19-0671; Rev 0; 11/06

MAXIM

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

General Description

The MAX7481/MAX7482 bidirectional video filters/buffers provide the reconstruction filter and line drive buffer for both composite (CVBS) and S-Video (Y/C) video signals in playback mode, and anti-aliasing in record mode for portable media devices. Each channel consists of a lowpass filter and an output buffer capable of driving a full $2V_{P-P}$ video signal into one standard 150Ω load (DC-coupled to ground). In record mode, the MAX7481/MAX7482 output buffers have a gain of +6dB. In playback mode, the MAX7481 output buffers have a gain of +6dB and the MAX7482 output buffers have a gain of +7dB.

The MAX7481/MAX7482 feature DirectDrive™ by utilizing an internal negative charge pump and regulator to maintain the output blanking level at ground, eliminating the need for a negative supply voltage, a large output coupling capacitor, or a sag correction configuration.

The MAX7481/MAX7482 operate from a single +2.7V to +3.6V power supply. These devices are available in a space-saving 28-pin TQFN package and operate over the -40°C to +85°C extended temperature range.

Applications

Portable Media Devices

Digital Camcorders

Digital Cameras

Features

- **Composite and S-Video, Video-Playback and Video-Record Interface for Portable Video Devices**
- **Saves Space by Sharing Connectors in Portable Devices**
- **DirectDrive**
  - **Eliminates Expensive AC-Coupling Capacitors**
  - **Blanking Level at Ground with Single Supply**
- **Composite and Y/C Signals**
- **Advanced Power-Down Modes for Extended Battery Life**
- **Low Supply Current in Shutdown Mode, < 1µA (typ)**
- **Filter Response Ideal for NTSC and PAL**
- **+6dB (MAX7481) or +7dB (MAX7482) Gain**
- **+2.7V to +3.6V Single-Supply Operation**
- **Small, 28-Pin, TQFN Package (5mm x 5mm)**

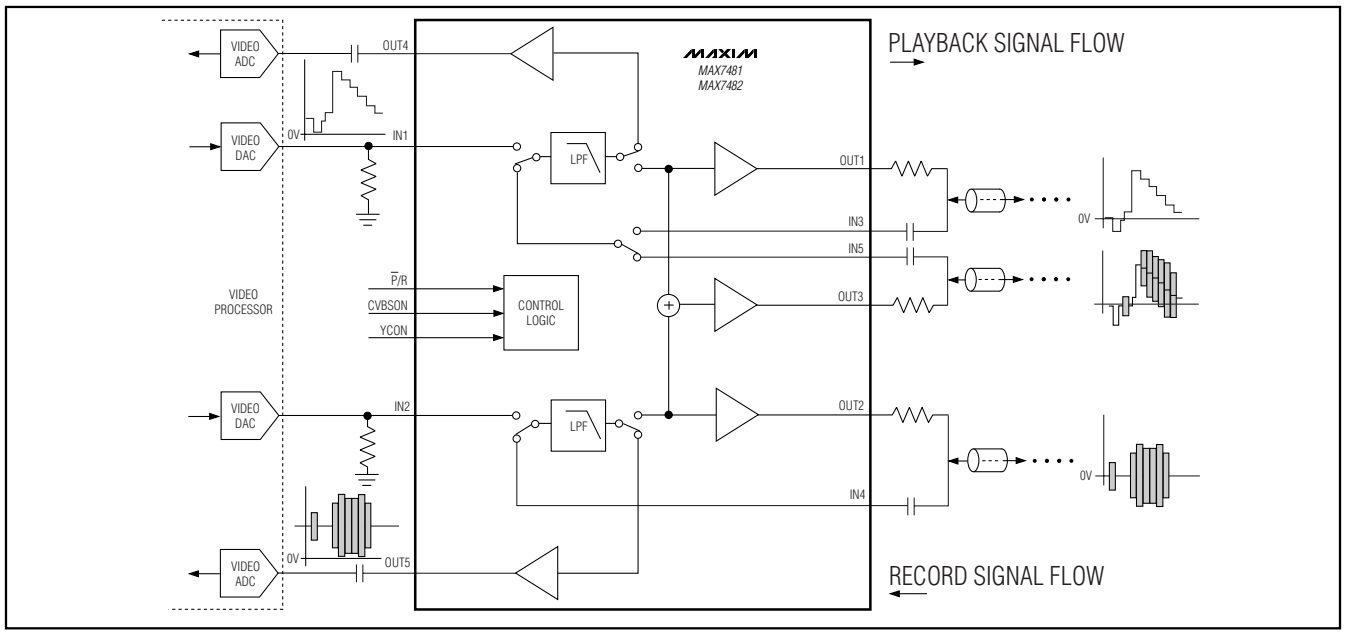
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX7481ETI+	-40°C to +85°C	28 TQFN-EP*	T2855-6
MAX7482ETI+	-40°C to +85°C	28 TQFN-EP*	T2855-6

+Denotes lead-free package.
**EP = Exposed pad.*

Pin Configuration appears at end of data sheet.

Simplified Block Diagram



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

ABSOLUTE MAXIMUM RATINGS

V_{CC} to GND ..... -0.3V to +4V
IN1–IN5 to GND ..... -0.3V to (V_{CC} + 0.3V)
OUT1–OUT5 to GND ..... -1.8V to (V_{CC} + 0.3V)
OUT1–OUT5 to GND (Shutdown) ..... -0.3V to (V_{CC} + 0.3V)
BIAS, SHDN, $\overline{P}$/R, YCON, CVBSON to GND ..... -0.3V to (V_{CC} + 0.3V)
CPV_{CC} to CPGND ..... -0.3V to +4V
C1P to GND ..... -0.3V to (V_{CC} + 0.3V)
C1N to GND ..... (V_{SS} - 0.3V) to +0.3V
CPGND to GND ..... -0.1V to +0.1V
CPV_{SS} to V_{SS} ..... -0.1V to +0.1V
V_{SS} to GND ..... -3.6V to +0.3V
Continuous Current
IN1–IN5, BIAS, CVBSON, YCON, C1P, C1N ..... ±50mA
Output Short-Circuit Current ..... ±90mA
Continuous Power Dissipation (T_A = +70°C)
28-Pin TQFN (derate 21.3mW/°C above +70°C) 1702mW
Operating Temperature Range ..... -40°C to +85°C
Junction Temperature ..... +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10s) ..... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{CC} = CPV_{CC} = +3.0V, T_A = +25°C, C1 = C2 = 1µF, C3 = C4 = C5 = 0.1µF, load at OUT1–OUT5 = 150Ω to GND, R_{BIAS} = 100kΩ to GND, unless otherwise noted. See the *Functional Diagram/Typical Application Circuit*.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Passband Flatness		f = 100kHz to 4.2MHz		-1		+1	dB
Stopband Attenuation		f = 27MHz		35			dB
Differential Gain Error	dG	5-step modulated staircase			0.2		%
Differential Phase Error	dP	5-step modulated staircase			0.3		Degrees
Signal-to-Noise Ratio	SNR	Peak signal ($2V_{P-P}$) to RMS noise, f = 100kHz to 4.2MHz			72		dB
Input Dynamic Swing	V_{RANGE}	IN1, V_{IN} = -0.10V to 0.92V				1.15	V_{P-P}
		IN2, V_{IN} = -0.09V to 0.92V				0.83	
		AC-coupled	IN3			1.15	
			IN4			0.90	
			IN5			1.15	
Input Leakage Current	I_{IN}					10	µA
Low Frequency Gain		f = 100kHz	MAX7481: All outputs MAX7482: OUT4, OUT5	5.5	6	6.5	dB
			MAX7482: OUT1, OUT2, OUT3	6.5	7	7.5	
Output Black Level Variation		OUT1, OUT2, OUT4				±150	mV
		OUT3, OUT5				±200	
Clamp Settling Time	T_{CLAMP}	To 5% with a 100 IRE step			300		Lines
Group-Delay Deviation	T_G	Deviation from 100kHz to 4.2MHz			4		ns
Line-Time Distortion	H_{DIST}	Deviation in a line with an 18µs, 100 IRE bar; 1 line = 63.5µs				0.3	%
Field-Time Distortion	V_{DIST}	Deviation in 130 lines with an 18µs, 100 IRE bar				0.5	%
Channel-to-Channel Crosstalk	X_{TALK}	f = 100kHz to 4.2MHz			-60		dB

