THE DATASHEET OF

MC44C402AC

MTS Stereo Encoder

MC44C402

MTS STEREO ENCODER

The MC44C402 Multi-Channel Television Sound (MTS) Stereo Encoder is based on the industry's first, single-chip, CMOS implementation of a Broadcast Television Systems Committee (BTSC)-compatible stereo encoder, the MC44C400.

The MC44C402 MTS Stereo Encoder is designed for use in set-top boxes, VCRs, DVD players/recorders, game stations, and other applications that are required to output high-quality stereo sound through a single RF coaxial cable.

The digital audio processing used in the MC44C402 preserves the full fidelity of surround sound and other audio coding schemes while ensuring overall system performance is not impacted by copy protection technologies.

The MC44C402 is engineered to process right and left analog audio signals and baseband composite video to generate a stereophonic composite signal in accordance with BTSC system standards. The MC44C402 is designed to output this signal to a Freescale RF modulator, which in turn produces a stereo encoded RF channel for use with any BTSC stereo television receiver.

AC SUFFIX
32-LEAD LQFP PACKAGE
CASE 873A-04

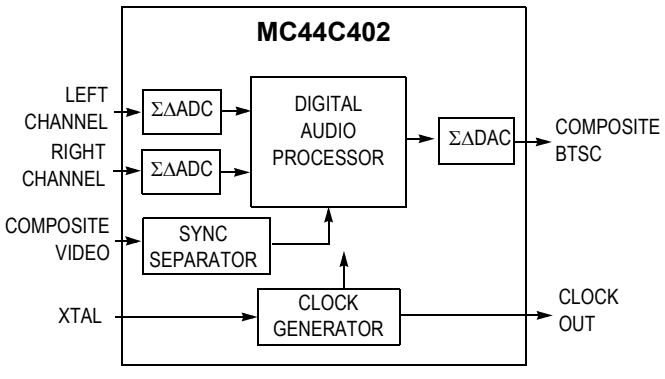
Features

- Integrated A/D converter input and D/A converter output circuitry
- CEX™ digital audio processing encodes and transports stereo signals
- Surround sound and Macrovision™ compatible
- Extended low frequency response (The MC44C402 frequency response extends below 25 Hz)
- Simple passive interface to Freescale's MC44BS373/4 (UHF/VHF) and MC44BC375 (VHF) modulators
- Preservation of original surround sound fidelity
- System performance not impacted by copy protection technologies
- Low system component count, small board size, and significantly low overall system cost
- No manual alignment of filters or phase controls

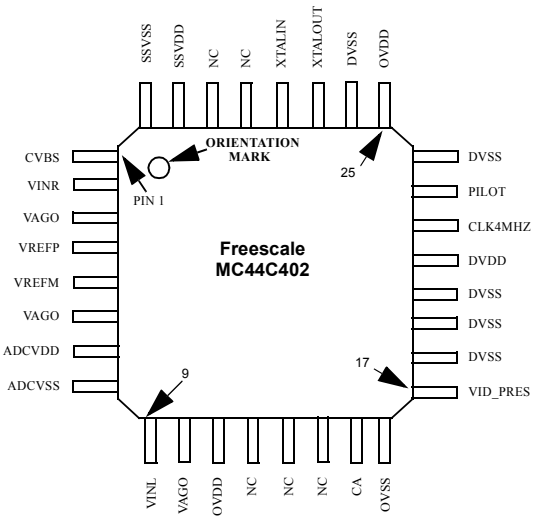
ORDERING INFORMATION			
Device	**Temp. Range**	**Package**	**RoHS**
MC44C402AC	–40°C to +85°C	32LQFP	yes
MC44C402ACR2	Tape & Reel		yes

Reference Documentation

"Multichannel Television Sound Transmission and Audio Processing Requirements for the BTSC System", FCC OET Bulletin No. 60, February 1986.



