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FAIRCHILD SEMICONDUCTOR®

May 2011

FMS6646
Six Channel, SD/HD 1080p Video Filter Driver

Features

- Three Selectable 8/75MHz (SD/HD 1080p) Filters
- Three Fixed 8MHz (SD) Filters
- 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
- Robust Output ESD Protection: 9kV HBM

Applications

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

Description

The FMS6646 Low Cost Video Filter (LCVF) is intended to replace passive LC filters and drivers with a low-cost integrated device. Six Butterworth filters provide improved image quality compared to typical passive solutions. The combination of low-power Standard-Definition (SD) and High-Definition (HD 1080p) filters greatly simplifies DVD video output circuitry. Three channels offer fixed SD filters, while the other three are selectable between SD and HD filters.

The FMS6646 offers a fixed gain of 6dB.

The FMS6646 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 the Applications Information 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	Gain Setting	Package	Packing Method
FMS6646MTC20X	-40°C to +85°C	6dB	TSSOP-20	2500 / Reel

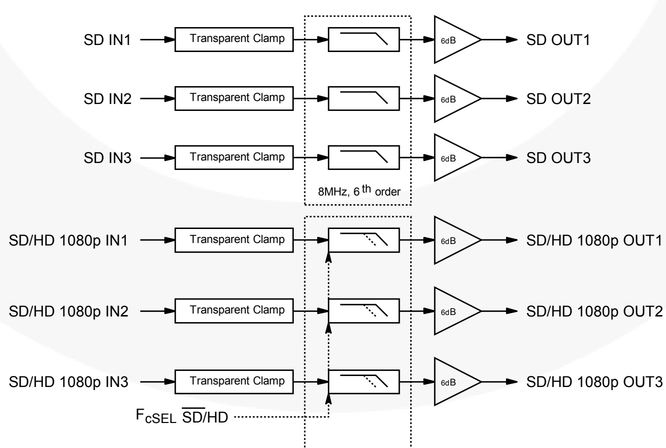


Figure 1. Block Diagram

Pin Configuration

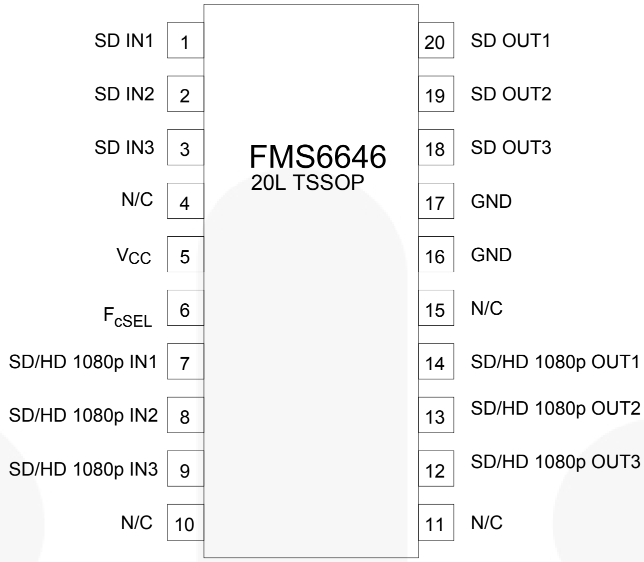


Figure 2. Pin Configuration

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 IN3	Input	SD video input, channel 3
4	N/C	Input	No Connection
5	V_{CC}	Input	+3.3V supply
6	F_{cSEL}	Input	Selects filter corner frequency for pins 7, 8, and 9: “0” = SD, “1” = HD (1080p)
7	SD/HD (1080p) IN1	Input	Selectable SD or HD (1080p) video input, channel 1
8	SD/HD (1080p) IN2	Input	Selectable SD or HD (1080p) video input, channel 2
9	SD/HD (1080p) IN3	Input	Selectable SD or HD (1080p) video input, channel 3
10	N/C	Input	No Connection
11	N/C	Input	No Connection
12	SD/HD (1080p) OUT3	Output	Filtered SD or HD (1080p) video output, channel 3
13	SD/HD (1080p) OUT2	Output	Filtered SD or HD (1080p) video output, channel 2
14	SD/HD (1080p) OUT1	Output	Filtered SD or HD (1080p) video output, channel 1
15	N/C	Input	No Connection
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

