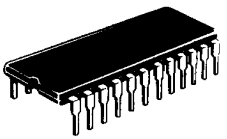
NET-C FULL-DUPLEX VOICEBAND INVERTER

FEATURES:

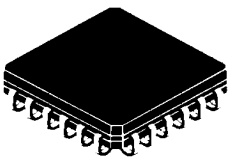
- **Full-Duplex Audio Processing**
- **On-Chip Audio Bandpass Filters (300-3000 Hz)**
- **Clear/Invert Facility**
- **Low Power CMOS**
- **High Baseband and Carrier Rejection**

APPLICATIONS:

- **Cellular "Privacy" Systems**
- **All "Private" Telephone Communications**



MX304J (CDIP)
MX304P (PDIP)
24 pins



MX304LH
(24p PLCC)

DESCRIPTION:

The MX304 is a duplex filter array and frequency inversion scrambler compatible with the German Net-C cellular radio specification. The two channels, C_1 and C_2, are identical and independent, each consisting of:

1) A 10th order 3.1 kHz input lowpass filter in the "Invert" path.

2) A balanced modulator, providing fixed frequency inversion (3.3kHz) and having high baseband and carrier rejection.

3) A 14th order channel output bandpass filter (300 Hz to 3kHz).

4) Input op-amps in both the "clear" and "invert" paths, allowing external components to set input gains, and preemphasis or deemphasis in the "clear" path.

5) Clear/Invert switching, which allows automatic changeover of signal routes and input circuitry.

6) A buffered low noise output with switching clock filter.

7) An output enable switching facility.

The MX304 uses CMOS switched-capacitor filter technology and requires a 5V power supply. The common carrier frequency and filter switching clock are generated on-chip using an external 4.433619 MHz crystal or clock input.

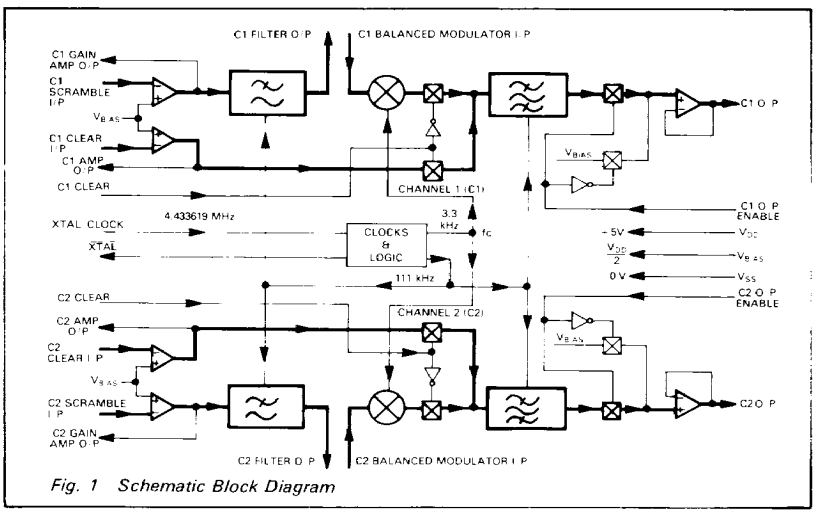
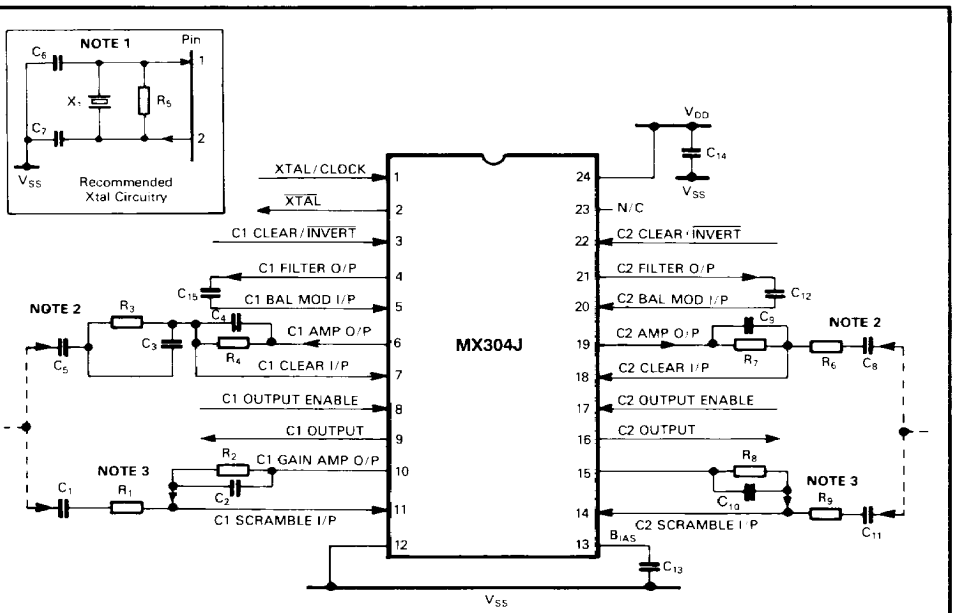


