

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

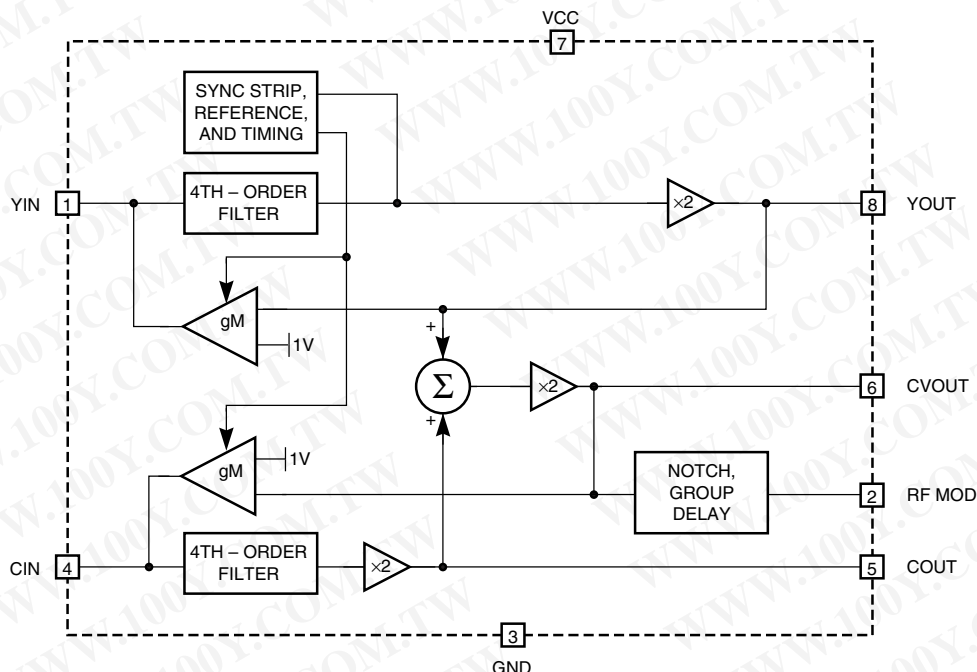
General Description

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.

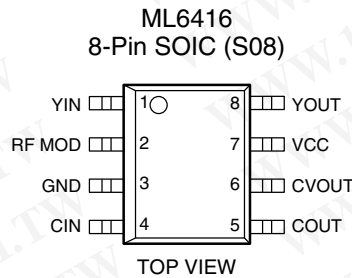
In a typical application, the Y and C input signals from DACs are AC coupled into the filter. Both channels have DC restore circuitry to clamp the DC input levels during video sync. The Y and C channels use a separate feedback clamp. The clamp pulse is derived from the Y channel.

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

Block Diagram



Pin Configuration



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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 2VP-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 1VP-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 2VP-P, or 1VP-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.

Composite Video (CV) Output

The composite video output is capable of driving 2 loads to 2VP-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.

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

The schematic diagram illustrates the video encoder circuit. It begins with two input signals, YIN and CIN, each passing through a 0.1 μF capacitor to pins 1 and 4 of the encoder block. The encoder block contains an ENCODER, two 4th-ORDER FILTERS, a NOTCH AND GROUP DELAY PROTECTION block, and a summing junction (Σ). The output of the encoder (pin 2) is connected to a 4.5MHz FM SOUND input and a VIDEO MODULATOR. The output of the video modulator is connected to the NOTCH AND GROUP DELAY PROTECTION block. The output of the NOTCH AND GROUP DELAY PROTECTION block is connected to the summing junction. The output of the summing junction is connected to pin 8 of the encoder block. The output of the encoder block (pin 6) is connected to a 220 μF capacitor and a 75 Ω resistor, which are connected to the input of a VIDEO CABLE. The output of the video cable is connected to the YOUT output. The output of the encoder block (pin 5) is connected to a 220 μF capacitor and a 75 Ω resistor, which are connected to the input of a VIDEO CABLE. The output of the video cable is connected to the TO TV output. The output of the encoder block (pin 3) is connected to a 220 μF capacitor and a 75 Ω resistor, which are connected to the input of a VIDEO CABLE. The output of the video cable is connected to the CVOUT TO VCR output. The output of the encoder block (pin 7) is connected to a 0.1 μF capacitor and a 75 Ω resistor, which are connected to the input of a VIDEO CABLE. The output of the video cable is connected to the COUT output. The circuit is powered by a 5.0V supply, which is connected to pins 1 and 4 of the encoder block. The output of the encoder block (pin 3) is connected to ground. The output of the encoder block (pin 7) is connected to a 0.1 μF capacitor and a 1 μF capacitor, which are connected to ground.

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

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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 = 1.8VP-P, Y/C Out at 3.58MHz		0.8	1.0	%
XTALK	Crosstalk (Note 5)	From CIN of 0.5VP-P at 3.58MHz to YOUT	-45	-55		dB
		From YIN 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

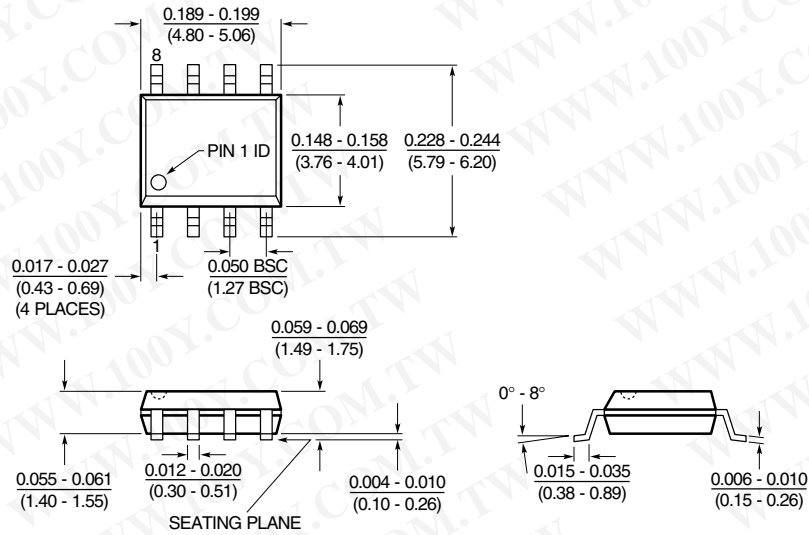
Notes

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

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Mechanical Dimensions Inches (millimeters)

Package: S08
8-Pin SOIC



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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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