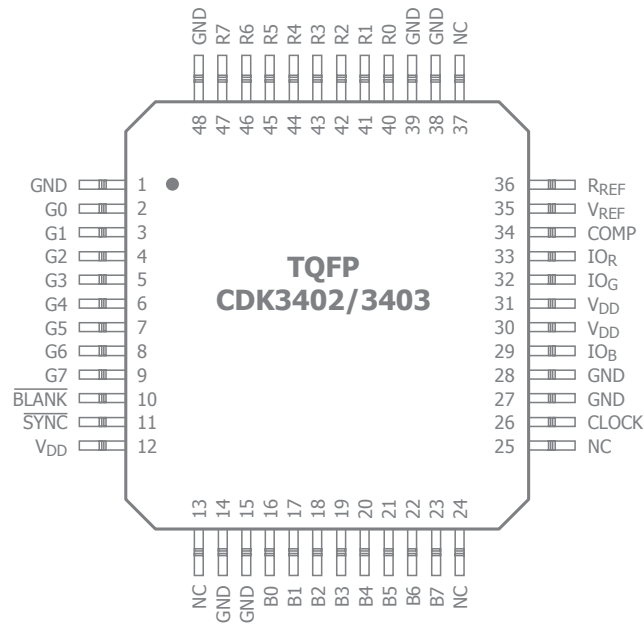






Pin Configuration

TQFP-48



Pin Assignments

| Pin No.                       | Pin Name | Description                    |
|-------------------------------|----------|--------------------------------|
| <b>Clock and Pixel I/O</b>    |          |                                |
| 26                            | CLK      | Clock Input                    |
| 47-40                         | R7-0     | Red Pixel Data Inputs          |
| 9-2                           | G7-0     | Green Pixel Data Inputs        |
| 23-16                         | B7-0     | Blue Pixel Data Inputs         |
| <b>Controls</b>               |          |                                |
| 11                            | SYNC     | Sync Pulse Input               |
| 10                            | BLANK    | Blanking Input                 |
| <b>Video Outputs</b>          |          |                                |
| 33                            | IOR      | Red Current Output             |
| 32                            | IOG      | Green Current Output           |
| 29                            | IOB      | Blue Current Output            |
| <b>Voltage Reference</b>      |          |                                |
| 35                            | VREF     | Voltage Reference Output/Input |
| 36                            | RREF     | Current-Setting Resistor       |
| 34                            | COMP     | Compensation Capacitor         |
| <b>Power and Ground</b>       |          |                                |
| 12, 30, 31                    | VDD      | Power Supply                   |
| 1, 14, 15, 27, 28, 38, 39, 48 | GND      | Ground                         |
| 13, 24, 25, 37                | NC       | No Connect                     |



## Absolute Maximum Ratings

The safety of the device is not guaranteed when it is operated above the "Absolute Maximum Ratings". The device should not be operated at these "absolute" limits. Adhere to the "Recommended Operating Conditions" for proper device function. The information contained in the Electrical Characteristics tables and Typical Performance plots reflect the operating conditions noted on the tables and plots.

| Parameter   | Min   | Max                   | Unit |
|---|-------|-----------------------|------|
| Power Supply Voltage  |       |                       |      |
| V <sub>DD</sub> (Measured to GND)                           | -0.5  | 7.0                   | V    |
| Inputs  |       |                       |      |
| Applied Voltage (measured to GND) <sup>(2)</sup>            | -0.5  | V <sub>DD</sub> + 0.5 | V    |
| Forced Current <sup>(3,4)</sup>                             | -10.0 | 10.0                  | mA   |
| Outputs   |       |                       |      |
| Applied Voltage (measured to GND) <sup>(2)</sup>            | -0.5  | V <sub>DD</sub> + 0.5 | V    |
| Forced Current <sup>(3,4)</sup>                             | -60.0 | 60.0                  | mA   |
| Short Circuit Duration (single output in HIGH state to GND) |       | unlimited             | sec  |
| Temperature   |       |                       |      |
| Operating, Ambient  | -20   | 110                   | °C   |
| Junction  |       | 150                   | °C   |
| Lead Soldering (10 seconds)                                 |       | 300                   | °C   |
| Vapor Phase Soldering (1 minute)                            |       | 220                   | °C   |
| Storage   | -65   | 150                   | °C   |

### Notes:

1. Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if Operating Conditions are not exceeded.
2. Applied voltage must be current limited to specified range.
3. Forcing voltage must be limited to specified range.
4. Current is specified as conventional current flowing into the device.