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = CPV_{CC} = +3.0V, T_A = +25°C, C1 = C2 = 1µF, C3 = C4 = C5 = 0.1µF, load at OUT1–OUT5 = 150Ω to GND, R_{BIAS} = 100kΩ to GND, unless otherwise noted. See the *Functional Diagram/Typical Application Circuit*.)

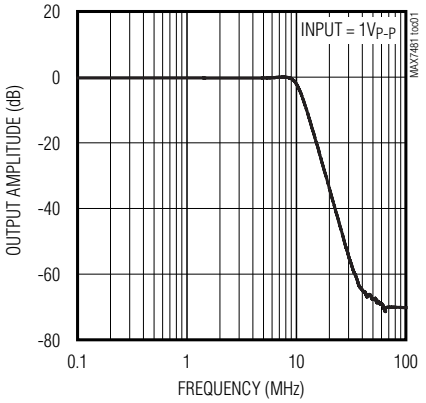
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Power-Supply Rejection Ratio	PSRR	V_{CC} = +2.7V to +3.6V		50			dB
CHARGE PUMP							
Switching Frequency					250		kHz
LOGIC SIGNALS (CVBSON, $\overline{P}$/R, YCON)							
Logic-Low Threshold	V_{IL}	V_{CC} = +2.7V to +3.6V				0.5	V
Logic-High Threshold	V_{IH}	V_{CC} = +2.7V to +3.6V		1.5			V
Logic Input Current	I_{IL}					10	µA
SUPPLY							
Supply Voltage Range	V_{CC}, CPV_{CC}			2.7		3.6	V
Quiescent Supply Current	I_{CC}	I_{CC} = I_{VCC} + I_{CPVCC}, no load, $\overline{P}$/R = GND, playback mode	CVBSON = YCON = GND		9	18	mA
			CVBSON = V_{CC}, YCON = GND		19	33	
			CVBSON = GND, YCON = V_{CC}		28	42	
			CVBSON = YCON = V_{CC}		40	52	
Shutdown Supply Current	I_{SHDN}	I_{SHDN} = I_{VCC} + I_{CPVCC}; SHDN = V_{CC}, $\overline{P}$/R = GND, CVBSON = YCON = V_{CC}			1	10	µA
Bias Voltage	V_{BIAS}				1		V

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

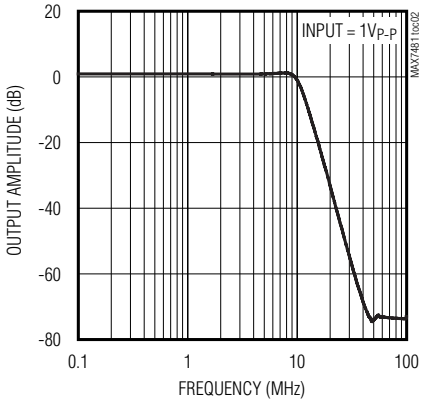
Typical Operating Characteristics

(V_{CC} = CPV_{CC} = +3.0V, T_A = +25°C, unless otherwise noted.)

