Feartures

- Wide Power Supply: +3.0V to +5.5V Single Supply
  - Robust ESD Protection:
- Robust 8kV – HBM and 2kV – CDM ESD Rating
- Green Product, SOP-8 Package

Video Filter:

- HDTV Video Filter Support Composite 1080p/60
- Optimized 6th-order Butterworth Video reconstruction filter：
  - HD Channel: -3dB BW 72MHz
- Support Multiple Input Biasing:
  - Provide 80-mV Level-Shift when DC-Coupled
- Very Low Quiescent Current: 11.5 mA(at 3.3V, Typical)
- 6dB Gain(2V/V), Rail to Rail Output
- AC- or DC-Coupled Output Driving Dual Video Loads (75Ω)

Comparator:

- Fast Response Time: 68 ns Propagation Delay
- Offset Voltage: ± 3.0 mV Maximum
- Internal Hysteresis Ensures Clean Switching
- Push-Pull, CMOS/TTL Compatible Output

Applications

- Video Signal Amplification
- Set-Top Box Video Driver
- PV、DVD Player Video Buffer
- Video Buffer for Portable or USB-Powered Video Devices
- HDTV

Description

The TPF1441 is a low power, 72M HD composite video filter and comparator on a single chip. Drawing less than 11.5mA supply current over the full operating temperature range, TP1441 operates from a single 3.0V to 5.5V power supply.

TPF1441 integrate high-performance low-cost 72MHz composite video reconstruction filter, it combine excellent video performance and low power consumption perfectly. It incorporates one high-definition (HD) filter channel. The filter feature sixth-order Butterworth characteristics that are useful as digital-to-analog converter (DAC) reconstruction filters or as analog-to-digital converter (ADC) anti-aliasing filters. The HD filters can be bypassed to support HDCVI 1080i/720p video.

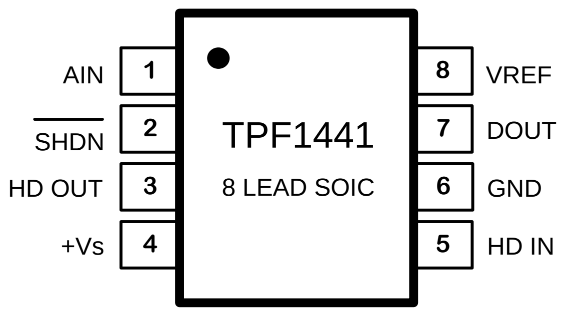
The TPF1441's on-board comparator incorporates 3PEAK's proprietary and patented design techniques to achieve the ultimate combination of high-speed (68ns propagation delay under 3.0~5.5V wide supply range) and low power consumption , The internal input hysteresis eliminates output switching due to internal input noise voltage, reducing current draw. The push-pull output supports rail-to-rail output swing, and interfaces with CMOS/TTL logic.

TPF1441 is available in SOP-8 package (TPF1441-SR). Its operation temperature range is from −40°C to +85°C.

Related Resources

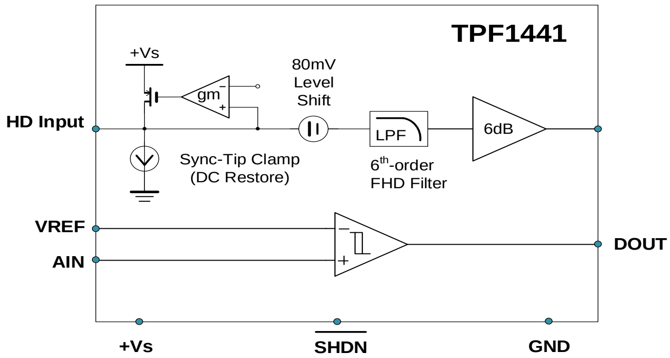
AN-1201:Application notes of TPF1XX

Pin Configuration (Top View)



Pin Name	Pin Function
AIN	Non-Inverting Input of the Comparator
DOUT	Comparator Output
VREF	Inverting Input of Comparator
HD IN	HD video input, LPF = 72 MHz
$+V_S$	Positive Power Supply
GND	Ground
HD OUT	HD video output, LPF = 72 MHz
$\overline{\text{SHDN}}$	High on this pin logic low to shut down the device. Range: Logic high enables the device and logic low Shut down the device. This pin defaults to logic high if left open.

