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FAIRCHILD SEMICONDUCTOR®

August 2009

FMS6690
Six Channel, 6th Order, SD/PS/HD Video Filter Driver

Features

- Three Selectable Sixth-Order 15/32MHz (PS/HD) Filters
- Three Fixed Sixth-Order 8MHz (SD) Filters with MUXed Input
- Transparent Input Clamping
- Single Video Load Drive ($2V_{PP}$, 150Ω, A_V= 6dB)
- AC-or DC-Coupled Inputs
- AC-or DC-Coupled Outputs
- DC-Coupled Outputs Eliminate AC-Coupling Capacitors
- Low Power
- 5V Only

Applications

- Cable and Satellite Set-Top Boxes
- DVD Players
- HDTV
- Personal Video Recorders (PVR)
- Video On Demand (VOD)

Description

The FMS6690 Low-Cost Video Filter (LCVF) is intended to replace passive LC filters and drivers with a low-cost integrated device. Six 6th-order Butterworth filters provide improved image quality compared to typical passive solutions. The combination of low-power Standard Definition (SD), Progressive Scan (PS), and High Definition (HD) filters greatly simplifies DVD video output circuitry. Three channels offer fixed SD filters and feature an additional MUXed input, while the other three channels are selectable between PS and HD filters. The FMS6690 offers a fixed gain of 6dB.

The FMS6690 may be directly driven by a DC-coupled DAC output or an AC-coupled signal. Internal diode clamps and bias circuitry may be used if AC-coupled inputs are required *(see Applications section for details)*.

The outputs can drive AC-or DC-coupled single (150Ω) video loads. DC-coupling the outputs removes the need for output coupling capacitors. The input DC levels are offset approximately +280mV at the output.

Ordering Information

Part Number	Operating Temperature Range	Eco Status	Package	Packing Method
FMS6690MTC20X	0° to 70°C	RoHS	20-Lead Thin Shrink Outline Package (TSSOP)	2500 Units in Tape and Reel

For Fairchild's definition of Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs_green.html.