Functional Block Diagram



MC44C402 32LQFP Package

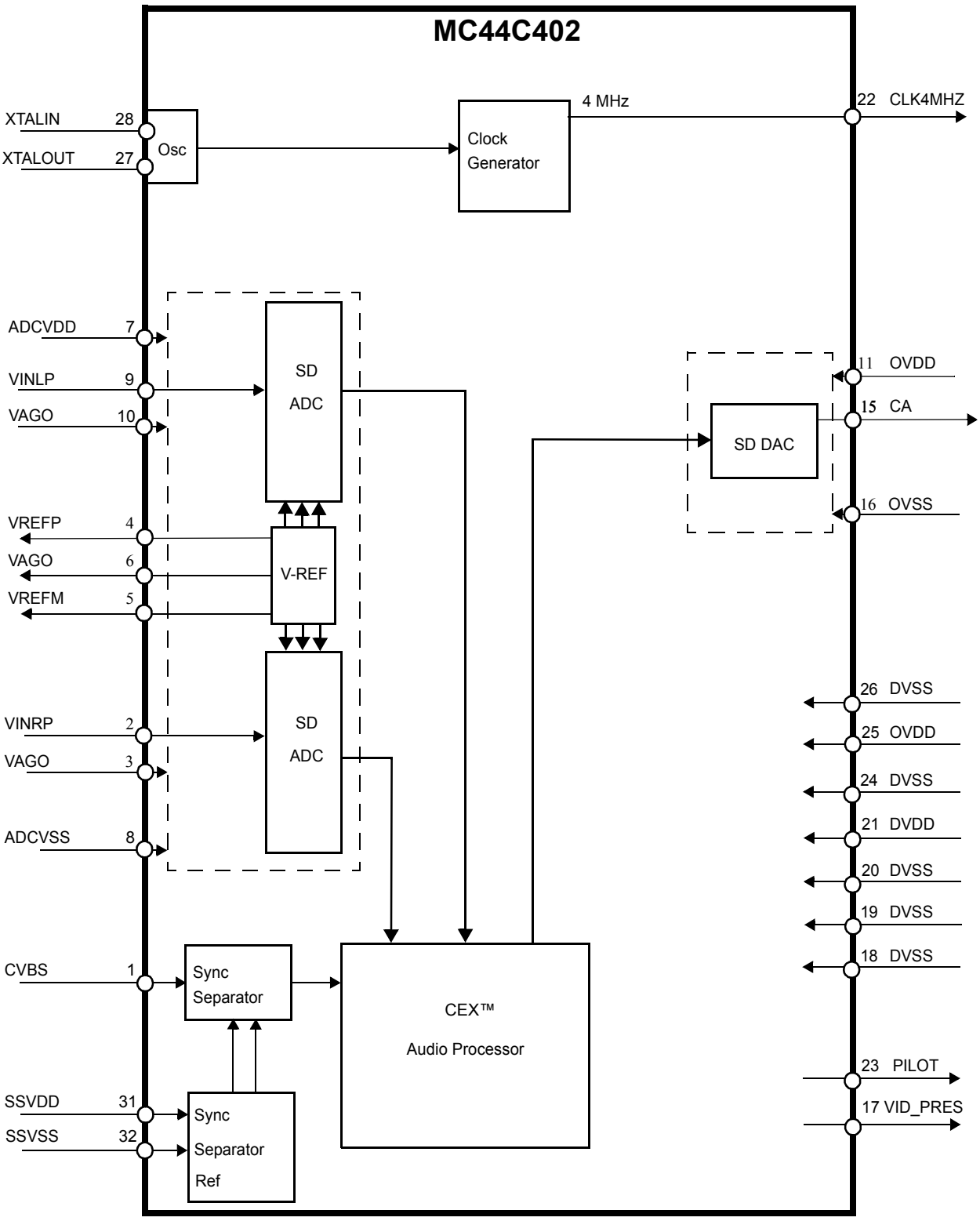


Figure 1. MC44C402 Block Diagram

PIN DESCRIPTION

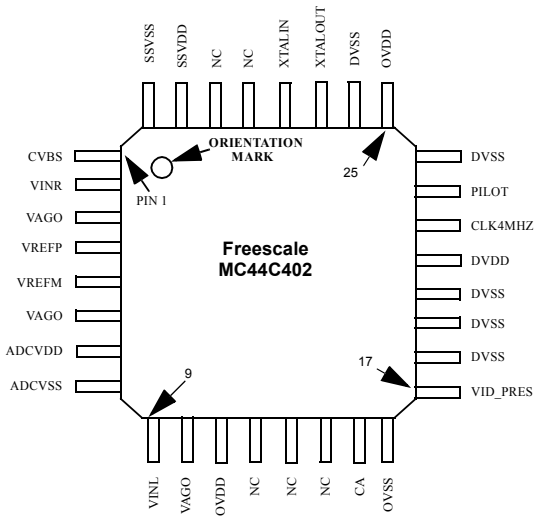


Figure 2. MC44C402 32LQFP Package

Table 1. Pin Descriptions (Listed by Function)

