

## Triple video buffer with filter for SD video

### Features

- 4.5V to 5.5V single supply operation
- R-G-B, Y-Pb-Pr, Y-C-CvBS driving
- 3 channels with 6dB gain buffer
- 3 video reconstruction filters for SD
- 3 internal input DC level shifter
- No input capacitor is required
- Very low harmonic distortion
- Each output can drive AC- or DC-coupled 150Ω loads
- Tested on 5V power supply
- Data min. and max. are tested during production

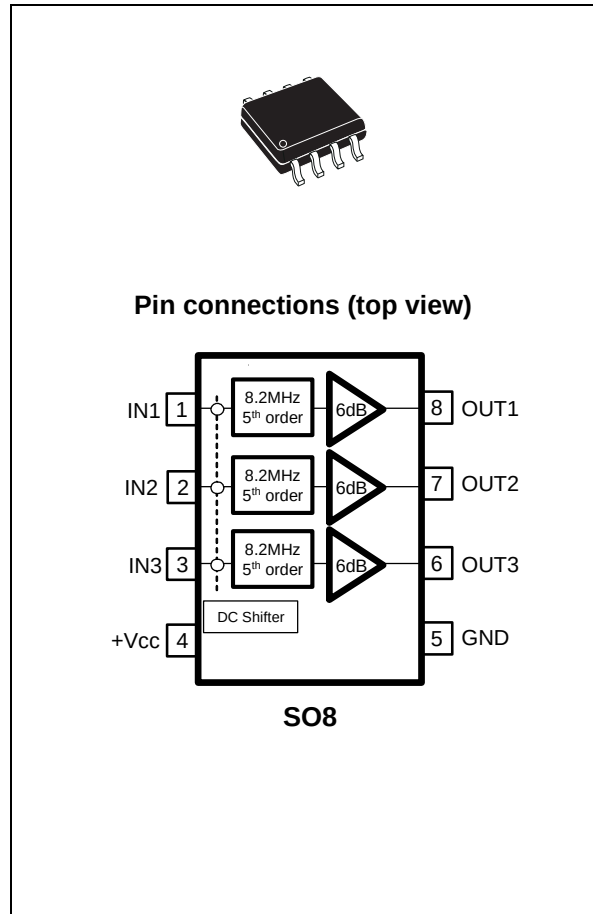
### Applications

- Set top boxes
- DVD players/recorders
- High-end video systems
- Standard definition TV (SD)
- Multimedia products

### Description

The TSH173 is a single supply triple video buffer featuring an internal gain of 6dB and an internal low pass filter of 8.2MHz cut-off frequency for each channel to fit with Standard Definition requirements for video line interfaces.

Another advantage of the TSH173 is its input DC level shifter to drive the video signal on a 75Ω video line without any damage to the synchronization tip, while using a single 5V power supply with no input capacitor. The DC level shifter is internally fixed and optimized to keep the output video signal between low and high output rails in the best position to improve linearity.



This datasheet gives technical information on using the TSH173 as a R-G-B, Y-Pb-Pr, or Y-C-CvBS driver for video DAC outputs on a video line.

The TSH173 is available in SO8 plastic package.

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## 1 Absolute maximum ratings

**Table 1. Absolute maximum ratings**

| Symbol     | Parameter                                                                                 | Value       | Unit |
|------------|-------------------------------------------------------------------------------------------|-------------|------|
| $V_{CC}$   | Supply voltage <sup>(1)</sup>                                                             | 6           | V    |
| $T_{oper}$ | Operating free air temperature range                                                      | -40 to +85  | °C   |
| $T_{stg}$  | Storage temperature                                                                       | -65 to +150 | °C   |
| $T_j$      | Maximum junction temperature                                                              | 150         | °C   |
| $R_{thjc}$ | SO8 thermal resistance junction to case                                                   | 28          | °C/W |
| $R_{thja}$ | SO8 thermal resistance junction to ambient area                                           | 157         | °C/W |
| $P_{max.}$ | Maximum power dissipation (@ $T_{amb}=25^{\circ}\text{C}$ ) for $T_j=150^{\circ}\text{C}$ | 800         | mW   |
| ESD        | CDM: charged device model                                                                 | 1.5         | kV   |
|            | HBM: human body model                                                                     | 2           | kV   |
|            | MM: machine model                                                                         | 200         | V    |
|            | Output short-circuit                                                                      | (2)         |      |

1. All voltage values, except differential voltage, are with respect to network terminal.
2. An output current limitation protects the circuit from transient currents. Short-circuits can cause excessive heating. Destructive dissipation can result from short-circuits on amplifiers.