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Block Diagram

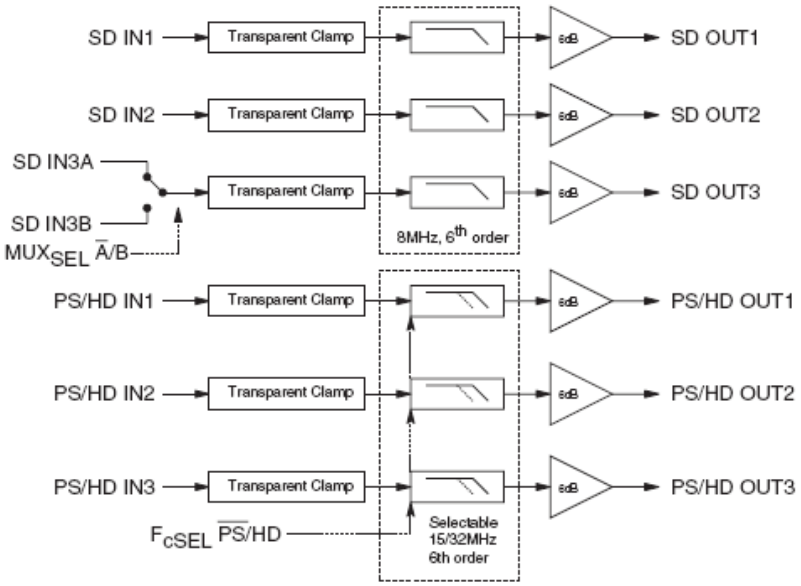


Figure 1. Block Diagram

Pin Configuration

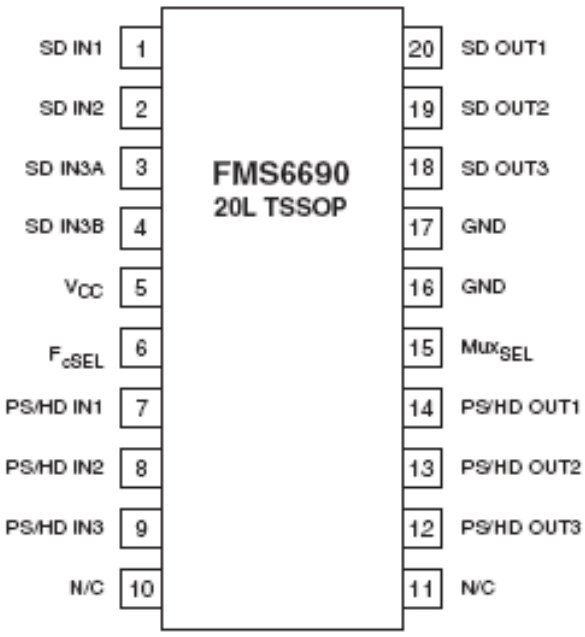


Figure 2. Pin Configuration

Pin Definitions

Pin #	Name	Type	Description
1	SD IN1	Input	SD Video Input, Channel 1
2	SD IN2	Input	SD Video Input, Channel 2
3	SD IN3A	Input	SD Video Input, Channel 3A
4	SD IN3B	Input	SD Video Input, Channel 3B
5	VCC	Input	+5V Supply
6	FcSEL	Input	Selects Filter Corner Rrequency for Pins 7, 8, and 9; “0” = PS, “1” = HD
7	PS/HD IN1	Input	Selectable PS or HD Video Input, Channel 1
8	PS/HD IN2	Input	Selectable PS or HD Video Input, Channel 2
9	PS/HD IN3	Input	Selectable PS or HD Video Input, Channel 3
10	N/C	Input	No Connect
11	N/C	Input	No Connect
12	PS/HD OUT3	Output	Filtered PS or HD Video Output, Channel 3
13	PS/HD OUT2	Output	Filtered PS or HD Video Output, Channel 2
14	PS/HD OUT1	Output	Filtered PS or HD Video Output, Channel 1
15	MUX_{SEL}	Input	MUX Selects Between Channel 3A and 3B Inputs; 0 = A, 1 = B
16	GND	Input	Must Be Tied to Ground
17	GND	Input	Must Be Tied to Ground
18	SD OUT3	Output	Filtered SD Video Output, Channel 3
19	SD OUT2	Output	Filtered SD Video Output, Channel 2
20	SD OUT1	Output	Filtered SD Video Output, Channel 1

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Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter		Min.	Max.	Unit
V_{CC}	DC Supply Voltage		-0.3	6.0	V
V_{IO}	Analog Digital I/O		-0.3	V_{CC} + 0.3	V
I_{OUT}	Output Current, Any One Channel, Do Not Exceed			50	mA
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114		9	kV
		Charged Device Model, JESD22-C101		2	

Reliability Information

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_J	Junction Temperature			+150	°C
T_{STG}	Storage Temperature Range	-65		+150	°C
T_L	Lead Temperature, Soldering 10 Seconds			+300	°C
Θ_{JA}	Thermal Resistance, JEDEC Standard, Multi-Layer Test Board, Still Air		74		°C/W

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_A	Operating Temperature Range	0		+70	°C
V_{CC}	Supply Voltage Range	4.75	5.00	5.25	V

DC Electrical Characteristics

Unless otherwise noted, T_A=25°C, V_{CC}=5V, AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω loads, referenced to 400kHz.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
I_{CC}	Supply Current(1)	No Load		60	80	mA
V_{IN}	Video Input Voltage Range	Referenced to GND if DC Coupled		1.4		V_{PP}
V_{IL}	Digital Input Low(1)	F_{cSEL}	0		0.8	V
V_{IH}	Digital Input High(1)	F_{cSEL}	2.4		V_{CC}	V

Note:
1. 100% tested at 25°C.

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Standard-Definition Electrical Characteristics

Unless otherwise noted, T_A=25°C, V_{IN}=1V_{PP}, V_{CC}=5V, all inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω loads, referenced to 400kHz.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
AV_{SD}	Channel Gain(2)	All SD Channels	5.6	6.0	6.4	dB
f_{1dBSD}	-1dB Flatness(2)	All SD Channels	5.20	7.15		MHz
f_{cSD}	-3dB Bandwidth(2)	All SD Channels	6.5	8.0		MHz
f_{SBSD}	Attenuation (Stopband Reject)(2)	All SD Channels at f=27MHz	43	50		dB
DG	Differential Gain	All SD Channels		0.7		%
DP	Differential Phase	All SD Channels		1.0		°
THD	Distortion, Output	V_{OUT}=1.4V_{PP}, 3.58MHz		0.35		%
X_{TALKSD}	Crosstalk (Ch-to-Ch)	at 1MHz		-54		dB
SNR	Signal-to-Noise Ratio(3)	NTC-7 Weighting, 100kHz to 4.2MHz		72		dB
t_{pdSD}	Propagation Delay	Delay from Input to Output, 4.5MHz		90		ns

Notes:
2. 100% tested at 25°C.
3. SNR=20 • log (714mV / rms noise).

Progressive Scan Electrical Characteristics

Unless otherwise noted, T_A=25°C, V_{IN}=1V_{PP}, V_{CC}=3.3V, R_{SOURCE}=37.5Ω, all inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω loads, referenced to 400kHz.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
AV_{PS}	Channel Gain(4)	All PS Channels	5.6	6.0	6.4	dB
f_{1dBSD}	-1dB Flatness(4)	All PS Channels	12	14		MHz
f_{cPS}	-3dB Bandwidth(4)	All PS Channels	13	16		MHz
f_{SBSD}	Attenuation (Stopband Reject)(4)	All PS Channels at f=54MHz	37	45		dB
THD	Total Harmonic Distortion, Output (All PS Channels)	V_{OUT}=1.4V_{PP}, 7MHz		0.35		%
X_{TALKPS}	Crosstalk (Ch-to-Ch)	at 1MHz		-53		dB
SNR	Signal-to-Noise Ratio(5)	Unweighted, 100kHz to 15MHz		66		dB
t_{pdSD}	Propagation Delay	Delay from Input to Output		47		ns

Notes:
4. 100% tested at 25°C.
5. SNR=20 • log (714mV / rms noise).

