FMS6408

Triple Video Filter Driver for RGB and YUV Signals

Features

- 7.6MHz 5th order RGB/YUV/YC CV filters
- 50dB stopband attenuation at 27MHz on all outputs
- Better than 0.5dB flatness to 4.2MHz on all outputs
- No external frequency selection components or clocks
- AC coupled inputs and AC or DC coupled outputs
- Supports both NTSC and PAL luminance bandwidth
- Continuous time low pass filters for video anti-aliasing or reconstruction applications
- <1% differential gain with 0.5° differential phase on all channels
- Integrated DC restore circuitry with low tilt

Applications

- Cable set top boxes
- Satellite set top boxes
- Terrestrial set top boxes
- DVD players
- Personal Video Recorders (PVR)
- Video On Demand (VOD)

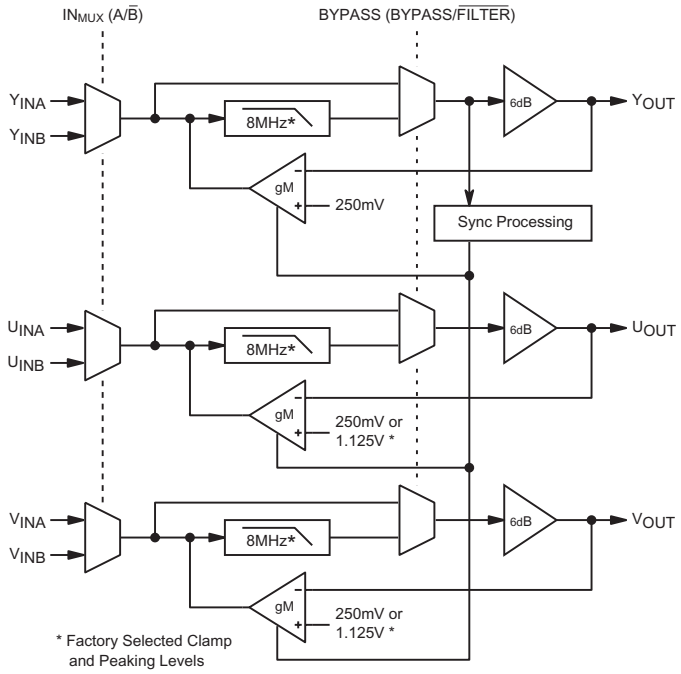
Description

The FMS6408 provides three video signal paths including a two-input mux, a video filter and a 6dB gain output driver. The filter bandwidth supports RGB and YUV signals in either NTSC or PAL formats.

The video filters approximate a 5th order Butterworth low pass characteristic optimized for minimum overshoot and flat group delay to provide excellent image quality. Four different peaking options are available. The video filters can be bypassed if desired.

In a typical application, the RGB or YUV DAC outputs are AC coupled into the filters through the input mux. All channels have DC restore circuitry to clamp the DC input levels during video sync. The clamp pulse derived from the selected Y input controls three independent feedback clamps. All outputs are capable of driving $2V_{pp}$, AC or DC coupled, into either a single (150Ω) or dual (75Ω) video load. The FMS6408 clamp levels can be factory programmed for YUV /RGB (250mV for all channels), YC / YPbPr (250mV on channel 1 and 1.125V on channels 2 and 3) or YC CV (250mV on channels 1 and 3 and 1.125V on channel 2).

Functional Block Diagram



Electrical Specifications

(T_C = 25˚C, V_i = 1V_{pp}, V_{CC} = 5.0V, all inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω, referenced to 400kHz, 0dB peaking option; unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{CC}	Supply Current[1]	V_{CC} no load		52	86	mA
V_i	Input Voltage Max			1.4		V_{pp}
V_{il}	Digital Input Low[1]	Bypass, A_NB	0		0.8	V
V_{ih}	Digital Input High[1]	Bypass, A_NB	2.0		V_{CC}	V
V_{CLAMP}	Clamp Voltage[2]	YUV/RGB/CV Inputs		250		mV
		PbPr/C Inputs		1.125		V
PSRR	Power Supply Rejection Ratio	DC		-40		dB

