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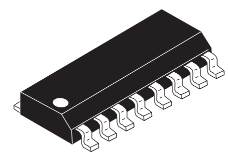
Document Number: MC44CC375AV
Rev 1, 11/2008

RoHS

PLL Tuned VHF (Channel 3 / 4) Audio / Video Modulator

MC44CC375AV

PLL TUNED VHF (CHANNEL 3/4) AUDIO/VIDEO MODULATOR



EF SUFFIX
SOIC 16 PACKAGE
CASE 751B-05

The MC44CC375 CMOS RF modulator is the latest generation of the legacy MC44BC375 products.

The MC44CC375AV is an audio/video RF modulator for use in VCRs, set-top boxes, and similar devices. It is designed for applications requiring US broadcast, channel 3 or channel 4, RF outputs.

A programmable Phase-Locked Loop (PLL) tunes the modulator, and the desired channel 3 or 4 frequency is selected using the external package pin, Channel Selection (CHS). No external tank circuit components are required, reducing the sensitivity of the PCB design and the need for external adjustments. The PLL obtains its reference from a 4.0 MHz crystal oscillator.

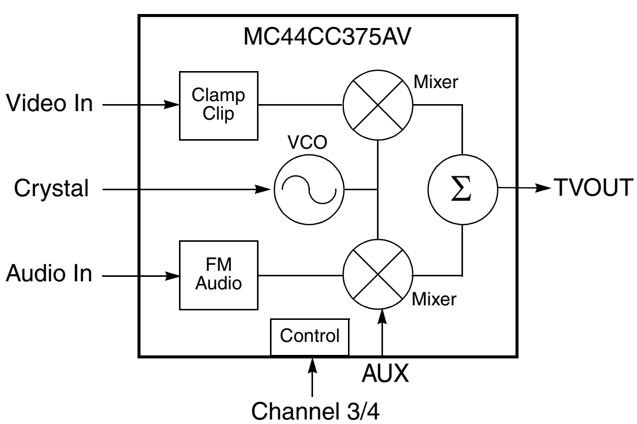
The sound oscillator can be turned ON and OFF by the external package pin Sound Oscillator Control ($\overline{\text{SOC}}$). A fixed Picture to Sound ratio of 12 dB and 4.5 MHz sound subcarrier are used for MC44CC375AV. A low-power standby mode is selectable via the pin, Power Save ($\overline{\text{PSAVE}}$), which turns off all internal VCOs and mixers.

Also included in this new generation CMOS RF modulator is the Sound Auxiliary Input, pin AUX, which bypasses the sound FM modulator. This direct sound RF modulator has found more and more applications in BTSC stereo systems.

- U.S. broadcast frequency for Channel 3 or 4 operation is selected by CHS pin
- Sound Oscillator ON/OFF control selectable by pin $\overline{\text{SOC}}$
- Picture to Sound ratio set to 12 dB
- Sound subcarrier frequency set to 4.5 MHz
- Low-power standby mode selectable by pin $\overline{\text{PSAVE}}$
- Direct RF sound carrier input pin AUX (FM modulator bypassed for stereo sound applications)
- ESD protection up to 2 kV
- Peak White Clip enabled
- Transient output inhibit during PLL Lock-up at power-ON
- Available in Pb-free, RoHS compliant, narrow body SOIC 16 package.

ORDERING INFORMATION		
Device	**Temp. Range**	**RoHS**
MC44CC375AVEF, R2	0°C to +70°C	Yes

Note: For tape and reel, add the R2 suffix.



This document contains certain information on a new product.
Specifications and information herein are subject to change without notice.

PIN DESCRIPTIONS

SO16 Pin Package

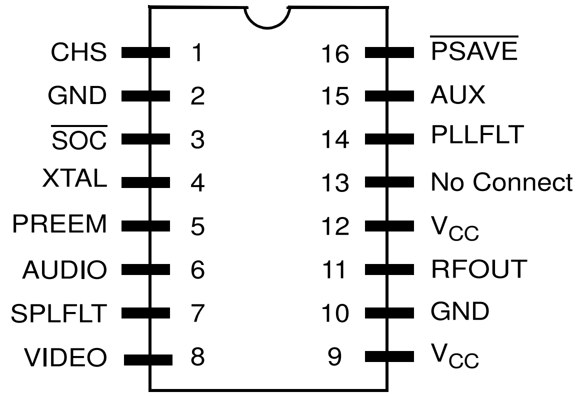


Figure 1. Pin Connections

Table 1. Package Pin Description

Pin Number	Pin Name	Description
1	CHS	Channel Select, Low - CH3; High - CH4
2	GND	Ground
3*	$\overline{SOC}$	Sound Oscillator ON/OFF Control, Low - ON, Open - OFF
4	XTAL	Crystal Input
5	PREEM	Pre Emphasis
6	AUDIO	Audio Input
7	SPLFLT	Sound PLL Loop Filter
8	VIDEO	Video Input
9	V_{CC}	V_{CC} Audio
10	GND	Ground
11	RFOUT	TV Output Plus
12	V_{CC}	V_{CC}
13	No Connect	Do not connect
14	PLLFLT	PLL Loop Filter
15	AUX	Auxiliary Input
16	$\overline{PSAVE}$	Power Save Mode Control, Low - Power Save; High - Normal

* Pin 3, $\overline{SOC}$, should not be pulled up to high voltage. It has an internal pull-up of 1.8V.

FUNCTIONAL OVERVIEW

Figure 2 shows a simplified block diagram of the MC44CC375AV device.

