Monolithic Compandor

GENERAL DESCRIPTION

The XR-2216 is a monolithic audio frequency compandor designed to compress or expand the dynamic range of speech or other analog signals transmitted through telecommunication systems. The monolithic circuit can be connected as either a compressor or an expander, the choice being determined by the external circuitry.

FEATURES

Functions as either a Compressor or an Expander
Wide Dynamic Range: 60 dB
Wide Supply Range: 6 to 20 Volts
Excellent Transfer Function Tracking
Low Power Supply Drain
Controlled Attack and Release Times
Low Noise and Low Distortion

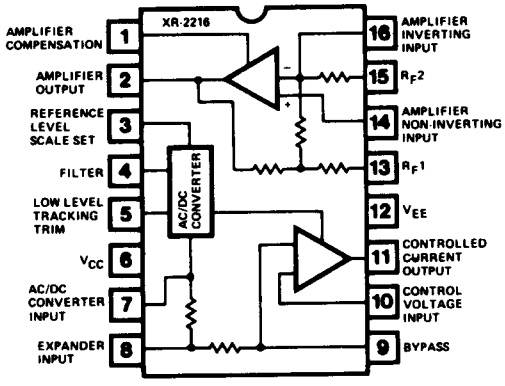
APPLICATIONS

Telephone Trunk—Line Compandor
Speech/Data Compression and Expansion
Telecommunication Systems
Mobile Communications
Model Data Processing

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	20V
Power Dissipation	
Ceramic Package	750 mW
Derate above +25°C	6 mW/°C
Plastic Package	625 mW
Derate above +25°C	5 mW/°C
Storage Temperature	−60°C to +150°C

FUNCTIONAL BLOCK DIAGRAM



ORDERING INFORMATION

Part Number	Package (16 Pin DIP)	Operating Temperature
XR-2216CN	Ceramic	−40°C to +60°C
XR-2216CP	Plastic	−40°C to +60°C

SYSTEM DESCRIPTION

The XR-2216 is comprised of four basic blocks: (1) an internal voltage reference; (2) an AC/DC converter which converts AC signal input to a DC current level; (3) an impedance converter whose impedance level is a function of a DC control signal; and (4) a high gain operational amplifier.

The XR-2216 is designed to accommodate a wide range of system configurations. It can be operated with positive or negative single supply systems, or dual power supplies over a power supply range of 6 volts to 20 volts.

XR-2216

ELECTRICAL CHARACTERISTICS

Test Conditions: V_C = +12V, T_A = 25°C

COMPANDOR

PARAMETERS	MIN	TYP	MAX	UNITS	CONDITIONS
Power Supply Voltage	6		20	VDC	
Nominal Power Supply Voltage	12		18	VDC	
Power Supply Current, No Signal Input			3	mA	
Gain Change Over Frequency Tolerance	−1		+1	dB	300 ~ 3500 Hz
Distortion Measured at −4 dB* Input Level at 1 KHz		3		% THD	
Attack Time Measured at −10 dB Input Level			5	ms	To 90% of Final Value
Decay Time Measured at −10 dB Input Level			5	ms	To 10% of Final Value
Transfer Characteristics** Compandor Output With Input Levels of:					
−4 dBm	3.5	+6	7.5	dBm	
−8 dBm	−0.5	+2	3.5	dBm	
−10 dBm	−1.5	0	+1.5	dBm	
−14 dBm (reference)		−4		dBm	
−24 dBm	−15.5	−14	−12.5	dBm	
−34 dBm	−25.5	−24	−22.5	dBm	
−44 dBm	−36.5	−34	−32.5	dBm	
−54 dBm	−49	−44	−42.5	dBm	
−64 dBm	−59	−54	−52.5	dBm	

