MX506

Advance

August 1989

MX·COM, INC.

DATA BULLETIN

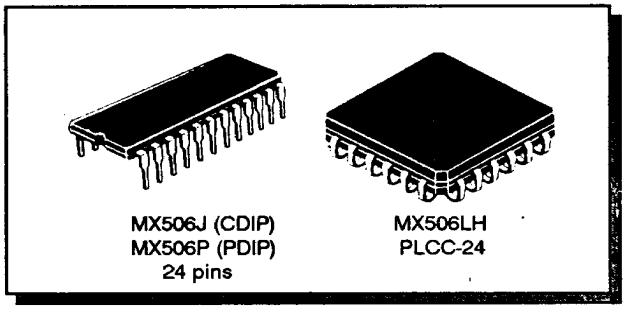
Single Chip LMR Audio Processor

Features

- AGC Amplifier
- Digital Gain Controls
- RX/TX Switching & Filtering
- Squelch Filter
- TX VOGAD
- Serial Bus for all Chip Functions

Benefits

- Serves both Hand-held and Mobiles
- Improves Range
- Saves Space, Power, Cost



MX506J (CDIP)
MX506P (PDIP)
24 pins

MX506LH
PLCC-24

Description

The MX506 is a microprocessor-controlled, single-chip device containing ALL the circuit elements necessary to perform the audio functions of a mobile (or portable) radio system.

Each function in the signal path can be addressed or bypassed --providing "real time" dynamic control -- through an externally produced serial control word.

This half-duplex device is comprised of two serial routes. The Pre-process path sets the incoming audio (RX or TX) to levels and frequencies suitable for amalgamation with auxiliary systems such as Frequency Inversion Scrambling, Sub-Audible tone, or In-band data signaling.

This path can be output to external processes or internally routed to the Post-process path.

The Post-process path can adjust and prepare the input audio (either internal or external) for output to the chosen transmitter driver or loudspeaker amplifier.

Suitably software configured, the MX506, which can operate on Voice, Direct Digital or Tone data, is compatible with FM, AM and SSB type transceivers. Digital gain elements are on-chip for dynamic control and balance of signal levels during manufacturing test and operation.

System squelch is sourced from either the input signal or The Received Signal Strength Indicator (RSSI) in the radio.

This low-power 5 volt CMOS device is available in 24-pin Cerdip, PDIP and PLCC.

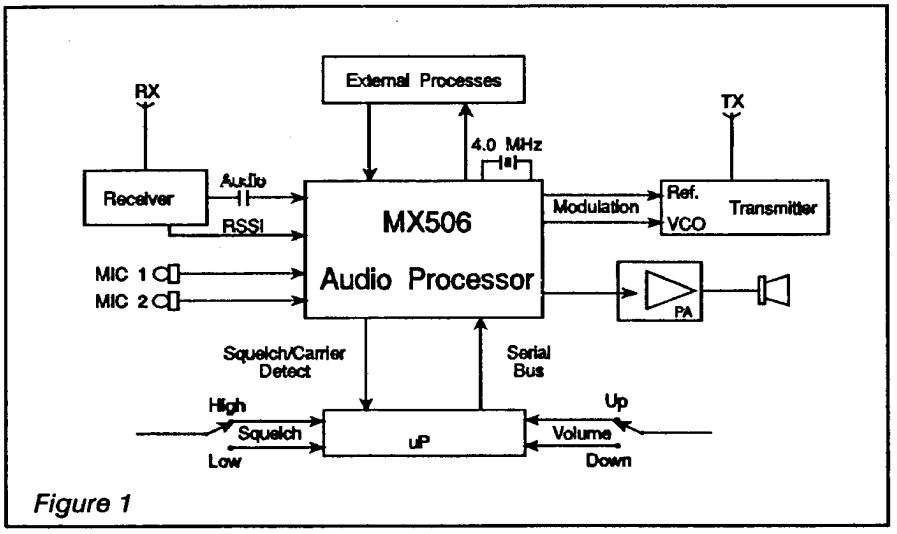


Figure 1

Block Diagram for a Typical Land Mobile Radio

The MX506 performs all the functions contained in the gray box in the diagram below.

