

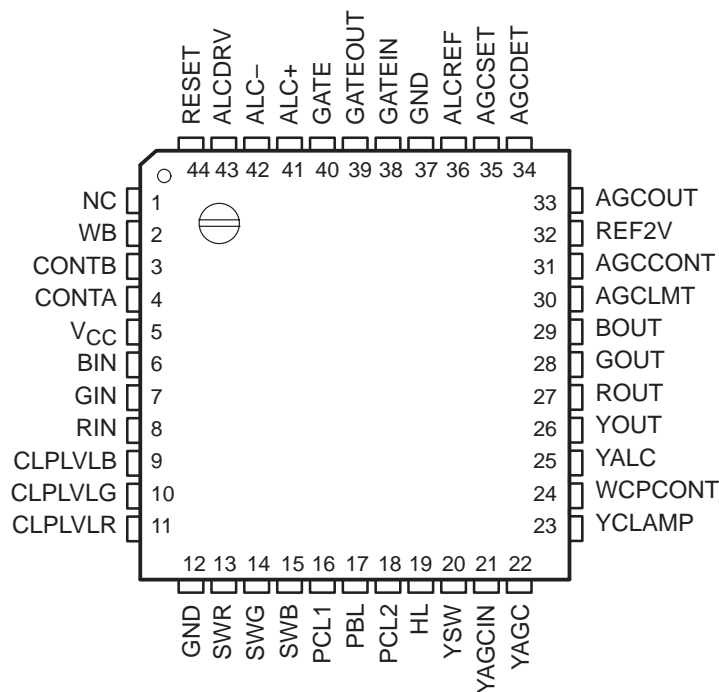
- Solid-State Reliability
- Supports Both Color and Monochrome Applications
- Three Independent Channels Available for Use With RGB Monitors
- Y Signal Generated From Three Independent Channels
- Clamp Pulse-Select Option
- White-Clip Function for Y Signal
- Gain Control for R, G, B, and Y
- Noise Suppression During Video-Blanking Periods

## description

The TL1051 is a bipolar monolithic integrated circuit designed for use in preprocessing three channels of TI CCD image sensors. It receives video inputs from the TI TL1593 three-channel sample-and-hold circuit and outputs three processed channel signals and a single multiplexed Y (luminance) signal. Processing functions of the TL1051 include gain, automatic gain control, clamp, white balance, and white clip.

The TL1051 is supplied in a 44-pin surface-mount plastic package and is characterized for operation from  $-20^{\circ}\text{C}$  to  $45^{\circ}\text{C}$ .

FR PACKAGE  
(TOP VIEW)



