

Triple video buffer with selectable filter for HD and SD video applications

Preliminary Data

Features

- Selectable 6th order filtering of 36 MHz, 18 MHz and 9 MHz
- 5 V single-supply operation
- Internal input DC level shifter
- No input capacitor required
- 3 matched 6 dB amplifiers
- AC or DC output-coupled
- Very low harmonic distortion
- Specified for 150 Ω loads
- Data min. and max. are tested during production

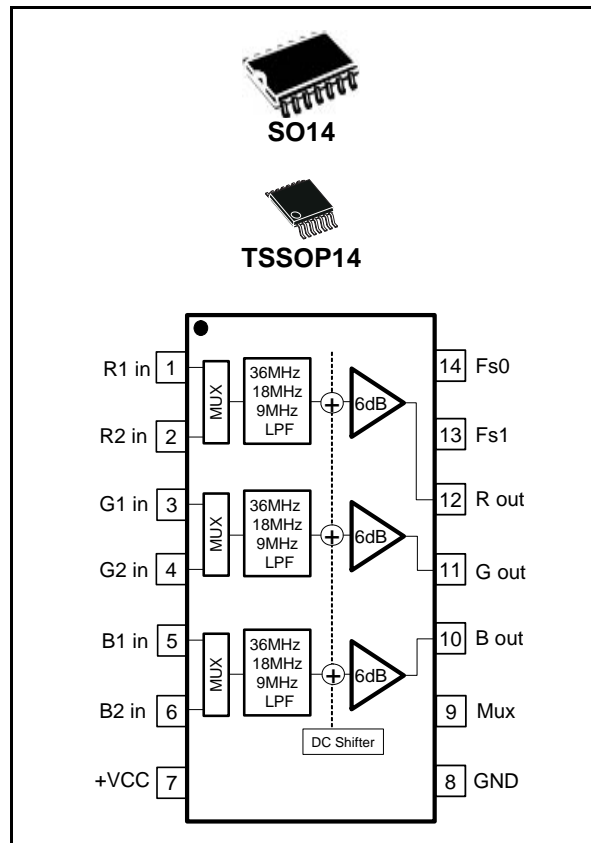
Applications

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

Description

The TSH345 is a triple single-supply video buffer featuring an internal gain of 6 dB and selectable filtering for HD and SD video outputs on 75 Ω video lines. The TSH345 is ideal to drive either Y-C, CVBS, Y-U-V, Y-Pb-Pr or R-G-B signals from video DAC outputs.

The main advantage of this circuit is its input DC level shifter. It allows you to drive video signals on 75 Ω video lines without damage to the synchronization tip, and without either input or output 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 in the best position for the greatest linearity.



The TSH345 is available in the SO14 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 ⁽¹⁾ | 6 | V |
| V_{in} | Input voltage range ⁽²⁾ | TBD | 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} | Thermal resistance junction to case | | |
| | SO14 TSSOP14 | 22 32 | °C/W |
| R_{thja} | Thermal resistance junction to ambient area | | |
| | SO14 TSSOP14 | 125 110 | °C/W |
| P_{max} | Maximum power dissipation (@ $T_{amb} = 25^{\circ}C$) for $T_j = 150^{\circ}C$ | | |
| | SO14 TSSOP14 | 1 1.1 | W |
| ESD | CDM: charged device model | 200 | V |
| | HBM: human body model | 2 | kV |
| | MM: machine model | 200 | V |

1. All voltage values, except differential voltage, are with respect to network terminal.
2. The magnitude of input and output voltage must never exceed $V_{CC} + 0.3 V$.