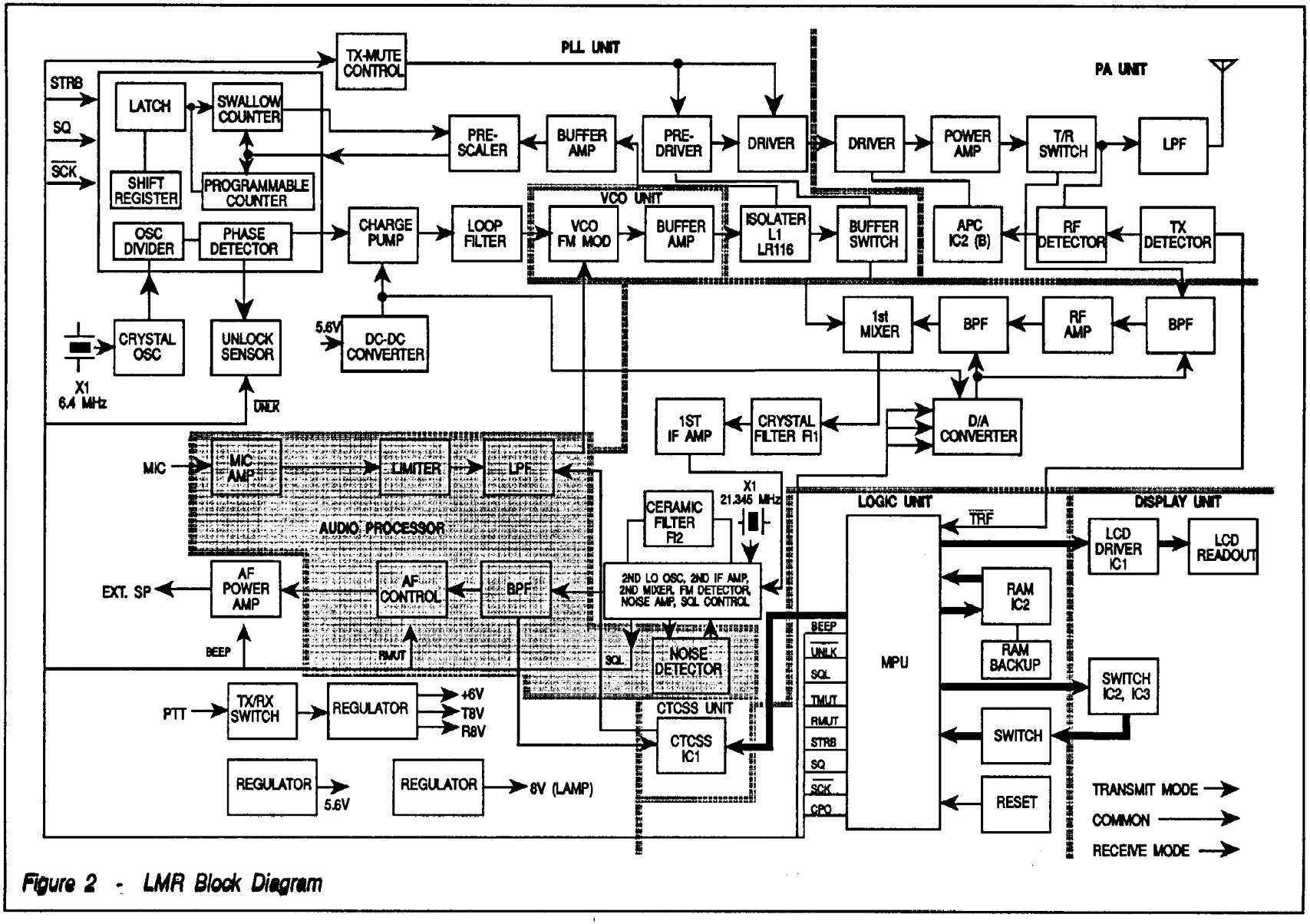


Figure 2 - LMR Block Diagram

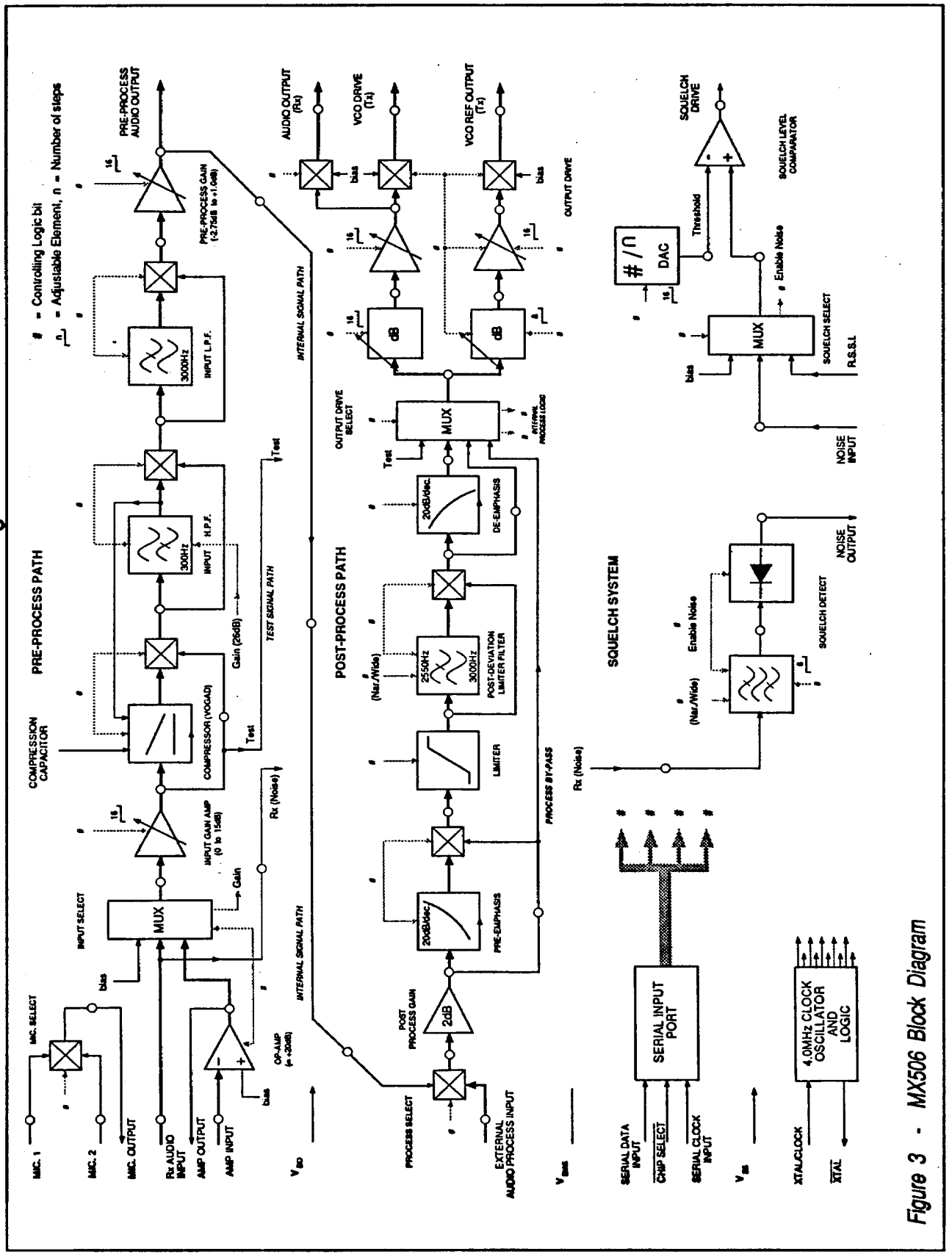


Figure 3 - MX506 Block Diagram

Functional Descriptions

The setting of all functions and levels in the MX506 is performed by the input of one 47-bit serial control word loaded at the Serial Input Port. The MX506 can use the facilities of the host microprocessor and its memory in both initial setting-up and dynamic real-time adjustment/ control. Descriptions of the selectable functions of the MX506 are in the following paragraphs.