Signal Name	Pin #	Description
Analog		
VINL	9	Left channel input
VREFP	4	ADC Voltage Ref. Bypass plus
VAGO	3, 6, 10	Analog virtual ground
VREFM	5	ADC Voltage Ref. Bypass minus
VINR	2	Right channel input
CVBS	1	Composite video input to sync separator
Digital		
CA	15	Composite Audio output
VID_PRES	17	Video present flag, 0 = no video, hi-z = video present
PILOT	23	15.734 KHz square wave output phased locked to incoming video
NC	12, 13, 14, 29, 30	No Connection
Clocks		
XTALIN	28	Crystal oscillator input
XTALOUT	27	Crystal oscillator output
CLK4MHZ	22	4 MHz clock output for Audio/Video modulator IC
Power Supply		
SSV_{DD}	31	Sync Separator analog supply voltage, 3.3 V
SSV_{SS}	32	Sync Separator analog ground
$ADCV_{DD}$	7	ADC analog supply voltage, 3.3 V
$ADCV_{SS}$	8	ADC analog ground
DV_{DD}	21	Digital Logic supply voltage, 1.8 V
DV_{SS}	16, 18, 19, 20, 24, 26	Digital Logic and I/O grounds
OV_{DD}	11, 25	I/O supply voltage, 3.3 V

Table 2. Absolute Maximum Ratings

Absolute maximum continuos ratings are those maximum values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation at absolute-maximum-rated conditions is not implied.

Characteristic	Symbol	Min	Max	Units
Digital Logic Supply Voltage	DV_{DD}	–0.3	+2.0	V
Digital Output Supply Voltage	OV_{DD}	–0.3	+4.0	V
ADC Supply Voltage	$ADCV_{DD}$	–0.3	+4.0	V
Sync. Separator Supply Voltage	SSV_{DD}	–0.3	+4.0	V
Input Voltage	V_{in}	–0.3	xxV_{DD} + 0.3	V
Storage Temperature Range	T_{stg}	–55	+150	°C

Table 3. General Specifications

Characteristic	Symbol	Min	Typ	max	Units
ESD Protection (Machine Model)	MM	200			V
ESD Protection (Human Body Model)	HBM	2000			V
Latch-Up Immunity	LU	200			mA

Table 4. Recommended Operating Conditions

Characteristic	Symbol	Min	Typ	Max	Units
Digital Logic Supply Voltage	DV_{DD}	+1.62	+1.8	+1.98	V
Digital Output Supply Voltage	OV_{DD}	+2.97	+3.3	+3.63	V
ADC Supply Voltage	$ADCV_{DD}$	+2.97	+3.3	+3.63	V
Sync. Separator Supply Voltage	SSV_{DD}	+2.97	+3.3	+3.63	V
Left/Right Channel Input Level	VINL, VINR			1.8	V_{pp}
Composite Video Input Level (See Figure 8)	CVBS	0.5	1.0	2.0	V_{pp}
Ambient Temperature	T_A	–40		+85	°C

Table 5. DC Characteristics

Characteristic[1]	Symbol	Min	Typ	Max	Units
Digital Logic Supply Current	IDV_{DD}		7.5	8.5	mA
Digital Output Supply Current	IOV_{DD}		2.0	8.0	mA
ADC Supply Current	$IADCV_{DD}$		7.0	9.0	mA
Sync. Separator Supply Current	$ISSV_{DD}$		2.0		mA
CLK4MHZ, Clock Output @ I = 0.6 mA	V_{ol}	2.97			V
ADC Voltage Ref. Bypass plus	VREFP		+2.0		V
ADC Voltage Ref. Bypass minus	VREFM		+1.0		V
ADC Voltage Ref. Ground	VAGO		+1.5		V
CLK4MHZ, Clock Output @ I = 0.6 mA	V_{oh}			3.63	V

1. Unless other wise noted; DV_{DD} = 1.8 ± 0.18 Vdc, OV_{DD} = $ADCV_{DD}$ = SSV_{DD} = 3.3 ± 0.33 Vdc, GND = 0 Vdc, -40 ≤ T_A ≤ 85°C.

Table 6. AC Characteristics

Characteristic[1]	Symbol	Min	Typ	Max	Units
Input Impedance (Left/Right Input)	R_{in}		75		kΩ
Composite Audio Output Level[2]	CA		1.0		V_{pp}
Composite Output Level	CA			2.2	V_{pp}
Signal to Noise Ratio[2],[3]	SNR	72	75		dB
Total Harmonic Distortion[2],[3]	THD		0.1	0.3	%
-1 dB Bandwidth	BW	20		14500	Hz
Stereo Separation 500 Hz - 5 KHz[4]			35		dB
Stereo Separation 100 Hz - 10 KHz[4]		30	35		dB

1. Unless other wise noted; DV_{DD} = 1.8 ± 0.18 Vdc, OV_{DD} = $ADCV_{DD}$ = SSV_{DD} = 3.3 ± 0.33 Vdc, GND = 0 Vdc, -40 ≤ T_A ≤ 85°C.
2. Test conditions, mono, 1 kHz @ 1.5 V_{pp}
3. Measured in 20 Hz to 13.5 kHz bandwidth
4. Measured -10 dB input level

