

# MC44C401L

## MTS Stereo Encoder

The MC44C401L Multi-Channel Television Sound (MTS) Stereo Encoder is the industry's first, single-chip, CMOS implementation of a Broadcast Television Systems Committee (BTSC)-compatible stereo encoder.

The MC44C401L 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 MC44C401L 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 MC44C401L 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 MC44C401L is designed to output this signal to a Motorola RF modulator, which in turn produces a stereo encoded RF channel for use with any BTSC stereo television receiver.

## 1 Features

- Integrated A/D input and D/A output circuitry
- CEX™ digital audio processing encodes and transports stereo signals
- Surround sound and Macrovision™ compatible

### Contents

|                                    |   |
|------------------------------------|---|
| 1. Features .....                  | 1 |
| 2. Reference Documentation .....   | 2 |
| 3. Block Diagrams .....            | 2 |
| 4. I/O Description .....           | 4 |
| 5. Electrical Specifications ..... | 5 |
| 6. Package Data .....              | 7 |
| 7. Functional Description .....    | 9 |

## Reference Documentation

- Extended low frequency response (The MC44C401L frequency response extends below 25 Hz)
- Simple passive interface to Motorola’s MC44BC374 (UHF/VHF) and MC44BC375 (VHF) modulators
- Preservation of original surround sound fidelity
- System performance not impacted by copy protection technologies
- Enables lower system component count, smaller board size, and significantly lower overall system cost
- Eliminates manual alignment of filters, phase controls, and composite signal amplitude

