One CVBS and One Full-HD Composite Video Filter Driver

## Features

- 1-SDTV Video Filter Support CVBS
- 1-HDTV Video Filter Support Y'Pb'Pr'-1080p, R'G'B' or VGA/SVGA/XGA
- Optimized 6th-order Butterworth Video reconstruction filter：
  CVBS Channel: -3dB at 9MHz
  HD Channel: -3dB ≥ 72MHz
- 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: 14.5 mA(at 3.3V, Typical)
- 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, MSOP-8 and TSSOP-14 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

## Description

TPF142 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 standard-definition (CVBS) 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 HD filters can be bypassed to support filters. The HD filters can be bypassed to support 1080p60 video or up to quad extended graphics array (QXGA) RGB video.

As part of the TP142 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 (CVBS), 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+.

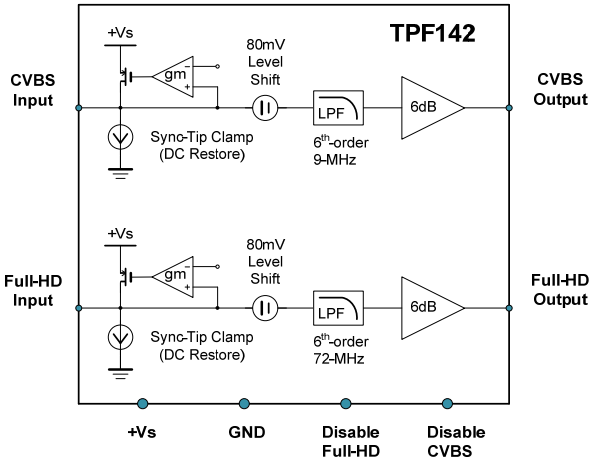
The TP142 rail-to-rail output stage with 6-dB gain allows for both ac and dc line driving. The ability to drive two lines, or 75-Ω loads, allows for maximum flexibility as a video line driver. The 14.5-mA total quiescent current at 3.3 V makes it an excellent choice for power-sensitive video applications.

TPF142 is available in MSOP-8 package (TPF142-VR) and TSSOP-14 package (TPF142-TR). Its operation temperature range is from −40°C to +85°C.

## Related Resources

AN-1201: Application notes of TPF1x

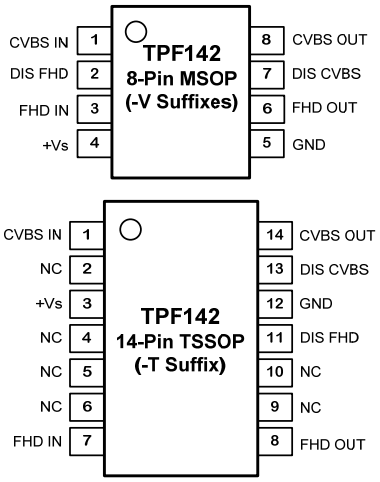
## Function Block



## Order Information

| Order Number | Operating Temperature Range | Package | Marking Information | Transport Media, Quantity |
|---|---|---|---|---|
| TPF142-VR | -40 to 85°C | 8-Pin MSOP | TPF142 | Tape and Reel, 3,000 |
| TPF142-TR | -40 to 85°C | 14-Pin TSSOP | TPF142 | Tape and Reel, 3,000 |

## Pin configuration (Top View)




| Pin Name | Function |
|---|---|
| CVBS IN | SD video input for CVBS signal, LPF = 9 MHz |
| DIS FHD | Disable Full-HD channel. Logic high disables the FHD channel and logic low enables the FHD channel. **This pin defaults to logic high if left open.** |
| FHD IN | Full-HD video input, LPF = 72 MHz |
| $+V_S$ | Positive Power Supply |
| GND | Ground |
| FHD OUT | Full-HD video output, LPF = 72 MHz |
| DIS CVBS | Disable SD channel. Logic high disables the SD channel and logic low enables the SD channel. **This pin defaults to logic high if left open.** |
| CVBS OUT | SD video output for CVBS signal, LPF = 9 MHz |
| NC | No Connection |