AC Electrical Specifications

(T_C = 25˚C, V_i = 1V_{pp}, V_{CC} = 5.0V, all inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω, referenced to 400kHz, 0dB peaking option; unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
A_{PB}	Passband Response[1]	4.2MHz	-0.5	0		dB
AV_{LF}	Low Frequency Gain (All Channels)[1]	at 400kHz	5.6	5.9	6.2	dB
ΔAV_{HF}	Delta High Frequency at 5MHz (All Channels)[3]	0dB Peaking Option		0.3		dB
		0.4dB Peaking Option		0.7		dB
		0.9dB Peaking Option		1.2		dB
		1.3dB Peaking Option		1.6		dB
f_C	-3dB Bandwidth	All Channels		7.6		MHz
f_{SBh}	Stopband Rejection (All Channels)[1]	at 27MHz	48	52		dB
dG	Differential Gain	All Channels		0.2		%
dθ	Differential Phase	All Channels		0.5		°
THD	Total Harmonic Distortion	at 3.58MHz		0.2		%
SNR	SNR All Channels (NTC7 Weighted)	4.2MHz Lowpass, 100kHz Highpass		75		dB
H_{DIST}	Line-Time Distortion	18µs, 100 IRE Bar		TBD		%
V_{DIST}	Field-Time Distortion	130 Lines, 18µs, 100 IRE Bar		TBD		%
t_{pd}	Propagation Delay (All Channels)	400kHz		65		ns
GD	Group Delay (All Channels)	to 3.58MHz (NTSC)		14		ns
t_{SKEW}	t_{pd}Skew Between Any 2 Channels	at 400kHz		2		ns
$A_{V(match)}$	Channel Gain Matching[1]	400kHz		0	5	%
T_{CLAMP}	Clamp Response Time (All Channels)	Settled to 10mV, Initial Condition 0V		5		ms
X_{TALK}	Crosstalk (Channel-to-Channel)	at 1.0MHz		-65		dB
IN_{MUXISO}	Input Mux Isolation	at 1.0MHz		-85		dB
f_{1dBWB}	Bypass Mode -1dB Bandwidth	1.4V_{pp} Output All Channels		25		MHz

Notes

1. 100% tested at 25°C.
2. Mode selection for YUV/RGB vs. PbPr/YC vs. YC CV operation based on factory programming
3. Peaking Options boost gain by 0dB, 0.4dB, 0.9dB, or 1.3dB from 4.2MHz to 5MHz based on factory programming

Factory Programming Options (See Ordering Information Table on Page 9 for current options)

Part Name	Part Number	Clamping Mode	Peaking Mode (dB)	Y_{OUT} Level (mV)	U_{OUT} Level (V)	V_{OUT} Level (V)
FMS6408-1	FMS6408MTC141_NL	YPbPr/YC	0	250	1.125	1.125
FMS6408-2	FMS6408MTC142_NL	YPbPr/YC	0.4	250	1.125	1.125
FMS6408-3	FMS6408MTC143_NL	YPbPr/YC	0.9	250	1.125	1.125
FMS6408-4	FMS6408MTC144_NL	YPbPr/YC	1.3	250	1.125	1.125
FMS6408-5	FMS6408MTC145_NL	YUV/RGB	0	250	250	250
FMS6408-6	FMS6408MTC146_NL	YUV/RGB	0.4	250	250	250
FMS6408-7	FMS6408MTC147_NL	YUV/RGB	0.9	250	250	250
FMS6408-8	FMS6408MTC148_NL	YUV/RGB	1.3	250	250	250
FMS6408-9	FMS6408MTC149_NL	YC/CV	0	250	1.125	250
FMS6408-10	FMS6408MTC1410_NL	YC/CV	0.4	250	1.125	250
FMS6408-11	FMS6408MTC1411_NL	YC/CV	0.9	250	1.125	250
FMS6408-12	FMS6408MTC1412_NL	YC/CV	1.3	250	1.125	250

Note
These factory programming options allow a single die to be configured for multiple operating modes.

Absolute Maximum Ratings (beyond which the device may be damaged)

Parameter	Min	Max	Units
V_{CC}	-0.3	6	V
Analog and Digital	-0.3	V_{CC} + 0.3	V
Output Current Any One Channel (Do not exceed)		50	mA
Input Source Resistance (R_S)		300	Ω

Note
Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if operating conditions are not exceeded.

