

## Triple 8-Bit, 40MSPS, RGB, 3-Channel D/A Converter

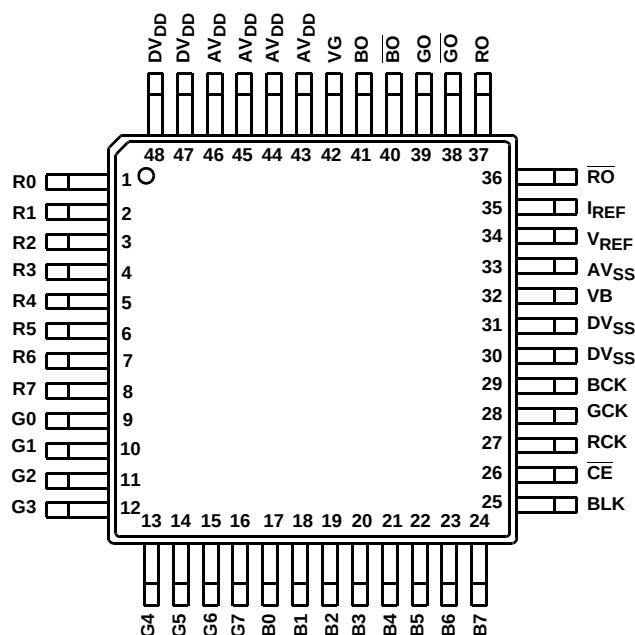
The HI1178 is a triple 8-bit, high-speed, CMOS D/A converter designed for video band use. It has three separate, 8-bit, pixel inputs, one each for red, green, and blue video data. A single 5.0V power supply and pixel clock input is all that is required to make the device operational. A bias voltage generator is internal. Each channel clock input can be controlled individually, or connected together as one. The HI1178 also has BLANK video control signal.

## Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE    | PKG. NO.    |
|-------------|------------------|------------|-------------|
| HI1178JCQ   | -40 to 85        | 48 Ld MQFP | Q48.12x12-S |

## Pinout

HI1178  
(MQFP)  
TOP VIEW



## Features

- Resolution . . . . . Triple 8-Bit
- Maximum Conversion Speed . . . . . 40MHz
- RGB 3-Channel Input/Output
- Differential Linearity Error . . . . . +0.3 LSB
- Low Power Consumption . . . . . 240mW (200Ω Load for 2V<sub>P-P</sub> Output)
- Single Power Supply . . . . . +5V
- Low Glitch Noise
- Direct Replacement for Sony CXD1178