## 2 Operating conditions

**Table 2. Operating conditions**

| Symbol   | Parameter            | Value                     | Unit |
|----------|----------------------|---------------------------|------|
| $V_{CC}$ | Power supply voltage | 4.5 to 5.5 <sup>(1)</sup> | V    |

1. Tested in full production at 0V/5V single power supply.

### 3 Electrical characteristics

**Table 3.**  $V_{CC} = +5V$  single supply, load:  $R_L = 150\Omega$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

| Symbol                                 | Parameter                                                                     | Test conditions                                                                                                                 | Min.     | Typ.       | Max. | Unit |
|----------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------|------------|------|------|
| DC performance                         |                                                                               |                                                                                                                                 |          |            |      |      |
| V <sub>DC</sub>                        | Output DC shift                                                               |                                                                                                                                 | 0.6      | 0.9        | 1.2  | V    |
|                                        |                                                                               | -40°C < T <sub>amb</sub> < +85°C                                                                                                |          | 0.95       |      |      |
| I <sub>ib</sub>                        | Input bias current                                                            | V <sub>CC</sub> =+5V, V <sub>icm</sub> =100mV                                                                                   |          | 3          | 6    | μA   |
|                                        |                                                                               | -40°C < T <sub>amb</sub> < +85°C                                                                                                |          | 5          |      |      |
| PSRR                                   | Power supply rejection ratio<br>20 log (ΔV <sub>cc</sub> /ΔV <sub>out</sub> ) | V <sub>CC</sub> =+5V,<br>ΔV <sub>CC</sub> =200mVp-p, F=1MHz<br>(without any improvement of the<br>power supply noise rejection) |          | 37         |      | dB   |
| I <sub>CC</sub>                        | Supply current per channel                                                    | V <sub>icm</sub> =100mV, no load                                                                                                |          | 7.4        | 9    | mA   |
|                                        |                                                                               | -40°C < T <sub>amb</sub> < +85°C                                                                                                |          | 8          |      |      |
| G                                      | DC voltage gain                                                               |                                                                                                                                 | 1.95     | 2          | 2.05 | V/V  |
|                                        |                                                                               | -40°C < T <sub>amb</sub> < +85°C                                                                                                |          | 1.95       |      |      |
| GM                                     | Gain matching                                                                 |                                                                                                                                 |          | 0.5        | 2    | %    |
| V <sub>OH</sub>                        | High level output voltage                                                     |                                                                                                                                 | 3.3      | 3.8        |      | V    |
| V <sub>OL</sub>                        | Low level output voltage                                                      |                                                                                                                                 |          | 210        |      | mV   |
| I <sub>OUT</sub>                       | I <sub>sink</sub>                                                             | V <sub>in</sub> =0.5V DC<br>V <sub>out</sub> is fixed by a generator at 2.5V                                                    | 25       | 34         |      | mA   |
|                                        | I <sub>source</sub>                                                           | V <sub>in</sub> =0.5V DC<br>V <sub>out</sub> is fixed by a generator at 1V                                                      | -28      | -38        |      |      |
| Dynamic performance (5th order filter) |                                                                               |                                                                                                                                 |          |            |      |      |
| F <sub>C-SD</sub>                      | -3dB bandwidth                                                                | Small signal                                                                                                                    |          | 8.2        |      | MHz  |
|                                        | -1dB bandwidth                                                                | Small signal<br>Large signal (V <sub>out</sub> =2Vp-p)                                                                          | 5.5<br>5 | 6.5<br>6.3 |      |      |
| F <sub>att</sub>                       | Filter attenuation                                                            | Small signal, F=27MHz                                                                                                           | 40       | 50         |      | dB   |
| Flatness                               | Gain flatness along a 4.5MHz band                                             | 10kHz to 4.5MHz<br>V <sub>out</sub> =2Vp-p                                                                                      |          | +/-0.1     |      | dB   |
| gd                                     | Group delay                                                                   | 0 to 6MHz                                                                                                                       |          | 17         |      | ns   |
| D                                      | Delay between each channel                                                    | 0 to 6MHz                                                                                                                       |          | 0.5        |      | ns   |
| dG                                     | Differential gain                                                             |                                                                                                                                 |          | 0.6        |      | %    |
| dPh                                    | Differential phase                                                            |                                                                                                                                 |          | 0.15       |      | °    |
| Noise                                  |                                                                               |                                                                                                                                 |          |            |      |      |
| SNR                                    | Signal-to-noise ratio                                                         | Bw = 10kHz to 6MHz                                                                                                              |          | 62         |      | dB   |