## 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 | $I_O$ |
| $T_J$ | Maximum Junction Temperature | 150 | $T_J$ |
| $T_A$ | Operating Temperature Range | –45 to 85 | $T_A$ |
| $T_{STG}$ | Storage Temperature Range | –65 to 150 | $T_{STG}$ |
| 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 |
|---|---|---|---|---|---|---|
| **Input Electrical Specifications** | | | | | | |
| $+V_S$ | Supply Voltage Range | | 3.0 | | 5.5 | V |
| $I_Q$ | Quiescent current ($I_Q$) | $+V_S$ = 3.3V, $V_{IN}$ = 500mV, no load, all channels on | | 14.5 | | mA |
| | | $+V_S$ = 3.3V, $V_{IN}$ = 500mV, no load, SD channel on, FHD channel off | | 3.66 | | mA |
| | | $+V_S$ = 3.3V, $V_{IN}$ = 500mV, no load, SD channel off, FHD channel on | | 11.24 | | mA |
| | | $+V_S$ = 3.3V, $V_{IN}$ = 500mV, no load, all channels off | | 1 | | μA |
| | | $+V_S$ = 5V, $V_{IN}$ = 500mV, no load, all channels on | | 14.89 | | mA |
| | | $+V_S$ = 5V, $V_{IN}$ = 500mV, no load, SD channel on, FHD channel off | | 3.67 | | mA |
| | | $+V_S$ = 5V, $V_{IN}$ = 500mV, no load, SD channel off, FHD channel on | | 11.27 | | mA |
| | | $+V_S$ = 5V, $V_{IN}$ = 500mV, no load, all channels off | | 1 | | μA |
| $I_{CLAMP-DOWN}$ | Clamp Discharge Current | $V_{IN}$=300mV, measure current | 1.5 | 2.0 | 5.1 | 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<br>$R_L$=150Ω to GND | 5.9 | 6.01 | 6.03 | dB |
| ΔAV | Channel Mismatch | | -2 | | +2 | % |
| $V_{OLS}$ | Output Level Shift Voltage | $V_{IN}$ = 0V, no load, input referred | 53 | 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 | $\Delta V_{DD}$ = 3.3V to 3.6V | | 61 | | dB |
| | | $\Delta V_{DD}$ = 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 |

| SYMBOL | PARAMETER | | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **AC Electrical Specifications** | | | | | | | |
| $f_{-1dB}$ | -1dB Bandwidth | SD Channel | $R_L$=150Ω | 7.6 | 8.2 | 9.1 | MHz |
| | | FHD Channel | | 53.1 | 63.2 | 72.9 | |
| $f_{-3dB}$ | -3dB Bandwidth | SD Channel | $R_L$=150Ω | 7.8 | 9.0 | 10.5 | MHz |
| | | FHD Channel | | 63.7 | 71.5 | 80.1 | |
| $Att_{27MHz}$ | Stop Band Attenuation | SD Channel | f = 27MHz | 38.2 | 57.2 | | dB |
| | | FHD Channel | f =148MHz | 34.0 | 39.0 | | dB |
| dG | Differential Gain | | Video input range 1V | -0.1 | 0.4 | 0.8 | % |
| dP | Differential Phase | | Video input range 1V | -1.1 | 0.7 | 1.1 | ° |
| THD | Total Harmonic Distortion | SD Channel | f=1MHz, $V_{OUT}$=1.4$V_{PP}$ | 0.03 | 0.1 | 0.2 | % |
| | | FHD Channel | f=10MHz, $V_{OUT}$=1.4$V_{PP}$ | | 0.15 | | |
| D/DT | Group Delay Variation | SD Channel | f = 100kHz to 5MHz | | 5.4 | | ns |
| | | FHD Channel | f = 100kHz t0 60MHz | | 6.0 | | |
| $X_{TALK}$ | Channel Crosstalk | | f = 1MHz, $V_{OUT}$=1.4$V_{PP}$ | -68 | -74 | | dB |
| SNR | Signal-to-Noise Ration | SD Channel | f= 100kHz to 4.43MHz | 65 | 69 | | dB |
| | | FHD Channel | f= 100kHz to 60MHz | | 64 | | |
| $R_{OUT\_AC}$ | 输出阻抗 | | f = 10MHz | | 0.5 | | Ω |
| CLG | Chroma-Luma-Gain (SD Channel) | | 400kHz to 3.58MHz and 4.43MHz | | 0.18 | 0.4 | dB |
| CLD | Chroma-Luma-Delay (SD Channel) | | 400kHz to 3.58MHz and 4.43MHz | | 5 | | ns |

