

## Features

- 1-FHDTV Video Filter Support FHD CVI-1080p60
- 1-HDTV Video Filter Support HD CVI-1080p30/720p60
- Optimized 6<sup>th</sup>-order Butterworth Video reconstruction filter:
  - FHD Channel: -3dB ≥ 72MHz
  - HD Channel: -3dB ≥ 36MHz
- Support Multiple Input Biasing:
  - Provide 80-mV Level-Shift when DC-Coupled
  - Transparent Input Clamping when AC-Coupled
  - Support External DC Biasing when AC-Coupled
- Very Low Quiescent Current: 6/11.5 mA(at 3.3V, HD/FHD typ.)
- 6dB Gain(2V/V), Rail To Rail Output
- AC- or DC-Coupled Output Driving Dual Video Loads (75Ω)
- Wide Power Supply: +3.0V to +5.5V Single Supply
- Robust ESD Protection:
  - Robust 8kV – HBM and 2kV – CDM ESD Rating
- Green Product, SOT23-6c Package

## Applications

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

## Selectable One HD/Full-HD Video Filter Description

TPF147 is a specially designed for consumer applications, high-performance, low-cost video reconstruction filter, it combine excellent video performance and low power consumption perfectly. It incorporates one selectable full high-definition (FHD) and one high-definition (HD) filter channels. All filters 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 FHD filters can be bypassed to support 1080p60 video and The HD filters can be bypassed to support 720p60 or 1080i60 video.

As part of the TP147 flexibility, the input can be configured for ac- or dc-coupled inputs. The 84-mV output level shift allows for a full sync dynamic range at the output with 0-V input. The ac-coupled modes include a transparent sync-tip clamp option for composite video (CVI), Y', and G'B'R' signals. AC-coupled biasing for C'/P'B/P'R channels can easily be achieved by adding an external resistor to VS+.

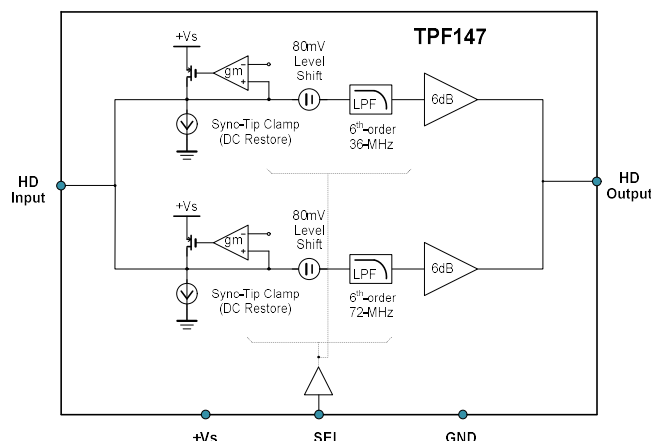
The TP147 rail-to-rail output stage with 6-dB gain allows for both ac and dc line driving. The ability to drive two lines, or 75-Ω loads, allows for maximum flexibility as a video line driver. The 6/11.5-mA total quiescent current at 3.3 V makes it an excellent choice for power-sensitive video applications.

TPF147 is available in SOT23-6 package (TPF147-TR). Its operation temperature range is from -40°C to +85°C.

## Related Resources

AN-1201: Application notes of TPF1x

## Function Block



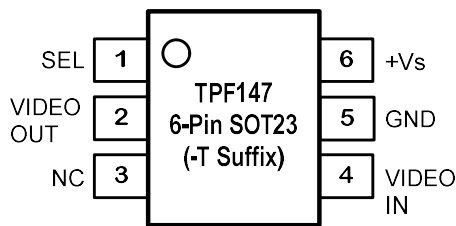
# TPF147

## Selectable One HD/Full-HD Video Filter

### Order Information

Order Number	Operating Temperature Range	Package	Marking Information	Transport Media, Quantity
TPF147-TR	-40 to 85°C	6-Pin SOT	TPF147	Tape and Reel, 3,000