High-Definition Electrical Characteristics

Unless otherwise noted, T_A=25°C, V_{IN}=1V_{PP}, V_{CC}=5V, R_{SOURCE}=37.5Ω, all inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into 150Ω loads, referenced to 400kHz.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
AV_{HD}	Channel Gain(6)	All HD Channels	5.6	6.0	6.4	dB
f_{1dBHD}	-1dB Flatness(6)	All HD Channels	28	31		MHz
f_{cHD}	-3dB Bandwidth(6)	All HD Channels	30	34		MHz
f_{SBHD}	Attenuation (Stopband Reject)(6)	All HD Channels at f=74.25MHz	30	41		dB
THD	Output Distortion,(All PS Channels)	V_{OUT}=1.4V_{PP}, 22MHz		0.9		%
X_{TALKHD}	Crosstalk (Ch-to-Ch)	at 1MHz		-54		dB
SNR	Signal-to-Noise Ratio(7)	Unweighted, 100kHz to 30MHz		60		dB
t_{pdHD}	Propagation Delay	Delay from Input to Output		25		ns

Notes:
6. 100% tested at 25°C.
7. SNR=20 • log (714mV / rms noise).

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Typical Performance Characteristics

Unless otherwise noted T_C=25°C, V_{IN}=1V_{PP}, V_{CC}=5V, R_{SOURCE}=37.5Ω, inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into150Ω loads.