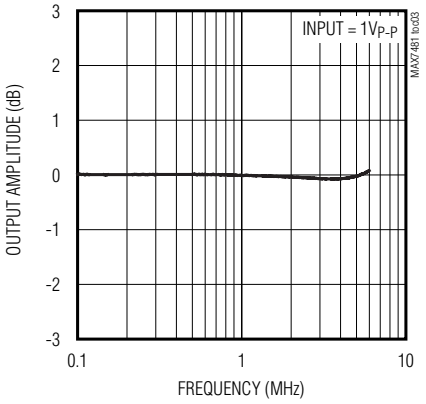
MAX7481 FREQUENCY RESPONSE



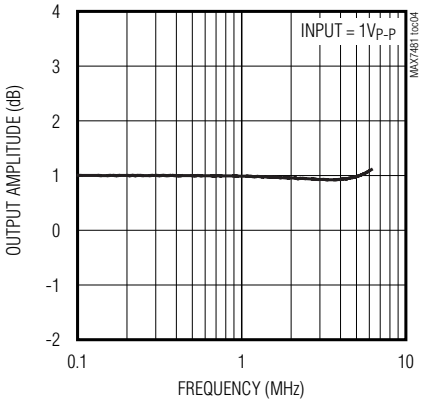
MAX7482 FREQUENCY RESPONSE



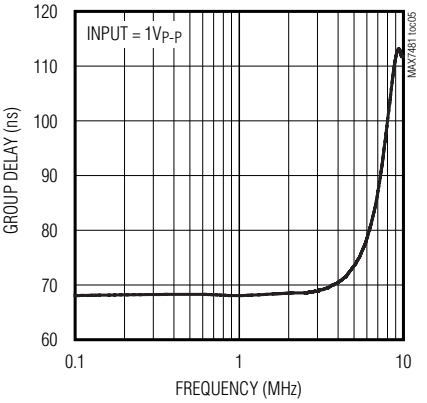
MAX7481 PASSBAND FLATNESS



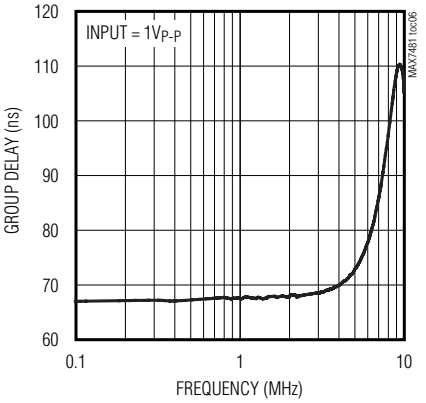
MAX7482 PASSBAND FLATNESS



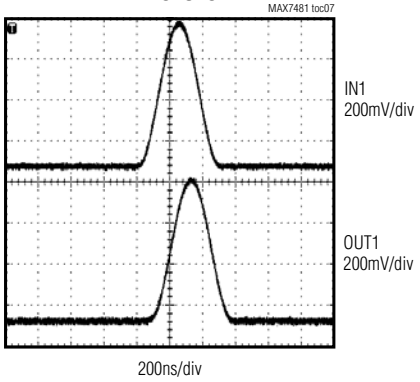
MAX7481 GROUP-DELAY RESPONSE



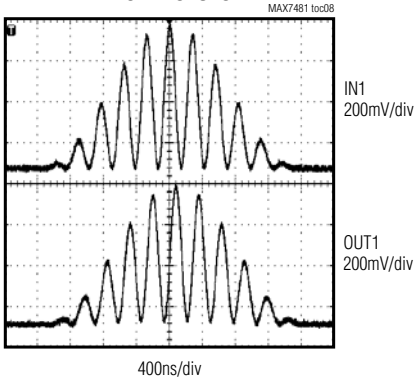
MAX7482 GROUP-DELAY RESPONSE



2T RESPONSE



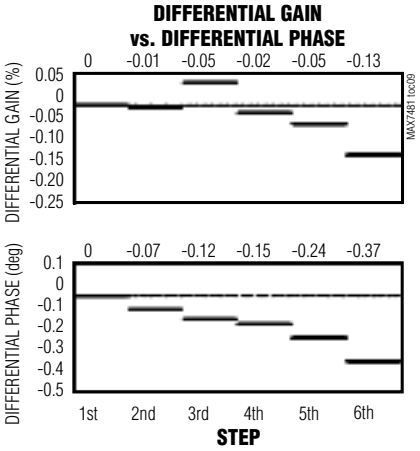
12.5T RESPONSE

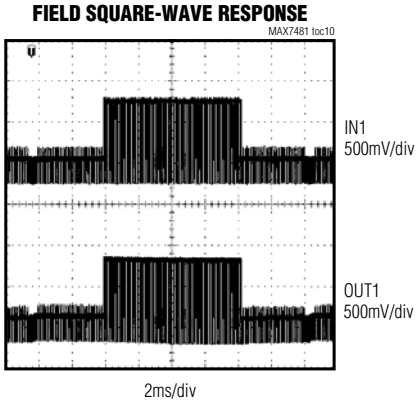


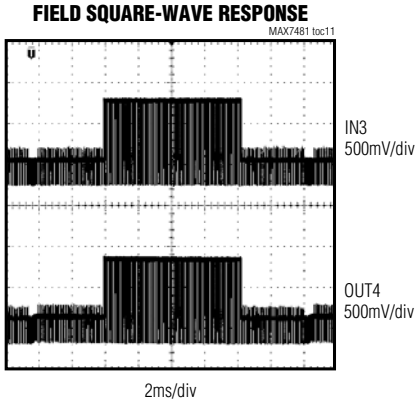
Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

Typical Operating Characteristics (continued)

(V_{CC} = CPV_{CC} = +3.0V, T_A = +25°C, unless otherwise noted.)







Pin Description

PIN	NAME	FUNCTION
1	CPV_{CC}	Charge-Pump Positive Power Supply. Bypass with a 1µF capacitor to CPGND.
2, 14, 17, 20	GND	Ground
3	IN2	Video Input 2
4	IN1	Video Input 1
5	OUT5	Video Output 5
6	OUT4	Video Output 4
7, 13, 23	V_{CC}	Positive Power Supply. Bypass with a 1µF capacitor to GND.
8	BIAS	Bias Current Setting Control. Connect a 100kΩ ±1% resistor from BIAS to GND.
9	SHDN	Shutdown Input. Drive high to put device in shutdown mode.
10	$\overline{P}$/R	Playback/Record Logic Input. Drive high for record mode and pull low for playback mode.
11	CVBSON	CVBS Select Logic Input. Drive high for composite video on output OUT3 in playback mode and output OUT4 in record mode. See Table 1.
12	YCON	Y/C Select Logic Input. Drive high to enable Y/C video on outputs OUT1 and OUT2 in playback mode and on outputs OUT4 and OUT5 in record mode. See Table 1.
15	IN3	Video Input 3
16	OUT1	Video Output 1
18	OUT3	Video Output 3
19	IN5	Video Input 5
21	OUT2	Video Output 2

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

Pin Description (continued)

PIN	NAME	FUNCTION
22	IN4	Video Input 4
24	V_{SS}	Negative Power Supply. Connect to CPV_{SS}.
25	CPV_{SS}	Charge-Pump Negative Power Supply. Bypass with a low-ESR 1µF capacitor to CPGND.
26	C1N	Charge-Pump Flying Capacitor Negative Terminal. Connect a low-ESR 1µF capacitor from C1P to C1N.
27	CPGND	Charge-Pump Power Ground
28	C1P	Charge-Pump Flying Capacitor Positive Terminal. Connect a low-ESR 1µF capacitor from C1P to C1N.
—	EP	Exposed Pad. Internally connected to GND. Do not route any PCB traces directly under the package. Connect EP to GND for improved heat dissipation.

Detailed Description

The MAX7481/MAX7482 bidirectional video filters and buffers are ideal for portable video applications where low-voltage, low-power operation is critical and applications that require both analog video inputs and outputs. The MAX7481/MAX7482 provide the reconstruction filter and line drivers for both composite video (CVBS) and Y/C (S-Video) for playback, while providing anti-aliasing filters and drivers for recording.

In playback mode, the IN1 and IN2 inputs are enabled while the IN3, IN4, and IN5 inputs are disabled. The MAX7481/MAX7482 provide the filtered Y/C outputs at OUT1 and OUT2, and the composite output at OUT3.

In record mode, IN1 and IN2 are disabled while IN3, IN4, and IN5 are enabled. Switches connecting OUT1 to GND, OUT2 to GND, and OUT3 to GND are turned on. These switches provide low-impedance paths to ground so that the same 75Ω external resistors that connect the playback outputs (OUT1, OUT2, and OUT3) and the external device can be used as terminating resistors for the recording signal source.

Inputs IN3, IN4, and IN5 require AC-coupling capacitors because the signal from the external video source can be DC level-shifted and an internal clamp uses these capacitors to restore the blanking level to GND. The internal clamp operates only on signals coming from the external source due to the uncertainty in the DC offset. The gain in either direction is fixed at +6dB for the MAX7481. The MAX7482 output buffers have a gain of +7dB in playback mode and +6dB in record mode.