There are two main sections:

1. A PLL section to synthesize the VHF output channel frequency for channel 3 or channel 4.
2. A modulator section which accepts audio and video inputs and modulates the VHF carrier.

The high frequency CMOS technology allows integration of the UHF tank circuit and certain filtering functions eliminating the need for a number of external components.

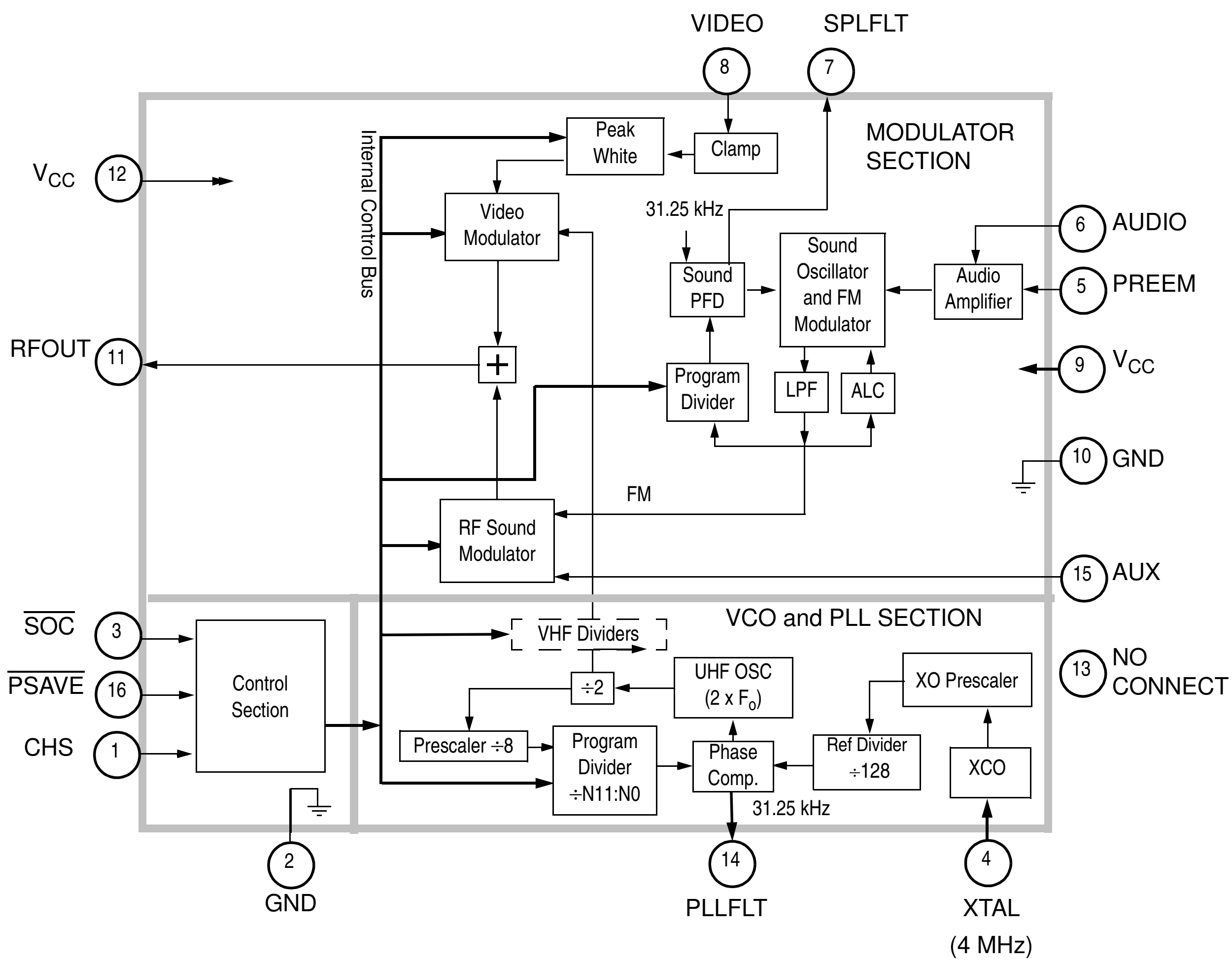


Figure 2. MC44CC375AV Simplified Block Diagram

POWER SUPPLY

Do NOT bias any other pin before V_{CC} is applied to the device.

STANDBY MODES

During standby mode, the modulator is switched to low power consumption. The sound oscillator, UHF oscillator and VHF dividers, video and sound modulator sections bias are internally turned OFF.

The modulator is programmed in standby mode when pin 16, $\overline{PSAVE}$, is set to a "LO" level

TRANSIENT OUTPUT INHIBIT

To minimize the risk of interference to other channels while the UHF PLL is acquiring a lock on the desired frequency, the Sound and Video modulators are turned OFF at power-ON (i.e., V_{CC} is switched from 0 V to 3.3 V).

There is a time-out of 263 ms until the output is enabled. This allows the UHF PLL to settle to its programmed frequency. During the 263 ms time-out, the sound PLL current source is set to 10 µA typical to speed up the locking time. After the 263 ms time-out, the current source is switched to 1.0 µA. Use care when selecting loop filter components to ensure the loop transient does not exceed this delay.

VIDEO SECTION

The modulator requires a composite video input with negative going sync pulses and a nominal level of 1.0 $V_{(pp)}$. This signal is AC coupled to the video input where the sync tip level is clamped.

The video modulation depth typical value is given for 1.0 V_{CBVS} input level. It can be reduced by simply adding a resistive divider at video input, resulting in a lower signal seen by the video input stage.