Reliability Information

Parameter	Min	Typ	Max	Units
Junction Temperature			+150	°C
Storage Temperature Range	-65		+150	°C
Lead Temperature (Soldering, 10s)			+300	°C
Thermal Resistance (θ_{JA}), JEDEC Standard Multi-layer Test Boards, Still Air		90		°C/W

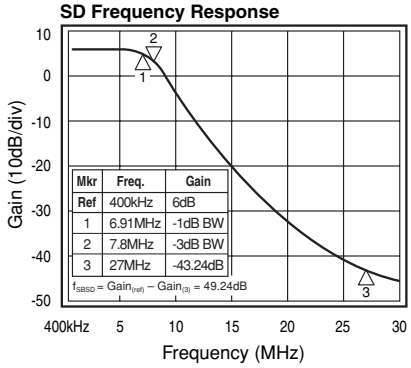
Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Temperature Range	0		70	°C
V_{CC} Range	+4.75	+5.0	+5.25	V

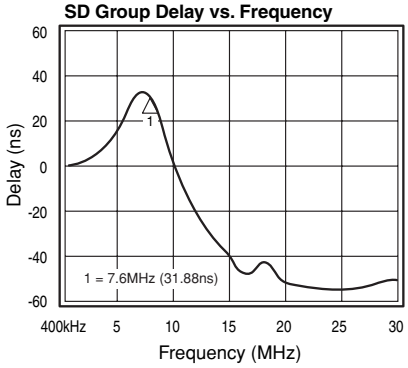
Typical Performance Characteristics

(T_C = 25˚C, V_i = 1V_{pp}, V_{CC} = 5.0V, all inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω, referenced to 400kHz, 0dB peaking option; unless otherwise noted)

