FAIRCHILD SEMICONDUCTOR®

December 2006

FMS6141
Low-Cost, Single-Channel 4th-Order Standard Definition Video Filter Driver

Features

- Single 4th-Order 8MHz (SD) Filter
- Drives Single, AC- or DC-coupled, Video Loads ($2V_{pp}$, 150Ω)
- Drives Dual, AC- or DC-coupled, Video Loads ($2V_{pp}$, 75 Ω)
- Transparent Input Clamping
- AC- or DC-Coupled Input
- AC- or DC-Coupled Output
- DC-Coupled Output Eliminates AC-Coupling Capacitors
- Single Supply
- Robust 8kV ESD Protection
- Lead-Free Packages: SOIC-8 or SC70-5

Applications

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

Description

The FMS6141 Low-Cost Video Filter is intended to replace passive LC filters and drivers with a low-cost integrated device. The 4th-order filter provides improved image quality compared to typical 2nd or 3rd-order passive solutions.

The FMS6141 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 an AC-coupled input is required (see Application Information for details).

The FMS6141's output can drive an AC- or DC-coupled single (150 Ω) or dual (75 Ω) load. DC-coupling the output removes the need for output coupling capacitors. The input DC level is offset approximately +280mV at the output (see Application Information for details).

Related Applications Notes

- *AN-6041 PCB Layout Considerations for Video Filter / Drivers*
- *AN-6024 FMS6xxx Product Series Understanding Analog Video Signal Clamps, Bias, DC-Restore, and AC or DC Coupling Methods*

Functional Block Diagram

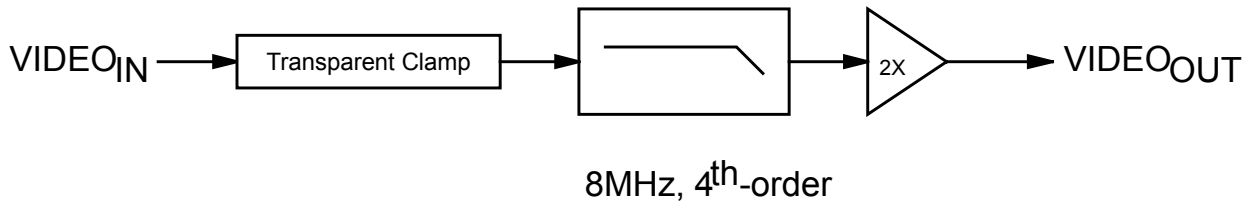


Figure 1. FMS6141 Block Diagram

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Ordering Information

Part Number	Package	Pb-Free	Operating Temperature Range	Packing Method
FMS6141CS	SOIC-8	Yes	-40°C to +85°C	Tube
FMS6141CSX	SOIC-8	Yes	-40°C to +85°C	Tape and Reel
FMS6141S5X	SC70-5	Yes	-40°C to +85°C	Tape and Reel

Pin Configurations

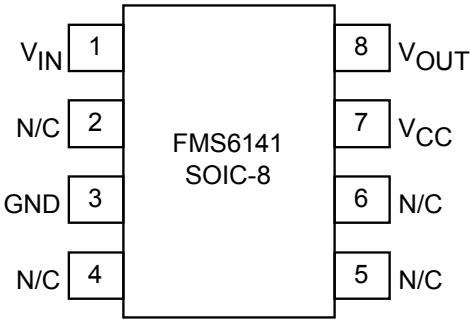


Figure 2. FMS6141 SOIC-8

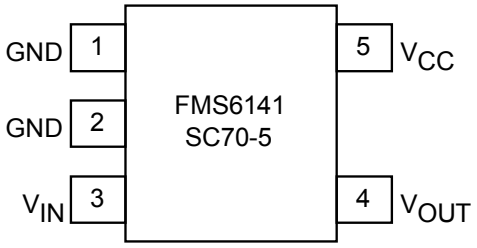


Figure 3. FMS6141 SC70

Pin Definitions

Pin #	Name	Description
1	V_{IN}	Video input
2	N/C	No connect
3	GND	Must be connected to ground
4	N/C	No connect
5	N/C	No connect
6	N/C	No connect
7	V_{CC}	+5V supply, do not float
8	V_{OUT}	Filtered video output

Table 1. SOIC Pin Definitions

Pin#	Name	Description
1	GND	Must be connected to ground
2	GND	Must be connected to ground
3	V_{IN}	Video input
4	V_{OUT}	Filtered video output
5	V_{CC}	+5V supply, do not float

Table 2. SC70 Pin Definitions

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Absolute Maximum Ratings

The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table defines the conditions for actual device operation.