The MAX7481/MAX7482 feature DirectDrive technology that allows the blanking level to stay at GND in a single supply system. The MAX7481/MAX7482 internally generate a negative supply voltage from an inverting charge pump and internal linear regulator. The regulated negative supply allows output buffers to drive $2V_{P-P}$ video signals without exceeding operating voltage limits.

Comparison Between DirectDrive Output and AC-Coupled Output

DirectDrive refers to the connection of the video signal from the MAX7481/MAX7482 to an external device without requiring large series AC-coupling capacitors in a single supply system. The actual level of the video signal varies less with a DirectDrive output than an AC-coupled output. The video-signal average can change greatly depending upon the picture content. With an AC-coupled output, the average changes according to the time constant formed by the series capacitor and series resistance (usually 150Ω). For example, Figure 1 shows an AC-coupled video signal alternating between a completely black screen and a completely white screen. Notice the excursion of the video signal as the screen changes. With a DirectDrive amplifier, the black level is held at ground. The video signal is constrained between -0.3V to +0.7V. Figure 2 shows the video signal from a DirectDrive amplifier with the same input signal as the AC-coupled system.

The large series AC-coupling capacitors create a high-pass filter. Since the lowest frequency in video is the frame rate, which can be between 24Hz and 30Hz, the pole of the highpass filter should ideally be an order of magnitude lower in frequency than the frame rate. Therefore, the AC-coupling capacitor must be very large, typically from 220µF to 3000µF. For space-constrained equipment, the series capacitor is unacceptable. Changing from a single series capacitor to a SAG network that requires two smaller capacitors can reduce space, but increases cost.

Playback Mode

Playback mode takes the video signal from the video processor and provides the reconstruction filter and line drive for both composite and Y/C video outputs. Figure 3 shows a signal flow diagram and Figure 4 shows the signal flow from the video processor to an external media

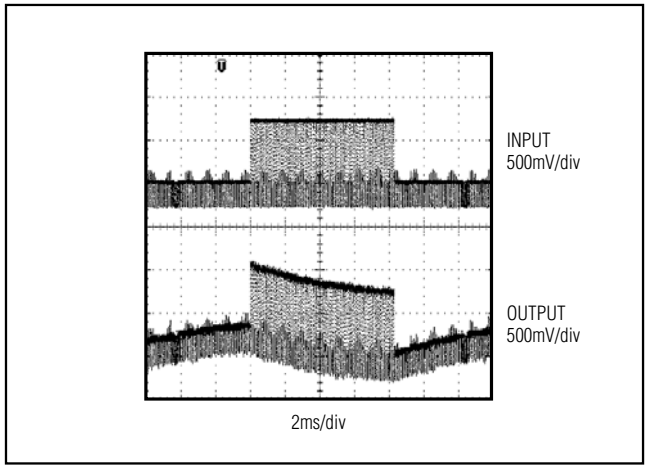


Figure 1. AC-Coupled Output

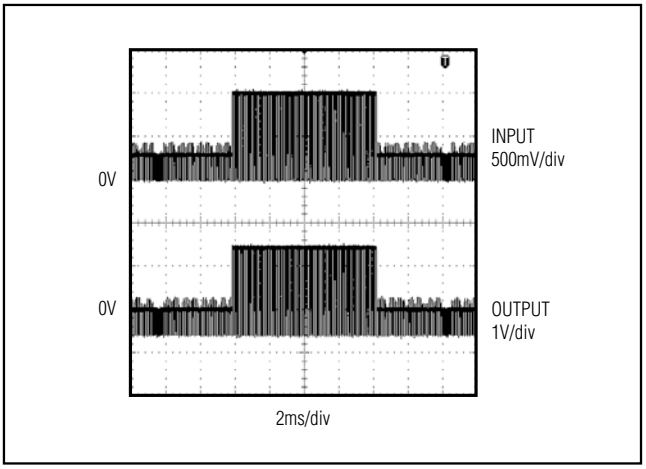


Figure 2. DirectDrive Output

device, such as a display in playback mode. In playback mode, internal switches S1, S2, S4, and S5 close the path from the video processor to the filter upon driving CVBSON and/or YCON high. Driving either YCON or CVBSON high enables the signal path from the video processor through the filter. Switches S6, S7, and S8 are open and not in the signal path in playback mode. Driving YCON high drives the Y signal to OUT1 and C signal to OUT2 while enabling CVBSON combines the Y and C signals to form composite video and output on OUT3. Both composite and Y/C video can be active in this mode. Pull $\overline{P}$/R low for playback mode.

Record Mode

Record mode takes the video signal from an external video source and provides anti-aliasing for both composite and Y/C signals. Figure 5 shows the signal flow from the external video source to the video processor. Upon driving $\overline{P}$/R high, switches S1, S2, S4, and S5 change states so that the signals utilize the same filters and now route to the video processor. Switches S6, S7, and S8 all close to ground so that the incoming signal sees a 75Ω load termination to ground. The inputs IN3, IN4, and IN5 are AC-coupled with a 0.1µF capacitor that works with an internal clamping circuit. Enabling CVBSON drives the video signal from IN5 through the upper filter and outputs at OUT4. In this mode, OUT5 is disabled and pulled to GND. Enabling YCON drives the Y signal from IN3 through the upper filter to output at OUT4 and the C signal from IN4 through the lower filter to output at OUT5. Switch S3 connects OUT4 to either the Y channel if YCON is high, or the composite video channel if CVBSON is high. Driving both CVBSON and YCON high results in an invalid state, resulting in all output buffers shutting down and pulling to GND.

Connection Sharing for Inputs and Outputs

Outputs OUT1, OUT2, and OUT3 and inputs IN3, IN4, and IN5 can share one connector to save space. Figure 6 shows a possible interface at OUT1/OUT2/OUT3 and IN3/IN4/IN5. In record mode, the switch closes, OUT1/OUT2/OUT3 go to GND, and the external 75Ω resistor looks like a load-termination resistor. Figure 4 shows that in playback mode, IN3/IN4/IN5 are not used and the switches to GND are open. The external 75Ω resistor serves as a back-termination resistor in playback mode and provides the cable termination in record mode.

Bidirectional Video Filter and Buffer

The MAX7481/MAX7482 output buffers are designed to drive both Y/C channels as well as composite video. The output buffers use the internally generated negative supply to shift the blanking level of video outputs (composite and Y only) to ground so that the active video signal is above ground and the negative sync pulse is below ground. The C signal is shifted so that it is centered at GND. The output buffers are capable of driving a full $2V_{P-P}$ video signal into a standard 150Ω load DC-coupled to GND. The output buffers can drive an AC-coupled load provided that the load impedance is greater than 5kΩ.