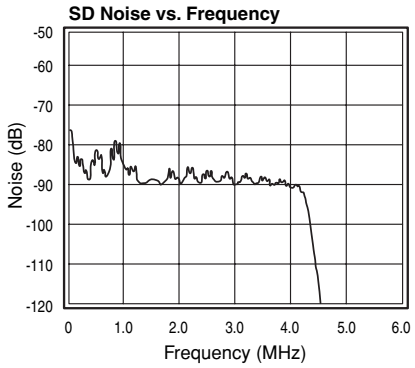
SD Frequency Response



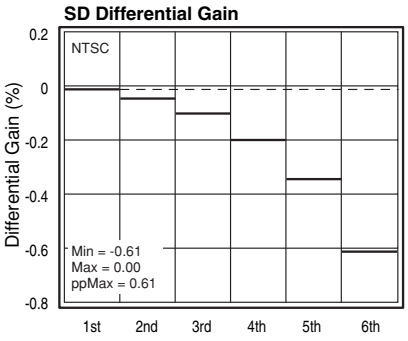
SD Group Delay vs. Frequency



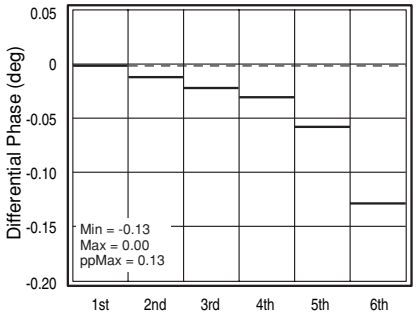
SD Noise vs. Frequency



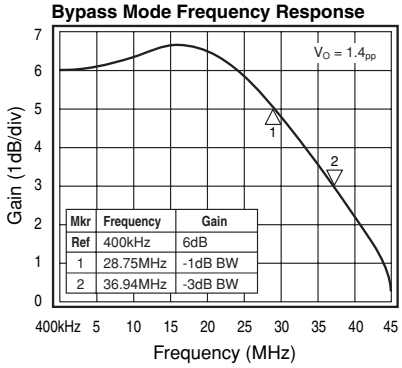
SD Differential Gain



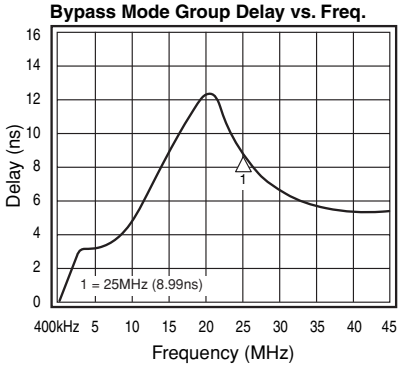
SD Differential Phase



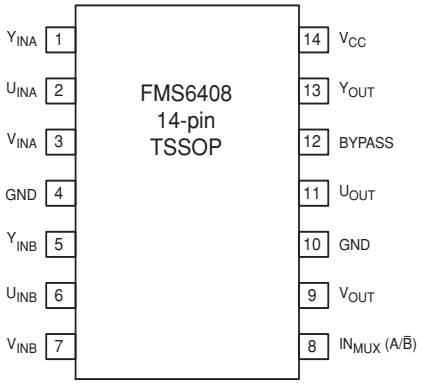
Bypass Mode Frequency Response



Bypass Mode Group Delay vs. Freq.



Pin Configuration



Pin#	Pin	Type	Description
1	Y_{INA}	Input	Y (Luminance) or Green input A, must be connected to a signal which includes sync
2	U_{INA}	Input	U or Blue input A
3	V_{INA}	Input	V or Red input A
4	GND	Input	Must be tied to ground, do not float
5	Y_{INB}	Input	Y (Luminance) or Green input B, must be connected to a signal which includes sync
6	U_{INB}	Input	U or Blue input B
7	V_{INB}	Input	V or Red input B
8	IN_{MUX} (A/$\overline{B}$)	Input	Mux select, A = '1', B = '0', must be externally tied high or low
9	V_{OUT}	Output	V or Red output
10	GND	Input	Must to be tied to ground, do not float
11	U_{OUT}	Output	U or Blue output
12	BYPASS (Bypass/$\overline{Filter}$)	Input	Filter bypass, BYPASS = '1', FILTER = '0', must be externally tied high or low
13	Y_{OUT}	Output	Y or Green output
14	V_{CC}	Input	+5V supply

Functional Description

Introduction

This product is a three channel monolithic continuous time video filter designed for reconstructing YUV, YC CV or RGB signals from a video D/A source. Inputs should be AC coupled while outputs can be either AC or DC coupled. The reconstruction filters approximate a 5th order Butterworth response optimized for minimum overshoot and flat group delay. This provides a maximally flat response in terms of delay and amplitude. Each of the three outputs is capable of driving $2V_{pp}$ into 75Ω loads.

All channels are clamped during the sync interval to set the appropriate dc output level. Sync tip clamping greatly reduces the effective input time constant allowing the use of small low cost input coupling capacitors. The input will settle to 10mV in 2ms for typical DC shifts present in the video signal.

In most applications the input coupling capacitors are 0.1µF. The inputs typically sink 1uA of current during active video. For YUV signals, this translates into a 2mV tilt in a horizontal line at the Y output. During sync, the clamp restores this leakage current by sourcing an average of 20µA over the clamp interval. Any change in the coupling capacitor values will affect the amount of tilt per line. Any reduction in tilt will come with an increase in settling time.

Sync processing is based on the Y/G input channel in all operating modes.

Inputs

The inputs will typically be driven by either a low impedance source of $1V_{pp}$ or the output of a 75Ω terminated line driven by the output of a current DAC. In either case, the inputs must be capacitively coupled to allow the sync-detect and DC restore circuitry to operate properly.

Outputs

The outputs are low impedance voltage drivers which can handle either a single or dual load. A single load consists of a 75Ω series termination resistor feeding a 75Ω terminated line for a total load at the part of 150Ω. Even when two loads are present (75Ω) the driver will produce a full $2V_{pp}$ signal at its output pin. The driver can also be used to drive an AC coupled single or dual load. When driving a dual load either output will still function if the other output connection is inadvertently shorted providing these loads are AC coupled.

