FAIRCHILD SEMICONDUCTOR TM

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ML6426

High Bandwidth Triple Video Filters with Buffered Outputs for RGB or YUV

Features

- 5V ±10% operation
- RGB/YUV filters for ATSC Digital Television VESA Standard
- 2:1 Mux Inputs for multiple RGB/YUV inputs
- Triple Reconstruction Filter options for 6.7, 12, 24, 30, and 36MHz to handle various line rates
- Multiple ML6426 outputs can be paralleled to drive RGB/YUV outputs at different frequencies for various line rates by means of Disable/Enable pin.
- 6dB drivers and sync tip clamps for DC restore
- DC restore with minimal tilt
- 0.4% differential gain on all channels
  0.4º differential phase on all channels
  0.8% total harmonic distortion on all channels
- 2kV ESD protection

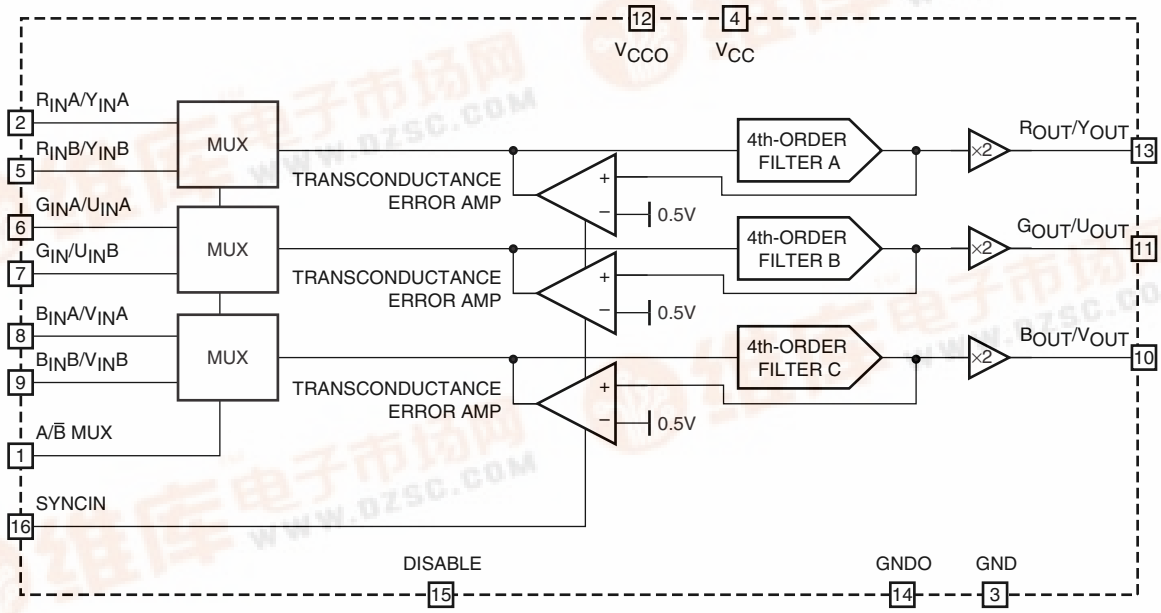
General Description

The ML6426 are a family of triple video filters with buffered outputs. There are several versions of the ML6426, each with different passband cut-off frequencies of 6.7MHz, 12MHz, 24MHz, 30MHz, and 36MHz. Each channel contains a 4th-order Butterworth lowpass reconstruction video filter. The filter is optimized for minimum overshoot and flat group delay and guaranteed differential gain and phase at the outputs of the integrated cable drivers.

All input signals from DACs are AC coupled into the ML6426. All channels have DC restore circuitry to clamp the DC input levels during video H-sync, using an output feedback clamp. An external H-sync signal is required for this purpose.

All outputs must be AC coupled into their loads. Each output can drive $2V_{P-P}$ into a 150Ω load. All channels have a gain of 2 (6dB) at $1V_{P-P}$ input levels.

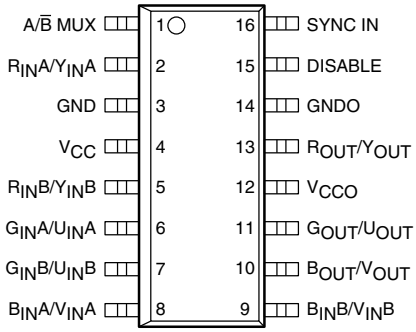
Block Diagram



	ML6426-1	ML6426-2	ML6426-3	ML6426-4	ML6426-5	ML6426-15
Filter A	6.7MHz	12MHz	24MHz	30MHz	36MHz	15MHz
Filter B	6.7MHz	12MHz	24MHz	30MHz	36MHz	15MHz
Filter C	6.7MHz	12MHz	24MHz	30MHz	36MHz	15MHz

Pin Configuration

ML6426
16-Pin Narrow SOIC (S16N)



TOP VIEW

Pin Description

PIN	NAME	FUNCTION
1	A/$\overline{B}$ MUX	**Logic input pin to select between Bank <A> and Bank <B> video inputs**. This pin is internally pulled high.
2	$R_{IN}A/Y_{IN}A$	**Unfiltered analog R- or Y-channel input for Bank <A>**. Sync must be provided at SYNC IN pin.
3	GND	**Analog ground**
4	V_{CC}	**Analog 5V supply**
5	$R_{IN}B/Y_{IN}B$	**Unfiltered analog R- or Y-channel input for Bank <B>**. Sync must be provided at SYNC IN pin.
6	$G_{IN}A/U_{IN}A$	**Unfiltered analog G- or U-channel input for Bank <A>**. Sync must be provided at SYNC IN pin.
7	$G_{IN}B/U_{IN}B$	**Unfiltered analog G- or U-channel input for Bank <B>**. Sync must be provided at SYNC IN pin.
8	$B_{IN}A/V_{IN}A$	**Unfiltered analog B- or V-channel input for Bank <A>**. Sync must be provided at SYNC IN pin.
9	$B_{IN}B/V_{IN}B$	**Unfiltered analog B- or V-channel input for Bank <B>**. Sync must be provided at SYNC IN pin.
10	B_{OUT}	**Analog B or V-channel output**
11	G_{OUT}	**Analog G or U-channel output**
12	V_{CCO}	**5V power supply for output buffers**
13	R_{OUT}	**Analog R or Y-channel output**
14	GNDO	**Analog ground**
15	DISABLE	**Disable/Enable pin**. Turns the chip off when logic high. Internally pulled low.
16	SYNC IN	**Input for an external H-sync logic signal for filter channels**. CMOS level input. Active High.