Parameter	Min.	Max.	Unit
DC Supply Voltage	-0.3	6.0	V
Analog and Digital I/O	-0.3	V_{CC} +0.3	V
Output Current, Do Not Exceed		50	mA

Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range	-40		85	°C
V_{CC} Range	4.75	5.0	5.25	V

ESD Information

Parameter	Value	Unit
Human Body Model (HBM)	8	kV
Charged Device Model (CDM)	1.5	kV

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, 10s)				300	°C
Θ_{JA}	Thermal Resistance (JEDEC Standard Multi-Layer Test Boards, Still Air)	SOIC-8		115		°C/W
		SC70-5		332		°C/W

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DC Specifications

T_A = 25°C, V_{CC} = 5.0V, R_S = 37.5Ω; input is AC coupled with 0.1µF; output is AC coupled with 220µF into a 150Ω load; unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current(1)	No load		7	12	mA
V_{IN}	Video Input Voltage Range	Referenced to GND if DC-coupled		1.4		V_{pp}
PSRR	Power Supply Rejection Ratio	DC		40		dB

Note:
1. 100% tested at 25°C.

AC Electrical Specifications

T_A = 25°C, V_{CC} = 5.0V, R_S = 37.5Ω; input is AC coupled with 0.1µF; output is AC coupled with 220µF into a 150Ω load; unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
AV	Channel Gain(1)		5.6	6.0	6.4	dB
f_{1dB}	-1dB Bandwidth(1)		4.0	6.5		MHz
f_C	-3dB Bandwidth			7.7		MHz
f_{SB}	Attenuation (Stopband Reject)	f = 27MHz		42		dB
dG	Differential Gain			0.4		%
dϕ	Differential Phase			0.4		°
THD	Output Distortion (all channels)	V_{OUT} = 1.8V_{pp}, 1MHz		0.4		%
SNR	Signal-to-Noise Ratio	NTC-7 weighting; 100kHz to 4.2MHz		75		dB
t_{pd}	Propagation Delay	Delay from input to output, 4.5MHz		55		ns

Note:
1. 100% tested at 25°C.

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Application Information

Input Considerations

The FMS6141 Low-Cost Video Filter provides 6dB (2X) gain from input to output. The device provides an internal diode clamp to support AC-coupled input signals. In this configuration, a 0.1µF ceramic capacitor is used to AC couple the input signal. If the input signal does not go below ground, the clamp is inactive; but if the input signal goes below ground, the clamp circuitry sets the bottom of the sync tip (or lowest voltage) to just below ground. The input level set by the clamp, combined with the internal DC offset, keeps the output signal within an acceptable range. This clamp feature also allows the FMS6141's input to be directly driven (DC-coupled) by a ground referenced DAC output. Figure 4 shows typical DC voltage levels for the input and output signals when driven by a DC-coupled DAC output or an AC-coupled and clamped Y, CV signal.

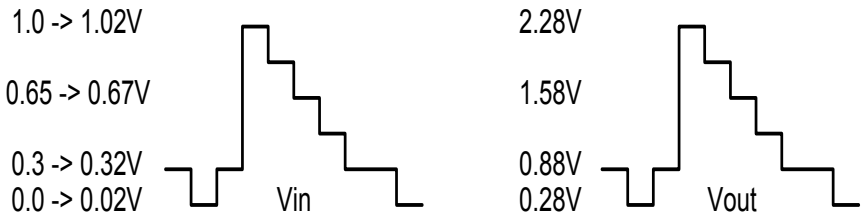


Figure 4. Typical DC Voltage Levels

Output Considerations

The FMS6141's output is DC offset from the input by 280mv; therefore V_{OUT} = 2 • V_{IN}+280mv. 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 FMS6141 has a 2x (6dB) gain, the output is typically connected via a 75Ω-series, back-matching resistor followed by the 75Ω video cable. Due to the inherent divide-by-two of this configuration, the blanking level at the load of the video signal is always less than 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's 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's output pin as possible. This greatly reduces parasitic capacitance and inductance effects on the FMS6141's output driver. The distance from the device's pin to the series termination resistor should be no greater than 0.1 inches, as shown in Figure 5.