## 2 Reference Documentation

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

## 3 Block Diagrams

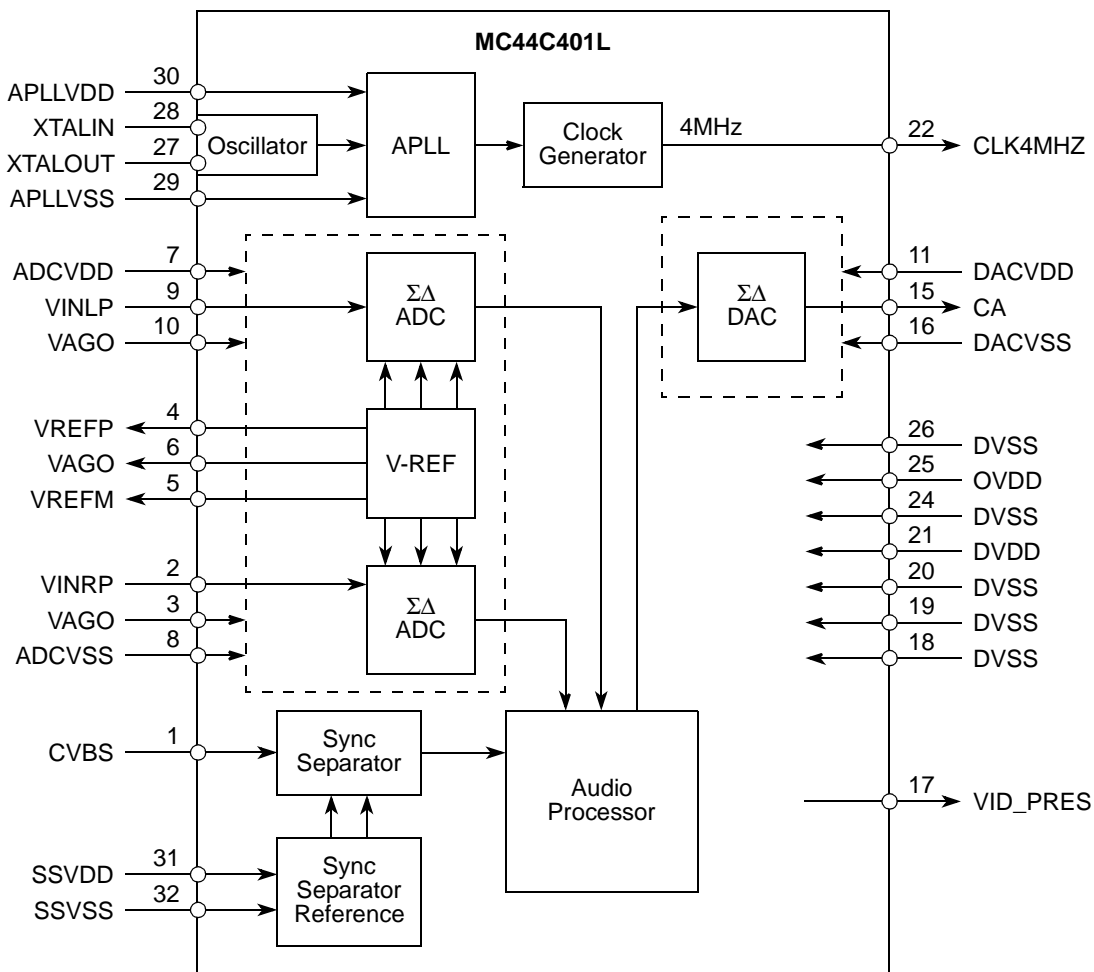


Figure 1. MC44C401L Block Diagram

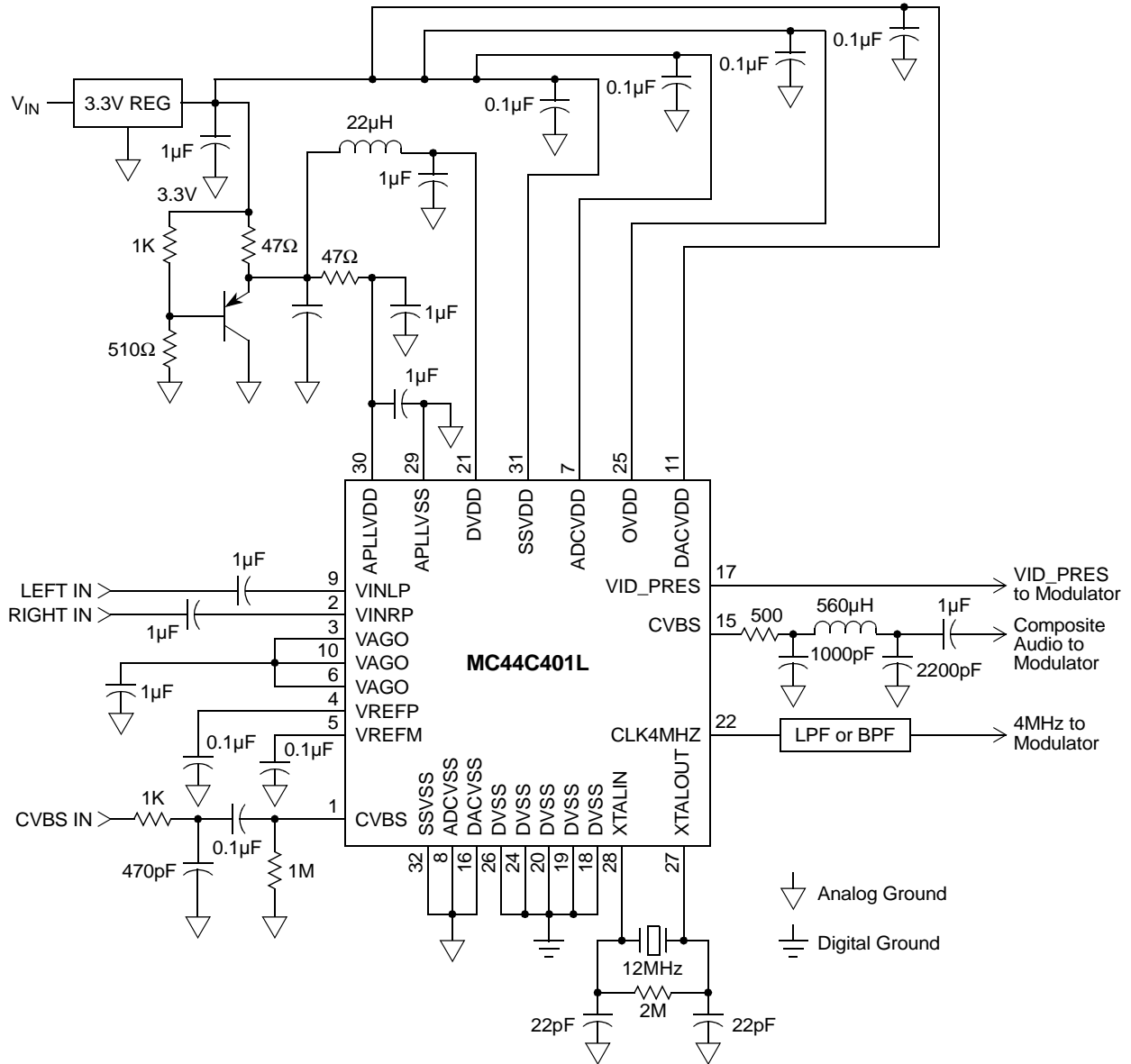


Figure 2. MC44C401L Recommended Usage

## 4 I/O Description

### 4.1 Signal List

The Stereo Modulator I/O signals are described in Table 1.

**Table 1. MC44C401L Signal Descriptions**

| Signal               | Pin #           | Description   |
|----------------------|-----------------|---|
| <b>Analog</b>        |                 |   |
| VINL                 | 9               | Left channel input voltage  |
| VREFP                | 4               | ADC ref. input voltage  |
| VAGO                 | 3,6,10          | Analog virtual ground   |
| VREFM                | 5               | ADC ref. input voltage  |
| VINR                 | 2               | Right channel input voltage   |
| CVBS                 | 1               | Composite video input   |
| <b>Digital</b>       |                 |   |
| CA                   | 15              | Composite Audio Output  |
| VID_PRES             | 17              | Video present flag, 0 = no video, hi-z = video present valid after 100 lines of valid video |
| NC                   | 23,14,<br>13,12 | No Connect  |
| <b>Clocks</b>        |                 |   |
| XTALIN               | 28              | Crystal input   |