Absolute Maximum Ratings

Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

Parameter	Min.	Max.	Unit
V_{CC}	–0.3	7	V
Junction Temperature		150	°C
ESD		>2000	V
Analog and Digital I/O	GND – 0.3	V_{CC} + 0.3	V
Storage Temperature Range	–65	150	°C
Lead Temperature (Soldering, 10 sec)		260	°C
Thermal Resistance (θ_{JA})		100	°C/W

Operating Conditions

Parameter	Min.	Max.	Unit
Temperature Range	0	70	°C
V_{CC} Range	4.5	5.5	V

Electrical Characteristics

Unless otherwise specified, V_{CC} = 5V±10%, T_A = Operating Temperature Range (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
General						
I_{CC}	Supply Current	No Load (V_{CC} = 5.5V)		52	80	mA
A_V	Low Frequency Gain (R, G, B)	V_{IN} = 100mV_{P-P} at 100KHz	5.34	6.0	6.65	dB
V_{OUT}	Output Level during Sync (R, G, B,)	DURING SYNC	0.7	0.9	1.2	V
	Output Capability	RL = 150Ω, AC-coupled@1MHz	2			V_{P-P}
t_{CLAMP}	Clamp Response Time	Settled to Within 10mV, C_{IN} = 0.1µF		10		ms
V_I	Input Signal Dynamic Range (R, G, B,)	AC Coupled		1.4		V_{P-P}
OS	Peak Overshoot (R, G, B,)	2V_{P-P} Output Pulse		4.3		%
C_L	Output Load Capacitance (R, G, B,)	All Outputs			35	pF
	Output Load Drive Capability, per Pin (YUV or RGB Outputs)	One Load is 150Ω		2		loads
dG	Differential Gain (R, G, B,)	All Outputs at $f_C/2$		0.4		%
dϕ	Differential Phase (R, G, B,)	All Outputs at $f_C/2$		0.4		°
T_{HD}	Output Distortion (R, G, B,)	V_{OUT} = 2V_{P-P} at 1 MHz		0.8		%
PSRR	PSRR (R, G, B,)	0.5V_{P-P} (100kHz) at V_{CC}		35		dB
I_{SC}	Output Short Circuit Current (R, G, B,)	Note 2		120		mA
V_{IH}	Input Voltage Logic High	DISABLE, SYNC IN	2.5			V
V_{IL}	Input Voltage Logic Low	DISABLE, SYNC IN			1.0	V
T_{MUX}	Input Mux Data Valid Time	A/$\overline{B}$ Mux Pin Valid High or Low		2		µs

Electrical Characteristics (continued)

Unless otherwise specified, V_{CC} = 5V±10%, T_A = Operating Temperature Range (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
6.7MHz Filter: ML6426-1						
f_{1dB}	–1dB Bandwidth Flatness (R, G, B,)	25°C	4.0	4.8		MHz
f_C	–3dB Bandwidth Flatness (R, G, B,)	25°C	6.0	6.7		MHz
$f_{0.8fc}$	0.8 x f_C Attenuation			1.5		dB
f_{SB}	StopBand Rejection (All Channels ≥ 4 f_C)	f_{IN} ≥ 4 fC, Note 3	–38	–42		dB
NOISE	Output Noise (R, G, B,)	Fullband		1.0		mV_{RMS}
X_{TALK}	Crosstalk	Input of 0.5V_{P-P} at 1 MHz Between any two Channels		–55		dB
X_{TALK}	A/$\overline{B}$ MUX Crosstalk	Input of 0.5V_{P-P} at 3.58/4.43MHz		–54		dB
T_{PD}	Group Delay (R, G, B,)	100kHz		70		ns
ΔT_{PD}	Group Delay Deviation from Flatness (R, G, B,)	to 3.58MHz		4.0		ns
		to 4.43MHz		8.0		ns
		to 10MHz		9		ns
12MHz Filter: ML6426-2						
f_{1dB}	–1dB Bandwidth Flatness (R, G, B,)	25°C	7.8	9.2		MHz
f_C	–3dB Bandwidth Flatness (R, G, B,)	25°C	10.8	12		MHz
$f_{0.8fc}$	0.8 x f_C Attenuation			1.2		dB
f_{SB}	StopBand Rejection (All Channels ≥ 4 f_C)	f_{IN} ≥ 4 f_C, Note 3		–40		dB
NOISE	Output Noise (R, G, B,)	Fullband		1		mV_{RMS}
X_{TALK}	Crosstalk	Input of 0.5V_{P-P} at 1 MHz Between any two Channels		–55		dB
X_{TALK}	A/$\overline{B}$ MUX Crosstalk	Input of 0.5V_{P-P} at 3.58/4.43MHz		–54		dB
T_{PD}	Group Delay (R, G, B,)	100kHz		40		ns
ΔT_{PD}	Group Delay Deviation from Flatness (R, G, B,)	to 3.58MHz		1		ns
		to 4.43MHz		1		ns
		to 10MHz		7		ns
24MHz Filter: ML6426-3						
f_{1dB}	–1dB Bandwidth Flatness (R, G, B,)	25°C	13.6	16		MHz
f_C	–3dB Bandwidth Flatness (R, G, B,)	25°C	21.6	24		MHz
$f_{0.8fc}$	0.8 x f_C Attenuation			1.7		dB
f_{SB}	StopBand Rejection (All Channels ≥ 4 f_C)	f_{IN} ≥ 4 f_C, Note 3		–40		dB
NOISE	Output Noise (R, G, B,)	Fullband		1.0		mV_{RMS}
X_{TALK}	Crosstalk	Input of 0.5V_{P-P} at 1 MHz Between any two Channels		–55		dB
X_{TALK}	A/$\overline{B}$ MUX Crosstalk	Input of 0.5V_{P-P} at 3.58/4.43MHz		-54		dB
T_{PD}	Group Delay (R, G, B,)	100kHz		22		ns
ΔT_{PD}	Group Delay Deviation from Flatness (R, G, B,)	to 3.58MHz		1		ns
		to 4.43MHz		1		ns
		to 10MHz		2		ns

Electrical Characteristics (continued)

Unless otherwise specified, V_{CC} = 5V±10%, T_A = Operating Temperature Range (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
30MHz Filter: ML6426-4						
f_{1dB}	–1dB Bandwidth Flatness (R, G, B,)	25°C	15.3	18		MHz
f_C	–3dB Bandwidth Flatness (R, G, B,)	25°C	27	30		MHz
$f_{0.8fc}$	0.8 x f_C Attenuation			1.7		dB
f_{SB}	StopBand Rejection (All Channels ≥ 4 f_C)	f_{IN} ≥ 4 f_C, Note 3		-40		dB
NOISE	Output Noise (R, G, B,)	Fullband		1.0		mV_{RMS}
X_{TALK}	Crosstalk	Input of 0.5V_{P-P} at 1 MHz Between any two Channels		-55		dB
X_{TALK}	A/$\overline{B}$ MUX Crosstalk	Input of 0.5V_{P-P} at 3.58/4.43MHz		-54		dB
T_{PD}	Group Delay (R, G, B,)	100kHz		18		ns
ΔT_{PD}	Group Delay Deviation from Flatness (R, G, B,)	to 10MHz		0.5		ns
		to 27MHz		2		ns
36MHz Filter: ML6426-5						
f_{1dB}	–1dB Bandwidth Flatness (R, G, B,)	25°C	17	20		MHz
f_C	–3dB Bandwidth Flatness (R, G, B,)	25°C	32.4	36		MHz
$f_{0.8fc}$	0.8 x f_C Attenuation			2		dB
f_{SB}	StopBand Rejection (All Channels ≥ 4 f_C)	f_{IN} ≥ 4 f_C, Note 3		–40		dB
NOISE	Output Noise (R, G, B,)	Fullband		1.0		mV_{RMS}
X_{TALK}	Crosstalk	Input of 0.5V_{P-P} at 1 MHz Between any two Channels		–55		dB
X_{TALK}	A/$\overline{B}$ MUX Crosstalk	Input of 0.5V_{P-P} at 3.58/4.43MHz		–54		dB
T_{PD}	Group Delay (R, G, B,)	100kHz		17		ns
ΔT_{PD}	Group Delay Deviation from Flatness (R, G, B,)	to 10MHz		0.5		ns
		to 30MHz		4		ns
15MHz Filter: ML6426-15						
f_{1dB}	–1dB Bandwidth Flatness (R, G, B,)	25°C	10.8	12.2		MHz
f_C	–3dB Bandwidth Flatness (R, G, B,)	25°C	13.8	15		MHz
$f_{0.8fc}$	0.8 x f_C Attenuation			1.2		dB
f_{SB}	StopBand Rejection (All Channels ≥ 4 f_C)	f_{IN} ≥ 4 f_C, Note 3		–40		dB
NOISE	Output Noise (R, G, B,)	Fullband		1.0		mV_{RMS}
X_{TALK}	Crosstalk	Input of 0.5V_{P-P} at 1 MHz Between any two Channels		–55		dB
X_{TALK}	A/$\overline{B}$ MUX Crosstalk	Input of 0.5V_{P-P} at 3.58/4.43MHz		–54		dB
T_{PD}	Group Delay (R, G, B,)	100kHz		40		ns
ΔT_{PD}	Group Delay Deviation from Flatness (R, G, B,)	to 3.58MHz		1		ns
		to 4.43MHz		1		ns
		to 10MHz		9		ns