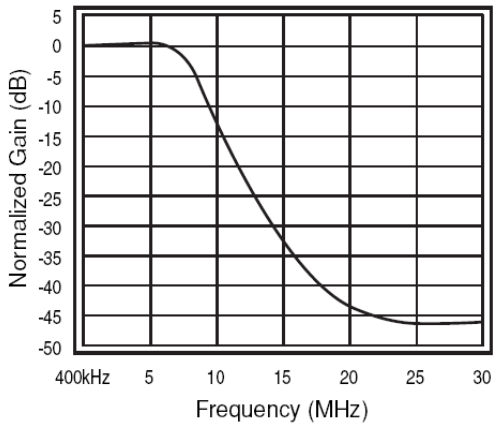


Figure 3. SD Gain vs. Frequency

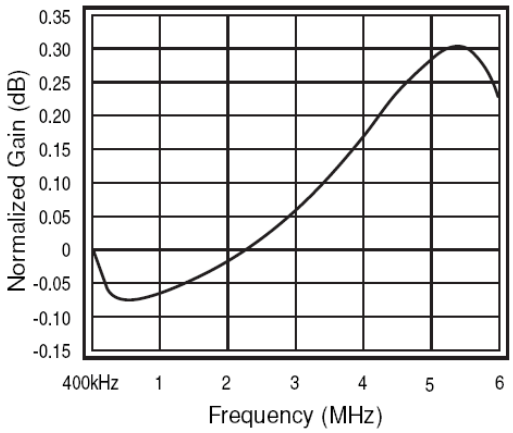


Figure 4. SD Flatness vs. Frequency

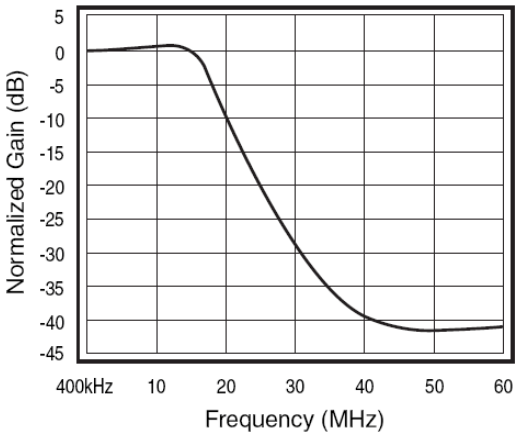


Figure 5. PS Gain vs. Frequency

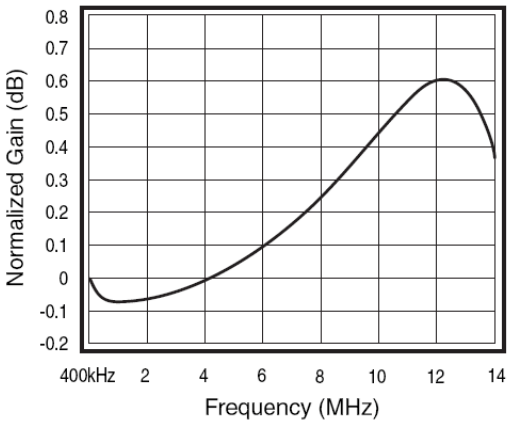


Figure 6. PS Flatness vs. Frequency

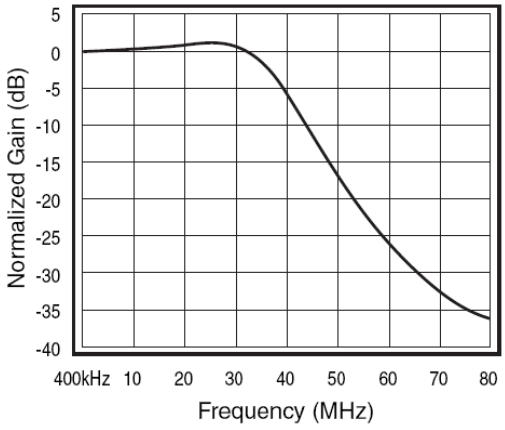


Figure 7. HD Gain vs. Frequency

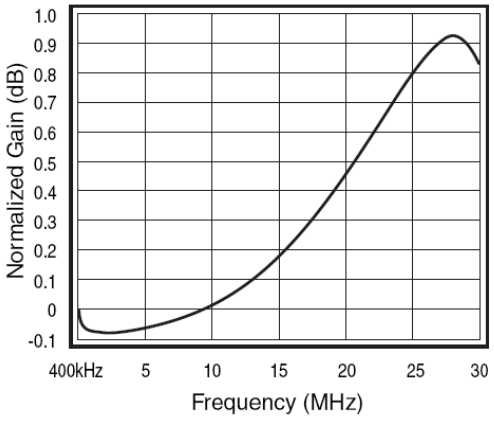


Figure 8. HD Flatness vs. Frequency

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Typical Performance Characteristics

Unless otherwise noted T_C=25°C, V_{IN}=1V_{PP}, V_{CC}=5V, R_{SOURCE}=37.5Ω, inputs AC coupled with 0.1µF, all outputs AC coupled with 220µF into150Ω loads.

