

## Triple video buffer/filter for HD video applications

### Features

- 6th order filtering of 36 MHz
- 5 V single-supply operation
- Internal input DC level shifter
- No input capacitor required
- Three matched 6 dB amplifiers
- AC or DC output-coupled
- Very low harmonic distortion
- Specified for 150  $\Omega$  loads
- Minimum and maximum data is tested during production

### Applications

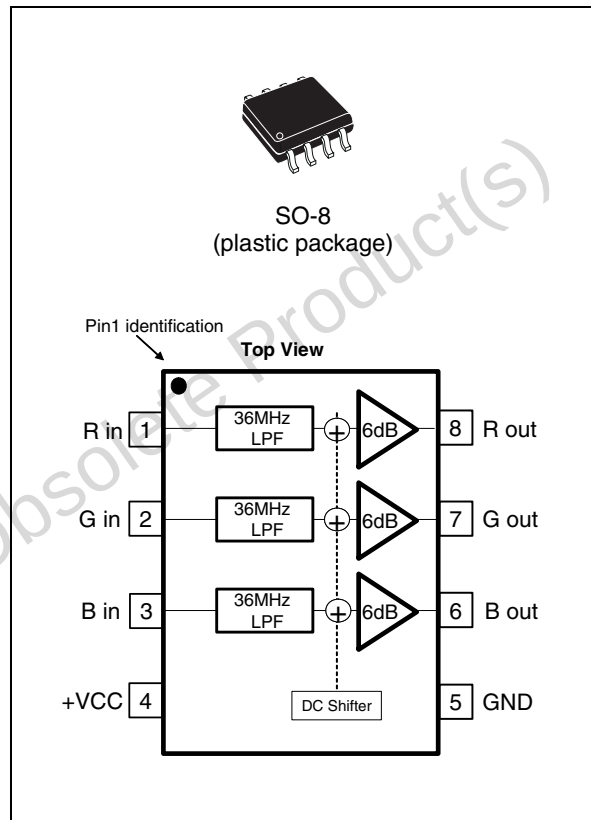
- High-end video systems
- High definition TV (HDTV)
- Broadcast and graphic video
- Multimedia products

### Description

The TSH346 is a triple single-supply video buffer featuring an internal gain of 6 dB and a 36 MHz filtering for HD video outputs on 75- $\Omega$  video lines.

The TSH346 is ideal to drive either YUV, YPbPr or RGB signals from video DAC outputs. The main advantage of this circuit is that its input DC level shifter allows for video signals on 75- $\Omega$  video lines without damaging the synchronization tip of the video signal, and with no input capacitor, while using a single 5 V power supply. The DC level shifter is internally fixed and optimized to keep the output video signals between low and high output rails. This level is as low as possible to minimize the output DC level in the video line.

The TSH346 is available in an SO-8 plastic package for optimum space saving.



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

| Symbol     | Parameter                                                                                  | Value       | Unit |
|------------|--------------------------------------------------------------------------------------------|-------------|------|
| $V_{CC}$   | Supply voltage <sup>(1)</sup>                                                              | 6           | V    |
| $V_{in}$   | Input voltage range <sup>(2)</sup>                                                         | 2.5         | V    |
| $T_{oper}$ | Operating free air temperature range                                                       | -40 to +85  | °C   |
| $T_{std}$  | 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                                            | 150         | °C/W |
| $P_{max.}$ | Maximum power dissipation (at $T_{amb} = 25^\circ\text{C}$ for $T_j = 150^\circ\text{C}$ ) | 1           | W    |
| ESD        | CDM: charged device model                                                                  | 500         | V    |
|            | HBM: human body model                                                                      | 2           | kV   |
|            | MM: machine model                                                                          | 100         | V    |

1. All voltage values, except the differential voltage, are with respect to the network terminal.

2. The magnitude of the input and output voltages must never exceed  $V_{CC} + 0.3\text{ V}$ .

**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 with a +5 V single power supply.

## 2 Electrical characteristics

Table 3.  $V_{CC} = +5\text{ V}$  single supply,  $T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

| Symbol                 | Parameter                  | Test conditions                                                                                      | Min. | Typ.     | Max. | Unit   |
|------------------------|----------------------------|------------------------------------------------------------------------------------------------------|------|----------|------|--------|
| DC performance         |                            |                                                                                                      |      |          |      |        |
| V <sub>DC</sub>        | Output DC shift            | R <sub>L</sub> = 150 Ω, T <sub>amb</sub>                                                             | 100  | 240      | 440  | mV     |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 310      |      |        |
| I <sub>ib</sub>        | Input bias current         | T <sub>amb</sub> , input to GND                                                                      |      | 1.3      | 3.6  | μA     |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 1.4      |      |        |
| R <sub>in</sub>        | Input resistance           |                                                                                                      |      | 1        |      | MΩ     |
| C <sub>in</sub>        | Input capacitance          |                                                                                                      |      | 0.1      |      | pF     |
| I <sub>CC</sub>        | Total supply current       | No load, input to GND                                                                                |      | 44.6     | 51.6 | mA     |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 45       |      |        |
| G                      | DC voltage gain            | R <sub>L</sub> = 150 Ω, V <sub>in</sub> = 0.5 V                                                      | 1.96 | 2        | 2.05 | V/V    |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 1.96     |      |        |
| Output characteristics |                            |                                                                                                      |      |          |      |        |
| V <sub>OH</sub>        | High level output voltage  | R <sub>L</sub> = 150 Ω                                                                               | 3.4  | 3.9      |      | V      |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 3.8      |      |        |
| V <sub>OL</sub>        | Low level output voltage   | R <sub>L</sub> = 150 Ω                                                                               |      | 47       |      | mV     |
| I <sub>OUT</sub>       | I <sub>source</sub>        |                                                                                                      | 76   | 100      |      | mA     |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 91       |      |        |
|                        | I <sub>sink</sub>          |                                                                                                      | 106  | 134      |      |        |
|                        |                            | -40° C < T <sub>amb</sub> < +85° C                                                                   |      | 126      |      |        |
| Filtering              |                            |                                                                                                      |      |          |      |        |
| High definition        | Bandwidth                  | Small signal, V <sub>ICM</sub> = 0.5 V, R <sub>L</sub> = 150 Ω<br>-3 dB bandwidth<br>-1 dB bandwidth | 25   | 36<br>32 |      | MHz    |
|                        | Attenuation                | Small signal, F = 74.25 MHz<br>V <sub>ICM</sub> = 0.5 V, R <sub>L</sub> = 150 Ω                      | 25   | 32       |      | dB     |
| D                      | Delay between each channel |                                                                                                      |      | 0.5      |      | ns     |
| Noise                  |                            |                                                                                                      |      |          |      |        |
| eN                     | Total input voltage noise  | F = 100 kHz, R <sub>IN</sub> = 50 Ω                                                                  |      | 86       |      | nV/√Hz |

