

ML6416

S-Video Filter with Summed Composite Output, Sound Trap, and Group Delay Compensation

Features

- 7.1MHz Y and C filters, with CV out
- 14dB notch at 4.5MHz for sound trap
- 42dB stopband attenuation at 27MHz on Y, C, and CV
- Better than 1dB flatness to 4.5 MHz on Y, C, and CV
- RF Modulator output differential group delay between 400kHz and 3.58MHz is typically -170ns.
- No external frequency select components or clocks
- 9ns group delay flatness on Y, C, and CV output
- AC coupled inputs and outputs
- 0.4% differential gain on Y, C and CV channels, 0.4° differential phase on Y, C and CV channels
- 0.8% total harmonic distortion on all channels
- DC restore with low tilt

Applications

- Cable Set-top Boxes
- Satellite Set-top Boxes
- DVD Players

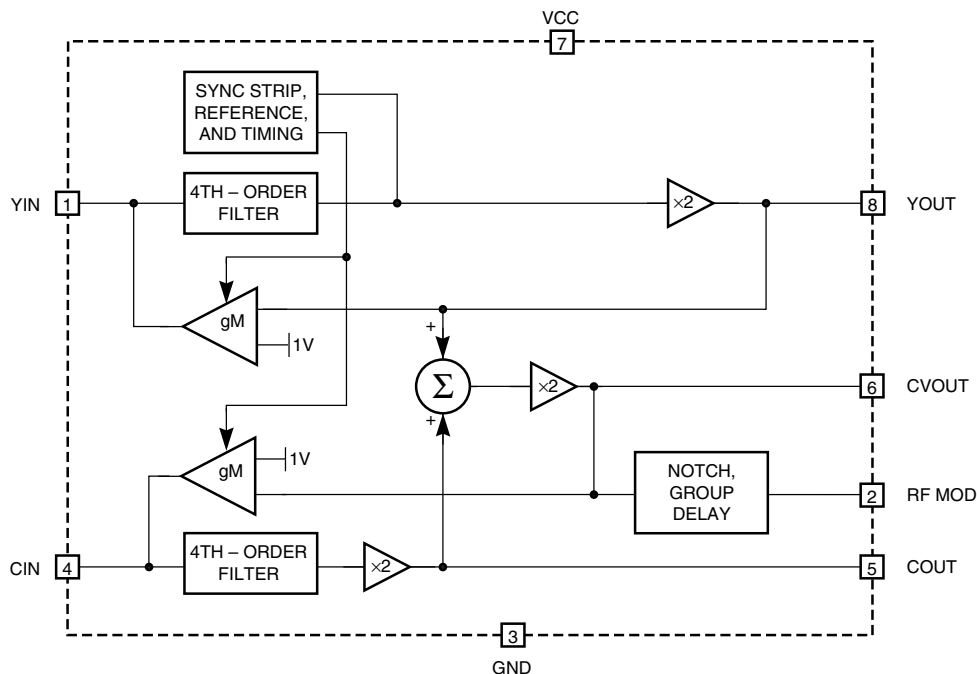
General Description

The ML6416 is a dual Y/C 4th-order Butterworth lowpass video filter optimized for minimum overshoot and flat group delay. The device also contains a summing circuit to generate filtered composite video, an audio trap and group delay compensation circuit to notch-out audio, providing an area for the addition of the FM audio carrier(s) and mimic the group delay distortion introduced at the transmitter. The group delay predistortion compensates for the nominal TV receiver IF filter distortion.

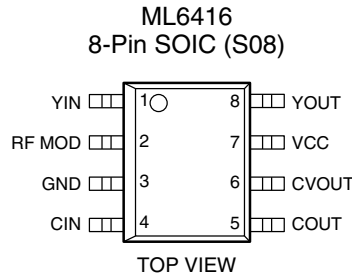
In a typical application, the Y and C input signals from DACs are AC coupled into the filter. Both channels have DC restore circuitry to clamp the DC input levels during video sync. The Y and C channels use a separate feedback clamp. The clamp pulse is derived from the Y channel.