NC – No internal connection

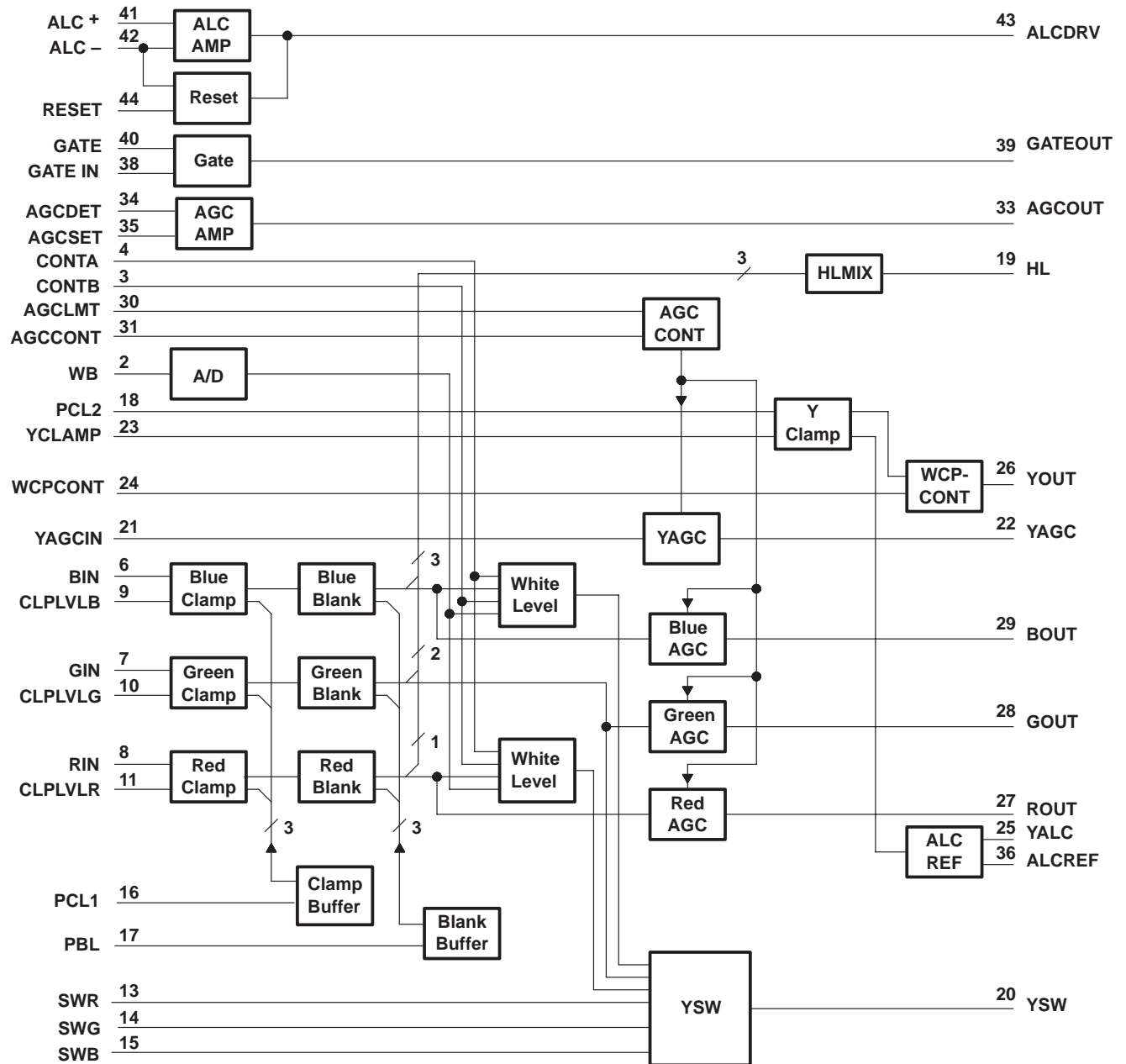


This device contains circuits to protect its inputs and outputs against damage due to high static voltages or electrostatic fields. These circuits have been qualified to protect this device against electrostatic discharges (ESD) of up to 2 kV according to MIL-STD-883C, Method 3015; however, precautions should be taken to avoid application of any voltage higher than maximum-rated voltages to these high-impedance circuits. During storage or handling, the device leads should be shorted together or the device should be placed in conductive foam. In a circuit, unused inputs should always be connected to an appropriate logic voltage level, preferably either  $V_{CC}$  or ground. Specific guidelines for handling devices of this type are contained in the publication *Guidelines for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices and Assemblies* available from Texas Instruments.

# TL1051 VIDEO PREPROCESSOR CIRCUIT

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## functional block diagram



### Terminal Functions

| TERMINAL        |        | I/O | DESCRIPTION                       |
|-----------------|--------|-----|-----------------------------------|
| NAME            | NO.    |     |                                   |
| AGCCONT         | 31     | I   | AGC control                       |
| AGCDET          | 34     | I   | AGC detect                        |
| AGCLMT          | 30     | I   | AGC limit                         |
| AGCOUT          | 33     | O   | AGC out                           |
| AGCSET          | 35     | I   | AGC set                           |
| ALCDRV          | 43     | O   | ALC drive                         |
| ALCREF          | 36     | O   | ALC reference                     |
| ALC+            | 41     | I   | ALC noninverting input            |
| ALC–            | 42     | I   | ALC inverting input               |
| BIN             | 6      | I   | Blue channel in                   |
| BOUT            | 29     | O   | Blue channel out                  |
| CLPLVLB         | 9      | I   | DC clamp level – blue             |
| CLPLVLG         | 10     | I   | DC clamp level – green            |
| CLPLVLR         | 11     | I   | DC clamp level – red              |
| CONTA           | 4      | I   | White balance digital control – A |
| CONTB           | 3      | I   | White balance digital control – B |
| GATE            | 40     | I   | Video gate control switch         |
| GATEIN          | 38     | I   | Video gate in                     |
| GATEOUT         | 39     | O   | Video gate out                    |
| GIN             | 7      | I   | Green channel in                  |
| GND             | 12, 37 |     | Ground                            |
| GOUT            | 28     | O   | Green channel out                 |
| HL              | 19     | O   | Highlight suppression (not used)  |
| NC              | 1      |     | No internal connection            |
| PBL             | 17     | I   | Process blanking                  |
| PCL1            | 16     | I   | Clamp signal 1                    |
| PCL2            | 18     | I   | Clamp signal 2                    |
| REF2V           | 32     | O   | 2-V reference                     |
| RESET           | 44     | I   | Reset                             |
| RIN             | 8      | I   | Red channel in                    |
| ROUT            | 27     | O   | Red channel out                   |
| SWB             | 15     | I   | Multiplex switch – blue           |
| SWG             | 14     | I   | Multiplex switch – green          |
| SWR             | 13     | I   | Multiplex switch – red            |
| V <sub>CC</sub> | 5      |     | Power supply voltage              |
| WB              | 2      | I   | White balance analog control      |
| WCPCONT         | 24     | I   | White clip control                |
| YAGC            | 22     | O   | YAGC out                          |
| YAGCIN          | 21     | I   | Y AGC in                          |
| YALC            | 25     | O   | Y automatic level control         |
| YCLAMP          | 23     | I   | Y clamp                           |
| YOUT            | 26     | O   | Y signal out                      |
| YSW             | 20     | O   | Multiplexed Y out                 |