Figure 1. Filtering

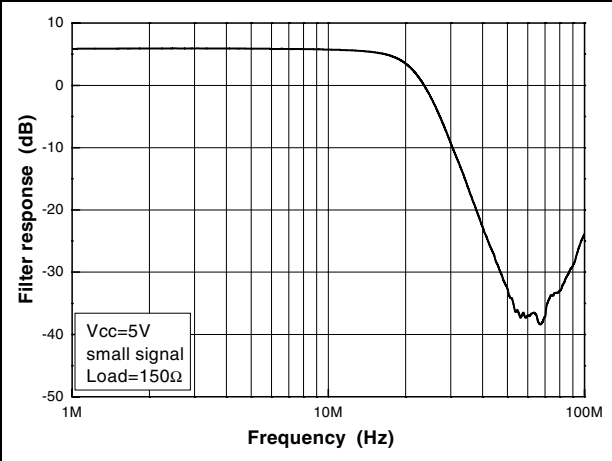


Figure 2. Gain flatness

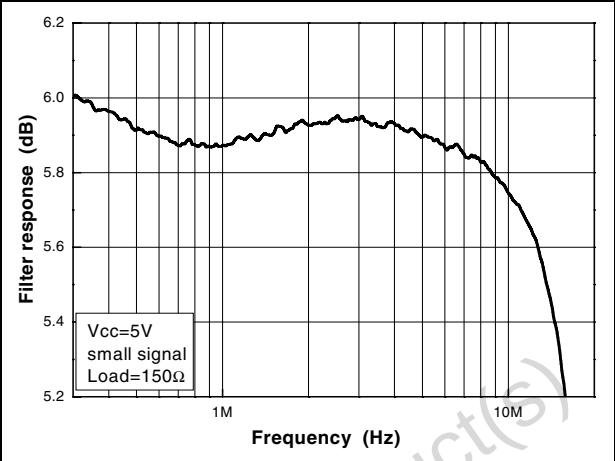


Figure 3. Distortion 1 MHz (HD)

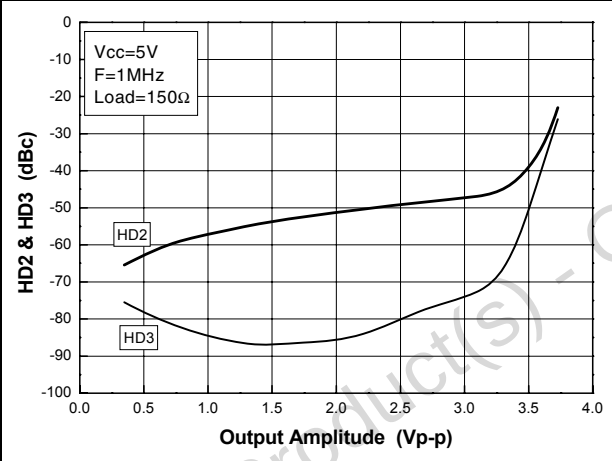


Figure 4. Distortion 10 MHz (HD)