| XTALOUT              | 27              | Crystal output  |
| CLK4MHZ <sup>1</sup> | 22              | 4 MHz clock for Audio/Video modulator IC  |
| <b>Power Supply</b>  |                 |   |
| APLLVDD              | 30              | APLL analog supply voltage, 1.8 V   |
| APLLVSS              | 29              | APLL analog ground  |
| SSVDD                | 31              | Sync Separator analog supply voltage, 3.3 V   |
| SSVSS                | 32              | Sync Separator analog ground  |
| ADCVDD               | 7               | ADC analog supply voltage, 3.3 V  |
| ADCVSS               | 8               | ADC analog ground   |

Table 1. MC44C401L Signal Descriptions (continued)

| Signal | Pin #                    | Description                         |
|--------|--------------------------|-------------------------------------|
| DACVDD | 11                       | DAC I/O supply voltage, 3.3 V       |
| DACVSS | 16                       | DAC I/O ground                      |
| DVDD   | 21                       | Digital Logic supply voltage, 1.8 V |
| DVSS   | 18, 19,<br>20, 24,<br>26 | Digital Logic/I/O ground            |
| OVDD   | 25                       | I/O supply voltage, 3.3 V           |

<sup>1</sup> Use a 4MHz LPF or BPF on this clock signal to the modulator

## 5 Electrical Specifications

### 5.1 DC Characteristics

Table 2. MC44C401L DC Characteristics (Preliminary)