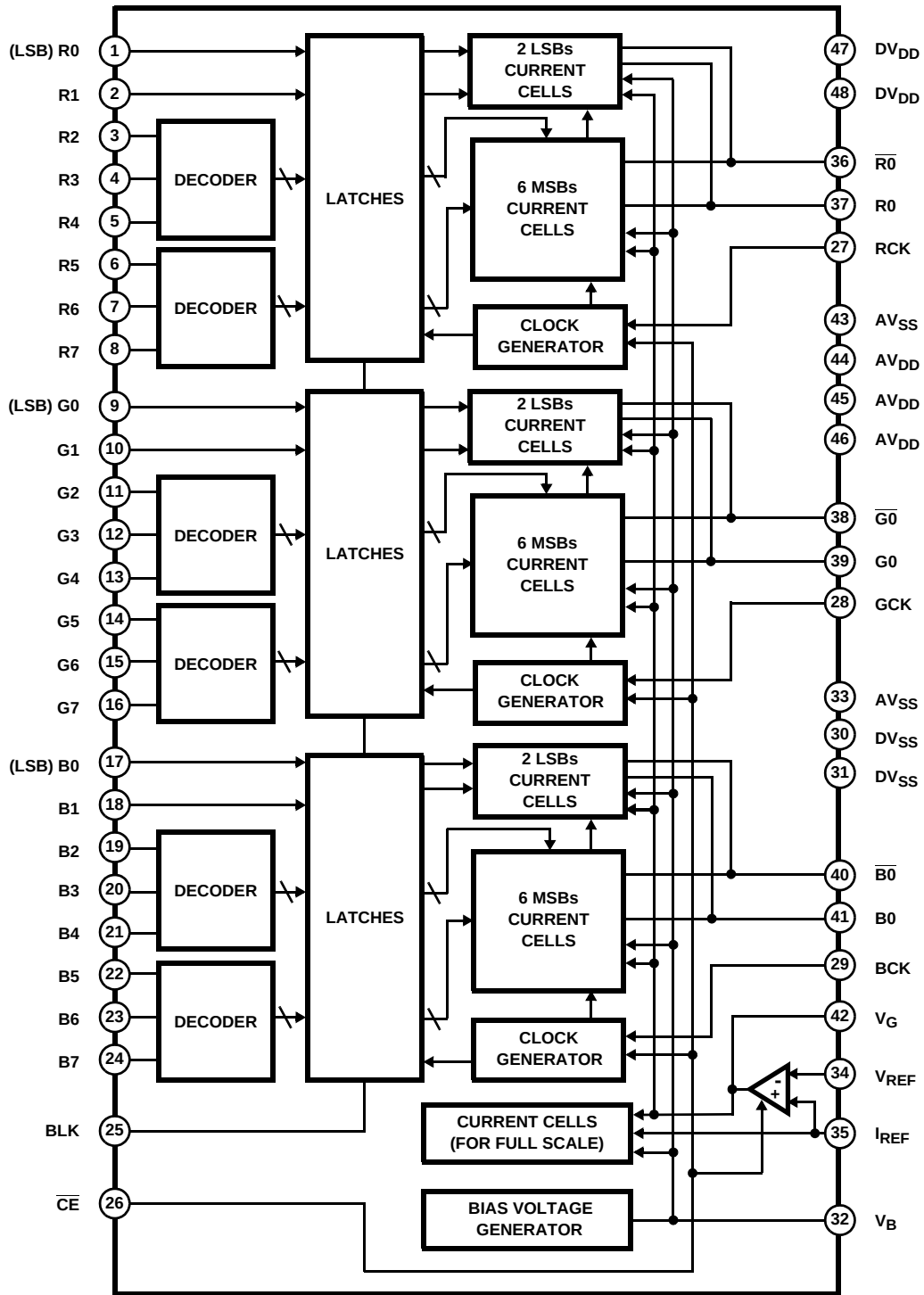
## Applications

- Digital TV
- Graphics Display
- High Resolution Color Graphics
- Video Reconstruction
- Instrumentation
- Image Processing
- I/Q Modulation

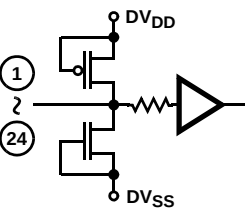
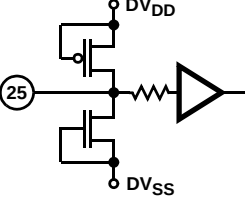
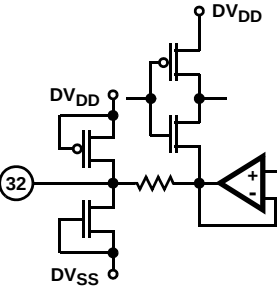
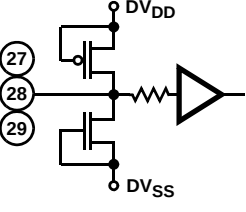
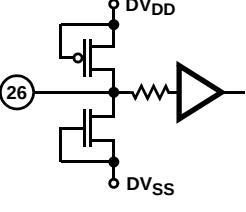
## Related Literature

- Technical Brief TB363 "Guidelines for Handling and Processing Moisture Sensitive Surface Mount Devices (SMDs)"

# Functional Block Diagram



# Pin Descriptions

| PIN NO.  | SYMBOL                 | EQUIVALENT CIRCUIT                                                                  | DESCRIPTION                                                                    |
|----------|------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 1 to 8   | R0 to R7               |    | Digital input.                                                                 |
| 9 to 16  | G0 to G7               |                                                                                     |                                                                                |
| 17 to 24 | B0 to B7               |                                                                                     |                                                                                |
| 25       | BLK                    |    | Blanking pin. No signal at "H" (Output 0V). Output condition at "L".           |
| 32       | V <sub>B</sub>         |   | Connect a capacitor of about 0.1μF.                                            |
| 27       | RCK                    |  | Clock pin. Moreover all input pins are TTL-CMOS compatible.                    |
| 28       | CLK                    |                                                                                     |                                                                                |
| 29       | BCK                    |                                                                                     |                                                                                |
| 30, 31   | DV <sub>SS</sub>       |                                                                                     | Digital GND.                                                                   |
| 33       | AV <sub>SS</sub>       |                                                                                     | Analog GND.                                                                    |
| 26       | $\overline{\text{CE}}$ |  | Chip enable pin. No signal (Output 0V) at "H" and minimizes power consumption. |

**Pin Descriptions** (Continued)

| PIN NO.  | SYMBOL          | EQUIVALENT CIRCUIT | DESCRIPTION                                                                    |
|----------|-----------------|--------------------|--------------------------------------------------------------------------------|
| 35       | $I_{REF}$       |                    | Connect a resistance 16 times "16R" that of output resistance value "R".       |
| 34       | $V_{REF}$       |                    | Set full scale output value.                                                   |
| 42       | $V_G$           |                    | Connect a capacitor of about 0.1 $\mu$ F.                                      |
| 43 to 46 | $AV_{DD}$       |                    | Analog $V_{DD}$ .                                                              |
| 37       | RO              |                    | Current output pin. Voltage output can be obtained by connecting a resistance. |
| 39       | GO              |                    | Inverted current output pin. Normally dropped to analog GND.                   |
| 41       | BO              |                    |                                                                                |
| 36       | $\overline{RO}$ |                    |                                                                                |
| 38       | $\overline{GO}$ |                    |                                                                                |
| 40       | $\overline{BO}$ |                    |                                                                                |
| 47, 48   | $DV_{DD}$       |                    | Digital $V_{DD}$ .                                                             |

**Absolute Maximum Ratings**  $T_A = 25^{\circ}\text{C}$ 

Supply Voltage ( $V_{DD}$ ) ..... 7V  
 Input Voltage ( $V_{IN}$ ) .....  $V_{DD}$  to  $V_{SS}$   
 Output Current ( $I_{OUT}$ ) .....  $V_{DD}$  to  $V_{SS}$   
 Digital Input Voltage (CLK) ..... 0mA to 15mA  
 (Every Each Channel)