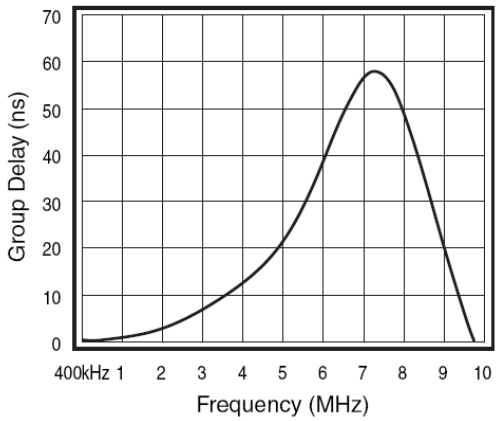


Figure 9. SD Group Delay vs. Frequency

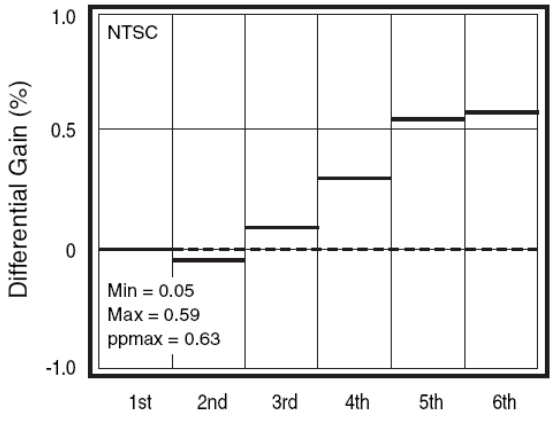


Figure 10. Noise vs. Frequency

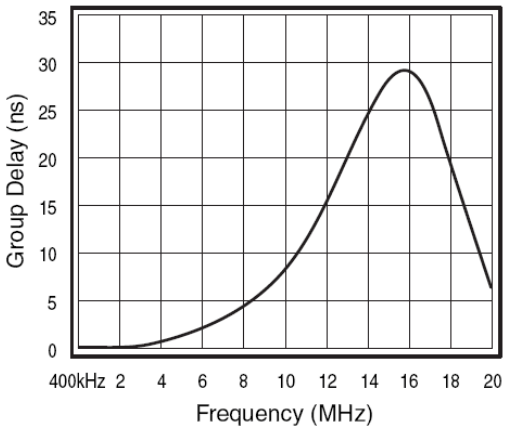


Figure 11. PS Group Delay vs. Frequency

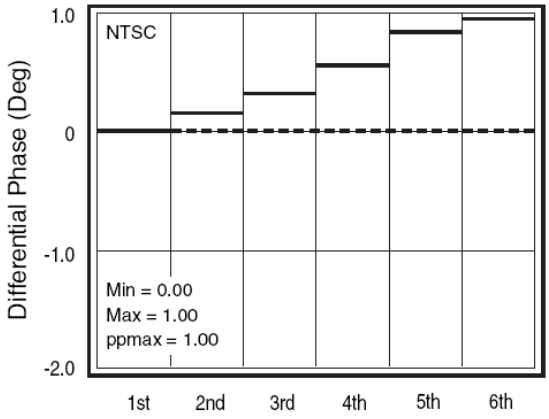


Figure 12. SD Differential Gain

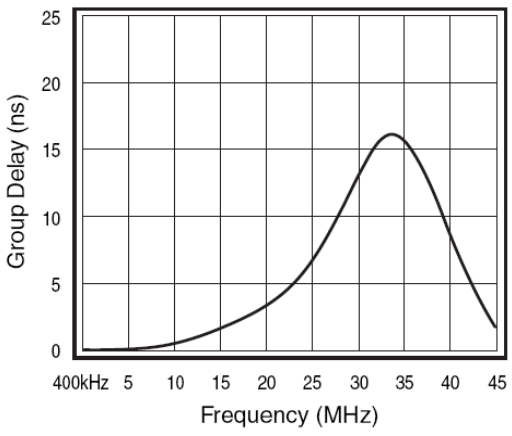


Figure 13. HD Group Delay vs. Frequency

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Applications Information

Functional Description

The FMS6690 Low-Cost Video Filter (LCVF) provides 6dB gain (9dB optional, contact factory for further information) from input to output. In addition, the input is slightly offset to optimize the output driver performance. The offset is held to the minimum required value to decrease the standing DC current into the load. Typical voltage levels are shown in Figure 14.

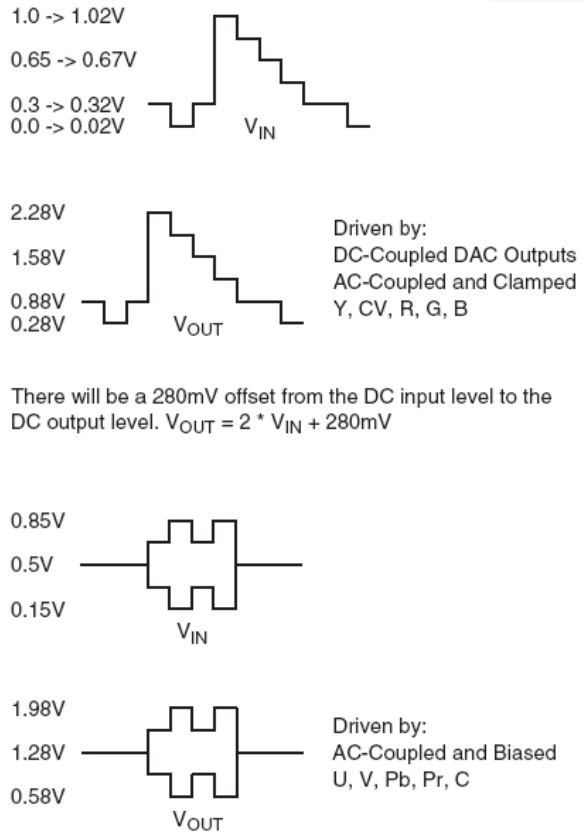


Figure 14. Typical Voltage Levels

The FMS6690 provides an internal diode clamp to support AC-coupled input signals. If the input signal does not go below ground, the input clamp does not operate. This allows DAC outputs to directly drive the FMS6690 without an AC coupling capacitor. The worst-case sync tip compression, due to the clamp, does not exceed 7mV. The input level set by the clamp, combined with the internal DC offset, keeps the output within acceptable range. When the input is AC-coupled, the diode clamp sets the sync tip (or lowest voltage) just below ground.

For symmetric signals like C, U, V, Cb, Cr, Pb, and Pr; the average DC bias is fairly constant and the inputs can be AC-coupled with the addition of a pull-up resistor to set the DC input voltage. DAC outputs can also drive these same signals without the AC coupling capacitor. A conceptual illustration of the input clamp circuit is shown in Figure 15.

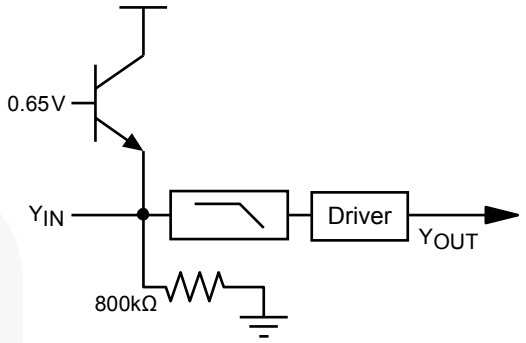


Figure 15. Input Clamp Circuit

I/O Configurations

For DC-coupled DAC drive with DC-coupled outputs, use the configuration in Figure 16.

