

# FMS6246

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

### Features

- Three selectable sixth-order 8/15MHz (SD/PS) filters
- Three fixed sixth-order 8MHz (SD) filters
- Transparent input clamping
- Single video load drive ( $2V_{pp}$ ,  $150\Omega$ ,  $A_V = 6dB$ )
- AC or DC-coupled inputs
- AC or DC-coupled outputs
- DC-coupled outputs eliminate AC-coupling capacitors
- Low power
- 5V only
- Robust (12kV HBM) output ESD protection
- Lead (Pb) free packages- TSSOP-20

### Applications

- Cable and satellite set-top boxes
- DVD players
- HDTV
- Personal Video Recorders (PVR)
- Video On Demand (VOD)

### Description

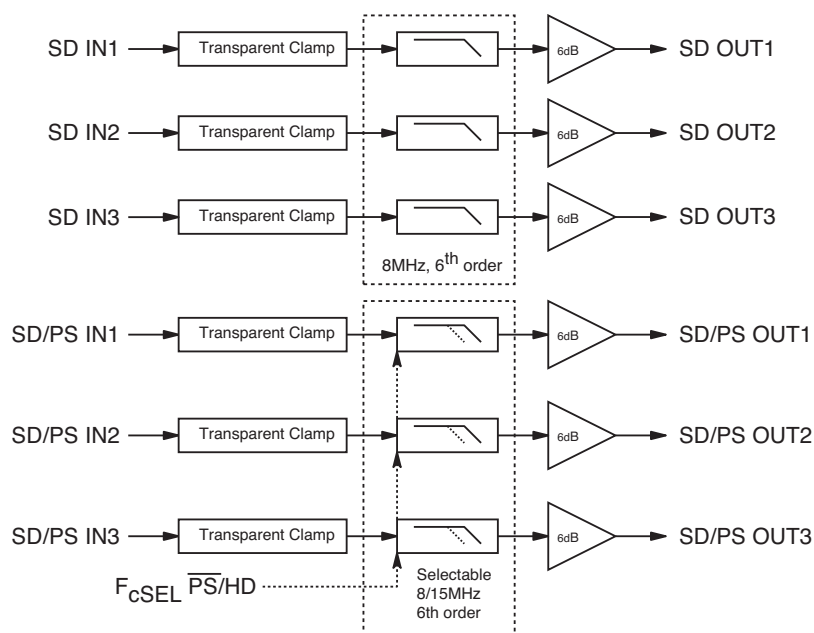
The FMS6246 Low Cost Video Filter (LCVF) is intended to replace passive LC filters and drivers with a low-cost integrated device. Six 6th order Butterworth filters provide improved image quality compared to typical passive solutions. The combination of low power Standard Definition (SD) and Progressive Scan (PS) filters greatly simplify DVD video output circuitry. Three channels offer fixed SD filters while the other three are selectable between SD and PS filters.

The FMS6246 offers a fixed gain of 6dB. A metal option is available that provides a fixed gain of 9dB, offering even more flexibility.

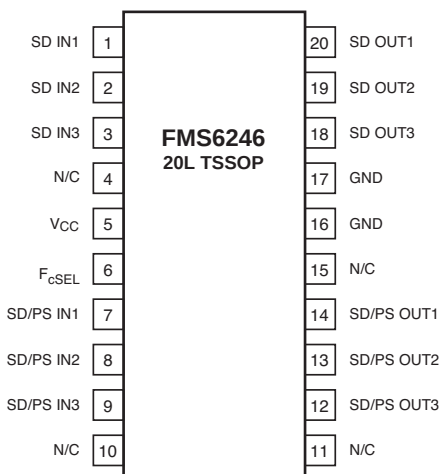
The FMS6246 may be directly driven by a DC-coupled DAC output or an AC-coupled signal. Internal diode clamps and bias circuitry may be used if AC-coupled inputs are required (see applications section for details).