Function Block



Order Information

Order Number	Operating Temperature Range	Package	Marking Information	Transport Media, Quantity
TPF1441-SR	-40 to 85°C	8-Pin SOP	TPF1441	Tape and Reel, 4000
TPF1441-VR	-40 to 85°C	8-Pin MSOP	TPF1441	Tape and Reel, 3000

Absolute Maximum Ratings*

Parameters		Value	Units
Power Supply, V_{DD} to GND		6.0	V
V_{IN}	Input Voltage	V_{DD} + 0.3V to GND - 0.3V	
I_O	Output Current	65	mA
T_J	Maximum Junction Temperature	150	°C
T_A	Operating Temperature Range	–45 to 85	°C
T_{STG}	Storage Temperature Range	–65 to 150	°C
TL	Lead Temperature (Soldering 10 sec)	300	°C
θ_{JA}	8-Lead SOP	158	°C/W

*** Note:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

(1) This data was taken with the JEDEC low effective thermal conductivity test board.

(2) This data was taken with the JEDEC standard multilayer test boards.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	MIL-STD-883H Method 3015.8	8	kV
CDM	Charged Device Model ESD	JEDEC-EIA/JESD22-C101E	2	kV

Electrical Characteristics-Video Filter Part

All test condition is VDD = 3.3V, TA = +25°C, RL = 150Ω to GND, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Electrical Specifications						
V_{DD}	Supply Voltage Range		3.0		5.5	V
I_{DD}	Quiescent current (I_Q) (1)	V_{DD} = 3.3V, V_{IN} = 500mV, no load		11.5	14.27	mA
		V_{DD} = 5.0V, V_{IN} = 500mV, no load		15	18.53	mA
$I_{CLAMP-DOWN}$	Clamp Discharge Current	V_{IN}=300mV, measure current	0.6	2.0	4.8	µA
$I_{CLAMP-UP}$	Clamp Charge Current	V_Y = -0.2V	-1.5	-1.7		mA
V_{CLAMP}	Input Voltage Clamp	I_Y = -100µA	-40	0	+40	mV
R_{IN}	Input Impedance	0.5V < V_Y < 1V	0.5	3		MΩ
AV	Voltage Gain	V_{IN}=0.5V,1V or 2V R_L=150Ω to GND	5.91	6.01	6.03	dB
V_{OLS}	Output Level Shift Voltage	V_{IN} = 0V, no load, input referred	54	80	124	mV
V_{OL}	Output Voltage Low Swing	V_{IN} = -0.3V, R_L =75Ω		0.05		V
V_{OH}	Output Voltage High Swing	V_{IN} = 3V, R_L =75Ω to GND (dual load)		3.18		V
PSRR	Power Supply Rejection Ratio	ΔV_{DD} = 3.3V to 3.6V		61		dB
		ΔV_{DD} = 5.0V to 5.5V, 50Hz		67		dB
I_{SC}	Short-circuit current	V_{IN} = 2V, 10Ω, output to GND	65			mA
		V_{IN} =0.1V, output short to V_{DD}	65			mA
V_{IH}	Disable Threshold	V_{DD} = 3.0V to 5.5V	1.6			V
V_{IL}	Enable Threshold	V_{DD} = 3.0V to 5.5V			0.4	V
t_{ON}	Enable Time	V_{IN} = 500mV, V_{OUT} to 1%		1000		ns
t_{OFF}	Disable Time	V_{IN} = 500mV, V_{OUT} to 1%		1000		ns
AC Electrical Specifications						
f_{-1dB}	-1dB Bandwidth HD Channel	R_L=150Ω	53.1	63.2	72.9	MHz
f_{-3dB}	-3dB Bandwidth HD Channel	R_L=150Ω	63.7	71.5	80.1	MHz
dG	Differential Gain	Video input range 1V		0.4		%
dP	Differential Phase	Video input range 1V		0.7		°
THD	Total Harmonic Distortion HD Channel	f=10MHz, V_{OUT}=1.4V_{PP}		0.15		%
		f=22MHz, V_{OUT}= 1.4V_{PP}		0.6		%
D/DT	Group Delay Variation HD Channel	f = 100kHz to 27MHz		2.2		ns
		f = 100kHz to 60MHz		6.0		ns
X_{TALK}	Channel Crosstalk	f = 1MHz, V_{OUT}=1.4V_{PP}	-68	-74		dB
SNR	Signal-to-Noise Ration HD Channel	f= 100kHz to 60MHz		64		dB
R_{OUT_AC}	Output Impedance	f = 10MHz		0.5		Ω