Table 2. Operating conditions

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

1. Tested in full production with +5 V single power supply.

2 Electrical characteristics

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

| Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------------------|--|------|-------------|------|---------------|
| DC performance | | | | | |
| V_{DC} | Output DC shift $R_L = 150\ \Omega$, T_{amb} $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | 197 | 329 405 | 389 | mV |
| I_{ib} | Input bias current T_{amb} , input to GND $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | 0.85 | 1.5 2.38 | 2.9 | μA |
| R_{in} | Input resistance, T_{amb} | | 12.6 | | G Ω |
| C_{in} | Input capacitance, T_{amb} | | 0.1 | | pF |
| I_{CC} | Total supply current No load, input to GND $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | | 50.7 TBD | 65 | mA |
| PSRR | Power supply rejection ratio $20\ \log(\Delta V_{out}/\Delta V_{CC})$ Input to GND, $R_L = 150\ \Omega$, ΔV_{CC} : 100 mVp/F = 1 MHz, $C_{LF} = 470\ \text{nF}$, $C_{HF} = 100\ \mu\text{F}$ | | -70 | | dB |
| G | DC voltage gain $R_L = 150\ \Omega$, $V_{in} = 0.5\text{V}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | 1.94 | 1.99 2 | 2.02 | V/V |
| DG | Variation of the DC voltage gain between inputs of 0.3 V and 1 V Input step from 0.3 V to 1 V | | 0.2 | 0.5 | % |
| MG_1 | Gain matching between 3 channels, input = 1 V | | 0.5 | 1 | % |
| $MG_{0.3}$ | Gain matching between 3 channels, input = 0.3 V | | 0.5 | 1 | % |
| Output characteristics | | | | | |
| V_{OH} | High level output voltage $R_L = 150\ \Omega$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | 3.84 | 3.87 TBD | | V |
| V_{OL} | Low level output voltage ⁽¹⁾ $R_L = 150\ \Omega$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | | 33 TBD | 40 | mV |
| I_{out} | I_{source} T_{amb} $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | 46 | 91 79 | | mA |
| | I_{sink} $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | TBD | 145 102 | | mA |

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

| Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|---|--|------|--------------|------|------|
| Filtering | | | | | |
| Standard definition | Bandwidth F1 selected, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ 3 dB bandwidth 1 dB bandwidth | 5.12 | 9.3 7.3 | | MHz |
| | Flatness F1 selected/F=6 MHz, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ | | 0.5 | | dB |
| | Attenuation F1 selected/F=27 MHz, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ | 30 | 47 | | dB |
| Standard definition with progressive scanning | Bandwidth F2 selected, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ 3 dB bandwidth 1 dB bandwidth | 10.4 | 21.5 18.2 | | MHz |
| | Flatness F2 selected/F=12 MHz small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ | | 0.36 | | dB |
| | Attenuation F2 selected/F=54 MHz, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ | 34 | 42.7 | | dB |
| High definition | Bandwidth F3 selected, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ 3 dB bandwidth 1 dB bandwidth | 22 | 35.6 30.8 | | MHz |
| | Flatness F3 selected/F=30 MHz, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ | | 0.46 | | dB |
| | Attenuation F3 selected/F=74.25 MHz, small signal, $V_{ICM} = 0.5\text{ V}$, $R_L = 150\ \Omega$ | TBD | 36 | | dB |
| D | Delay between each channel | | 0.5 | | ns |
| gd | Group delay variation F1 selected/F=0 to 6 MHz | | 10.3 | | ns |
| Δg | Differential gain F1 selected/F=6 MHz, $R_L = 150\ \Omega$ | | 0.5 | | % |
| $\Delta\Phi$ | Differential phase F1 selected/F=6 MHz, $R_L = 150\ \Omega$ | | 0.5 | | ° |

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

| Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------------|--|------|------|------|------------------------|
| Noise and distortion | | | | | |
| eN | Total input voltage noise in Standard Definition $F = 100\text{ kHz}$, $R_{IN} = 50\ \Omega$ | | 70 | | nV/ $\sqrt{\text{Hz}}$ |
| | Total input voltage noise in High Definition $F = 100\text{ kHz}$, $R_{IN} = 50\ \Omega$ | | 93 | | |
| HD2 | 2nd harmonic distortion $F1\text{ selected}/F=1\text{ MHz}$, $V_{out} = 2\text{ Vp-p}$, $R_L = 150\ \Omega$ | | -44 | | dBc |
| HD3 | 3rd harmonic distortion $F1\text{ selected}/F=1\text{ MHz}$, $V_{out} = 2\text{ Vp-p}$, $R_L = 150\ \Omega$ | | -63 | | dBc |
| Standby mode | | | | | |
| I_{STBY} | Total current consumption in standby mode $Fs1=1$, $Fs0=1$ | | TBD | 570 | μA |
| T_{on} | Time from standby to active mode | | 5 | | μs |
| T_{off} | Time from active to standby mode | | 5 | | μs |
| Fs1, Fs0 and Mux features | | | | | |
| V_{high} | High level | 0.9 | | | V |
| V_{low} | Low level | | | 0.3 | V |