Fig. 1 Schematic Block Diagram



Component References		
Component	Unit Value	Note
R_1	100k	3
R_2	100k	3
R_3	200k	2
R_4	75k	2
R_5	1M	1
R_6	240k	2
R_7	330k	2
R_8	100k	3

Component References		
Component	Unit Value	Note
R_9	100k	3
C_1	0.1 u	
C_2	120p	3
C_3	1000p	2
C_4	120p	2
C_5	0.1μ	
C_6	33p	1
C_7	47p	1

Component References		
Component	Unit Value	Note
C_8	.0022μ	
C_9	.001μ	2
C_{10}	120p	3
C_{11}	0.1 u	
C_{12}	1.0μ	
C_{13}	1.0μ	
C_{14}	0.47μ	
C_{15}	1.0μ	
X_1	4.433619MHz	

Tolerance
Resistors ±10%
Capacitors ±20%

Notes:

1. *Recommended Xtal Circuitry (see above).*
2. *'Clear' channel inputs are shown with Ch1 (pre-emphasis) and Ch2 (de-emphasis) components. See figures 4 and 5.*
3. *Gain setting components for the 'scrambled paths' are shown for a gain of 0dB. See figure 6.*

Figure 2: External Component Connections

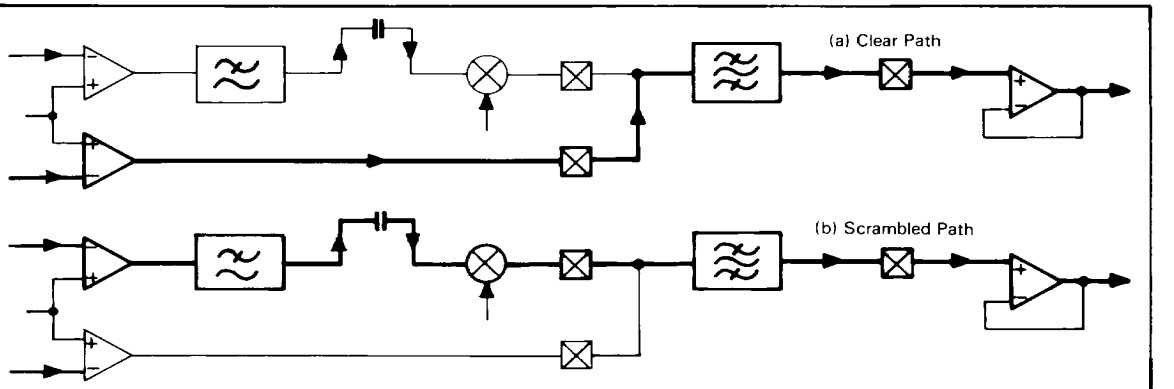


Figure 3: Simplified Signal Paths

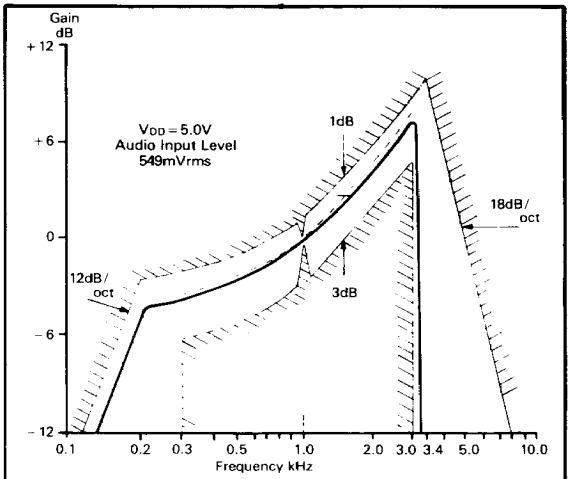


Fig. 4 Typical Audio Frequency Response of Transmit Path in 'Clear'