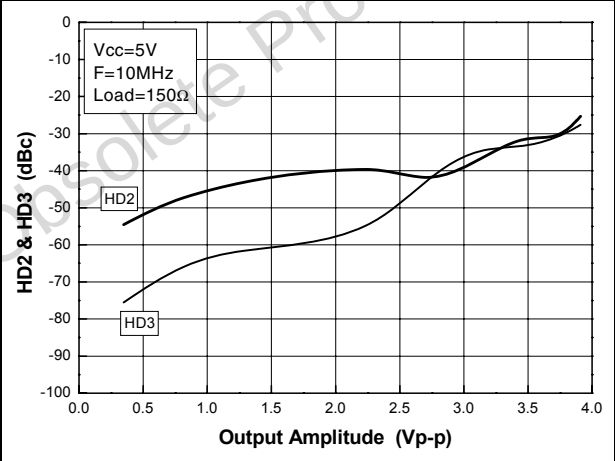


Figure 5. Input noise vs. frequency

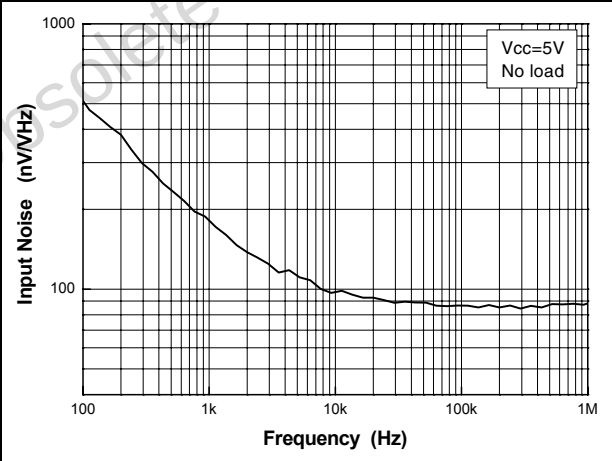


Figure 6. Channel crosstalk vs. frequency

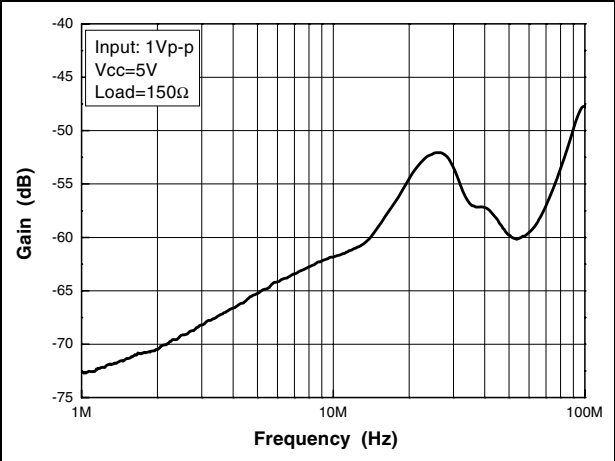


Figure 7. Gain vs. input amplitude

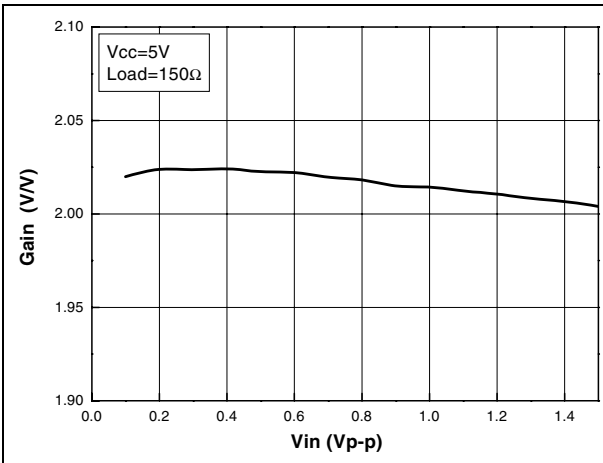


Figure 8. Output vs input amplitude

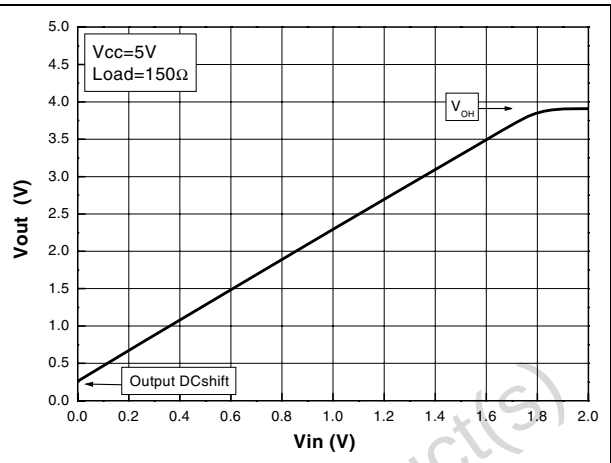


Figure 9. Current consumption vs. supply

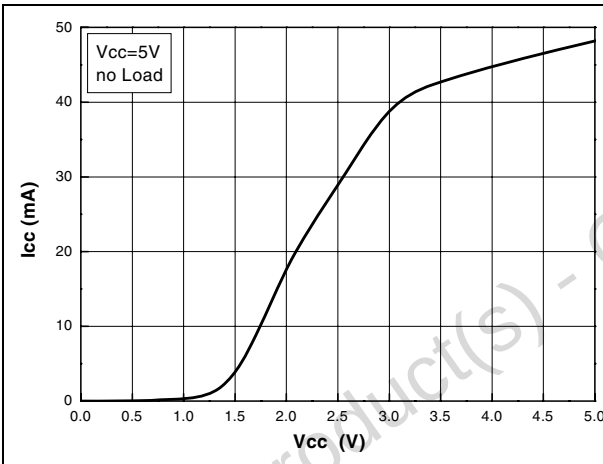


Figure 10. Supply current vs. temperature

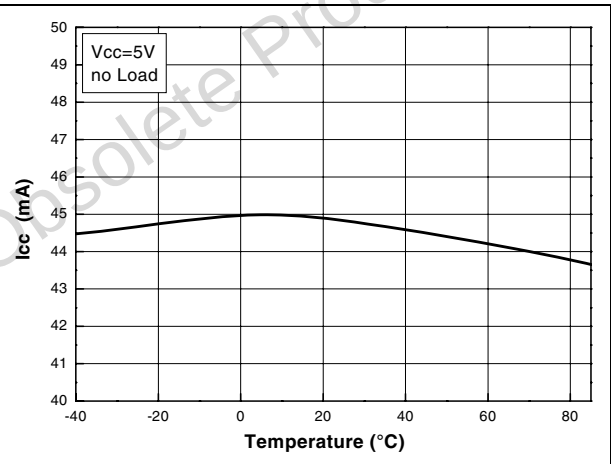


Figure 11. Filtering vs. temperature

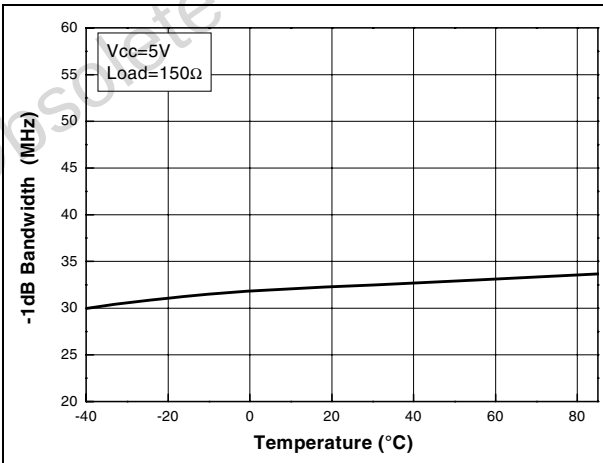


Figure 12. Filter attenuation vs. temperature