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

### Block Diagram



## Pin Configuration



## Pin Assignments

| Pin # | Pin        | 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 Connect                                                               |
| 5     | VCC        | Input  | +5V supply                                                               |
| 6     | FcSEL      | Input  | Selects filter corner frequency for pins 7, 8, and 9. "0" = SD, "1" = PS |
| 7     | SD/PS IN1  | Input  | Selectable SD or PS video input, channel 1                               |
| 8     | SD/PS IN2  | Input  | Selectable SD or PS video input, channel 2                               |
| 9     | SD/PS IN3  | Input  | Selectable SD or PS video input, channel 3                               |
| 10    | N/C        | Input  | No Connect                                                               |
| 11    | N/C        | Input  | No Connect                                                               |
| 12    | SD/PS OUT3 | Output | Filtered SD or PS video output, channel 3                                |
| 13    | SD/PS OUT2 | Output | Filtered SD or PS video output, channel 2                                |
| 14    | SD/PS OUT1 | Output | Filtered SD or PS video output, channel 1                                |
| 15    | N/C        | Input  | No Connect                                                               |
| 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                                      |

## Factory Programming Options

| Part Name | Part Number   | Gain Option |
|-----------|---------------|-------------|
| FMS6246   | FMS6246MTC20  | 6dB         |
| FMS6246-9 | FMS6246MTC209 | 9dB         |

## Absolute Maximum Ratings

| Parameter                                       | Min  | Max            | Unit |
|-------------------------------------------------|------|----------------|------|
| DC Supply Voltage                               | -0.3 | 6              | V    |
| Analog and Digital I/O                          | -0.3 | $V_{CC} + 0.3$ | V    |
| Output Current, Any One Channel (Do Not Exceed) |      | 50             | mA   |

## Reliability Information

| Parameter                                                                               | Min | Typ | Max | Unit |
|-----------------------------------------------------------------------------------------|-----|-----|-----|------|
| Junction Temperature                                                                    |     |     | 150 | °C   |
| Storage Temperature Range                                                               | -65 |     | 150 | °C   |
| Lead Temperature (Soldering, 10s)                                                       |     |     | 300 | °C   |
| Thermal Resistance ( $\theta_{JA}$ ), JEDEC Standard Multi-Layer Test Boards, Still Air |     | 74  |     | °C/W |

## Recommended Operating Conditions

| Parameter                   | Min  | Typ | Max  | Unit |
|-----------------------------|------|-----|------|------|
| Operating Temperature Range | 0    |     | 70   | °C   |
| Supply Voltage Range        | 4.75 | 5.0 | 5.25 | V    |

## DC Electrical Characteristics

$T_c = 25^\circ\text{C}$ ,  $V_{cc} = 5\text{V}$ ,  $R_{source} = 37.5\Omega$ , inputs AC coupled with  $0.1\mu\text{F}$ , all outputs AC coupled with  $220\mu\text{F}$  into  $150\Omega$  loads, referenced to  $400\text{kHz}$ ; unless otherwise noted.

| Symbol   | Parameter                       | Conditions                       | Min | Typ | Max      | Units           |
|----------|---------------------------------|----------------------------------|-----|-----|----------|-----------------|
| $I_{CC}$ | Supply Current <sup>1</sup>     | no load                          |     | 60  | 80       | mA              |
| $V_{in}$ | Video Input Voltage Range       | Referenced to GND, if DC-coupled |     | 1.4 |          | V <sub>pp</sub> |
| $V_{il}$ | Digital Input Low <sup>1</sup>  | $F_{cSEL}$                       | 0   |     | 0.8      | V               |
| $V_{ih}$ | Digital Input High <sup>1</sup> | $F_{cSEL}$                       | 2.4 |     | $V_{cc}$ | V               |

## Standard Definition Electrical Characteristics

$T_c = 25^\circ\text{C}$ ,  $V_{in} = 1\text{V}_{pp}$ ,  $V_{cc} = 5\text{V}$ ,  $R_{source} = 37.5\Omega$ , all inputs AC coupled with  $0.1\mu\text{F}$ , all outputs AC coupled with  $220\mu\text{F}$  into  $150\Omega$  loads, referenced to  $400\text{kHz}$ ; unless otherwise noted.