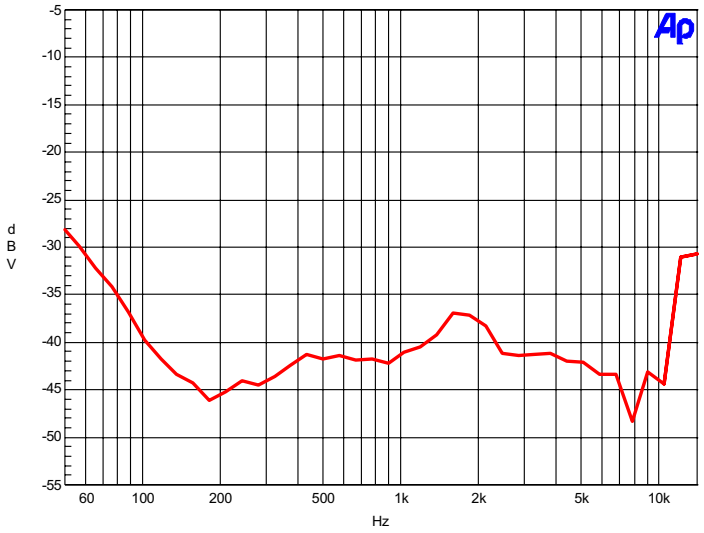


Figure 3. Stereo Separation

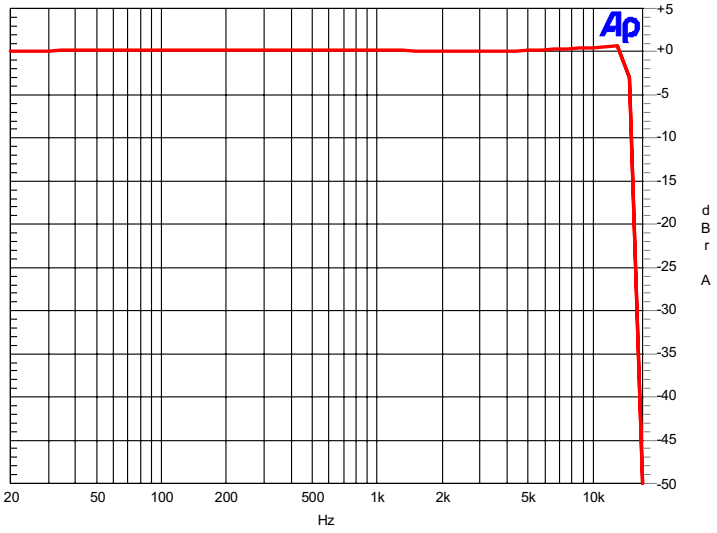


Figure 4. Amplitude Response

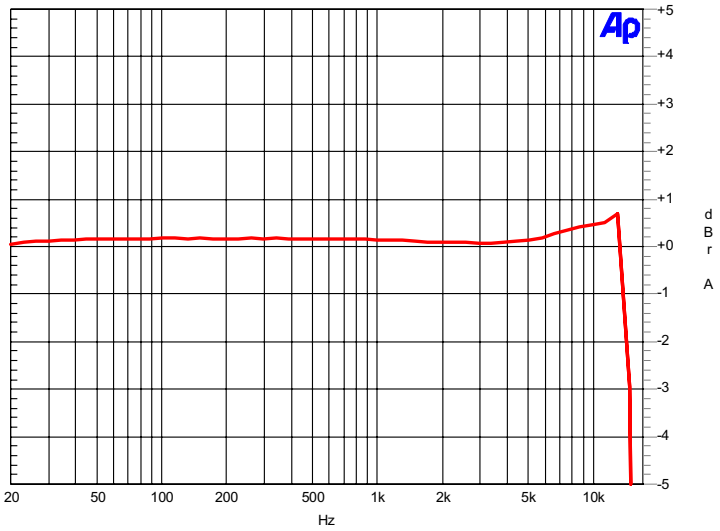


Figure 5. Amplitude Ripple

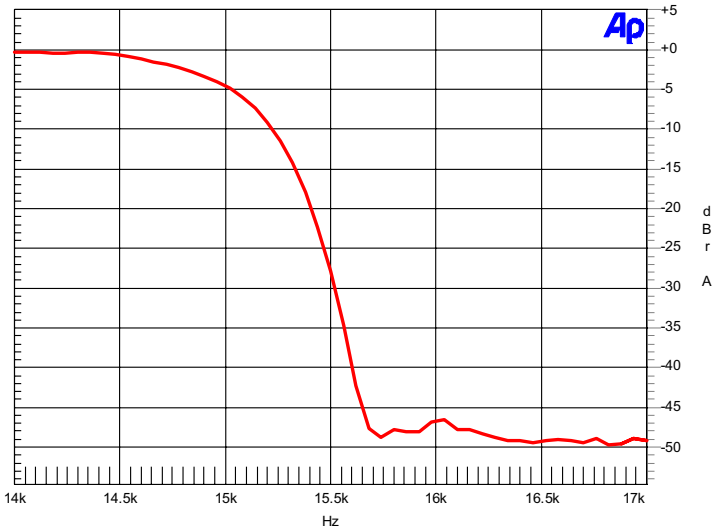


Figure 6. Amplitude-Notch

SYSTEM APPLICATION NOTES

DESIGN CONSIDERATIONS

When developing application using the MC44C402 Stereo Encoder, the user can significantly improve the performance by following the suggestions below:

1. Disable the pre-emphasis on the modulator
2. There must be a 4.5 MHz notch in the video because Video spectra that fall into the 4.5 MHz range will severely impact the audio performance. See the notch filter shown in Figure 7.
3. Measurements must be made with a precision demodulator followed by a precision decoder, measuring audio performance using mono or wide band output will give erroneous results. We suggest the setup as described below

Equipment suggestions

Demodulator:	Tektronix	TV1450
Decoder:	Modulation Sciences	SRD-1

4. A low pass filter is required on the CA (baseband) output. The filter shown in Figure 7 note 1 is recommended. It is a Bessell filter with uniform group delay to 50 kHz and an input impedance of 500Ω and high output impedance.
5. Crystal frequency is critical. It MUST be within +/- 2 kHz (100 PPM) under all conditions. Recommend 30 PPM or better at room temperature. Measure the frequency, being careful not to load the crystal oscillator pins or alternatively the frequency can be determined by measuring the 4 MHz using (spectrum analyzer), being careful not to load the crystal oscillator pins, or with a frequency counter on the 4 MHz port to +/- 400 Hz max or 100 Hz at room temp. A symptom of the crystal being off frequency is stereo separation changing at about a 1 Hz rate (Pulsing).

MODULATOR INTERFACE

1. The 4 MHz clock drive to the MC44BS373 must be filtered and the level set correctly. This can be achieved simply by using a 1 μH inductor and 1500 pF and series 750 ohm resistor and 100 pF blocking cap, as shown in Figure 7 note 2.
2. The MC44BS373 SPLL filter must be changed to a single 2.2 μF capacitor to ground. Please see Figure 7 note 3. (note some caps exhibit microphonic problems in this application.
3. Input impedance of the MC44BS373 is around 70 Kohms and to preserve the low frequency performance the coupling caps should be greater than 0.1 μF