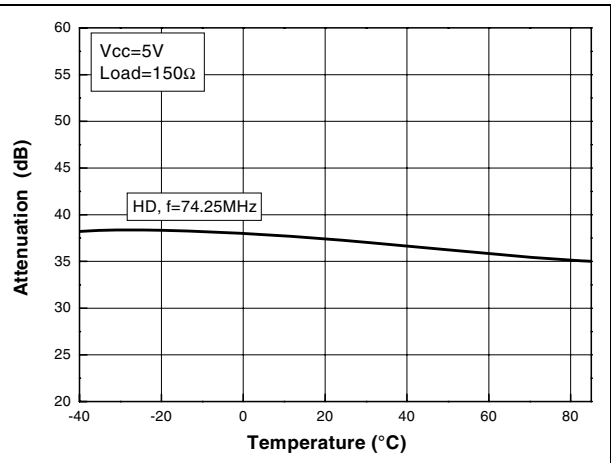


Figure 13. Gain matching vs. temperature

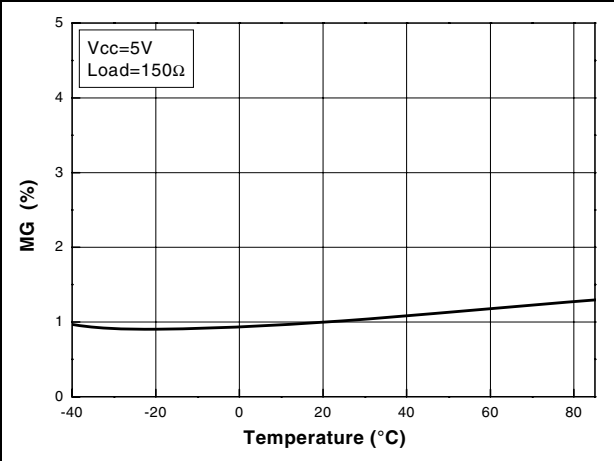


Figure 14. Output DC shift vs. temperature

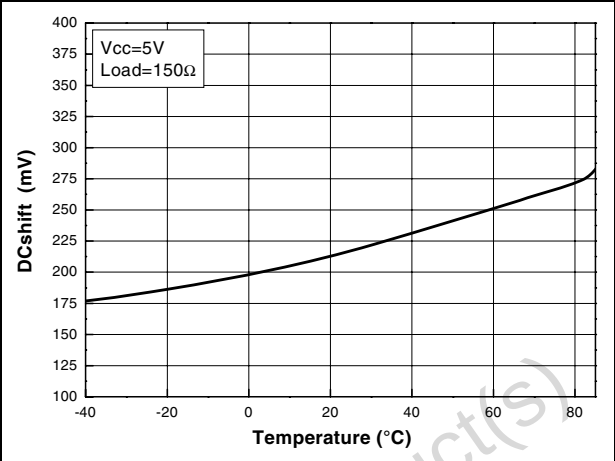


Figure 15. Isink vs. temperature

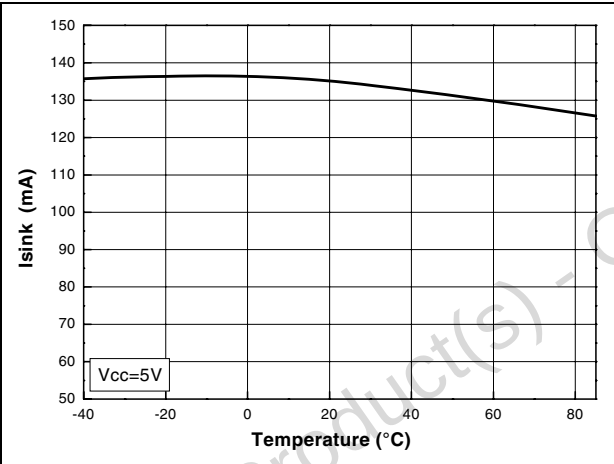


Figure 16. Isource vs. temperature

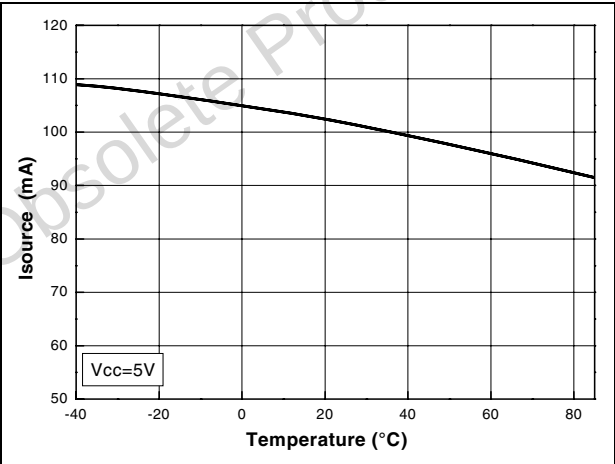


Figure 17. Ibias vs. temperature

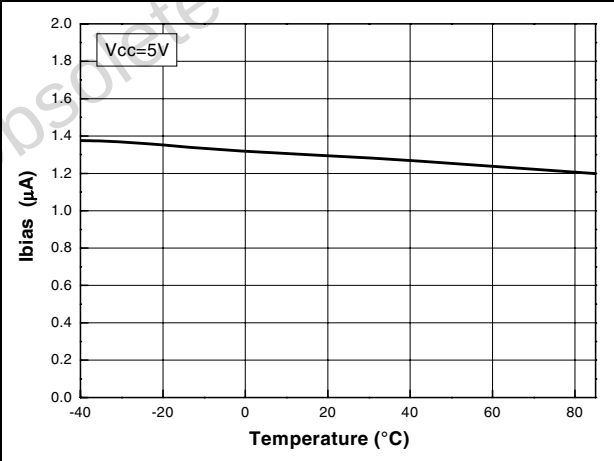


Figure 18. VOH vs. temperature

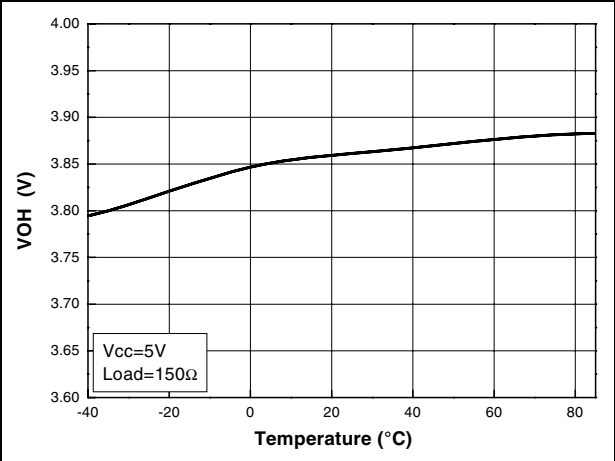


Figure 19. VOL vs. temperature

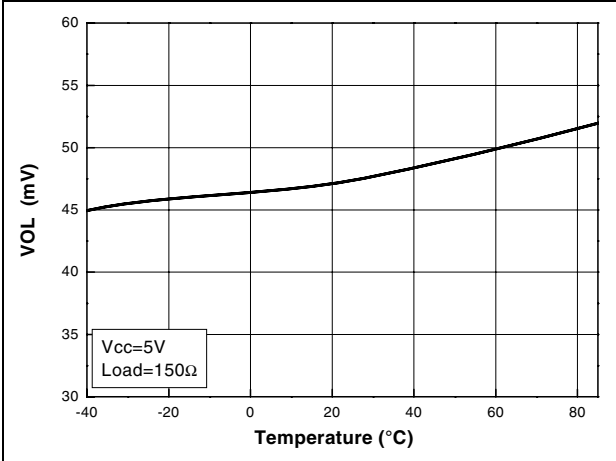
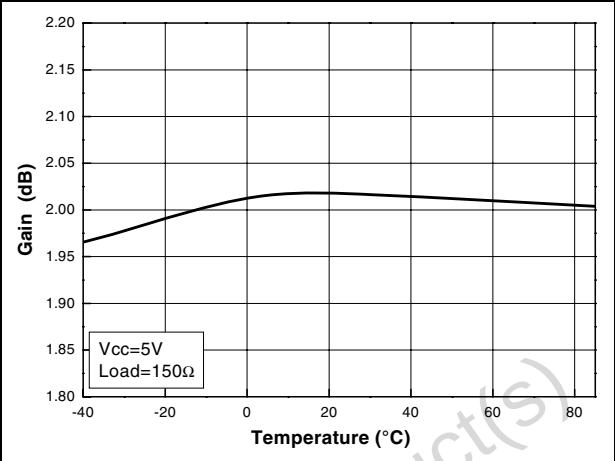


