

**36M HD Composite Video Filter Driver With Comparator**

## Features

- 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:

- 1-HDTV Video Filter Support Composite 1080i/720p
- Optimized 6<sup>th</sup>-order Butterworth Video reconstruction filter:
  - HD Channel: -3dB ≥ 36MHz
- Support Multiple Input Biasing:
  - Provide 80-mV Level-Shift when DC-Coupled
- Very Low Quiescent Current: 9 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
- PVR、DVD Player Video Buffer
- Video Buffer for Portable or USB-Powered Video Devices
- HDTV

## Description

The TPF1341 is a low power, 36M HD composite video filter and comparator on a single chip. Drawing less than 9mA supply current over the full operating temperature range, the TPF1341 operates from a single 3.0V to 5.5V.

TPF1341 integrate high-performance low-cost 36MHz composite video reconstruction filter, it combine excellent video performance and low power consumption perfectly. It incorporates one high-definition (HD) filter channels. 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.

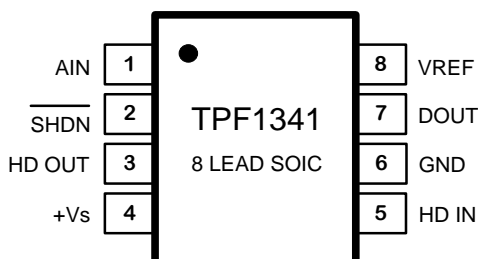
The TPF1341's on-board comparator incorporates 3PEAK's proprietary and patented design techniques to achieve the ultimate combination of high-speed (68ns propagation delay under 3.0~5.5V wide supply range) and low power consuming, The internal input hysteresis eliminates output switching due to internal input noise voltage, reducing current draw. The push-pull output supports rail-to-rail output swing, and interfaces with CMOS/TTL logic.

TPF1341 is available in SOP-8 package (TPF1341-SR). Its operation temperature range is from -40°C to +85°C.

## Related Resources

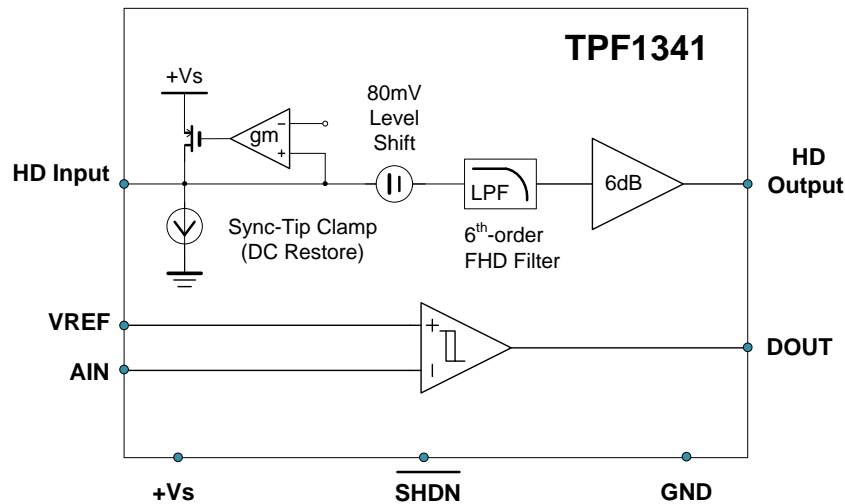
AN-1201: Application notes of TPF1xx

## Pin configuration (Top View)



| Pin Name | Pin Function  |
|----------|---|
| AIN      | Inverting Input of the Comparator   |
| DOUT     | Comparator Output   |
| VREF     | Non-Inverting Input of Comparator   |
| HD IN    | HD video input, LPF = 36 MHz  |
| +Vs      | Positive Power Supply   |
| GND      | Ground  |
| HD OUT   | HD video output, LPF = 36 MHz   |
| 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. <b>This pin defaults to logic high if left open.</b> |