### Pin configuration (Top View)



Pin Name	Function
VIDEO IN	Video input
+V <sub>S</sub>	Positive Power Supply
GND	Ground
VIDEO OUT	Video output
SEL	Select filter 36MHz or 72MHz, Logic high select the FHD channel and logic low select the HD channel(when one channel is selected, the other channel is powered down). <b>This pin defaults to logic high if left open.</b>
NC	No Connection

### Absolute Maximum Ratings\*

Parameters		Value	Units
Power Supply, V <sub>DD</sub> to GND		6.0	V
V <sub>IN</sub>	Input Voltage	V <sub>DD</sub> + 0.3V to GND - 0.3V	
I <sub>O</sub>	Output Current	65	I <sub>O</sub>
T <sub>J</sub>	Maximum Junction Temperature	150	T <sub>J</sub>
T <sub>A</sub>	Operating Temperature Range	-45 to 85	T <sub>A</sub>
T <sub>STG</sub>	Storage Temperature Range	-65 to 150	T <sub>STG</sub>
TL	Lead Temperature (Soldering 10 sec)	300	TL

\* **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.

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

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Input Electrical Specifications</b>						
+VS	Supply Voltage Range		3.0		5.5	V
IQ	Quiescent current (IQ)	+VS = 3.3V, VIN = 500mV, no load, select FHD channel		11.5	14.27	mA
		+VS = 3.3V, VIN = 500mV, no load, select HD channel		6	7.44	mA
		+VS = 5V, VIN = 500mV, no load, select FHD channel		15	18.53	mA
		+VS = 5V, VIN = 500mV, no load, select HD channel		7	9.6	mA
ICLAMP-DOWN	Clamp Discharge Current	VIN=300mV, measure current	1.5	2.0	5.1	μA
ICLAMP-UP	Clamp Charge Current	VY = -0.2V	-1.5	-1.7		mA
VCLAMP	Input Voltage Clamp	IY = -100μA	-40	0	+40	mV
RIN	Input Impedance	0.5V < VY < 1V	0.5	3		MΩ
AV	Voltage Gain	VIN=0.5V,1V or 2V RL=150Ω to GND	5.9	6.01	6.03	dB
ΔAV	Channel Mismatch		-2		+2	%
VOLS	Output Level Shift Voltage	VIN = 0V, no load, input referred	53	80	124	mV
VOL	Output Voltage Low Swing	VIN = -0.3V, RL =75Ω		0.05		V
VOH	Output Voltage High Swing	VIN = 3V, RL =75Ω to GND (dual load)		3.18		V
PSRR	Power Supply Rejection Ratio	ΔVDD = 3.3V to 3.6V		61		dB
		ΔVDD = 5.0V to 5.5V, 50Hz		67		dB
ISC	Short-circuit current	VIN = 2V, 10Ω, output to GND	65			mA
		VIN =0.1V, output short to VDD	65			mA
VIH	Select High Voltage Threshold	VDD = 3.0V to 5.5V	1.6			V
VIL	Select Low Voltage Threshold	VDD = 3.0V to 5.5V			0.4	V
tON	Enable Time	VIN = 500mV, VOUT to 1%		1000		ns
tOFF	Disable Time	VIN = 500mV, VOUT to 1%		1000		ns