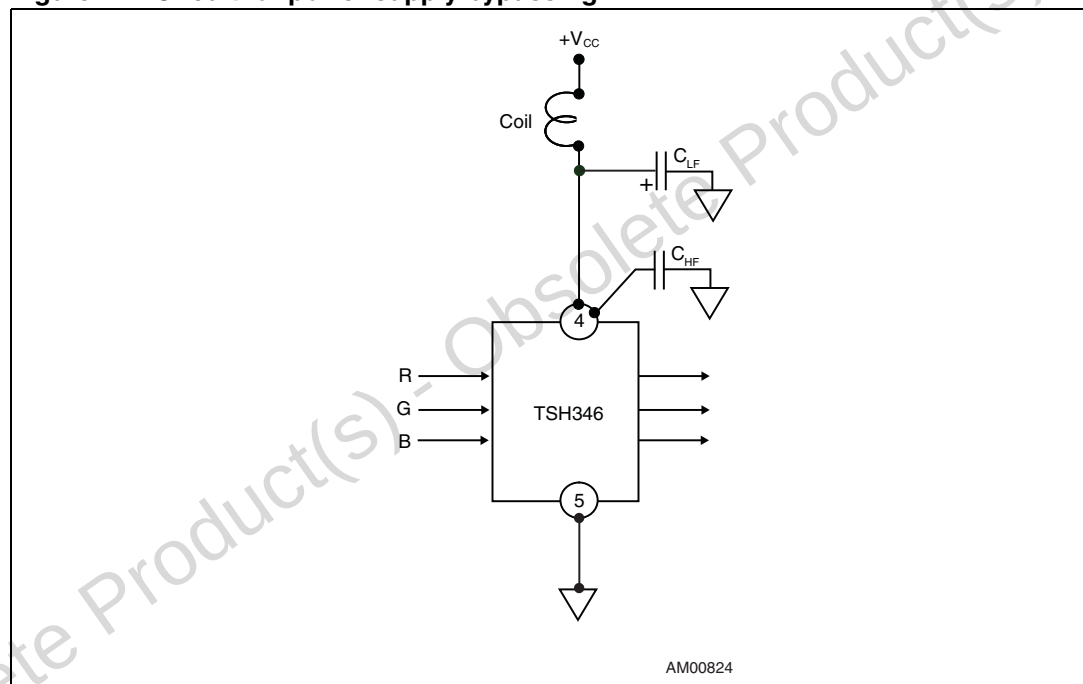
Figure 20. Gain vs. temperature



### 3 Power supply considerations and improvement of the PSRR

Correct power supply bypassing is very important to optimize performance in low and high-frequency ranges. Bypass capacitors should be placed as close as possible to the IC pin (pin 4) to improve high-frequency bypassing. A capacitor ( $C_{LF}$ ) greater than  $10\ \mu\text{F}$  is necessary to improve the PSRR in low frequencies. For better quality bypassing, a capacitor of  $100\ \text{nF}$  ( $C_{HF}$ ) can be added.  $C_{HF}$  must be placed as close as possible to the IC pin, to improve the noise supply rejection in the higher frequency ranges. A coil can be added in order to better reject the noise from the supply and to prevent current peaks as much as possible.