The MAX7481/MAX7482 utilize the same filter in both playback and record modes by using switches that route the signals through different paths in the two modes (see Figure 3). Switches S1–S8 change states depending on the mode of operation and control input settings. The use of these internal switches enables utilizing a single filter in both modes for a unique solution in space constrained and cost-sensitive applications.

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

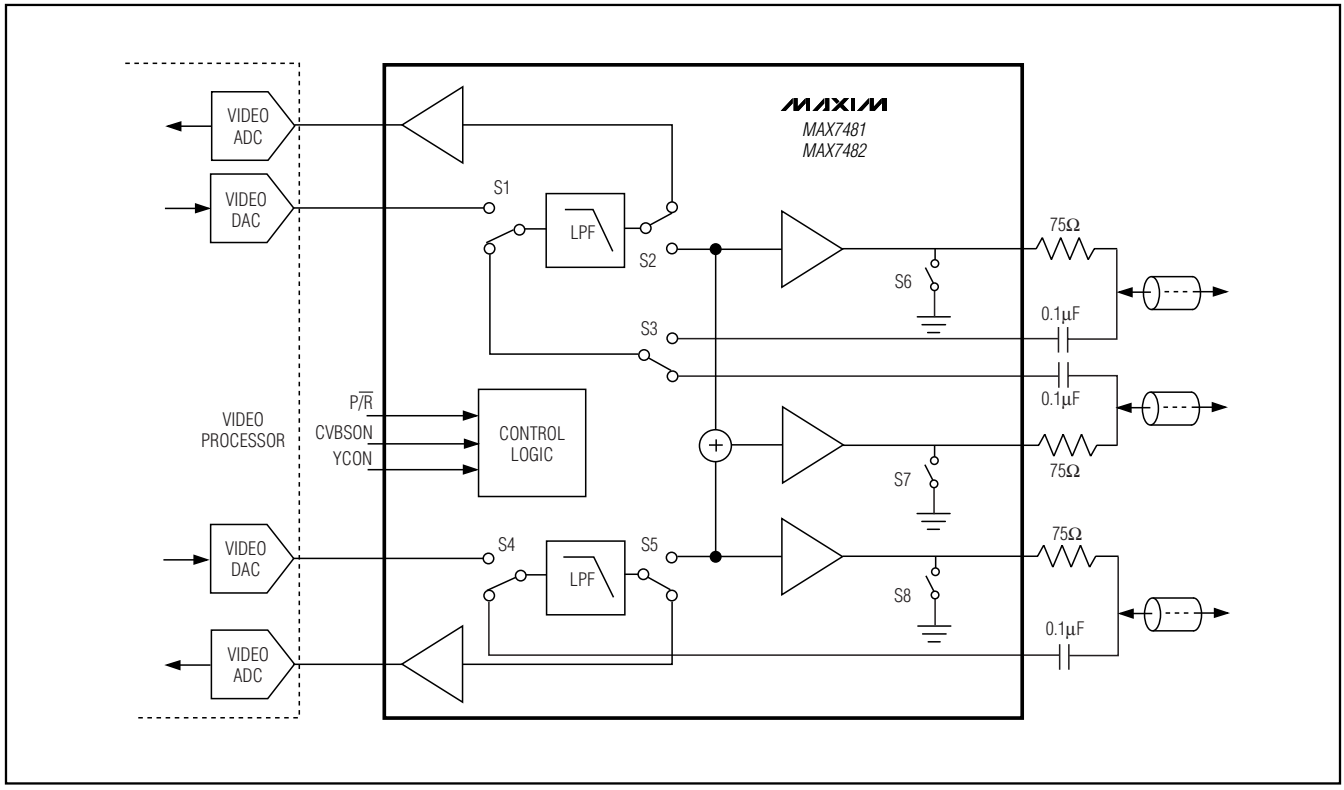


Figure 3. Signal Flow Diagram

Clamp

In record mode, signals are AC-coupled into IN3, IN4, and IN5 through small 0.1µF capacitors. The clamp circuit internally DC-restores the signal for optimal performance of the circuit so that the OUT4 blanking level sits at GND and the OUT5 signal is centered at GND. Do not connect any resistors in series or parallel with clamp capacitors.

Analog Inputs/Outputs

Figures 4 and 5 show the signal flow diagrams for playback and record modes. $\overline{P}$/R controls the mode of operation, while CVBSON and YCON select which outputs are enabled. Table 1 shows the various combinations of inputs and outputs that can be selected.

In playback mode, inputs IN1 and IN2 are active and the outputs are selected by driving CVBSON and YCON. IN1 receives the composite or luma (Y) signal and level-shifts the signal by approximately 350mV at the output such that the sync tip is below GND and the active video is above GND. IN2 receives the chroma (C) signal and level-shifts by approximately 500mV at the output such that the signal is centered at GND. Drive YCON high for outputs OUT1 and OUT2 to be active and/or drive CVBSON high to combine IN1 and IN2 into composite video and output on OUT3. Pull both control inputs low to disable outputs and power down the output buffers. OUT4 and OUT5 are always disabled in playback mode.

In record mode, drive YCON high and CVBSON low to output Y/C format video on OUT4 and OUT5 or drive CVBSON high and YCON low to output composite video on OUT4. Pull both control inputs low to disable OUT4 and OUT5 and power down the output buffers. Driving both CVBSON and YCON high in record mode results in an invalid state and all output buffers power down. The Y signal inputs on IN3, C signal inputs on IN4, and composite signal inputs on IN5. OUT4 is shared between the composite signal and Y signal. The composite or Y signal that outputs on OUT4 has the blanking level set to GND with the sync tip below GND and active video above GND. The C signal that outputs on OUT5 is centered at GND. The outputs get level-shifted by the bias of the video processor input after the AC-coupling capacitors.

Table 1. Input/Output Truth Table

P/R		CVBSON	YCON	OUT3 (CVBS)	OUT1 (Y) AND OUT2 (C)	OUT4 (Y, CVBS)	OUT5 (C)	IN3 AND IN4 (Y, C)	IN5 (CVBS)	IN1 (Y)	IN2 (C)
Low	PLAYBACK	Low	Low	Not Active	Not Active	GND	GND	Not Used	Not Used	Active	Active
Low		Low	High	Not Active	Active	GND	GND	Not Used	Not Used	Active	Active
Low		High	Low	Active	Not Active	GND	GND	Not Used	Not Used	Active	Active
Low		High	High	Active	Active	GND	GND	Not Used	Not Used	Active	Active
High	RECORD	Low	Low	GND	GND	GND	GND	Not Used	Not Used	Not Used	Not Used
High		Low	High	GND	GND	Active	Active	Active	Not Used	Not Used	Not Used
High		High	Low	GND	GND	Active	GND	Not Used	Active	Not Used	Not Used
High		High	High	GND	GND	GND	GND	Not Used	Not Used	Not Used	Not Used