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

Electrical Characteristics-Comparator Part

All test condition is VDD = 3.3V, TA = +25°C, VIN+ = VDD, VIN- = 1.2V, RPU=10kΩ, CL =15pF, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{DD}	Supply Voltage		3		5.5	V
V_{OS}	Input Offset Voltage Note 1	V_{CM} = 1.2V	-3	±0.6	+3	mV
V_{OS} TC	Input Offset Voltage Drift Note 1	V_{CM} = 1.2V		0.3		μV/°C
V_{HYST}	Input Hysteresis Voltage Note 1	V_{CM} = 1.2V	4	6	8	mV
V_{HYST} TC	Input Hysteresis Voltage Drift Note 1	V_{CM} = 1.2V		20		μV/°C
I_B	Input Bias Current	V_{CM} = 1.2V		6		pA
I_{OS}	Input Offset Current			4		pA
R_{IN}	Input Resistance			> 100		GΩ
C_{IN}	Input Capacitance	Differential Common Mode		2 4		pF
CMRR	Common Mode Rejection Ratio	V_{CM} = V_{SS} to V_{DD}	50	70		dB
V_{CM}	Common-mode Input Voltage Range		V_{DD}-0.2		V_{SS}+0.2	V
PSRR	Power Supply Rejection Ratio		60	75		dB
V_{OH}	High-Level Output Voltage	I_{OUT}=-1mA	V_{DD}-0.3			V
V_{OL}	Low-Level Output Voltage	I_{OUT}=1mA			V_{SS}+0.3	V
I_{SC}	Output Short-Circuit Current	Sink or source current		25		mA
I_Q	Quiescent Current per Comparator			46	58	μA
t_R	Rising Time			5		ns
t_F	Falling Time			5		ns
T_{PD+}	Propagation Delay (Low-to-High)	Overdrive=100mV, V_{IN-} =1.2V		68		ns
T_{PD-}	Propagation Delay (High-to-Low)	Overdrive=100mV, V_{IN-} =1.2V		72		ns
T_{PDSKEW}	Propagation Delay Skew	Overdrive=100mV, V_{IN-} =1.2V		-4		ns

Note 1: The input offset voltage is the average of the input-referred trip points. The input hysteresis is the difference between the input-referred trip points.

Typical Performance Characteristics-Video Filter Part

All test condition is VDD = 3.3V, TA = +25°C, RL = 150Ω to GND, unless otherwise noted.