## Function Block



## Order Information

| Order Number | Operating Temperature Range | Package   | Marking Information | Transport Media, Quantity |
|--------------|-----------------------------|-----------|---------------------|---------------------------|
| TPF1341-SR   | -40 to 85°C                 | 8-Pin SOP | TPF1341             | Tape and Reel, 4000       |

## 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    |
| $\theta_{JA}$                 | 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  $V_{DD} = 3.3V$ ,  $T_A = +25^{\circ}C$ ,  $R_L = 150\Omega$  to GND, unless otherwise noted.

| SYMBOL                                 | PARAMETER                                  |            | CONDITIONS  | MIN  | TYP  | MAX  | UNITS      |
|--|--|------------|---|------|------|------|------------|
| <b>Input Electrical Specifications</b> |  |            |   |      |      |      |            |
| $V_{DD}$                               | Supply Voltage Range                       |            |   | 3.0  |      | 5.5  | V          |
| $I_{DD}$                               | Quiescent current ( $I_Q$ ) <sup>(1)</sup> |            | $V_{DD} = 3.3V, V_{IN} = 500mV$ , no load           |      | 6    | 8    | mA         |
|  |  |            | $V_{DD} = 5.0V, V_{IN} = 500mV$ , no load           |      | 8.3  | 9.8  | mA         |
| $I_{CLAMP-DOWN}$                       | Clamp Discharge Current                    |            | $V_{IN}=300mV$ , measure current                    | 0.6  | 2.0  | 4.8  | $\mu A$    |
| $I_{CLAMP-UP}$                         | Clamp Charge Current                       |            | $V_Y = -0.2V$                                       | -1.5 | -1.7 |      | mA         |
| $V_{CLAMP}$                            | Input Voltage Clamp                        |            | $I_Y = -100\mu A$                                   | -40  | 0    | +40  | mV         |
| $R_{IN}$                               | Input Impedance                            |            | $0.5V < V_Y < 1V$                                   | 0.5  | 3    |      | M $\Omega$ |
| AV                                     | Voltage Gain                               |            | $V_{IN}=0.5V, 1V$ or $2V$<br>$R_L=150\Omega$ 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                   |            | $V_{IN} = -0.3V, R_L = 75\Omega$                    |      | 0.05 |      | V          |
| $V_{OH}$                               | Output Voltage High Swing                  |            | $V_{IN} = 3V, R_L = 75\Omega$ 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                      |            | $V_{IN} = 2V, 10\Omega$ , 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         |
| <b>AC Electrical Specifications</b>    |  |            |   |      |      |      |            |
| $f_{-1dB}$                             | -1dB Bandwidth                             | HD Channel | $R_L=150\Omega$                                     | 27.3 | 31.0 | 34.7 | MHz        |
| $f_{-3dB}$                             | -3dB Bandwidth                             | HD Channel | $R_L=150\Omega$                                     | 31.9 | 35.5 | 39.3 | MHz        |
| 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  | $^{\circ}$ |
| THD                                    | Total Harmonic Distortion                  | HD Channel | $f=1MHz, V_{OUT}=1.4V_{PP}$                         |      | 0.02 |      | %          |
| D/DT                                   | Group Delay Variation                      | HD Channel | $f = 100kHz$ to $60MHz$                             |      | 5.0  |      | 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 $30MHz$                              | 66   | 71   |      | dB         |
| $R_{OUT\_AC}$                          | Output Impedance                           |            | $f = 10MHz$   |      | 0.5  |      | $\Omega$   |

Note: (1). 100% tested at  $T_A=25^{\circ}C$ .