COMPRESSOR

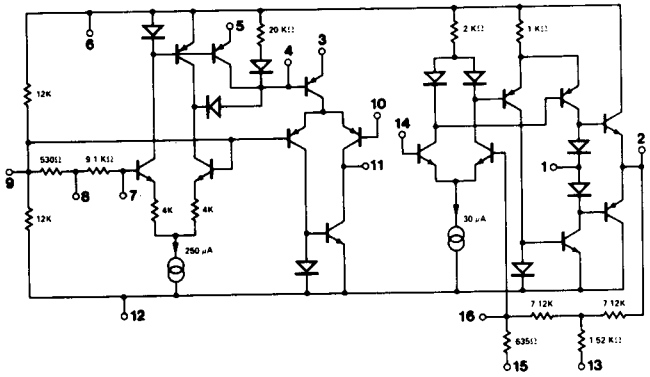
PARAMETERS	MIN	TYP	MAX	UNITS	CONDITIONS
Input Impedance	50			k ohm	
Output Impedance			50	ohm	
Output Signal Level for −10 dBm Input at 1 KHz		−10		dBm	
Output Voltage Swing	0			dB	
Output Noise, Input AC Grounded			30	dBrnc	
Compressor Transfer Characteristics** Compressor Output With Input Levels of:					
−4 dBm		−7		dBm	
−8 dBm		−9		dBm	
−10 dBm		−10		dBm	
−14 dBm (reference)		−12		dBm	
−24 dBm		−17		dBm	
−34 dBm		−22		dBm	
−44 dBm		−27		dBm	
−54 dBm		−32		dBm	
−64 dBm		−37		dBm	

EXPANDER

PARAMETERS	MIN	TYP	MAX	UNITS	CONDITIONS
Input Impedance	50			k ohm	
Output Impedance			50	ohm	
Output Signal Level for −10 dBm		0		dBm	
Output Voltage Swing	+8			dB	
Output Noise Input AC Grounded			+5	dBrnc	
Expander Transfer Characteristics** Expander Input Levels Required for Output of:					
+6 dBm		−7		dBm	
+2 dBm		−9		dBm	
0 dBm		−10		dBm	
−4 dBm (reference)		−12		dBm	
−14 dBm		−17		dBm	
−24 dBm		−22		dBm	
−34 dBm		−27		dBm	
−44 dBm		−32		dBm	
−55 dBm		−37		dBm	

Notes: *0 dBm = 0.775 Vrms (1 mW across 600 ohm load) **Recommended transfer characteristics.

EQUIVALENT SCHEMATIC DIAGRAM



CIRCUIT DESCRIPTION

The analog signal compressor/expander or "compandor" circuits are among the most fundamental building blocks in telecommunication systems. These circuits are intended to compress or expand the dynamic range of speech or other analog signals transmitted through telecommunication systems.

Figure 1 shows the simplified block diagram of a typical speech transmission system, using the compression/expansion or "companding" technique. The dynamic range of the input signal is first compressed at the transmitting end; then transmitted through the system, and finally expanded back to the original amplitude at the receiving end. Thus, the "compressor" and the "expander" sections of a compandor system perform reciprocal functions. In a bi-directional transmission system, there is a compandor at each end of the line which compresses the out-going signal, or expands the incoming signal by an equal amount.

Figure 2 shows the typical transfer characteristics of compressor and expander circuits commonly used in telecommunication systems. In the compressor, the output amplitude varies 1 dB for every 2 dB change of input amplitude; the reverse is true for the expander.

The functional block diagram of XR-2216 compandor is shown on Page 1, in terms of the monolithic circuit package. The XR-2216 is designed to be connected as *either* a compressor or an expander, the choice being determined by the external circuitry. The monolithic system is comprised of four basic blocks: (1) an internal voltage reference; (2) an ac/dc converter which converts ac signal input to a dc current level; (3) an impedance converter whose impedance level is a function of a dc control signal; and (4) a high gain operational amplifier.

The XR-2216 is designed to accommodate a wide range of system configurations It can be operated with positive, or negative, single-supply systems, or with balanced power supplies, over a power supply range of 6 volts to 20 volts.

Some of its key features are: low external component count, excellent transfer function, tracking, low power supply drain, controlled attack and release times, low noise and low distortion.

EXPANDER (Figure 3)

Figure 3 shows the external circuit connections and components necessary to operate XR-2216 as an expander. An input signal is applied to Pin 7 which is the

AC/DC converter input. The AC/DC converter converts the AC signal input to a dc current level which in turn controls the transconductance of the impedance converter. Part of the input signal is applied to the impedance converter by connecting Pins 8 and 10. Thus the signal current at Pin 11 is proportional to the product of the input signal and its average value.