The outputs are AC coupled. The Y, C, CV, and modulator outputs can drive 2V_{P-P} into a 150Ω load (1V_{P-P} 75Ω coax load). The Y, C, CV, and notch channels have a gain of approximately 2 (6dB) with 1V_{P-P} input levels.

Block Diagram



Pin Configuration



Pin Descriptions

| Pin # | Signal Name | Description |
|-------|-------------|-------------------------------|
| 1 | YIN | Luminance input |
| 2 | RF MOD | Output to RF modulator driver |
| 3 | GND | Ground |
| 4 | CIN | Chrominance input |
| 5 | COUT | Chrominance output |
| 6 | CVOUT | Composite video output |
| 7 | VCC | 5V supply |
| 8 | YOUT | Luminance output |

Functional Description

Introduction

This product is a dual monolithic continuous time video filter designed for reconstructing the luminance and chrominance signals from an S-Video D/A source. Composite video output is generated by summing the Y and C outputs. The chip is intended for use in applications with AC coupled input and AC coupled outputs. (See Figure 1)

The reconstruction filters approximate a 4th-order Butterworth characteristic with an optimization toward low overshoot and flat group delay. Y, C, and CV outputs are capable of driving 2V_{P-P} into AC coupled 150Ω video loads, with up to 35pF of load capacitance at the output pin.

All channels are clamped during sync to establish the appropriate output voltage swing range. Thus the input coupling capacitors do not behave according to the conventional RC time constant. Clamping for all channels settles to less than 10mv within 5ms of a change in video input sources.

In most applications the input coupling capacitors are 0.1μF. The Y and C input typically sinks 1μA during active video,

which nominally tilts a horizontal line by about 2mV at the Y output. During sync, the clamp typically sources 20μA to restore the DC level. The net result is that the average input current is zero.

Any change in the input coupling capacitor's value will inversely alter the amount of tilt per line. Such a change will also linearly affect the clamp response times.

This product is robust and stable under all stated load and input conditions. Capacitive bypassing VCC directly to ground ensures this performance.

Luminance (Y) I/O

The luma input is driven by either a low impedance source of 1V_{P-P} or the output of a 75Ω terminated line. The input is required to be AC coupled via a 0.1μF coupling capacitor which allows for a settling time of 5ms. The luma output is capable of driving an AC coupled 150Ω load at 2V_{P-P}, or 1V_{P-P} into a 75Ω load. Up to 35pF of load capacitance (at the output pin) can be driven without stability or slew issues. The output is AC coupled with a 220μF or larger AC coupling capacitor.

Chrominance (C) I/O

The chroma input is driven by a low impedance source of 0.7V_{p-p} or the output of a 75Ω terminated line. The input is required to be AC coupled via a 0.1μF coupling capacitor which allows for a clamp setting time of 5ms. The chroma output is capable of driving an AC coupled 150Ω load at 2V_{p-p}, or 1V_{p-p} into a 75Ω load. Up to 35pF of load capacitance can be driven without stability or slew issues. A 0.1μF AC coupling capacitor is recommended at the output. (This reduces the circuit cost as chroma does not contain low frequency components.)

Composite Video (CV) Output

The composite video output is capable of driving 2 loads to 2V_{p-p}. It is intended to drive a TV and a VCR. Either the TV input or the VCR input can be shorted to ground and the other output will still meet specifications. Up to 35pF of load capacitance (at the output pin) can be driven without stability or slew issues.

RF Modulator Output

The RF modulator output is capable of driving a 600Ω load to 2V_{p-p}, but is primarily intended to drive a modulator load.