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 and Digital I/O	-0.3	V_{CC}+0.3	V
I_{OUT}	Output Current, Any One Channel, Do Not Exceed		50	mA

Reliability Information

Symbol	Parameter	Min.	Typ.	Max.	Unit
T_J	Junction Temperature			+150	°C
T_{STG}	Storage Temperature Range	-65		+150	°C
T_L	Reflow Temperature			+260	°C
Θ_{JA}	Thermal Resistance, JEDEC Standard Multi-Layer Test Boards, Still Air		74		°C/W

Electrostatic Discharge Information

Symbol	Parameter	Max.	Unit
ESD	Human Body Model, JESD22-A114	9	kV
	Charged Device Model, JESD22-C101	2	

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	-40		+85	°C
V_{CC}	Supply Voltage Range	3.135	3.300	5.250	V

DC Electrical Characteristics

Unless otherwise noted, T_A=25°C, V_{CC}=3.3V, R_{SOURCE}=37.5Ω, 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
I_{CC}	Supply Current[(1)]	No Load		80	95	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 T_A=25°C.

Standard-Definition (480i) 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_{SD}	Channel Gain(2)	All SD Channels	5.8	6.0	6.2	dB
f_{01dBSD}	-0.1dB Flatness	All SD Channels		5.5		MHz
f_{1dBSD}	-1dB Flatness(2)	All SD Channels	5.50	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	50	60		dB
DG	Differential Gain	All SD Channels		0.5		%
DP	Differential Phase	All SD Channels		0.3		°
THD	Total Harmonic Distortion, Output	V_{OUT}=1.4V_{PP}, 3.58MHz		0.25		%
X_{TALKSD}	Crosstalk (ch-to-ch)	1MHz		-70		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
CLG_{SD}	Chroma Luma Gain	f=3.58MHz (Refer to SD_{IN} at 400kHz)		100		%
CLD_{SD}	Chroma Luma Delay	f=3.58MHz (Refer to SD_{IN} at 400kHz)		6		ns

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

High-Definition (1080p) 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_{HD}	Channel Gain(4)	All HD Channels	5.8	6.0	6.2	dB
f_{1dBHD}	-1dB Bandwidth(4)	All HD Channels	55	65		MHz
f_{cHD}	-3dB Bandwidth(4)	All HD Channels	70	75		MHz
f_{sbHD}	Attenuation Stopband Reject(4)	All HD Channels, f=148MHz	15	20		dB
THD	Total Harmonic Distortion, Output	All HD Channels, V_{OUT}=1.4V_{PP}, 22MHz		0.2		%
X_{TALKHD}	Crosstalk (Channel-to-Channel)	1MHz		-72		dB
SNR	Signal-to-Noise Ratio(5)	Unified Weighting; 100kHz to 60MHz		70		dB
t_{pdHD}	Propagation Delay	Delay from Input to Output		6		ns