Typical Application Diagrams

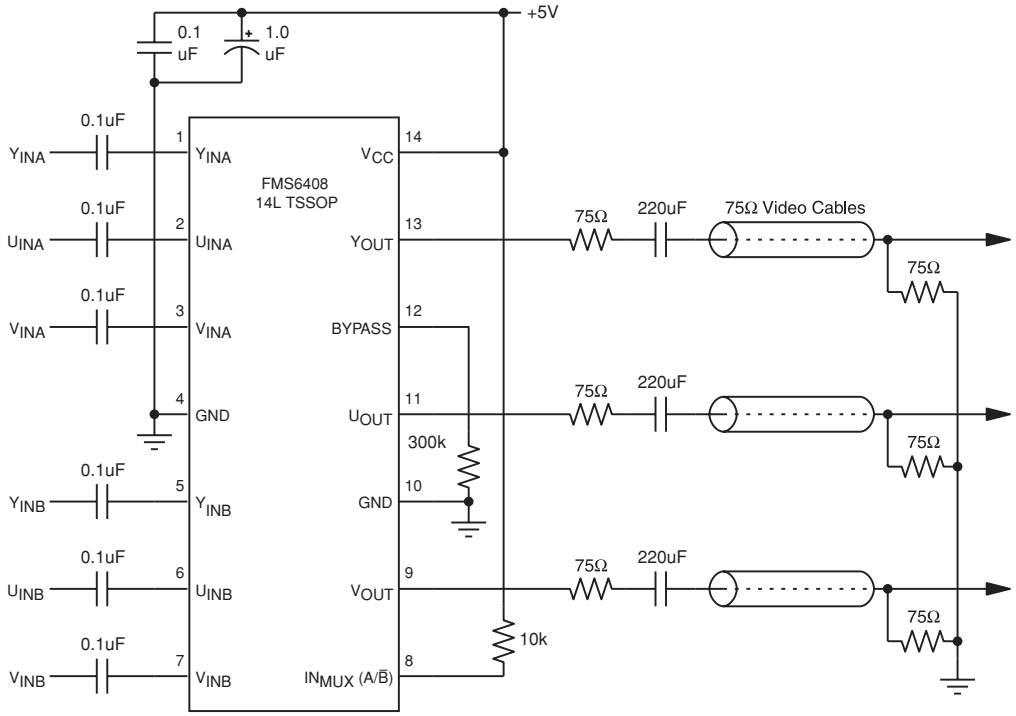


Figure 1. AC-Coupled YUV Line Driver with Single Video Loads

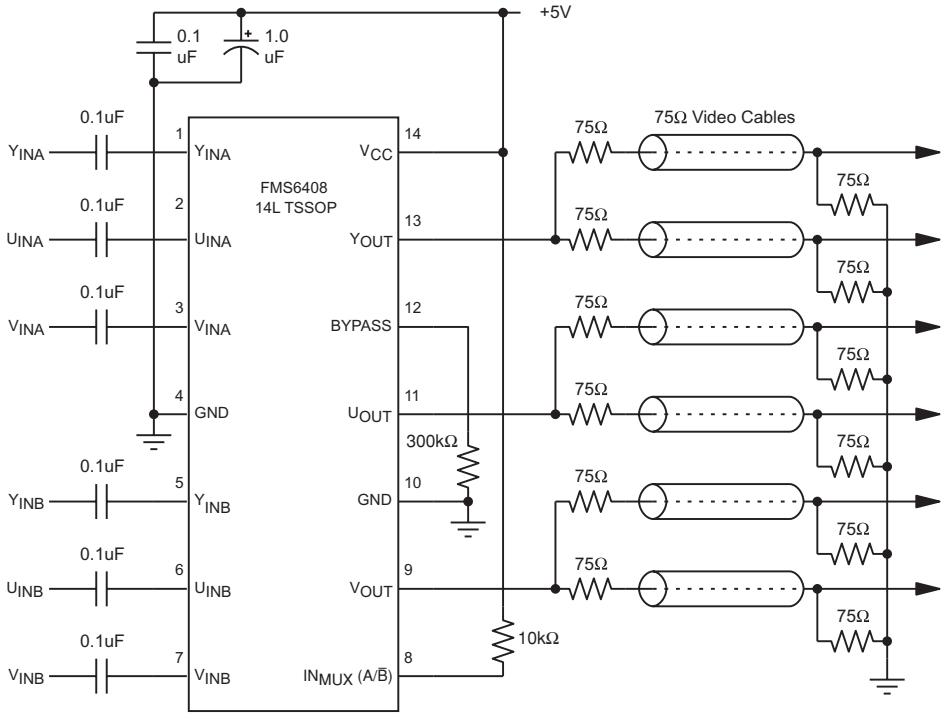


Figure 2. DC-Coupled YUV Line Driver with Dual Video Loads

Application Notes

Output Drive Capability

The FMS6408 can drive dual 75Ω loads where each load consists of a 75Ω resistor in series with a 75Ω termination resistor in the driven device. This presents a 150Ω load to the output so two similar loads in parallel look like 75Ω from the output to ground. In some cases it may be desirable to drive a single load on one or more outputs with a dual load on the remaining outputs. This is an acceptable loading condition but might cause a slight degradation in gain matching.