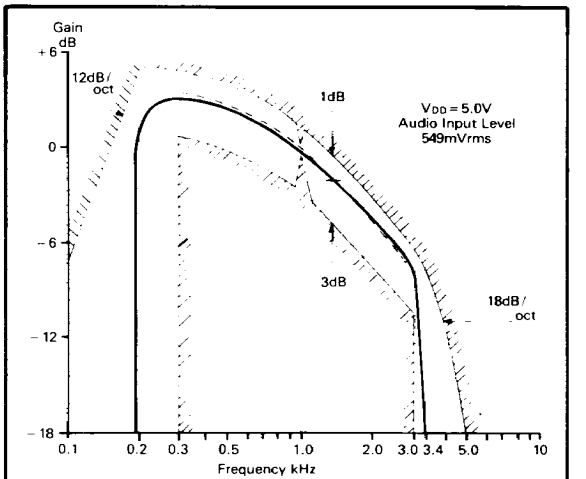


Fig. 5 Typical Audio Frequency Response of Receive Path in 'Clear'

CLEAR AND SCRAMBLE PASSBANDS

Gain levels for Figures 4, 5, and 6 are with respect to an audio input level of 549 mVrms.

Figure 4 shows the MX304 "Clear" path response compared with the Net-C specification, using preemphasis components at the input with a time constant of 200 μs. See Figure 2.

Figure 5 shows the MX304 "Clear" path response compared with the Net-C specification, using deemphasis components at the input with a time constant of 200 μs. See Figure 2.

Figure 6 shows the MX304 overall response of a scrambled or de-scrambled channel compared with the Net-C specification.

In the "Clear" path, the 4 dB gain of the output bandpass filter must be considered and compensated for by the input components (as in Figure 2) for an overall Passband Gain of 0 dB.