1. Simulated data.

Table 4. Filter and standby settings, $V_{CC} = +5\text{ V}$ single supply, $T_{amb} = 25^\circ\text{C}$

| Fs1 | Fs0 | Settings | |
|-----|-----|----------|---|
| 0 | 0 | F3 | Filtering for high definition (HD), 36 MHz |
| 0 | 1 | F2 | Filtering for progressive video (PV), 18 MHz |
| 1 | 0 | F1 | Filtering for standard definition (SD), 9 MHz |
| 1 | 1 | Standby | TSH345 in standby mode |

Fs1 and Fs0 floating: forbidden
(for proper behavior of the TSH345, the Fs1 and Fs0 pins must never be left floating)

Table 5. Mux settings, $V_{CC} = +5\text{ V}$ single supply, $T_{amb} = 25^\circ\text{C}$

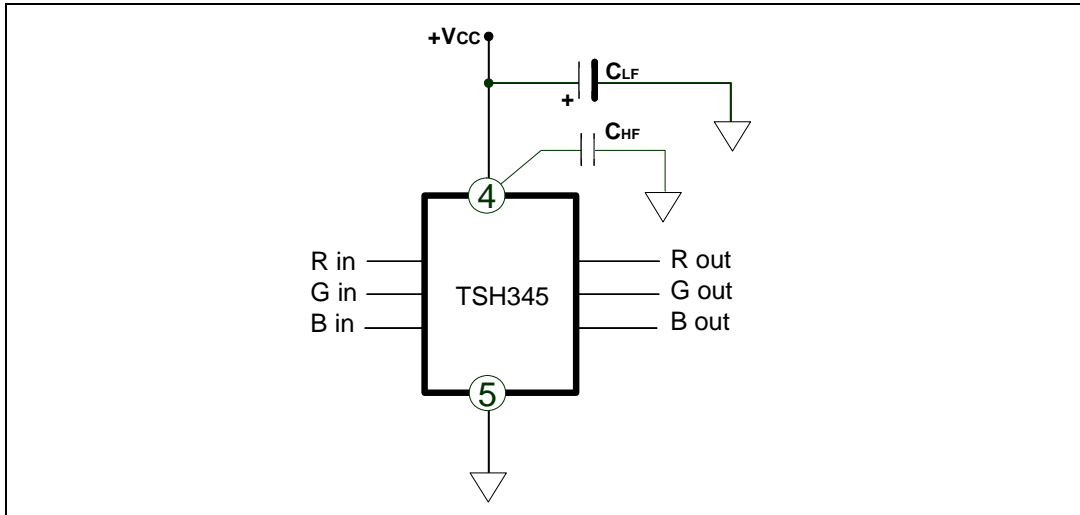
| Mux | Settings | |
|----------|----------|-----------------|
| 0 | R1 G1 B1 | Video1 selected |
| 1 | R2 G2 B2 | Video2 selected |
| Floating | R1 G1 B1 | Video1 selected |

MUX floating: forbidden
(for proper behavior of the TSH345, the MUX pin must never be left floating)

3 Power supply considerations

Correct power supply bypassing is very important for optimizing 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 100 μF is necessary to improve the PSRR in low frequencies. For better quality bypassing, you can add a capacitor of 470 nF (C_{HF}), also placed as close as possible to the IC pin, to improve the PSRR in the higher frequencies.