Figure 21. Circuit for power supply bypassing



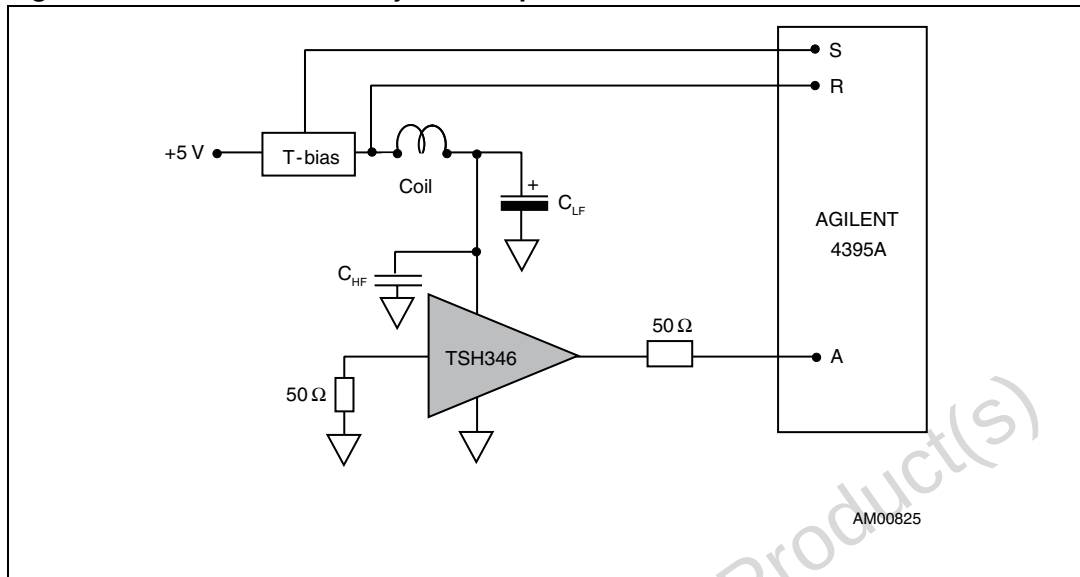
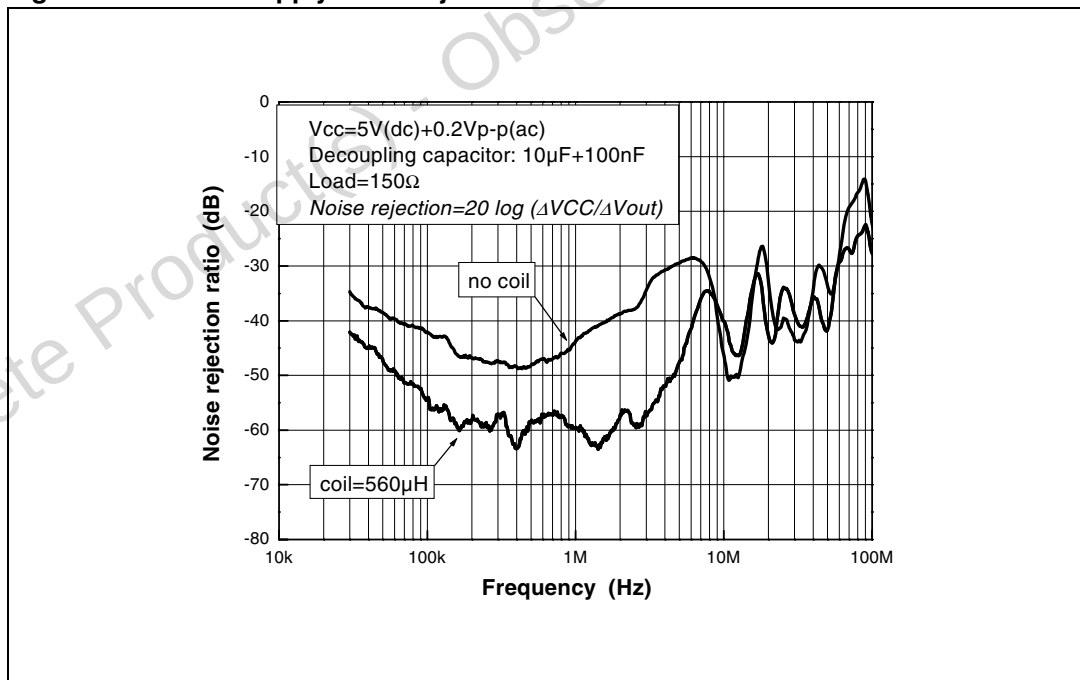
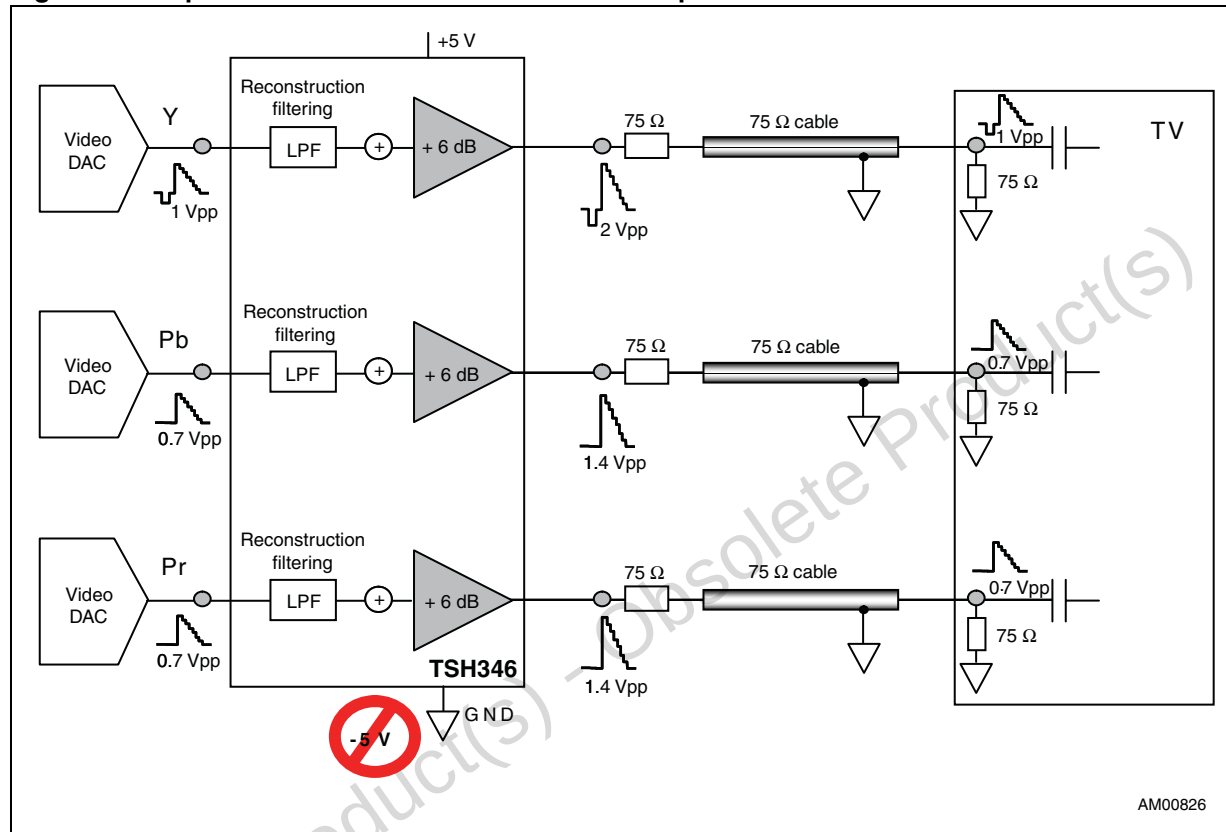
**Figure 22. Circuit for noise rejection improvement measurement**

Figure 23 shows how the power supply noise rejection evolves versus frequency depending on how carefully the power supply decoupling is achieved.

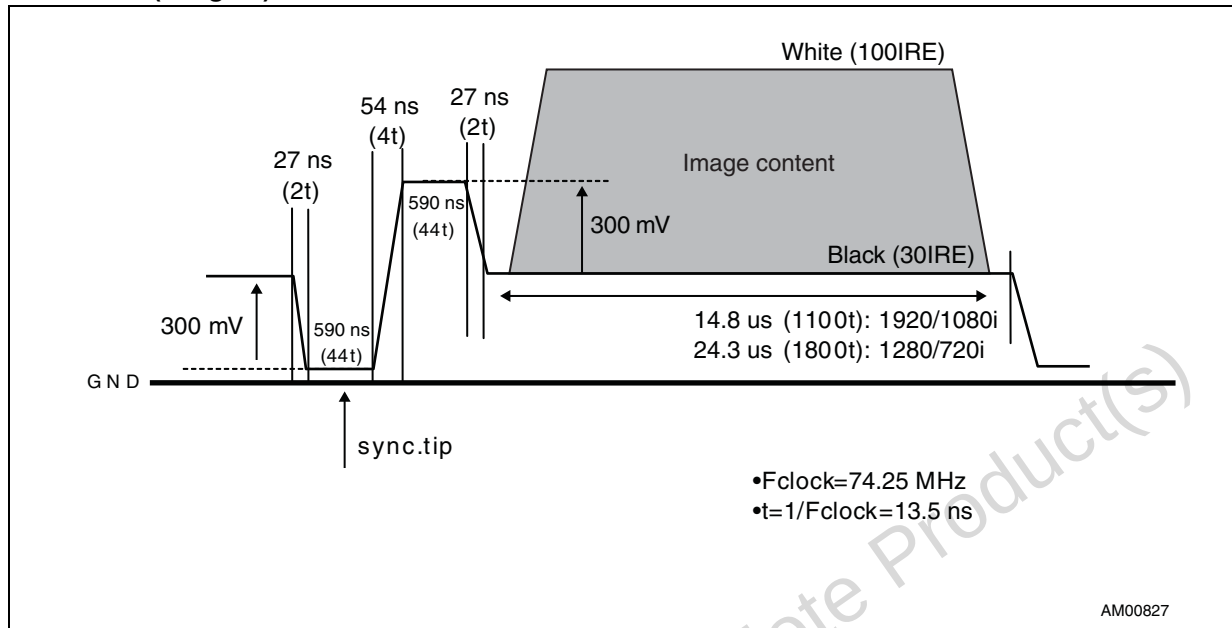
**Figure 23. Power supply noise rejection**