The video signal is then passed to a peak white clip circuit whose function is to soft clip the top of the video waveform if the amplitude from the sync tip to peak white goes too high. In this way, over-modulation of the carrier by the video is avoided. The clipping function is always engaged.

The clipping happens at 106IRE with 1.0 V_{pp} video signal (100IRE = 0.7 V_{pp} video blank to white).

SOUND SECTION

The PLL multivibrator oscillator is fully integrated.

The sound modulator system consists of an FM modulator incorporating the sound subcarrier oscillator. The audio input signal is AC coupled into the amplifier which then drives the modulator.

The audio pre-emphasis circuit is a high-pass filter with an external capacitor C1 and an internal resistor (100 kΩ typical). The recommended capacitor value (750 pF) is for NTSC standards, time constant is 75 µs.

The audio bandwidth specification is for 50 Hz to 15 KHz range, with pre-emphasis circuit engaged. Without this pre-emphasis circuit, it is possible to extend the audio bandwidth to high frequencies, as there is no internal frequency limitation (stereo application, SAP, etc.).

PLL SECTION — DIVIDERS

The reference divider is a fixed ÷128 resulting in a reference frequency of 31.25 KHz with a 4.0 MHz crystal. The 31.25 KHz reference frequency is used for both the UHF and Sound PLLs.

The prescaler is a fixed ÷8 and is permanently engaged. The VHF divider is also a fixed ÷8.

The programmable divider's division ratio is controlled by the CHS pin voltage in order to select channel 3 or channel 4.

PIN SELECTION

Pins CHS and $\overline{\text{PSAVE}}$ are internally pulled up to 3.3 V, $\overline{\text{SOC}}$ is internally pulled up by 1.8 V. By default (open condition), all pins are "HI".

Table 2. Configuration Pin Settings

Pin No	Pin Name	LO (grounded)	HI*
1	CHS	CH3 - 61.25 MHz	CH4 - 67.25 MHz
3	SOC	Sound ON	Sound OFF
16	$\overline{\text{PSAVE}}$	Power Save Mode	Normal Mode

*Please do not pull pin 3 to high voltage. For HI condition, leave pin 3 open.

ELECTRICAL SPECIFICATIONS

Table 3. Absolute Maximum Ratings

Absolute maximum continuous 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
Supply Voltage	V_{CC}	-0.3	+3.6	V
Any Input Voltage*	V_{in}	-0.3	V_{CC} + 0.3	V
Storage Temperature Range	T_{stg}	-65	+150	°C
Junction Temperature	T_J	—	+105	°C

*Except for Pin 3, $\overline{\text{SOC}}$.

Table 4. General Specifications

Characteristic	Symbol	Min	Typ	Max	Units
ESD Protection (Charge Device Model)	CDM	-500	—	+500	V
ESD Protection (Human Body Model)[1]	HBM	-2000	—	+2000	V
Latch-up Immunity	LU	200	—	—	mA
Thermal resistance from Junction to Ambient	$R_{\Theta JA}$	—	102	—	°C/W

1. JEDEC JESD22-A114D.

Table 5. Recommended Operating Conditions and DC Characteristics

Characteristic	Symbol	Min	Typ	Max	Units
Supply Voltage	V_{CC}	+3	+3.3	+3.6	V
Total supply current (all sections active)	I_{CC}	65	85	98	mA
Sound comparator charge pump current: While locking When locked		1.0 —	3.9 1.0	7.0 1.5	µA µA
RF comparator charge pump current		1.2	1.6	2	mA
Threshold level on pins: CHS, $\overline{\text{PSAVE}}$,	V_{th}	—	2.1	—-	V
Ambient Temperature	T_A	0	—	+70	°C

NOTE: Crystal specification reference information
Frequency = 4 MHz
Mode = Parallel Resonance
Load Capacitance = 27 pF
Motional Resistance = 10 Ohms Typical (100 Ohms Maximum Starting)

PERFORMANCE CHARACTERISTICS

Unless otherwise stated, all performance characteristics are for:

- Power Supply, V_{CC} = 3.3 V
- Ambient Temperature, T_A = 25°C
- Video Input 1.0 V_{p-p}, 10-step grayscale.
- RF inputs/outputs into 75 Ω load.

NOTE:
Specifications only valid for envelope demodulation.

The parameters listed are based on the type of test conditions found in the column Type.

- A = 100% tested
- B = 100% Correlation tested
- C = Characterized on samples
- D = Design parameter

See the "Characterization Measurement Conditions" on page 8 for each C type parameter.

Table 6. High Frequency Characteristics

Parameter	Test Conditions[1]	Min	Typ	Max	Unit	Type
RFOUT output level	Output video carrier level from modulator section	84	90	94	dBµV	B
Sound subcarrier harmonics (Fp+n*Fs)	Reference picture carrier	—	-63	—	dBc	C
Second harmonic of chroma subcarrier	Using red EBU bar	—	-54	—	dBc	C
Chroma/Sound intermodulation: Fp+ (Fsnd - Fchr)	Using red EBU bar	—	-65	—	dBc	C
Fo (picture carrier) harmonics[2]	2nd harmonic	—	50	—	dBµV	C
	3rd harmonic:	—	77	—	dBµV	C
Out band (picture carrier) spurious	1/4*Fo, 1/2*Fo, 3/4*Fo, 3/2*Fo	—	12	30	dBµV	C
In band spurious (Fo @ 5.0 MHz)	No video sound modulation	-65	—	—	dBc	C

1. See Performance Measurement Test Set-ups, Table 9.
2. Picture carrier harmonics are highly dependant on PCB layout and decoupling capacitors.