Mic. Select: A Multiplexed "microphone" input allowing the use of differing voice inputs (internal/ headset/boom mic.) or a line input.

Input Op-Amp: Available with external components as a microphone pre-amplifier and pre-emphasis circuit in the TX speech path.

Input Selection: Transmit or receive audio sources are selected, inserting the appropriate gain for the chosen input automatically. The input path can be set to bias while allowing receiver monitoring.

Input Gain Amplifier: A gain element available to adjust the drive level for differing signal sources and microphone sensitivity levels.

Compressor (VOGAD): Pre-set, selectable voice amplitude compression circuitry with a +30dB input dynamic range. It provides optimum drive levels to the transmission medium from differing signal level inputs. External components at this element set the attack and decay time constants for compression.

Input Highpass Filter: A 300 Hz speech-path shaping filter.

Input Lowpass Filter: A 3000 Hz speech-path shaping filter.

The above filters perform a bandpass function prior to active audio processing. Each can be individually selected or powersaved to facilitate differing system applications.

Pre-process Gain: An in-line output drive stage providing adjustable gain or attenuation to compensate for tolerances in the following audio processes and peripherals.

The output of this amplifier stage can be used through an internal path, or it can be output to improve voice processing (as in Frequency Inversion Voice Scrambling). It can also be used to introduce sub-audible tones or in-band data to the system.

Process Select: Selects either the internal signal path or the External Audio Process Input. This external input could be from a "Voice Scrambler" or the composite audio from a sub-audible or data signaling system.

Post Process Gain: A fixed +2 dB gain stage.

Pre-emphasis: A selectable stage set around 1 kHz with a characteristic of 20 dB per decade.

Deviation Limiter: A selectable amplitude limiting stage for deviation control.

Post Deviation Limiter Filter: This selectable lowpass filter is adjustable to Wide (3000 Hz) and Narrow (2550 Hz) bandwidths.

De-emphasis: A selectable stage set around 1 kHz, with a characteristic of 20 dB per decade.

Output Drive Selector: This switching circuit selects either Process, Process Bypass, or Test Signal paths.

Signal Paths:

1) Process Path - suitable for normal transmission and normal reception.

2) Process Bypass Path - suitable for direct digital transmission.

3) Test Signal Path - A convenient, selectable path to enable balancing of the modulation driver stages. This is a distinct advantage in "two-point" modulation systems.

VCO Drive and Reference Channels: The final modulator drive (TX) and audio output (RX) stages consist of selectable fine attenuation and gain elements to achieve good 2-point balance to the modulator stages under all frequency and transmit

mode conditions. With a wide range of adjustment (gain and attenuation), these output stages are for variations in systems with large frequency spectrums.

Squelch Detect: This function is available from two selectable sources.

1) **RX Audio (Noise)** - Receiver input signal noise is selected, adjusted, and processed to provide a squelch level. Gain and Frequency parameters of the bandpass filters can be selected to work in wide or narrow channel spacing environments.

2) **Received Signal Strength Indicator** - RSSI from the radio's IF circuits is employed as a detected squelch signal. Squelch detection levels can be finely set using the Digital-to-Analog Converter.

Alternatively, a separate source could be used at the Noise Input.

Audio Output (Volume): Received audio output with fine, wide-ranging adjustment (attenuation and gain), a loudspeaker or line input.

Clock Oscillator: All internal clocks and frequencies required by the MX506 are generated on-chip from a single 4.0 MHz Xtal or clock pulse input.