**Electrical Characteristics-Comparator Part**

All test condition is  $V_{DD} = 3.3V$ ,  $T_A = +25^{\circ}C$ ,  $V_{IN+} = V_{DD}$ ,  $V_{IN-} = 1.2V$ ,  $R_{PU}=10k\Omega$ ,  $C_L=15pF$ , unless otherwise noted.

| SYMBOL         | PARAMETER  | CONDITIONS                        | MIN          | TYP       | MAX          | UNITS             |
|----------------|--|-----------------------------------|--------------|-----------|--------------|-------------------|
| $V_{DD}$       | Supply Voltage                                   |                                   | 3            |           | 5.5          | V                 |
| $V_{OS}$       | Input Offset Voltage <sup>Note 1</sup>           | $V_{CM} = 1.2V$                   | -3           | $\pm 0.6$ | +3           | mV                |
| $V_{OS\ TC}$   | Input Offset Voltage Drift <sup>Note 1</sup>     | $V_{CM} = 1.2V$                   |              | 0.3       |              | $\mu V/^{\circ}C$ |
| $V_{HYST}$     | Input Hysteresis Voltage <sup>Note 1</sup>       | $V_{CM} = 1.2V$                   | 4            | 6         | 8            | mV                |
| $V_{HYST\ TC}$ | Input Hysteresis Voltage Drift <sup>Note 1</sup> | $V_{CM} = 1.2V$                   |              | 20        |              | $\mu V/^{\circ}C$ |
| $I_B$          | Input Bias Current                               | $V_{CM} = 1.2V$                   |              | 6         |              | pA                |
| $I_{OS}$       | Input Offset Current                             |                                   |              | 4         |              | pA                |
| $R_{IN}$       | Input Resistance                                 |                                   |              | > 100     |              | G $\Omega$        |
| $C_{IN}$       | Input Capacitance                                | Differential<br>Common Mode       |              | 2<br>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           | $\mu A$           |
| $t_R$          | 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  $V_{DD} = 3.3V$ ,  $T_A = +25^{\circ}C$ ,  $R_L = 150\Omega$  to GND, unless otherwise noted.