Typical Applications Diagram

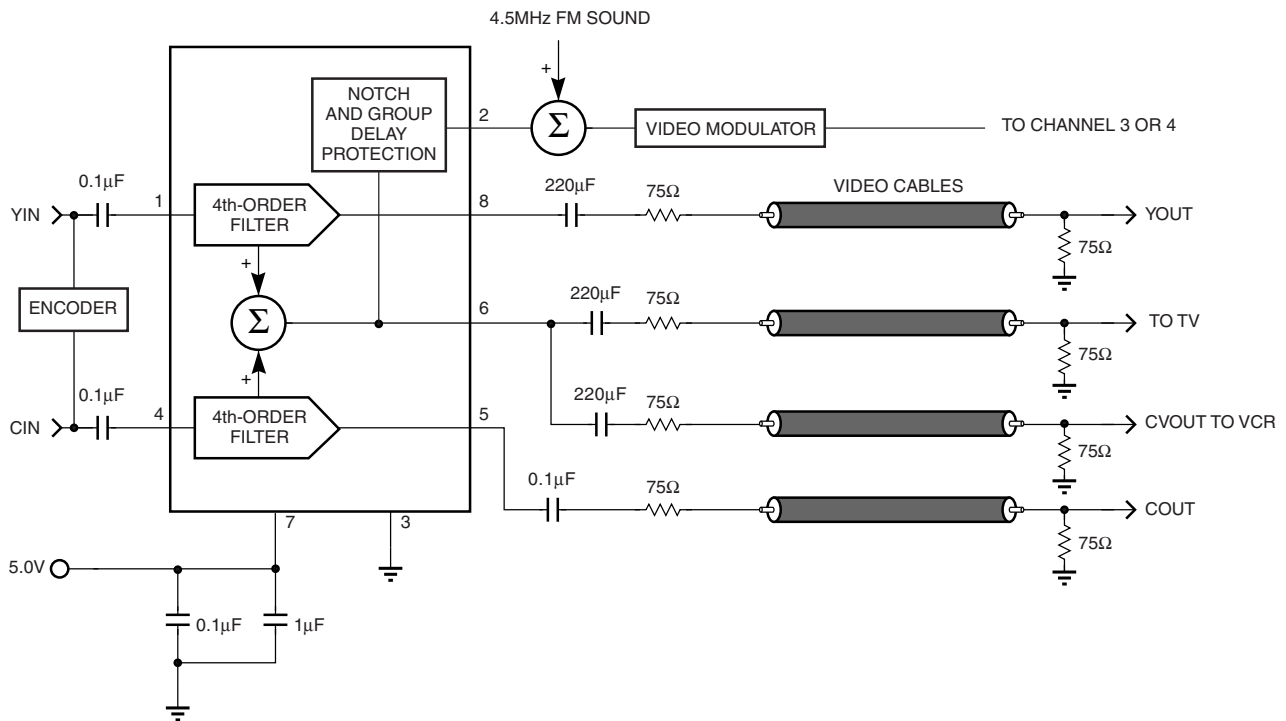


Figure 1. Coupled S-Video, Composite Video Line Driver, Sound Trap, and Group Delay Pre-distortion

Absolute Maximum Ratings

Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

| Parameter | Min. | Max. | Units |
|--------------------------------------|-----------|-----------|-------|
| DC Supply Voltage | -0.3 | 7 | V |
| Analog & Digital I/O | GND - 0.3 | VCC + 0.3 | V |
| Output Current (Continuous) | | | |
| CV Channel | | 60 | mA |
| C and Y Channels | | 30 | mA |
| Junction Temperature | | 150 | °C |
| Storage Temperature Range | -65 | 150 | °C |
| Lead Temperature (Soldering, 10s) | | 260 | °C |
| Thermal Resistance (θ_{JA}) | | 115 | °C/W |

Operating Conditions

| Parameter | Min. | Max. | Units |
|-------------------|------|------|-------|
| Temperature Range | 0 | 70 | °C |
| VCC Range | 4.5 | 5.5 | V |

Electrical Characteristics

Unless otherwise specified, VCC = 5.0V \pm 10%, All inputs AC coupled with 100nF, TA = Operating Temperature Range