**Operating Conditions**

Temperature Range ( $T_{OPR}$ ) .....  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$   
 Supply Voltage  
    $AV_{DD}$ ,  $AV_{SS}$  ..... 4.75V to 5.25V  
    $DV_{DD}$ ,  $DV_{SS}$  ..... 4.75V to 5.25V  
 Reference Input Voltage ( $V_{REF}$ ) ..... 2V  
 Clock Pulse Width  
    $t_{PW1}$  ..... 12.5ns (Min)  
    $t_{PW0}$  ..... 12.5ns (Min)

**Thermal Information**

Thermal Resistance (Typical, Note 1)  $\theta_{JA}$  ( $^{\circ}\text{C/W}$ )  
 MQFP Package ..... 94  
 Maximum Junction Temperature (Plastic Package) .....  $150^{\circ}\text{C}$   
 Maximum Storage Temperature Range ( $T_{STG}$ ) ...  $-65^{\circ}\text{C}$  to  $150^{\circ}\text{C}$   
 Maximum Lead Temperature (Soldering 10s) .....  $300^{\circ}\text{C}$   
 (MQFP - Lead Tips Only)

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

**NOTE:**

1.  $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

**Electrical Specifications**  $f_{CLK} = 40\text{MHz}$ ,  $V_{DD} = 5\text{V}$ ,  $R_{OUT} = 200\Omega$ ,  $V_{REF} = 2.0\text{V}$ ,  $T_A = 25^{\circ}\text{C}$ 

| PARAMETER                        |         | SYMBOL    | TEST CONDITIONS                  | MIN  | TYP | MAX | UNITS         |
|----------------------------------|---------|-----------|----------------------------------|------|-----|-----|---------------|
| Resolution                       |         | n         |                                  | -    | 8   | -   | bit           |
| Maximum Conversion Speed         |         | $f_{MAX}$ |                                  | 40   | -   | -   | MSPS          |
| Linearity Error                  |         | $E_L$     |                                  | -2.5 | -   | 2.5 | LSB           |
| Differential Linearity Error     |         | $E_D$     |                                  | -0.3 | -   | 0.3 | LSB           |
| Full Scale Output Voltage        |         | $V_{FS}$  |                                  | 1.8  | 2.0 | 2.2 | V             |
| Full Scale Output Ratio (Note 1) |         | $F_{SR}$  |                                  | 0    | 1.5 | 3   | %             |
| Full Scale Output Current        |         | $I_{FS}$  |                                  | -    | 10  | 15  | mA            |
| Offset Output Voltage            |         | $V_{OS}$  |                                  | -    | -   | 1   | mV            |
| Power Supply Current             |         | $I_{DD}$  | 14.3MHz, at Color Bar Data Input | -    | -   | 48  | mA            |
| Digital Input Current            | H Level | $I_{IH}$  |                                  | -    | -   | 5   | $\mu\text{A}$ |
|                                  | L Level | $I_{IL}$  |                                  | -5   | -   | -   | $\mu\text{A}$ |
| Set Up Time                      |         | $t_S$     |                                  | 5    | -   | -   | ns            |
| Hold Time                        |         | $t_H$     |                                  | 10   | -   | -   | ns            |
| Propagation Delay Time           |         | $t_{PD}$  |                                  | -    | 10  | -   | ns            |
| Glitch Energy                    |         | GE        | $R_{OUT} = 75\Omega$             | -    | 30  | -   | pV/s          |
| Crosstalk                        |         | CT        | 1MHz Sine Wave Output            | -    | 57  | -   | dB            |

**NOTE:**

1. Full scale output ratio =  $\left| \frac{\text{Full Scale Voltage of Channel}}{\text{Average of the Full Scale Voltage of the Channels}} - 1 \right| \times 100(\%)$

# I/O Chart (When Full Scale Output Voltage at 2.00V)

| INPUT CODE |   |   |   |   |   |   |     | OUTPUT CODE |
|------------|---|---|---|---|---|---|-----|-------------|
| MSB        |   |   |   |   |   |   | LSB |             |
| 1          | 1 | 1 | 1 | 1 | 1 | 1 | 1   | 2.0V        |
|            |   |   |   | . |   |   |     |             |
|            |   |   |   | . |   |   |     |             |
| 1          | 0 | 0 | 0 | 0 | 0 | 0 | 0   | 1.0V        |
|            |   |   |   | . |   |   |     |             |
|            |   |   |   | . |   |   |     |             |
| 0          | 0 | 0 | 0 | 0 | 0 | 0 | 0   | 0V          |