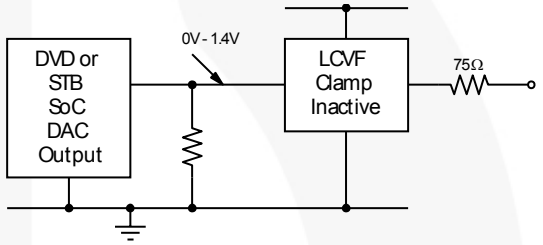


Figure 16. DC-Coupled Inputs and Outputs

Alternatively, if the DAC's average DC output level causes the signal to exceed the range of 0V to 1.4V, it can be AC-coupled, as shown in Figure 17.

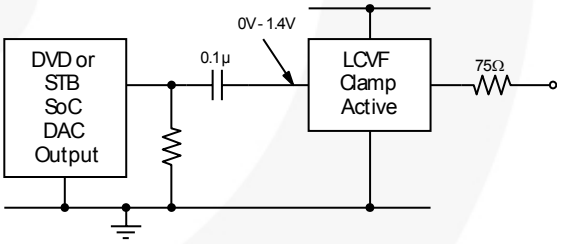


Figure 17. AC-Coupled Inputs, DC-coupled Outputs

When the FMS6690 is driven by an unknown external source or a SCART with its own clamping circuitry, the inputs should be AC-coupled, shown in Figure 18.

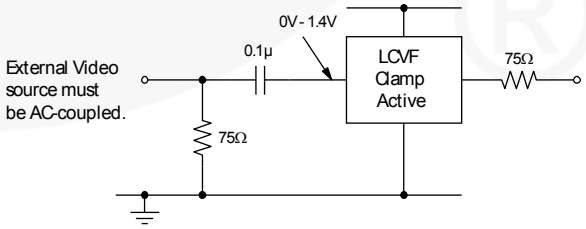


Figure 18. SCART with DC-Coupled Outputs

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The same method can be used for biased signals with the addition of a pull-up resistor to make sure the clamp never operates. The internal pull-down resistance is 800kΩ ±20%, so the external resistance should be 7.5MΩ to set the DC level to 500mV. If a pull-up resistance of less than 7.5MΩ desired, add an external pull-down such that the DC input level is set to 500mV.

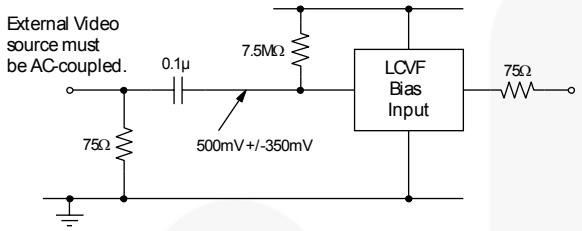


Figure 19. Biased SCART with DC-Coupled Outputs

The same circuits can be used with AC-coupled outputs if desired.

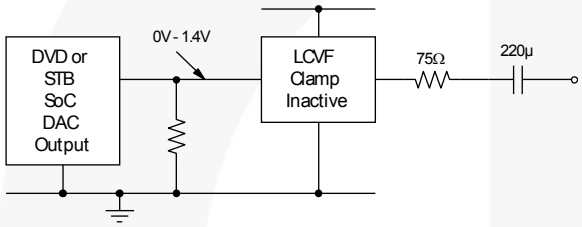


Figure 20. DC-Coupled Inputs, AC-coupled Outputs

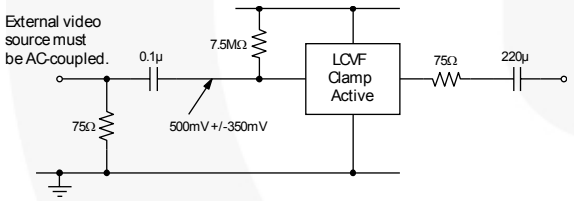


Figure 21. Biased SCART with AC-Coupled Outputs

Note:

8. The video tilt or line time distortion is dominated by the AC-coupling capacitor. The value may need to be increased beyond 220µF to obtain satisfactory operation in some applications.

Power Dissipation

The FMS6690 output drive configuration must be considered when calculating overall power dissipation. Care must be taken not to exceed the maximum die junction temperature. The following example can be used to calculate the FMS6690's power dissipation and internal temperature rise.

$$T_J = T_A + P_d \bullet \Theta_{JA} \quad (1)$$

where $P_d = P_{CH1} + P_{CH2} + P_{CHx}$,

and $P_{CHx} = V_S \bullet I_{CH} - (V_O^2/R_L)$ (2)

where:
$V_O = 2V_{IN} + 0.280V$;
$I_{CH} = (I_{CC}/6) + (V_O/R_L)$;
V_{IN}= RMS value of input signal;
I_{CC} = 60mA;
V_S= 5V; and
R_L= channel load resistance.

Board layout affects thermal characteristics. *Refer to the Layout Considerations section for more information*.