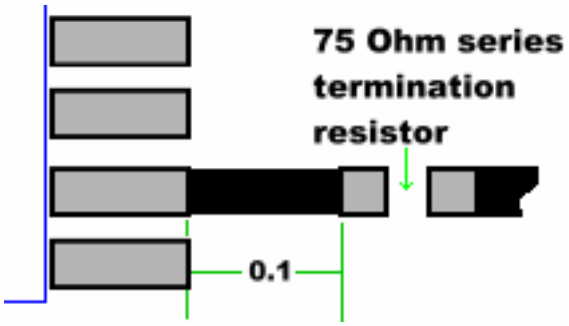


Figure 5. Resistor Placement

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I/O Configurations

Figure 6 shows a typical AC-coupled input configuration for driving the filter/driver. Using this configuration, a 0.1µF ceramic capacitor is used to AC couple the input signal. The coupling capacitor and the input termination resistor at the input of the filter/driver should be placed close to the input pin for optimal signal integrity.

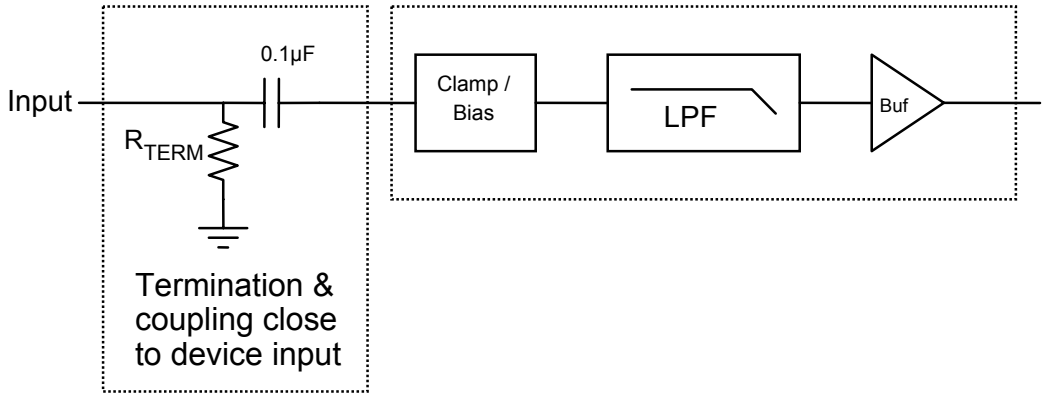


Figure 6. Typical Input Configuration

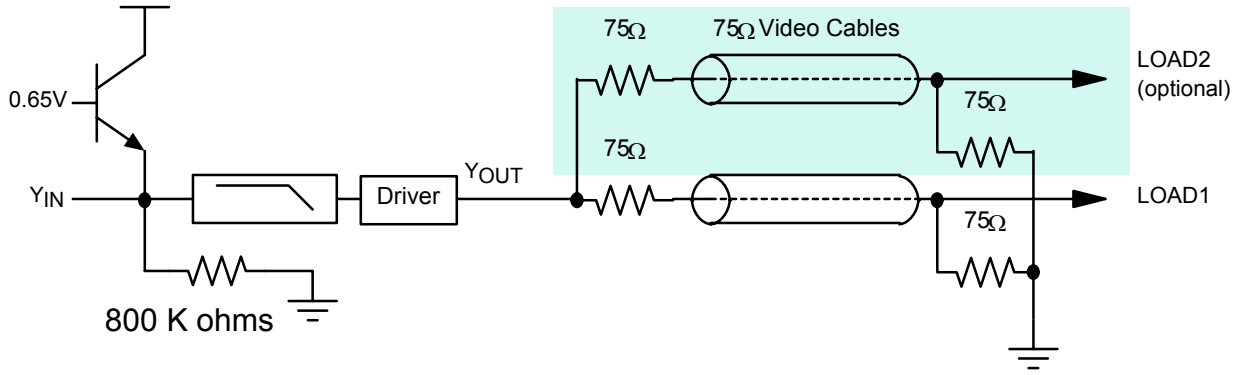


Figure 7. Conceptual Illustration — Input Clamp Circuit and Output Driver Connected to Drive Single or Dual Video Loads