| Symbol       | Parameter                                 | Conditions                                          | Min | Typ  | Max | Units |
|--------------|-------------------------------------------|-----------------------------------------------------|-----|------|-----|-------|
| $AV_{SD}$    | Channel Gain <sup>1</sup>                 | All SD Channels                                     | 5.6 | 6.0  | 6.4 | dB    |
| $f_{1dBSD}$  | -1dB Bandwidth <sup>1</sup>               | All SD Channels                                     | 5.2 | 7.15 |     | MHz   |
| $f_{cSD}$    | -3dB Bandwidth <sup>1</sup>               | All SD Channels                                     | 6.5 | 8.0  |     | MHz   |
| $f_{SBSD}$   | Attenuation(stopband reject) <sup>1</sup> | All SD Channels at $f = 27\text{MHz}$               | 43  | 50   |     | dB    |
| DG           | Differential Gain                         | All SD Channels                                     |     | 0.7  |     | %     |
| DP           | Differential Phase                        | All SD Channels                                     |     | 1.0  |     | °     |
| THD          | Output Distortion                         | $V_{OUT} = 1.4\text{V}_{pp}$ , $3.58\text{MHz}$     |     | 0.35 |     | %     |
| $X_{TALKSD}$ | Crosstalk (ch-to-ch)                      | at $1\text{MHz}$                                    |     | -54  |     | dB    |
| SNR          | Signal-to-Noise Ratio <sup>2</sup>        | NTC-7 weighting, $100\text{kHz}$ to $4.2\text{MHz}$ |     | 72   |     | dB    |
| $t_{pdSD}$   | Propagation Delay                         | Delay from input to output, $4.5\text{MHz}$         |     | 90   |     | ns    |

## Progressive Scan Electrical Characteristics

$T_c = 25^\circ\text{C}$ ,  $V_{in} = 1\text{V}_{pp}$ ,  $V_{cc} = 5\text{V}$ ,  $R_{source} = 37.5\Omega$ ,  $F_{cSEL} = 0$ , all inputs AC coupled with  $0.1\mu\text{F}$ , all outputs AC coupled with  $220\mu\text{F}$  into  $150\Omega$  loads, referenced to  $400\text{kHz}$ ; unless otherwise noted.

| Symbol       | Parameter                                 | Conditions                                    | Min | Typ  | Max | Units |
|--------------|-------------------------------------------|-----------------------------------------------|-----|------|-----|-------|
| $AV_{PS}$    | Channel Gain <sup>1</sup>                 | All PS Channels                               | 5.6 | 6.0  | 6.4 | dB    |
| $f_{1dBSPS}$ | -1dB Bandwidth <sup>1</sup>               | All PS Channels                               | 12  | 14   |     | MHz   |
| $f_{cPS}$    | -3dB Bandwidth <sup>1</sup>               | All PS Channels                               | 13  | 16   |     | MHz   |
| $f_{SBPS}$   | Attenuation(stopband reject) <sup>1</sup> | All PS Channels at $f = 54\text{MHz}$         | 37  | 45   |     | dB    |
| THD          | Output Distortion (All PS channels)       | $V_{OUT} = 1.4\text{V}_{pp}$ , $7\text{MHz}$  |     | 0.35 |     | %     |
| $X_{TALKPS}$ | Crosstalk (ch-to-ch)                      | at $1\text{MHz}$                              |     | -53  |     | dB    |
| SNR          | Signal-to-Noise Ratio <sup>2</sup>        | unweighted; $100\text{kHz}$ to $15\text{MHz}$ |     | 66   |     | dB    |
| $t_{pdPS}$   | Propagation Delay                         | Delay from input to output                    |     | 47   |     | ns    |

### Notes:

- 100% tested at  $25^\circ\text{C}$
- $\text{SNR} = 20 * \log(714\text{mV}/\text{rms noise})$

### Typical Performance Characteristics

$T_C = 25^\circ\text{C}$ ,  $V_{in} = 1V_{pp}$ ,  $V_{CC} = 5V$ ,  $R_{source} = 37.5\Omega$ , inputs AC coupled with  $0.1\mu F$ , all outputs AC coupled with  $220\mu F$  into  $150\Omega$  loads; unless otherwise noted.