## Typical Performance Characteristics

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

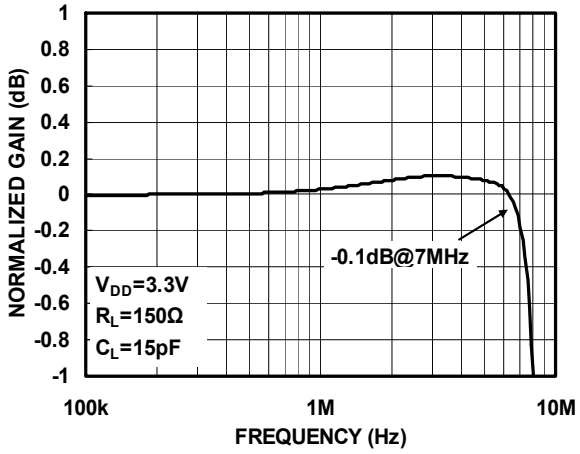



Figure1. Small-Scale Frequency Response(SD Channel)

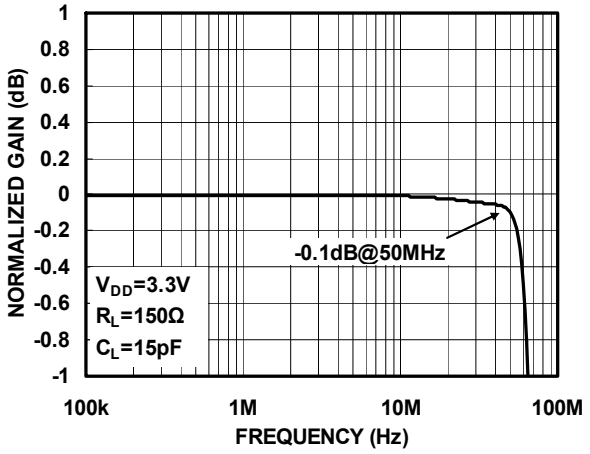



Figure2. Small-Scale Frequency Response(FHD Channel)

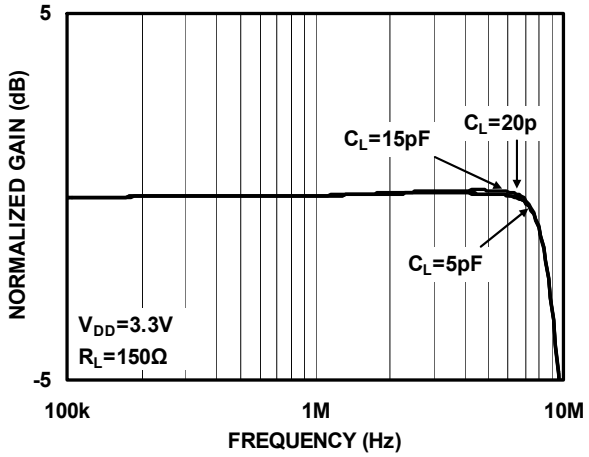



Figure3. Gain Vs. Frequency With $C_{LOAD}$ (SD Channel)

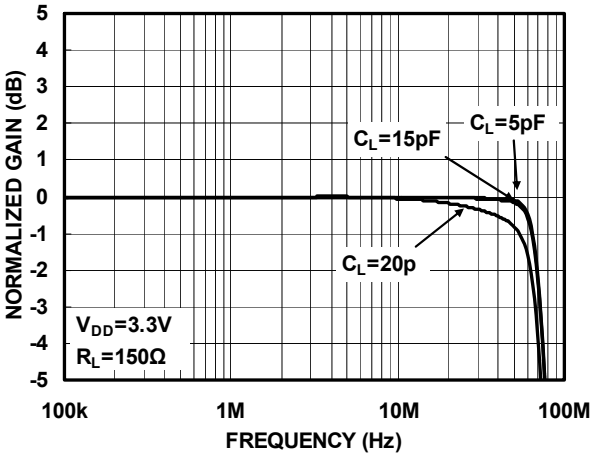



Figure4. Gain Vs. Frequency With $C_{LOAD}$(FHD Channel)