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

Typical Performance Characteristics

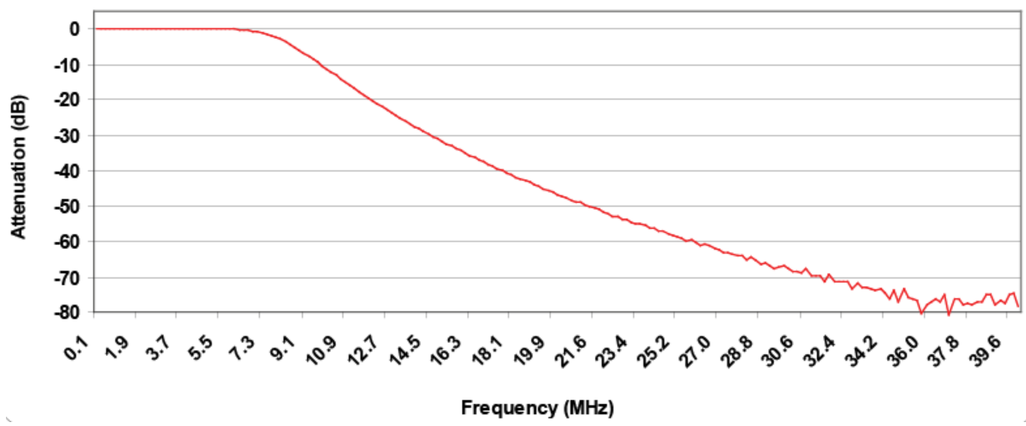


Figure 3. SD Frequency Response

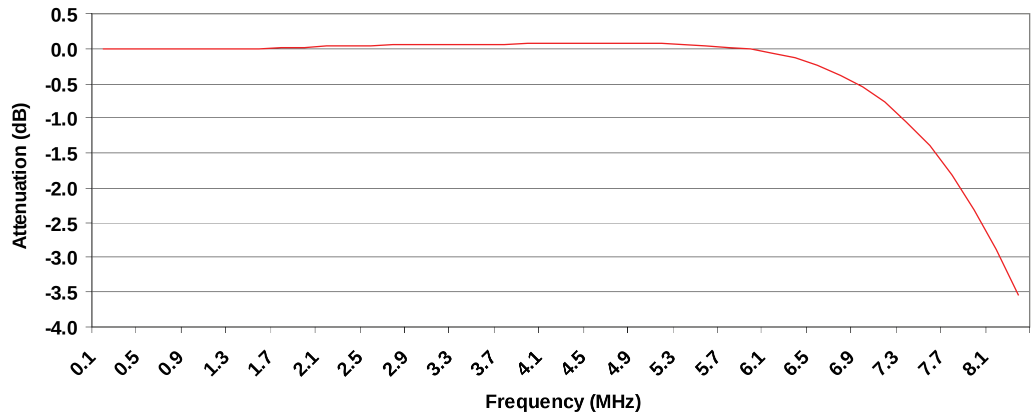


Figure 4. SD Frequency Response (Flatness)

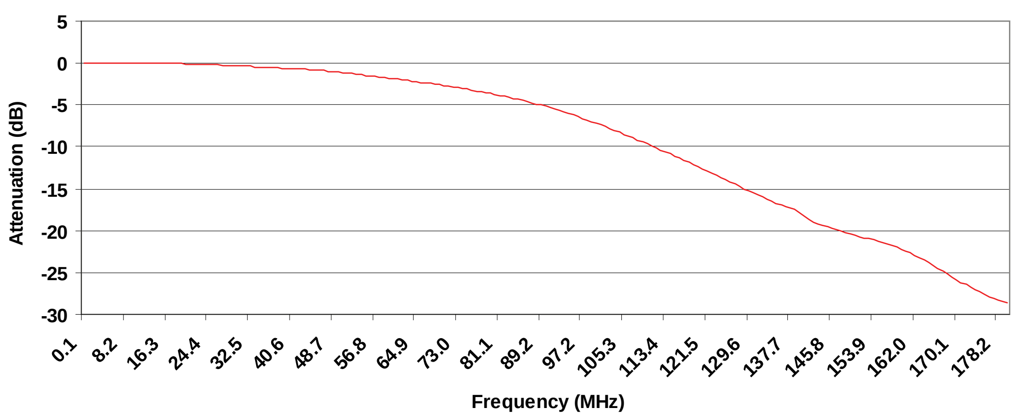


Figure 5. HD Frequency Response

Typical Performance Characteristics (Continued)