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### detailed description

#### white-balance control

White balance in the monochrome mode can be adjusted with either terminal 2 (white-balance analog control) or with terminals 3 and 4 (white-balance digital controls B and A, respectively). If analog control is selected, terminals 3 and 4 should be left open and terminal 2 adjusted appropriately (see Figure 1 and Figure 2 for control characteristics). The white balance is controlled per the following table:

| CONTB | CONTA | VOLTAGE LEVEL ON WB | RED   | BLUE    |
|-------|-------|---------------------|-------|---------|
| L     | L     | 2.4 V               | –3 dB | –4 dB   |
| L     | H     | 2.7 V               | –1 dB | –1.5 dB |
| H     | L     | 3 V                 | 1 dB  | 1.5 dB  |
| H     | H     | 3.5 V               | 3 dB  | 4 dB    |

#### analog inputs RIN, GIN, BIN

The TI TL1593 sample-and-hold circuit is normally the source for these inputs. The source signals should be ac coupled into the TL1051. Gain control should be used on at least two of the three channels in order to obtain an optimum balance.

#### clamp level

Input terminals 9, 10, and 11 (CLPLVLB, CLPLVLG, and CLPLVLR, respectively) should initially be set at approximately 2 V dc. The levels should then be balanced so that clock feedthrough on terminal 20 (YSW) is minimized under dark conditions.

#### multiplexed switching

Input terminals 13, 14, and 15 (SWR, SWG, and SWB, respectively) are the TTL-level signals used to multiplex the three channels.

#### clamping and process blanking

Input terminals 16, 17, and 18 (PCL1, PBL, and PCL2) are used for TTL clamp and blank signals. The dark references are clamped by the PCL1 signal. Unwanted noise in the video signal is eliminated by the PBL signal. The Y signal can then be reclamped with the PCL2 signal.

Depending on the application, gain and automatic gain control (AGC) may or may not be selected. The following descriptions cover both selections.

#### YSW

YSW output (terminal 20): Fast sampling of the video input signals with the TTL multiplex signals generates this high-bandwidth output without adjustable gain or AGC.

#### gain and AGC selected

YAGCIN input (terminal 21): If gain or AGC operation is selected, the YSW output (terminal 20) should be directly connected to YAGCIN.

YAGC output (terminal 22): The multiplexed signal with controllable gain (controlled by the AGCCONT input) is available at this terminal if terminals 20 (YSW) and 21 (YAGCIN) are connected. If further signal processing is desired, this terminal should be ac coupled to terminal 23 (YCLAMP).

YCLAMP input (terminal 23): The Y signal from YAGC can be reclamped at this point by applying a wider clamp pulse to terminal 18 (PCL2).

WCPCONT input (terminal 24): A dc voltage applied to this white clip control input causes the white clip function to be performed on the Y signal. See Figure 4 for the clip control characteristics.

YALC output (terminal 25): If either AGC or automatic level control (ALC) is selected, the Y signal at this point should be fed back to either the ALC or AGC block.

YOUT output (terminal 26): The white-clipped Y signal is available at this output.



### **analog output channels**

Terminals 27, 28, and 29 (ROUT, GOUT, and BOUT) are the individual analog output signals used in RGB color applications. Their gain can be affected by the control voltage applied to terminal 31 (AGCCONT).

### **AGC section**

The AGC amplifier is a high-gain amplifier that requires an appropriate feedback network.

AGCLMT input (terminal 30): A dc voltage applied to this terminal limits the amount of gain for R, G, B, and Y.

AGCCONT input (terminal 31): A dc voltage applied to this terminal sets the gain (see Figure 3). It is also possible to build a feedback network and obtain AGC action. In this case, the video signal is fed back through AGCCONT.

REF2V output (terminal 32): This terminal provides a 2-V reference output.

AGCOUT output (terminal 33): This is the output from the AGC block.

AGCDET input (terminal 34): Video from terminal 26 (YOUT) can be applied to this node to obtain feedback action.

AGCSET input (terminal 35): A dc voltage applied to this terminal sets the gain for AGC action.

### **gate section**

GATEIN input (terminal 38): If a gating function is desired, video from the YOUT output (terminal 26) can be applied to this terminal.

GATEOUT output (terminal 39): Video is passed from GATEIN to GATEOUT if GATE (terminal 40) is low. If GATE is high, GATEOUT is in the high-impedance state.

GATE input (terminal 40): A TTL signal can be applied to this input to control the active video (see the description of the GATEOUT terminal above).

### **ALC section**

An amplifier similar to that in the AGC section is available for use as an integrator. If used, a capacitor should be connected from the ALC-input (terminal 42) to the ALCDRV output (terminal 43). A reset switch is available at the RESET input (terminal 44). The ALC amplifier is a high-gain amplifier requiring an appropriate feedback network.

# TL1051

## VIDEO PREPROCESSOR CIRCUIT

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### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

|  |                |
|--|----------------|
| Supply voltage, $V_{CC}$ (see Note 1)                        | 8 V            |
| Input voltage range, $V_I$                                   | 8 V            |
| Operating free-air temperature range, $T_A$                  | –25°C to 75°C  |
| Storage temperature range                                    | –40°C to 125°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C          |

<sup>†</sup> Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to the GND terminal.