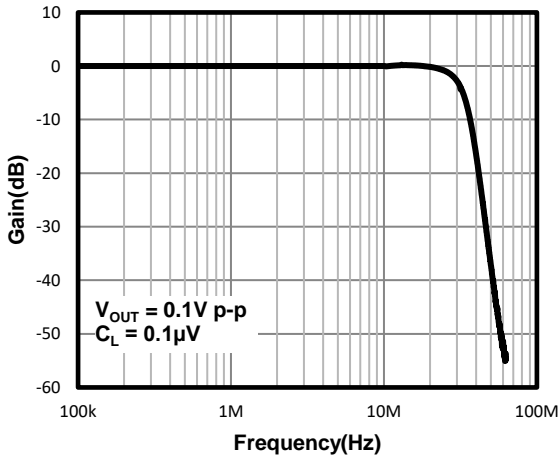


Figure5. Frequency Response

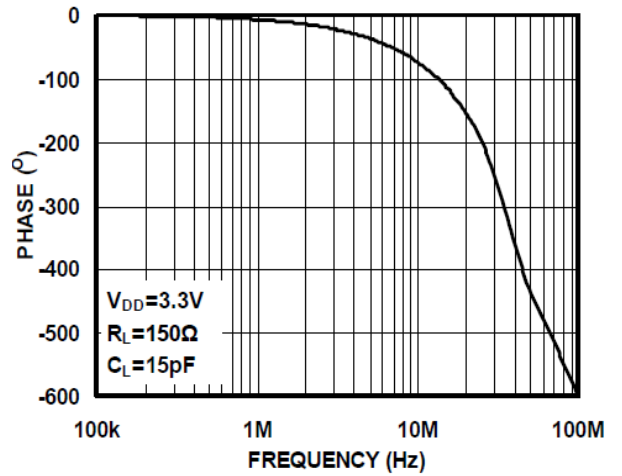


Figure6. Phase Vs. Frequency

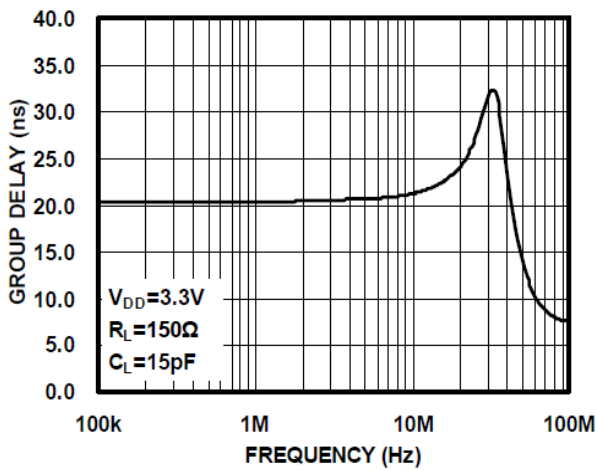


Figure7. Group Delay vs Frequency

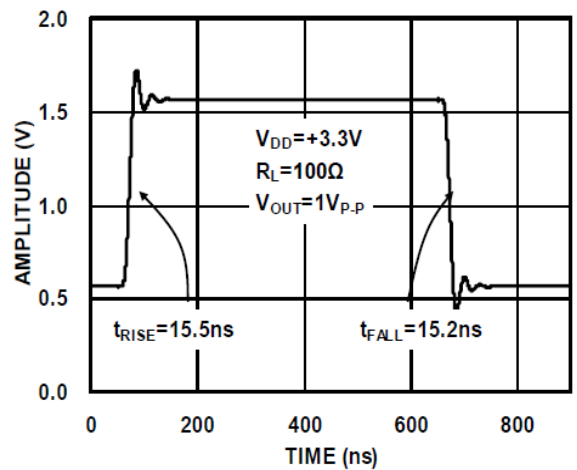


Figure8. Large-Signal Pulse Response Vs. Time

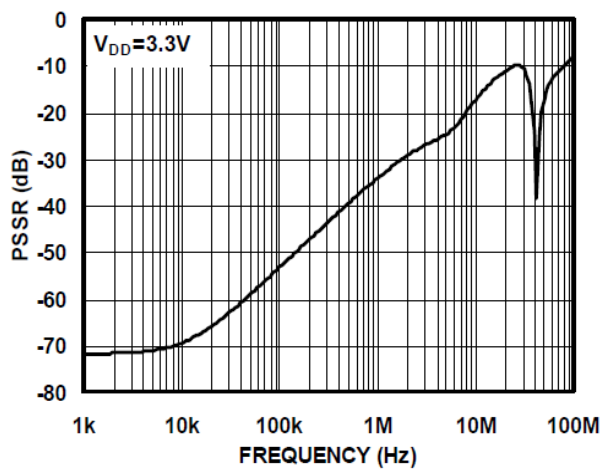


Figure9. PSRR Vs. Frequency

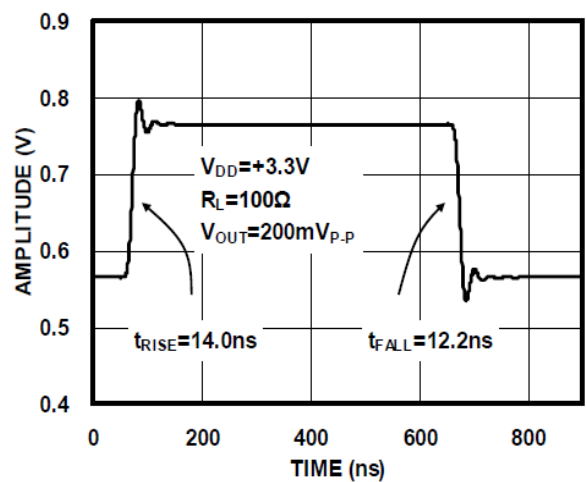
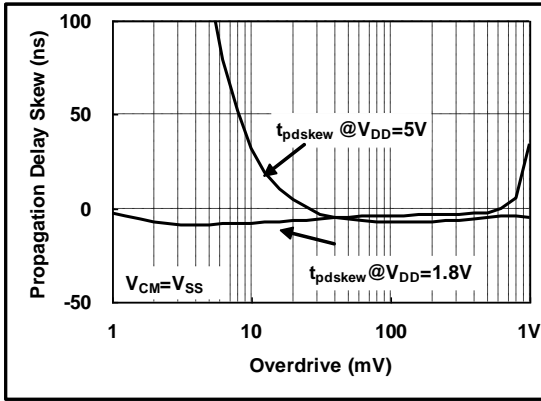