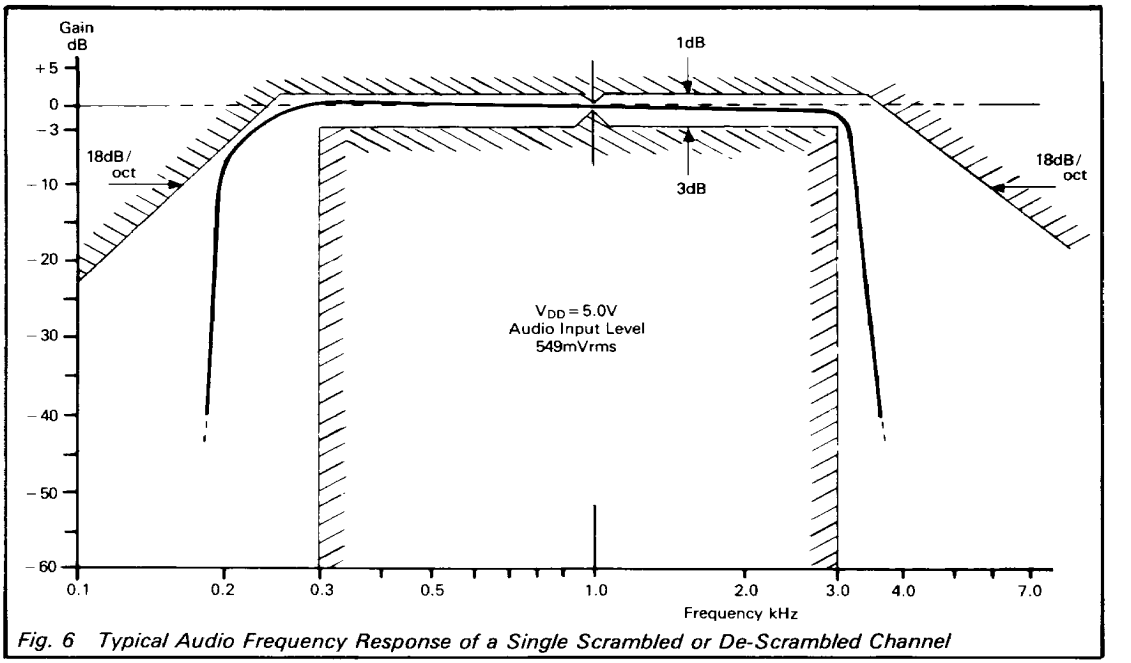


Fig. 6 Typical Audio Frequency Response of a Single Scrambled or De-Scrambled Channel

MX304 PIN FUNCTION TABLE

PIN NUMBER (ALL PKGS)	FUNCTION
1	**Xtal/Clock:** 4.433619 MHz or externally derived clock is injected at this pin. See Fig. 2.
2	**$\overline{\text{Xtal}}$:** output of a clock oscillator inverter.
3	**C_1 Clear/$\overline{\text{Invert}}$:** controls the operation of channel 1 modulation. See Table 1. Internal 1 MΩ pull-up.
4	**C_1 Filter Output:** Output of the channel 1 input filter. It is to be coupled to "C_1 balanced modulator input" via a 1.0 μF cap (C_{15}). See Fig. 2.
5	**C_1 Balanced Modulator Input:** The input to channel 1 balanced modulator. Internally biased at $V_{DD}/2$. It is to be coupled to "C_1 Filter Output" via a 1.0 μF cap (C_{15}). See Fig. 2.
6	**C_1 Amp Input:** Channel 1 amplifier, with external components (see Fig. 2). Can be used to provide preemphasis, deemphasis, and/or gain in the "Clear" path.
7	**C_1 Clear Input:** The negative input of channel 1 amplifier for use in the "Clear" path. Recommended external components in Fig. 2.
8	**C_1 Output Enable:** controls the status of channel 1 output. See Table 1. Internal 1 MΩ pull-up.
9	**C_1 Output:** The analog output of channel 1. Internally biased at $V_{DD}/2$. Output state is dependent on channel 1 "Clear/$\overline{\text{Invert}}$" and "Output Enable" pins. See Table 1.

Table 1: Output Control

Channel 1/2		
Clear/Invert	**Output Enable**	**Output**
1	1	Clear
0	1	Frequency Inverted
X	0	$V_{DD}/2$

10	**C_1 Gain Amp Output:** The output pin of channel 1 gain adjusting op-amp. See Fig. 2 for gain-setting components.
11	**C_1 Scramble Input:** The analog signal input to channel 1 in the "Invert" mode. This input is to a gain adjusting op-amp whose gain is set by external components. See Fig. 2.
12	**V_{ss}:** Negative Supply (GND)
13	**Bias:** The analog bias line at $V_{DD}/2$. It should be decoupled to V_{ss} via a 1.0 μF or greater capacitor. See Fig. 2.
14	**C_2 Scramble Input:** The analog signal input to channel 2 in the "Invert" mode. This input is to a gain adjusting op-amp whose gain is set by external components. See Fig. 2.
15	**C2 Gain Amp Output:** The output pin of Channel 2 gain adjusting op-amp. See Fig. 2 for gain setting components.
16	**C_2 Output:** The analog output of channel 2, internally biased at $V_{DD}/2$. Output state is dependent on channel 2 "Clear/$\overline{\text{Invert}}$" and "Output Enable" pins. See Table 1.
17	**C_2 Output Enable:** controls the status of channel 2 output. See Table 1. Internal 1 MΩ pull-up.
18	**C_2 Clear Input:** The negative input of channel 2 amplifier for use in the "Clear" path. Recommended external components shown in Fig. 2.

MX304 PIN FUNCTION TABLE (cont.)