Figure 1. Circuit for power supply bypassing



4 Using the TSH345 to drive Y-C, CVBS, Y-U-V, Y-Pb-Pr and R-G-B video components

Figure 2. Implementation of the video driver on output video DACs

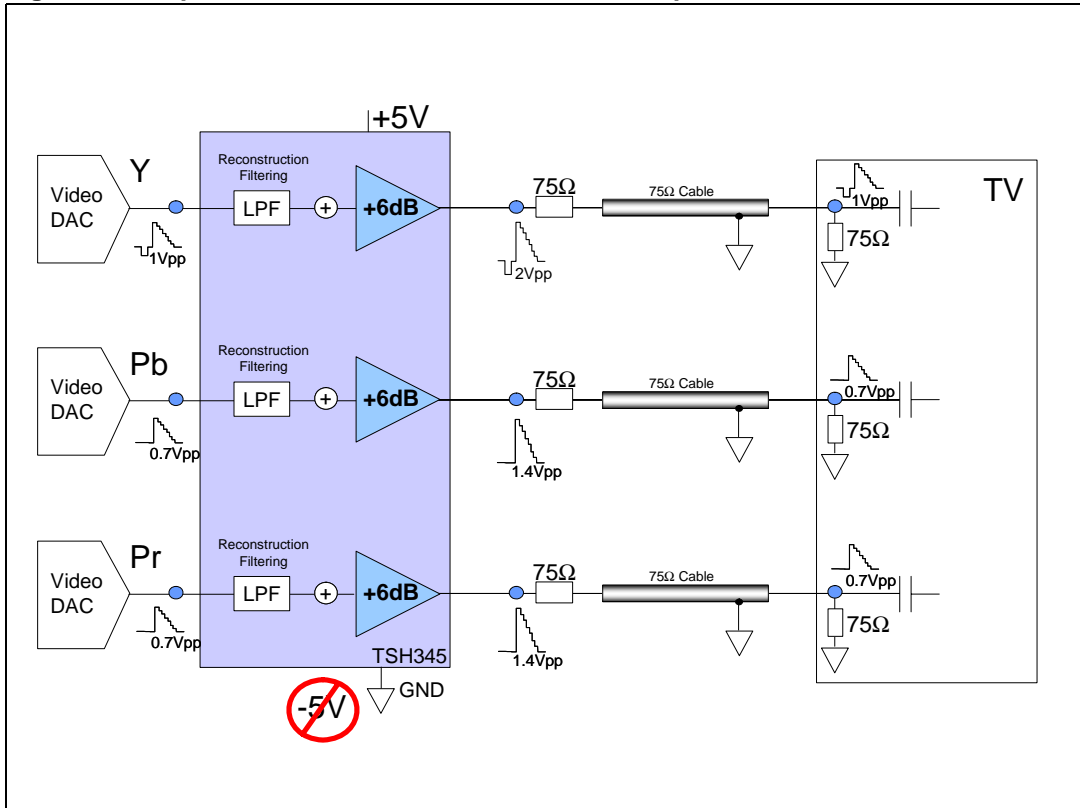


Figure 3. Shapes of video signals coming from DACs (example for a black picture)