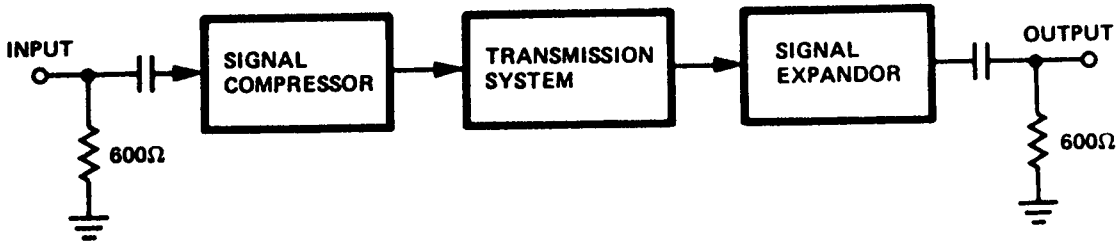


Figure 1. Simplified Block Diagram of a Speech Transmission System Using Companding Technique

The output signal current is then fed to the operational amplifier by connecting Pins 11 and 16, and the output signal voltage is directly proportional to the signal current flowing into Pin 16. The output signal of the expander is available at Pin 2. In this operation, the reference level is set by the trim pot R1, and the trim pot R2 provides a means for trimming low level tracking.

In the connection of Figure 3, the input signals of −37 dBm to −7 dBm are expanded to 60 dB output range with up to 0 dBm power matched output to 600Ω load.

COMPRESSOR (Figure 4)

Figure 4 shows the typical circuit connection for compressor operation. It is just a non-inverting voltage amplifier whose input level is proportional to the product of the incoming signal and the impedance of the impedance converter which is inversely proportional to the amplifier output. Consequently, the output signal at Pin 2 is proportional to square root of the input signal.

In this operation, just like expander operation, the reference level is set by the trim pot R1 and low level tracking is adjusted by the trim pot R2. In the connection of Figure 4, the output change is 1 dB for 2 dB input change. The output range can be adjusted to −37 dBm to −7 dBm for input signals of 60 dB dynamic range.

Note: Attack and Decay Times:

The speed with which gain changes to follow changes in input signal levels is determined by the capacitor C1 and the resistor R1. A small capacitor will yield rapid response but will not fully filter low frequency signals. Any ripple on the gain control signal will modulate the signal passing through the impedance converter. In an expander and compressor application, this would lead to a 3rd harmonic distortion, so there is a tradeoff to be made between fast attack and decay times, and distortion.