Figure 1. Frequency response

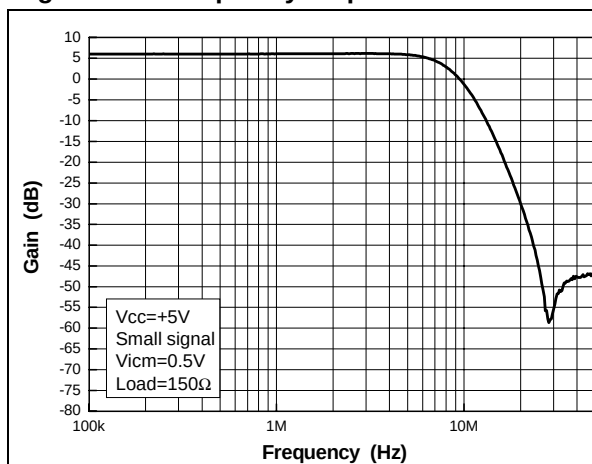


Figure 2. Gain flatness

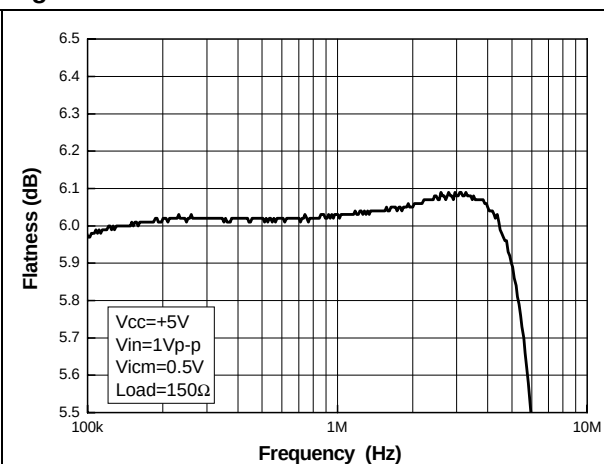


Figure 3. Total input noise vs. frequency

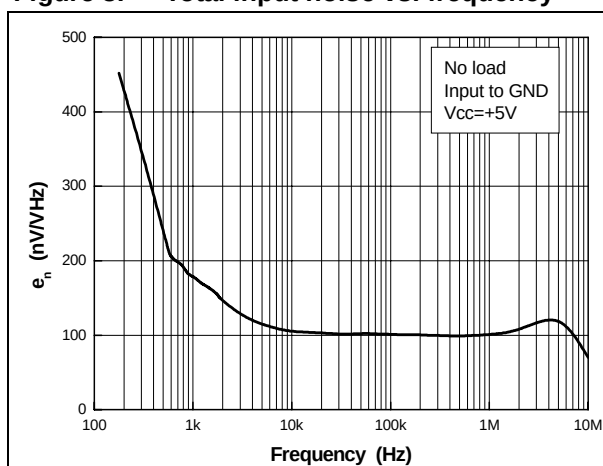


Figure 4. Distortion on 150Ω load

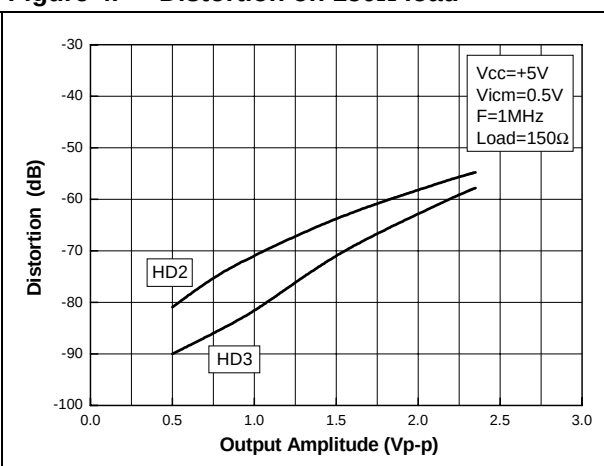


Figure 5. Cross-talk vs. frequency

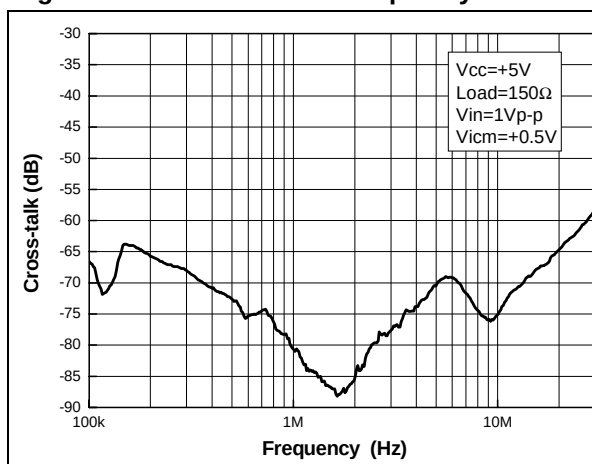


Figure 6. Output voltage swing vs. supply

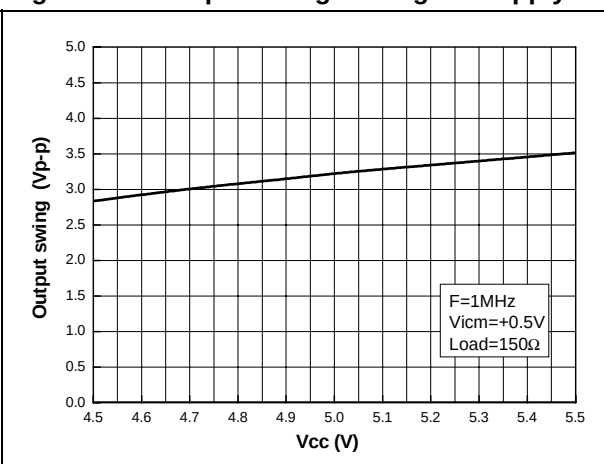