**TPF147****Selectable One HD/Full-HD Video Filter**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>AC Electrical Specifications</b>							
f <sub>-1dB</sub>	-1dB Bandwidth	HD Channel	R <sub>L</sub> =150Ω	27.3	31	34.7	MHz
		FHD Channel		53.1	63.2	72.9	
f <sub>-3dB</sub>	-3dB Bandwidth	HD Channel	R <sub>L</sub> =150Ω	31.9	35.5	39.3	MHz
		FHD Channel		63.7	71.5	80.1	
Att <sub>27MHz</sub>	Stop Band Attenuation	HD Channel	f = 74.25MHz	32.3	38		dB
		FHD Channel	f = 148MHz	34.0	39.0		dB
dG	Differential Gain	HD Channel	Video input range 1V		0.2	0.5	%
		FHD Channel	Video input range 1V	-0.1	0.4	0.8	%
dP	Differential Phase	HD Channel	Video input range 1V		0.4	0.6	°
		FHD Channel	Video input range 1V	-1.1	0.7	1.1	°
THD	Total Harmonic Distortion	HD Channel	f=1MHz, V <sub>OUT</sub> =1.4V <sub>PP</sub>		0.02		%
		FHD Channel	f=10MHz, V <sub>OUT</sub> =1.4V <sub>PP</sub>		0.15		
D/DT	Group Delay Variation	HD Channel	f = 100kHz to 27MHz		5		ns
		FHD Channel	f = 100kHz to 60MHz		6.0		
X <sub>TALK</sub>	Channel Crosstalk		f = 1MHz, V <sub>OUT</sub> =1.4V <sub>PP</sub>	-68	-74		dB
SNR	Signal-to-Noise Ratio	HD Channel	f = 100kHz to 30MHz	66	71		dB
		FHD Channel	f = 100kHz to 60MHz		64		
R <sub>OUT_AC</sub>	Output Impedance		f = 10MHz		0.5		Ω

**Typical Performance Characteristics** All test condition is  $V_{DD} = 3.3V$ ,  $T_A = +25^{\circ}C$ ,  $R_L = 150\Omega$  to GND, unless otherwise noted.

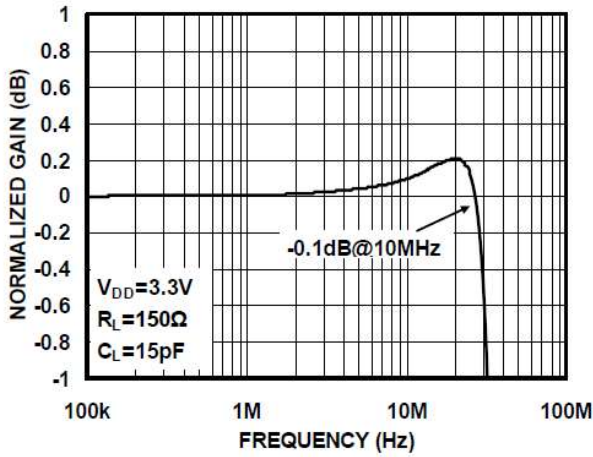


Figure1. Small-Scale Frequency Response(HD Channel)

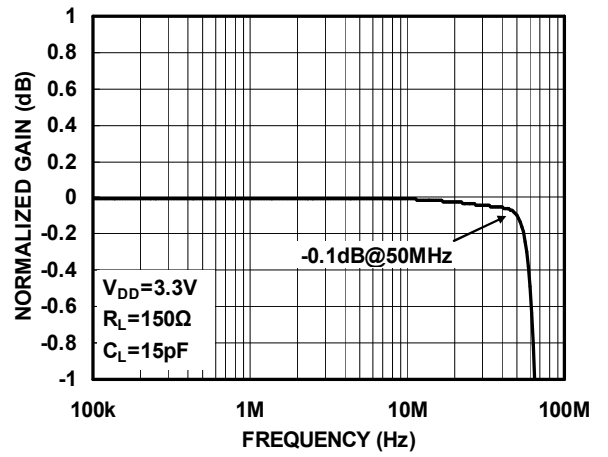


Figure2. Small-Scale Frequency Response(FHD Channel)