PIN NUMBER (ALL PKGS)	FUNCTION
19	**C_2 Amp Output:** Channel 2 amplifier with external components (see Fig. 2) can be used to provide preemphasis, deemphasis and/or gain in the "Clear" path.
20	**C_2 Balanced Modulator Input:** The input to channel 2 balanced modulator. Internally biased at $V_{DD}/2$, it is to be coupled to "C_2 Filter Output" via 1.0 µF capacitor (C_{12}). See Fig. 2.
21	**C_2 Filter Output:** The output of the channel 2 input filter. It should be coupled to "C_2 Balanced Modulator Input" via a 1.0 µF capacitor (C_{12}). See Fig. 2.
22	**C_2 Clear/$\overline{\text{Invert}}$:** Controls the operation of channel 2 modulation. See Table 1. Internal 1 MΩ pull-up.
23	**No Connection.**
24	**V_{DD}:** A positive 5V supply.

MX304 ELECTRICAL SPECIFICATION

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		-0.3V to 7.0V
Input Voltage at any pin (ref. V_{ss} = 0V)		-0.3V to (V_{DD} + 0.3V)
Output sink/source current (supply pins)		+/-30ma
(other pins)		+/-20ma
Total Device Dissipation @ 25°C		800 mW Max.
Derating		10 mW/°C
Operating Temperature Range:	MX304J	-30°C to + 85°C (Ceramic)
	MX304P,LH	-30°C to + 70°C (Plastic)
Storage Temperature Range:	MX304J	-55°C to + 125°C (Ceramic)
	MX304P,LH	-40°C to + 85°C (Plastic)

Operating Limits

All characteristics measured using the following parameters unless otherwise specified: V_{DD} = 5V, T_{amb} = 25°C, Clock = 4.433619 MHz, Audio Level Ref: 0 db = 775 mVrms @ 1kHz.

Characteristics	See Note	Min	Typ	Max	Unit
Static Values:					
Supply Voltage	1	4.5	5.0	5.5	V
Supply Current		—	7.0	—	mA
Input Impedance (Digital)		100	—	—	kΩ
Input Impedance (Amplifiers)		—	18	—	MΩ
Input Impedance (Bal. Mod.)		—	20	—	kΩ
Output Impedance (LP Filters)		—	20	—	kΩ
Output Impedance (C_1, C_2)		—	800	—	Ω
Output Impedance (C_1, C_2 Amps)		—	10	—	kΩ
Inputs Logic "1"		3.5	—	—	V
Inputs Logic "0"		—	—	1.5	V

Characteristics	See Note	Min	Type	Max	Unit
Dynamic Values	1				
Analog Signal Input Levels		-30	—	+6	dB
Analog Signal Output Levels		-30	—	+6	dB
Unwanted Modulation Products	2 & 3	—	—	-40	dB
Carrier Breakthrough	2 & 3	—	-55	—	dB
Baseband Breakthrough	2 & 3	—	—	-40	dB
Carrier Frequency		—	3299	—	Hz
Analog Output Noise	4	—	-50	—	dB
Filters:					
Input Lowpass Filter					
Cut-off Frequency (-3dB)		—	3100	—	Hz
Passband Flatness (300 Hz to 3kHz)		—	0.5	—	dB
Attenuation at 3.3 kHz		—	30	—	dB
Attenuation at 3.6 kHz		—	50	—	dB
Passband Gain		—	0.5	—	dB
Output Bandpass Filter	5				
Passband Frequencies		300		3000	Hz
Passband Flatness		—	1.0	—	dB
Low Freq. Roll-off <200 Hz		12	—	—	dB/oct
High Freq. Roll-off >3.4 kHz		24	—	—	dB/oct
Passband Gain		3	4	5	dB
Distortion	2	—	3	—	%
Overall Modulated or De-Modulated Channel Response					
Passband Frequencies		300	—	3000	Hz
Passband Flatness		-3	—	+1	dB
Low Freq. Roll-off <250 Hz		18	—	—	dB/oct
High Freq. Roll-off >3.4 kHz		18	—	—	dB/oct
Passband Gain	5	—	2	—	dB

Notes: 1. Dynamic characteristics specified at 5V V_{DD}.
2. Measured with Input Level -3dB.
3. Single Modulated Channel.
4. Short circuit input, any analog output, in 30 kHz bandwidth.
5. Op Amp gain 0 dB.