Notes

1. Limits are guaranteed by 100% testing, sampling, or correlation with worst case test conditions.
2. Sustained short circuit protection limited to 10 seconds.
3. 38dB is based on tester noise limits.

Functional Description

The ML6426 is a triple monolithic continuous time video filter designed for reconstructing video signals from an YUV/RGB video D/A source. The ML6426 is intended for use in AC coupled input and output applications.

The filters approximate a 4th-order Butterworth characteristic with an optimization toward low overshoot and flat group delay. All outputs are capable of driving $2V_{P-P}$ into AC coupled 150Ω video loads, with up to 35pF of load capacitance. All outputs are capable of driving a 75Ω load at $1V_{P-P}$.

All channels are clamped during sync to establish the appropriate output voltage swing range (DC restore). Thus the input coupling capacitors do not behave according to the conventional RC time constant. In most applications, the ML6426's input coupling capacitors are only 0.1µF. An external CMOS compatible HSYNC pulse is required which is Active High on the SYNC IN Pin. See Figure 2.

During sync, the feedback clamp sources/sinks current to restore the DC level. The net result is that the average input current is zero. Any change in the input coupling capacitors' value will linearly affect the clamp response times.

Each channel is essentially tilt-free. Each input is clamped by a feedback amp which responds to the output during sync.

The ML6426 is robust and stable under all stated load and input conditions. Bypassing both V_{CC} pins directly to ground ensures this performance.

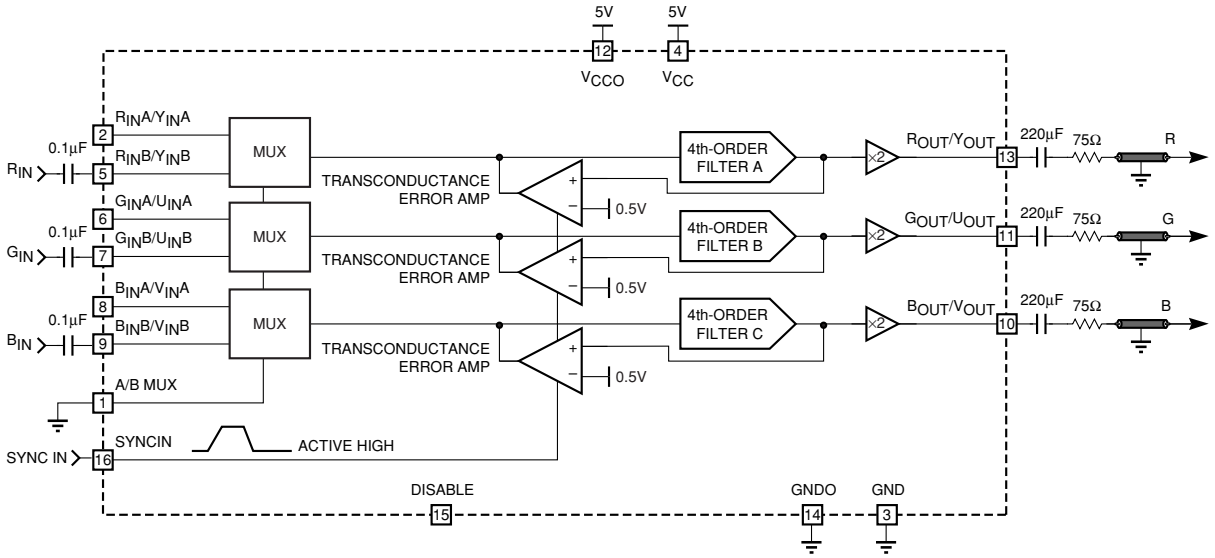


Figure 1. Typical Application Schematic

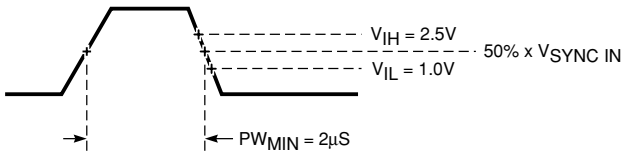


Figure 2. SYNC IN Pulse Width

Typical Applications

Reconstruction filter selection for HDTV and VGA signal filtering

The filtering requirements for HDTV and VGA standards vary depending on the resolution of the image to be displayed, and its refresh rate. The actual refresh rate of the display is not necessarily the same as the transmission rate of the frames of images. Some formats use a frame rate of 30Hz, but the display of those formats cannot be scanned onto the CRT at 30Hz. Excessive large area flicker would result. Such kinds of flicker can be seen on a PAL display with its brightness set high. To avoid this, the video will need to be stored in a frame buffer. This buffer already exists in the MPEG decoder of HDTV systems, so there is no cost penalty. The buffer is read out at twice the rate as the frame rate for 30Hz systems, thus getting us a refresh rate of 60Hz. Similar things are done for the 24Hz frame rate formats to boost them to a 60Hz refresh rate.