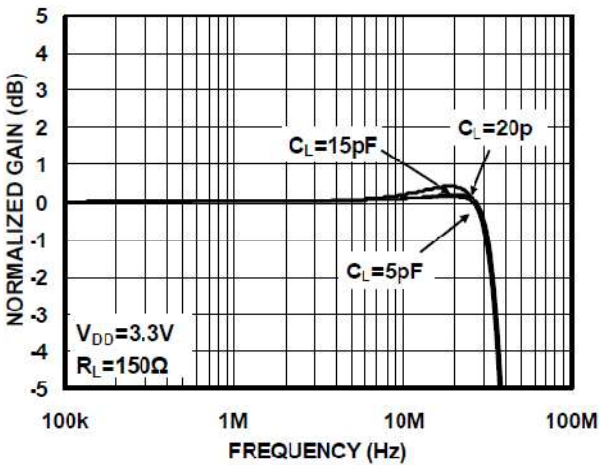


Figure3. Gain Vs. Frequency With  $C_{LOAD}$  (HD Channel)

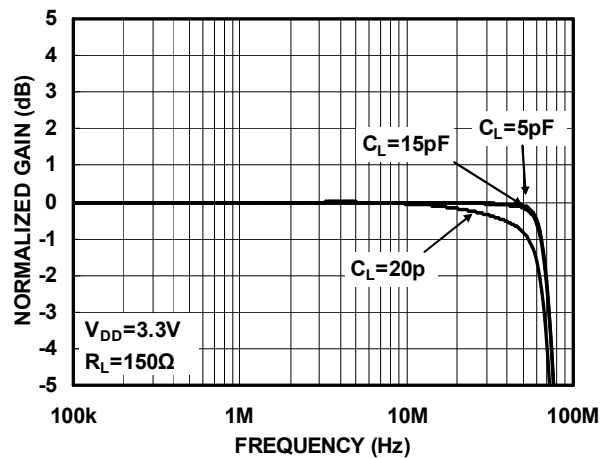


Figure4. Gain Vs. Frequency With  $C_{LOAD}$  (FHD Channel)

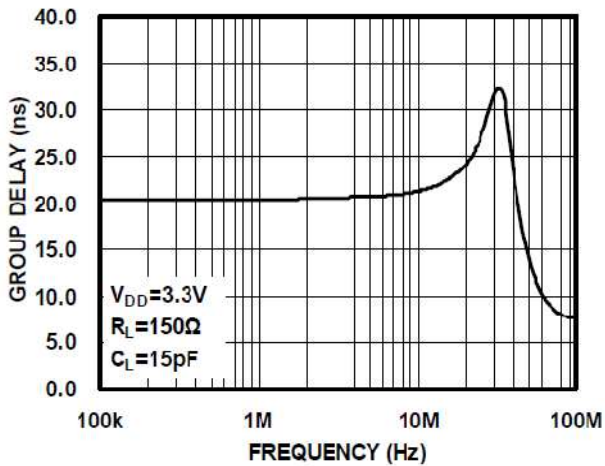


Figure5. Group Delay vs Frequency(HD Channel)

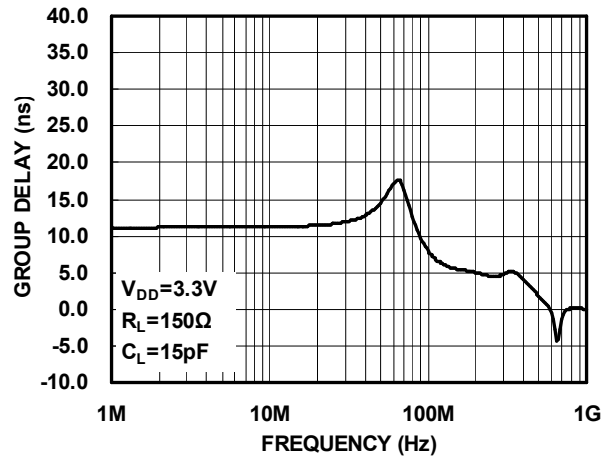


Figure6. Group Delay vs Frequency(FHD Channel)