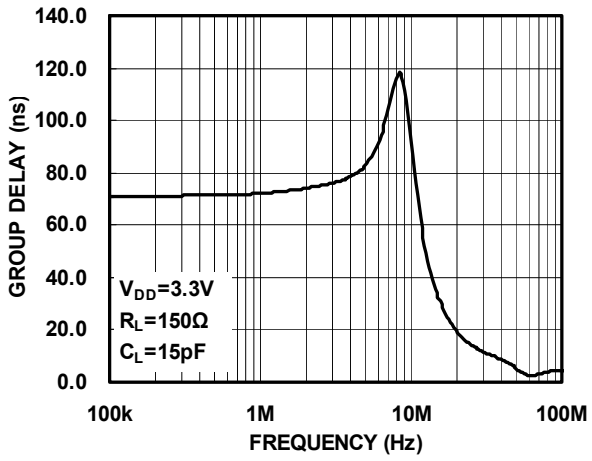



Figure5. Group Delay vs Frequency(SD Channel)

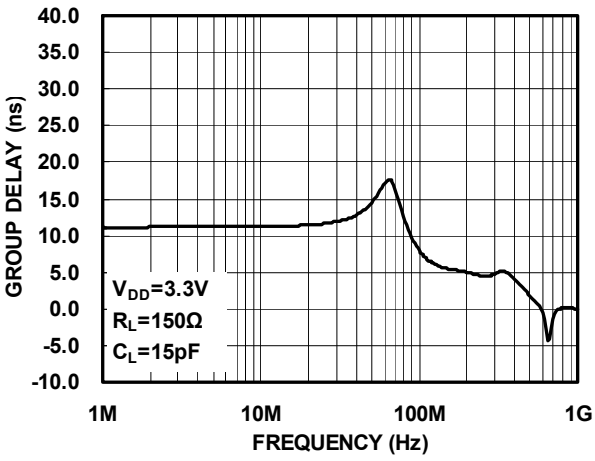



Figure6. Group Delay vs Frequency(FHD Channel)

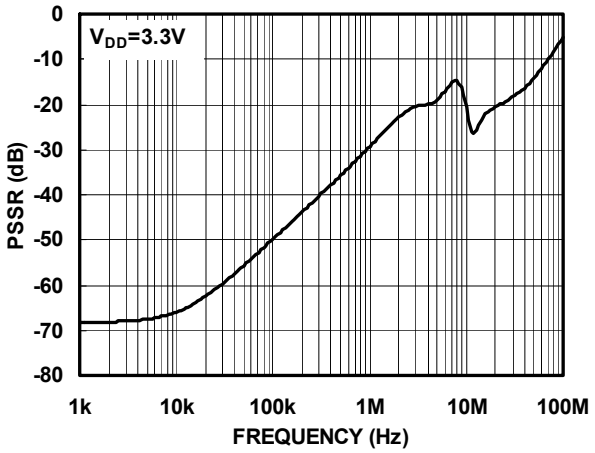



Figure7. PSRR Vs. Frequency(SD)

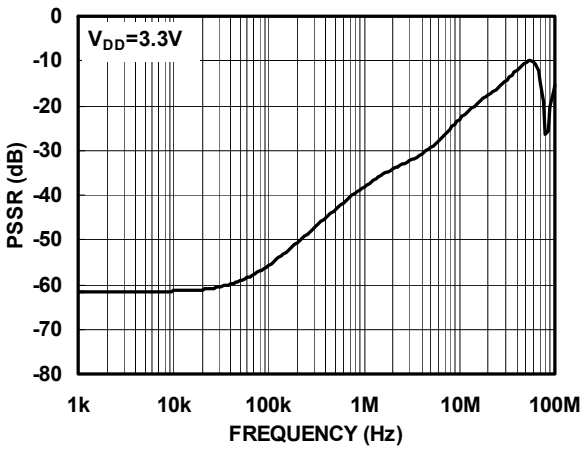



Figure8. PSRR Vs. Frequency(FHD)