## 4 Using the TSH346 to drive YC, CVBS, YUV, YPbPr and RGB video components

Figure 24. Implementation of the video driver on output video DACs



**Figure 25. Shapes of HD video signals coming from DACs including the synchronization tip (Y signal)**



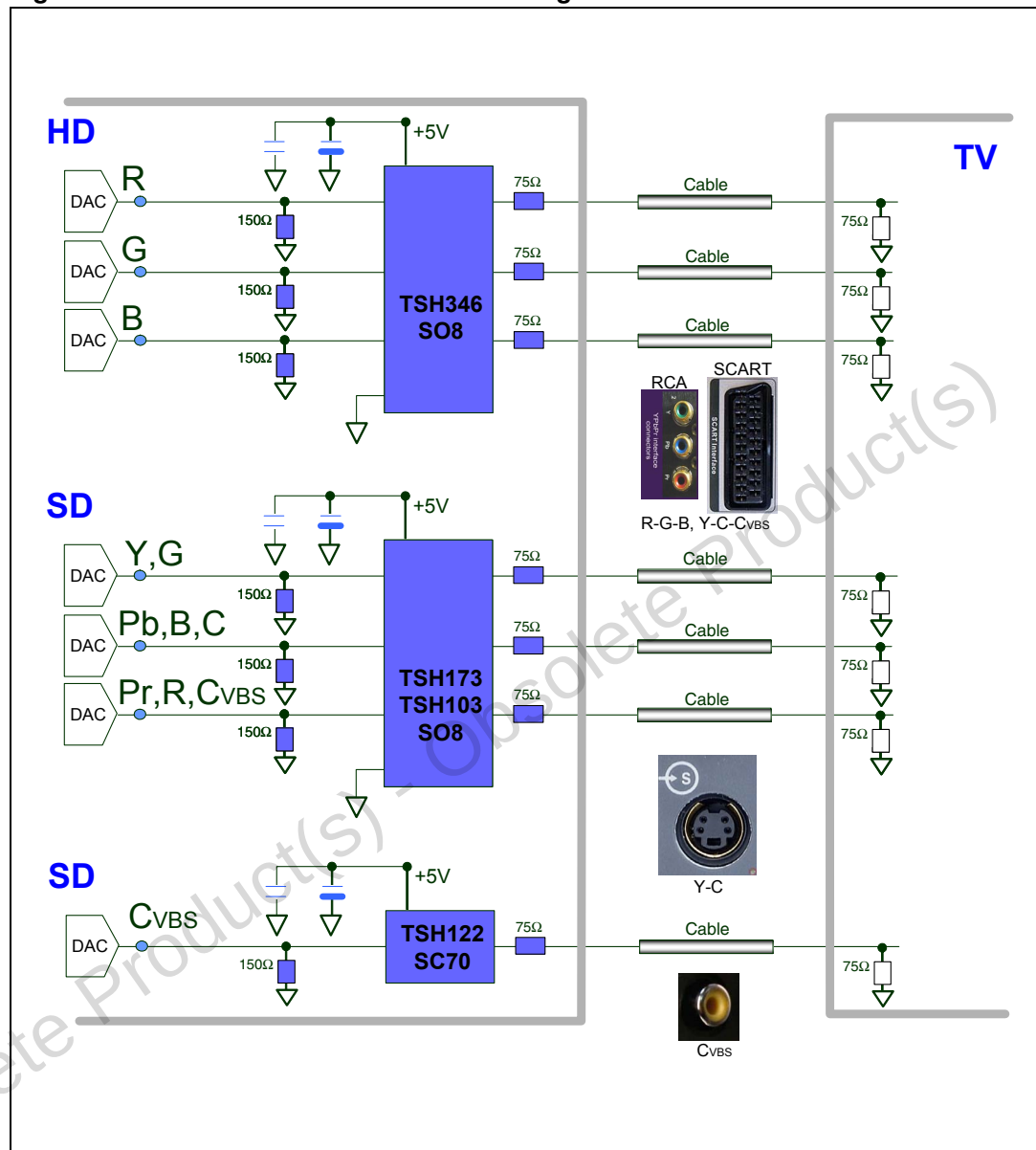
The TSH346 is used to drive high definition video signals up to 30 MHz. It can drive components such as YPbPr and RGB where the bottom of the signal is close to zero volts. An internal input DC value is added to the video signal in order to shift the bottom from GND.

The shift is not based on the average of the signal, but is an analog summation of a DC component to the video signal. Therefore, no input capacitors are required. This provides a real advantage in terms of cost and board space.

Under these conditions, it is possible to drive the signal in single supply with no saturation of the driver against the lower rail.

Because half of the signal is lost through output impedance matching, in order to correctly drive the video line the shifted signal is multiplied by a gain of +2 or +6 dB.

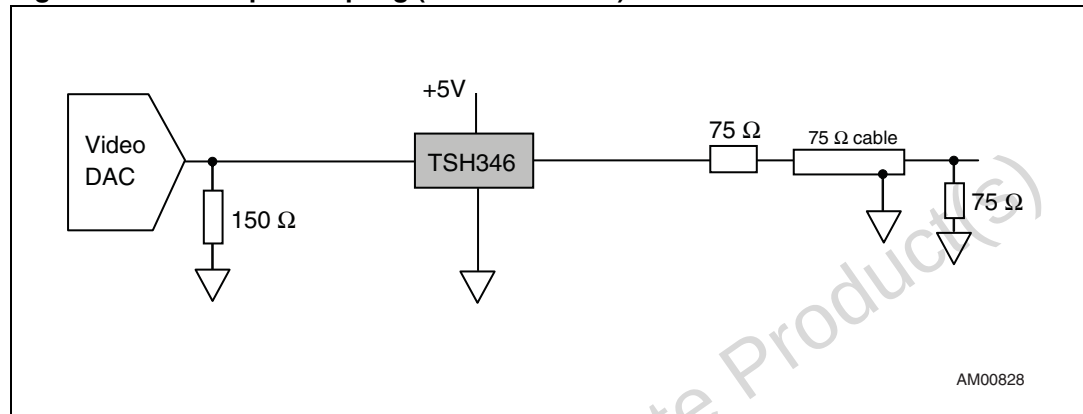
Figure 26. Flexible solution for SD and HD signals