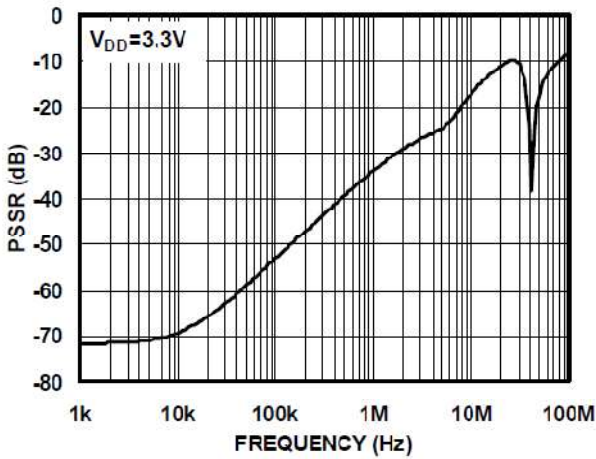


Figure7. PSRR Vs. Frequency(HD)

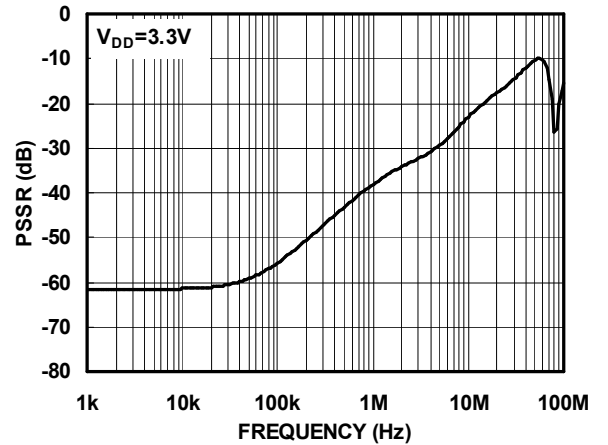


Figure8. PSRR Vs. Frequency(FHD)

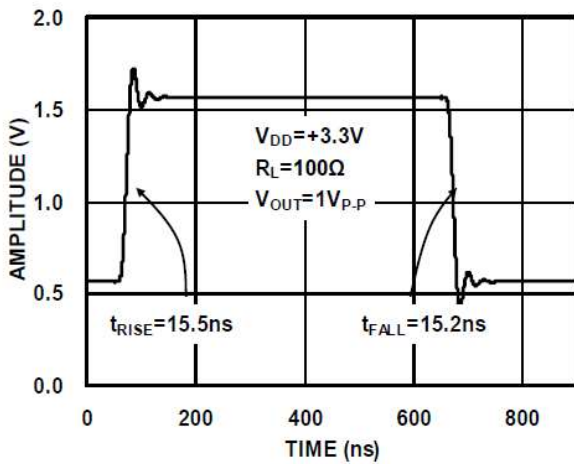


Figure9. Large-Signal Pulse Response Vs. Time(HD Channel)

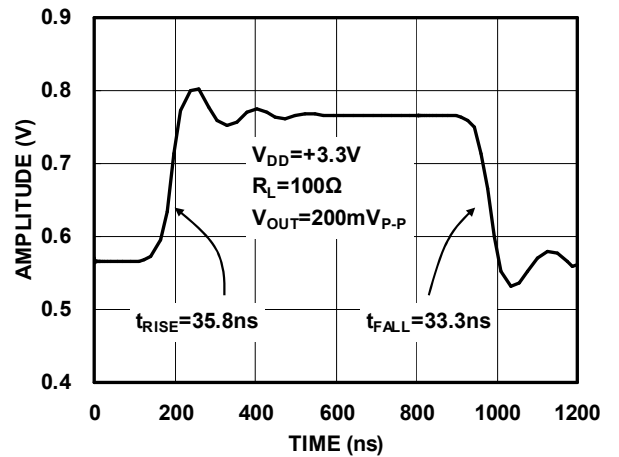


Figure10. Small-Signal Pulse Response Vs. Time(SD Channel)