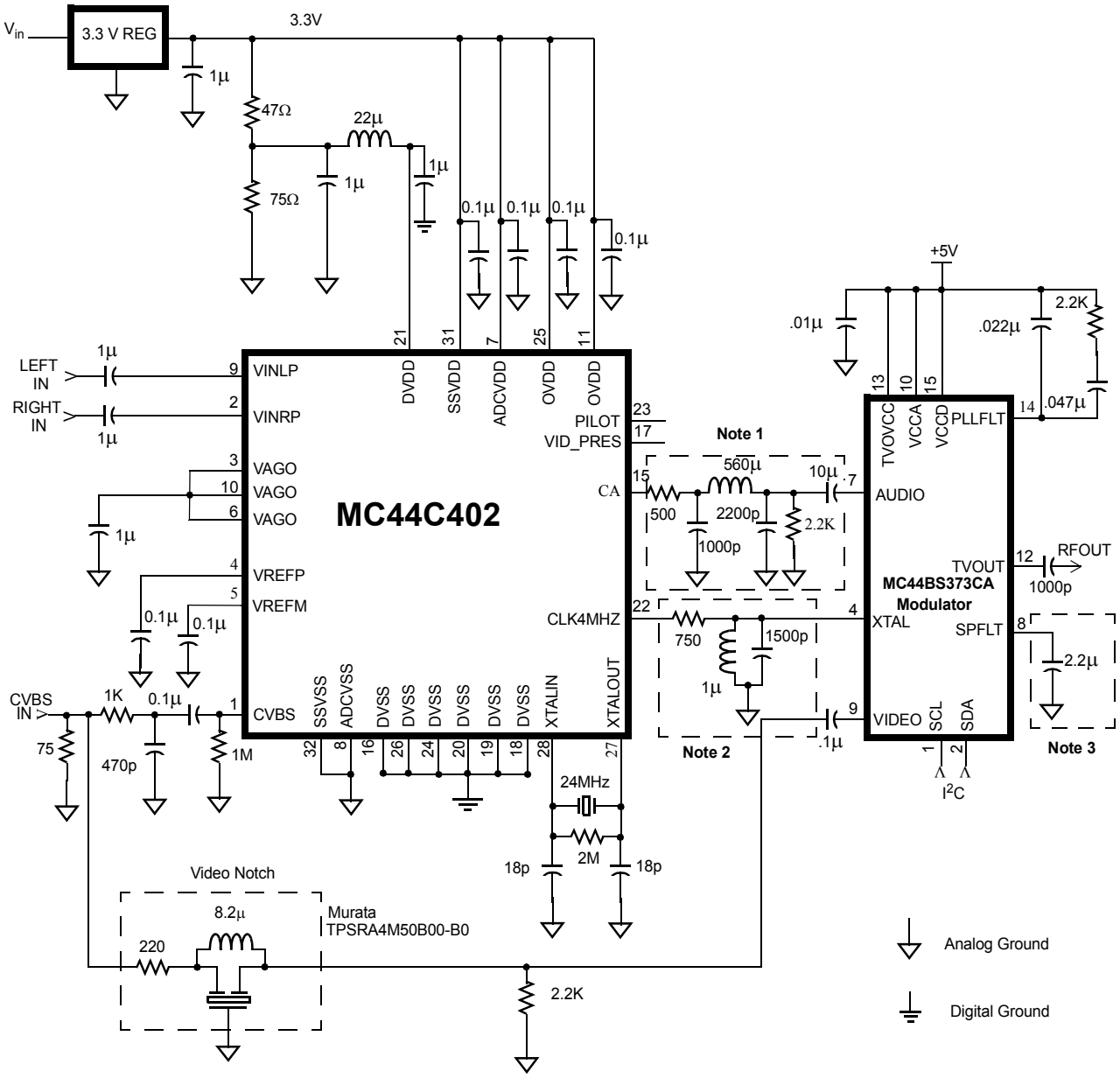
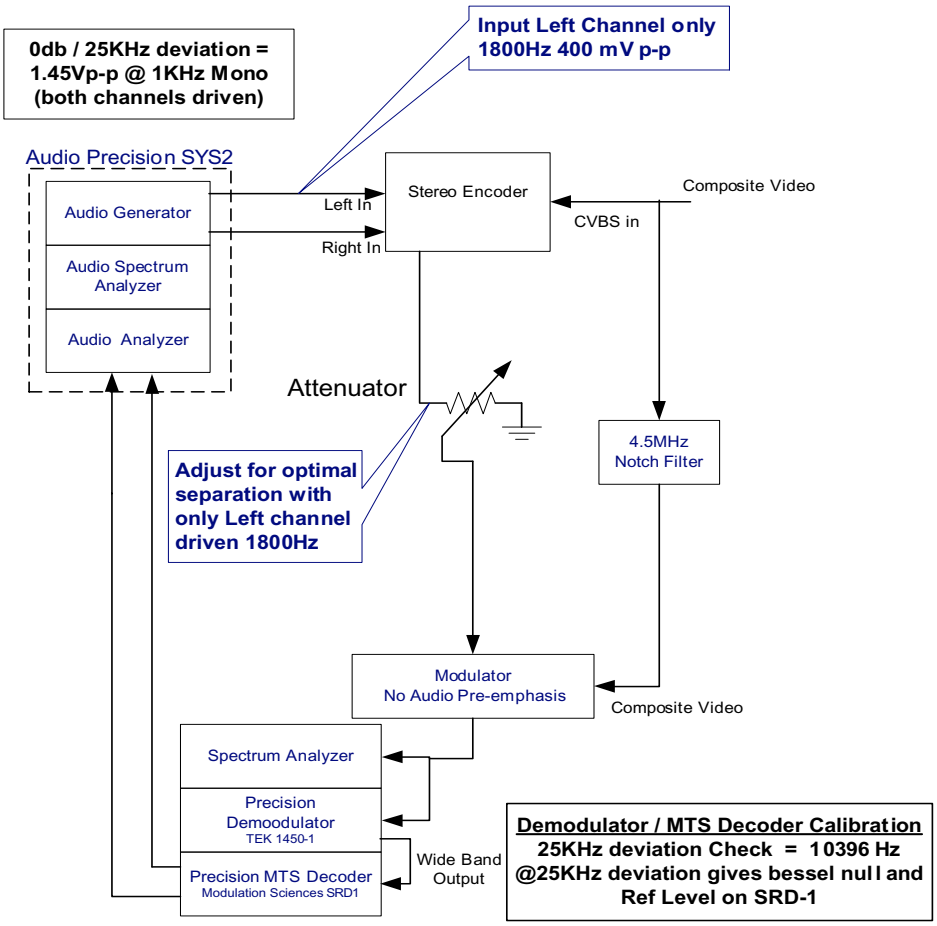