## Recommended Operating Conditions

| Symbol           | Parameter                      | Min     | Typ   | Max             | Unit |
|------------------|--------------------------------|---------|-------|-----------------|------|
| V <sub>DD</sub>  | Power Supply Voltage           | 4.75    | 5.0   | 5.25            | V    |
| f <sub>S</sub>   | Conversion Rate                | CDK3402 |       | 100             | MSPS |
|                  |                                | CDK3403 |       | 150             | MSPS |
| t <sub>PWH</sub> | CLK Pulsewidth, HIGH           | CDK3402 | 3.1   |                 | ns   |
|                  |                                | CDK3403 | 2.5   |                 | ns   |
| t <sub>PWL</sub> | CLK Pulsewidth, LOW            | CDK3402 | 3.1   |                 | ns   |
|                  |                                | CDK3403 | 2.5   |                 | ns   |
| t <sub>W</sub>   | CLK Pulsewidth                 | CDK3402 | 10    |                 | ns   |
|                  |                                | CDK3403 | 6.6   |                 | ns   |
| t <sub>S</sub>   | Input Data Setup Time          | 1.7     |       |                 | ns   |
| t <sub>h</sub>   | Input Data Hold Time           | 0       |       |                 | ns   |
| V <sub>REF</sub> | Reference Voltage, External    | 1.0     | 1.235 | 1.5             | V    |
| C <sub>C</sub>   | Compensation Capacitor         |         | 0.1   |                 | μF   |
| R <sub>L</sub>   | Output Load                    |         | 37.5  |                 | Ω    |
| V <sub>IH</sub>  | Input Voltage, Logic HIGH      | 2.0     |       | V <sub>DD</sub> | V    |
| V <sub>IL</sub>  | Input Voltage, Logic LOW       | GND     |       | 0.8             | V    |
| T <sub>A</sub>   | Ambient Temperature, Still Air | 0       |       | 70              | °C   |



## Electrical Characteristics

( $T_A = 25^\circ\text{C}$ ,  $V_{DD} = +5\text{V}$ ,  $V_{REF} = 1.235\text{V}$ ,  $R_L = 37.5\Omega$ ,  $R_{REF} = 540\Omega$ ; unless otherwise noted)

| Symbol    | Parameter                              | Conditions  | Min  | Typ   | Max       | Units         |
|-----------|--|---|------|-------|-----------|---------------|
| $I_{DD}$  | Power Supply Current <sup>(1)</sup>    | $V_{DD} = 5.25\text{V}$ , $T_A = 0^\circ\text{C}$ |      |       | 125       | mA            |
| PD        | Total Power Dissipation <sup>(1)</sup> | $V_{DD} = 5.25\text{V}$ , $T_A = 0^\circ\text{C}$ |      |       | 655       | mW            |
| $R_O$     | Output Resistance                      |   |      | 100   |           | k $\Omega$    |
| $C_O$     | Output Capacitance                     | $I_{OUT} = 0\text{mA}$                            |      |       | 30        | pF            |
| $I_{IH}$  | Input Current, HIGH                    | $V_{DD} = 5.25\text{V}$ , $V_{IN} = 2.4\text{V}$  |      |       | -5        | $\mu\text{A}$ |
| $I_{IL}$  | Input Current, LOW                     | $V_{DD} = 5.25\text{V}$ , $V_{IN} = 0.4\text{V}$  |      |       | 5         | $\mu\text{A}$ |
| $I_{REF}$ | $V_{REF}$ Input Bias Current           |   |      | 0     | $\pm 100$ | $\mu\text{A}$ |
| $V_{REF}$ | Reference Voltage Output               |   |      | 1.235 |           | V             |
| $V_{OC}$  | Output Compliance                      | Referred to $V_{DD}$                              | -0.4 | 0     | +1.5      | V             |
| $C_{DI}$  | Digital Input Capacitance              |   |      | 4     | 10        | pF            |

### Notes:

- 100% tested at  $25^\circ\text{C}$ .
- Parameter is guaranteed (but not tested) by design and characterization data.

## Switching Characteristics

( $T_A = 25^\circ\text{C}$ ,  $V_{DD} = +5\text{V}$ ,  $V_{REF} = 1.235\text{V}$ ,  $R_L = 37.5\Omega$ ,  $R_{REF} = 590\Omega$ ; unless otherwise noted)

| Symbol     | Parameter             | Conditions  | Min | Typ | Max | Units |
|------------|-----------------------|---|-----|-----|-----|-------|
| $t_D$      | Clock to Output Delay | $V_{DD} = 4.75\text{V}$ , $T_A = 0^\circ\text{C}$ |     | 10  | 15  | ns    |
| $t_{SKEW}$ | Output Skew           |   |     | 1   | 2   | ns    |
| $t_R$      | Output Risettime      | 10% to 90% of Full Scale                          |     |     | 3   | ns    |
| $t_F$      | Output Falltime       | 90% to 10% of Full Scale                          |     |     | 3   | ns    |

### Notes:

- 100% production tested at  $+25^\circ\text{C}$ .
- Parameter is guaranteed (but not tested) by design and characterization data.