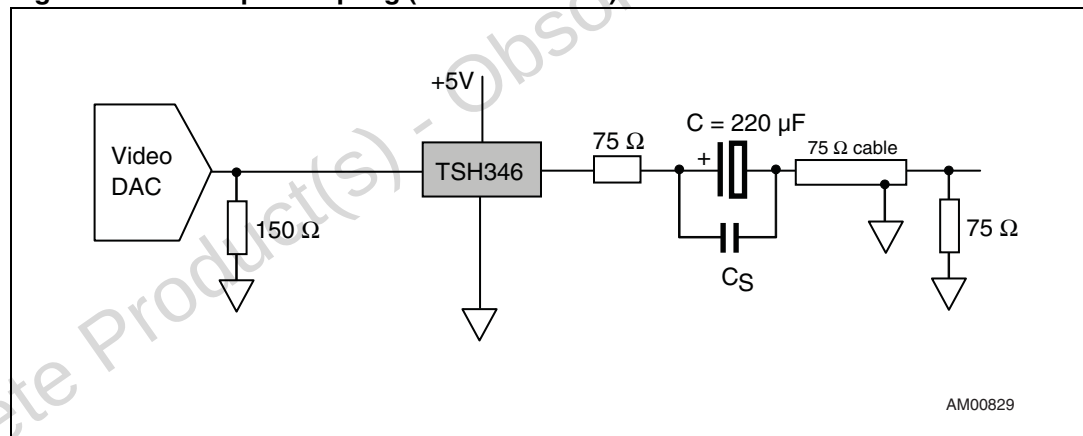
## 4.1 Output capacitor

The output can be either DC- or AC-coupled, and can be directly connected to the line via a 75- $\Omega$  resistor (4) ([Figure 27](#)). Alternatively, an output capacitor can be used to remove any DC components in the load. Assuming a 150- $\Omega$  load, a coupling capacitor of 220  $\mu\text{F}$  can be used to provide a very low cut-off frequency close to 5 Hz ([Figure 28](#)).

**Figure 27. IDC output coupling (1 of 3 channels)**



**Figure 28. AC output coupling (1 of 3 channels)**



1.  $C_S$  is a 100 nF used to decrease the parasitic components of C in high frequencies.
2. The 75- $\Omega$  resistor must be as close as possible to the output of the driver to minimize the effect of parasitic capacitance.

## 5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

Obsolete Product(s) - Obsolete Product(s)

Figure 29. SO-8 package mechanical drawing

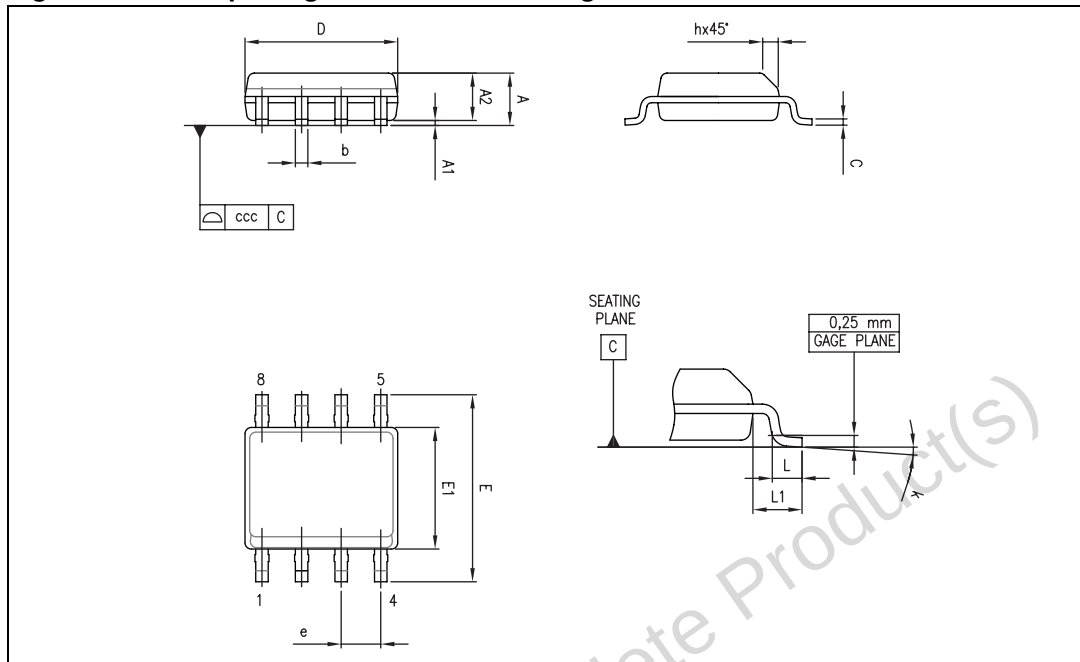


Table 4. SO-8 package mechanical data

| Ref. | Dimensions  |      |      |        |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Millimeters |      |      | Inches |       |       |
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    |             |      | 1.75 |        |       | 0.069 |
| A1   | 0.10        |      | 0.25 | 0.004  |       | 0.010 |
| A2   | 1.25        |      |      | 0.049  |       |       |
| b    | 0.28        |      | 0.48 | 0.011  |       | 0.019 |
| c    | 0.17        |      | 0.23 | 0.007  |       | 0.010 |
| D    | 4.80        | 4.90 | 5.00 | 0.189  | 0.193 | 0.197 |
| E    | 5.80        | 6.00 | 6.20 | 0.228  | 0.236 | 0.244 |
| E1   | 3.80        | 3.90 | 4.00 | 0.150  | 0.154 | 0.157 |
| e    |             | 1.27 |      |        | 0.050 |       |
| h    | 0.25        |      | 0.50 | 0.010  |       | 0.020 |
| L    | 0.40        |      | 1.27 | 0.016  |       | 0.050 |
| L1   |             | 1.04 |      |        | 0.040 |       |
| k    | 0           |      | 8°   | 1°     |       | 8°    |
| ccc  |             |      | 0.10 |        |       | 0.004 |

## 6 Ordering information

**Table 5. Order codes**

| Part number | Temperature range | Package | Packing     | Marking |
|-------------|-------------------|---------|-------------|---------|
| TSH346ID    | -40°C to +85°C    | SO-8    | Tube        | TSH346I |
| TSH346IDT   |                   |         | Tape & reel | TSH346I |

## 7 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes                                                                                                                       |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------|
| 29-May-2007 | 1        | Initial release.                                                                                                              |
| 16-Dec-2008 | 2        | Added curves in <a href="#">Chapter 2: Electrical characteristics</a> .<br>Added all test limits in <a href="#">Table 3</a> . |

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