Output Considerations

The FMS6690 outputs are DC offset from the input by 150mV therefore, $V_{OUT} = 2 \bullet V_{IN}$ DC+150mv. This offset is required to obtain optimal performance from the output driver and is held at the minimum value to decrease the standing DC current into the load. Since the FMS6690 has a 2x (6dB) gain, the output is typically connected via a 75Ω-series back-matching resistor followed by the 75Ω video cable. Because of the inherent divide by two of this configuration, the blanking level at the load of the video signal is always less then 1V. When AC-coupling the output, ensure that the coupling capacitor of choice passes the lowest frequency content in the video signal and that line time distortion (video tilt) is kept as low as possible.

The selection of the coupling capacitor is a function of the subsequent circuit input impedance and the leakage current of the input being driven. To obtain the highest-quality output video signal, the series termination resistor must be placed as close to the device output pin as possible. This greatly reduces the parasitic capacitance and inductance effect on the FMS6690 output driver. The distance from device pin to place series termination resistor should be no greater than 0.1 inches.

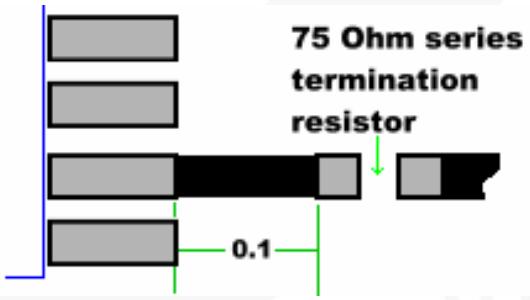


Figure 22. Distance from Device Pin to Series Termination Resistor

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Layout Considerations

Layout and supply bypassing play major roles in high-frequency performance and thermal characteristics. Fairchild offers a demonstration board, FMS6690DEMO, to use as a guide for layout and to aid in device testing and characterization. The FMS6690DEMO is a four-layer board with a full power and ground plane. Following this layout configuration provides the optimum performance and thermal characteristics. For optimum results, follow these steps as a basis for high-frequency layout:

- Include 10µF and 0.1µF ceramic bypass capacitors.
- Place the 10µF capacitor within 0.75 inches of the power pin.
- Place the 0.1µF capacitor within 0.1 inches of the power pin.
- For multi-layer boards, use a large ground plane to help dissipate heat.
- For 2 layer boards, use a ground plane that extends beyond the device by at least 0.5.
- Minimize all trace lengths to reduce series inductances.