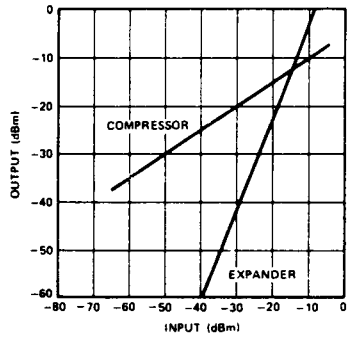


Figure 2. Transfer Characteristics of Compressor a Expander Circuits

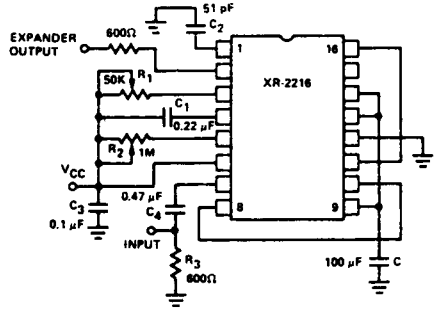


Figure 3. External Connections for Operation Expander

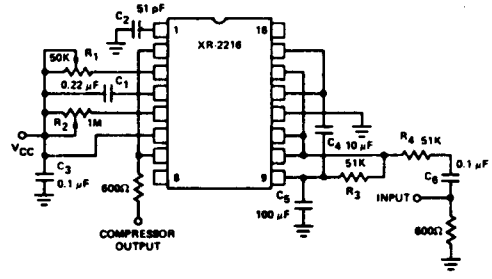


Figure 4. External Connections for Compressor Operation

TYPICAL PERFORMANCE CURVES

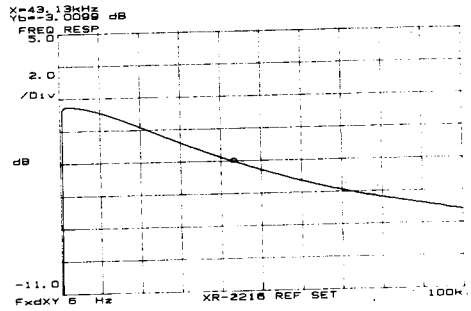


Figure 5. XR-2216 Compressor Output Error vs. Input Signal Amplitude

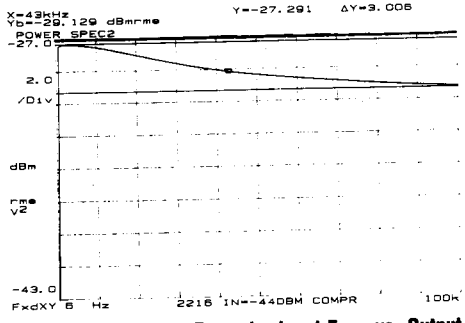


Figure 6. XR-2216 Expander Input Error vs. Output Signal Amplitude

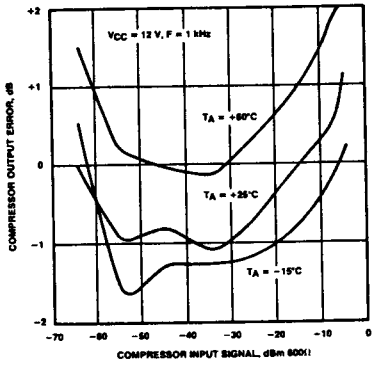


Figure 7. XR-2216 Compandor Tracking Error vs. Input Signal

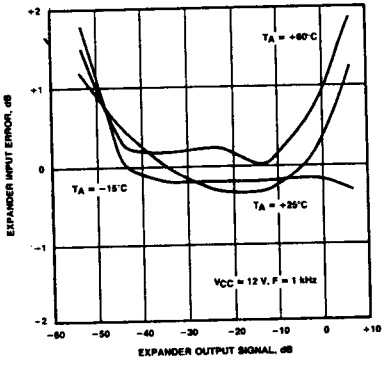


Figure 8. Showing the Typical Frequency Response of the XR-2216 with the Reference Level Set as described in the Test Procedure (Compression Mode)

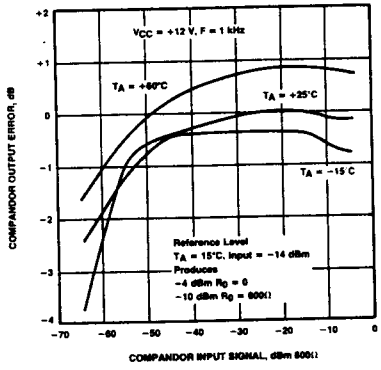


Figure 9. Showing the Frequency Response of the XR-2216 (Compression Mode) with the Input at −44 dBm. Please note that the Response has not changed appreciably from the reference set amplitude

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EXAR

XR-1488/1489A

Quad Line Driver/Receiver

GENERAL DESCRIPTION

The XR-1488 is a monolithic quad line driver designed to interface data terminal equipment with data communications equipment in conformance with the specifications of EIA Standard No. RS232C. This extremely versatile integrated circuit can be used to perform a wide range of applications. Features such as output current limiting, independent positive and negative power supply driving elements, and compatibility with all DTL and TTL logic families greatly enhance the versatility of the circuit.

The XR-1489A is a monolithic quad line receiver designed to interface data terminal equipment with data communications equipment. the XR-1489A quad receiver along with its companion circuit, the XR-1488 quad driver, provide a complete interface system between DTL or TTL logic levels and the RS232C defined voltage and impedance levels.