Figure 7. Quiescent current vs. supply

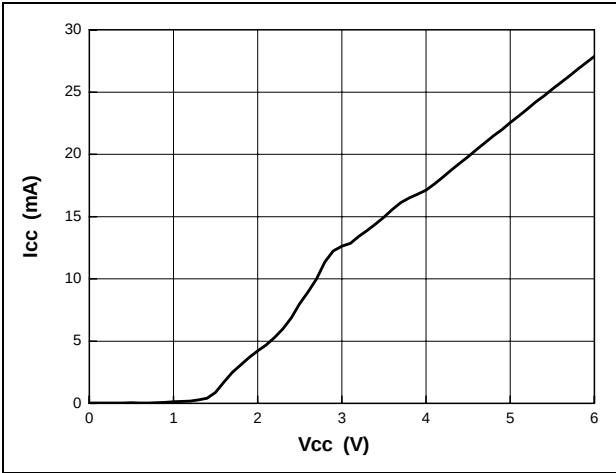


Figure 8.  $I_{sink}$  and  $I_{source}$

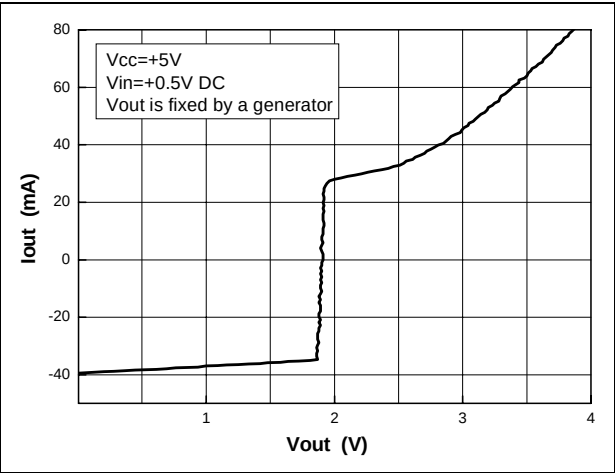


Figure 9. Supply current vs.  $T_{amb}$

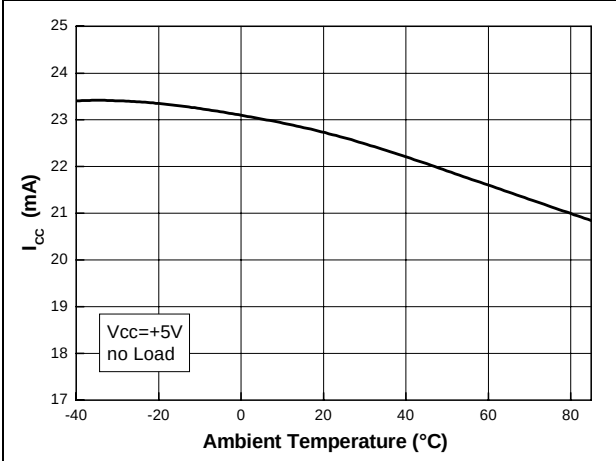


Figure 10. Output DC shift vs.  $T_{amb}$

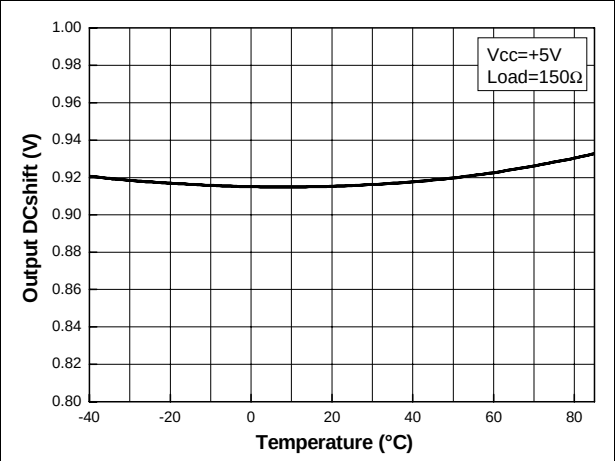


Figure 11. Voltage gain vs.  $T_{amb}$

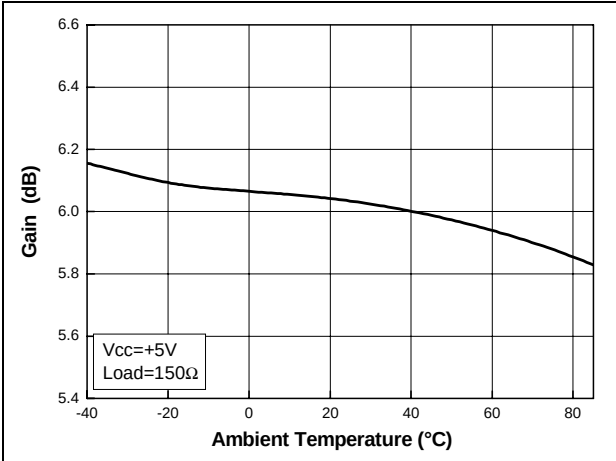


Figure 12. -1dB bandwidth vs.  $T_{amb}$