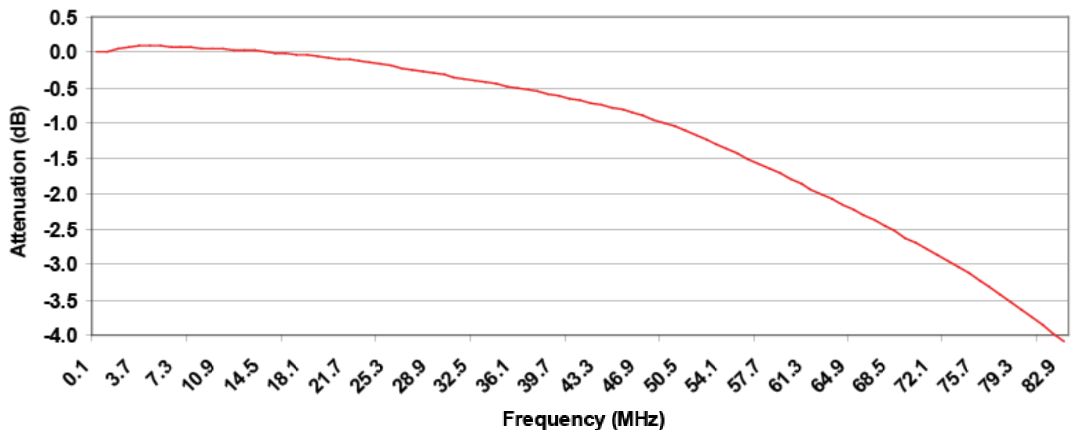


Figure 6. HD Frequency Response (Flatness)