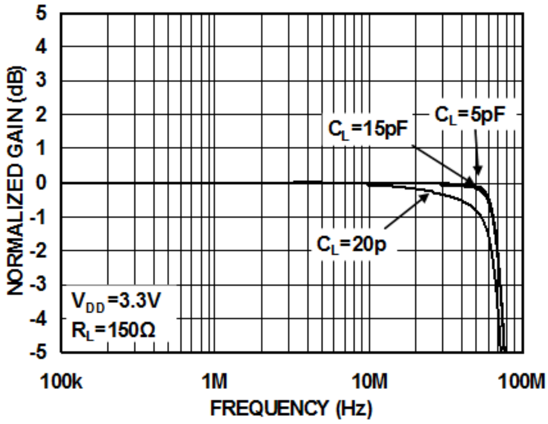


Figure3. Small-Scale Frequency Response

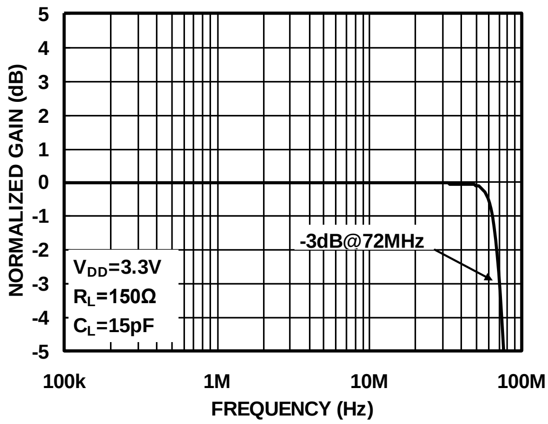


Figure4. Large-Scale Frequency Response

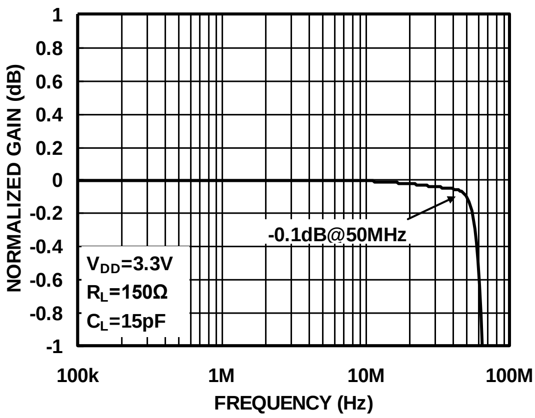


Figure5. Gain Vs. Frequency With CLOAD

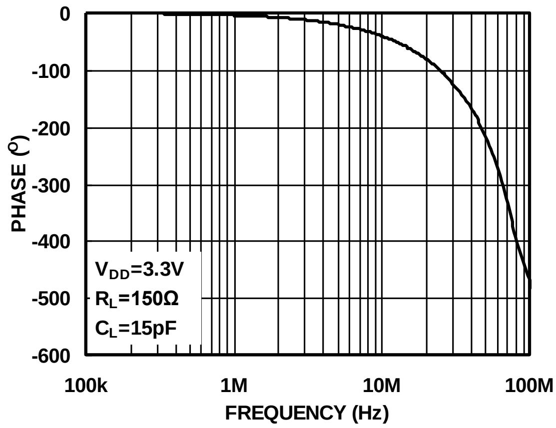


Figure6. Gain Vs. Frequency

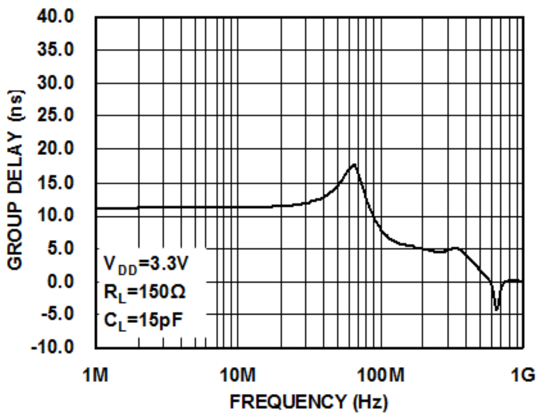


Figure7. Group Delay vs Frequency