Table 1. HDTV / Advanced TV Applications: (From Table 10.3 from ATSC document A54)

Pixels	Vertical Lines	Aspect Ratio	Picture Transmission Rate
1920	1080	16:9	60I, 30P, 24P
1280	720	16:9	60P, 30P, 24P
704	480	16:9 and 4:3	60P, 60I, 30P, 24P
640	480	4:3	60P, 60I, 30P, 24P

P=progressive scan, I=interlaced scan

Table 2. Choosing the Correct Reconstruction Filter and Video Amplifier for TV Applications, ML6426 options

Standard	Pixels	Vertical Lines	Picture Transmission Rate (Note 2)	Display Refresh Rate (Note 2)	Approximate Horizontal Rate	Approximate Sample Clock	Approximate Reconstruction Filter Cutoff	Fairchild Filter to Use (Note 3)
	1920	1080	30P, 24P	60Hz	70.6KHz	162MHz	81MHz	N/A
SMPTE	1280	720	60P, 30P, 24P	60Hz	47.1KHz	60MHz	30MHz	ML6426-5 ML6426-4
	704	480 (Note 1)	60I	60Hz	15.7KHz	13.5MHz	6.75MHz	ML6426-1
	704	480	60P, 30P, 24P	60Hz	31KHz	27MHz	13.5MHz	ML6426-2 ML6426-4
	640	480 (Note 1)	60I	60Hz	15.7KHz	24.5MHz	12MHz	ML6426-2
	640	480	60P, 30P, 24P	60Hz	31KHz	12.27MHz	6MHz	ML6426-1

P=progressive scan, I=interlaced scan, na = not available

Notes

1. NTSC display rates, can be fed directly into NTSC encoder (set top box)
2. 60 Hz also includes 59.94Hz
3. Custom frequencies ranging ± 3 to 6MHz can be special cut to order

Pixel clock rates for the output D/A converters can be roughly determined from the Table 1. Don't forget that the deflection system of a CRT display needs retrace time for the vertical and horizontal.

This retrace time can vary from one design of an HDTV set to another, as it only involves tradeoffs between the frame buffer in the MPEG decoder and the CRT deflection system. Allowing for 10% retrace time for the vertical and 20% for the horizontal, the appropriate Reconstruction Filter is summarized in Table 2.

For VGA or RGB monitors, the following resolutions can use the corresponding Reconstruction Filter and Video Amplifier as shown in Table 3.

Figures 4, 5, and 6 show system diagrams when the ML6426 provides a good solution. Figure 7 provides a more detailed description for advanced TV applications using various resolutions for legacy video, SDTV, and HDTV.

Using the ML6426 in Multiple Resolutions

Several ML6426 devices can be used in parallel to construct a selectable filter selection block ranging from frequencies between 6.7 MHz to 50MHz. Each ML6426 can be individually controlled via the disable pin. In a parallel configuration, as shown in Figure 3 and 7, several ML6426 devices can be used and selected via general purpose I/O or other logic to perform the proper reconstruction filtering for the resolution of choice. This configuration allows for a minimum of bill of materials and reduces cost. Fairchild's ML6426 EVAL Kit demonstrates multi-resolution designs. Furthermore, since the ML6426 pin-out is identical for all the options, the filters can be interchanged. This allows for ease of product migration to integrate newer resolutions to filter and drive various DAC outputs at different sampling frequencies.

Table 3. Choosing the Correct Reconstruction Filter and Video Amplifier for TV Applications, ML6426 options

Pixels	Vertical Lines	Name	Refresh Rate (Prog except noted)	Horizontal Rate	Sample Clock	Reconstruction Filter Cutoff	Fairchild Filter to Use
640	480	VGA	60Hz	31.5kHz	25.175MHz	12.5MHz	ML6426-2
		VGA	72Hz	37.9kHz	31.5MHz	15.5MHz	ML6426-3
		VGA	75Hz	37.5kHz	31.5MHz	15.5MHz	ML6426-3
800	600	SVGA	56Hz	35.1kHz	36MHz	18MHz	ML6426-3
		SVGA	60Hz	37.9kHz	40MHz	20MHz	ML6426-3
		SVGA	72Hz	48.1kHz	50MHz	25MHz	ML6426-3
		SVGA	75Hz	46.9kHz	49.5MHz	25MHz	ML6426-3
1024	768	XGA	43Hz Interlaced	35.5kHz	44.9MHz	23MHz	ML6426-3
		XGA	60Hz	37.9kHz	65MHz	33MHz	ML6426-5
		XGA	70Hz	56.5kHz	75MHz	37.5MHz	ML6426-5
1280	1024	SXGA	75Hz	80kHz	135MHz	68MHz	na
		SXGA	60Hz		113MHz	57MHz	na
1600	1200	UXGA	60Hz		166MHz	83MHz	na