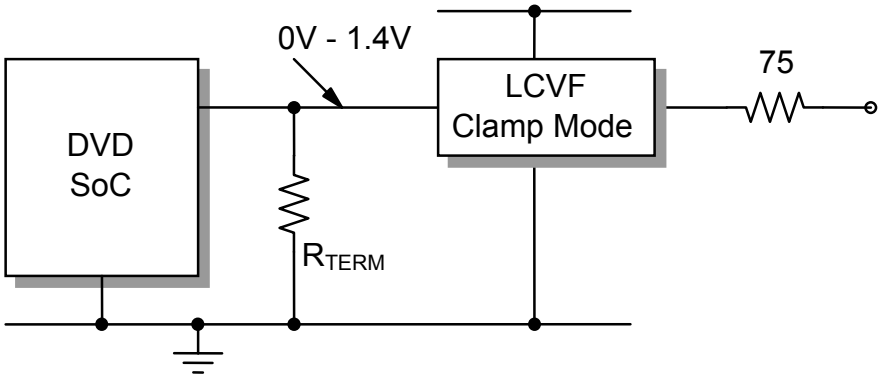


Figure 8. DC-Coupled Input and DC-Coupled Output

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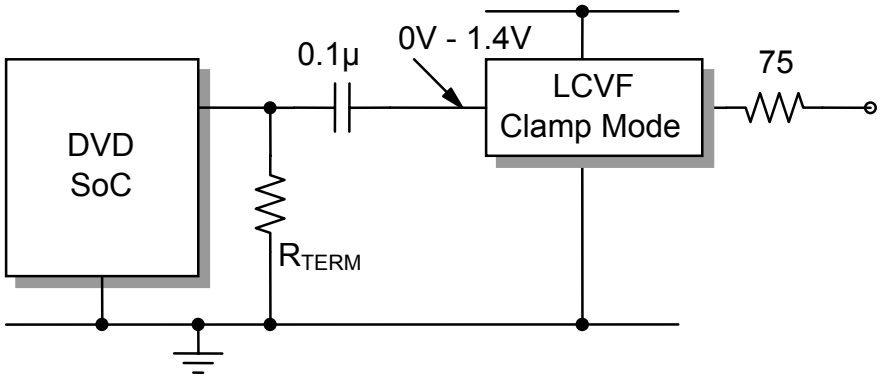