Device Power Dissipation

The FMS6408 specifications provide a quiescent no-load supply current of 52mA (typical). With a nominal 5V supply, this results in a power dissipation of 260mW. The overall power dissipation can be significantly affected by the applied load, particularly in DC-coupled applications. In order to calculate the total power dissipation the typical output voltages and the loading must be known.

The highest power dissipation will occur for YUV video signals that are DC-coupled into dual video loads. Refer to the the diagram in Figure 3 below.

Assume a video signal on the Y channel that averages 50% luminance with an output voltage of 1.55V then calculate the load current:

$$I_{load}\ (Y) = 1.55V/75\Omega = 20.6mA$$

The device dissipation due to this load will be the internal voltage drop multiplied by the load current:

$$P_{diss}\ (Y) = (5V - 1.55V) * 20.6mA = 71mW$$

The average DC level for the U and V channels is set by the clamp circuit to 1.125V. The signal will be symmetrical about this voltage so:

$$I_{load}\ (U) = 1.125V/75\Omega = 15mA$$

The device dissipation due to this load will be the internal voltage drop multiplied by the load current:

$$P_{diss}\ (U) = (5V - 1.125V) * 15mA = 58.125mW$$

Since the U and V power dissipation are approximately the same, the total dissipation due to the load can be estimated by:

$$P_{diss}\ (load) = P\ (Y) + 2 * P\ (U) = 71mW + (2 * 58.125mW) = 187.55mW$$

This will bring the typical total device power dissipation to 260mW (quiescent power) + 187.55mW (load power) or 447.55mW. It is advisable to calculate the highest possible power dissipation using worst-case quiescent supply current and the maximum allowable power supply voltage. This result should be used when calculating the die temperature rise with the supplied θ_{JA}, thermal resistance value.

Field Time Distortion

In applications with AC-coupled outputs, the AC-coupling capacitors will dominate the field time distortion. Performance is specified with 220µF coupling capacitors; if better performance is desired, the capacitors may be increased or the outputs may be DC-coupled.

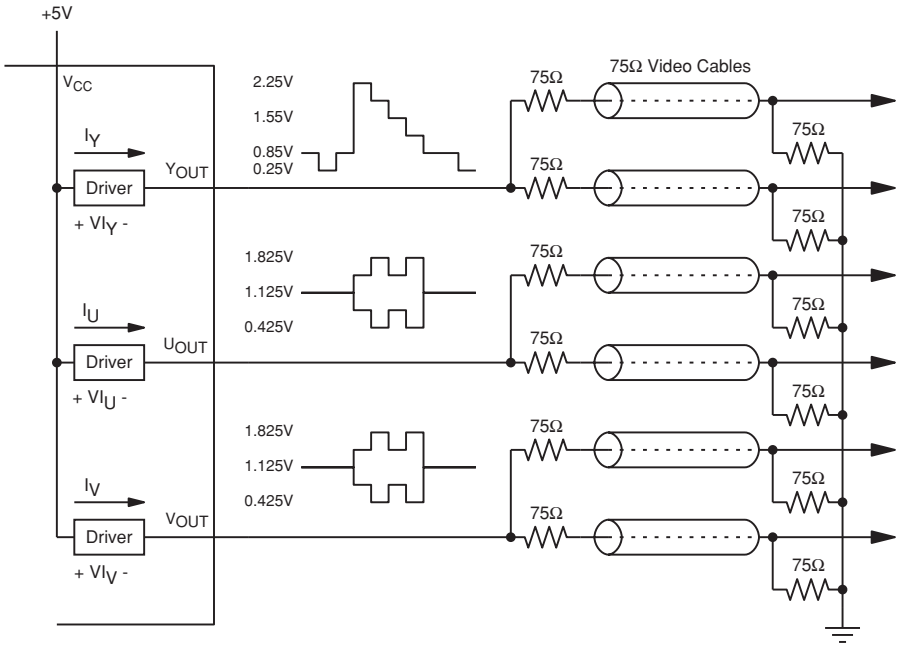
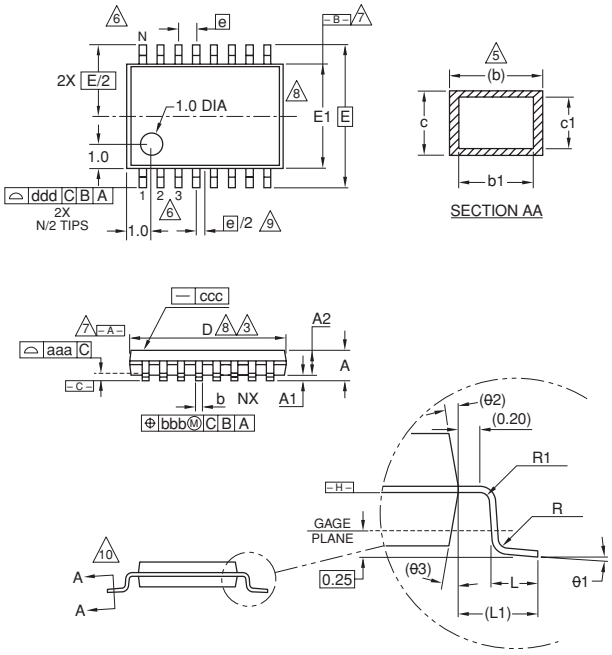