### recommended operating conditions

|                                       |                                    | MIN | NOM  | MAX | UNIT |
|---------------------------------------|------------------------------------|-----|------|-----|------|
| Supply voltage, $V_{CC}$              |                                    | 4.8 | 5    | 5.2 | V    |
| Input voltage, $V_I$                  | RIN, GIN, BIN                      |     | 250  |     | mV   |
|                                       | WB                                 | 0   | 3.05 | 5   | V    |
|                                       | CLPLVLR, CLPLVLG, CLPLVLB          |     | 2    |     |      |
|                                       | WCPCONT, AGCLMT, AGCCONT           | 0   | 3    | 5   |      |
|                                       | AGCDET, AGCSET                     |     | 3    |     |      |
| High-level input voltage, $V_{IH}$    | CONTA, CONTB, SWR, SWG, SWB, PCL1, | 3.5 |      |     | V    |
| Low-level input voltage, $V_{IL}$     | PCL2, PBL, RESET                   |     |      | 0.4 | V    |
| Operating free-air temperature, $T_A$ |                                    | –20 |      | 45  | °C   |

### electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

#### all sections

| PARAMETER               | TEST CONDITIONS | MIN | TYP <sup>‡</sup> | MAX | UNIT |
|-------------------------|-----------------|-----|------------------|-----|------|
| $I_{CC}$ Supply current | $V_{CC} = 5$ V  |     | 40               | 50  | mA   |

#### Y-switch section

| PARAMETER                     | TEST CONDITIONS | MIN  | TYP <sup>‡</sup> | MAX | UNIT       |
|-------------------------------|-----------------|------|------------------|-----|------------|
| White-clip level (see Note 2) |                 | 400% |                  |     |            |
| Gate-pulse impedance          | SWB, SWG,       |      | 5                |     | k $\Omega$ |
| Gate-pulse capacitance        | SWR             |      |                  | 10  | pF         |

#### clamp section

| PARAMETER                     | TEST CONDITIONS | MIN  | TYP <sup>‡</sup> | MAX | UNIT     |
|-------------------------------|-----------------|------|------------------|-----|----------|
| Clamp-pulse current           | PCL1            | –0.2 |                  | 0.2 | mA       |
| Clamp resistance              | BIN, GIN, RIN   |      | 30               |     | $\Omega$ |
| Clamp-pulse input capacitance | PCL1            |      |                  | 30  | pF       |
| Noise rejection               | PCL1 to YSW     | 30   |                  |     | dB       |

<sup>‡</sup> All typical values are at  $T_A = 25^\circ$  C.

NOTE 2: 250 mV = 100%.



**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted) (continued)**

**blanking section**

| PARAMETER                        |            | TEST CONDITIONS | MIN  | MAX | UNIT |
|----------------------------------|------------|-----------------|------|-----|------|
| Blanking-pulse current           | PBL        |                 | −0.2 | 0.2 | mA   |
| Blanking-pulse input capacitance | PBL        |                 |      | 30  | pF   |
| Noise rejection                  | PBL to YSW |                 | 30   |     | dB   |

**white-balance section**

| PARAMETER         |                | TEST CONDITIONS | MIN  | MAX  | UNIT |
|-------------------|----------------|-----------------|------|------|------|
| Input current     | WB             |                 | −10  | 10   | μA   |
| Red channel gain  | RIN, WB to YSW | WB = 3.5 V      | 2.6  | 3.5  | dB   |
|                   |                | WB = 3 V        | 0.5  | 1.5  |      |
|                   |                | WB = 2.7 V      | −1.7 | −0.6 |      |
|                   |                | WB = 2.4 V      | −3.7 | −2.7 |      |
| Blue channel gain | BIN, WB to YSW | WB = 3.5 V      | −4.4 | −3.1 | dB   |
|                   |                | WB = 3 V        | −1.9 | −0.8 |      |
|                   |                | WB = 2.7 V      | 1    | 1.9  |      |
|                   |                | WB = 2.4 V      | 3.5  | 4.5  |      |

**AGC section**

| PARAMETER                           |  | TEST CONDITIONS           | MIN  | TYP† | MAX  | UNIT |
|-------------------------------------|--|---------------------------|------|------|------|------|
| Gain delta between R, G, B channels |  |                           | −0.5 | 0    | 0.5  | dB   |
| Gain control                        | RIN, GIN, BIN to ROUT,<br>GOUT, BOUT, YAGC | AGCCONT = 1.5 V           | −1   | 0    | 1    | dB   |
|                                     |  | AGCCONT = 4.5 V           | 11.5 | 12.5 | 14.5 |      |
| AGC limit 1                         |  | AGCLMT = 0                |      |      | 0    | dB   |
| AGC limit 2                         |  | AGCLMT = 5 V              | 12.5 |      |      |      |
| RGB bandwidth                       | RIN, GIN, BIN to<br>ROUT, GOUT, BOUT       | AGCCONT = 2.5 V (AGC on)  | 2.9  | 3.6  |      | MHz  |
|                                     |  | AGCCONT = 0.5 V (AGC off) | 3    | 5.1  |      |      |
|                                     | RIN, GIN, BIN to YAGC                      | AGCCONT = 2.5 V (AGC on)  | 3.4  | 4.2  |      |      |
|                                     |  | AGCCONT = 0.5 V (AGC off) | 5    | 6.2  |      |      |
| Output impedance                    | ROUT, GOUT, BOUT                           |                           |      |      | 150  | Ω    |