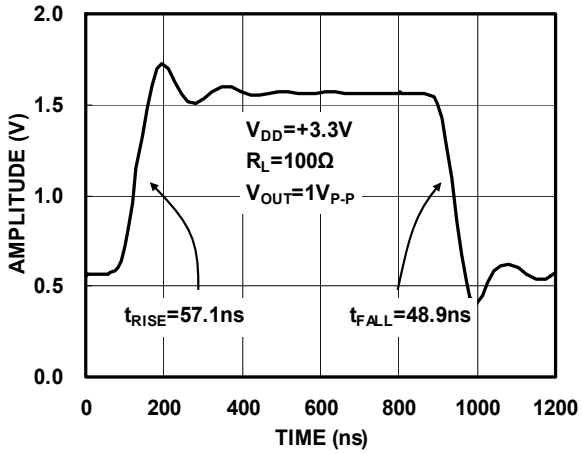



Figure9. Large-Signal Pulse Response Vs. Time(SD Channel)

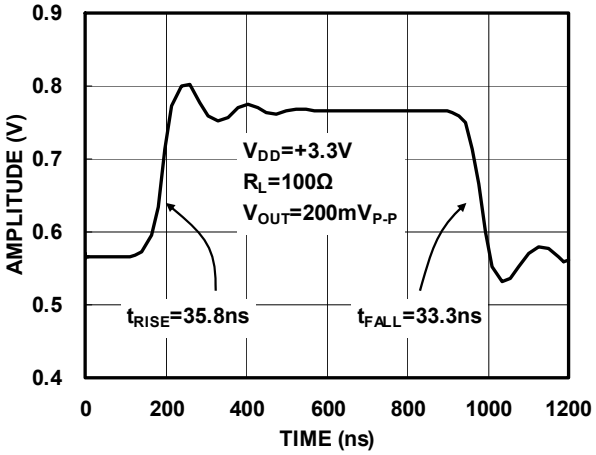



Figure10. Small-Signal Pulse Response Vs. Time(SD Channel)

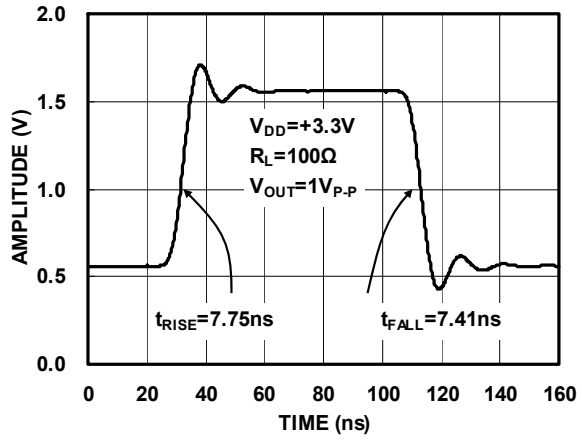



Figure11. Large-Signal Pulse Response Vs. Time(FHD Channel)

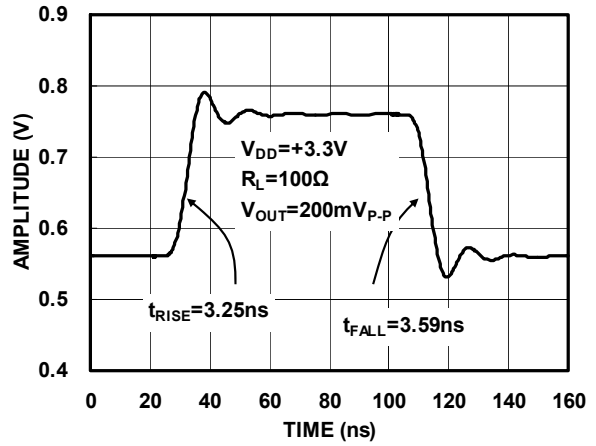



Figure11. Small-Signal Pulse Response Vs. Time(FHD Channel)

## Application Information

The TPF142 is targeted for systems that require a single standard-definition (CVBS) video output for CVBS video support along with 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 TPF142. The TPF142 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 TPF142 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 TPF142 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 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.