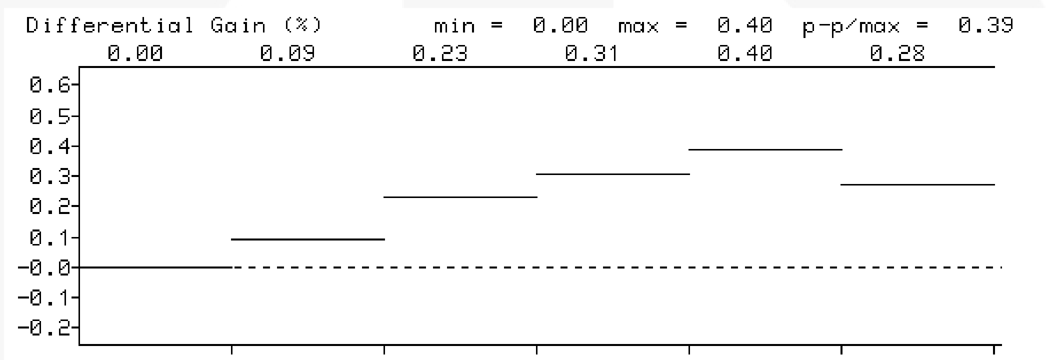


Figure 7. Differential Gain

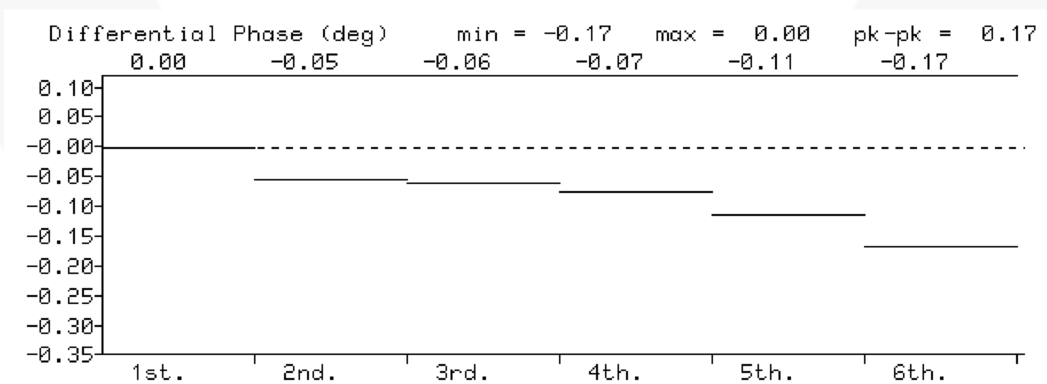


Figure 8. Differential Phase

Typical Application

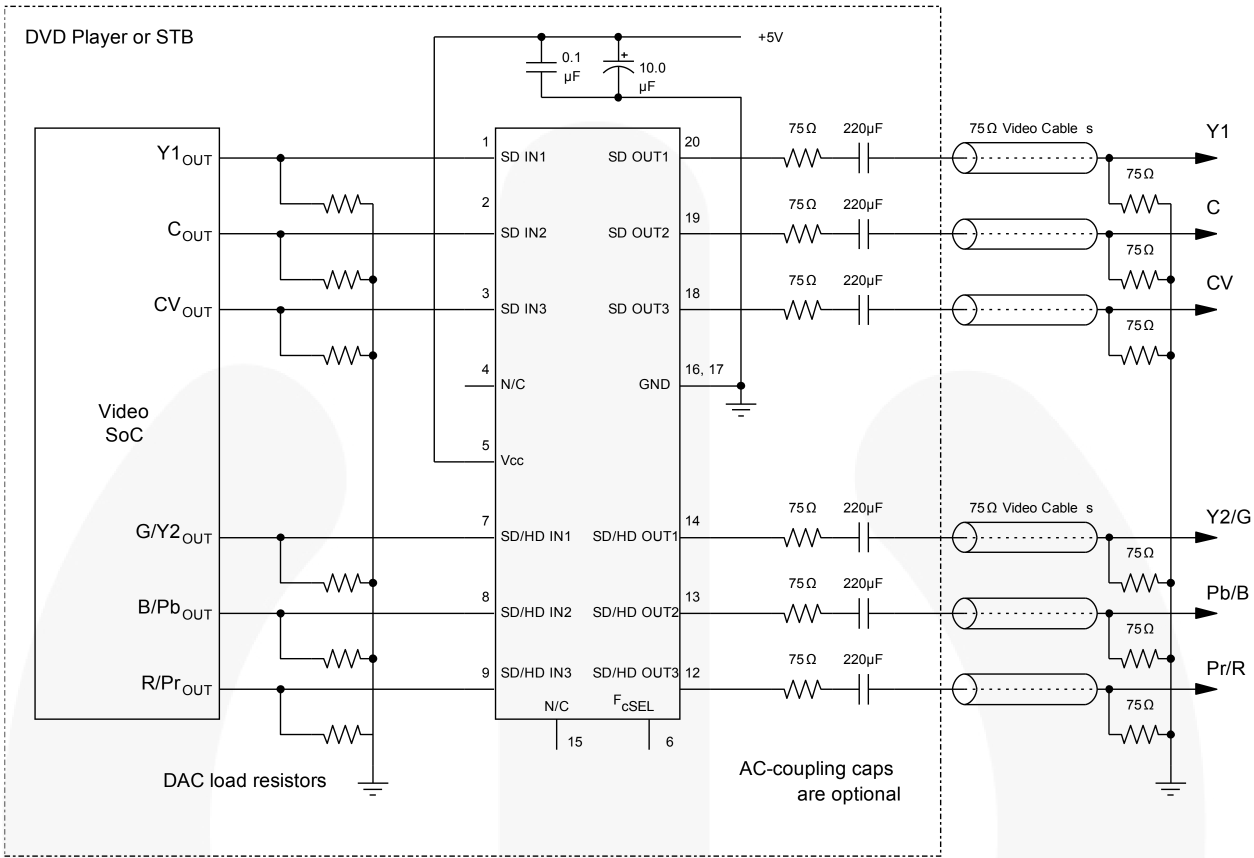


Figure 9. Typical Application

Applications Information

Functional Description

The FMS6646 Low-Cost Video Filter (LCVF) provides 6dB gain 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 10.