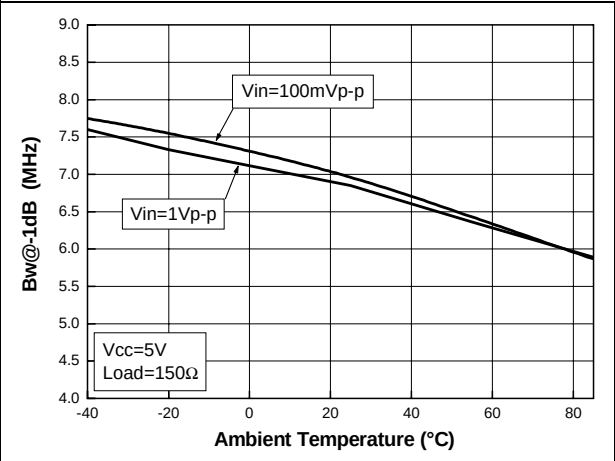


Figure 13. Higher output rail vs.  $T_{amb}$

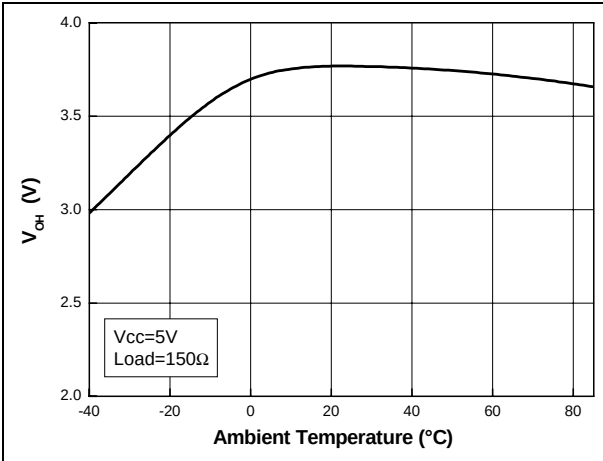


Figure 14. Gain matching vs.  $T_{amb}$

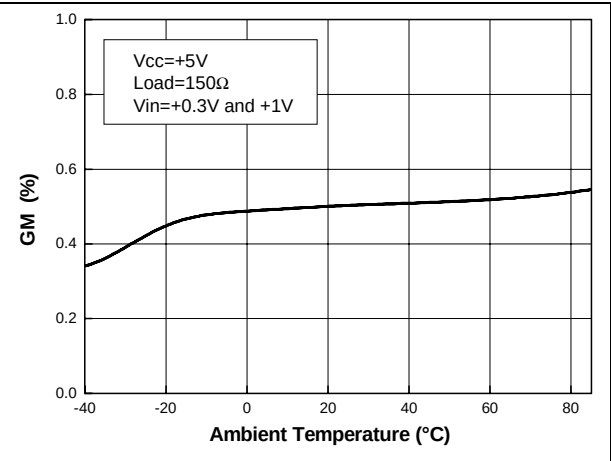


Figure 15.  $I_{sink}$  vs.  $T_{amb}$

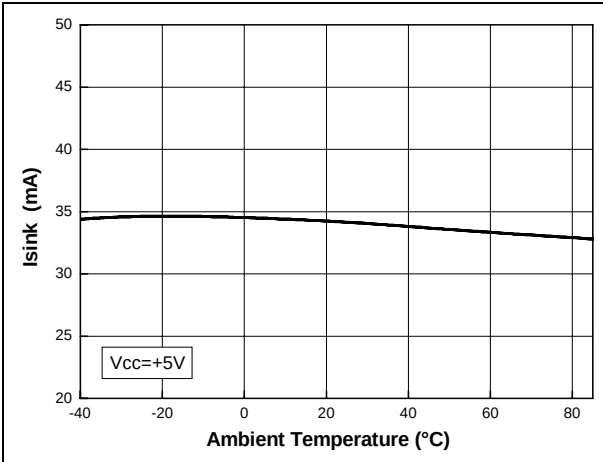


Figure 16.  $I_{source}$  vs.  $T_{amb}$

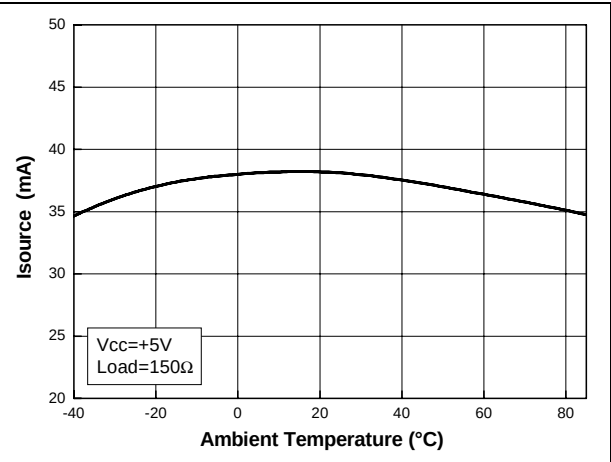
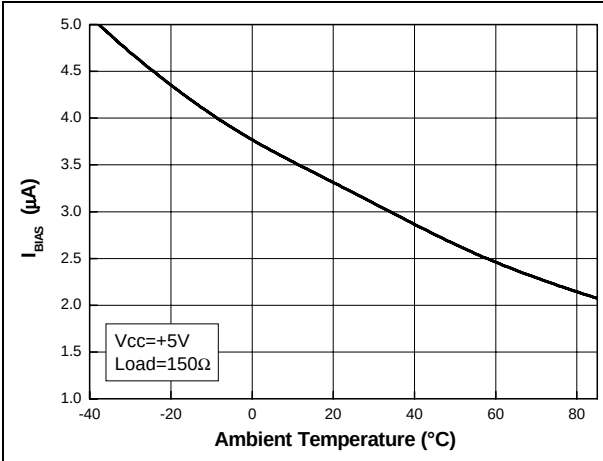


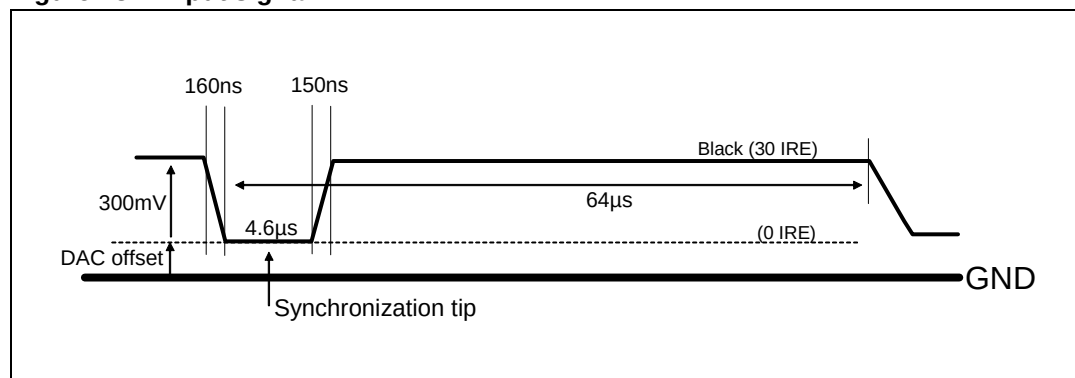
Figure 17.  $I_{bias}$  vs.  $T_{amb}$