Applications Advantages

Single-Chip, Multi-Function Audio Processor

Filters, Amplifiers and Limiters - All controllable on one chip. This versatile, single device option means a saving in cost, components and required board area.

Serial Data Microprocessor Interface

A single-shot 47-bit data word will set or reconfigure ALL device parameters.

No Manual Setting-Up

During initial factory set-up the gain and control of ALL on-chip circuit elements can be set by ATE, requiring no manual intervention. Initial setting parameters can be recorded in the "host" system.

Fewer Mechanical Failures

Using Microprocessor driven configurations and gains requires less mechanical components or manual fitting in the finished radio.

"Real Time" Dynamic Adjustment

Host Microprocessor can monitor, configure and optimize all audio functions while in use. Constant adjustment allows accurate setting when using non-linear peripherals, i.e. synthesizers.

Low-Power 5 Volt CMOS

A single, stable 5 V power supply is required.

Auxiliary Process Compatible

Filters and gain stages can be configured to introduce external processes, such as Frequency Inversion Scrambling, Sub-Audio Tone, and In-Band Data, to the MX506 signal path.

Speech Compression (VOGAD)

Distortionless transmitter output drive levels can be achieved using the on-chip voice compression circuit. External components enable attack/decay time selection to suit the application.

On-Chip "Thro" Test Path

A direct input/output test path is selectable to enable very accurate balancing of the output stages in the transmit mode.

Selectable, Controllable Squelch

RX output (noise) or RSSI is available for squelch indication. Frequencies and levels are programmable.

Half-Duplex System

The receive to transmit action needs only one data word for complete transition - it can be software formulated.

Single-Clock Frequency Requirement

The MX506 requires only a single external 4.0 MHz Xtal/clock pulse input, which can be derived from the "host" system.

Pin Function Chart

Pin	Function
1	CSN: During Serial loading this pin should be kept at logical "0" until data is completely loaded, then the 0-1 edge of CSN latches the new data in.
2	V_{DD}: Positive supply rail. A single +5-volt power supply is required.
3	External Process Input: When in transmit this pin is for plain audio signals with sub audio, or scrambled audio signals with or without sub audio and encrypted signals. In receive, this pin is for unscrambled audio signals and decrypted signals. It is self-biased at $V_{DD}/2$.
4	External Process Output: This pin is for external processes like scrambling and encryption when in transmit. In receive, it outputs to the descrambler, decryptor and sub audio detector. In both transmit and receive, if there is no external process requirement, an internal bypass switch path can be selected. When in powersave it is self-biased at $V_{DD}/2$.
5	Op Amp O/P: Microphone O/P, Op Amp I/P and Op Amp O/P can be used to form an inverting amplifier with pre-emphasis.
6	RX Audio Input
7	Amp I/P
8	BIAS: The output of the on-chip analog bias circuitry, internally set to $V_{DD}/2$, this pin requires decoupling to V_{SS} with a capacitor of 1 μF.
9	Microphone Output: This is the multiplexer output for Mic 1 and Mic 2. It is biased at $V_{DD}/2$ by an inverting amplifier.
10 11	Microphone Input 1: These inputs are multiplexed by 1 control bit. Microphone Input 2: They are biased at $V_{DD}/2$.
12	V_{SS}: Negative supply rail (GND).
13	Compression Cap: This is the rectified audio signal power level. A decoupling capacitor and two resistors are connected to this pin to provide the appropriate time contsant for compression.
14	Ref TX O/P: This output pin is used to drive the reference oscillator modulator. When in powersave, it is self-biased at $V_{DD}/2$.
15	RX Audio O/P: This is the receive audio output. When in powersave, it is self-biased at $V_{DD}/2$.
16	VCO TX Output: This output pin is used to drive the VCO modulator. When in powersave it is