**Y-clamp section**

| PARAMETER               |      | TEST CONDITIONS | MIN  | TYP† | MAX | UNIT |
|-------------------------|------|-----------------|------|------|-----|------|
| Clamp pulse current     | PCL2 |                 | −0.2 |      | 0.2 | mA   |
| Clamp pulse capacitance | PCL2 |                 |      |      | 50  | pF   |

**white-clip section**

| PARAMETER              |             | TEST CONDITIONS           | MIN  | TYP† | MAX  | UNIT |
|------------------------|-------------|---------------------------|------|------|------|------|
| White-clip point       | YCL to YOUT | See Note 3                | 400% |      |      |      |
| Knee point 1           |             | WCPCONT open, See Note 3  |      | 118% |      |      |
| Knee point 2           |             | WCPCONT = 3 V, See Note 3 | 176% | 236% |      |      |
| Knee point 3           |             | WCPCONT = 2 V, See Note 3 |      | 35%  | 59%  |      |
| Knee compression ratio |             |                           | 13.5 | 15.5 | 17.5 | dB   |
| Output impedance       | YOUT        |                           |      |      | 100  | Ω    |

† All typical values are at  $T_A = 25^\circ\text{C}$ .

NOTE 3: 340 mV = 100%.

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**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted) (continued)**

### ALC-clip section

| PARAMETER                     |              | TEST CONDITIONS                  | MIN | TYP† | MAX | UNIT |
|-------------------------------|--------------|----------------------------------|-----|------|-----|------|
| V <sub>O</sub> Output voltage | ALCREF       | V <sub>CC</sub> = 4.8 V to 5.2 V | 2.6 | 2.8  | 3   | V    |
|                               | YALC         |                                  |     | 340  |     | mV   |
| Clip level                    | YALC         |                                  |     | 800  |     | mV   |
| Output impedance              | ALCREF, YALC |                                  |     |      | 100 | Ω    |

### AGCDET section (see Note 4)

| PARAMETER      |                        | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|----------------|------------------------|-----------------|-----|------|-----|------|
| Gain           | AGCDET, AGCOUT         |                 |     | 60   |     | dB   |
| AGC setpoint 1 | AGCDET, AGCSET, AGCOUT | AGCSET = 3.5 V  |     | 41%  |     |      |
| AGC setpoint 2 |                        | AGCSET = 1.5 V  |     | 12%  |     |      |
| AGC setpoint 3 |                        | AGCSET open     |     | 24%  |     |      |

### ALC-amplifier section

| PARAMETER                            |                    | TEST CONDITIONS | MIN  | TYP† | MAX | UNIT |
|--------------------------------------|--------------------|-----------------|------|------|-----|------|
| Maximum output voltage               | ALCDRV             |                 | 3.5  |      |     | V    |
| Minimum output voltage               | ALCDRV             |                 |      |      | 0.5 | V    |
| V <sub>IO</sub> Input offset voltage | ALC+, ALC–         |                 | –8   | 0    | 8   | mV   |
| I <sub>IB</sub> Input bias current   | ALC+, ALC–         |                 |      |      | 200 | nA   |
| I <sub>I</sub> Input current         | RESET              |                 | –0.5 |      | 0.5 | mA   |
| Gain                                 | ALC+, ALC–, ALCDRV |                 |      | 60   |     | dB   |

† All typical values are at T<sub>A</sub> = 25° C.

NOTE 4: The YAGC output is 100% when the YAGCIN input = 250 mV.

**operating characteristics over recommended operating temperature range (unless otherwise noted)**

### Y-switch section

| PARAMETER                                 |                         | TEST CONDITIONS             | MIN | TYP | MAX | UNIT |
|---|-------------------------|-----------------------------|-----|-----|-----|------|
| Switching frequency, RIN, GIN, BIN to YSW |                         | WB = 0 V to V <sub>CC</sub> | 8   | 10  |     | MHz  |
| t <sub>pd</sub>                           | RIN or BIN to YSW       |                             |     | 20  | 30  | ns   |
|   | GIN to YSW              |                             |     | 10  | 20  |      |
|   | SWR, SWG, or SWB to YSW |                             |     | 5   |     |      |
| SWR, SWG, SWB acquisition time            |                         |                             |     |     | 20  | ns   |
| YSW output settling time                  |                         |                             |     | 30  |     | ns   |

### clamp section

| PARAMETER       |             | TEST CONDITIONS | MIN | MAX | UNIT |
|-----------------|-------------|-----------------|-----|-----|------|
| t <sub>pd</sub> | PCL1 to YSW |                 |     | 100 | ns   |