## Timing Diagram

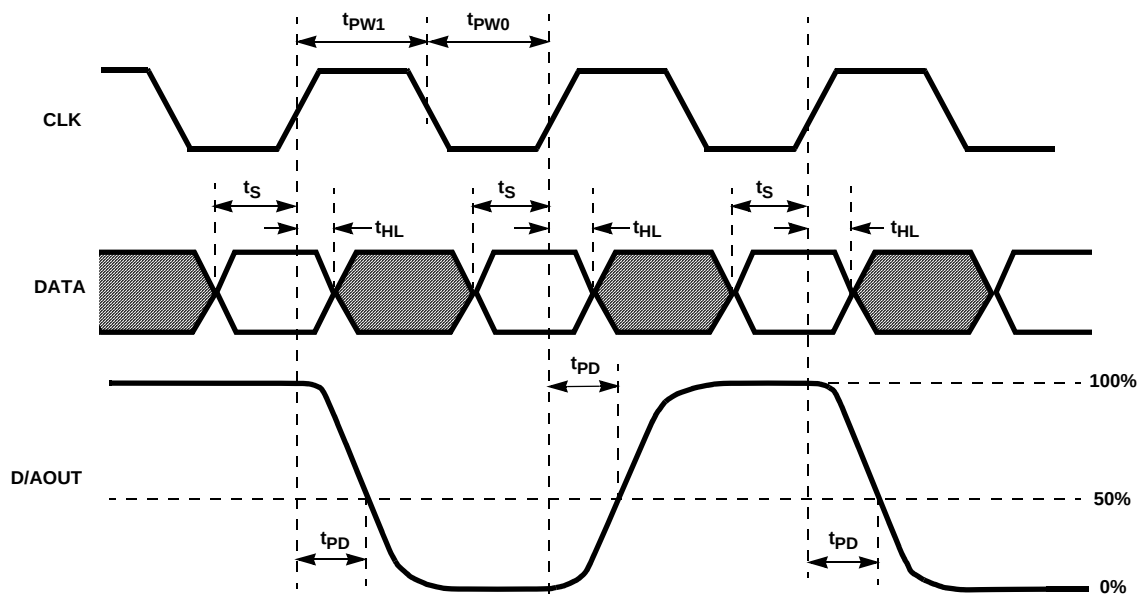


FIGURE 1.