Figure 7. MC44C402 Typical Application Circuit

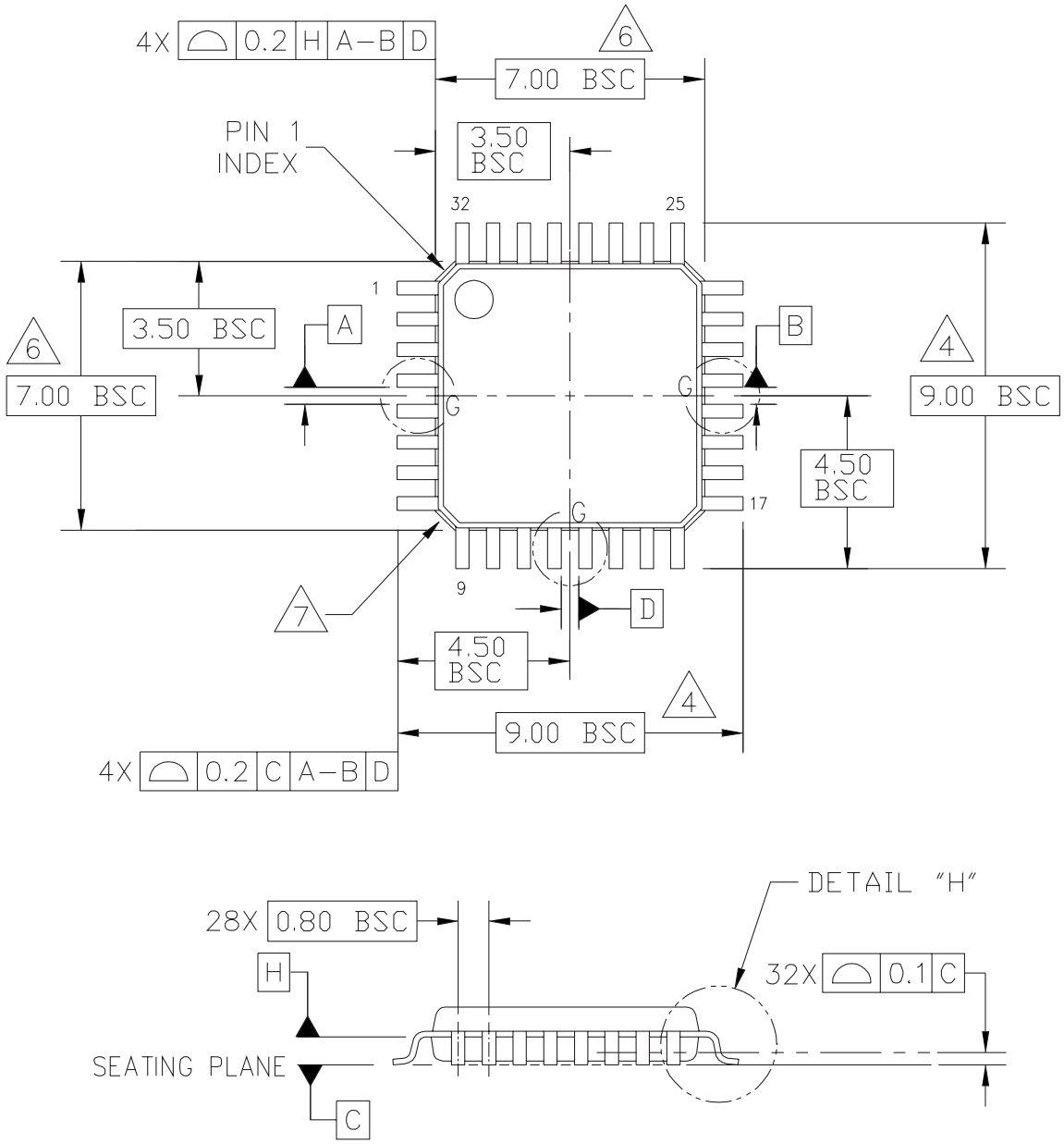
SETTING LEVEL FOR MODULATOR/ENCODER INTERFACE

1. Verify calibration of the equipment. This requires a modulator and precision signal source. The audio signal cannot be passed through the stereo encoder for this setup. Suggest using 10396.48 Hz audio test signal directly into first Bessel null on a spectrum analyzer. The null will occur at precisely 25 KHz deviation of the 10396.48 Hz audio test signal. Please see Figure 8 for test equipment setup.
2. Input 1800 Hz @ 0.4 V p-p into left channel and set adjust attenuation between stereo encoder and the modulator for optimum separation using calibrated demodulator and decoder.