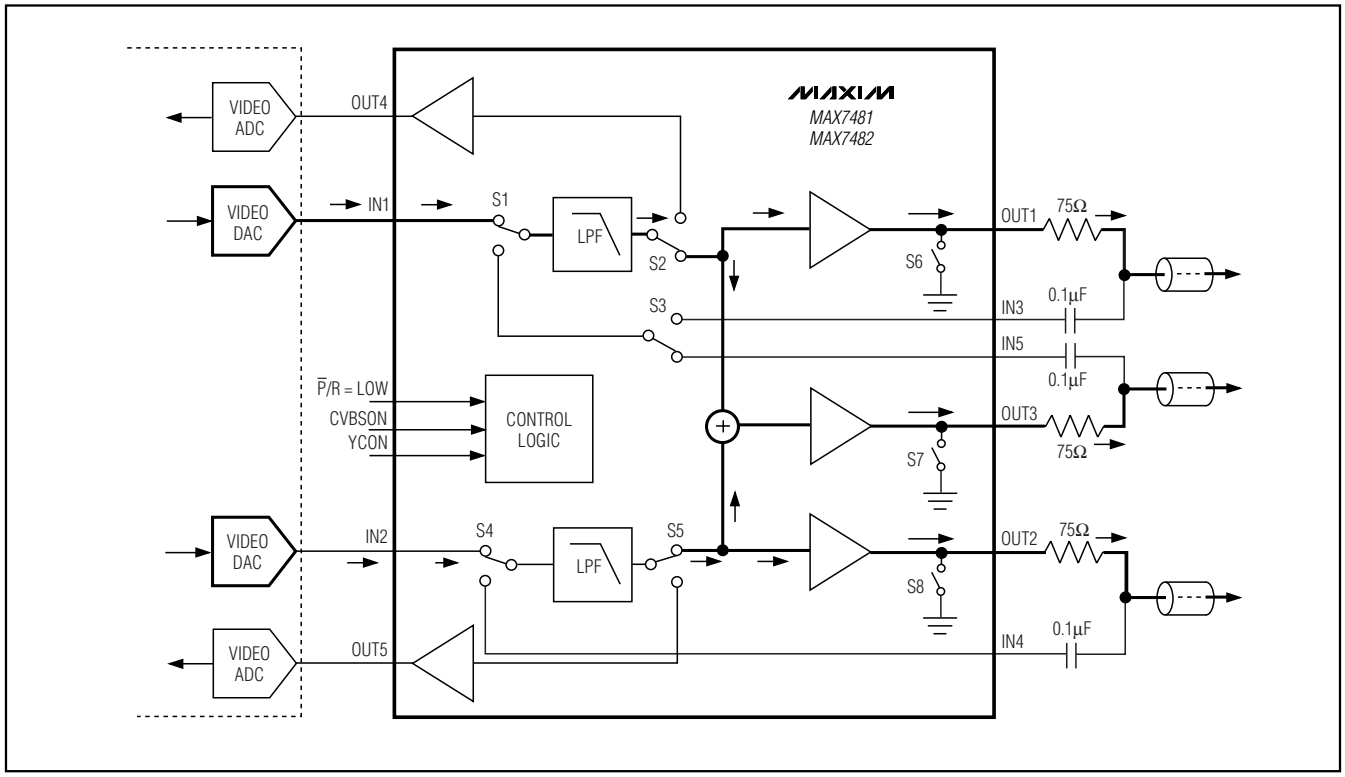


Figure 4. Signal Flow Diagram for Playback Mode

Short-Circuit Protection

The MAX7481/MAX7482 typical application circuit includes a 75Ω back-termination resistor that limits short-circuit current if an external short is applied to the video output. The MAX7481/MAX7482 provide additional output short-circuit protection to prevent damage in applications where amplifier output can be directly shorted.

Charge Pump and Linear Regulator

Portable video applications have space constraints that limit the use of AC-coupling capacitors and power constraints that limit the use of batteries to generate the negative supply rail. The MAX7481/MAX7482 simplify and reduce space and power constraints by integrating a charge pump and linear regulator to create a low-noise negative supply from a single positive supply. The charge pump inverts the positive supply to create

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

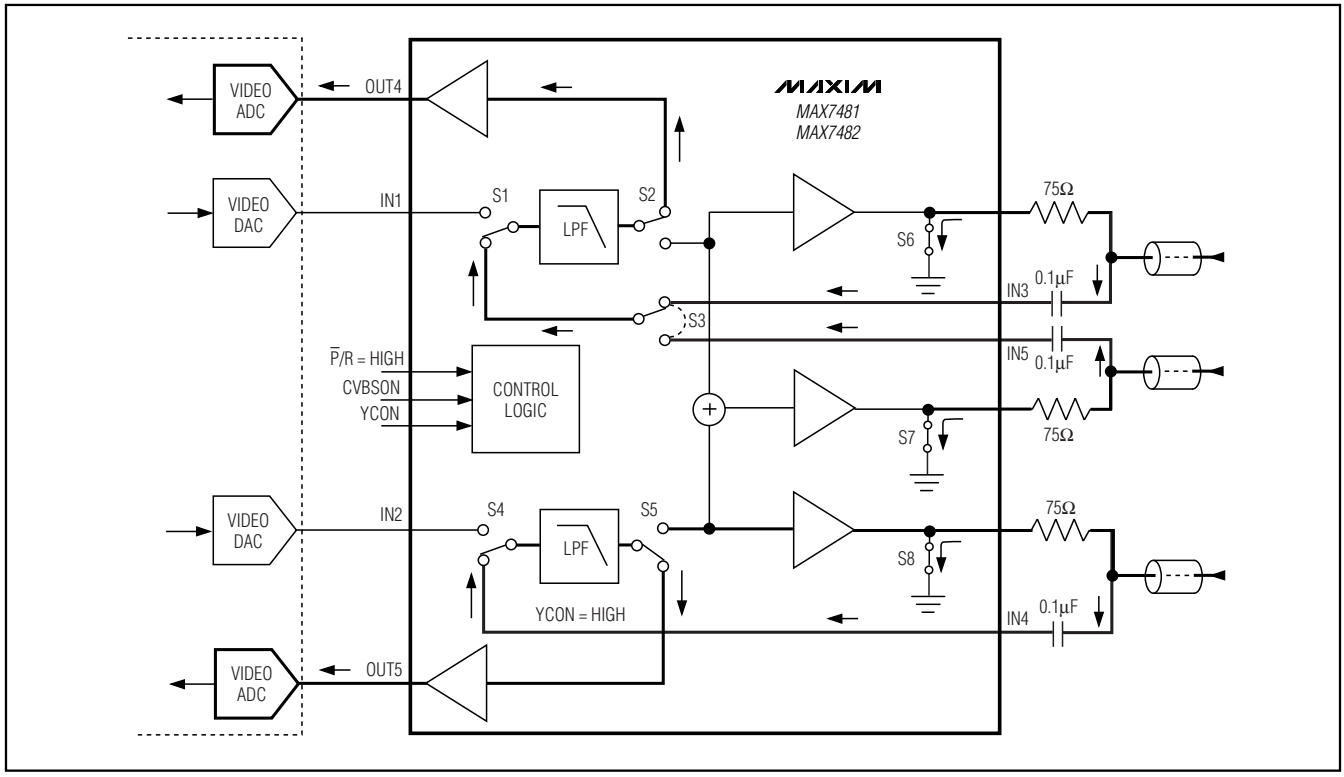


Figure 5. Signal Flow Diagram for Record Mode

a raw negative voltage that is fed into a linear regulator. The linear regulator filters out the charge-pump noise for a clean negative supply rail. The use of an integrated charge pump facilitates a direct connection without the use of large series AC-coupling capacitors in a single supply system.