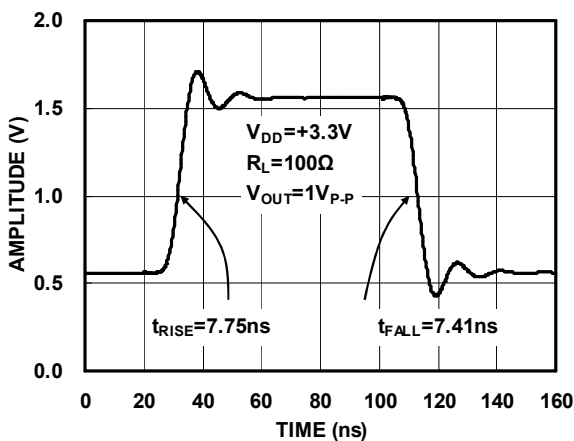


Figure11. Large-Signal Pulse Response Vs. Time(FHD Channel)

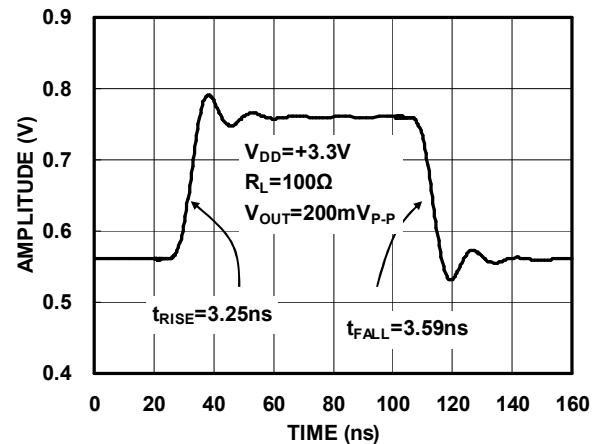


Figure11. Small-Signal Pulse Response Vs. Time(FHD Channel)

## Application Information

The TPF147 is targeted for systems that require a selectable Full high-definition (FHD) video output for CVI video support and single 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 TPF147. The TPF147 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 TPF147 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 TPF147 in Page-1. 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 64 $\mu$ s NTSC line is 4 $\mu$ s during which clamp circuit restores its DC level. In the remaining 60 $\mu$ s period, the voltage droops because of a small constant 2.0 $\mu$ A sinking current. If the AC-coupling

capacitance is 0.1 $\mu$ F, 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 4 $\mu$ s sync tip width and 0.1 $\mu$ F 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.

## 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 TPF147, two six-pole roll-off at around 36MHz and 72MHz. The six-pole function is accomplished with an RC low pass network placed in series with and before the Sallen Key.

## Output Couple

TPF147 output could support both "AC Couple" and "DC Couple", if use "AC Couple", this capacitor is typically between 220- $\mu$ F and 1000- $\mu$ F, although 470- $\mu$ F 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 TPF147 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 TPF147 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 6.6mA used when DC coupling.

## Output Drive Capability and Power Dissipation

With the high output drive capability of the TPF147, it



## TPF147

### Selectable One HD/Full-HD Video Filter

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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:

$T_{JMAX}$  = Maximum junction temperature

$T_{AMAX}$  = Maximum ambient temperature

$\theta_{JA}$  = 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:

$V_s$  = Supply voltage

$I_{SMAX}$  = Maximum quiescent supply current

$V_{OUT}$  = Maximum output voltage of the application

$R_{LOAD}$  = Load resistance tied to ground

By setting the two PD<sub>MAX</sub> equations equal to each other, we can solve the output current and R<sub>LOAD</sub> 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**

<b>P/N</b>	<b>Product Description</b>	<b>Channel</b>	<b>-3dB Bandwidth</b>	<b>Package</b>
TPF110 /TPF110L	Low power, enable function and SAG correction, 1 channel 6 <sup>th</sup> 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 and 3 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