Pin	Function
	self-biased at $V_{DD}/2$.
17	RSSI Input: The RSSI signal is to be applied to this pin. (RX signal strength indicator.)
18	Integrated Noise Input: The integrated noise level is to be applied to this pin.
19	Noise Output: This is the rectifier output for noise. It drives an external passive integrator. The rectifier produces a decreasing voltage output with increasing noise power. It is biased at $V_{DD}/2$ with 0 mVrms noise.
20	Comparator Output: This is a TTL compatible output. It compares the chosen squelch input with a DAC reference level. A logic "1" is output when the squelch output is higher than the DAC reference level and a logic "0" for squelch outputs is lower than the DAC reference level.
21 22	Serial Clock: When CSN is kept at logical "0," 47 bits of data are clocked serially into this pin Serial Data In: on the 0 - 1 edge of the Serial Clock. Bit 47 is clocked into the internal shift register, followed by Bit 46 until all 47 bits have been clocked in. They can then be latched in using the 0-1 edge of CSN.
23	Xtal: This is the input to the clock oscillator inverter. An external 4 MHz Xtal clock input is to be applied at this pin.
24	$\overline{\text{Xtal}}$: The 4MHz output of the clock oscillator circuitry

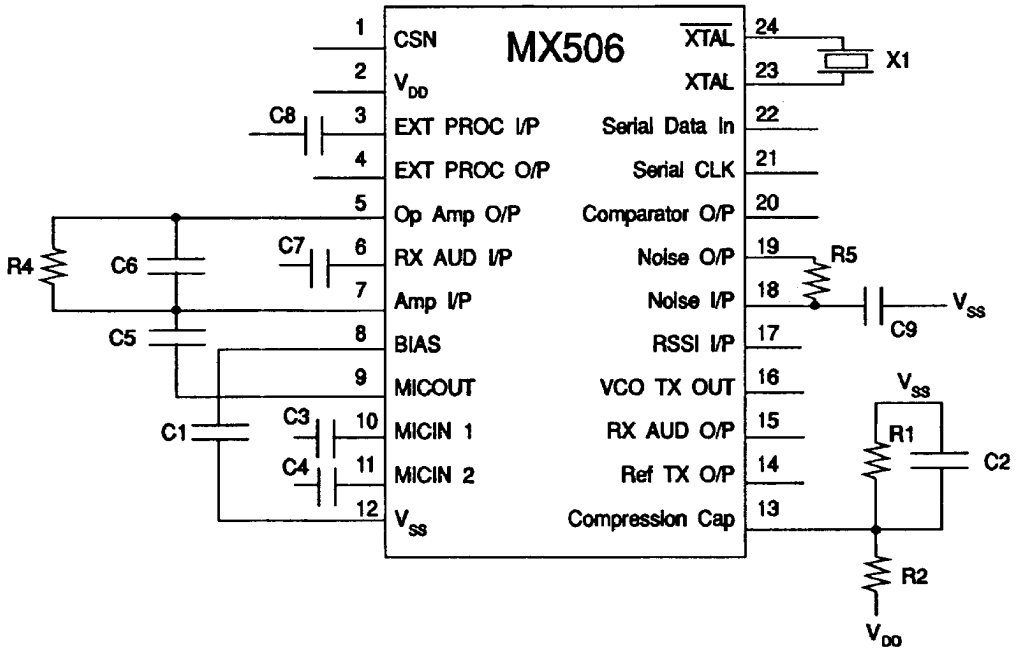


Figure 4 - External Components

Specifications

Absolute Maximum Ratings

Exceeding the maximum rating can result in device damage. Operation of the device outside the operating limits is not implied.

Supply voltage	-0.3 to 7.0V
Input voltage at any pin (ref V_{SS} = 0V)	-0.3 to (V_{DD} + 0.3V)
Sink/source current	±20mA
Total device dissipation @ 25°C	800mW Max.
Derating	10mW/°C
Operating temperature	-40°C to +85°C
Storage temperature	-55°C to 125°C

Operating Limits

All device characteristics are measured under the following conditions unless otherwise specified:

V_{DD} = 5.0V

T_{AMB} = 25°C

Xtal/Clock f_0 = 4.0 MHz

Audio level 0dB ref: = 600 mVrms.