Figure 9. AC-Coupled Input and DC-Coupled Output

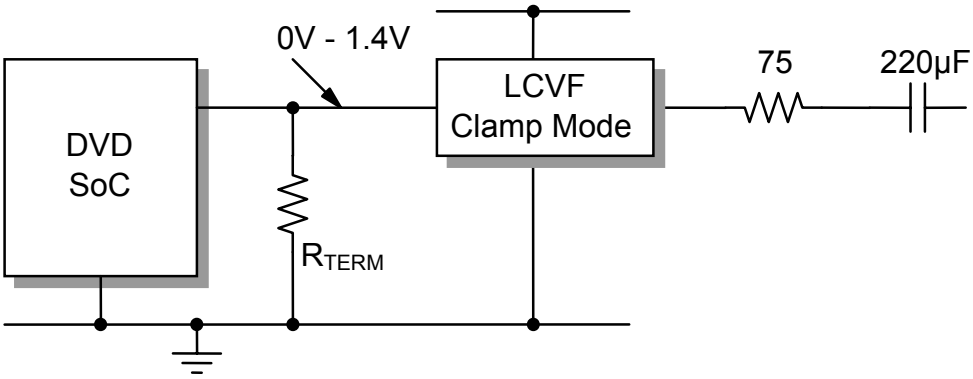


Figure 10. DC-Coupled Input and AC-Coupled Output

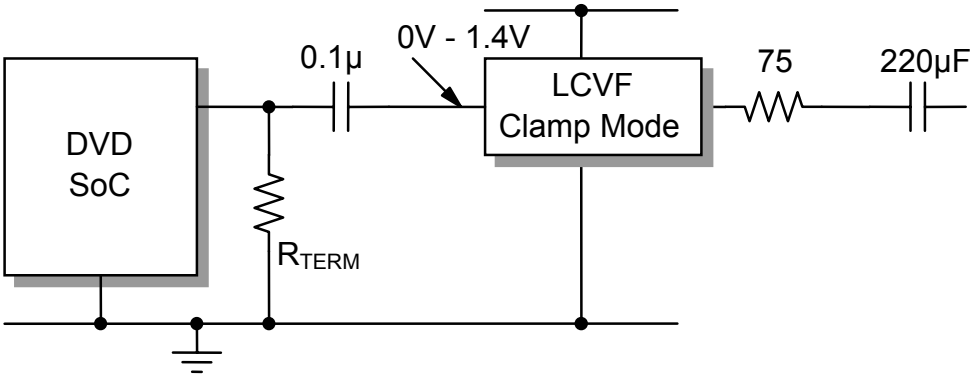


Figure 11. AC-Coupled Input and AC-Coupled Output

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Layout Considerations

General layout and supply bypassing play a major role in high-frequency performance and thermal characteristics. Fairchild offers a demonstration board for the FMS6141 to guide layout and aid device evaluation. The demo board is a four-layer board with full power and ground planes. Following this layout configuration provides optimum performance and thermal characteristics for the device. For the best results, follow the steps and recommended routing rules listed below.

Recommended Routing/Layout Rules

- Do not run analog and digital signals in parallel.
- Use separate analog and digital power planes to supply power.
- Traces should run on top of the ground plane at all times.
- No trace should run over ground/power splits.
- Avoid routing at 90-degree angles.
- Minimize clock and video data trace length differences.
- Include 10µF and 0.1µF ceramic power supply bypass capacitors.
- Place the 0.1µF capacitor within 0.1 inches of the device power pin.
- Place the 10µF capacitor within 0.75 inches of the device power pin.
- For multilayer boards, use a large ground plane to help dissipate heat.
- For two-layer boards, use a ground plane that extends beyond the device body by at least 0.5 inches on all sides. Include a metal paddle under the device on the top layer.
- Minimize all trace lengths to reduce series inductance.

Thermal Considerations

Since the interior of most systems, such as set-top boxes, TVs, and DVD players are at +70ºC; consideration must be given to providing an adequate heat sink for the device package for maximum heat dissipation. When designing a system board, determine how much power each device dissipates. Ensure that devices of high power are not placed in the same location, such as directly above (top plane) and below (bottom plane) each other on the PCB.

PCB Thermal Layout Considerations

- Understand the system power requirements and environmental conditions.
- Maximize thermal performance of the PCB.
- Consider using 70µm of copper for high-power designs.
- Make the PCB as thin as possible by reducing FR4 thickness.
- Use vias in power pad to tie adjacent layers together.
- Remember that baseline temperature is a function of board area, not copper thickness.
- Modeling techniques can provide a first-order approximation.

Power Dissipation

Consider the FMS6141's output drive configuration 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 FMS6141's power dissipation and internal temperature rise.