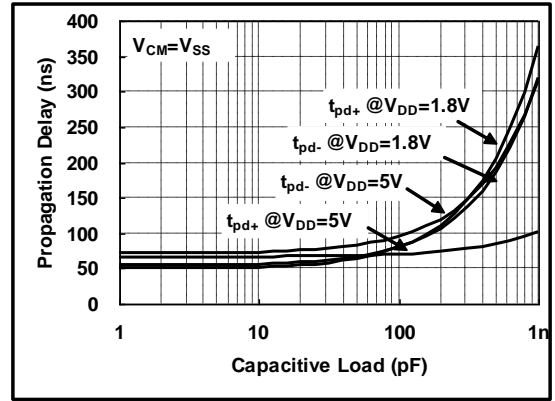
Figure10. Small-Signal Pulse Response Vs. Time

**Typical Performance Characteristics-Comparator Part**

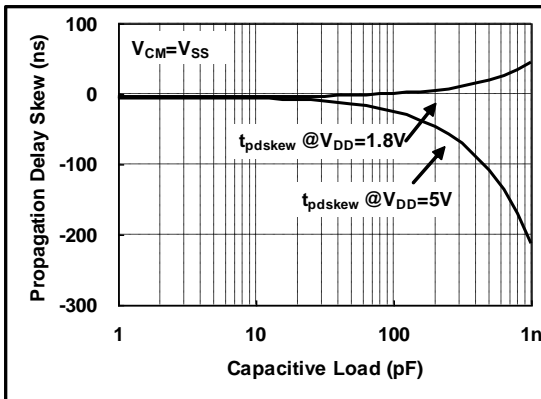
Propagation Delay Skew V.S. Overdrive Voltage



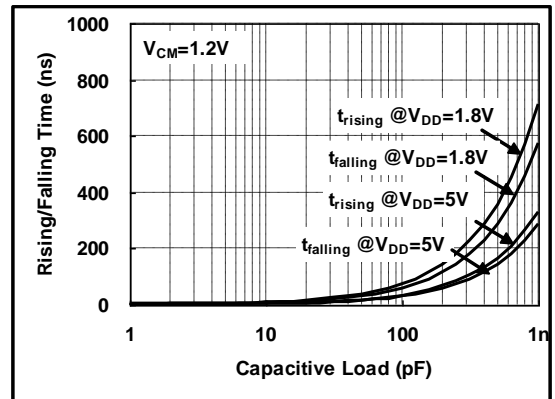
Propagation Delay V.S. Capacitor Loading



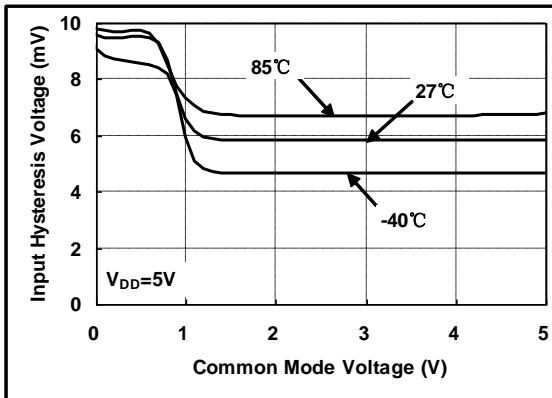
Propagation Delay Skew V.S. Capacitor Loading