Figure 1. SD Gain vs. Frequency

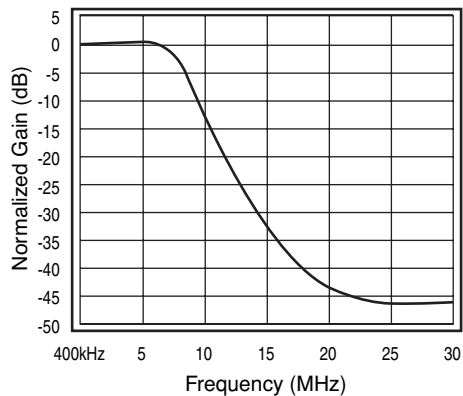


Figure 2. SD Flatness vs. Frequency

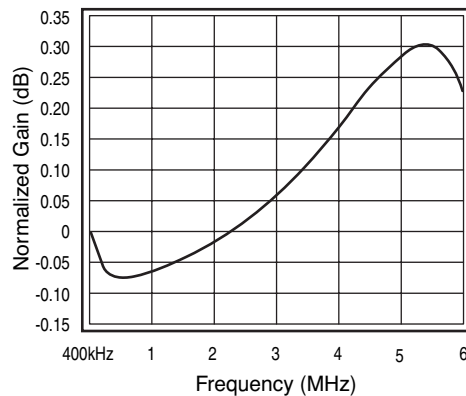


Figure 3. PS Gain vs. Frequency

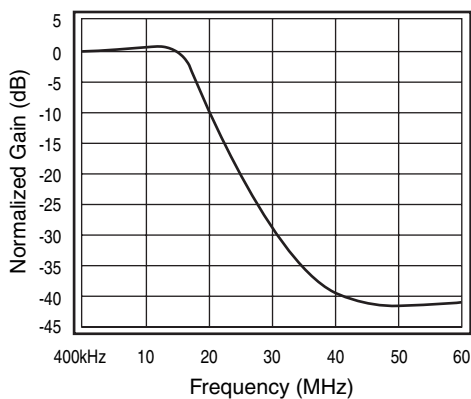


Figure 4. PS Flatness vs. Frequency

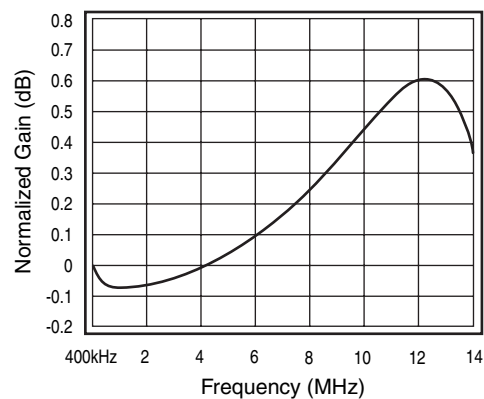


Figure 5. SD Group Delay vs. Frequency

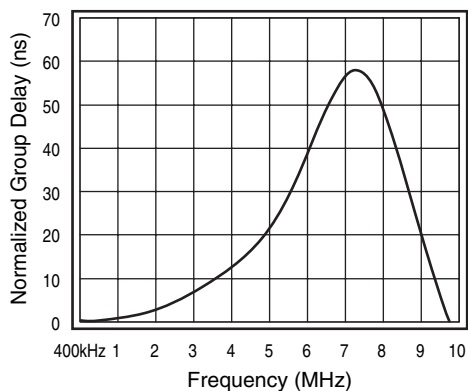
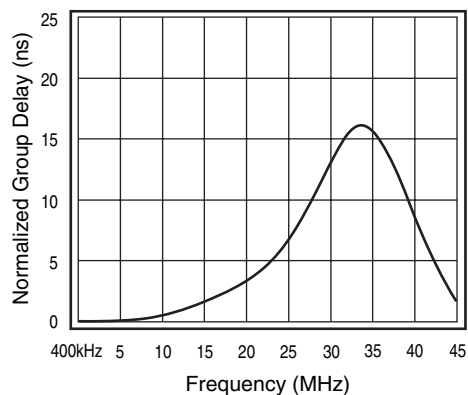