BIAS

Connect a 100kΩ resistor with 1% accuracy or better from BIAS to GND to create the bias current used throughout the MAX7481/MAX7482.

Power-Down Modes

The MAX7481/MAX7482 feature a shutdown mode that significantly reduces power consumption. Drive SHDN high to put the MAX7481/MAX7482 in shutdown mode. In shutdown mode, the video filters, output buffers, charge pump, and linear regulator are turned off, and all video output drivers are pulled to GND. The MAX7481/MAX7482 consume less than 10µA in shutdown mode.

The MAX7481/MAX7482 also feature advanced power-down modes that turn off the output buffers not in use during normal operation. In playback mode, the record output buffers are turned off and in record mode, the playback output buffers are turned off. CVBSON and YCON further reduce power dissipation by turning off output buffers not in use. The MAX7481/MAX7482 are designed to extend battery life in portable video applications.

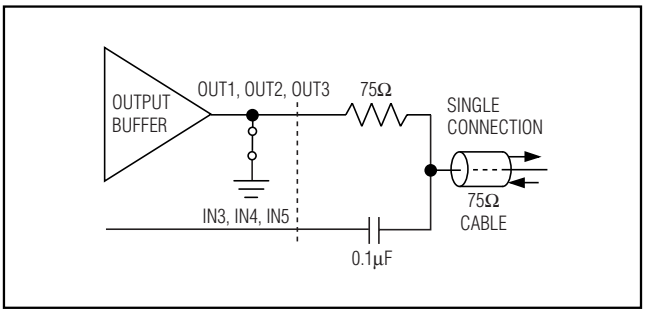
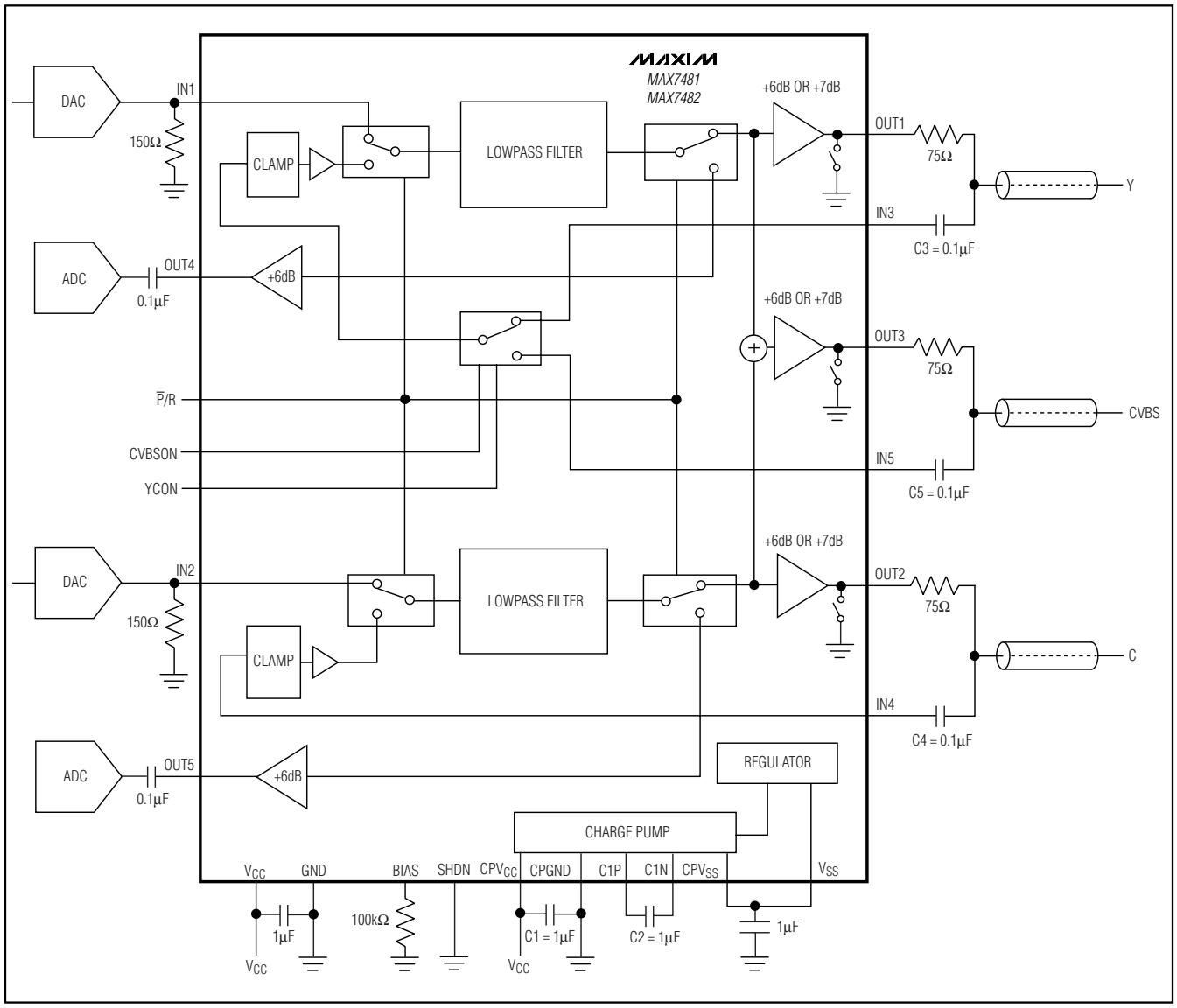


Figure 6. Single Connector for Input and Output

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

Functional Diagram/Typical Application Circuit



Applications Information

Power-Supply Considerations

The MAX7481/MAX7482 operate from a +2.7V to +3.6V single supply and require proper layout and bypassing. For best performance, place components as close as possible to the device.