Table 7. Video Performance Characteristics

Parameter	Test Conditions[1]	Min	Typ	Max	Unit	Type
Video bandwidth	Reference 0 dB at 100 KHz, measured at 5.0 MHz	-0.5	0.1	0.5	dB	C
Video input level	75 Ω load	—	1	1.5	Vcvbs	D
Video input current		8	10	12	µA	A
Video input impedance		75	93	110	KΩ	A
Video S/N	No sound. CCIR Rec.567 weighting filter	53	55	—	dB	C
Differential Phase	On line 17 in M standard (FCC). PWC set to 0	-5	—	+5	deg	C
Differential Gain	On line 17 in M standard (FCC). PWC set to 0	-5	—	+5	%	C
Luma/Sync ratio	Input ratio 7.0:3.0	6.8/3.2	—	7.2/2.8	—	B
Video modulation depth	Video input level = 1.0 V_{CVBS}	75	83	88	%	B
Peak White Clip	Video Modulation depth for video = 1.4 V_{CVBS}	90.5	94	97.5	%	B

1. See Performance Measurement Test Set-ups, Table 9.

Table 8. Audio Performance Characteristics

Parameter	Test Conditions[1]	Min	Typ	Max	Unit	Type
Picture-to-Sound Ratio		13	15	18	dB	B
Audio Modulation Index	Using specific pre-emphasis circuit, Audio input = 1.0 KHz @ 200 mVrms					
	Fs = 4.5 MHz (100% modulation = ±25 KHz FM deviation)	95	100	104	%	B
Audio Input Impedance		60	71	80	KΩ	A
Audio Frequency Response	Reference 0 dB at 1.0 KHz, Measure from 50 Hz to 15 KHz *Depends on Audio PLL loop filter components*	-2.5	—	+2.0	dB	C
Audio Distortion FM (THD only)	At 1.0 KHz, 100% modulation (±25 KHz) No video	—	0.5	1.0	%	C
Audio S/N	Pre-emphasis	51	56	—	dB	C

1. See Performance Measurement Test Set-ups, Table 9.

CHARACTERIZATION MEASUREMENT CONDITIONS

Device default configuration unless otherwise specified:

- CH3 - 61.25 MHz and CH4 - 67.25 MHz frequencies
- RF Inputs / Output into 75 Ω Load using a 75 to 50 Ω transformation
- Video Input 1.0 V pk-pk
- Audio pre-emphasis circuit engaged

Table 9. Performance Measurement Test Set-Ups

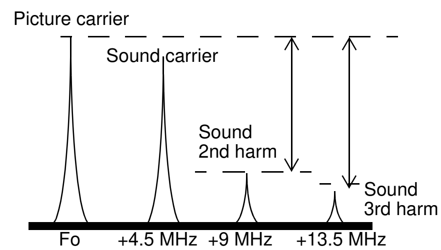
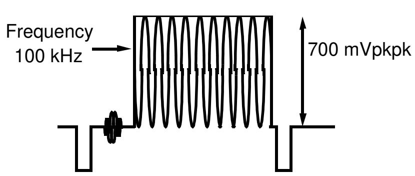
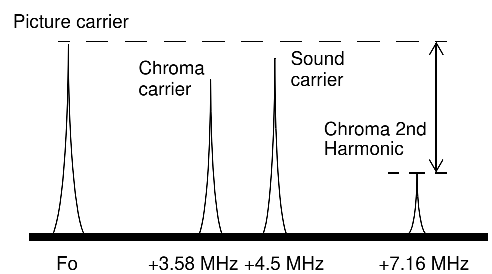
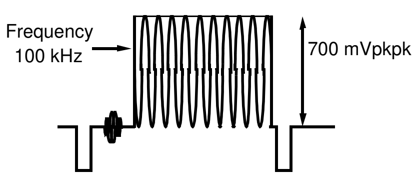
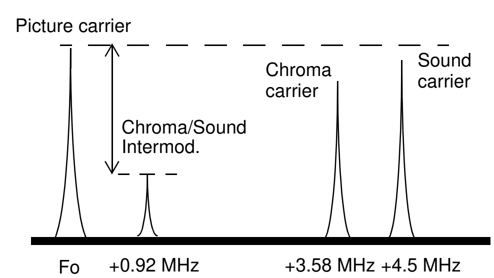
Device and Signals Set-Up	Measurement Set-Up
RFOUT Output Level	
Video: 10 steps grey scale No audio	Measured picture carrier in dBμV with the HP8596E Spectrum Analyzer using a 75 to 50 Ω transformation, all cables losses and transformation pads having been calibrated. Measurement is used as a reference for other tests: RFOUT
Sound Subcarrier Harmonics	
Video: 10 steps grey scale No audio signal	Measure in dBc second and third sound harmonics levels in reference to picture carrier (RFOUT). 
Second Harmonics of Chroma Subcarrier	
No audio Video: a 700 $mV_{(pp)}$ 100 kHz sinusoidal signal is inserted on the black level of active video area. 	Measure in dBc, in reference to picture carrier (RFOUT), second harmonic of chroma at channel frequency plus 2 times chroma frequency, resulting in the following spectrum. 
Chroma/Sound Intermodulation	
No audio signal Video: 700 $mV_{(pp)}$ 100 kHz sinusoidal signal inserted on the black level of active video area.This is generated using a Video Generator and inserting the required frequency from a RF Signal generator. 	Measure in dBc, in reference to picture carrier (RFOUT), intermodulation product at channel frequency plus the sound carrier frequency (+5.5 MHz) minus the chroma frequency (-4.43 MHz), resulting in the following spectrum. Intermodulation product is at the channel frequency +1.07 MHz. 