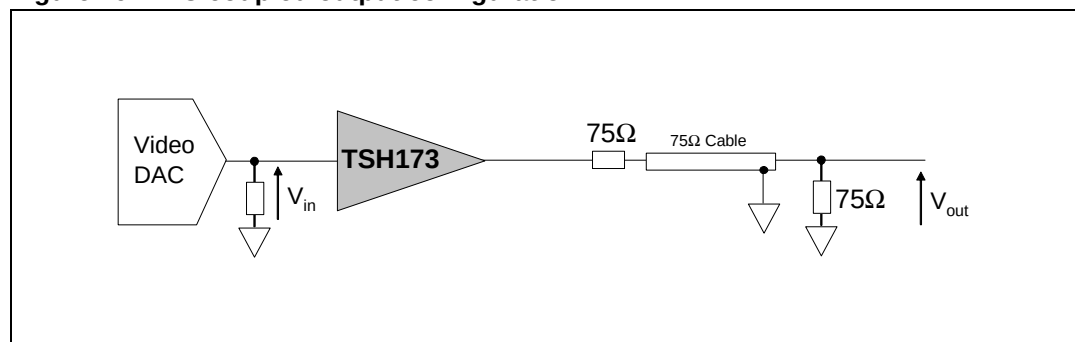
### 3.1 Synchronization tip

The TSH173, in single 0/5V supply, is designed to drive the video signal on the line without any damage to the synchronization tip. This is achieved by a small internal DC shift and a very low output rail. The DAC offset, as shown in *Figure 18*, can be as low as 0V. Nevertheless, in order to minimize the DC component on the line, the output can be AC coupled by a capacitor (*Figure 20*).