Proper grounding improves performance, minimizes crosstalk, and prevents any switching noise from coupling into the video signal. Connect GND (pin 2) and CPGND together at a single point on the PCB. Route CPGND and all traces carrying switching transients away from GND traces and components in the video signal path. Bypass each analog supply (V_{CC}) with a 1µF capacitor to GND, placed as close as possible to the device. Bypass the charge-pump supply (CPV_{CC}) with a 1µF capacitor to CPGND, placed as close as possible to the device. Connect CPV_{SS} to V_{SS} and bypass with a low-ESR 1µF capacitor to CPGND as close as possible to the device.

Bidirectional Video Filters/Buffers for Composite and S-Video Portable Media Devices

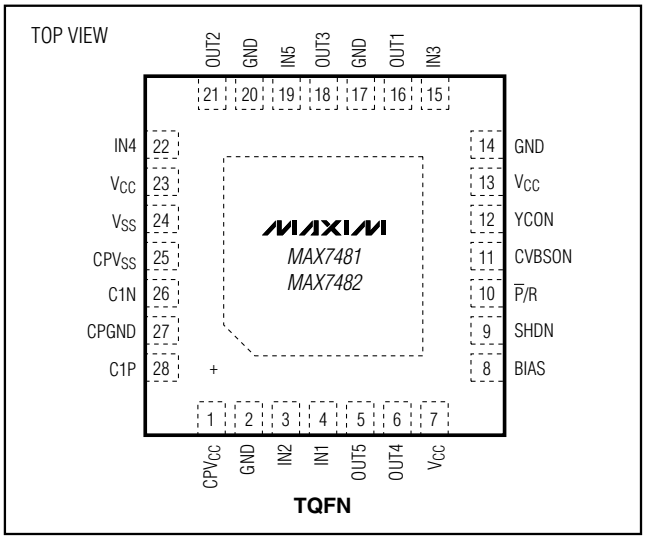
Exposed Pad and Heat Dissipation

The MAX7481/MAX7482 are available in TQFN packages that have an exposed pad on the bottom. This pad is electrically connected to GND and can be soldered to the ground plane for improved thermal conductivity. Do not route signals directly under the package.

Chip Information

PROCESS: BiCMOS

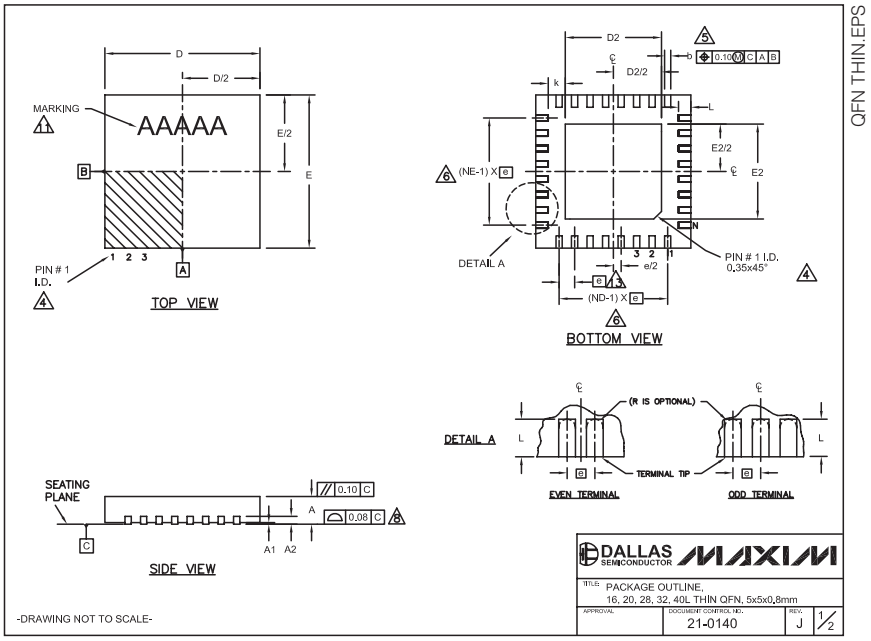
Pin Configuration



Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

QFN THIN.EPS



COMMON DIMENSIONS

PKG.	16L 5x5			20L 5x5			28L 5x5			32L 5x5			40L 5x5		
SYMBOL	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80
A1	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05
A2	0.20 REF.			0.20 REF.			0.20 REF.			0.20 REF.			0.20 REF.		
b	0.25	0.30	0.35	0.25	0.30	0.35	0.20	0.25	0.30	0.20	0.25	0.30	0.15	0.20	0.25
D	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
E	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
e	0.80 BSC.			0.65 BSC.			0.50 BSC.			0.50 BSC.			0.40 BSC.		
k	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-
L	0.30	0.40	0.50	0.45	0.55	0.65	0.45	0.55	0.65	0.30	0.40	0.50	0.30	0.40	0.50
N	16			20			28			32			40		
ND	4			5			7			8			10		
NE	4			5			7			8			10		
JEDEC	WHHB			WHHC			WHHD-1			WHHD-2			----		

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
T1655-2	3.00	3.10	3.20	3.00	3.10	3.20
T1655-3	3.00	3.10	3.20	3.00	3.10	3.20
T1655N-1	3.00	3.10	3.20	3.00	3.10	3.20
T2055-3	3.00	3.10	3.20	3.00	3.10	3.20
T2055-4	3.00	3.10	3.20	3.00	3.10	3.20
T2055-5	3.15	3.25	3.35	3.15	3.25	3.35
T2855-3	3.15	3.25	3.35	3.15	3.25	3.35
T2855-4	2.60	2.70	2.80	2.60	2.70	2.80
T2855-5	2.60	2.70	2.80	2.60	2.70	2.80
T2855-6	3.15	3.25	3.35	3.15	3.25	3.35
T2855-7	2.60	2.70	2.80	2.60	2.70	2.80
T2855-8	3.15	3.25	3.35	3.15	3.25	3.35
T2855N-1	3.15	3.25	3.35	3.15	3.25	3.35
T3255-3	3.00	3.10	3.20	3.00	3.10	3.20
T3255-4	3.00	3.10	3.20	3.00	3.10	3.20
T3255-5	3.00	3.10	3.20	3.00	3.10	3.20
T3255N-1	3.00	3.10	3.20	3.00	3.10	3.20
T4055-1	3.40	3.50	3.60	3.40	3.50	3.60
T4055-2	3.40	3.50	3.60	3.40	3.50	3.60

**SEE COMMON DIMENSIONS TABLE

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25 mm AND 0.30 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220, EXCEPT EXPOSED PAD DIMENSION FOR T2855-3 AND T2855-6.
10. WARPAGE SHALL NOT EXCEED 0.10 mm.
11. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
12. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
13. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM
TITLE: PACKAGE OUTLINE, 16, 20, 28, 32, 40L THIN QFN, 5x5x0.8mm
APPROVAL
DOCUMENT CONTROL NO. 21-0140
REV. J
2/2

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