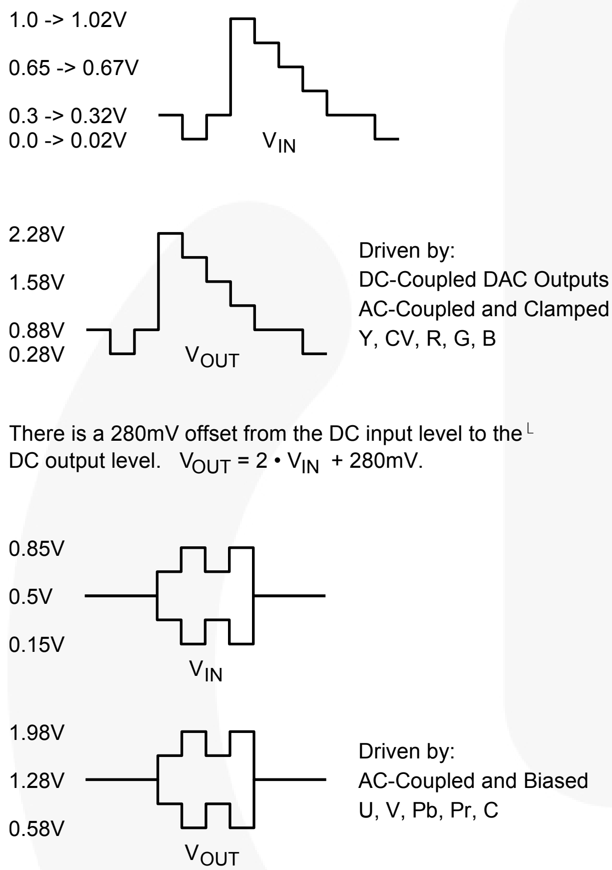


Figure 10. Typical Voltage Levels

The FMS6646 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 out puts to directly drive the FMS6646 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 its 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 11.

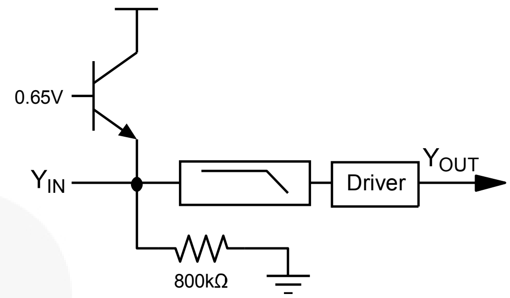


Figure 11. Input Clamp Circuit

I/O Configurations

For DC-coupled DAC drive with DC-coupled outputs, use the configuration shown in Figure 12.

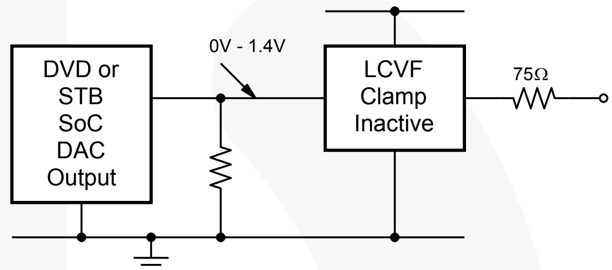


Figure 12. DC-Coupled Inputs and Outputs

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 13.

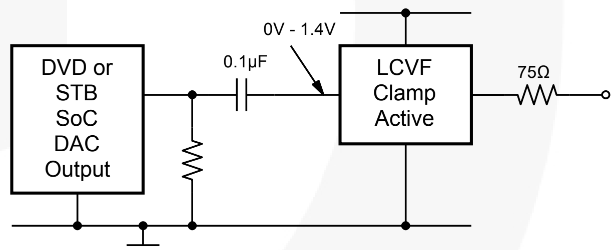


Figure 13. AC-Coupled Inputs, DC-Coupled Outputs

When the FMS6646 is driven by an unknown external source or a SCART switch with its own clamping circuitry, the inputs should be AC-coupled as shown in Figure 14.

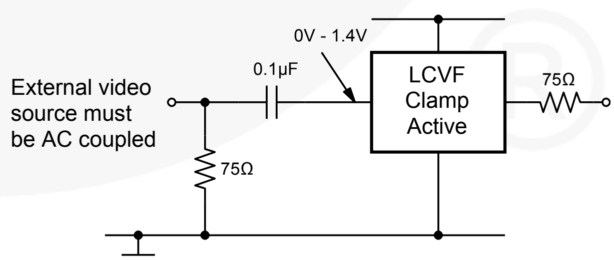


Figure 14. SCART Configuration with DC-Coupled Outputs

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 less than 7.5MΩ is desired, an external pull-down can be added such that the DC input level is set to 500mV.

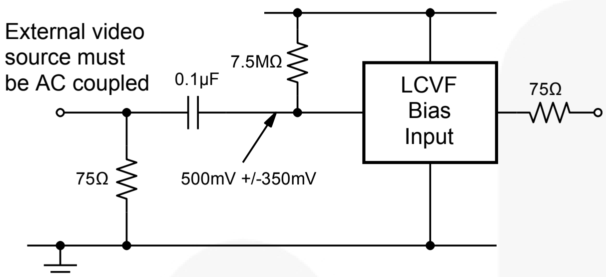


Figure 15. Biased SCART with DC-Coupled Outputs

The same circuits can be used with AC-coupled outputs if desired, as shown in Figure 16.