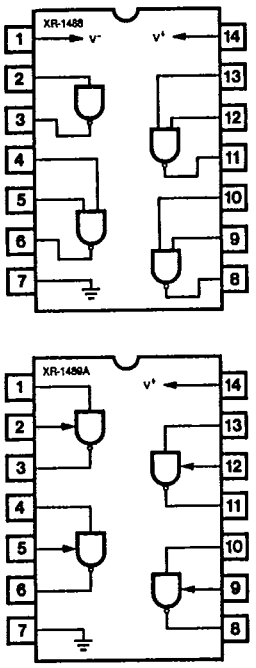
ABSOLUTE MAXIMUM RATINGS

Power Supply	
XR-1488	±15 Vdc
XR-1489A	+10 Vdc
Power Dissipation	
Ceramic Package	1000 mW
Derate above +25°C	6.7 mW/°C
Plastic Package	650 mW/°C
Derate above +25°C	5 mW/°C

ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-1488N	Ceramic	0°C to +70°C
XR-1488P	Plastic	0°C to +70°C
XR-1489AN	Ceramic	0°C to +70°C
XR-1489AP	Plastic	0°C to +70°C

FUNCTIONAL BLOCK DIAGRAMS



SYSTEM DESCRIPTION

The XR-1488 and XR-1489A are a matched set of quad line drivers and line receivers designed for interfacing between TTL/DTL and RS232C data communication lines.

The XR-1488 contains four independent split supply line drivers, each with a ±10 mA current limited output. For RS232C applications, the slew rate can be reduced to the 30 V/μS limit by shunting the output to ground with a 410 pF capacitor. The XR-1489A contains four independent line receivers, designed for interfacing RS232C to TTL/DTL. Each receiver features independently programmable switching thresholds with hysteresis, and input protection to ±30 V. The output can typically source 3 mA and sink 20 mA.

XR-494

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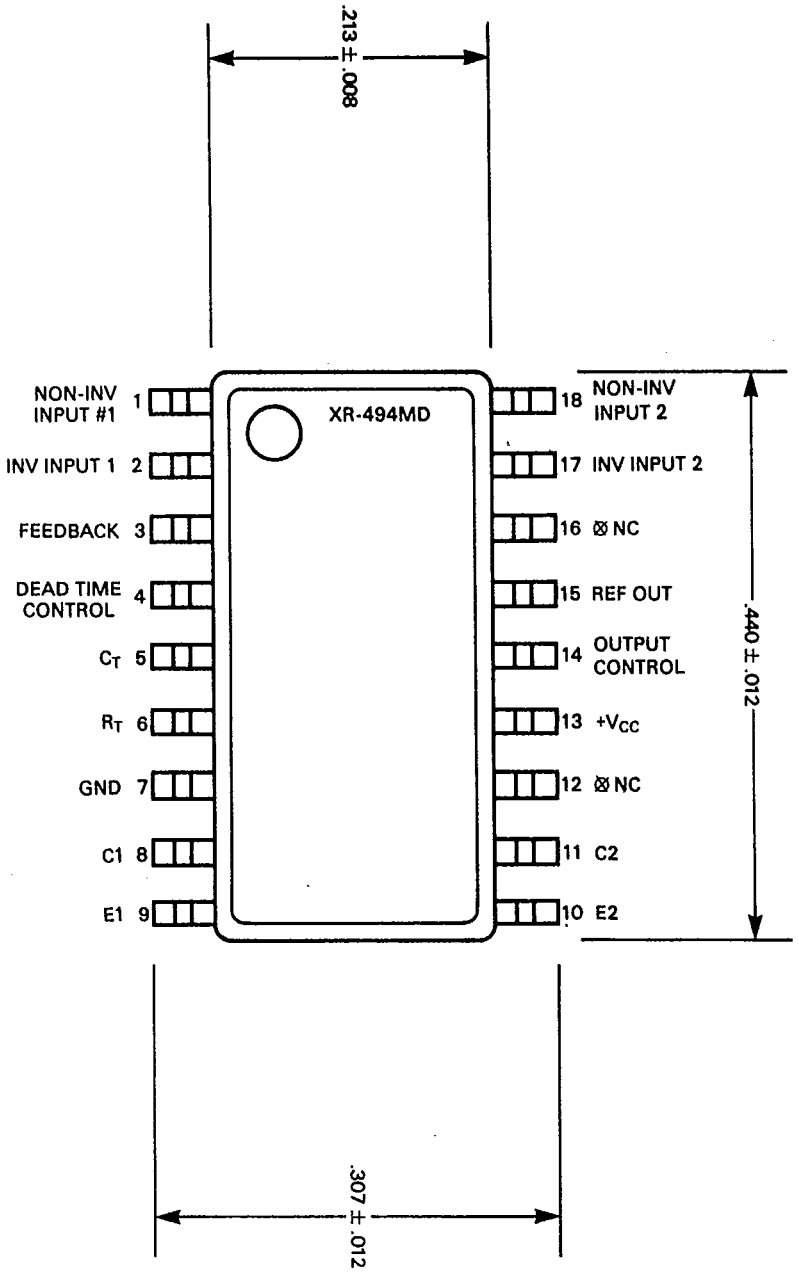