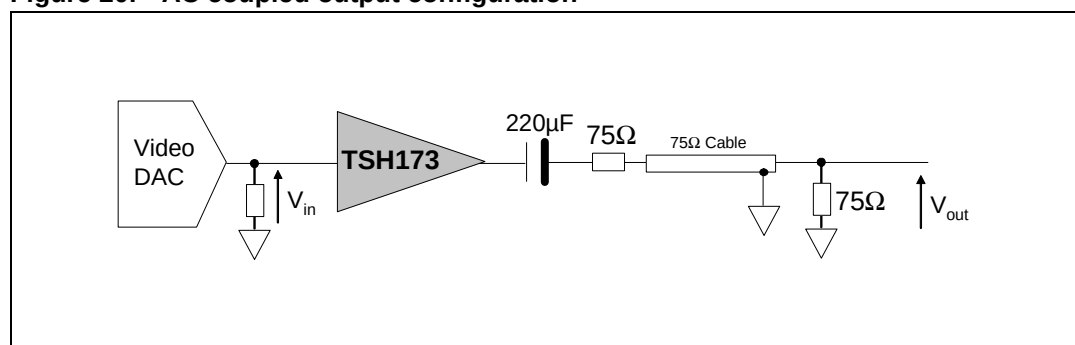
**Figure 18. Input signal**



**Figure 19. DC coupled output configuration**



**Figure 20. AC coupled output configuration**

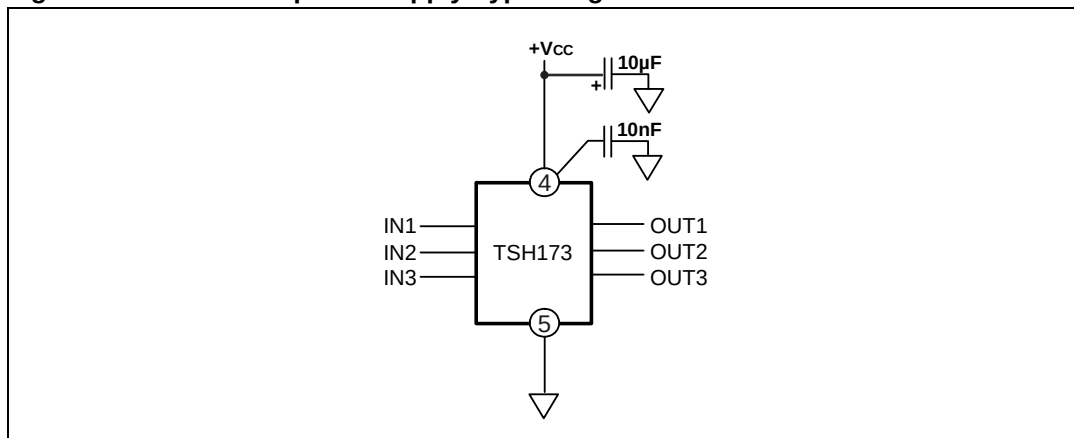




### 3.2 Power supply considerations

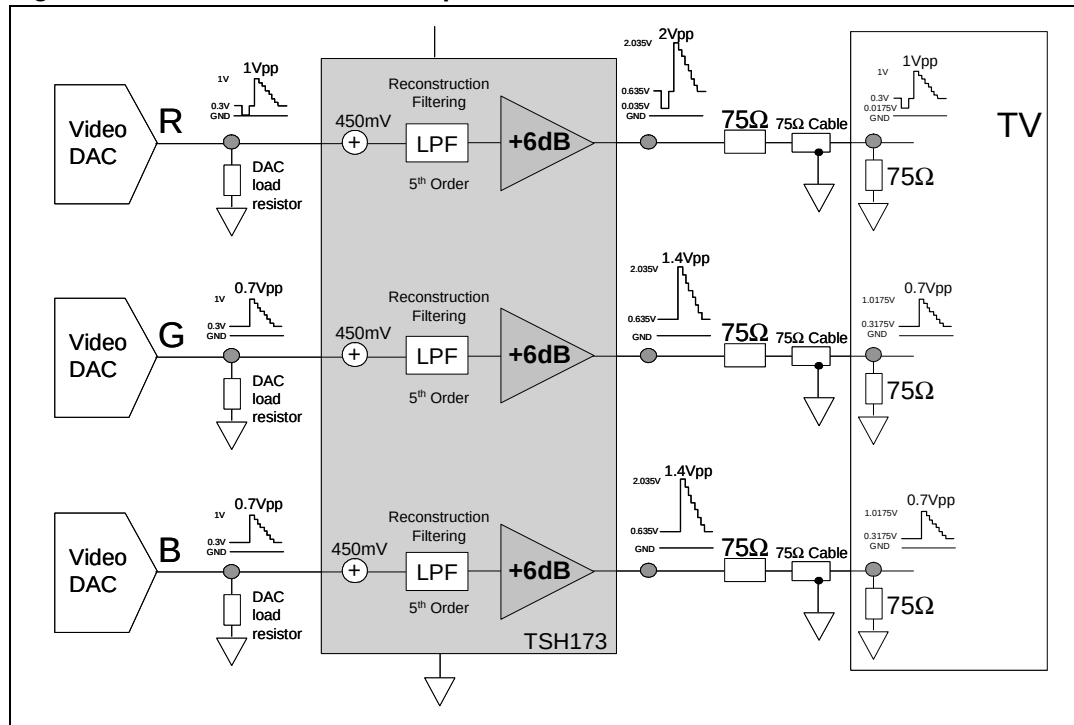
Correct power supply bypassing is very important for optimizing performance in high-frequency ranges. Bypass capacitors should be placed as close as possible to the IC pins to improve high-frequency bypassing. A capacitor greater than  $10\mu\text{F}$  is necessary to minimize the distortion. For better quality bypassing, we recommend to add a  $10\text{nF}$  capacitor, also placed as close as possible to the IC pins. Bypass capacitors must be incorporated for both the negative and the positive supply.