N/A = not available

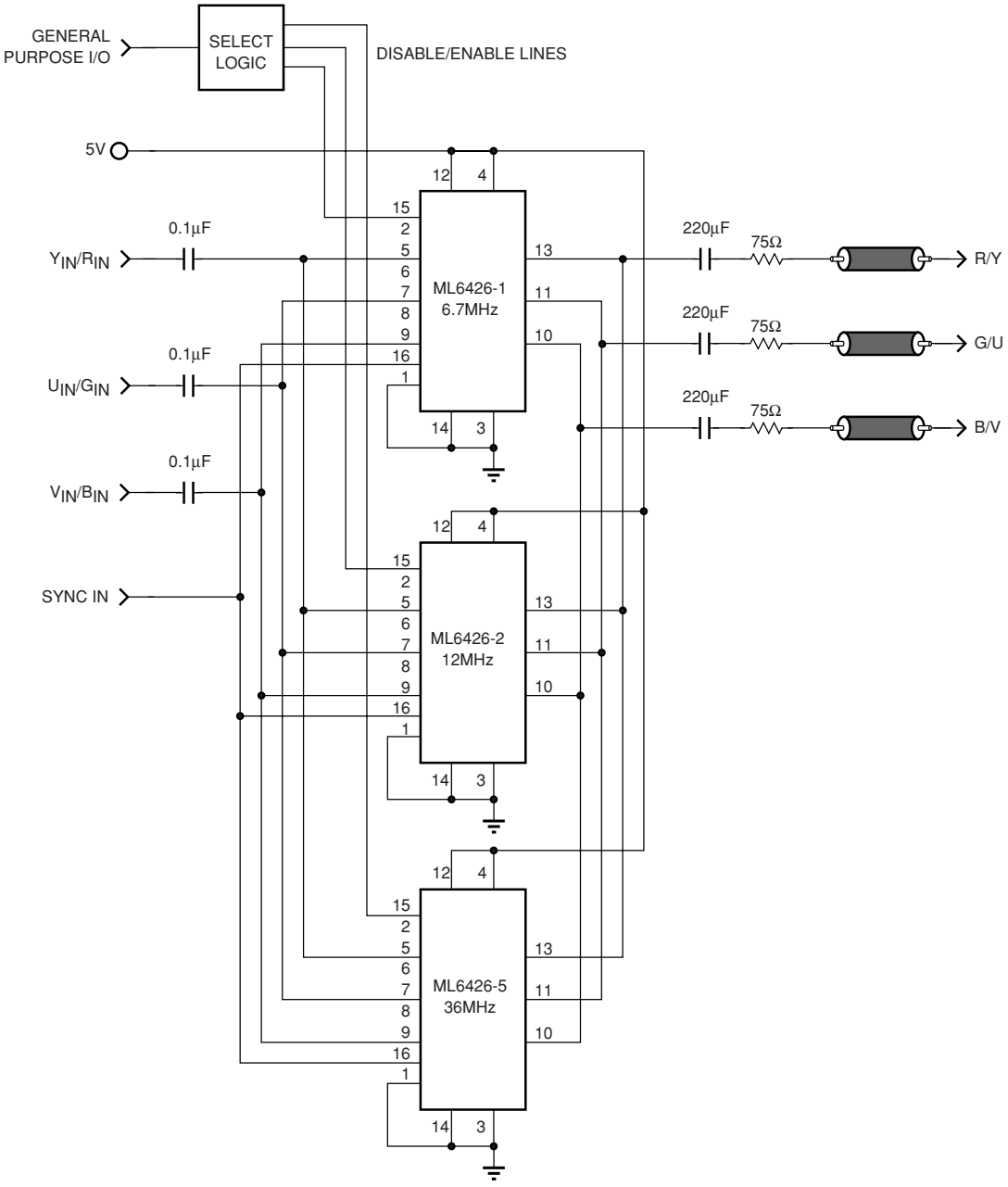


Figure 3. ATSC Digital Television Application

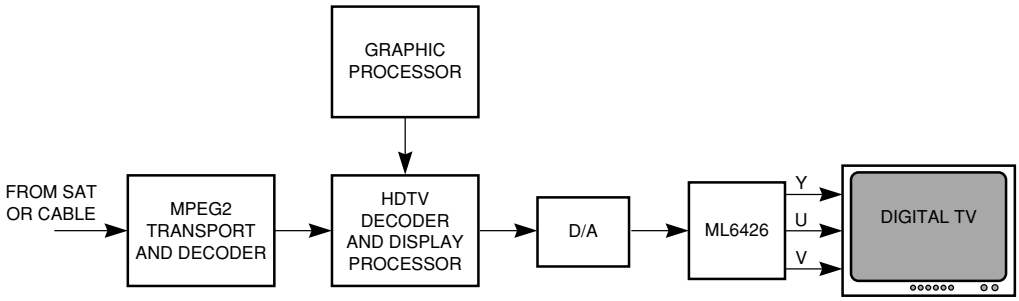


Figure 4. Digital TV Receiver or HDTV Decoder Box

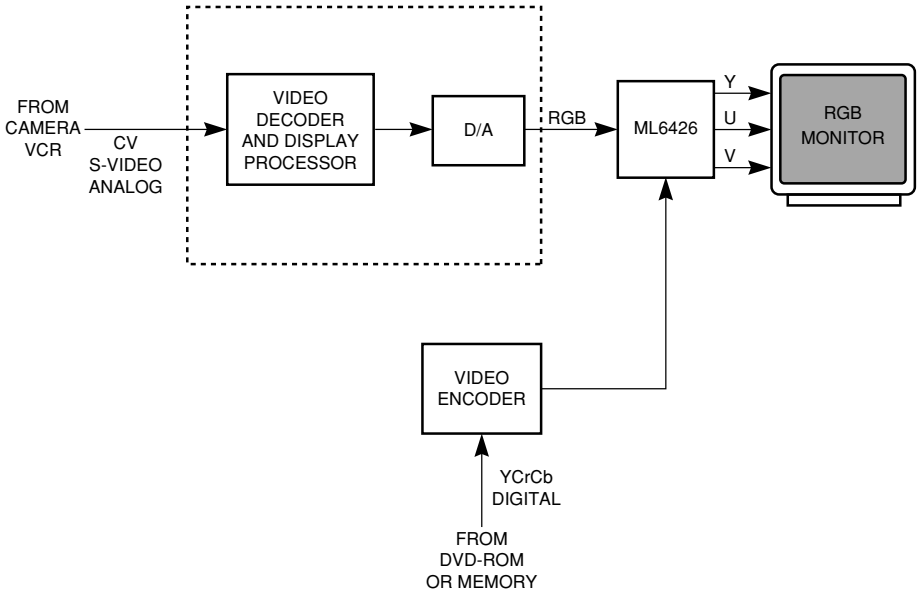


Figure 5. PC Graphics/Frame Grabber Editing Card

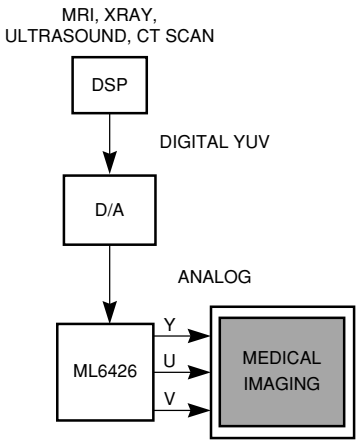


Figure 6. PC MRI, XRAY, Ultrasound, CT Scan

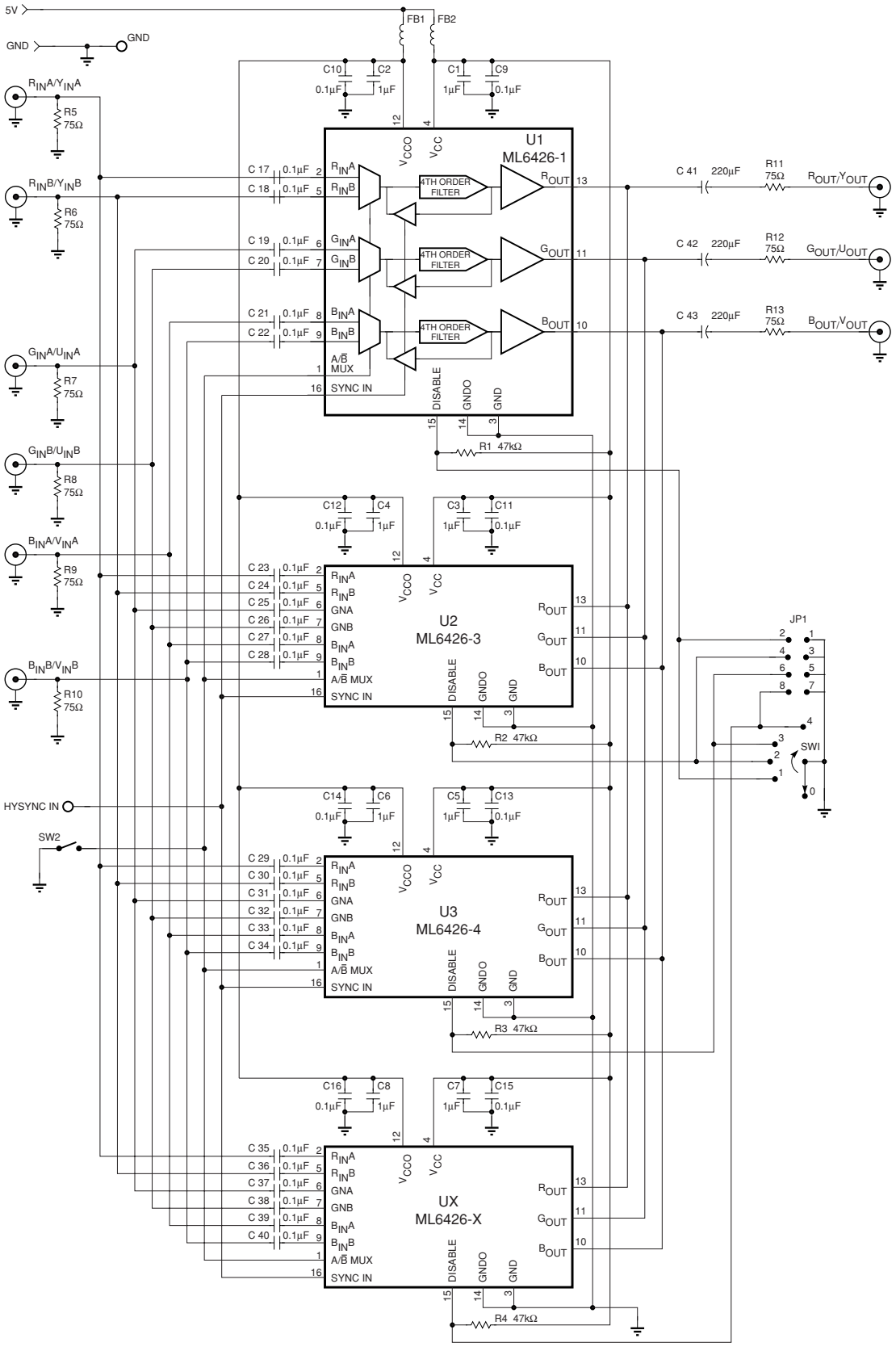


Figure 7. Typical Applications Schematic

Performance Data

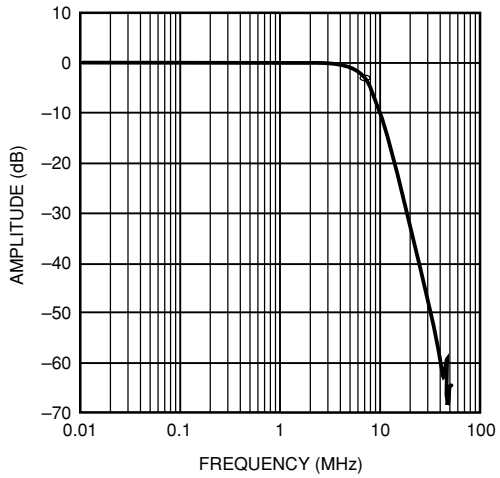


Figure 8. Passband Flatness all Outputs (Normalized) 6.7 MHz, ML6426CS-1

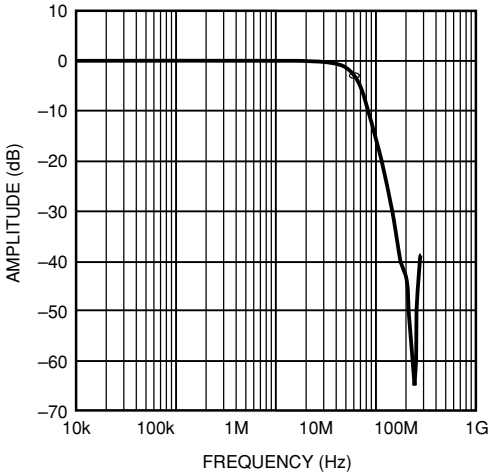


Figure 9. Passband Flatness all Outputs (Normalized) 12 MHz, ML6426CS-2

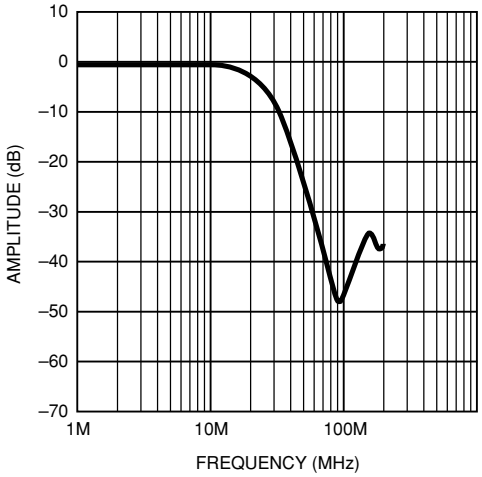


Figure 10. Passband Flatness all Outputs (Normalized) 24 MHz, ML6426CS-3

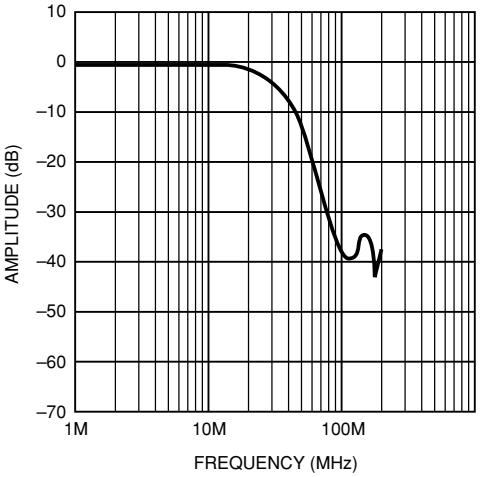


Figure 11. Passband Flatness all Outputs (Normalized) 30 MHz, ML6426CS-4