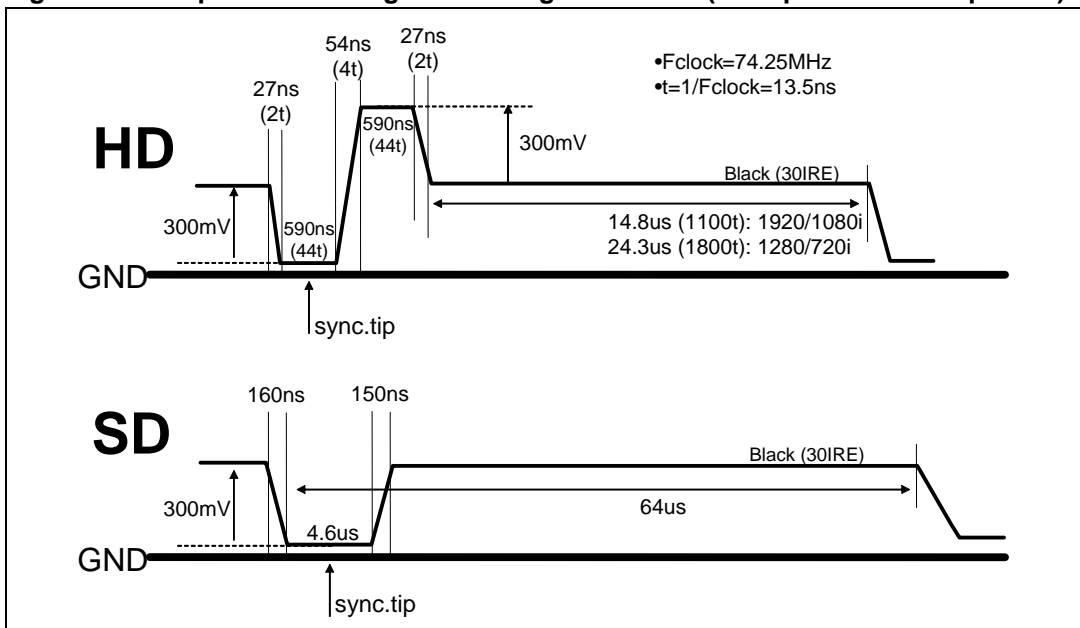
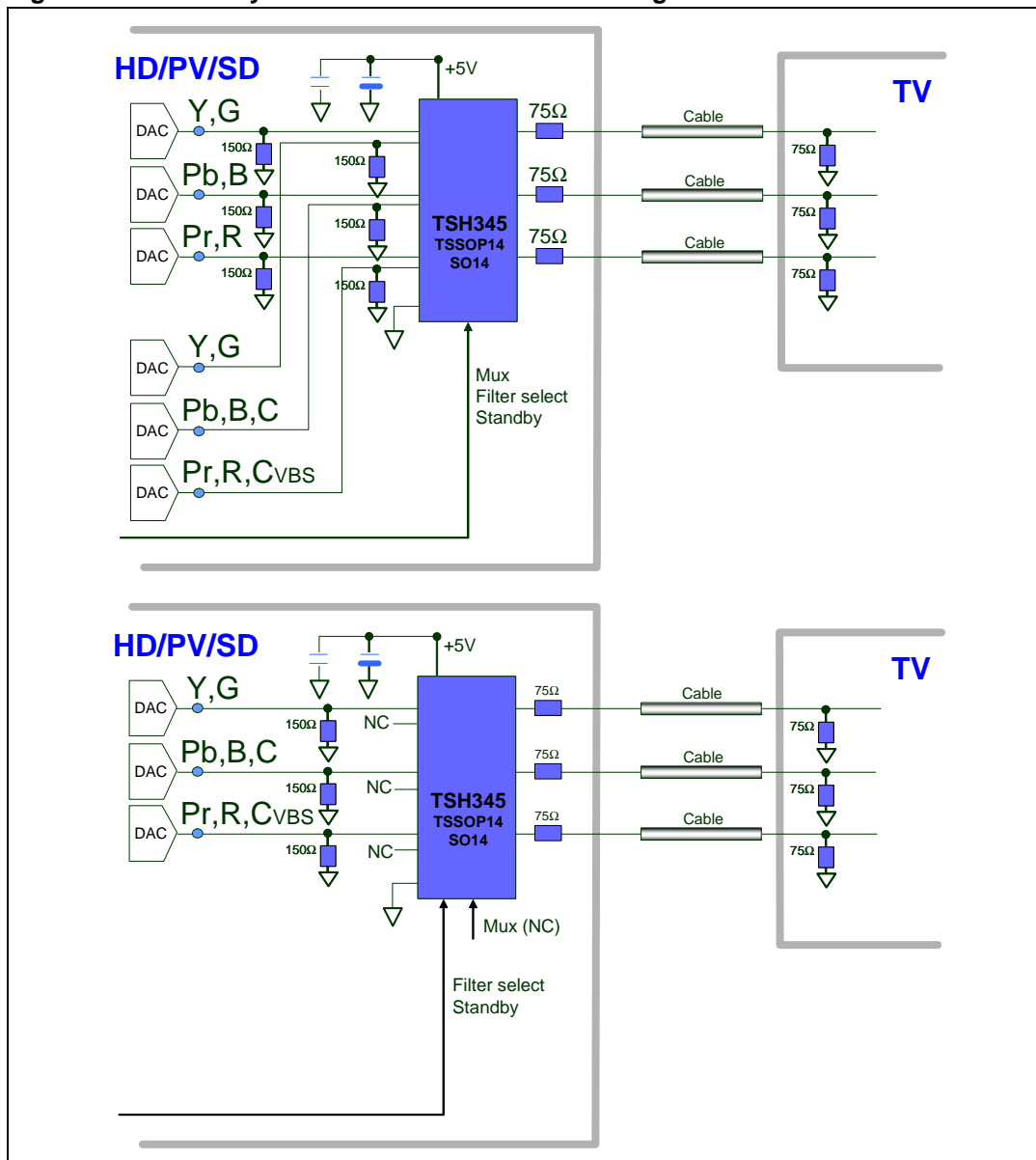