## System Performance Characteristics

( $T_A = 25^\circ\text{C}$ ,  $V_{DD} = +5\text{V}$ ,  $V_{REF} = 1.235\text{V}$ ,  $R_L = 37.5\Omega$ ,  $R_{REF} = 590\Omega$ ; unless otherwise noted)

| Symbol   | Parameter                    | Conditions | Min | Typ       | Max       | Units |
|----------|------------------------------|------------|-----|-----------|-----------|-------|
| INL      | Integral Linearity Error     |            |     | $\pm 0.2$ | $\pm 0.3$ | %/FS  |
| DNL      | Differential Linearity Error |            |     | $\pm 0.2$ | $\pm 0.3$ | %/FS  |
| $E_{DM}$ | DAC to DAC Matching          |            |     | 5         | 10        | %     |
| PSRR     | Power Supply Rejection Ratio |            |     |           | 0.05      | %/%   |

### Notes:

- 100% production tested at  $+25^\circ\text{C}$ .
- Parameter is guaranteed (but not tested) by design and characterization data.

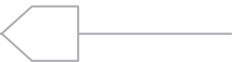


Table 1. Output Voltage vs. Input Code,  $\overline{\text{SYNC}}$  and  $\overline{\text{BLANK}}$ ,  $V_{\text{REF}} = 1.235\text{V}$ ,  $R_{\text{REF}} = 590\Omega$ ,  $R_L = 37.5\Omega$

| RGB7-0 (MSB...LSB) | BLUE AND RED             |                           |                  | GREEN                    |                           |                  |
|--------------------|--------------------------|---------------------------|------------------|--------------------------|---------------------------|------------------|
|                    | $\overline{\text{SYNC}}$ | $\overline{\text{BLANK}}$ | $V_{\text{OUT}}$ | $\overline{\text{SYNC}}$ | $\overline{\text{BLANK}}$ | $V_{\text{OUT}}$ |
| 1111 1111          | X                        | 1                         | 0.7140           | 1                        | 1                         | 1.0000           |
| 1111 1111          | X                        | 1                         | 0.7140           | 0                        | 1                         | 0.7140           |
| 1111 1110          | X                        | 1                         | 0.7134           | 1                        | 1                         | 0.9994           |
| 1111 1101          | X                        | 1                         | 0.7127           | 1                        | 1                         | 0.9987           |
| •                  | •                        | •                         | •                | •                        | •                         | •                |
| •                  | •                        | •                         | •                | •                        | •                         | •                |
| 0000 0000          | X                        | 1                         | 0.3843           | 1                        | 1                         | 0.6703           |
| 1111 1111          | X                        | 1                         | 0.3837           | 1                        | 1                         | 0.6697           |
| •                  | •                        | •                         | •                | •                        | •                         | •                |
| •                  | •                        | •                         | •                | •                        | •                         | •                |
| 0000 0010          | X                        | 1                         | 0.0553           | 1                        | 1                         | 0.3413           |
| 0000 0001          | X                        | 1                         | 0.0546           | 1                        | 1                         | 0.3406           |
| 0000 0000          | X                        | 1                         | 0.0540           | 1                        | 1                         | 0.3400           |
| 0000 0000          | X                        | 1                         | 0.0540           | 0                        | 1                         | 0.054            |
| XXXX XXXX          | X                        | 0                         | 0.0000           | 1                        | 0                         | 0.2860           |
| XXXX XXXX          | X                        | 0                         | 0.0000           | 0                        | 0                         | 0.0000           |
| XXXX XXXX          | X                        | 1                         | valid            | 0                        | 1                         | valid            |