Figure 3. YUV Video Signals that are DC-Coupled into Dual Video Loads

Package Dimensions

MTC-14



MTC-14			
SYMBOL	**MIN**	**NOM**	**MAX**
A	–	–	1.10
A1	0.05	–	0.15
A2	0.85	0.90	0.95
L	0.50	0.60	0.75
R	0.09	–	–
R1	0.09	–	–
b	0.19	–	0.30
b1	0.19	0.22	0.25
c	0.09	–	0.20
c1	0.09	–	0.16
θ1	0	–	8
L1	1.0 REF		
aaa	0.10		
bbb	0.10		
ccc	0.05		
ddd	0.20		
e	0.65 BSC		
θ2	12 REF		
θ3	12 REF		
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	14		

NOTES:

1 All dimensions are in millimeters (angle in degrees).

2 Dimensioning and tolerancing per ASME Y14.5–1994.

3 Dimensions "D" does not include mold flash, protusions or gate burrs. Mold flash protusions or gate burrs shall not exceed 0.15 per side .

4 Dimension "E1" does not include interlead flash or protusion. Interlead flash or protusion shall not exceed 0.25 per side.

5 Dimension "b" does not include dambar protusion. Allowable dambar protusion shall be 0.08mm total in excess of the "b" dimension at maximum material condition. Dambar connot be located on the lower radius of the foot. Minimum space between protusion and adjacent lead is 0.07mm for 0.5mm pitch packages.

6 Terminal numbers are shown for reference only.

7 Datums – A – and – B – to be determined at datum plane – H –.

8 Dimensions "D" and "E1" to be determined at datum plane – H –.

9 This dimensions applies only to variations with an even number of leads per side. For variation with an odd number of leads per side, the "center" lead must be coincident with the package centerline, Datum A.

10 Cross sections A – A to be determined at 0.10 to 0.25mm from the leadtip.

Ordering Information

Model	Part Number	Lead Free	Mode	Output Peaking	Package	Container	Pack Qty
FMS6408	FMS6408MTC141_NL	✓	YUV/RGB	0dB	TSSOP-14	Tube	94
FMS6408	FMS6408MTC141X_NL	✓	YUV/RGB	0dB	TSSOP-14	Tape and Reel	2500
FMS6408	FMS6408MTC143_NL	✓	YUV/RGB	0.9dB	TSSOP-14	Tube	94
FMS6408	FMS6408MTC143X_NL	✓	YUV/RGB	0.9dB	TSSOP-14	Tape and Reel	2500

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

Contact Fairchild for ordering information regarding other clamping and peaking options. Refer to the Factory Programming Options Table on page 3 for a detailed description of available options.