| PIN     | Symbol   | Parameter                  | Min   | Typ  | Max   | Unit     |
|---------|----------|----------------------------|-------|------|-------|----------|
| DVDD    | -        | 1.8 V Digital Logic        | 1.62  | 1.80 | 1.98  | V        |
| DVDD    | -        | 1.8 V Digital Logic        |       | 18.0 | 22.0  | mA       |
| OVDD    | -        | 3.3 V Digital Output       | 2.97  | 3.30 | 3.63  | V        |
| OVDD    | -        | 3.3 V Digital Output       |       | 2.0  | 8.0   | mA       |
| DACVDD  | -        | 3.3 V DAC Supply           | 2.97  | 3.30 | 3.63  | V        |
| DACVDD  | -        | 3.3 V DAC Supply           |       | 7.0  | 9.0   | mA       |
| ADCVDD  | -        | 3.3 V ADC Supply           | 2.97  | 3.30 | 3.63  | V        |
| ADCVDD  | -        | 3.3 V ADC Supply           |       | 7.0  | 9.0   | mA       |
| SSVDD   | -        | 3.3 V Sync. Sep Supply     | 2.97  | 3.3  | 3.63  | V        |
| SSVDD   | -        | 3.3 V Sync. Sep Supply     |       | 2.0  |       | mA       |
| APLLVDD | -        | 1.8 V APLL Supply          | 1.62  | 1.8  | 1.98  | V        |
| APLLVDD | -        | 1.8 V APLL Supply          |       | 3.0  |       | mA       |
| VREFP   | -        | Voltage Ref. Bypass plus   |       | 2.0  |       | V        |
| VREFM   | -        | Voltage Ref. Bypass minus  |       | 1.0  |       | V        |
| VAGO    | -        | Voltage Ref. Ground        |       | 1.5  |       | V        |
| VINX    | $V_{il}$ | Signal Input               | VREFM |      | VREFP | V        |
| VINX    | $V_{ih}$ | Signal Input               | VREFM |      | VREFP | V        |
| CVBS    |          | Video input (See Figure 2) |       | 1    |       | $V_{pp}$ |

Table 2. MC44C401L DC Characteristics (continued)(Preliminary)

| PIN     | Symbol     | Parameter                       | Min  | Typ | Max  | Unit     |
|---------|------------|---------------------------------|------|-----|------|----------|
| CLK4MHZ | $V_{ol}$   | 4 MHz Clock Output @ $I = 6$ mA | 2.97 |     |      | V        |
| CLK4MHZ | $V_{oh}$   | 4 MHz Clock Output @ $I = 6$ mA |      |     | 3.63 | V        |
| CA      | $V_{ol}^1$ | Composite Audio Output          |      | 2.2 |      | $V_{pp}$ |

<sup>1</sup>  $V_{ol}$  is measured at  $I_{load} = 6$  mA (see test circuit Figure 2)

## 5.2 AC Characteristics

Table 3. MC44C401L AC Characteristics (Preliminary) (See Figure 2)

| SIGNALS       | Symbol   | Parameter <sup>1</sup>                       | Min | Typ  | Max   | Unit      |
|---------------|----------|--|-----|------|-------|-----------|
| LEFT/RIGHT IN |          | Input Level                                  |     |      | 1.0   | $V_{pp}$  |
| LEFT/RIGHT IN |          | Input Impedance                              |     | 250  |       | $k\Omega$ |
| COMPOSITE     |          | Composite Output Level <sup>2</sup>          |     | 2.2  |       | $V_{pp}$  |
| COMPOSITE     |          | SNR <sup>3</sup>                             | 65  | 75   |       | dB        |
| COMPOSITE     |          | THD <sup>2</sup>                             |     | 0.1  | 0.3   | %         |
| COMPOSITE     |          | -1 db Bandwidth                              | 20  |      | 14000 | Hz        |
| CVBS IN       |          | Video Level                                  | 0.5 |      | 2.0   | $V_{pp}$  |
| CVBS          | $Z_{in}$ | Video Input Impedance                        |     | 1000 |       | $\Omega$  |
|               |          | Stereo Separation 500Hz - 5KHz <sup>4</sup>  |     | 35   |       | dB        |
|               |          | Stereo Separation 100Hz - 10KHz <sup>4</sup> | 30  | 35   |       | dB        |

<sup>1</sup> See Figure 2 for test setup

<sup>2</sup> Test conditions 1 kHz 0 dB

<sup>3</sup> Measured in 20 Hz to 13.5 kHz bandwidth

<sup>4</sup> Measured -10 dB input level

## 6 Package Data

### 6.1 MC44C401L Package

The MC44C401L pin-outs (32TQFP package) are shown in Figure 3.