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---------|---|--|------|------|------|-------|
| ICC | Supply Current | | | 60 | 85 | mA |
| VCC | Supply Range | | 4.5 | 5.0 | 5.5 | V |
| AVYC | Low Frequency Gain (YOUT, COUT) | at 400KHz | 5.75 | 6.0 | 6.25 | dB |
| AVRFMOD | Low Frequency Gain (RFMOD) | at 400KHz | 6.1 | 6.7 | 7.3 | dB |
| AVCV | Low Frequency Gain (CVOUT) | at 400KHz | 5.55 | 5.9 | 6.25 | dB |
| | COUT Output Level (During Sync) | Sync Present on YIN | 1.6 | 2.0 | 2.4 | V |
| | YOUT Output Level (During Sync) | Sync Present on YIN | 0.75 | 1.0 | 1.25 | V |
| | CVOUT Output Level (During Sync) | Sync Present on YIN | 0.75 | 1.0 | 1.25 | V |
| | RFMOD Output Level (During Sync) | Sync Present on YIN | 0.65 | 1.0 | 1.35 | V |
| tCLAMP | Clamp Response Time (Y Channel) | Settled to Within 10mV, 0.1 μ F cap on YIN and CIN | | 5 | 9 | ms |
| f1dB | -1.0dB Bandwidth (Flatness) (YOUT, COUT, and CVOUT) | No Peaking Cap (Note 1) | 4.2 | 4.5 | | MHz |
| fC | -3dB Bandwidth (Flatness) (YOUT, COUT, and CVOUT) | | 6.7 | 7.1 | | MHz |
| fSB | Stopband Rejection (YOUT, COUT, and CVOUT) | fIN = 27MHz | -37 | -42 | | dB |
| Vi | Input Signal Dynamic Range (All Channels) | AC Coupled | 1.2 | 1.4 | | VP-P |
| ISC | Output Short Circuit Current (All Channels) | COUT, YOUT, CVOUT, RFMOD to GND (Note 2) | | 40 | 80 | mA |

Electrical Characteristics (continued)

Unless otherwise specified, VCC = 5.0V ±10%, All inputs AC coupled with 100nF, TA = Operating Temperature Range