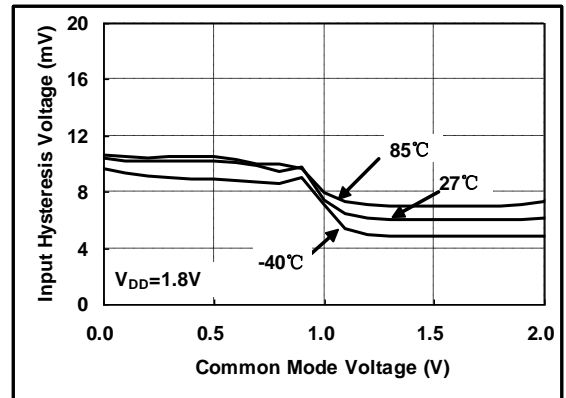
Rising/Falling Time V.S. Capacitor Loading



Input Hysteresis Voltage V.S. Common Mode Voltage



Input Hysteresis Voltage V.S. Common Mode Voltage



## Application Information

The TPF1341 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 TPF1341. The TPF1341 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 TPF1341 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 TPF1341 in 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.

Table 1. Maximum restoration voltage and droop voltage of Y 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 TPF1341, the six-pole roll-off at around 36MHz. The six-pole function is accomplished with an RC low pass network placed in series with and before the Sallen Key.

## Output Couple

TPF1341 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 TPF1341 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 TPF1341 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

## TPF1341

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1mA, compared to typical 6.6mA used when DC coupling.

### Output Drive Capability and Power Dissipation

With the high output drive capability of the TPF1341, 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 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

| P/N                | Product Description  | Channel       | -3dB Bandwidth | Package             |
|--------------------|--|---------------|----------------|---------------------|
| TPF110<br>/TPF110L | Low power, enable function and SAG correction, 1 channel 6 <sup>th</sup> order 9MHz        | 1-SD          | 9MHz           | SC70-5<br>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<br>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&<br>3-SD | 9MHz<br>36MHz  | MSOP-10<br>TSSOP-14 |

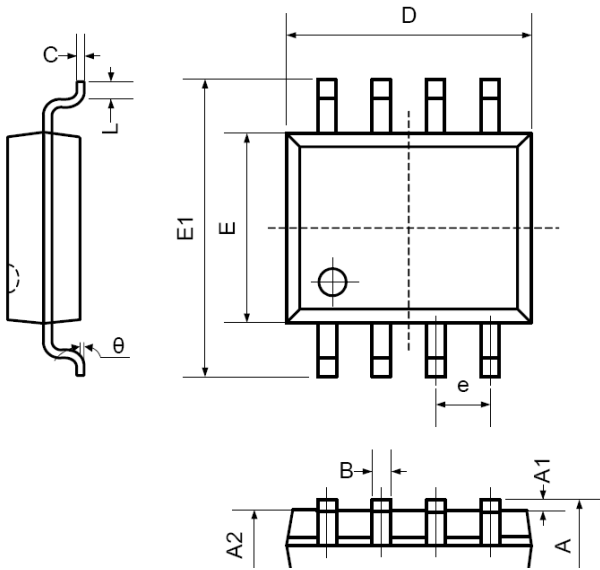


**36M HD Composite Video Filter Driver With Comparator**

|        |   |                |               |                     |
|--------|---|----------------|---------------|---------------------|
| TPF136 | Low power 3 channel, 6th-order<br>36MHz HD video filter and 3 channel<br>SD video filter      | 3-SD&<br>3-HD  | 9MHz<br>36MHz | TSSOP-20            |
| TPF143 | Low power 3 channel, 6th-order<br>72MHz Full HD video filter                                  | 3-FHD          | 72MHz         | SO-8                |
| TPF144 | Low power 3 channel, 6th-order<br>72MHz Full HD video filter and 1<br>channel SD video filter | 1-SD&<br>3-FHD | 9MHz<br>72MHz | MSOP-10<br>TSSOP-14 |
| TPF146 | Low power 3 channel, 6th-order<br>72MHz Full HD video filter and 3<br>channel SD video filter | 3-SD&<br>3-FHD | 9MHz<br>72MHz | TSSOP-20            |
| TPF153 | Low power 3 channel, 6th-order<br>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 |
| theta  | 0°                        | 8°    | 0°                   | 8°    |

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