Supply Voltage (V_{DD}) is normally from 4.5 to 5.5 V.

When Logic "1" is input, the supply voltage is 3.5 V Min. If Logic "0" is input, it is 1.5 V Max.

Supply Current
Enabled: 8.0 mA typ.
Quiescent: 3.0 mA typ.

Impedance
Audio Amplifier Input: 1.0 MΩ Typ.
REF (TX), VCO (TX), and RX Audio Output: 3.0 kΩ Max.
Digital Input: 1.0 MΩ Typ.
Mic 1 and 2 switch Input: 1.0 kΩ Typ.
RX Audio Input: 50.0 kΩ Min.
External Process Input: 1.0 MΩ Min.
External Process Output: 3.0 kΩ Max.
Noise Input and RSSI Input: 1.0 MΩ Min.

Analog Signal Input Levels
(Specified at 5V V_{DD})

MIC 1 and 2 Input level is typically1.0 mVrms, and 100 mVrms maximum.

RX Audio Input is typically 123 mVrms and 200 mVrms max. (For typical value, block 2 is set at +14dB and block 9 at 0dB. Compressor must be activated for maximum input level reference to 1 kHz.)

External Process RX and TX is 794 mVrms Max. when the External Process signal input is an externally attenuated signal of 2.2 Vp-p and band limited.

RSSI is from 0 to 5V.

Analog Signal Output Levels

External Process Output is typically 600 mVrms, but may reach a maximum of 1000 mVrms.

REF (TX), VCO (TX) output is a maximum of 1000 mVrms.

RX Audio Output is a maximum of 1000 mVrms.

Analog Output S/N

This value is typically -48 dB and reaches a maximum level of -45 dB. (Output level is at 60% or 600 mVrms deviation.)

Analog Output Distortion (THD)

THD is -40 dB Max. (Output level is at 60% or 600 mVrms deviation.)

Compressor Dynamic Range is typically 40 dB.

Attack time is typically .55 ms. Decay time is typically 8.5 ms.

Input Conditioner Frequency Response (excludes pre-emphasis)

Passband Ripple in the range of 300-400Hz is from -3 to +1 dB. In the range of 400 Hz - 3.4 kHz, it is from -1.5 to +1 dB.

Attenuation at 5 kHz is a minimum of 3 dB, but typically 4.2 dB.

High Frequency Roll off from 5kHz - 20kHz is a minimum of 12 dB/oct.

Attenuation at 250 Hz is typically 2.3 dB.

Low Frequency Roll off at frequencies below 250Hz is 6 dB/oct.

Wideband Response

Passband Ripple over the range of 0 Hz - 2.7 kHz is between -1.5 and +1 dB. Over the range of 2.7 kHz - 3 kHz, it is between -3 and +1 dB. (If de-emphasis is included, passband remains within specification.)

Attenuation at 5 kHz is at least +12.2 dB and typically 17 dB.

High Frequency Roll off over the range of 3 kHz - 20 kHz is a minimum of 18 dB/oct.

Narrow Band Response

Passband Ripple over the range of 0 Hz - 2.3 kHz is from -1.5 to +1 dB. Over the range of 2.3 kHz - 2.55 kHz, it is from -3 to +1 dB.

Attenuation at 4.25 kHz is a minimum of 12.2 and a maximum of 17 dB.

High Frequency Roll off between 2.3 kHz and 5.1 kHz is at least 18 dB per oct.

Package Outline

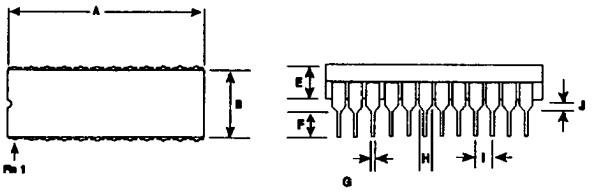
The MX506J Cerdip package is shown in Figure 5. The PDIP version is shown in Figure 6, and the LH in Figure 7.