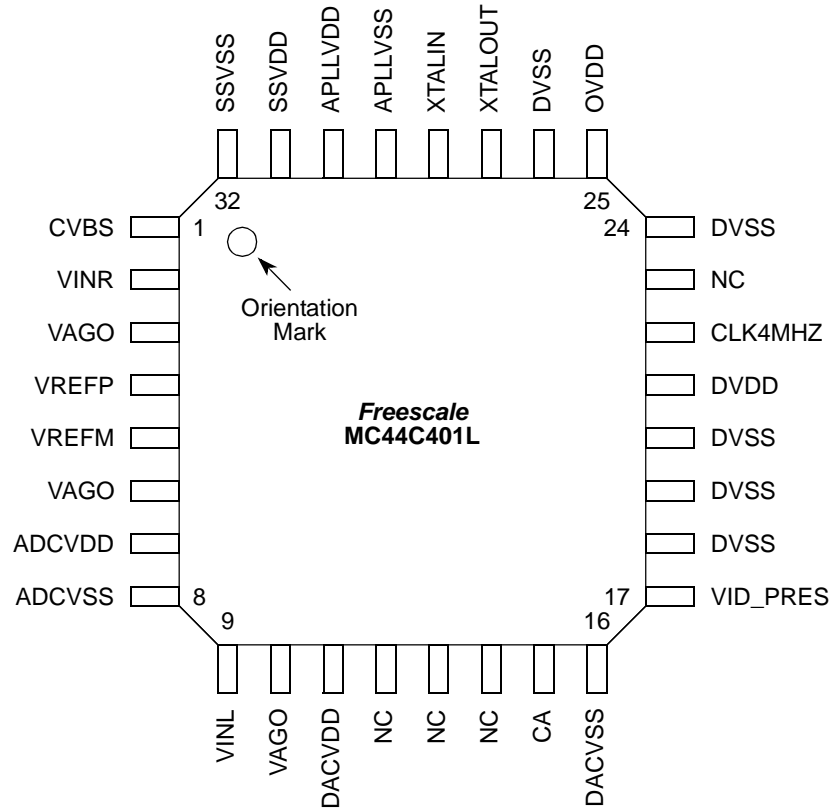


Figure 3. MC44C401L 32LQFP Package

## 6.2 Mechanical Data

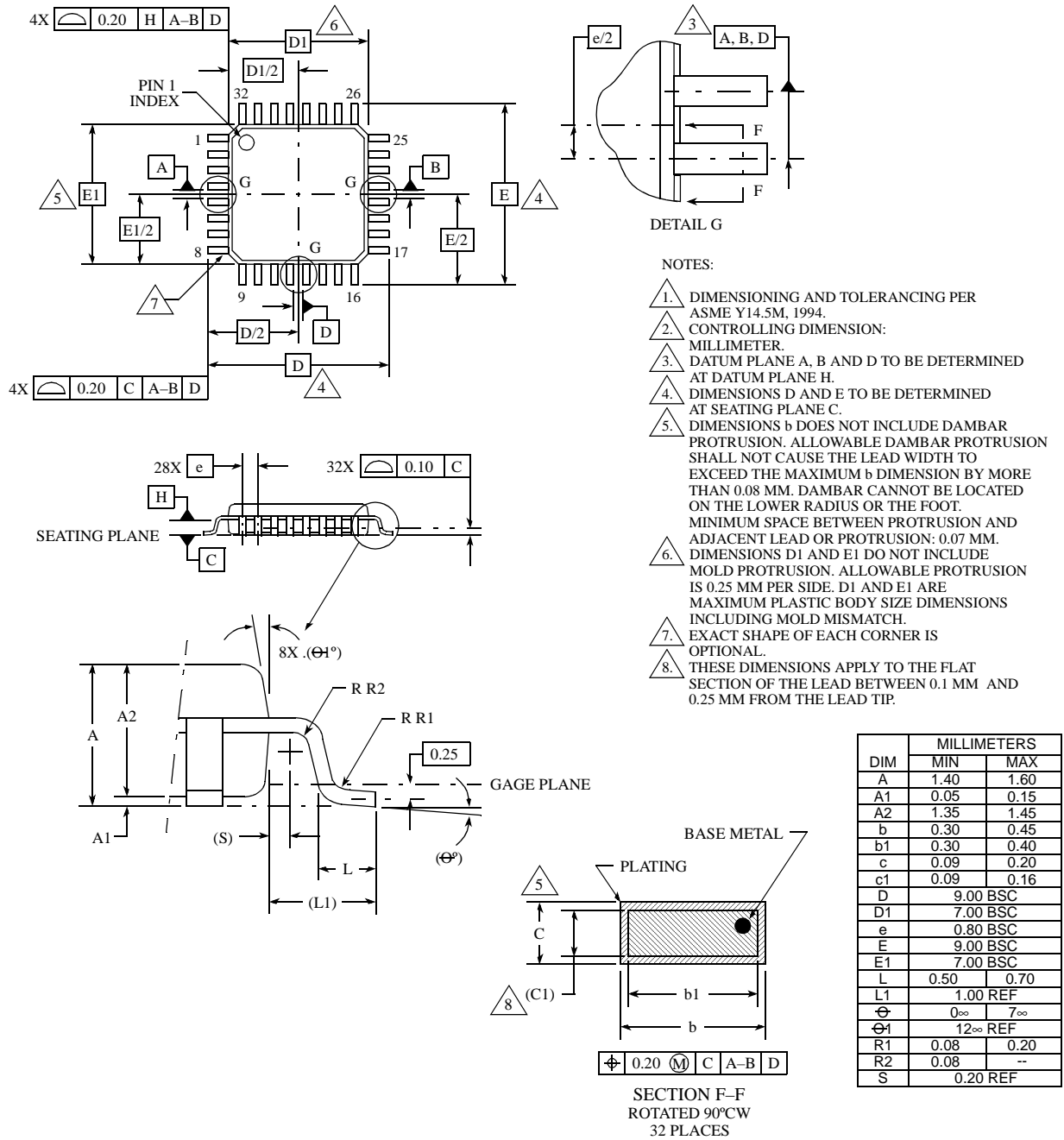


Figure 4.



## 7 Functional Description

The following sections provide brief descriptions of the MC44C401L modules.

### 7.1 Phase Locked Loop (APLL)

The APLL, shown in Figure 5, locks to the reference frequency of 12 MHz and generates the master clock.

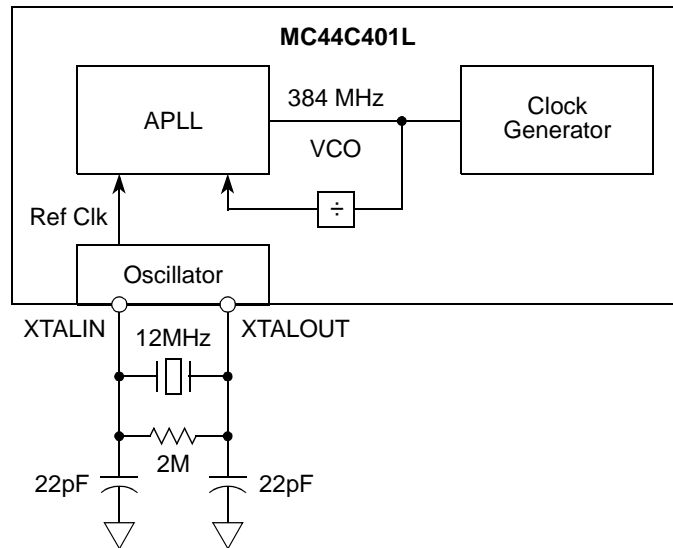


Figure 5. APLL and Clock Generator

### 7.2 Sync Separator

The Sync Separator, shown in Figure 6, extracts the composite sync from the incoming composite video signal.

The composite sync is used by the Audio Processor to generate the 15.734 kHz pilot tone and the 31.468 kHz carrier to modulate the Left-Right channel. The nominal output level of composite video signal sources is  $1 V_{pp}$  on  $75 \Omega$  and the sync amplitude is 0.3 V.