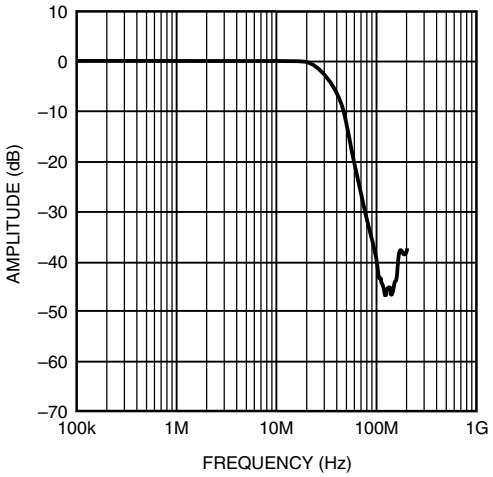


Figure 12. Passband Flatness all Outputs (Normalized) 36MHz, ML6426CS-5

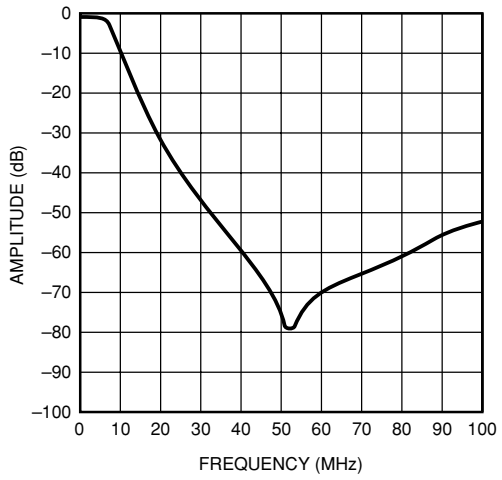


Figure 13. Frequency Response All Outputs ML6426-CS-1

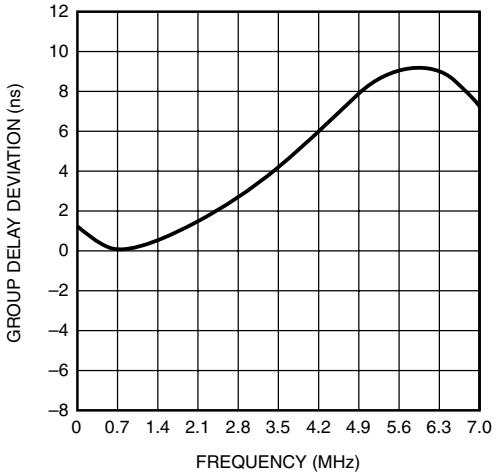


Figure 14. Group Delay Deviation of Passband, All Outputs ML6426CS-1

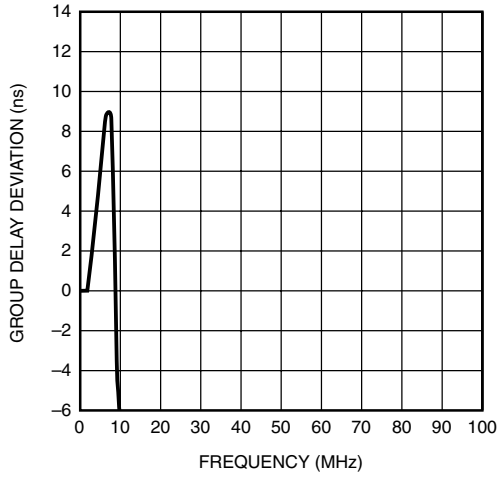


Figure 15. Group Delay Deviation All band, All Outputs ML6426CS-1

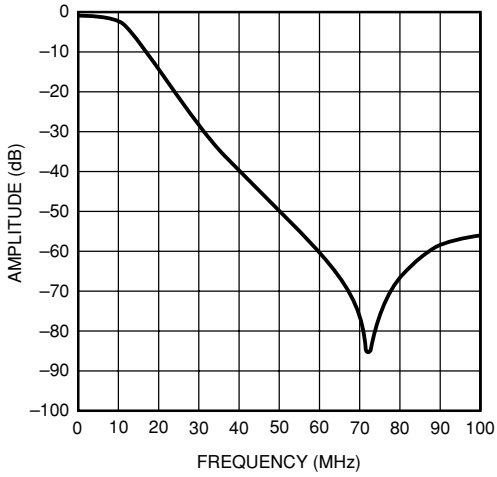


Figure 16. Frequency Response All Outputs ML6426CS-2

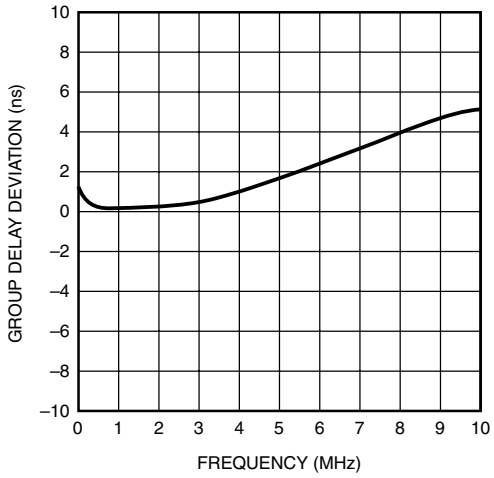


Figure 17. Group Delay Deviation of Passband, All Outputs ML6426CS-2

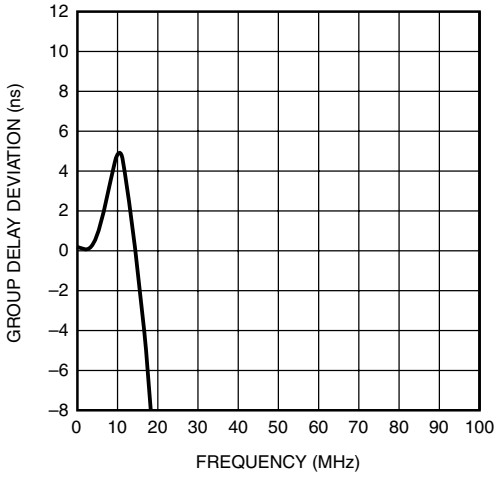


Figure 18. Group Delay Deviation All Band, All Outputs ML6426CS-2

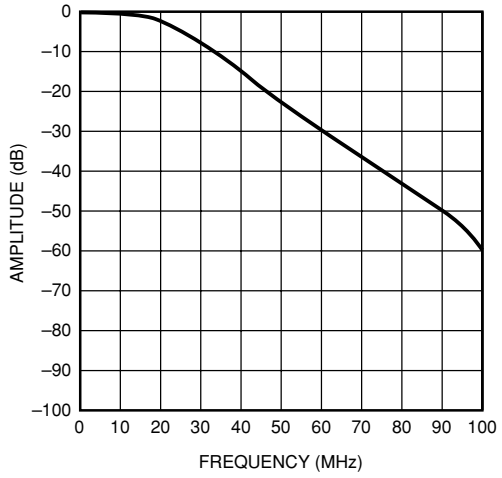


Figure 19. Frequency Response All Outputs ML6426CS-3

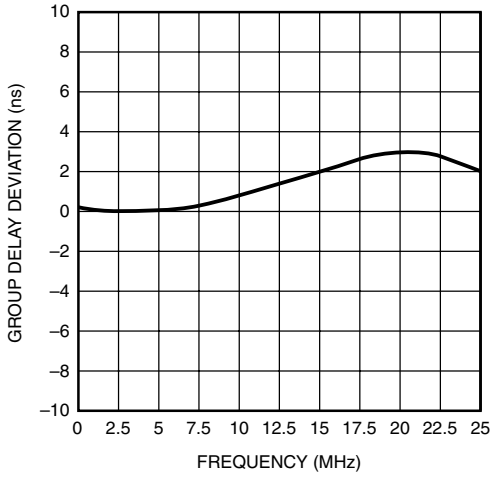