Figure 4. Flexibility of the TSH345 for SD and HD signals



The TSH345 is used to drive either high definition video signals up to 30 MHz, or progressive and interlaced standard definition video signals on 75-ohm video lines. It can drive a large panel of signals like Y-C and CVBS, Y-U-V, Y-Pb-Pr and R-G-B where the bottom of the signal (the synchronization tip in the case of Y and CVBS signals) 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, which provides a real advantage in terms of cost and board space.

Under these conditions, it is possible to drive the signal in single supply without any saturation of the driver against the lower rail.

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

4.1 Output capacitor

The output can be either DC-coupled or AC-coupled. The output can be connected to the line via a 75-ohm resistor directly (see [Figure 5](#)). Or, an output capacitor can be used to remove any DC components in the load. Assuming the load is 150-ohm, a coupling capacitor of 220 μF can be used to provide a very low cut-off frequency close to 5 Hz (see [Figure 6](#)).

Figure 5. DC output coupling (1 of 3 channels)

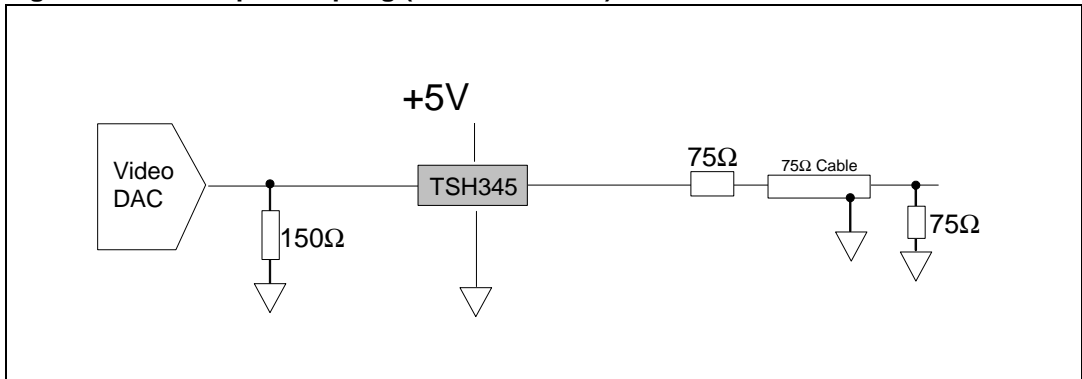
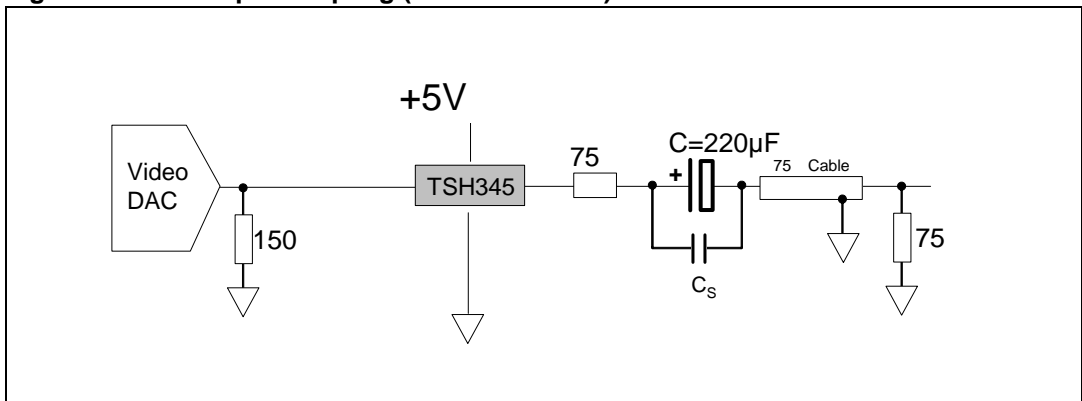