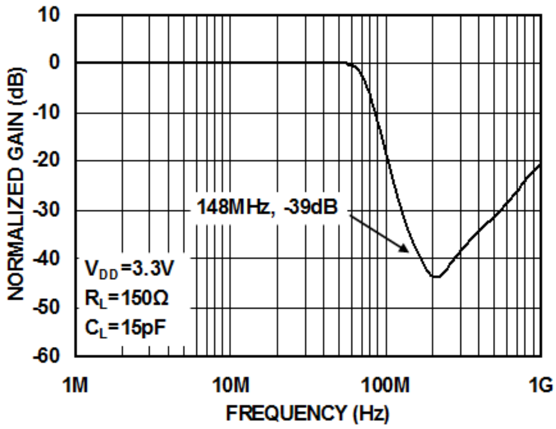


Figure8. Stop Band Attenuation

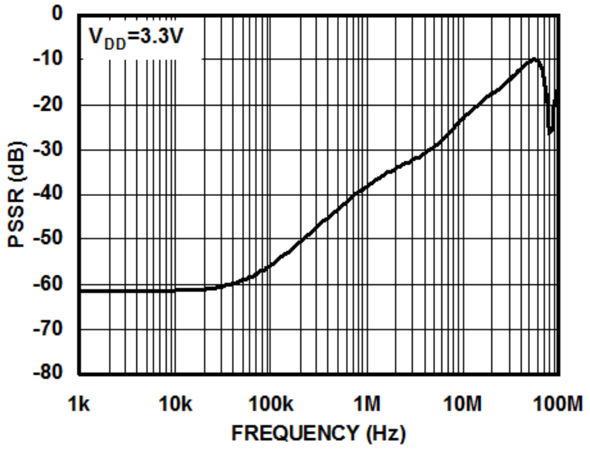


Figure9. PSRR Vs. Frequency

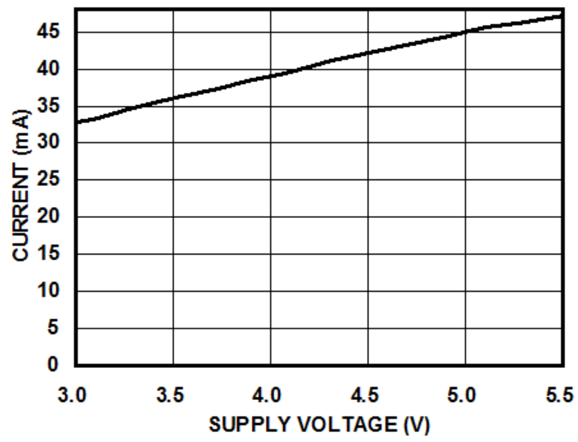


Figure10. Current Vs. Supply Voltage

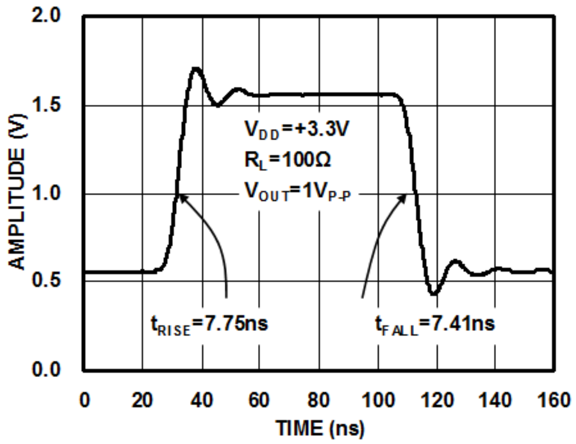


Figure11. Large-Signal Pulse Response Vs. Time

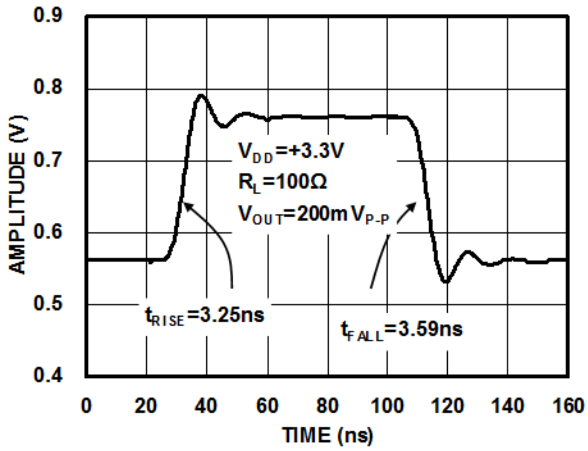
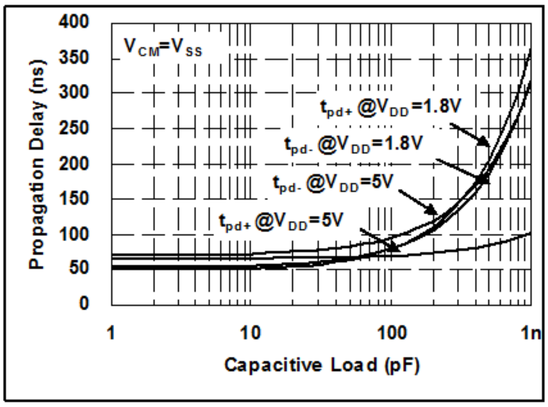
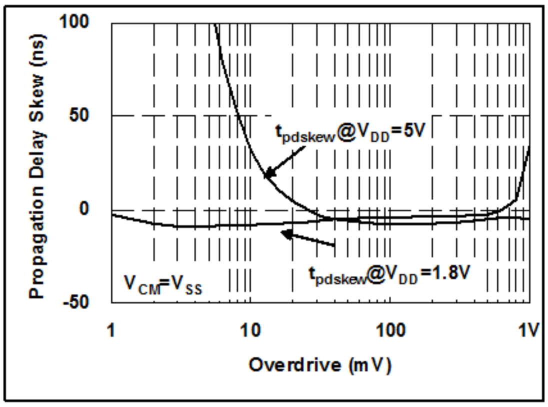