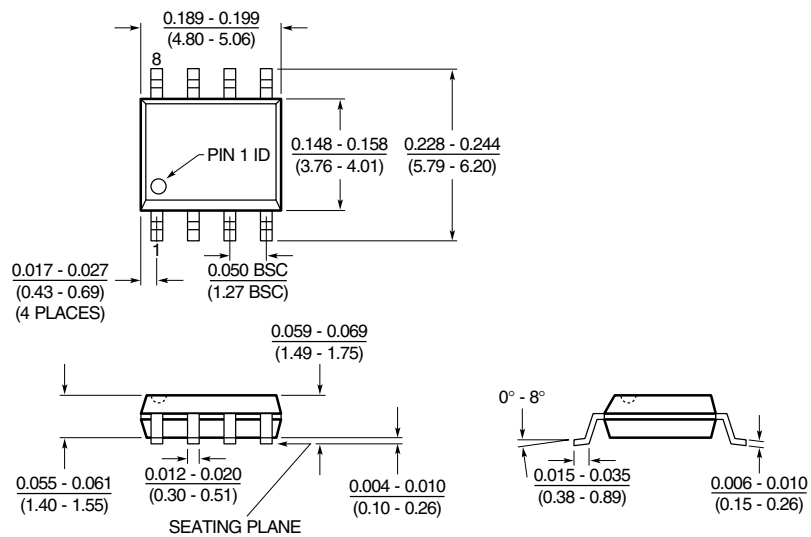
| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Units |
|---------|---|---|------|------|-------|-------|
| CL | Output Shunt Capacitance (All Channels) (Note 5) | All Outputs | | 35 | | pF |
| dG | Differential Gain (Note 5) | YOUT, COUT, and CVOUT | | 0.4 | 1 | % |
| dP | Differential Phase (Note 5) | YOUT, COUT, and CVOUT | | 0.4 | 1 | ° |
| THD | Output Distortion (All Channels) (Note 5) | VOU _T = 1.8VP-P, Y/C Out at 3.58MHz | | 0.8 | 1.0 | % |
| XTALK | Crosstalk (Note 5) | From C _{IN} of 0.5VP-P at 3.58MHz to YOUT | -45 | -55 | | dB |
| | | From Y _{IN} Input of 0.4VP-P at 3.58MHz, to COUT | -50 | -58 | | dB |
| PSRR | PSRR (All Channels) (Note 5) | 0.5VP-P (100KHz) at VCC | -30 | -40 | | dB |
| SNR | Y, C Channel (Note 5) | NTC-7 weighting 4.2 MHz lowpass | -65 | -75 | | dB |
| | CV Channel (Note 5) | NTC-7 weighting 4.2 MHz lowpass | -60 | -70 | | dB |
| | RFMOD Channel (Note 5) | NTC-7 weighting 4.2 MHz lowpass | -55 | -65 | | dB |
| tpd | Propagation Delay (Y, C, CV) (Note 5) | | 30 | 70 | 110 | ns |
| Δtpd | Group Delay Deviation from Flatness (Y, C, and CV) (Note 5) | to 3.58MHz (NTSC) | | 9 | | ns |
| tSKEW | Skew Between YOUT and COUT (Note 5) | at 1MHz | | 0 | | ns |
| TCLDCV | Chroma-Luma Delay CVOUT | f = 3.58 MHz (referenced to 400kHz) | -35 | 0 | 35 | ns |
| TCLGCV | Chroma-Luma Gain CVOUT | f = 3.58 MHz (referenced to 400kHz) | 92 | 95 | 104 | % |
| GDMOD | Group Delay RFMOD | f = 3.58MHz (referenced to 400kHz) | -205 | -170 | -135 | ns |
| TCLDMOD | Chroma-Luminance Delay RFMOD | f = 3.58MHz (referenced to 400kHz) | -185 | -150 | -115 | ns |
| TCLGMOD | Chroma-Luminance Gain RFMOD | f = 3.58MHz (referenced to 400kHz) | 95 | 100 | 105 | % |
| dGRFMOD | Differential Gain | RFMOD Channel | | 1.5 | 4 | % |
| dPRFMOD | Differential Phase | RFMOD Channel | | 1.0 | 1.5 | ° |
| pK | Gain Peaking (Note 3) | RFMOD Channel at 2.0MHz | | 0.5 | 0.75 | dB |
| MCF | Modulator Channel Flatness (Note 3) | at 3.75MHz | -0.5 | -0.1 | +0.75 | dB |
| AV | Notch Attenuation (Note 3) | From 4.425MHz to 4.63MHz | 14 | | | dB |
| AV | Notch Attenuation (Note 3) | At 4.1MHz | | | 2.5 | dB |
| AV | Notch Attenuation (Note 3) | At 4.2MHz | | | 5 | dB |
| TPASS | Passband Group Delay, RFMOD (Note 4) | f = 200kHz to f = 3MHz | -50 | | 50 | ns |

Notes


1. Peaking capacitor increases CV output at 4.2MHz nominally by 0.7dB
2. Sustained short circuit protection limited to 10 seconds
3. Referenced to 400kHz
4. Group Delay is tested down to 400kHz but guaranteed by design to 200kHz.
5. Guaranteed by characterization

Mechanical Dimensions Inches (millimeters)

Package: S08
8-Pin SOIC



Ordering Information

| Model | Part Number | Lead Free | Package | Container | Pack Quantity |
|--------|--------------|---|---------|-----------|---------------|
| ML6416 | ML6416CS | | SOIC-8 | Rail | 95 |
| ML6416 | ML6416CSX | | SOIC-8 | Reel | 2500 |
| ML6416 | ML6416CSX_NL |  | SOIC-8 | Reel | 2500 |

Temperature range for all parts: 0°C to +70°C

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