# TPF147

## Selectable One HD/Full-HD Video Filter

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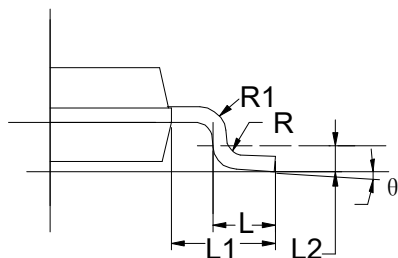
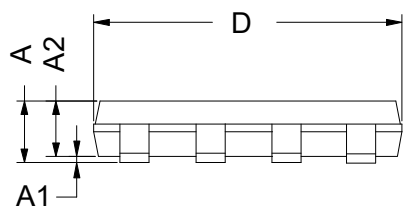
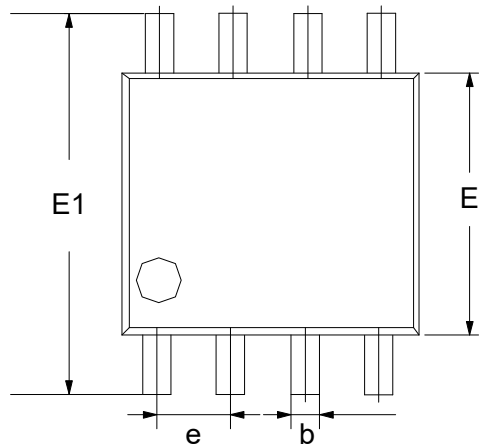
### Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest revision.

Revision	Change
Rev1.0	Initial Release
Rev1.1	Delete $V_{IH}$ Max Value data, Add $V_{IH}$ Min Value data 1.6V on page 4 Delete $V_{IL}$ Min Value data, Add $V_{IL}$ Max Value data 0.4V on page 4 Change page header Date from @2013 to @2014

**Package Outline Dimensions**

10 Lead MSOP Package—Main Body 3.00 mm [MSOP\_N]



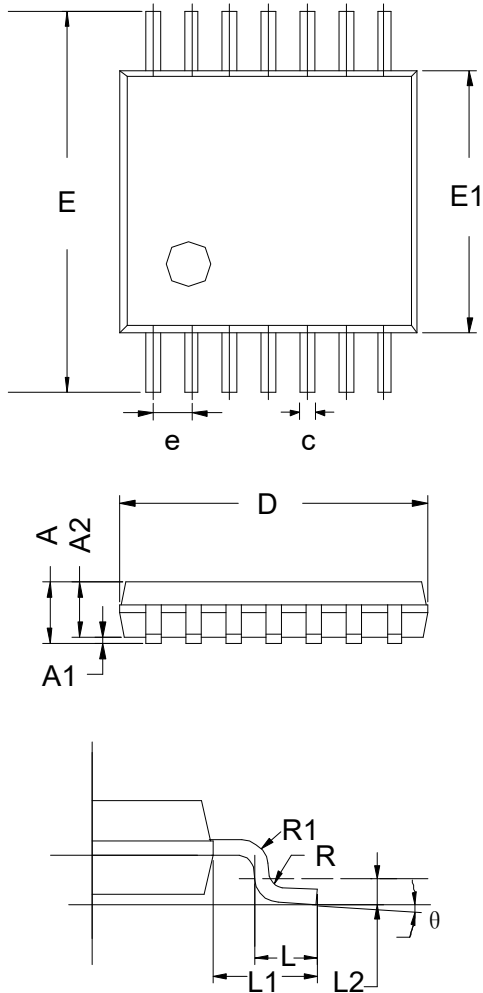
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L1	0.410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

# TPF147

Selectable One HD/Full-HD Video Filter

## Package Outline Dimensions

14 Lead TSSOP Package—Main Body 4.40 mm [TSSOP\_N]



Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
b	0.20	-	0.28
c	0.10	-	0.19
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
$\theta$	0°	-	8°

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