Figure12. Small-Signal Pulse Response Vs. Time

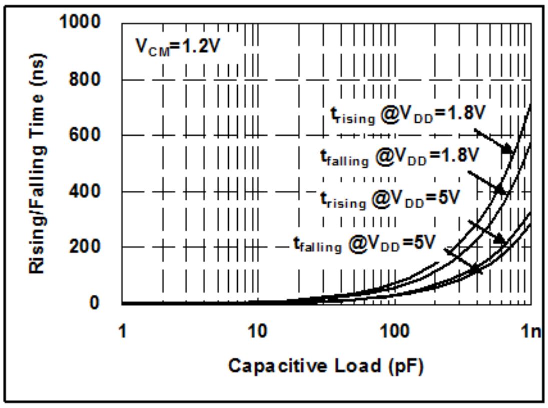
Typical Performance Characteristics-Comparator Part



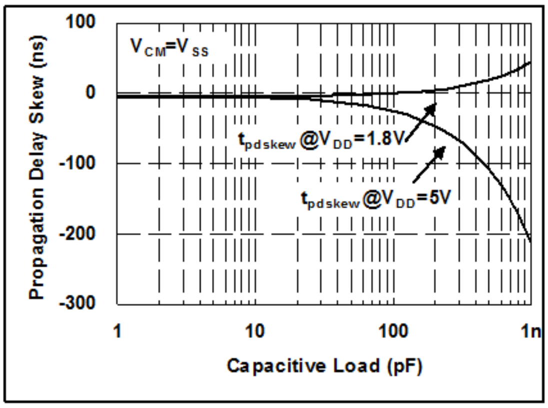
Propagation Delay Skew V.S. Overdrive Voltage



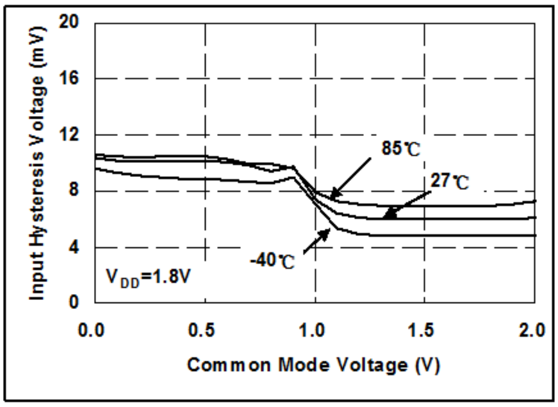
Propagation Delay V.S. Capacitor Loading



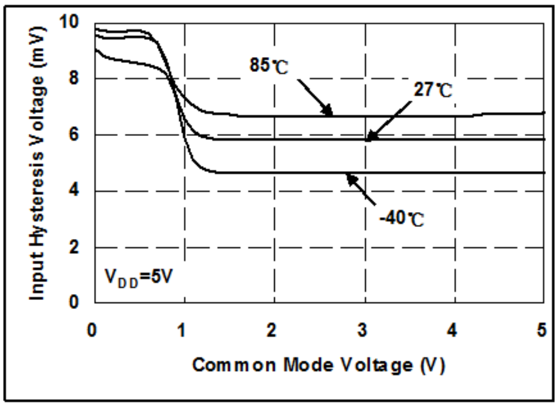
Propagation Delay Skew V.S. Capacitor Loading



Rising/Falling Time V.S. Capacitor Loading



Input Hysteresis Voltage V.S. Common Mode Voltage



Input Hysteresis Voltage V.S. Common Mode Voltage

Application Information

The TPF1441 is targeted for systems that require 1 channel high-definition (HD) video outputs. Although it can be used for numerous other applications, the needs and requirements of the video signal are the most important design parameters of the TPF1441. The TPF1441 incorporates many features not typically found in integrated video parts while consuming very low power.

Internal Sync Clamp

The typical embedded video DAC operates from a ground referenced single supply. This becomes an issue because the lower level of the sync pulse output may be at a 0V reference level to some positive level. The problem is presenting a 0V input to most single supply driven amplifiers will saturate the output stage of the amplifier resulting in a clipped sync tip and degrading the video image. A larger positive reference may offset the input above its positive range.

The TPF1441 features an internal sync clamp and offset function to level shift the entire video signal to the best level before it reaches the input of the amplifier stage. These features are also helpful to avoid saturation of the output stage of the amplifier by setting the signal closer to the best voltage range.