Figure 20. Group Delay Deviation of Passband, All Outputs ML6426CS-3

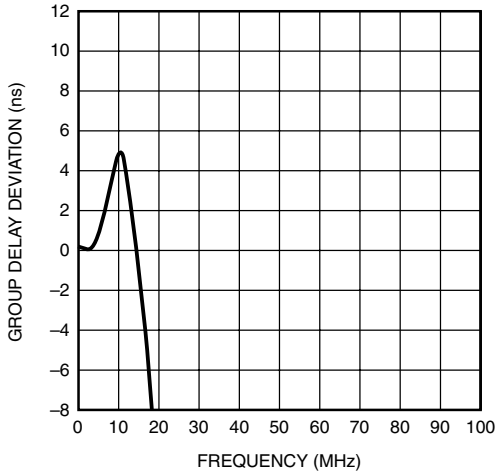


Figure 21. Group Delay Deviation All Band, All Outputs ML6426CS-3

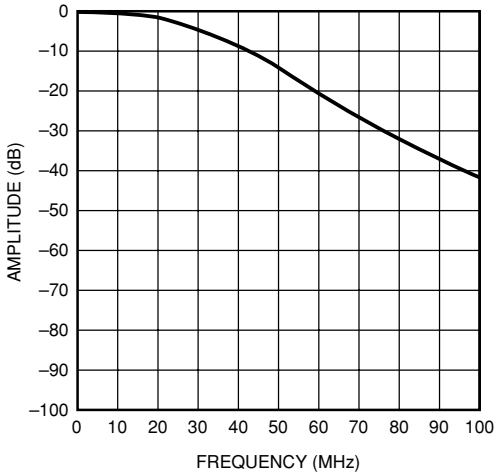


Figure 22. Frequency Response All Outputs ML6426CS-4

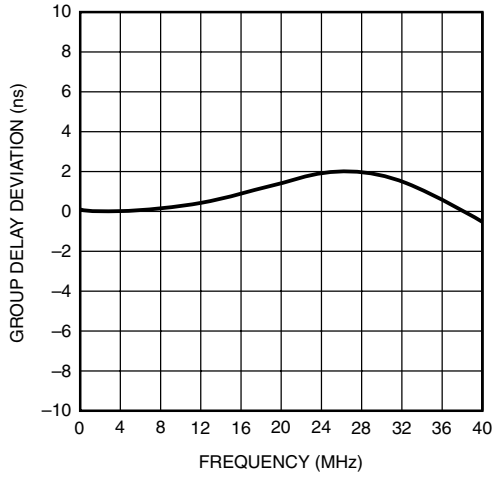


Figure 23. Group Delay Deviation of Passband, All Outputs ML6426CS-4

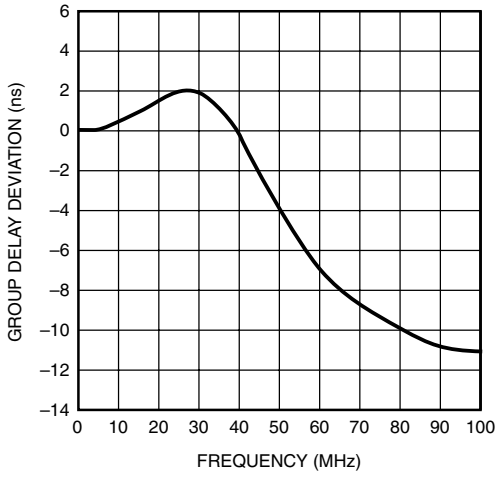


Figure 24. Group Delay Deviation All Band, All Outputs ML6426CS-4

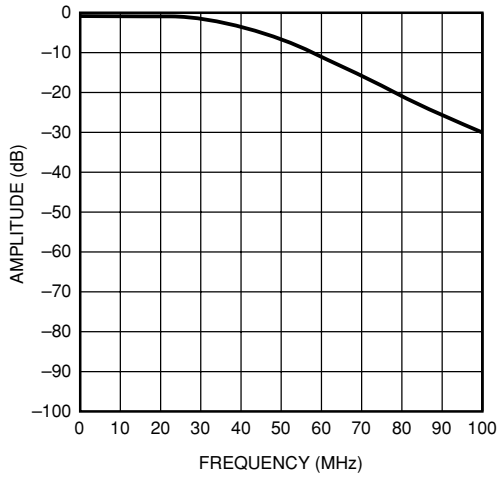


Figure 25. Frequency Response All Outputs ML6426-CS-5

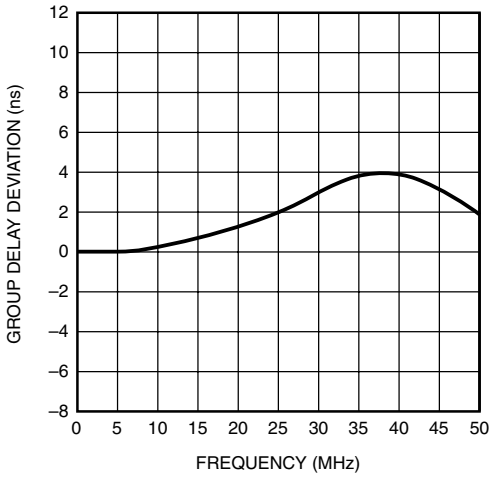


Figure 26. Group Delay Deviation of Passband, All Outputs ML6426CS-5

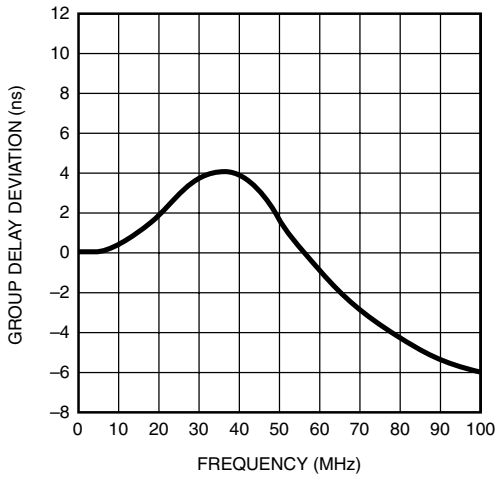
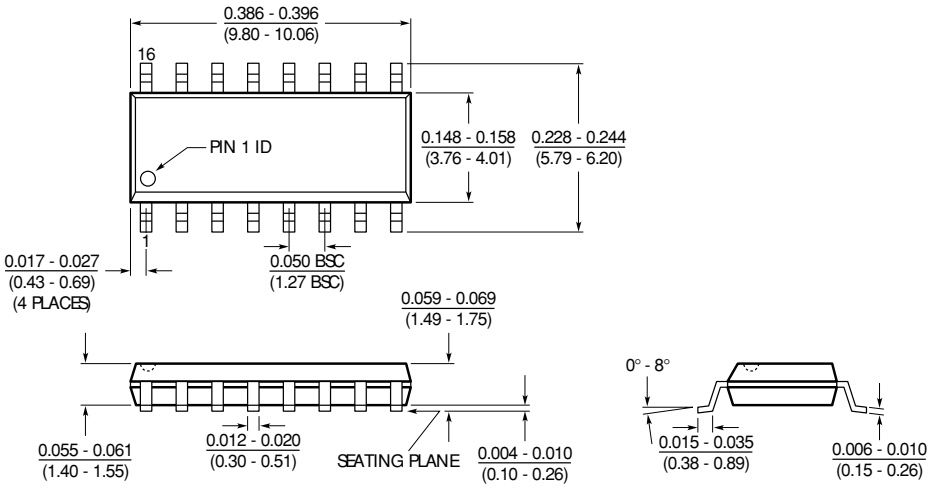


Figure 27. Group Delay Deviation All band, All Outputs ML6426CS-5

Mechanical Dimensions

Package: S16N
16-Pin Narrow SOIC



Ordering Information

Model	Part Number	Cuttoff Freq	Lead Free	Package	Container	Pack Quantity
ML6426	ML6426CS1	6.7MHz		SOIC-16 (Narrow)	Rail	48
ML6426	ML6426CS1X	6.7MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS1X_NL	6.7MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS2	12MHz		SOIC-16 (Narrow)	Rail	48
ML6426	ML6426CS2X	12MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS3	24MHz		SOIC-16 (Narrow)	Rail	48
ML6426	ML6426CS3X	24MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS4	30MHz		SOIC-16 (Narrow)	Raill	48
ML6426	ML6426CS4X	30MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS4X_NL	30MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS5	36MHz		SOIC-16 (Narrow)	Rail	48
ML6426	ML6426CS5X	36MHz		SOIC-16 (Narrow)	Reel	2500
ML6426	ML6426CS15	15MHz		SOIC-16 (Narrow)	Rail	48
ML6426	ML6426CS15X	15MHz		SOIC-16 (Narrow)	Reel	2500

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