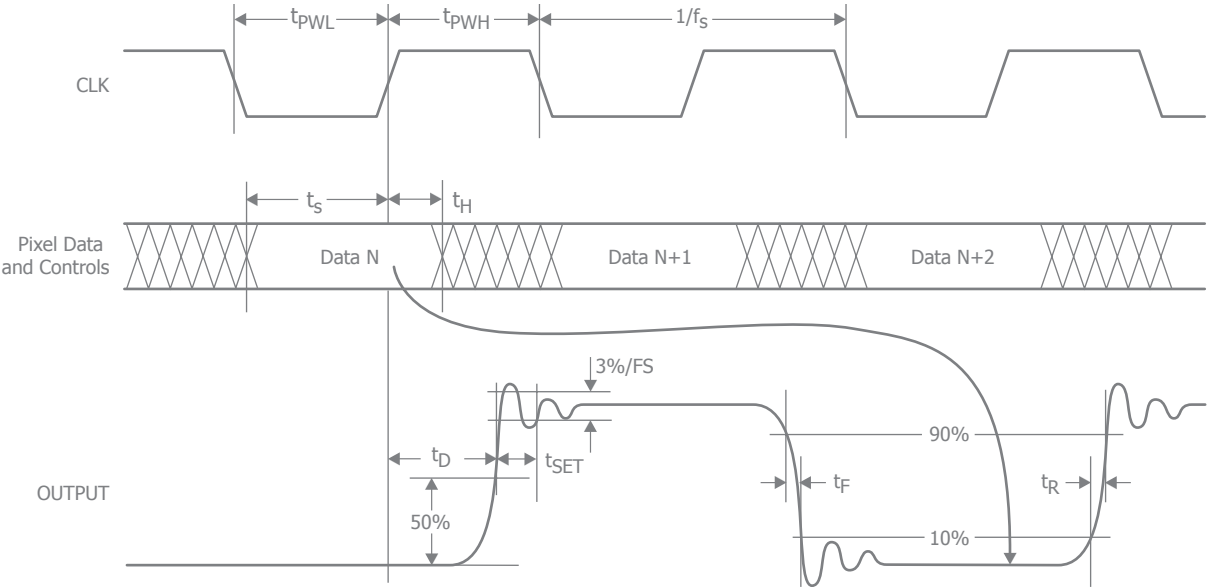


Figure 1. CDK3402/3403 Timing Diagram



## Functional Description

Within the CDK3402/3403 are three identical 8-bit D/A converters, each with a current source output. External loads are required to convert the current to voltage outputs. Data inputs RGB7-0 are overridden by the  $\overline{\text{BLANK}}$  input.  $\overline{\text{SYNC}} = \text{H}$  activates, sync current from  $\text{I}_{\text{OS}}$  for sync-on-green video signals.

## Digital Inputs

All digital inputs are TTL-compatible. Data is registered on the rising edge of the CLK signal. Following one stage of pipeline delay, the analog output changes  $t_{\text{DO}}$  after the rising edge of CLK.

### Clock Input - CLK

The clock input is TTL-compatible and all pixel data is registered on the rising edge of CLK. It is recommended that CLK be driven by a dedicated TTL buffer to avoid reflection induced jitter, overshoot, and undershoot.

### Pixel Data Inputs - R7-0, B7-0, G7-0

TTL-compatible Red, Green and Blue Data Inputs are registered on the rising edge of CLK.

### $\overline{\text{SYNC}}$ and $\overline{\text{BLANK}}$

$\overline{\text{SYNC}}$  and  $\overline{\text{BLANK}}$  inputs control the output level (Figure 2 and Table 1, on the previous page) of the D/A converters during CRT retrace intervals.  $\overline{\text{BLANK}}$  forces the D/A outputs to the blanking level while  $\overline{\text{SYNC}} = \text{L}$  turns off a current source that is connected to the green D/A converter.  $\overline{\text{SYNC}} = \text{H}$  adds a  $40 \text{ I}_{\text{RE}}$  sync pulse to the green output,  $\overline{\text{SYNC}} = \text{L}$  sets the green output to 0.0V during the sync tip.  $\overline{\text{SYNC}}$  and  $\overline{\text{BLANK}}$  are registered on the rising edge of CLK.

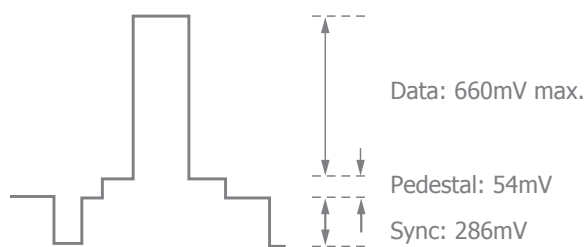


Figure 2. Normal Output Levels

$\overline{\text{BLANK}}$  gates the D/A inputs and sets the pedestal voltage. If  $\overline{\text{BLANK}} = \text{HIGH}$ , the D/A inputs are added to a pedestal

which offsets the current output. If  $\overline{\text{BLANK}} = \text{Low}$ , data inputs and the pedestal are disabled.

### Sync Pulse Input - $\overline{\text{SYNC}}$

Bringing  $\overline{\text{SYNC}}$  LOW, turns off a  $40 \text{ I}_{\text{RE}}$  (7.62mA) current source which forms a sync pulse on the Green D/A converter output.  $\overline{\text{SYNC}}$  is registered on the rising edge of CLK with the same pipeline latency as  $\overline{\text{BLANK}}$  and pixel data.  $\overline{\text{SYNC}}$  does not override any other data and should be used only during the blanking interval.

Since this is a single-supply D/A and all signals are positive-going, sync is added to the bottom of the Green D/A range. So turning  $\overline{\text{SYNC}}$  OFF means turning the current source ON. When a sync pulse is desired, the current source is turned OFF. If the system does not require sync pulses from the Green D/A converter,  $\overline{\text{SYNC}}$  should be connected to GND.