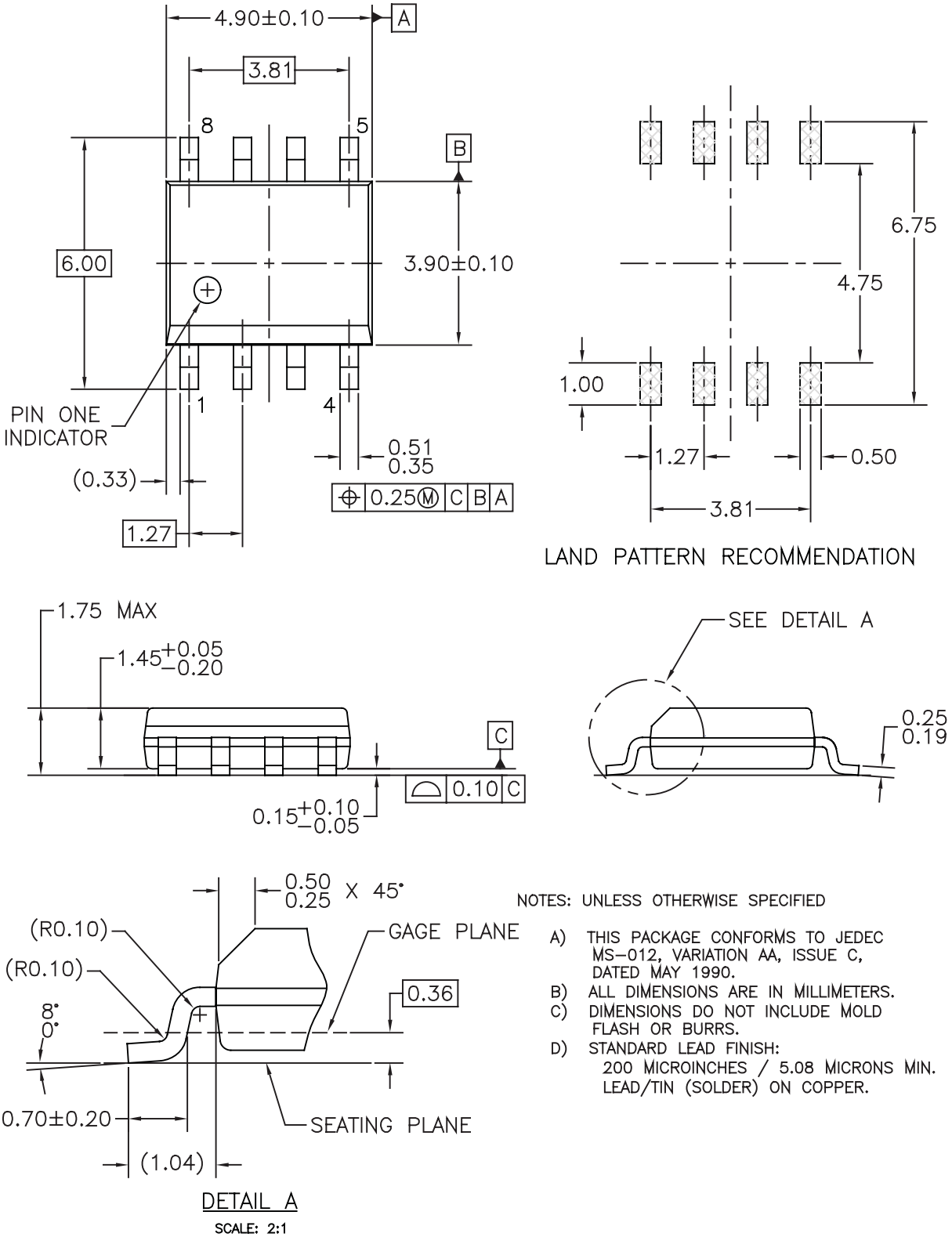
$T_J = T_A + P_{CHANNEL}\ \Theta_{JA}$
where $P_{CHANNEL} = V_{CC} \bullet I_{CH} + (V_O^2/R_L)$
$V_O = 2V_{IN} + 0.280V$
$I_{CH} = I_{CC} + (V_O/R_L)$
V_{IN} = RMS value of input signal
$I_{CC} = 7mA$
$V_S = 5V$
R_L = channel load resistance

The FMS6141 is specified to operate with output currents typically less than 50mA, which is more than sufficient for a dual (75Ω) video load. The internal amplifiers of the FMS6141 are current limited to a maximum of 100mA and can withstand a brief-duration short-circuit condition, but this capability is not guaranteed.

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Physical Dimensions

Dimensions are in millimeters unless otherwise noted.



NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AA, ISSUE C, DATED MAY 1990.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
D) STANDARD LEAD FINISH: 200 MICROINCHES / 5.08 MICRONS MIN. LEAD/TIN (SOLDER) ON COPPER.

Figure 12. SOIC-8 Package

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Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.

