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Please note: As part of the Fairchild Semiconductor integration, some of the Fairchild orderable part numbers will need to change in order to meet ON Semiconductor’s system requirements. Since the ON Semiconductor product management systems do not have the ability to manage part nomenclature that utilizes an underscore (_), the underscore (_) in the Fairchild part numbers will be changed to a dash (-). This document may contain device numbers with an underscore (_). Please check the ON Semiconductor website to verify the updated device numbers. The most current and up-to-date ordering information can be found at www.onsemi.com. Please email any questions regarding the system integration to Fairchild_questions@onsemi.com.
FMS6143A
Three-Channel 6th-Order Standard-Definition VoltagePlus™ Video Filter Driver

Features
- Three 6th-Order 8MHz (SD) Filter
- Drives Single AC- or DC-Coupled Video Loads (150Ω)
- Transparent Input Clamping
- Single Supply: 3.3V
- AC- or DC-Coupled Inputs and Outputs
- DC-Coupled Output Eliminates AC-Coupling Capacitor
- Robust 8.5kV ESD Protection
- Supply Voltage Range: 3.3V to 5.0V
- Lead-Free SOIC-8 Package

Description
The FMS6143A VoltagePlus™ video filter is intended to replace passive LC filters and drivers with a cost-effective integrated device. Three 6th-order filters provide improved image quality compared to typical 2nd- and 3rd-order passive solutions.

The FMS6143A 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) or dual (75Ω) video loads. DC coupling the outputs removes the need for large output coupling capacitors. The input DC levels are offset approximately +280mV at the output (see Applications section for details).

Related Applications Notes
AN-6024 – FMS6xxx Product Series Understanding Analog Video Signal Clamps, Bias, DC Restore, and AC or DC coupling Methods
AN-6041 – PCB Layout Considerations for Video Filter / Drivers

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

Ordering Information

<table>
<thead>
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<th>Part Number</th>
<th>Operating Temperature Range</th>
<th>Package</th>
<th>Packing Method</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>FMS6143ACSX</td>
<td>-40°C to +85°C</td>
<td>8-Lead, Small Outline Integrated Circuit (SOIC)</td>
<td>Reel</td>
<td>5000</td>
</tr>
</tbody>
</table>
Pin Configuration

IN1   OUT1
IN2   OUT2
IN3   OUT3
VCC   GND

Fairchild
FMS6143A
8-Lead SOIC

Figure 2. Pin Assignments

Pin Definitions

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IN1</td>
<td>Input</td>
<td>Video Input Channel 1</td>
</tr>
<tr>
<td>2</td>
<td>IN2</td>
<td>Input</td>
<td>Video Input Channel 2</td>
</tr>
<tr>
<td>3</td>
<td>IN3</td>
<td>Input</td>
<td>Video Input Channel 2</td>
</tr>
<tr>
<td>4</td>
<td>Vcc</td>
<td>Input</td>
<td>Positive Power Supply</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Input</td>
<td>Device Ground Connection</td>
</tr>
<tr>
<td>6</td>
<td>OUT3</td>
<td>Output</td>
<td>Filtered Output Channel 3</td>
</tr>
<tr>
<td>7</td>
<td>OUT2</td>
<td>Output</td>
<td>Filtered Output Channel 2</td>
</tr>
<tr>
<td>8</td>
<td>OUT1</td>
<td>Output</td>
<td>Filtered Output Channel 1</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_S$</td>
<td>DC Supply Voltage</td>
<td>-0.3</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>$V_{IO}$</td>
<td>Analog and Digital I/O</td>
<td>-0.3</td>
<td>$V_{CC}+0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Maximum Output Current, Do Not Exceed</td>
<td></td>
<td>50</td>
<td>mA</td>
</tr>
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</table>

Electrostatic Discharge Information

<table>
<thead>
<tr>
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<th>Parameter</th>
<th>Min.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD</td>
<td>Human Body Model, JESD22-A114</td>
<td>8.5</td>
<td>kV</td>
</tr>
<tr>
<td>ESD</td>
<td>Charged Device Model, JESD22-C101</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

Reliability Information

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_J$</td>
<td>Junction Temperature</td>
<td></td>
<td>+150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_{STG}$</td>
<td>Storage Temperature Range</td>
<td>-65</td>
<td>+150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$\Theta_JA$</td>
<td>Thermal Resistance, JEDEC Standard, Multilayer Test Boards, Still Air</td>
<td>115</td>
<td></td>
<td>°C/W</td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_A$</td>
<td>Operating Temperature Range</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$V_{CC}$</td>
<td>Supply Voltage Range</td>
<td>3.14</td>
<td>3.30</td>
<td>5.25</td>
<td>V</td>
</tr>
</tbody>
</table>
### DC Electrical Characteristics