Table 9. Performance Measurement Test Set-Ups (continued)

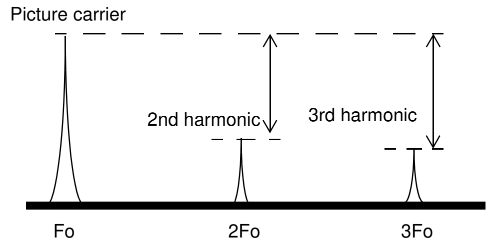
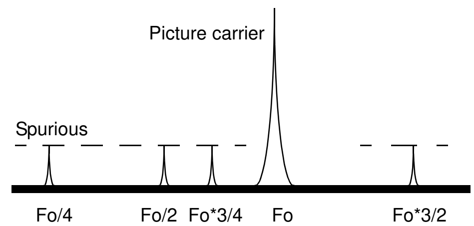
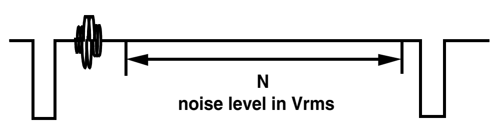
Device and Signals Set-Up	Measurement Set-Up
Picture Carrier Harmonics	
No video signal No audio signal	Measure in dBc, in reference to picture carrier (RFOUT), second and third harmonic of channel frequency, resulting in the following spectrum. 
Out of Band Spurious	
No video signal No audio signal	Measure in dBµV spurious levels at 0.25, 0.5, 0.75 and 1.5 times channel frequency, resulting in the following spectrum. Measure from 40 MHz to 1.0 GHz. 
In Band Spurious / 4 MHz Crystal Spurious	
No video signal No audio signal	Measure in dBc, in reference to picture carrier (RFOUT), spurious levels falling into video bandwidth Fo ± 4.2 MHz (15.125 KHz & 31.25 KHz from reference dividers and 4 MHz from crystal).
Video Bandwidth	
No audio Video: 600 mV$_{(pp)}$ sinusoidal signal inserted on the black level of active video area.	The Video signal is demodulated on the spectrum analyzer, and the peak level of the 100 KHz signal is measured as a reference. The frequency is then swept from 100 KHz to 4.2 MHz, and then the difference in dBc from the 100 KHz reference level is measured.
Weighted Video Signal to Noise	
Video: 100% White video signal — 1 Vpk-pk. No audio signal This is measured using a Demodulator using a CCIR Rec. 567 weighting network, 100 KHz to 4.2 MHz band with sound trap and envelope detection, and a Video Analyzer.	The Video Analyzer measures the ratio between the amplitude of the active area of the video signal (700 mV) and the noise level in Vrms on a video black level which is shown below. VideoS/N is calculated as 20 x log(700 /N) in dB. 
Unweighted Video Signal to Noise	
Same as above with CCIR filter disabled.	Same as above.

Table 9. Performance Measurement Test Set-Ups (continued)

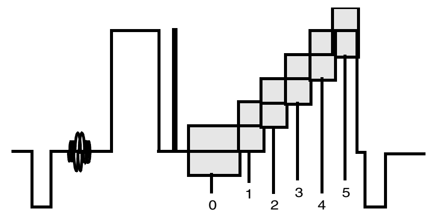
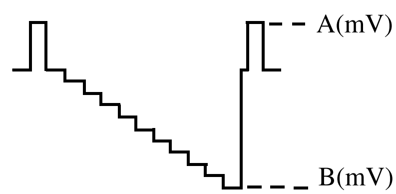
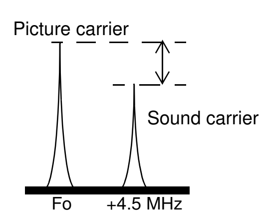
Device and Signals Set-Up	Measurement Set-Up
Video Differential Phase	
Video: 5 step Grey Scale — 1 $V_{(pp)}$. No audio signal This is measured using a Demodulator using a CCIR Rec. 567 weighting network, 100 KHz to 4.2 MHz band with sound trap, and envelope detection, and a Video Analyzer.	On line CCIR 330, the video analyzer DP measure consists of calculating the difference of the Chroma phase at the black level and the different chroma subcarrier phase angles at each step of the greyscale. The largest positive or negative difference indicates the distortion. $\text{DIFF PHASE} = \frac{\text{the largest positive or negative difference}}{\text{the phase at position 0}} * 100\%$ The video analyzer method takes the worst step from the first 4 steps.
Video Differential Gain	
Video: 5 step Grey Scale — 1 $V_{(pp)}$. No audio signal This is measured using a Demodulator using a CCIR Rec. 567 weighting network, 100 KHz to 4.2 MHz band with sound trap and envelope detection, and a Video Analyzer.	On line CCIR 330 shown below, the video analyzer DG measure consists of calculating the difference of the Chroma amplitude at the black level and the different amplitudes at each step of the greyscale. The largest positive or negative difference indicates the distortion.  5-step Greyscale with Chroma subcarrier superimposed (not to scale), line CCIR 330. $\text{DIFF GAIN} = \frac{\text{the largest positive or negative difference}}{\text{the amplitude at position 0}} * 100\%$ The video analyzer method takes the worst step from the first 4 steps. CCIR line 330 corresponds to FCC line 17 in NTSC/M standard.
Video Modulation Depth	
No audio signal Video: 10 step grey scale	This is measured using a HP8596E Spectrum Analyzer with a TV Trigger option, allowing demodulation and triggering on any specified TV Line. The analyzer is centered on the maximum peak of the Video signal and reduced to zero Hertz span in Linear mode to demodulate the Video carrier.  TV Line Demodulated by Spectrum Analyzer-BG standard The Modulation Depth is calculated as (A-B)/A x 100 in%.
Picture to Sound Ratio	
No video signal No audio signal	Measure in dBc sound carrier in reference to picture carrier (RFOUT) , 