1) Calibrate MTS Decoder to Demodulator connection using Bess el Null Technique
2) input 1.8KHz 0.4 V p-p on left channel only and optimiz e stereo separation with attenuator.

Figure 8. MC44C402 Level Setup



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	CASE NUMBER: 873A-04	01 APR 2005
	STANDARD: JEDEC MS-026 BBA	

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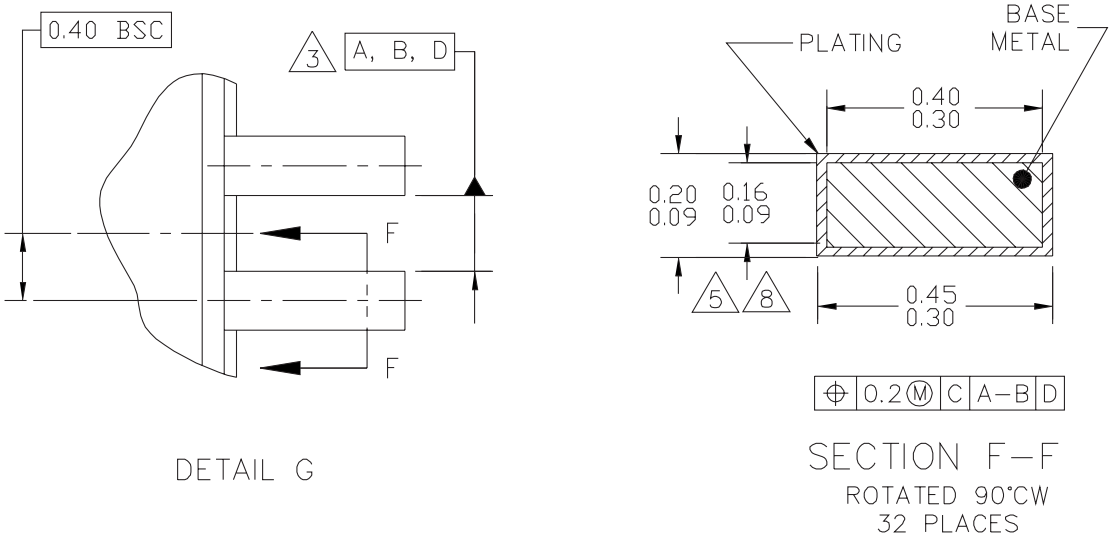
Figure 9. 32QLFP Package Mechanical Data



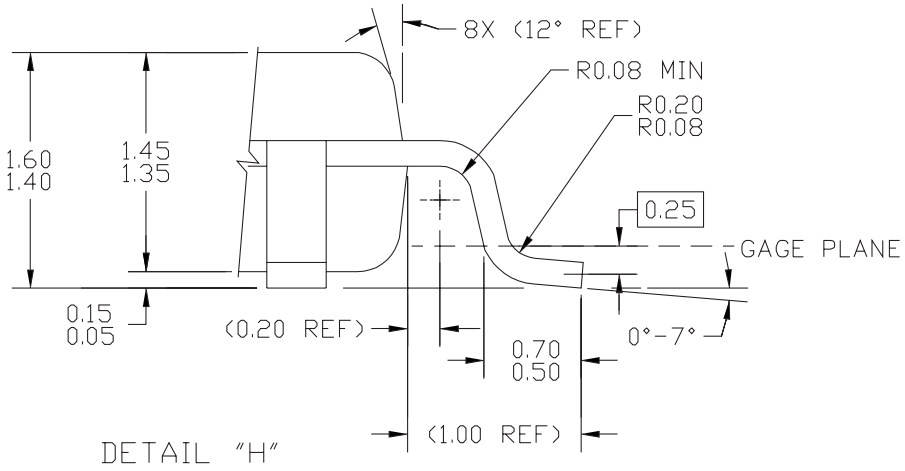


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Figure 9. 32QLFP Package Mechanical Data (continued)

NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5–1994.

3. DATUMS A, B, AND D TO BE DETERMINED AT DATUM PLANE H.

4. DIMENSIONS TO BE DETERMINED AT SEATING PLANE DATUM C.

5. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED THE MAXIMUM DIMENSION BY MORE THAN 0.08 MM. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD OR PROTRUSION: 0.07 MM.

6. DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25 MM PER SIDE. DIMENSIONS ARE MAXIMUM PLASTIC BODY SIZE DIMENSIONS INCLUDING MOLD MISMATCH.

7. EXACT SHAPE OF EACH CORNER IS OPTIONAL.

8. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.1 MM AND 0.25 MM FROM THE LEAD TIP.

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Figure 9. 32QLFP Package Mechanical Data (continued)

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