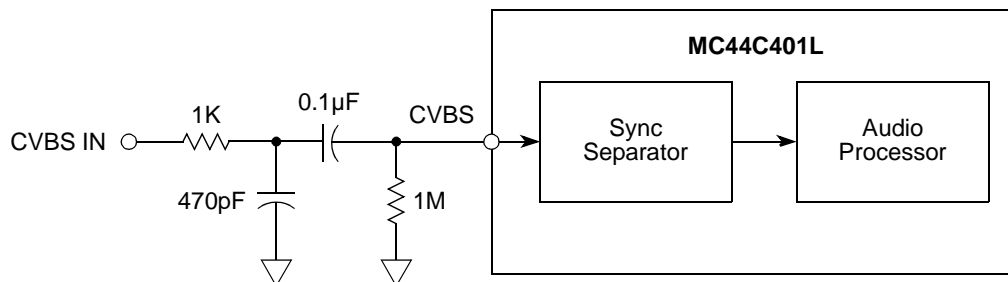
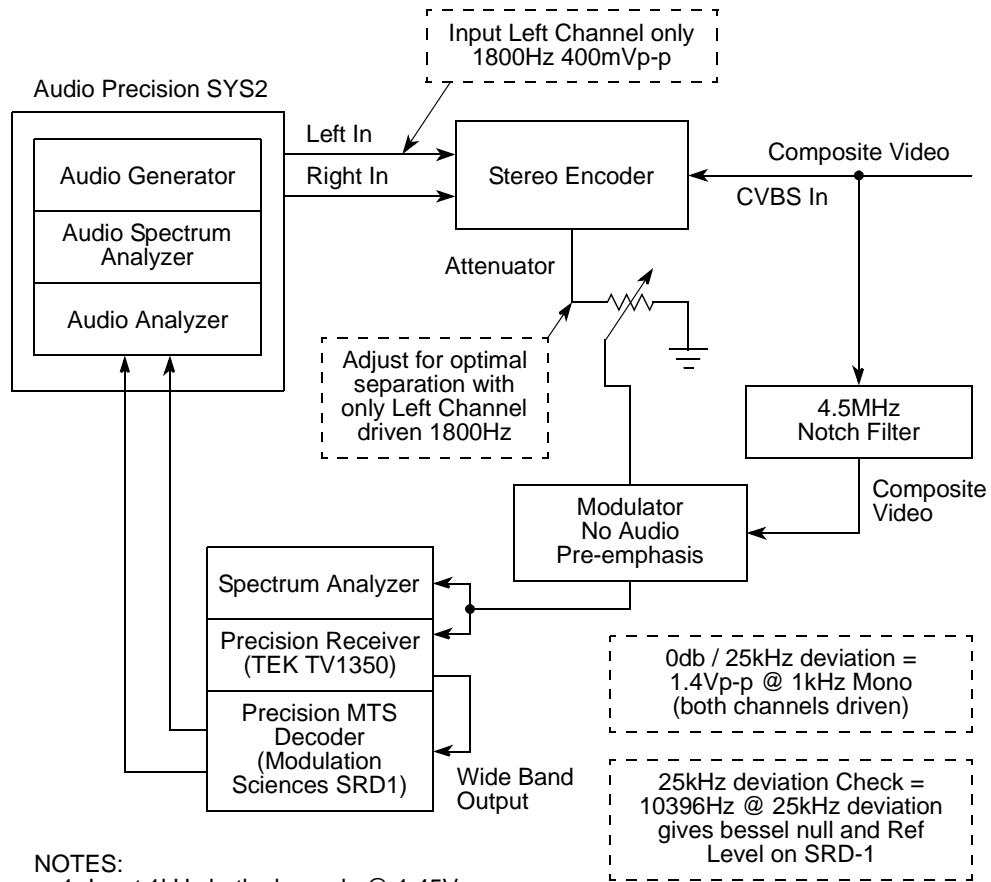


Figure 6. Sync Separator

## Functional Description



### NOTES:

1. Input 1kHz both channels @ 1.45Vp-p.
2. Set attenuator for 25kHz deviation out of modulator.
3. Input 1.8kHz 0.4Vp-p on left channel only and optimize stereo separation with attenuator.

**Figure 7. MC44C401L Level Setup**

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