### Blanking Input - $\overline{\text{BLANK}}$

When  $\overline{\text{BLANK}}$  is LOW, pixel inputs are ignored and the D/A converter outputs fall to the blanking level.  $\overline{\text{BLANK}}$  is registered on the rising edge of CLK and has the same pipeline latency as  $\overline{\text{SYNC}}$ .

## D/A Outputs

Each D/A output is a current source. To obtain a voltage output, a resistor must be connected to ground. Output voltage depends upon this external resistor, the reference voltage, and the value of the gain-setting resistor connected between  $\text{R}_{\text{REF}}$  and GND.

Normally, a source termination resistor of  $75\Omega$  is connected between the D/A current output pin and GND near the D/A converter. A  $75\Omega$  line may then be connected with another  $75\Omega$  termination resistor at the far end of the cable. This "double termination" presents the D/A converter with a net resistive load of  $37.5\Omega$ .

The CDK3402/3403 may also be operated with a single  $75\Omega$  terminating resistor. To lower the output voltage swing to the desired range, the nominal value of the resistor on  $\text{R}_{\text{REF}}$  should be doubled.

### R, G, and B Current Outputs - $\text{I}_{\text{OR}}$ , $\text{I}_{\text{OG}}$ , $\text{I}_{\text{OB}}$

The R, G, and B current source outputs of the D/A converters are capable of driving RS-343A/SMPTE-170M compatible levels into doubly-terminated  $75\Omega$  lines. Sync pulses may be added to the Green D/A output.



### Current-Setting Resistor - $R_{REF}$

Full-scale output current of each D/A converter is determined by the value of the resistor connected between  $R_{REF}$  and GND. Nominal value of  $R_{REF}$  is found from:

$$R_{REF} = 9.1 (V_{REF}/I_{FS})$$

where  $I_{FS}$  is the full-scale (white) output current (in amps) from the D/A converter (without sync). Sync is  $0.4 * I_{FS}$ .

D/A full-scale (white) current may also be calculated from:

$$I_{FS} = V_{FS}/R_L$$

Where  $V_{FS}$  is the white voltage level and  $R_L$  is the total resistive load ( $\Omega$ ) on each D/A converter.  $V_{FS}$  is the blank to full-scale voltage.

### Voltage Reference

All three D/A converters are supplied with a common voltage reference. Internal bandgap voltage reference voltage is +1.235V with a  $3k\Omega$  source resistance. An external voltage reference may be connected to the  $V_{REF}$  pin, overriding the internal voltage reference.

A  $0.1\mu F$  capacitor must be connected between the COMP pin and  $V_{DD}$  to stabilize internal bias circuitry and ensure low-noise operation.

### Voltage Reference Output/Input - $V_{REF}$

An internal voltage source of +1.235V is output on the  $V_{REF}$  pin. An external +1.235V reference may be applied here which overrides the internal reference. Decoupling  $V_{REF}$  to GND with a  $0.1\mu F$  ceramic capacitor is required.

### Power and Ground

Required power is a single +5.0V supply. To minimize power supply induced noise, analog +5V should be connected to  $V_{DD}$  pins with  $0.1\mu F$  and  $0.01\mu F$  decoupling capacitors placed adjacent to each  $V_{DD}$  pin or pin pair.

The high slew-rate of digital data makes capacitive coupling to the outputs of any D/A converter a potential problem. Since the digital signals contain high-frequency components of the CLK signal, as well as the video output signal, the resulting data feedthrough often looks like harmonic distortion or reduced signal-to-noise performance. All ground pins should be connected to a common solid ground plane for best performance.