Figure 6. AC output coupling (1 of 3 channels)



1. C_S is a 100nF used to decrease the parasitic components of C in high frequencies.
2. The 75-ohm 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, STMicroelectronics offers these devices in ECOPACK[®] packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

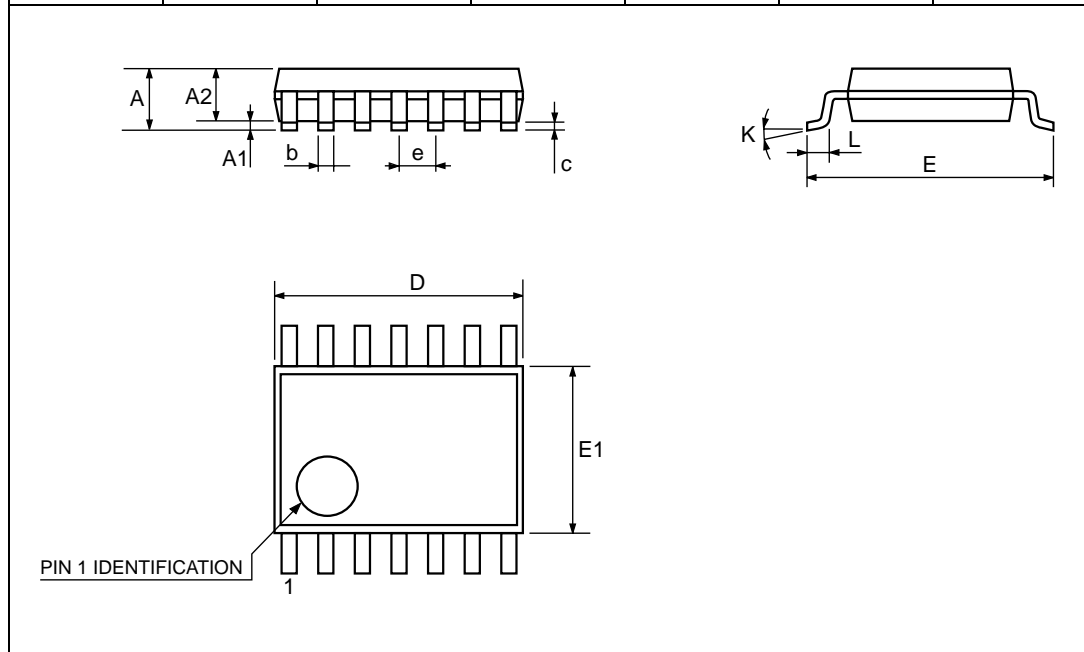
5.1 SO-14 package

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.003 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 8.55 | | 8.75 | 0.336 | | 0.344 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 7.62 | | | 0.300 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.68 | | | 0.026 |
| S | 8° (max.) | | | | | |

The figure contains three mechanical drawings of the SO-14 package. The top-left drawing is a side view showing dimensions A (total height), a2 (lead height), b (lead width), e (lead pitch), and e3 (total lead length). The top-right drawing is a perspective view showing dimensions L (lead length), G (package width), C (package height), c1 (lead angle), a1 (lead height), b1 (lead width), and s (lead thickness). The bottom drawing is a top view showing dimensions D (package length), M (lead length), F (package width), and pin numbers 1, 7, 8, and 14.

5.2 TSSOP14 package

| Ref. | Dimensions | | | | | |
|------|-------------|----------|------|--------|------------|--------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L1 | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |



6 Ordering information

Table 6. Order codes

| Part number | Temperature range | Package | Packing | Marking |
|-------------|-------------------|---------|-------------|---------|
| TSH345ID | -40°C to +85°C | SO14 | Tube | TSH345I |
| TSH345IDT | | | Tape & reel | TSH345I |
| TSH345IPT | | TSSOP14 | Tape & reel | TSH345I |

7 Revision history

| Date | Revision | Changes |
|-----------|----------|------------------------------------|
| 29-May-07 | 1 | Preliminary data, initial release. |

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