Table 9. Performance Measurement Test Set-Ups (continued)

Device and Signals Set-Up	Measurement Set-Up
Audio Modulation Index — FM Modulation	
Video: Black Sync Audio signal: 1.0 KHz, 205 mVrms. This is measured using a Demodulator and an Audio Analyzer at 1.0 KHz.	The audio signal 205 mV at 1.0 KHz is supplied by the Audio Analyzer, and the FM demodulated signal deviation is indicated on the Demodulator in KHz peak. This value is then converted in% of FM deviation, based on specified standards.
Audio Frequency Response	
Video: Black Sync Audio signal: 50 Hz to 15 KHz, 100 mV_{rms} This is measured using a Demodulator and an Audio Analyzer.	The audio signal 1.0 KHz 100 mV_{rms} is supplied by the Audio Analyzer, demodulated by the Demodulator and the audio analyzer measures the AC amplitude of this demodulated audio signal: this value is taken as a reference (0 dB). The audio signal is then swept from 50 Hz to 15 KHz, and demodulated AC amplitude is measured in dB relative to the 1.0 KHz reference. Audio pre-emphasis and de-emphasis circuits are engaged, all audio analyzer filters are switched OFF.
Audio Distortion FM	
Audio: 1.0 KHz, adjustable level Video: Black Sync This is measured using a Demodulator and an Audio Analyzer at 1.0 KHz. The output level of the Audio analyzer is varied to obtain a deviation of ±25 KHz indicated on the Demodulator.	The input rms detector of the Audio Analyzer converts the ac level of the combined signal + noise + distortion to dc. It then removes the fundamental signal (1.0 KHz) after having measured the frequency. The output rms detector converts the residual noise + distortion to dc. The dc voltmeter measures both dc signals and calculates the ratio in% of the two signals. $ADist = (Distorsion + Noise)/(Distorsion + Noise + Signal)$
Audio Signal to Noise	
Audio: 1.0 KHz, adjustable level Video: EBU Color Bars This is measured using a Demodulator and an Audio Analyzer at 1.0 KHz. The output level of the Audio analyzer is varied to obtain a Modulation Deviation of ±25 KHz indicated on the AMFS Demodulator.	The Audio Analyzer alternately turns ON and OFF its internal audio source to make a measure of the Audio signal plus noise and then another measure of only the noise. The measurement is made using the internal CCIR468-2 Filter of the Audio Analyzer together with the internal 30 ± 2.0 KHz (60 dB/decade) Lowpass filters. The AMFS demodulator uses a quasi-parallel demodulation as is the case in a normal TV set. In this mode the Nyquist filter is bypassed and the video carrier is used without added delay to effectuate intercarrier conversion. In this mode the phase noise information fully cancels out and the true S/N can be measured. $ASN(dB) = 20 \times \log(Signal + Noise)/(Noise)$