## Test Circuits

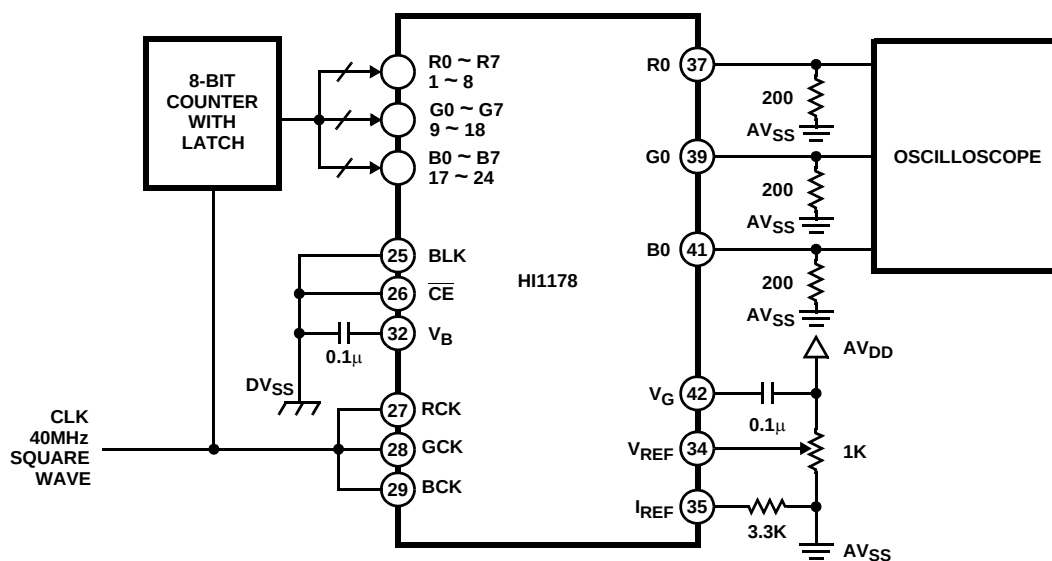


FIGURE 2. MAXIMUM CONVERSION RATE TEST CIRCUIT

## Test Circuits (Continued)

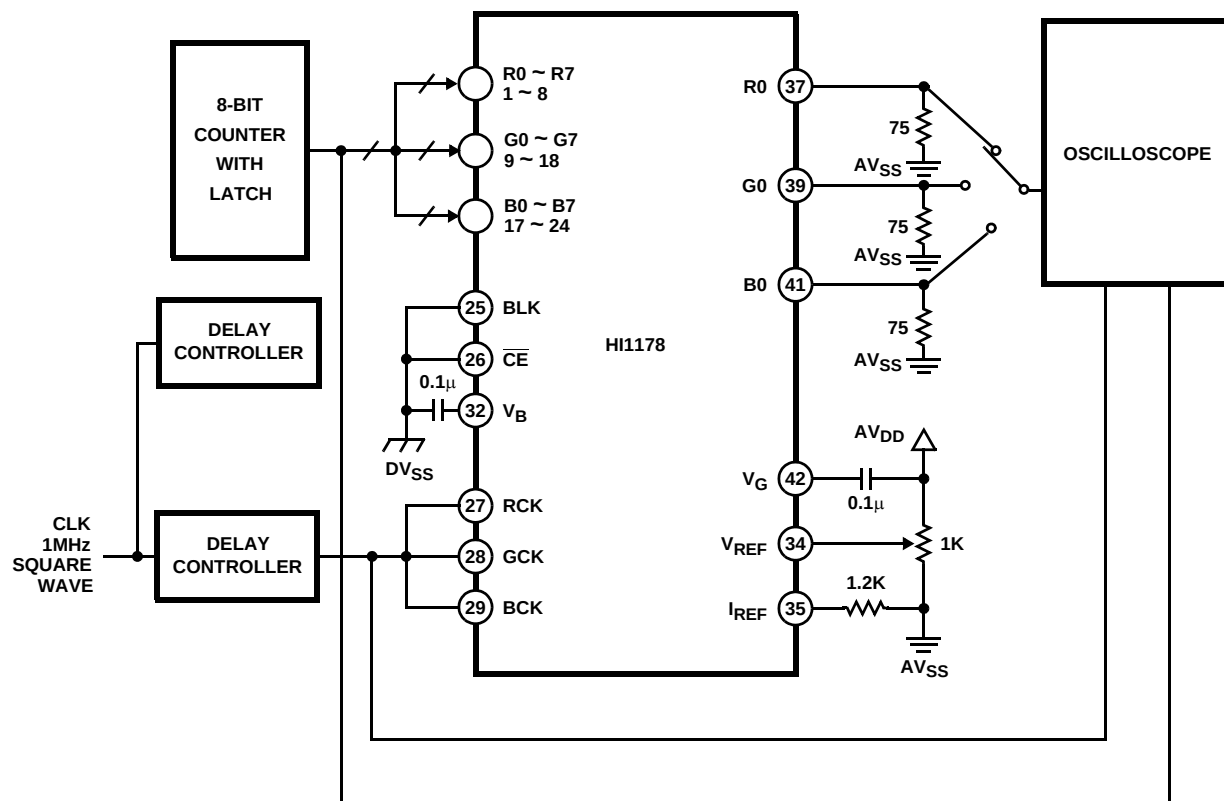


FIGURE 3. SETUP HOLD TIME AND GLITCH ENERGY TEST CIRCUIT

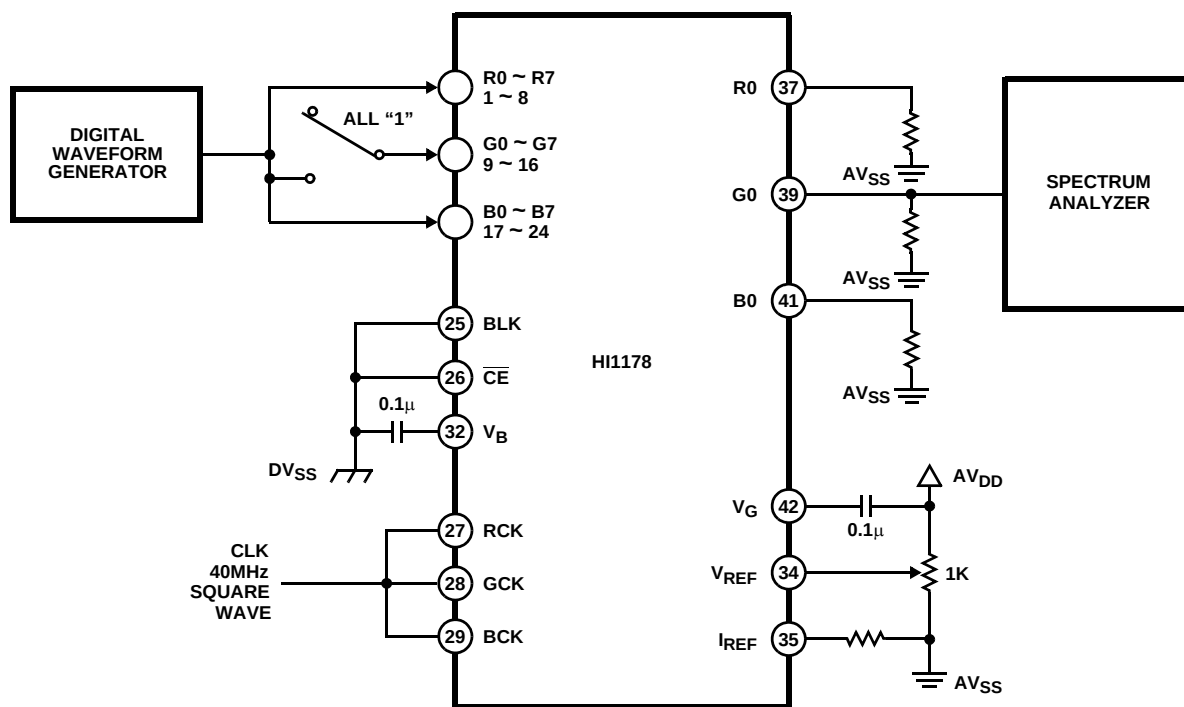


FIGURE 4. CROSSTALK TEST CIRCUIT

Test Circuits (Continued)

