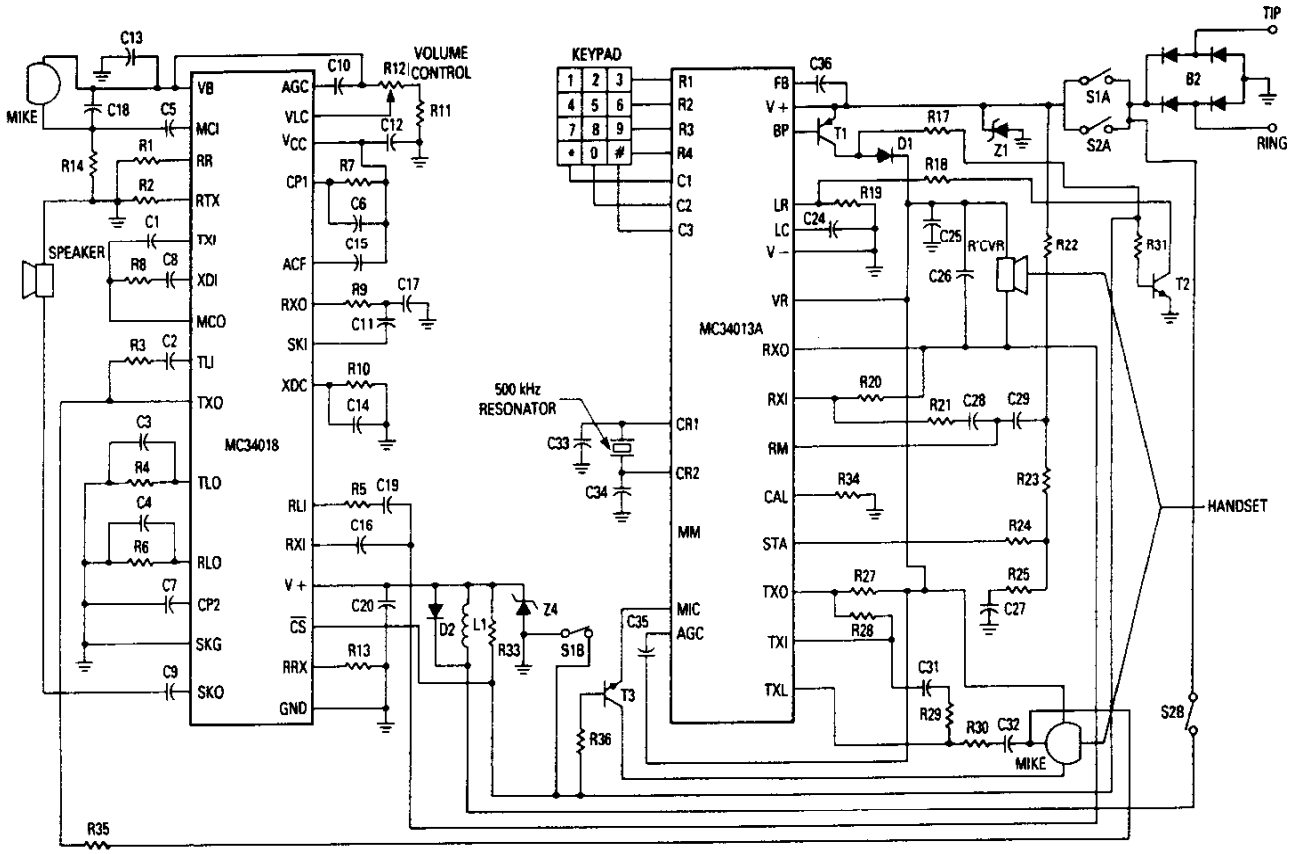
T1 — 2N4126
T2 — 2N2222A

B2 — 1N4004's

S1 — DPDT (Hookswitch)
S2 — DPST (Speakerphone switch)

Handset R'cvr — 300 Ω
Handset Mike — Electret
Spkr'phone Speaker — 25 Ω, 0.3 W
Spkr'phone Mike — Electret

Figure 10. Handset/Handsfree System Using the MC34013 and MC34018



MC34013A and MC34018
COMPONENT VALUES

R1 — 30 k
R2 — 91 k
R3 — 3.3 k
R4 — 1 M
R5 — 4.7 k
R6 — 1 M
R7 — 100 k
R8 — 4.7 k
R9 — 4.3 k
R10 — 200 k
R11 — 24 k
R12 — 20 k
R13 — 18 k
R14 — 2 k
R17 — 3 k
R18 — 100
R19 — 390
R20 — 56 k
R21 — 200 k
R22 — 150 k
R23 — 56 k
R24 — 1.5 k
R25 — 1.5 k
R27 — 270
R28 — 200 k
R29 — 4.7 k
R30 — 4.7 k
R31 — 1 k
R33 — 4.7 k
R34 — 36
R35 — 33 k
R36 — 3 k

C1 — 0.1
C2 — 0.068
C3 — 2.2 μF
C4 — 2.2 μF
C5 — 0.1
C6 — 47 μF
C7 — 4.7 μF
C8 — 0.068
C9 — 47 μF
C10 — 1 μF
C11 — 0.05
C12 — 47 μF
C13 — 47 μF
C14 — 4.7 μF
C15 — 4.7 μF
C16 — 0.05
C17 — 0.01
C18 — 0.05
C19 — 0.1
C20 — 1000 μF
C24 — 0.1
C25 — 2.2 μF
C26 — 0.01
C27 — 0.1
C28 — 0.05
C29 — 0.05
C31 — 0.1
C32 — 0.1
C33 — 100 pF
C34 — 100 pF
C35 — 1 μF
C36 — 0.1

L1 — 1 Hry, < 100 Ω

Z1 — 18 V
Z4 — 7 V

D1, D2 — 1N4001

T1 — 2N4126
T2, T3 — 2N2222A

B2 — 1N4004's

S1 — DPDT (Hookswitch)
S2 — DPST (Speakerphone switch)

Handset R'cvr — 300 Ω
Handset Mike — Electret
Spkr'phone Speaker — 25 Ω, 0.3 W
Spkr'phone Mike — Electret

Figure 11. Handset/Handsfree System Using the MC34013A and MC34018

CONCLUSION

Interfacing the MC34018 speakerphone circuit to the MC34010 series of speech networks has been shown to be simple and straightforward. The interface requires the addition of 2 diodes, 5 resistors, either 1 or 2 transistors (depending on the speech network), and one diode bridge for the tone ringer circuit in the MC34010(A) and the MC34011(A). Any existing MC34010 type circuit can be easily modified to accept the speakerphone circuit.

REFERENCES

MC34010 Data Sheet, Dec. 1983, Motorola, Inc.
MC34010A Data Sheet, May, 1985, Motorola, Inc.
MC34013 Data Sheet, Nov. 1983, Motorola, Inc.
MC34013A Data Sheet, Feb. 1985, Motorola, Inc.
MC34018 Data Sheet, Apr. 1985, Motorola, Inc.

Literature Distribution Centers:
USA: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.
EUROPE: Motorola Ltd.; European Literature Centre; 88 Tanners Drive, Blakelands, Milton Keynes, MK14 5BP, England.
JAPAN: Nippon Motorola Ltd.; 4-32-1, Nishi-Gotanda, Shinagawa-ku, Tokyo 141 Japan.
ASIA-PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Center, No. 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.

PRINTED IN USA IMPERIAL LITHO