### blanking section

| PARAMETER       |            | TEST CONDITIONS | MIN | MAX | UNIT |
|-----------------|------------|-----------------|-----|-----|------|
| t <sub>pd</sub> | PBL to YSW |                 |     | 150 | ns   |





operating characteristics over recommended operating temperature range (unless otherwise noted) (continued)

**Y-clamp section**

| PARAMETER |              | TEST CONDITIONS | MIN | MAX | UNIT |
|-----------|--------------|-----------------|-----|-----|------|
| $t_{pd}$  | PCL2 to YOUT |                 |     | 500 | ns   |

**white-clip section**

| PARAMETER                        |  | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|----------------------------------|--|-----------------|-----|-----|-----|------|
| Switching frequency, YCL to YOUT |  | WCPCONT open    | 6   | 8   |     | MHz  |

**ALC-clip section**

| PARAMETER                        |  | TEST CONDITIONS | MIN | MAX | UNIT |
|----------------------------------|--|-----------------|-----|-----|------|
| Switching frequency, YCL to YALC |  |                 | 2   |     | MHz  |

## TYPICAL CHARACTERISTICS

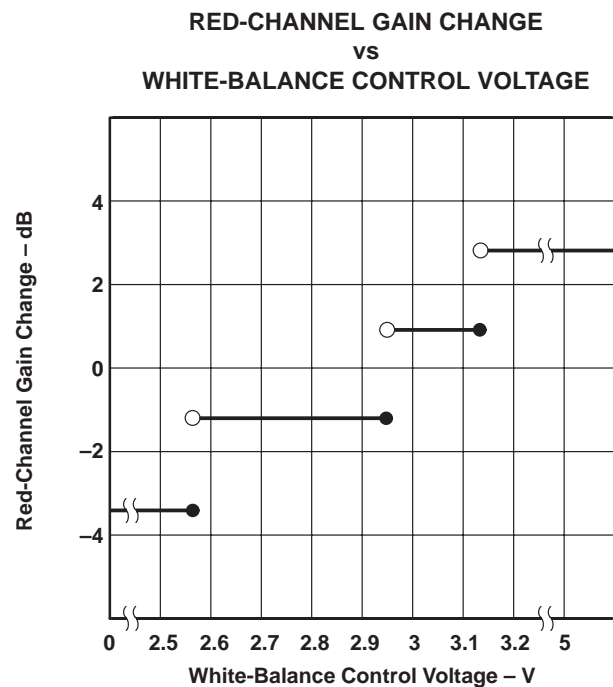


Figure 1

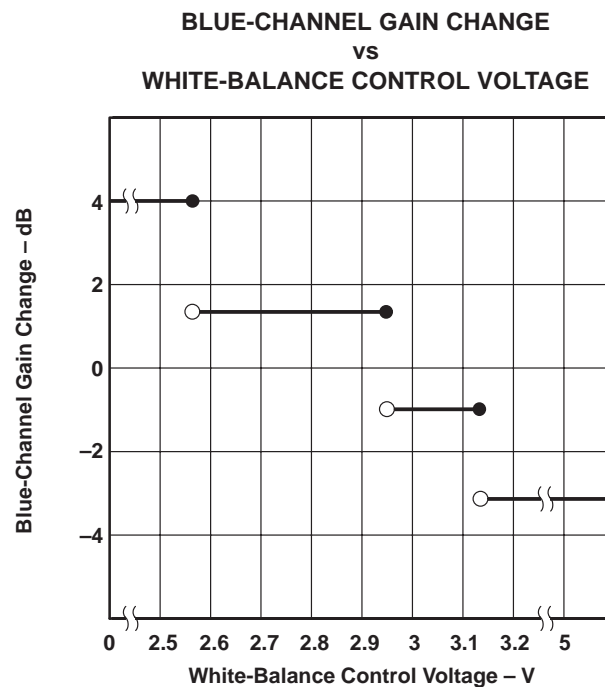


Figure 2

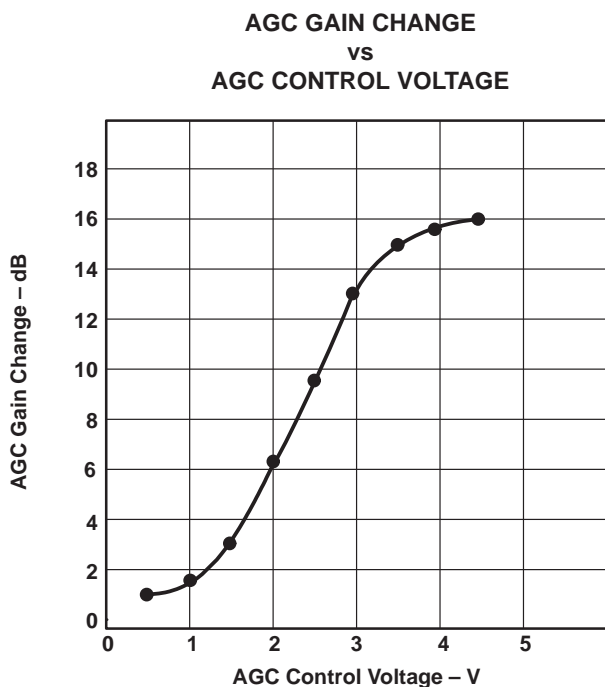


Figure 3

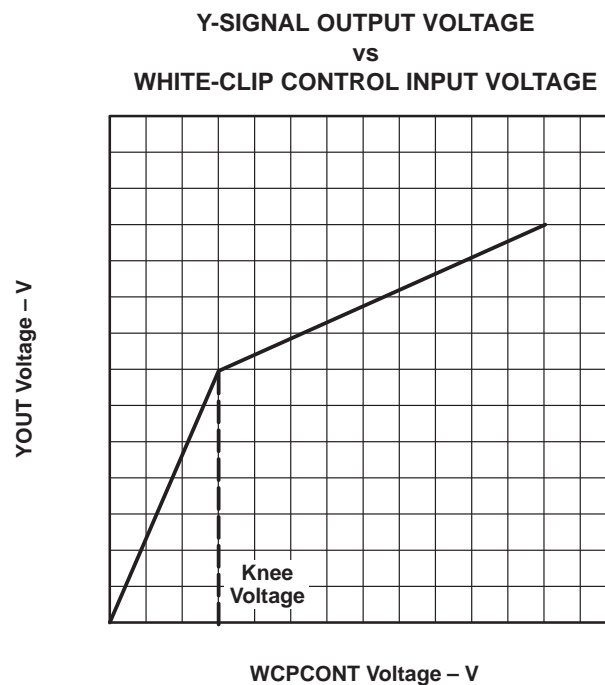
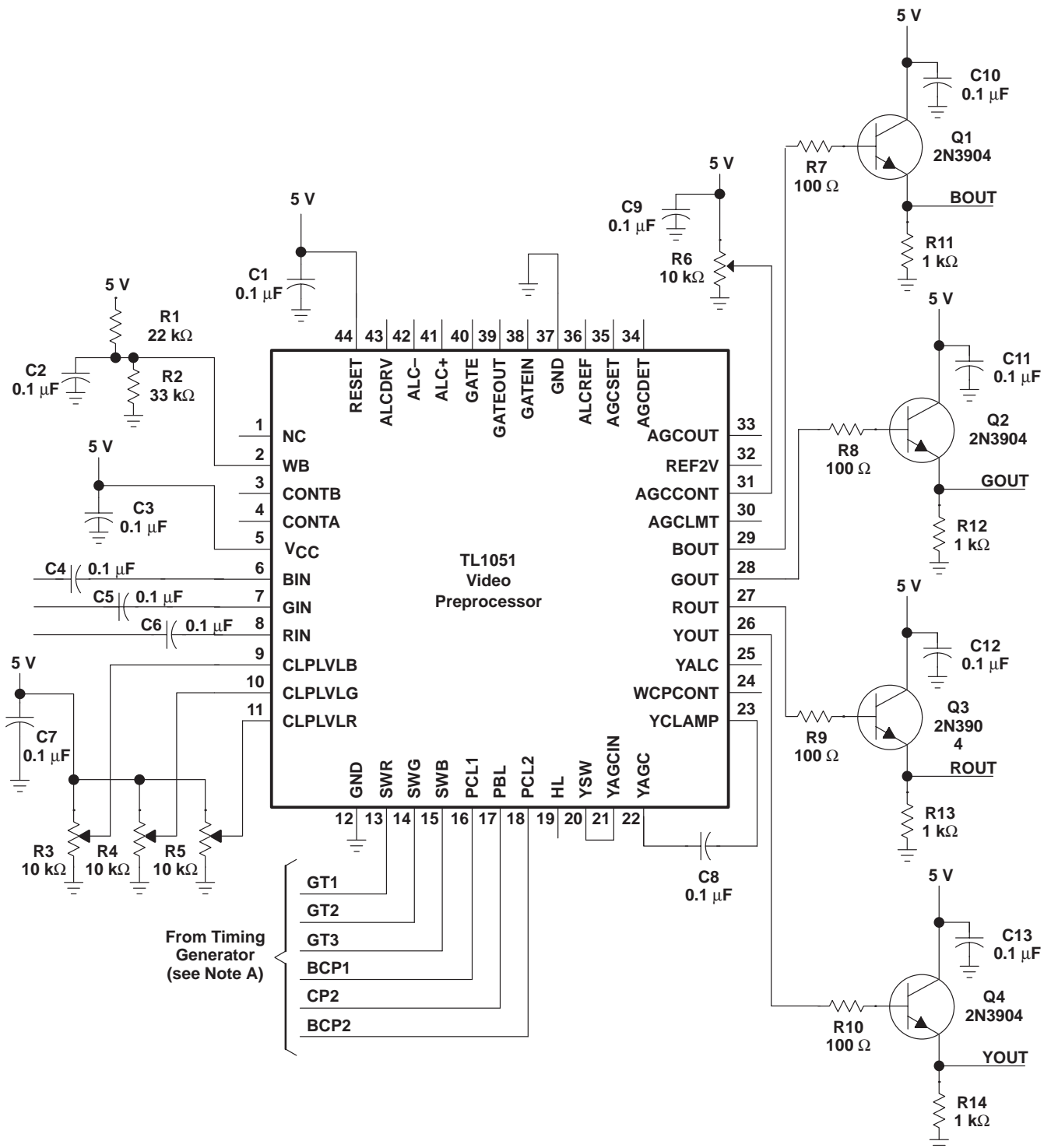