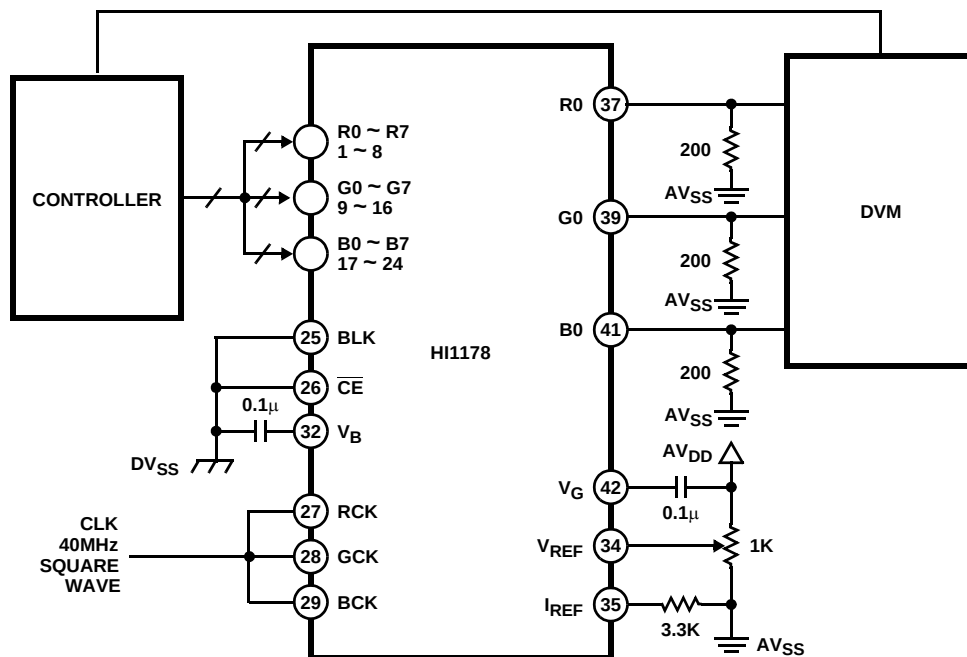


FIGURE 5. DC CHARACTERISTICS TEST CIRCUIT

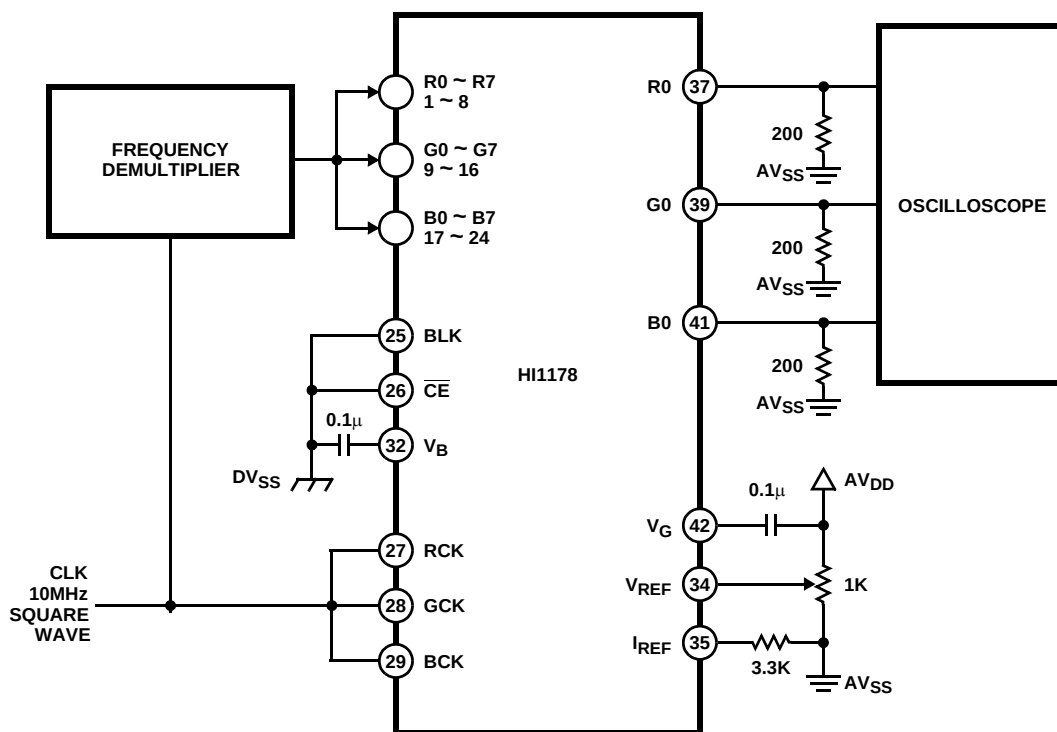


FIGURE 6. PROPAGATION DELAY TIME TEST CIRCUIT



## Typical Performance Curves

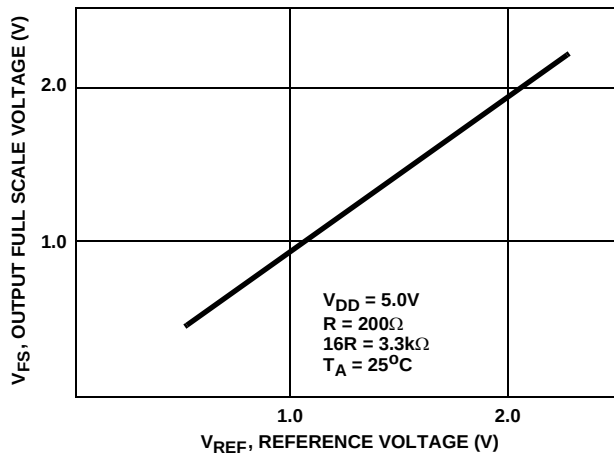


FIGURE 7. OUTPUT FULL SCALE VOLTAGE vs REFERENCE VOLTAGE

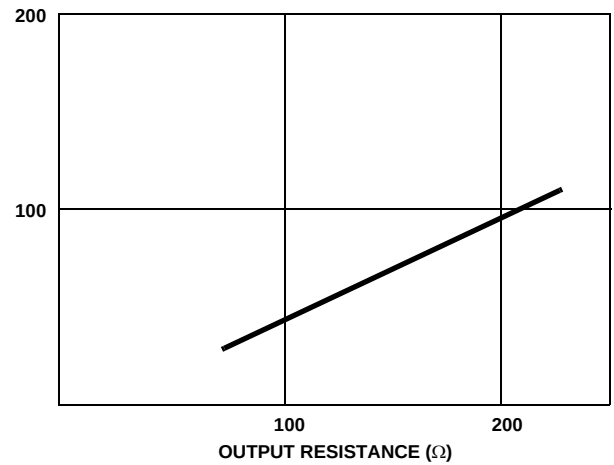