**Figure 21. Circuit for power supply bypassing**



## 4 Using the TSH173 to drive video components

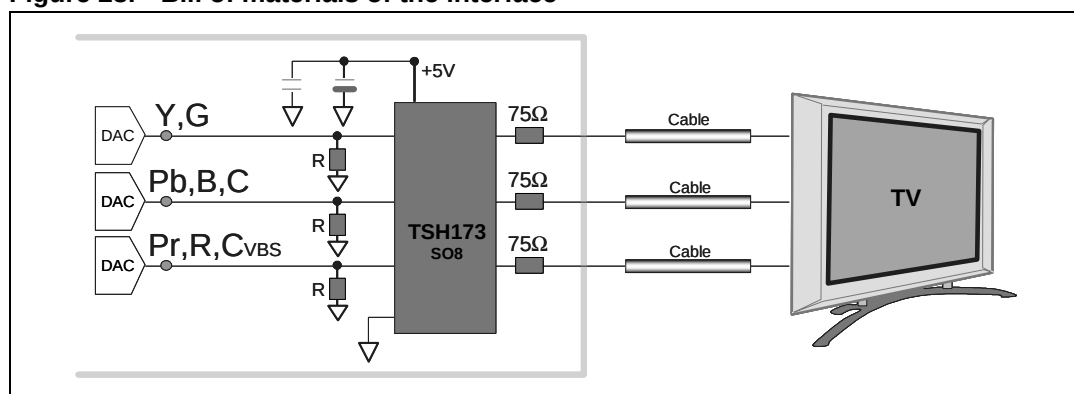
Figure 22. Video line interface implementation schematics



The interface is illustrated in Figure 23. It is composed of:

- Three 75-ohm resistors
- Three matching resistors
- One 10 $\mu$ F power supply decoupling capacitor
- One 10nF power supply decoupling capacitor

Figure 23. Bill of materials of the interface



# 5 Package mechanical data

Figure 24. SO-8 package

| Ref. | Dimensions  |      |      |        |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Millimeters |      |      | Inches |       |       |
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    | 1.35        |      | 1.75 | 0.053  |       | 0.069 |
| A1   | 0.10        |      | 0.25 | 0.04   |       | 0.010 |
| A2   | 1.10        |      | 1.65 | 0.043  |       | 0.065 |
| B    | 0.33        |      | 0.51 | 0.013  |       | 0.020 |
| C    | 0.19        |      | 0.25 | 0.007  |       | 0.010 |
| D    | 4.80        |      | 5.00 | 0.189  |       | 0.197 |
| E    | 3.80        |      | 4.00 | 0.150  |       | 0.157 |
| e    |             | 1.27 |      |        | 0.050 |       |
| H    | 5.80        |      | 6.20 | 0.228  |       | 0.244 |
| h    | 0.25        |      | 0.50 | 0.010  |       | 0.020 |
| L    | 0.40        |      | 1.27 | 0.016  |       | 0.050 |
| k    | 8° (max.)   |      |      |        |       |       |
| ddd  |             |      | 0.1  |        |       | 0.04  |

## 6 Ordering information

Table 4. Order codes

| Part number | Temperature range | Package | Packaging   | Marking |
|-------------|-------------------|---------|-------------|---------|
| TSH173ID    | -40°C to +85°C    | SO-8    | Tube        | TSH173I |
| TSH173IDT   |                   | SO-8    | Tape & reel | TSH173I |

## 7 Revision history

| Date        | Revision | Changes          |
|-------------|----------|------------------|
| 21-Mar-2007 | 1        | Initial release. |

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