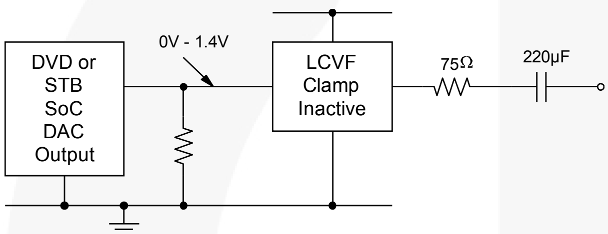


Figure 16. DC-Coupled Inputs, AC-Coupled Outputs

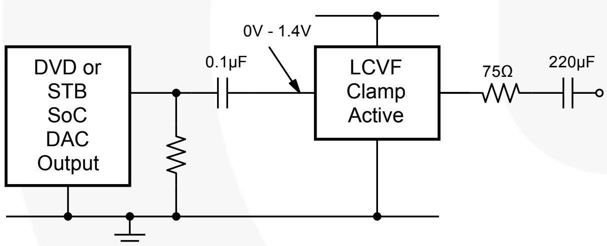


Figure 17. Coupled Inputs, AC-Coupled Outputs

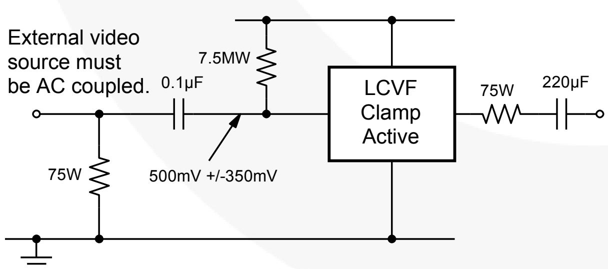


Figure 18. Biased SCART with AC-Coupled Outputs

Note:

6. 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 FMS6646 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 FMS6646's power dissipation and internal temperature rise:

$T_J = T_A + P_d \cdot \theta_{JA}$

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

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

where $V_O = 2V_{IN} + 0.280V$

$I_{CH} = (I_{CC} / 6) + (V_O/R_L)$

V_{IN} = RMS value of input signal

$I_{CC} = 90mA$, $V_S = 3.3V$

R_L = channel load resistance

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

Output Considerations

The FMS6646 outputs will be DC offset from the input by 150mv therefore $V_{OUT} = 2{*}V_{IN}$ DC+150mv. This offset is required to obtain optimal performance from the output driver and is held at the minimum value in order to decrease the standing DC current into the load. Since the FMS6646 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 will pass 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. In order 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 FMS6646 output driver. Recommend distance from device pin to place series termination resistor should be no greater than 0.1 inches.