Unless otherwise noted; \( T_A=25°C \), \( V_{CC}=3.3V \), \( R_S=37.5Ω \); all inputs are AC coupled with 0.1µF; and all outputs are AC coupled with 220µF into 150Ω load.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_S )</td>
<td>Supply Voltage Range</td>
<td>( V_S ) Range</td>
<td>( V_S ) Range</td>
<td>3.14</td>
<td>3.30</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>( I_{CC} )</td>
<td>Quiescent Supply Current(^{(1)})</td>
<td>( V_S=+3.3V ), No Load</td>
<td>( V_S=+5.0V ), No Load</td>
<td>15</td>
<td>22</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>( V_{IN} )</td>
<td>Video Input Voltage Range</td>
<td>Referenced to GND if DC Coupled</td>
<td>( V_{p-p} )</td>
<td>1.4</td>
<td>( V_{p-p} )</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>PSRR</td>
<td>Power Supply Rejection Ratio</td>
<td>DC (All Channels)</td>
<td>-65</td>
<td>-65</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. 100% tested at \( T_A=25°C \).

### AC Electrical Characteristics

Unless otherwise noted; \( T_A=25°C \), \( V_{CC}=3.3V \), \( R_S=37.5Ω \); all inputs are AC coupled with 0.1µF; and all outputs AC coupled with 220µF into 150Ω load.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_V )</td>
<td>Channel Gain</td>
<td>Active Video Input Range = 1( V_{p-p} )</td>
<td>5.8</td>
<td>6.0</td>
<td>6.2</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>( BW_{0.1dB} )</td>
<td>±0.1dB Bandwidth(^{(2)})</td>
<td>( R_{SOURCE}=75Ω ), ( R_L=150Ω )</td>
<td>5.0</td>
<td>MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( BW_{1.0dB} )</td>
<td>-1.0 dB Bandwidth(^{(2)})</td>
<td>( R_{SOURCE}=75Ω ), ( R_L=150Ω )</td>
<td>6.5</td>
<td>7.0</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( BW_{3.0dB} )</td>
<td>-3.0 dB Bandwidth(^{(2)})</td>
<td>( R_{SOURCE}=75Ω ), ( R_L=150Ω )</td>
<td>7.5</td>
<td>8.0</td>
<td>MHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Att_{27M} )</td>
<td>Normalized Stopband Attenuation(^{(2)})</td>
<td>( R_{SOURCE}=75Ω ), ( f=27MHz )</td>
<td>45</td>
<td>60</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DG</td>
<td>Differential Gain - NTSC/PAL</td>
<td>Active Video Input Range = 1( V_{p-p} )</td>
<td>( V_{OUT}=1.4V_{p-p} )</td>
<td>0.6</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DP</td>
<td>Differential Phase - NTSC/PAL</td>
<td>Active Video Input Range = 1( V_{p-p} )</td>
<td>( V_{OUT}=1.4V_{p-p} )</td>
<td>( ° )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THD</td>
<td>Total Harmonic Distortion</td>
<td>( f=1.00MHz ), ( V_{OUT}=1.4V_{p-p} )</td>
<td>0.2</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( X_{talk} )</td>
<td>Crosstalk (Channel to Channel)</td>
<td>( f=1.00MHz ), ( V_{OUT}=1.4V_{p-p} )</td>
<td>-65</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNR</td>
<td>Peak Signal to RMS Noise</td>
<td>NTC-7 Weighting: 100kHz to 4.43MHz</td>
<td>74</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t_{pd} )</td>
<td>Propagation Delay</td>
<td>Delay from Input to Output: ( 100kHz ) to 4.43MHz</td>
<td>90</td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLG</td>
<td>Chroma-Luma Gain(^{(2)})</td>
<td>400KHz to 3.58MHz and 4.43MHz</td>
<td>95</td>
<td>100</td>
<td>105</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>CLD</td>
<td>Chroma-Luma Delay</td>
<td>400KHz to 3.58MHz and 4.43MHz</td>
<td>5.0</td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
2. 100% tested at \( T_A=25°C \).
Typical Performance Characteristics

Unless otherwise noted, $T_A = 25^\circ C$, $V_{CC} = 3.3V$, $R_S = 37.5\Omega$, and AC-coupled output into $150\Omega$ load.

Figure 3. Frequency Response

Figure 4. Frequency Response Flatness
Typical Performance Characteristics

Unless otherwise noted, $T_A = 25°C$, $V_{CC} = 3.3V$, $R_S = 37.5Ω$, and AC-coupled output into $150Ω$ load.

![Delay vs Frequency](image)

**Figure 5. Delay vs. Frequency**

Noise Spectrum

- **Field = 1 Line = 178**
- **Amplitude (0 dB = 714 mV p-p)**
- **Noise Level = -77.7 dB rms**
- **Bandwidth 100kHz to 4.2MHz (NTC-7 Weight)**

![Noise vs Frequency](image)

**Figure 6. Noise vs. Frequency**
Typical Performance Characteristics

Unless otherwise noted, $T_A = 25^\circ C$, $V_{CC} = 3.3V$, $R_S = 37.5\Omega$, and AC-coupled output into 150\$ load.

![Differential Gain](image)

Figure 7. Differential Gain

![Differential Phase](image)

Figure 8. Differential Phase

![Chroma / Luma Gain & Delay](image)

Figure 9. Chroma / Luma Gain & Delay
Applications Information

DVD Player or STB

Video SoC

DAC Load Resistors per SoC specs. AC-Coupling Caps are Optional.