## Equivalent Circuits

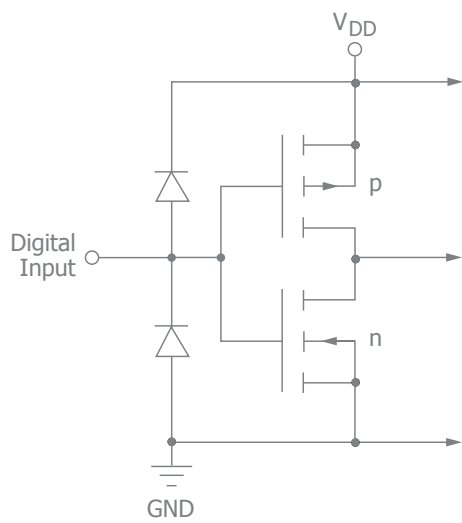


Figure 3. Equivalent Digital Input Circuit

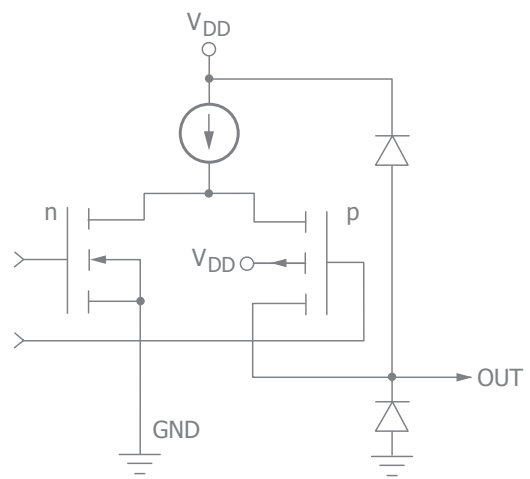


Figure 4. Equivalent Analog Output Circuit

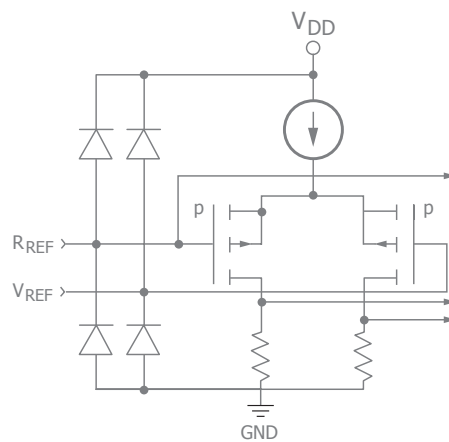


Figure 5. Equivalent Analog Input Circuit





Typical Application Diagrams

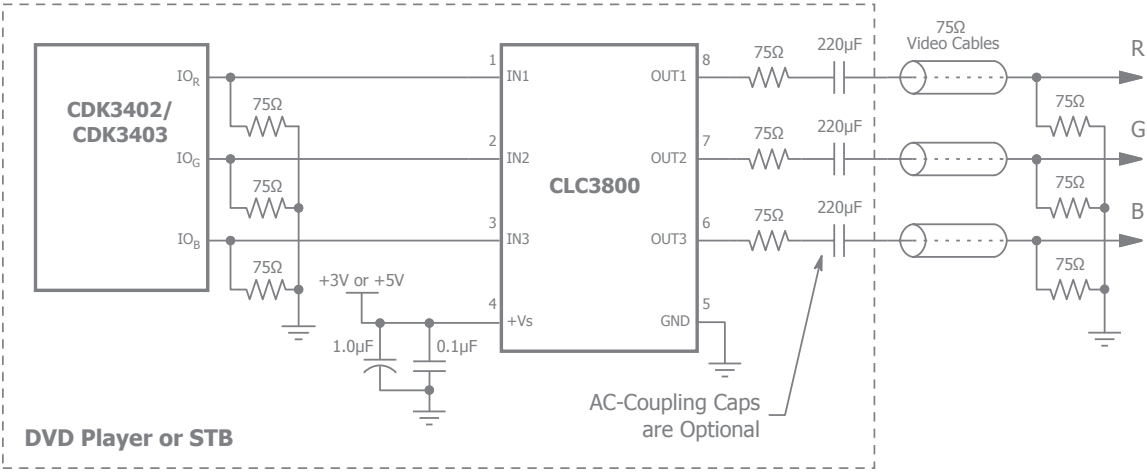


Figure 6. Standard Definition Video Output Circuit Diagram

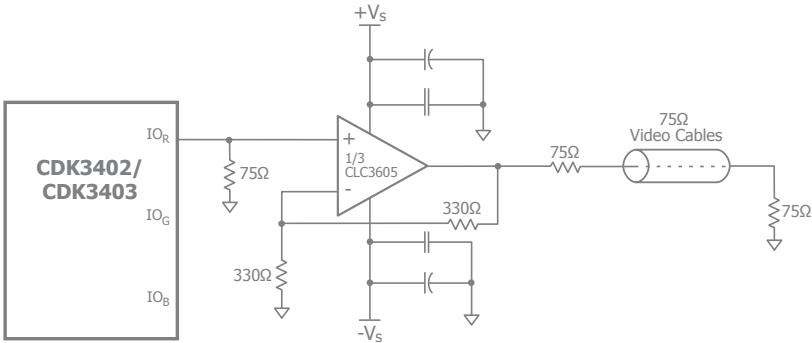


Figure 7. Graphics Output Driver Circuit Diagram

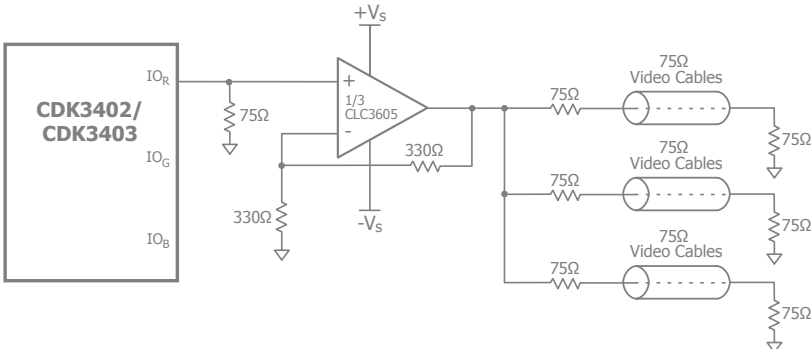


Figure 8. Standard Definition Video Distribution Circuit Diagram



## Applications Discussion

Figure 9 below illustrates a typical CDK3402/3403 interface circuit. In this example, an optional 1.2V bandgap reference is connected to the  $V_{REF}$  output, overriding the internal voltage reference source.

## Grounding

It is important that the CDK3402/3403 power supply is well-

regulated and free of high-frequency noise. Careful power supply decoupling will ensure the highest quality video signals at the output of the circuit. The CDK3402/3403 has separate analog and digital circuits. To keep digital system noise from the D/A converter, it is recommended that power supply voltages ( $V_{DD}$ ) come from the system analog power source and all ground connections (GND) be made to the analog ground plane. Power supply pins should be individually decoupled at the pin.

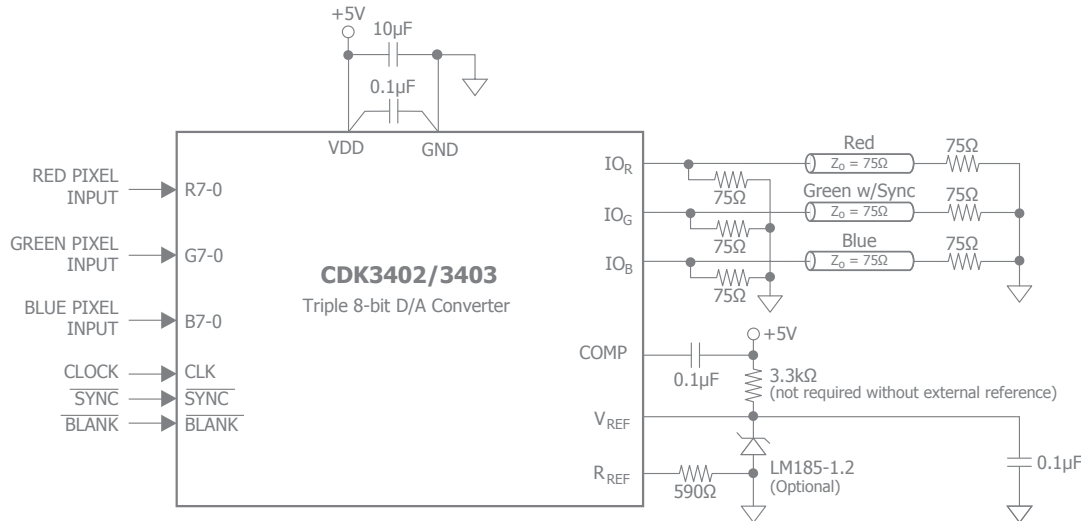


Figure 9. Typical Interface Circuit Diagram