Figure 4

APPLICATION INFORMATION



NOTE A: This application circuit shows TTL signals originating from the TI SN28835 1/2-Inch NTSC Timer. However, the TL1051 video preprocessor interfaces equally well with a TI TMS3471C 2/3-Inch NTSC timer, a TI SN28837 1/2-Inch PAL timer, or a user-defined timing generator.

Figure 5. Typical Application Circuit

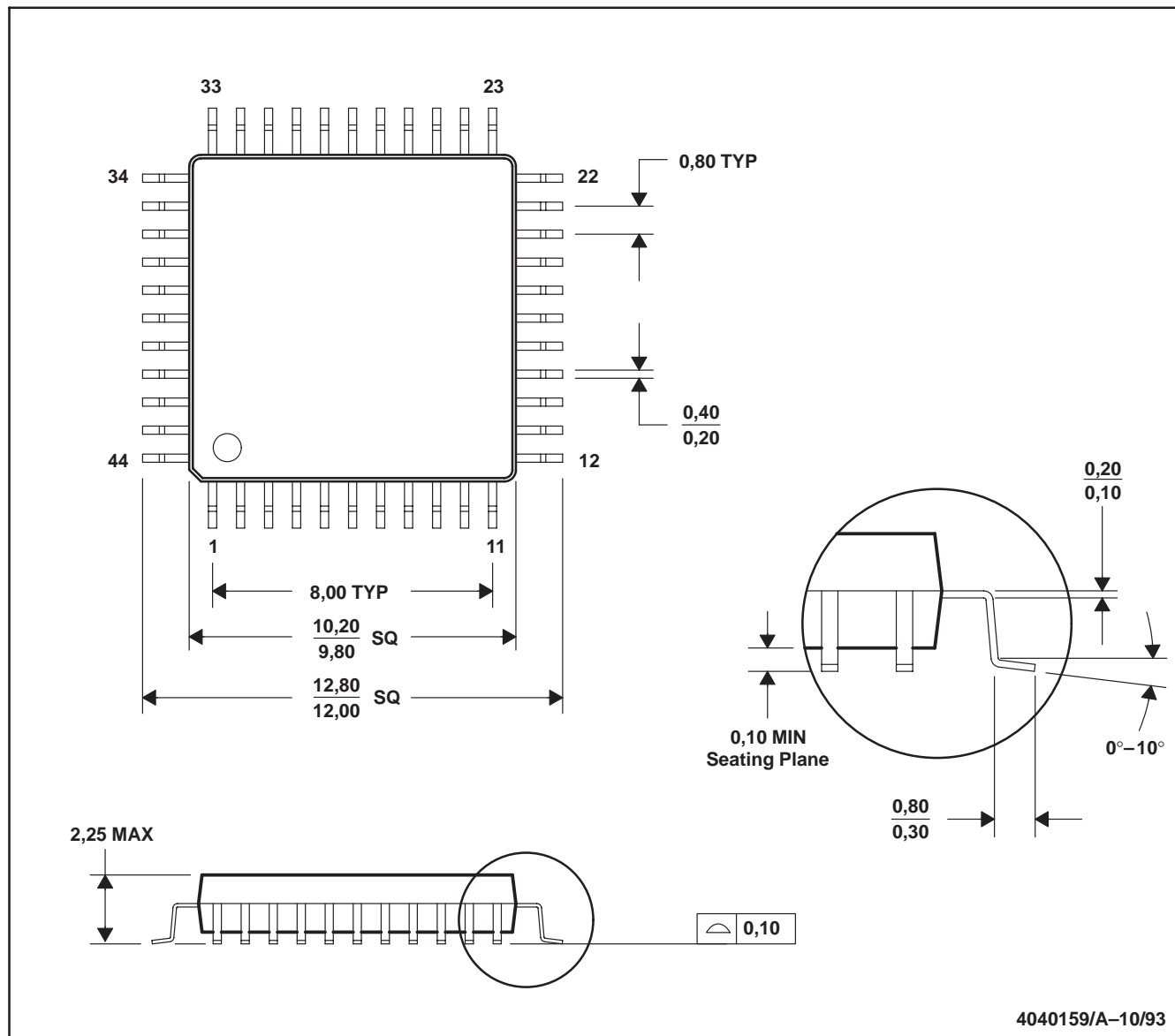
# TL1051 VIDEO PREPROCESSOR CIRCUIT

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## MECHANICAL DATA

FR/S-PDFP-G44

PLASTIC QUAD FLATPACK



NOTES: A. All linear dimensions are in millimeters.  
B. This drawing is subject to change without notice.

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