FIGURE 8. GLITCH ENERGY vs OUTPUT RESISTANCE

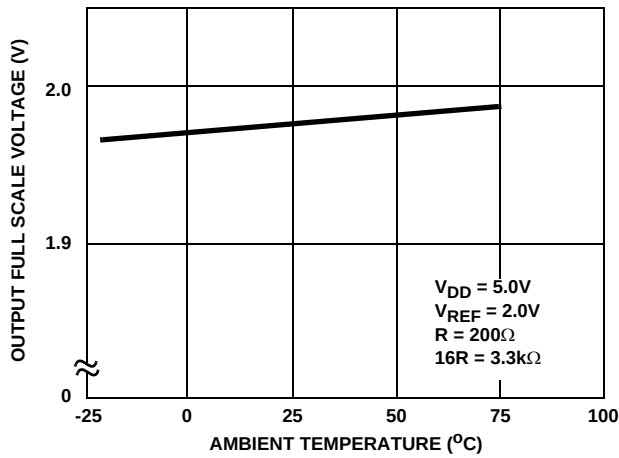


FIGURE 9. OUTPUT FULL SCALE VOLTAGE vs AMBIENT TEMPERATURE

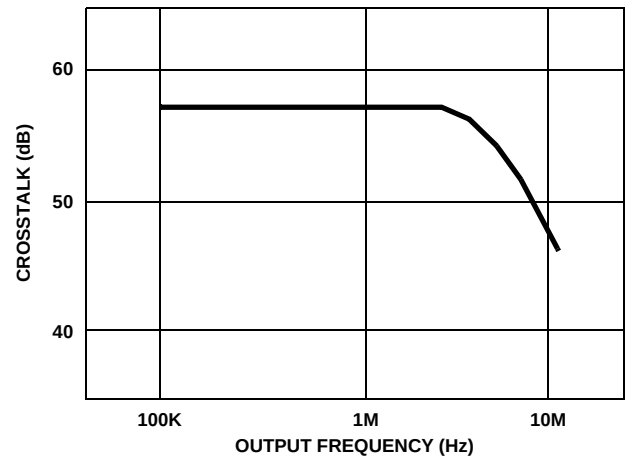


FIGURE 10. CROSSTALK vs OUTPUT FREQUENCY

## Application Circuit

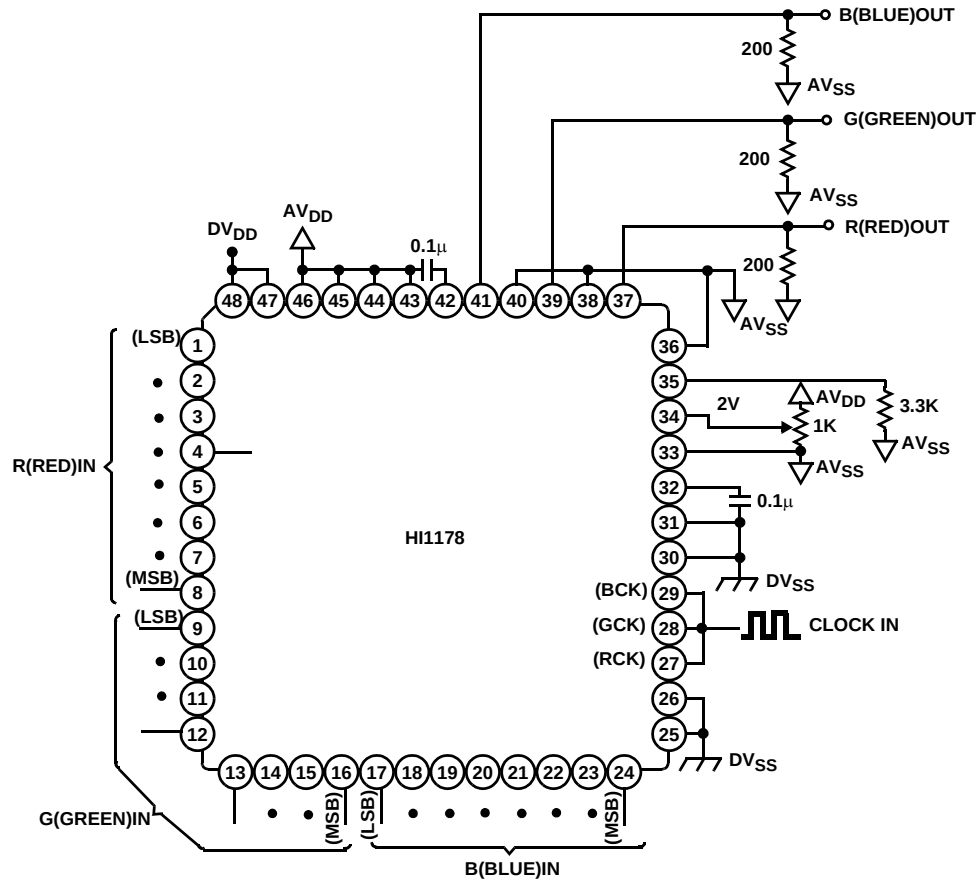


FIGURE 11.