The simplified block diagram of the TPF1441 is on Page-2. The AC coupled video sync signal is pulled negative by a current source at the input of the comparator amplifier. When the sync tip goes below the comparator threshold the output comparator is driven negative, The PMOS device turns on clamping sync tip to near ground level. The network triggers on the sync tip of video signal.

Droop Voltage and DC Restoration

Selection of the input AC-coupling capacitance is based on the system requirements. A typical sync tip width of a 64μs NTSC line is 4μs during which clamp circuit restores its DC level. In the remaining 60μs period, the voltage droops because of a small constant 2.0μA sinking current. If the AC-coupling capacitance is 0.1μF, the maximum droop voltage is about 1mV which is restored by the clamp circuit. The maximum pull-up current of the clamp circuit is 1.7mA. For a 4μs sync tip width and 0.1μF capacitor, the maximum restoration voltage is about 80mV.

The line droop voltage will increase if a smaller AC-coupling capacitance is used. For the same reason, if larger capacitance is used the line droop voltage will decrease. Table 1 is droop voltage and maximum restoration voltage of the clamp for typical capacitance.

CAP VALUE (nF)	DROOP IN 60μs (mV)	CHARGE IN 4μs (mV)
100	1.2	68
1,000	0.12	6.8

Table 1. Maximum restoration voltage and droop voltage of Y signals for different capacitance

Low Pass Filter--Sallen Key

The Sallen Key is a classic low pass configuration. This provides a very stable low pass function, and in the case of the TPF1441, the six-pole roll-off at around 72MHz. The six-pole function is accomplished with an RC low pass network placed in series with and before the Sallen Key.

Output Couple

TPF1441 output could support both “AC Couple” and “DC Couple”, if use “AC Couple”, this capacitor is typically between 220-μF and 1000-μF, although 470-μF is common. This value of this capacitor must be this large to minimize the line tilt (droop) and/or field tilt associated with ac-coupling as described previously in this document.

The TPF1441 internal sync clamp makes it possible to DC couple the output to a video load, eliminating the need for any AC coupling capacitors, thereby saving board space and additional expense for capacitors. This makes the TPF1441 extremely attractive for portable video applications. Additionally, this solution completely eliminates the issue of field tilt in the lower frequency. The trade off is greater demand of supply current. Typical load current for AC coupled is around 1mA, compared to typical 11.5mA used when DC coupling.

Output Drive Capability and Power Dissipation

With the high output drive capability of the TPF1441, it is possible to exceed the +125°C absolute maximum junction temperature under certain load current conditions. Therefore, it is important to calculate the maximum junction temperature for an application to determine if load conditions or package types need to be modified to assure operation of the amplifier in a safe operating area. The maximum power dissipation allowed in a package is determined according to Equation:

$$PD_{MAX} = \frac{T_{JMAX} - T_{AMAX}}{\theta_{JA}}$$

Where：

TJMAX = Maximum junction temperature

TAMAX = Maximum ambient temperature

ΘJA = Thermal resistance of the package

The maximum power dissipation actually produced by an IC is the total quiescent supply current times the total power supply voltage, plus the power in the IC due to the load, or: for sourcing:

$$PD_{MAX} = V_s \times I_{SMAX} + (V_s - V_{OUT}) \times \frac{V_{OUT}}{R_L}$$

Where：

VS = Supply voltage

ISMAX = Maximum quiescent supply current

VOUT = Maximum output voltage of the application

RLOAD = Load resistance tied to ground

By setting the two PDMAX equations equal to each other, we can solve the output current and RLOAD to avoid the device overheat.

Power Supply Bypassing Printed Circuit Board Layout

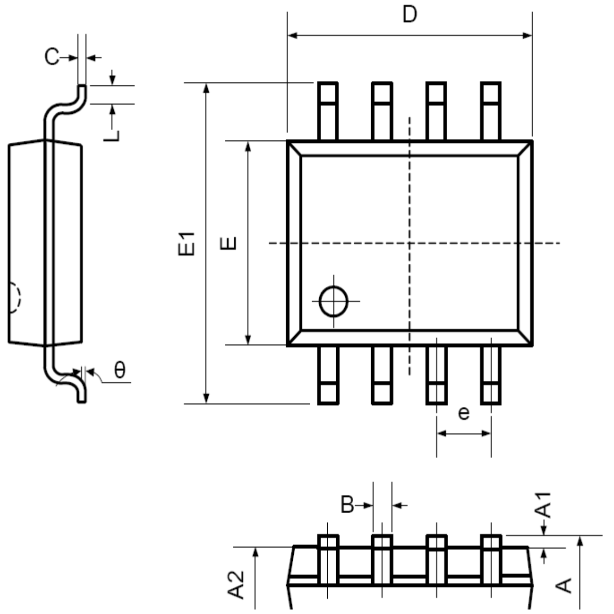
As with any modern operational amplifier, a good printed circuit board layout is necessary for optimum performance. Lead lengths should be as short as possible. The power supply pin must be well bypassed to reduce the risk of oscillation. For normal single supply operation, a single 4.7μF tantalum capacitor in parallel with a 0.1μF ceramic capacitor from VS+ to GND will suffice.