Figure 10. Typical Application
Application Information

Application Circuits
The FMS6143A VoltagePlus™ video filter 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 11.

<table>
<thead>
<tr>
<th>VIN</th>
<th>VOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 -&gt; 0.02V</td>
<td>2 * VIN + 280mV</td>
</tr>
<tr>
<td>0.3 -&gt; 0.32V</td>
<td></td>
</tr>
<tr>
<td>0.65 -&gt; 0.67V</td>
<td></td>
</tr>
<tr>
<td>1.0 -&gt; 1.02V</td>
<td></td>
</tr>
</tbody>
</table>

There is a 280mV offset from the DC input level to the DC output level. VOUT = 2 * VIN + 280mV.

Figure 11. Typical Voltage Levels

I/O Configurations
For a DC-coupled DAC drive with DC-coupled outputs, use this configuration:

Figure 13. 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:

Figure 14. AC-Coupled Inputs, DC-Coupled Outputs

When the FMS6143A 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 15.

Figure 15. SCART 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 $800\,\text{k}\Omega \pm 20\%$, so the external resistance should be $7.5\,\text{M}\Omega$ to set the DC level to $500\,\text{mV}$:

![Figure 16. Biased SCART with DC-Coupled Outputs](image)

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

![Figure 17. DC-Coupled Inputs, AC-Coupled Outputs](image)

![Figure 18. AC-Coupled Inputs and Outputs](image)

**Power Dissipation**

The FMS6143A 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 power dissipation and internal temperature rise:

$$T_J = T_A + P_D \cdot \theta_JA$$  \hspace{1cm} (1)

where:

$$P_D = P_{CH1} + P_{CH2} + P_{CH3}$$ \hspace{1cm} (2)

$$P_{CHX} = V_{CC} \cdot I_{CH} - \left(\frac{V_0}{2}/R_L\right)$$ \hspace{1cm} (3)

$$I_{CH} = \left(\frac{I_{CC}}{3}\right) + \left(\frac{V_0}{2}/R_L\right)$$ \hspace{1cm} (4)

$$V_{IN} = \text{RMS value of input signal}$$

$$I_{CC} = 15\,\text{mA}$$

$$V_{CC} = 3.3\,\text{V}$$

$$R_L = \text{channel load resistance}.$$  

Board layout can also affect thermal characteristics. Refer to the Layout Considerations section for details.

The FMS6143A is specified to operate with output currents typically less than $50\,\text{mA}$, more than sufficient for a dual ($75\,\Omega$) video load. Internal amplifiers are current limited to a maximum of $100\,\text{mA}$ and should withstand brief-duration short-circuit conditions. This capability is not guaranteed.
Layout Considerations

General layout and supply bypassing play a major role in high-frequency performance and thermal characteristics. Fairchild offers a demonstration board to guide layout and aide 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 2.54mm (0.1in) of the device power pin.
- Place the 10μF capacitor within 19.05mm (0.75in) of the device 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 body at least 12.7mm (0.5in) on all sides. Include a metal paddle under the device on the top layer.
- Minimize all trace lengths to reduce series inductance.

Output Considerations

The FMS6143A outputs are DC offset from the input by 150mV; therefore, \( V_{\text{OUT}} = 2 \times V_{\text{IN}} \text{ DC} + 150\text{mV} \). 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 FMS6143A has a 2 x (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.

Thermal Considerations

Since the interior of most systems; such as set-top boxes, TVs, and DVD players; are at \( T_A=+70ºC \); 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) or 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 the power pad to tie adjacent layers together.
- Remember that baseline temperature is a function of board area, not copper thickness.
- Modeling techniques provide a first-order approximation.
Physical Dimensions

Figure 21. 8-Lead, Small Outline Integrated Circuit (SOIC)

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild’s worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor’s online packaging area for the most recent package drawings: [http://www.fairchildsemi.com/packaging/](http://www.fairchildsemi.com/packaging/)
FMS6143A — Three-Channel 6th-Order Standard-Definition VoltagePlus™ Video Filter Driver

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FMS6143A — Three-Channel 6th-Order Standard-Definition VoltagePlus™ Video Filter Driver

LIFE SUPPORT POLICY

ANTI-COUNTERFEITING POLICY
Fairchild Semiconductor Corporation’s Anti-Counterfeiting Policy. Fairchild’s Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

PRODUCT STATUS DEFINITIONS

<table>
<thead>
<tr>
<th>Definition of Terms</th>
<th>Product Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advance Information</td>
<td>Formative/In Design</td>
<td>Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.</td>
</tr>
<tr>
<td>Preliminary</td>
<td>First Production</td>
<td>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.</td>
</tr>
<tr>
<td>No Identification</td>
<td>Full Production</td>
<td>Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.</td>
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<tr>
<td>Obsolete</td>
<td>Not In Production</td>
<td>Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.</td>
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</table>

Rev. 1.0.0

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