EXAR

XR-1468/1568

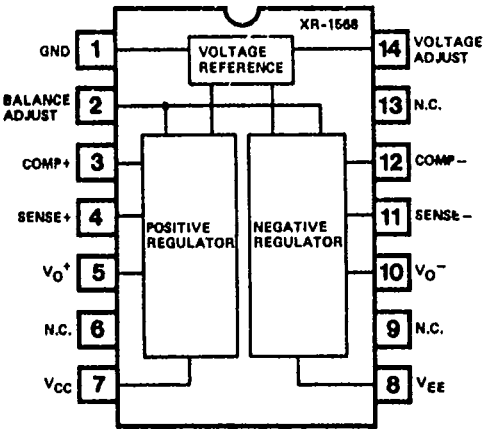
Dual-Polarity Tracking Voltage Regulator

GENERAL DESCRIPTION

The XR-1468/1568 is a dual polarity tracking voltage regulator, internally trimmed for symmetrical positive and negative 15V outputs. Current output capability is 100 mA, and may be increased by adding external pass transistors. The device is intended for local "on-card" regulation, which eliminates the distribution problems associated with single point regulation.

The XR-1468CN and XR-1568N are guaranteed over the 0°C to 70°C commercial temperature range. The XR-1568M is rated over the full military temperature range of −55°C to +125°C.

FUNCTIONAL BLOCK DIAGRAM



FEATURES

Internally Set for ±15V Outputs
±100 mA Peak Output Current
Output Voltages Balanced Within 1% (XR-1568)
0.06% Line and Load Regulation
Low Stand-By Current
Output Externally Adjustable from ±8 to ±20 Volts
Externally Adjustable Current Limiting
Remote Sensing

APPLICATIONS

Main Regulation in Small Instruments
On-Card Regulation in Analog and Digital Systems
Point-of-Load Precision Regulation

ORDERING INFORMATION

Part Number	Temperature	Output Offset	Package
XR-1568M	−55°C to +125°C	±150 mV max	Ceramic
XR-1568N	0°C to +70°C	±150 mV max	Ceramic
XR-1468CN	0°C to +70°C	±300 mV max	Ceramic

ABSOLUTE MAXIMUM RATINGS

Power Supply	±30 Volts
Minimum Short-Circuit Resistance	4.0 Ohms
Load Current, Peak	±100 mA
Power Dissipation	
Ceramic (N) Package	1.0 Watt
Derate Above +25°C	6.7 mW/°C
Operating Temperature	
XR-1568M	−55°C to +125°C
XR-1568/XR-1468C	0°C to +70°C
Storage Temperature	−65°C to +150°C

SYSTEM DESCRIPTION

The XR-1468/1568 is a dual polarity tracking voltage regulator combining two separate regulators with a common reference element in a single monolithic circuit, thus providing a very close balance between the positive and negative output voltages. Outputs are internally set to ±15 Volts but can be externally adjusted between ±8.0 to ±20 Volts with a single control. The circuit features ±100 mA output current, with externally adjustable current limiting, and provision for remote voltage sensing.

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