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

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

## 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 TPF142, two six-pole roll-off at around 9MHz 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

TPF142 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 TPF142 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 TPF142 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 TPF142, 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:
$T_{JMAX}$ = 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 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 | 1-SD& | 9MHz | MSOP-10 |

| | | | | |
|---|---|---|---|---|
| | 36MHz HD video filter and 1 channel SD video filter | 3-SD | 36MHz | 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 |

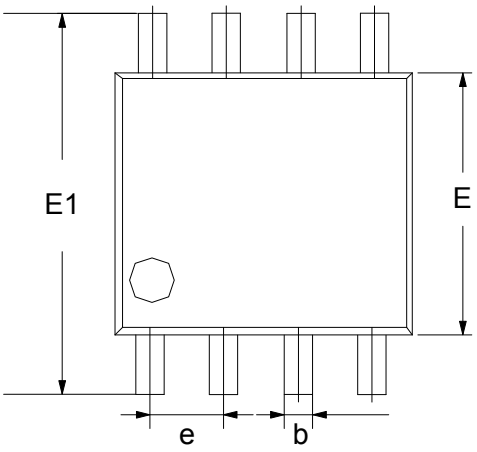
## Revision History

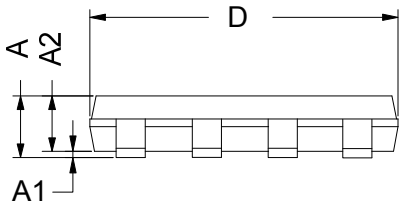
The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest revision.

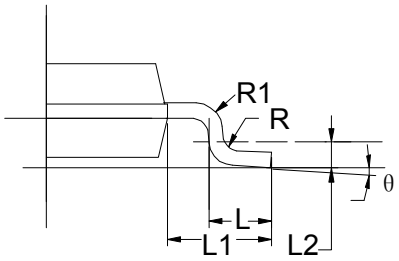
| Revision | Change |
|---|---|
| Rev1.0 | Initial Release |
| Rev1.1 | Delete $V_{IH}$ Max Value data, Add $V_{IH}$ Min Value data 1.6V on page 4<br>Delete $V_{IL}$ Min Value data, Add $V_{IL}$ Max Value data 0.4V on page 4<br>Change page header Date from @2013 to @2014 |

## Package Outline Dimensions

**10 Lead MSOP Package——Main Body 3.00 mm [MSOP_N]**



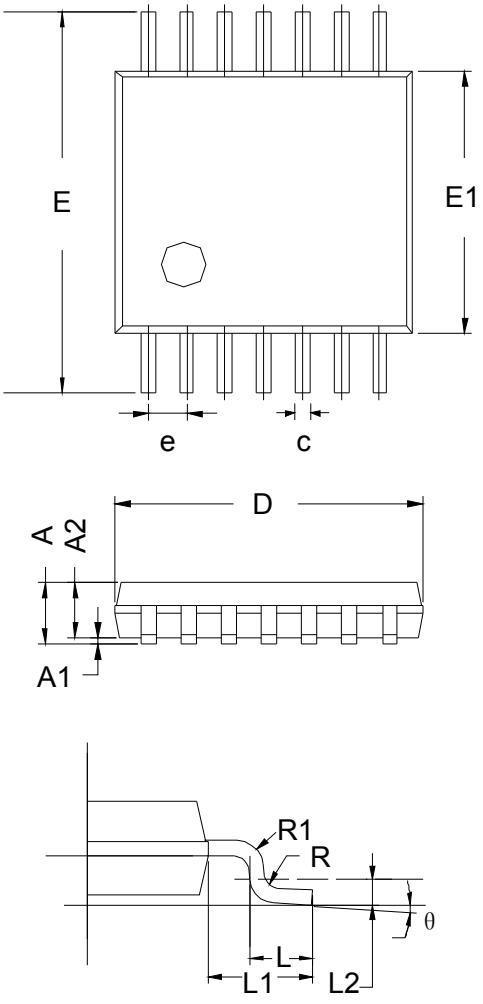




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 0.800 | 1.200 | 0.031 | 0.047 |
| A1 | 0.000 | 0.200 | 0.000 | 0.008 |
| A2 | 0.760 | 0.970 | 0.030 | 0.038 |
| b | 0.30 TYP | | 0.012 TYP | |
| C | 0.15 TYP | | 0.006 TYP | |
| D | 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° |

## 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 | - | - |
| θ | 0° | - | 8° |

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