PIN CIRCUIT SCHEMATICS

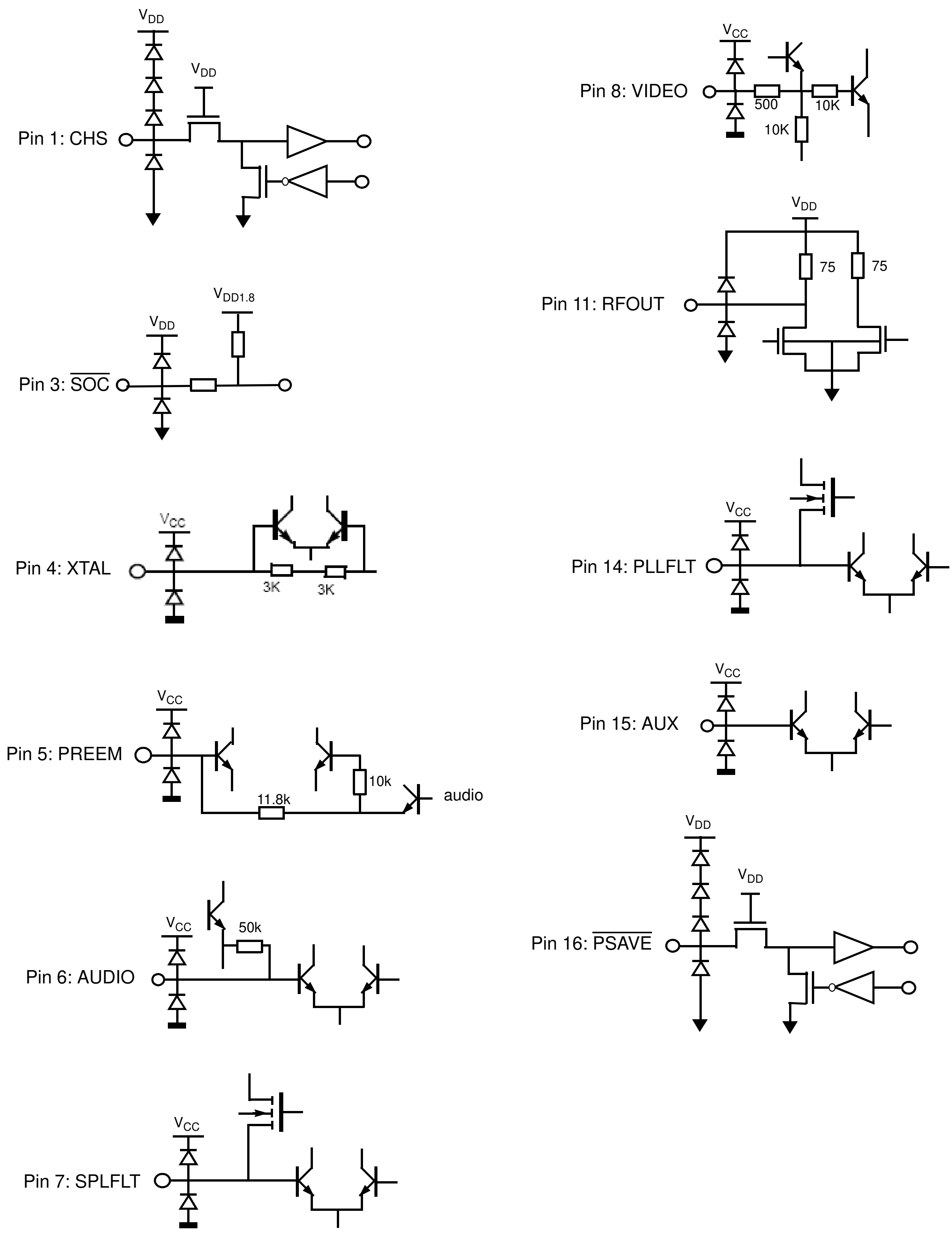


Figure 3. Pin Schematics

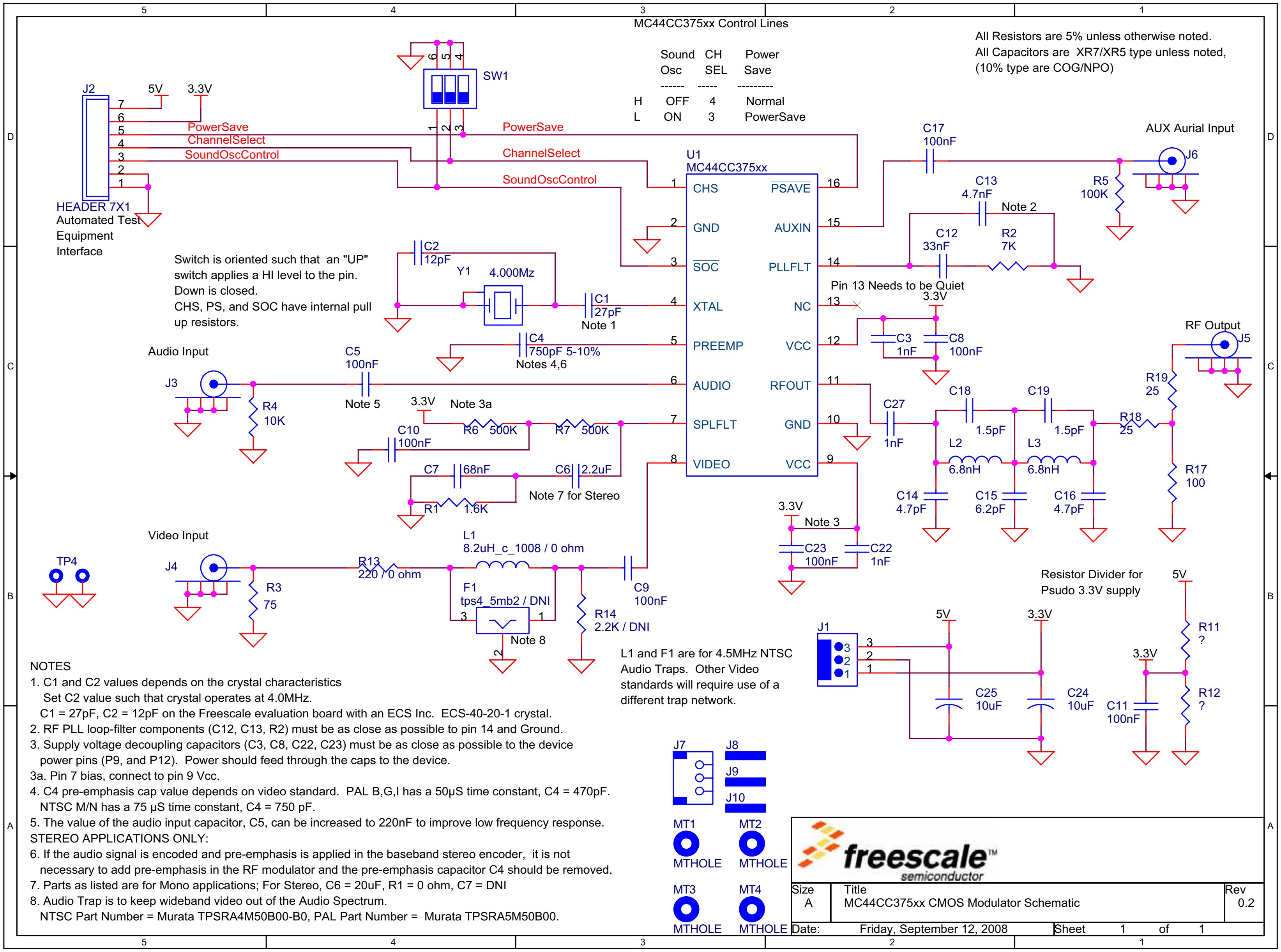
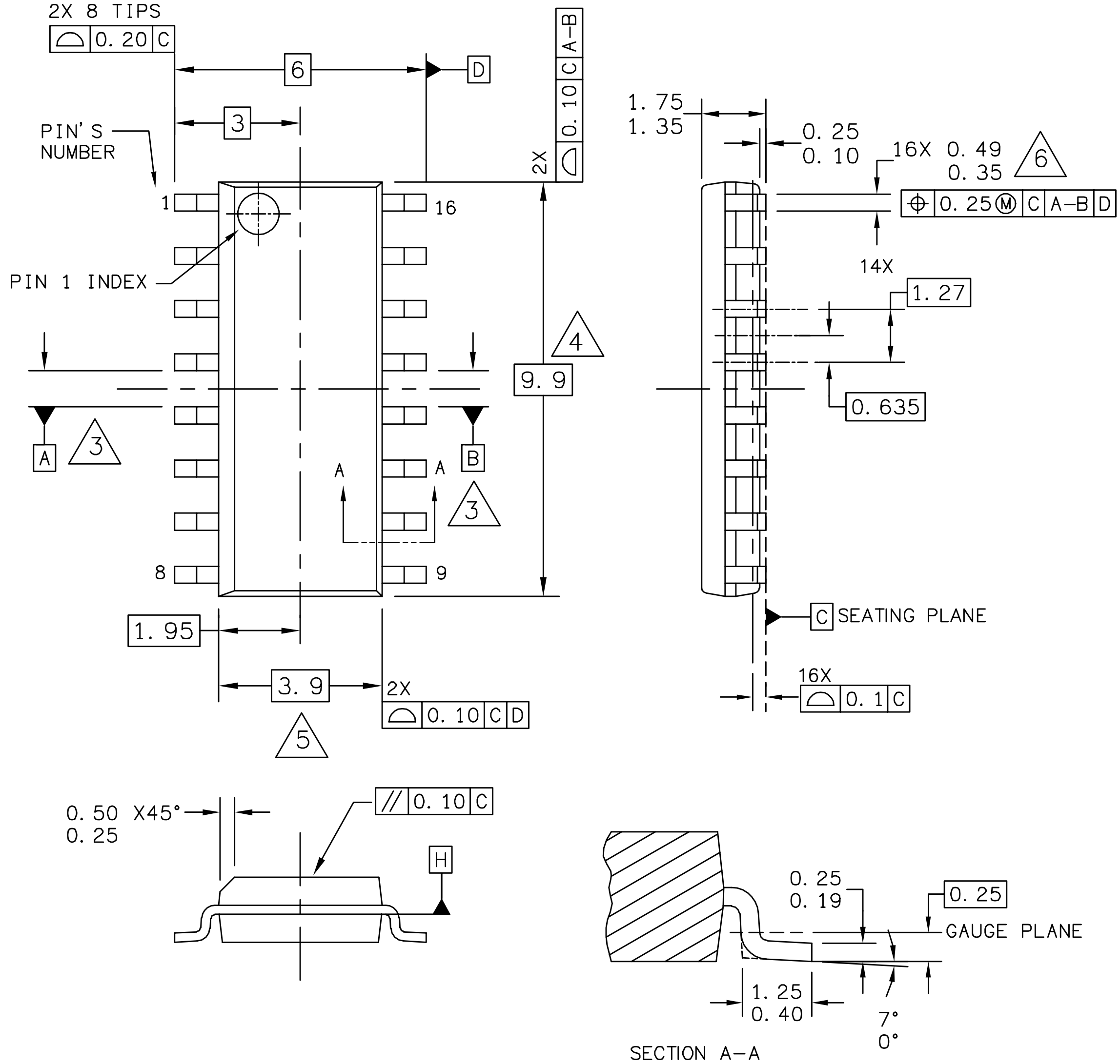


Figure 4. MC44CC375AV Application Schematic



© FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED.	**MECHANICAL OUTLINE**	PRINT VERSION NOT TO SCALE	
TITLE: 16LD SOIC N/B, 1.27 PITCH CASE–OUTLINE		DOCUMENT NO: 98ASB42566B	REV: M
		CASE NUMBER: 751B–05	06 FEB 2006
		STANDARD: JEDEC MS–012AC	

Figure 5. SOIC16 Package Dimensions

NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M−1994.
3. DATUMS A & B TO BE DETERMINED AT DATUM H.
4. THIS DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSION OR GATE BURRS SHALL NOT EXCEED 0.15 MM PER SIDE.
5. THIS DIMENSION DOES NOT INCLUDE INTER−LEAD FLASH OR PROTRUSIONS. INTER−LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.25 MM PER SIDE. THIS DIMENSION IS DETERMINED AT THE PLANE WHERE THE BOTTOM OF THE LEADS EXIT THE PLASTIC BODY.
6. THIS DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED 0.62 mm.

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE	
TITLE: 16LD SOIC N/B, 1.27 PITCH, CASE OUTLINE	DOCUMENT NO: 98ASB42566B		REV: M
	CASE NUMBER: 751B−05		06 FEB 2006
	STANDARD: JEDEC MS−012AC		

Figure 6. SOIC16 Package Dimensions - part 2

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