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Typical Application

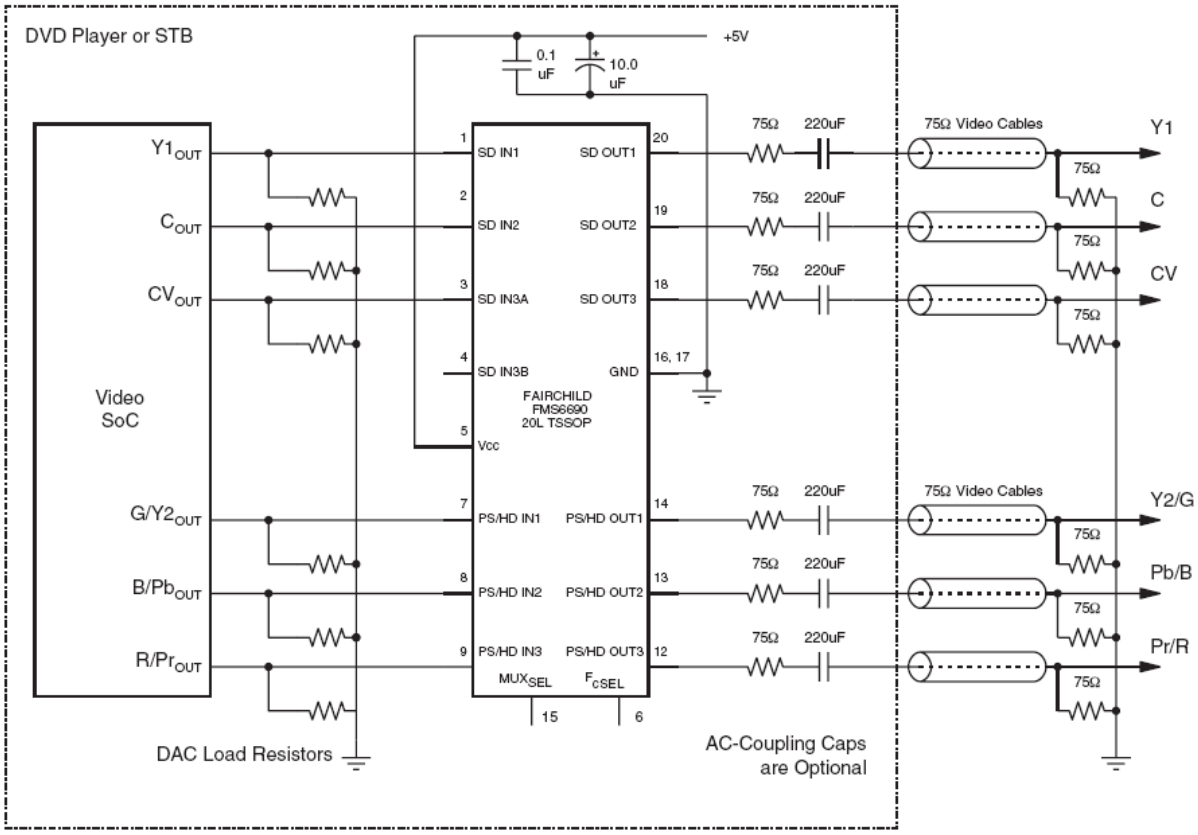
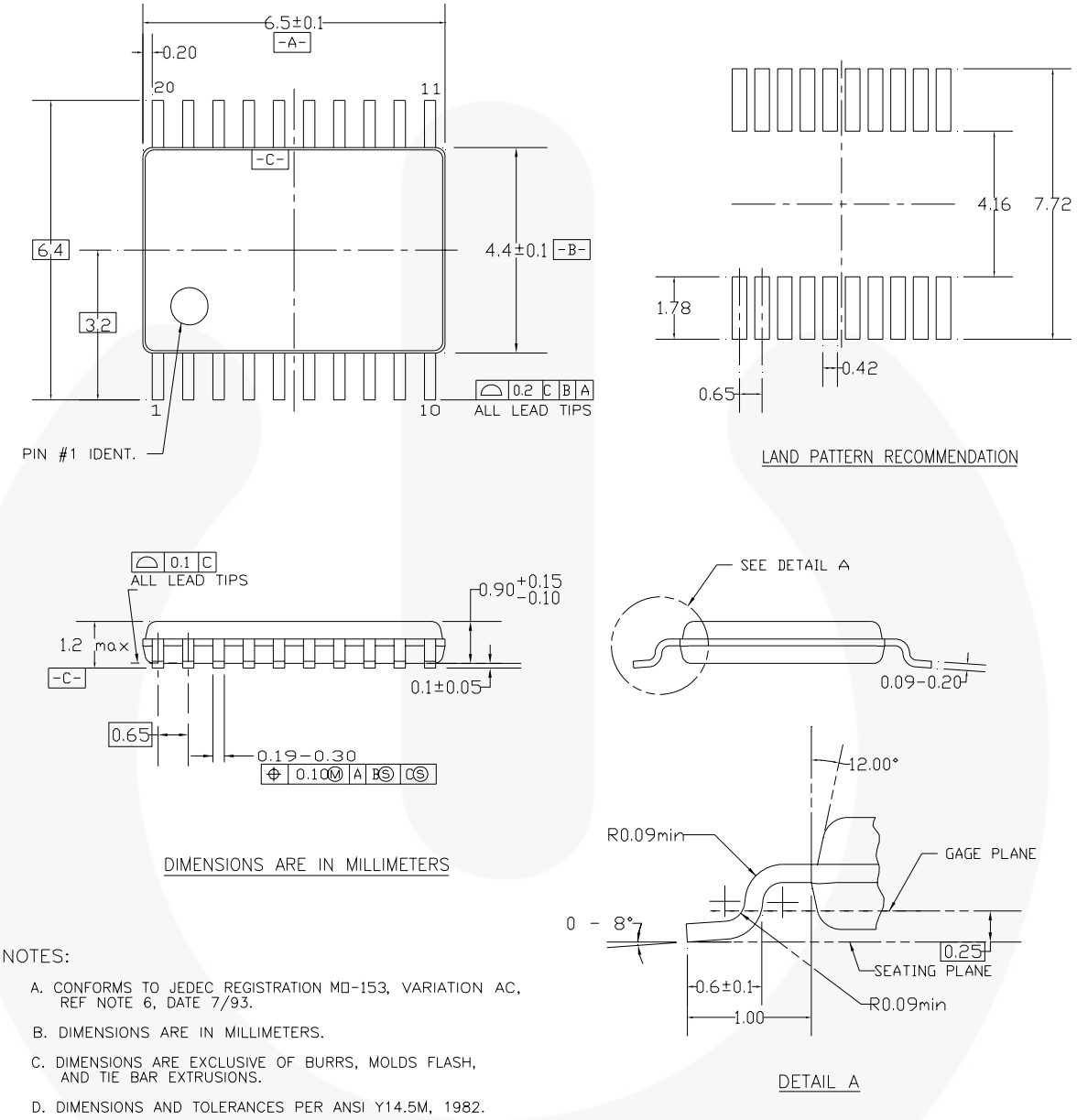


Figure 23. Typical Application Diagram

Physical Dimensions



NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AC, REF NOTE 6, DATE 7/93.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLDS FLASH, AND TIE BAR EXTRUSIONS.

D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTC20REVD1

Figure 24. 20-Lead Thin Shrink Outline Package (TSSOP)

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