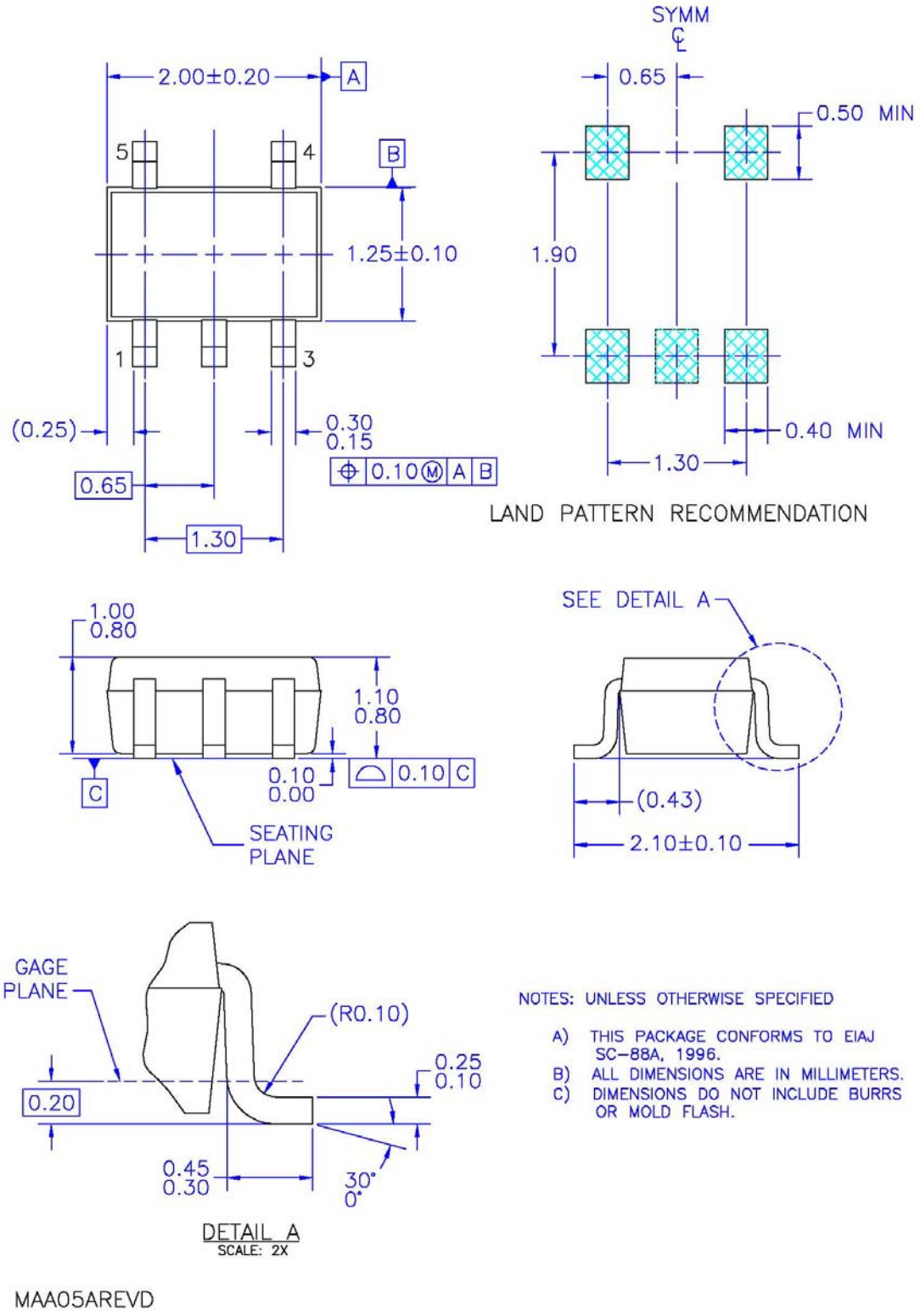


Figure 13. SC70-5 Package

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EnSigna™	MICROCOUPLER™	QFET®	SyncFET™	VCX™
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FACT Quiet Series™	MicroPak™	QT Optoelectronics™		
FAST®	MICROWIRE™	Quiet Series™		
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