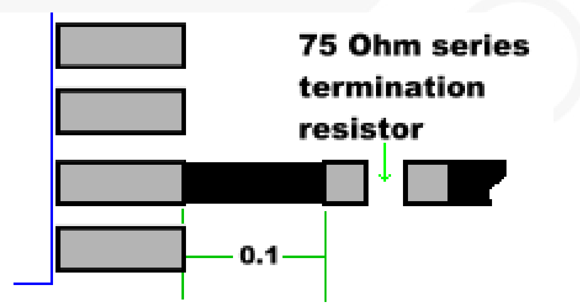


Figure 19. Distance from Device Pin to Series Termination Resistor

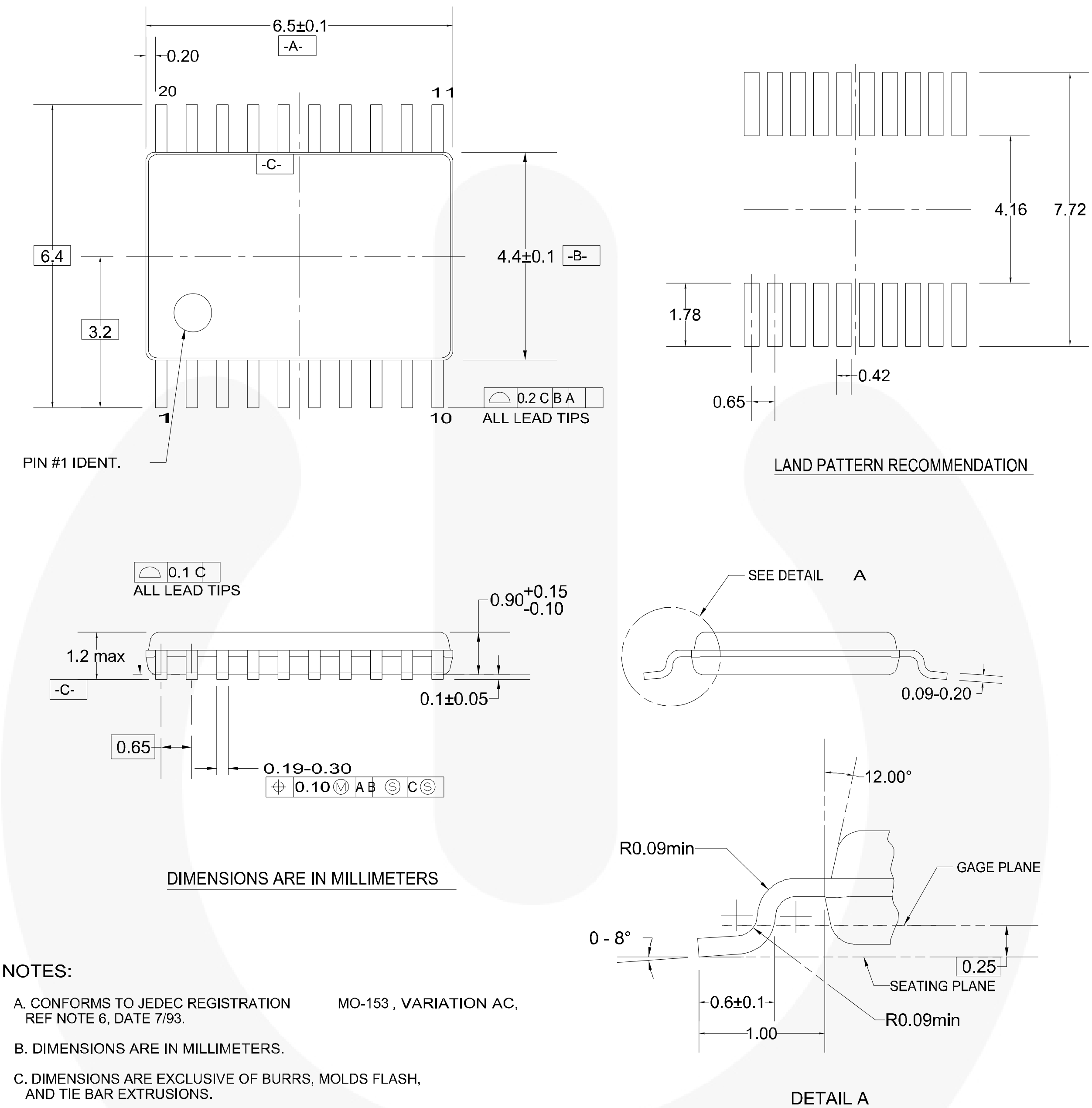
Layout Considerations

General layout and supply bypassing play major roles in high-frequency performance and thermal characteristics. Fairchild offers a demonstration board, FMS6646DEMO, to guide layout and aid device testing and characteriza-tion.

The FMS6646DEMO is a four-layer board with a full power and ground plane. Following this layout configura-tion pro vides the optimum performance and thermal char-acteristics. For best results, follow the steps below as a basis for high-frequency layout:

- Include 0.01µF and 0.1µF ceramic bypass capacitors.
- Place the 0.01µF 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 two-layer boards, use a ground plane that extends beyond the device by at least 0.5 inches.
- Minimize all trace lengths to reduce series inductances.

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 20.20-Lead Thin Shrink Small Outline Package (TSSOP)

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Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I54

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