## Printed Circuit Board Layout

Designing with high-performance mixed-signal circuits demands printed circuits with ground planes. Overall system performance is strongly influenced by the board layout. Capacitive coupling from digital to analog circuits may result in poor D/A conversion. Consider the following suggestions when doing the layout:

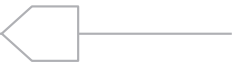
1. Keep the critical analog traces ( $V_{REF}$ ,  $I_{REF}$ , COMP,  $IO_S$ ,  $IO_R$ ,  $IO_G$ ) as short as possible and as far as possible from all digital signals. The CDK3402/3403 should be located near the board edge, close to the analog out-put connectors.
2. Power plane for the CDK3402/3403 should be separate from that which supplies the digital circuitry. A single power plane should be used for all of the  $V_{DD}$  pins. If the power supply for the CDK3402/3403 is the same as that of the system's digital circuitry, power to the CDK3402/3403 should be decoupled with 0.1µF and 0.01µF capacitors and iso-lated with a ferrite bead.

3. The ground plane should be solid, not cross-hatched. Connections to the ground plane should have very short leads.
4. If the digital power supply has a dedicated power plane layer, it should not be placed under the CDK3402/3403, the voltage reference, or the analog outputs. Capacitive coupling of digital power supply noise from this layer to the CDK3402/3403 and its related analog circuitry can have an adverse effect on performance.
5. CLK should be handled carefully. Jitter and noise on this clock will degrade performance. Terminate the clock line carefully to eliminate overshoot and ringing.