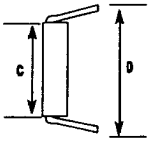
For identification purposes the LH package has an ident spot adjacent to pin 1 and a chamfered corner between pins 3 and 4. Pins number counter-clockwise when viewed from the top (indent side).

Handling Precautions

The MX506LH is a CMOS LSI circuit which includes input protection. However, precautions should be taken to prevent static discharges which may cause damage.

Fig. 6 - MX506P 24-pin Plastic DIP

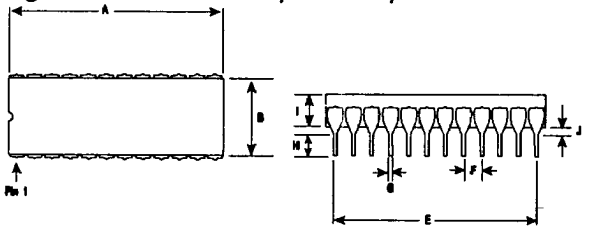


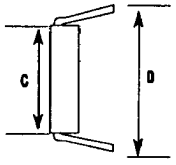


Package Tolerances

Dimension [in. (mm)]	Min.	Max.
A	1.23 (31.24)	1.26 (32.004)
B	0.53 (13.46)	0.55 (13.97)
C	0.59 (14.98)	0.610 (15.49)
D	0.63 (16.002)	0.67 (17.018)
E	0.170 (4.318)	.220 (5.588)
F	0.125 (3.175)	.160 (4.064)
G	0.015 (.381)	.020 (.508)
H	0.40 (1.016)	0.65 (1.651)
I	.090 (2.286)	.110 (2.794)
J	.015 (0.381)	.065 (1.651)

Figure 5 - MX506J 24-pin Cerdip

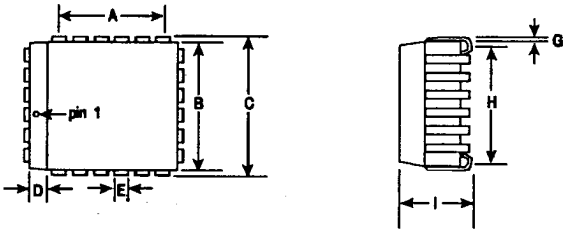


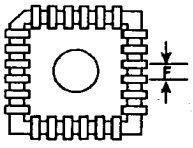


Package Tolerances

Dimension [in. (mm)]	Min.	Max.
A	1.24 (31.50)	1.26 (32.03)
B	.514 (13.06)	.583 (14.81)
C	.60 (15.14)	.615 (15.61)
D	.63 (16.002)	.67 (17.018)
E	1.10(27.84)	1.11(28.04)
F	.100 (2.54)	typical
G	.018 (0.46)	typical
H	.171 (4.35)	typical
I	.171 (4.35)	.196 (4.99)
J	.020 (0.50)	———

Figure 7 - MX506LH PLCC-24 Package





Package Tolerances

Dimension [In, (mm)]	Min.	Max.
A	.250 (6.35)	typical
B	.427 (10.85)	.437 (11.10)
C	.435 (11.05)	.445 (11.30)
D	.045 (1.14x45°)	typical
E	.019 (0.47)	.022 (0.55)
F	.050 (1.27)	typical
G	.004 (0.10)	typical
H	.340 (8.64)	.380 (9.65)
I	.136 (3.45)	typical

Ordering Information

MX506J 24-pin Cerdip

MX506P 24-pin PDIP

MX506LH 24-lead Plastic Leaded Chip Carrier

MX-COM, INC. ICs are available throughout the free world:

in Europe,
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CAUTION
MOS Device. May be damaged by static discharge. Observe handling precautions

Specifications subject to change.

Document No. 20480014.001

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COMMUNICATION MICROSYSTEMS

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