Video Filter Driver Selection Guide

P/N	Product Description	Channel	-3dB Bandwidth	Package
TPF110 /TPF110L	Low power, enable function and SAG correction, 1 channel 6th order 9MHz	1-SD	9MHz	SC70-5，SOT23-6
TPF113	Low power 3 channel, 6th-order 9MHz SD video filter	3-SD	9MHz	SO-8
TPF114	Low power 4 channel, 6th-order 9MHz SD video filter	4-SD	9MHz	MSOP-10,TSSOP-14
TPF116	Low power 4 channel, 6th-order 9MHz SD video filter for CVBS, SVIDEO	6-SD	9MHz	TSSOP-14
TPF123	3 channel 6th-order 13.5MHz, 960H/720H-CVBS video filter or Y'Pb'Pr 480P/576P video filter	3-ED	13.5MHz	SO-8
TPF133	Low power 3 channel, 6th-order 36MHz HD video filter	3-HD	36MHz	SO-8
TPF134	Low power 3 channel, 6th-order 36MHz HD video filter and 1 channel SD video filter	1-SD&,3-SD	9MHz,36MHz	MSOP-10,TSSOP-14
TPF136	Low power 3 channel, 6th-order 36MHz HD video filter and 3 channel SD video filter	3-SD&,3-HD	9MHz,36MHz	TSSOP-20
TPF143	Low power 3 channel, 6th-order 72MHz Full HD video filter	3-FHD	72MHz	SO-8
TPF144	Low power 3 channel, 6th-order 72MHz Full HD video filter and 1 channel SD video filter	1-SD&,3-FHD	9MHz,72MHz	MSOP-10,TSSOP-14
TPF146	Low power 3 channel, 6th-order 72MHz Full HD video filter and3 channel SD video filter	3-SD&,3-FHD	9MHz,72MHz	TSSOP-20
TPF153	Low power 3 channel, 6th-order 220MHz Full HD video filter	3-CH	220MHz	SO-8

Package Outline Dimensions

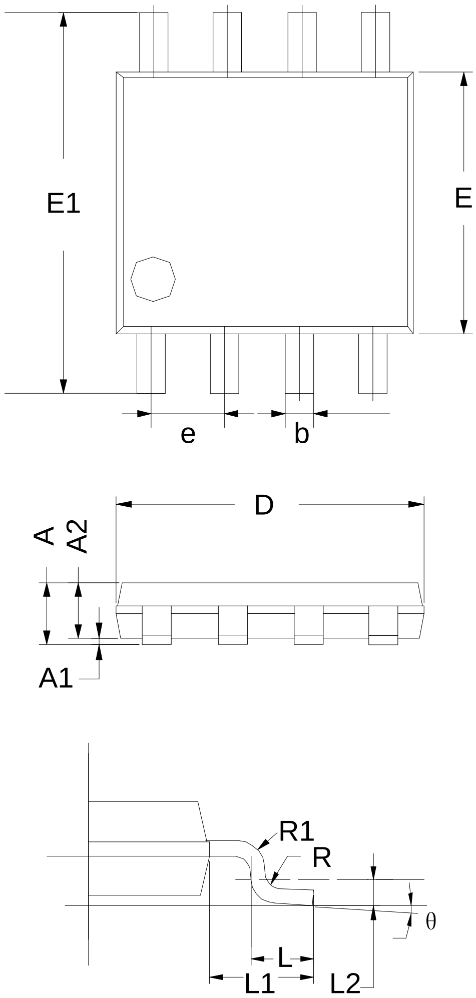
SOIC-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L1	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package Outline Dimensions

MSOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L1	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°