Evaluation boards are available (CEB3402 and CEB3403), contact CADEKA for more information.

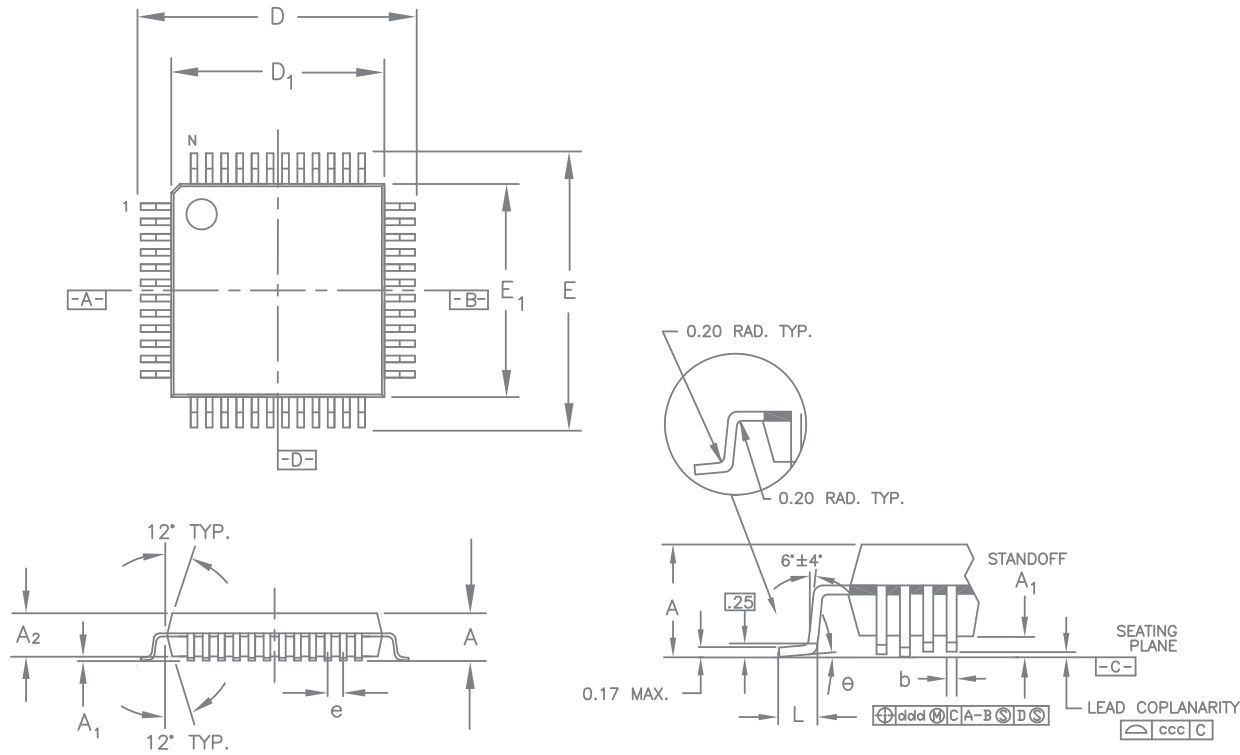
## Related Products

- CDK3400/3401 Triple 10-bit 100/150MSPS DACs
- CDK3404 Triple 8-bit 180MSPS DAC



Mechanical Dimensions

TQFP-48 Package



| LEAD COUNT              |            | 48L      |          |
|-------------------------|------------|----------|----------|
| DIMS.                   | TOL.       |          |          |
| A                       | MAX.       | 1.20     | 1.60     |
| A <sub>1</sub>          |            | .05 MIN. | .15 MAX. |
| A <sub>2</sub>          | ±.05       | 1.00     | 1.40     |
| D                       | ±.20       | 9.00     |          |
| D <sub>1</sub>          | ±.10       | 7.00     |          |
| E                       | ±.20       | 9.00     |          |
| E <sub>1</sub>          | ±.10       | 7.00     |          |
| L                       | +.15/- .10 | .60      |          |
| e                       | BASIC      | .50      |          |
| φ                       | ±.05       | .22      |          |
| θ                       |            | 0°-7°    |          |
| ddd                     | MAX.       | .08      |          |
| ccc                     | MAX.       | .08      |          |
| JEDEC REFERENCE DRAWING |            | MS-026   | MS-026   |
| VARIATION DESIGNATOR    |            | ABC      | BBC      |

- NOTES.
- 1. All dimensions in mm.
  - 2. Dimension shown are nominal with tolerances indicated.
  - 3. Foot length 'L' is measured at gage plane 0.25mm above seating plane.
  - 4. L/F: Eftec 64T Cu or equivalent, 0.127mm (0.005") thick

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- Экспресс доставка в любую точку России;
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- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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