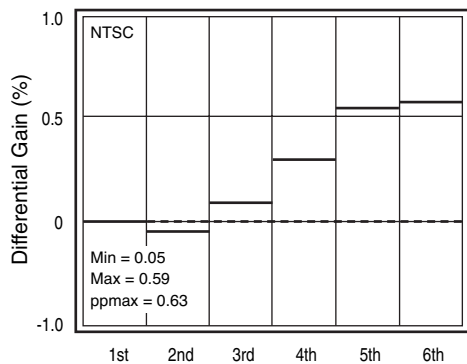
Figure 6. PS Group Delay vs. Frequency



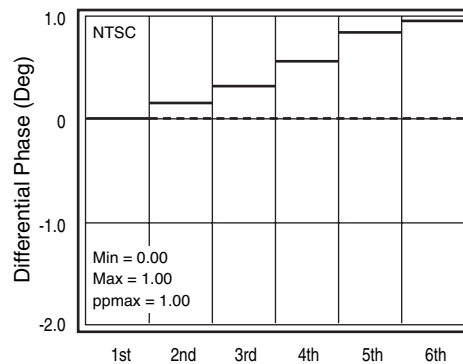
## Typical Performance Characteristics

$T_c = 25^\circ\text{C}$ ,  $V_{in} = 1V_{pp}$ ,  $V_{CC} = 5V$ ,  $R_{source} = 37.5\Omega$ , inputs AC coupled with  $0.1\mu\text{F}$ , all outputs AC coupled with  $220\mu\text{F}$  into  $150\Omega$  loads; unless otherwise noted.

**Figure 7. SD Differential Gain**



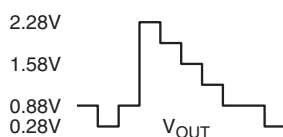
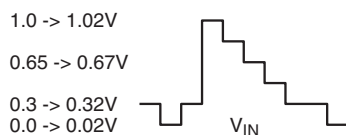
**Figure 8. SD Differential Phase**



## Applications Information

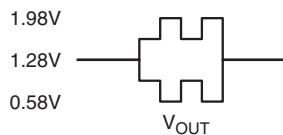
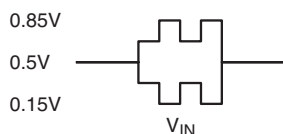
### Functional Description

The FMS6246 Low Cost Video Filter (LCVF) provides 6dB gain (9dB optional, contact factory for further information) from input to output. In addition, the input will be 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 the diagram below.



Driven by:  
DC-Coupled DAC Outputs  
AC-Coupled and Clamped  
Y, CV, R, G, B

There will be a 280mV offset from the DC input level to the DC output level.  $V_{OUT} = 2 * V_{IN} + 280\text{mV}$

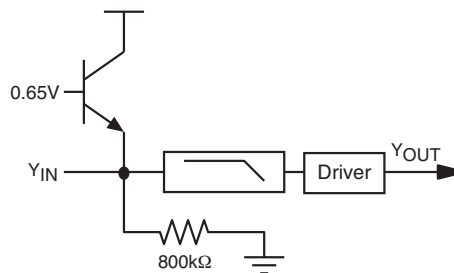


Driven by:  
AC-Coupled and Biased  
U, V, Pb, Pr, C

**Figure 9. Typical Voltage Levels**

The FMS6246 provides an internal diode clamp to support AC-coupled input signals. If the input signal does not go below ground, the input clamp will not operate. This allows DAC outputs to directly drive the FMS6246 without an AC coupling capacitor. The worst-case sync tip compression due to the clamp will not exceed 7mV. The input level set by the clamp combined with the internal DC offset will keep the output within its acceptable range. When the input is AC-coupled, the diode clamp will set the sync tip (or lowest voltage) just below ground.

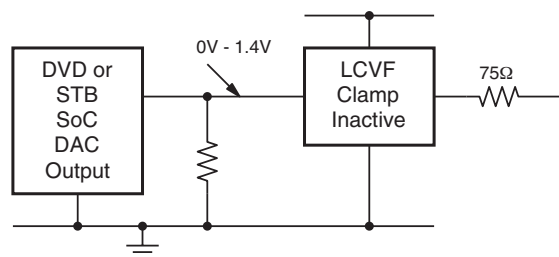
For symmetric signals like C, U, V, Cb, Cr, Pb and Pr, the average DC bias is fairly constant and the inputs can be AC-coupled with the addition of a pull-up resistor to set the DC input voltage. DAC outputs can also drive these same signals without the AC coupling capacitor. A conceptual illustration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



**Figure 10. Input Clamp Circuit**

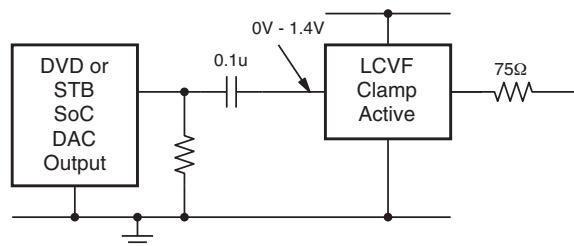
### I/O Configurations

For DC-coupled DAC drive with DC-coupled outputs, use this configuration:



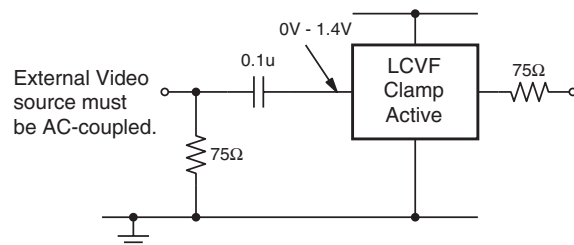
**Figure 11. DC-coupled Inputs and Outputs**

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 follows:



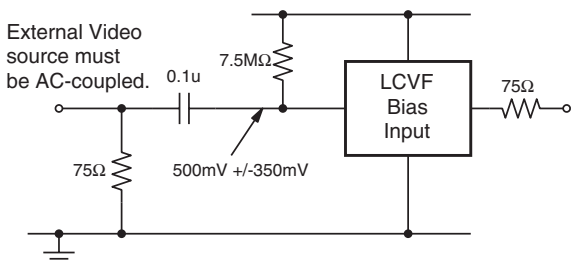
**Figure 12. AC-coupled Inputs, DC-coupled Outputs**

When the FMS6246 is driven by an unknown external source or a SCART switch with its own clamping circuitry, the inputs should be AC-coupled as follows:



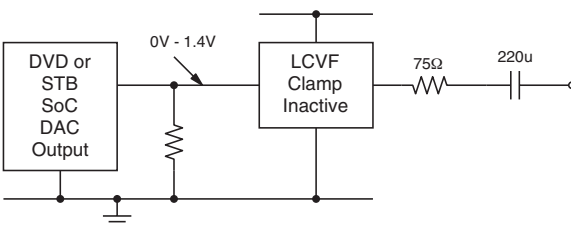
**Figure 13. SCART Configuration with DC-coupled Outputs**

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  $800k\Omega \pm 20\%$  so the external resistance should be  $7.5M\Omega$  to set the DC level to 500mV. If a pull-up resistance less than  $7.5M\Omega$  is desired, an external pull-down can be added such that the DC input level is set to 500mV.

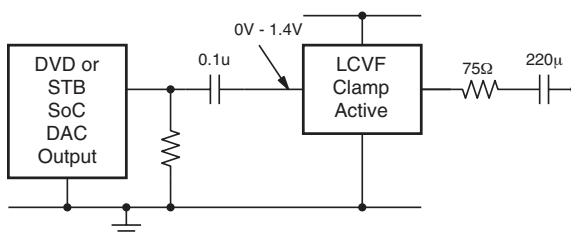


**Figure 14. Biased SCART with DC-coupled Outputs**

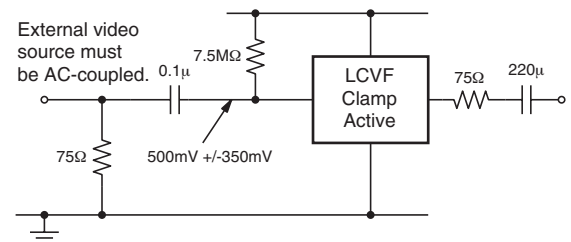
The same circuits can be used with AC-coupled outputs if desired.



**Figure 15. DC-coupled Inputs, AC-coupled Outputs**



**Figure 16. AC-coupled Inputs, AC-coupled Outputs**



**Figure 17. Biased SCART with AC-coupled Outputs**

NOTE: The video tilt or line time distortion will be dominated by the AC-coupling capacitor. The value may need to be increased beyond  $220\mu F$  in order to obtain satisfactory operation in some applications.

## Power Dissipation

The FMS6246 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 FMS6246's power dissipation and internal temperature rise.

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

$$\text{where } P_d = P_{CH1} + P_{CH2} + P_{CHx}$$

$$\text{and } P_{CHx} = V_s \cdot I_{CH} - (V_o^2/R_L)$$

where

$$V_o = 2V_{in} + 0.280V$$

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

$V_{in}$  = RMS value of input signal

$$I_{CC} = 60mA$$

$$V_s = 5V$$

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

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

## Layout Considerations

General layout and supply bypassing play major roles in high frequency performance and thermal characteristics. Fairchild offers a demonstration board, FMS6246DEMO, to use as a guide for layout and to aid in device testing and characterization. The FMS6246DEMO is a 4-layer board with a full power and ground plane. Following this layout configuration will provide the optimum performance and thermal characteristics. For optimum results, follow the steps below as a basis for high frequency layout:

- Include  $10\mu F$  and  $0.1\mu F$  ceramic bypass capacitors
- Place the  $10\mu F$  capacitor within 0.75 inches of the power pin
- Place the  $0.1\mu F$  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

## Typical Application Diagram

The following circuit may be used for direct DC-coupled drive by DACs with an output voltage range of 0V to 1.4V. AC-coupled or DC-coupled outputs may be used with AC-coupled outputs offering slightly lower power dissipation.

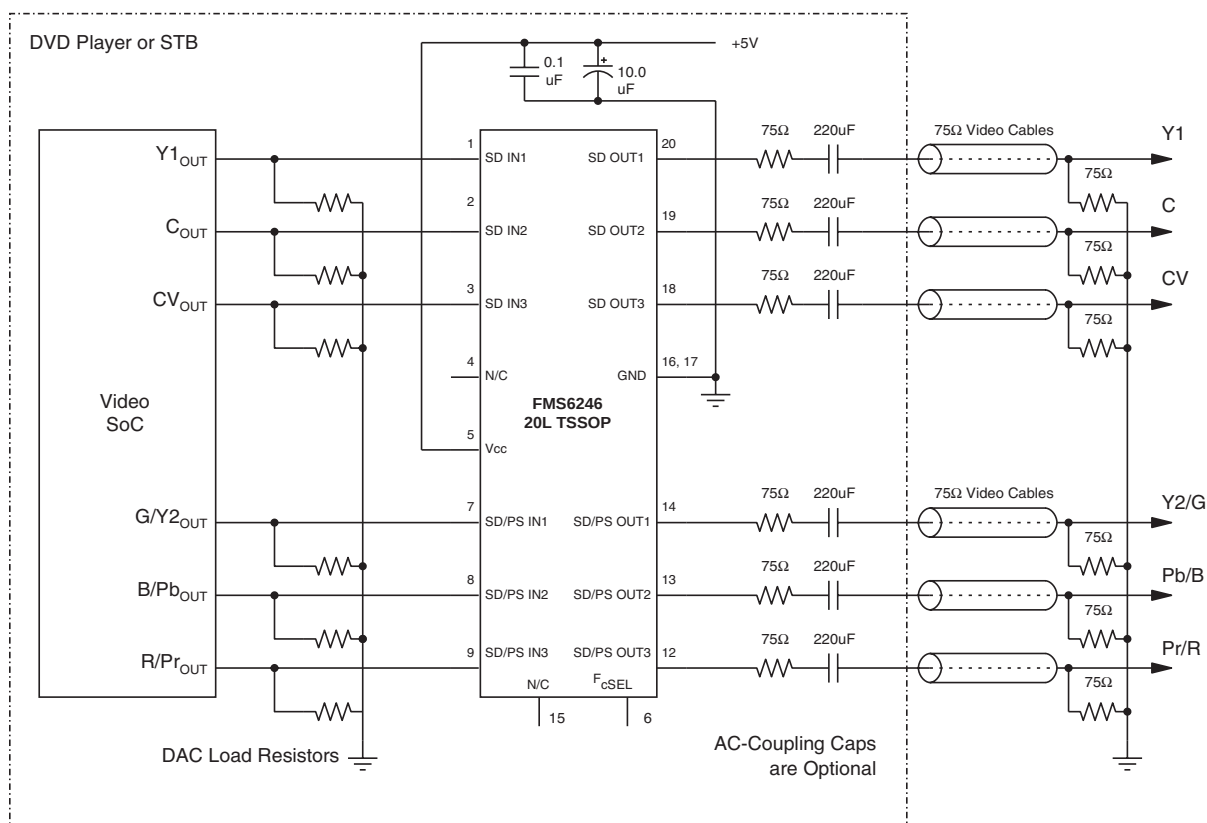
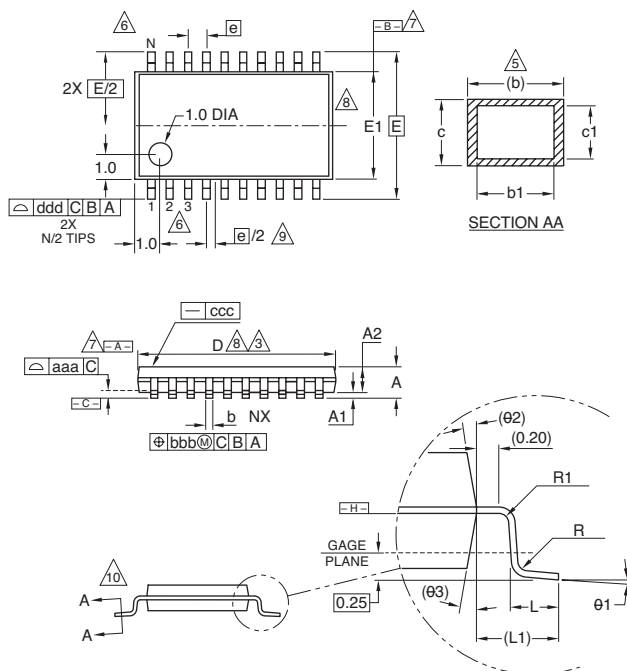


Figure 18. Typical Application Diagram

## Mechanical Dimensions

### 20-Lead Thin Shrink Outline Package (TSSOP)



| TSSOP-20 |          |      |      |
|----------|----------|------|------|
| 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        | 6.50     | 6.50 | 6.60 |
| E1       | 4.30     | 4.40 | 4.50 |
| E        | 6.4 BSC  |      |      |
| e        | 0.65 BSC |      |      |
| N        | 20       |      |      |

**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 cannot 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  $\boxed{-A-}$  and  $\boxed{-B-}$  to be determined at datum plane  $\boxed{-H-}$ .
- 8 Dimensions "D" and "E1" to be determined at datum plane  $\boxed{-H-}$ .
- 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   | Gain Option | Lead Free | Package  | Container | Pack Qty |
|---------|---------------|-------------|-----------|----------|-----------|----------|
| FMS6246 | FMS6246MTC20  | 6dB         | Yes       | TSSOP-20 | Rail      | 94       |
| FMS6246 | FMS6246MTC20X | 6dB         | Yes       | TSSOP-20 | Reel      | 2500     |

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

Contact Fairchild for additional gain options. Refer to the Factory Programming Options table for more information.

## TRADEMARKS

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|                                      |                     |               |                     |                 |
|--------------------------------------|---------------------|---------------|---------------------|-----------------|
| ACEx™                                | FAST®               | ISOPLANAR™    | PowerSaver™         | SuperSOT™-6     |
| ActiveArray™                         | FASTr™              | LittleFET™    | PowerTrench®        | SuperSOT™-8     |
| Bottomless™                          | FPS™                | MICROCOUPLER™ | QFET®               | SyncFET™        |
| Build it Now™                        | FRFET™              | MicroFET™     | QS™                 | TCM™            |
| CoolFET™                             | GlobalOptoisolator™ | MicroPak™     | QT Optoelectronics™ | TinyLogic®      |
| CROSSVOLT™                           | GTO™                | MICROWIRE™    | Quiet Series™       | TINYOPTO™       |
| DOME™                                | HiSeC™              | MSX™          | RapidConfigure™     | TruTranslation™ |
| EcoSPARK™                            | I <sup>2</sup> C™   | MSXPro™       | RapidConnect™       | UHC™            |
| E <sup>2</sup> CMOS™                 | i-Lo™               | OCX™          | μSerDes™            | UltraFET®       |
| EnSigna™                             | ImpliedDisconnect™  | OCXPro™       | ScalarPump™         | UniFET™         |
| FACT™                                | IntelliMAX™         | OPTOLOGIC®    | SILENT SWITCHER®    | VCX™            |
| FACT Quiet Series™                   |                     | OPTOPLANAR™   | SMART START™        | Wire™           |
|                                      |                     | PACMAN™       | SPM™                |                 |
| Across the board. Around the world.™ |                     | POPT™         | Stealth™            |                 |
| The Power Franchise®                 |                     | Power247™     | SuperFET™           |                 |
| Programmable Active Droop™           |                     | PowerEdge™    | SuperSOT™-3         |                 |

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification | Product Status         | Definition                                                                                                                                                                                                            |
|--------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Advance Information      | Formative or In Design | This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.                                                                                    |
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