## Notes On Operation

- How to select the output resistance

The HI1178 is a current-output D/A converter. To obtain the output voltage, connect the resistance to IO pin (RO, GO, BO). For specifications we have:

Output Full Scale Voltage  $V_{FS} = \text{less than } 2.0 \text{ [V]}$

Output Full Scale Current  $I_{FS} = \text{less than } 15 \text{ [mA]}$

Calculate the output resistance value from the relation of  $V_{FS} = I_{FS} \times R$ . Also, 16 times resistance of the output resistance is connected to reference current pin  $I_{REF}$ . In some cases, however, this turns out to be a value that does not actually exist. In such a case a value close to it can be used as a substitute. Here please note that  $V_{FS}$  becomes  $V_{FS} = V_{REF} \times 16R/R'$ . R is the resistance connected to IO while R' is connected to  $I_{REF}$ . Increasing the resistance value can curb power consumption. On the other hand glitch energy and data settling time will inversely increase. Set the most suitable value according to the desired application.

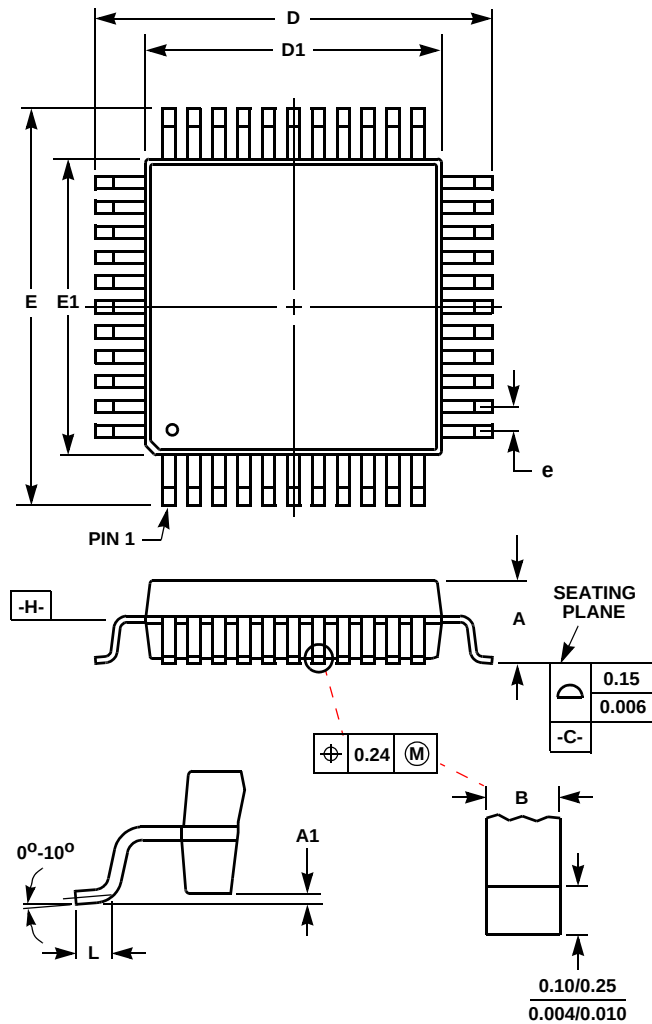
- Phase Relation Between Data and Clock

To obtain the expected performance as a D/A converter, it is necessary to set properly the phase relation between data and clock applied from the exterior. Be sure to satisfy the provisions of the set up time ( $t_S$ ) and hold time ( $t_H$ ) as stipulated in the Electrical Characteristics.

- $V_{DD}$ ,  $V_{SS}$

To reduce noise effects separate analog and digital systems in the device periphery. For  $V_{DD}$  pins, both digital and analog, bypass respective GNDs by using a ceramic capacitor of  $0.1\mu\text{F}$ , as close as possible to the pin.

## Metric Plastic Quad Flatpack Packages (MQFP/PQFP)



## Q48.12x12-S

## 48 LEAD METRIC PLASTIC QUAD FLATPACK PACKAGE

| SYMBOL | INCHES    |       | MILLIMETERS |       | NOTES |
|--------|-----------|-------|-------------|-------|-------|
|        | MIN       | MAX   | MIN         | MAX   |       |
| A      | 0.081     | 0.100 | 2.05        | 2.55  | -     |
| A1     | 0.000     | 0.011 | 0.00        | 0.30  | -     |
| B      | 0.008     | 0.017 | 0.20        | 0.45  | 5     |
| D      | 0.587     | 0.618 | 14.90       | 15.70 | 2     |
| D1     | 0.469     | 0.488 | 11.90       | 12.40 | 3, 4  |
| E      | 0.587     | 0.618 | 14.90       | 15.70 | 2     |
| E1     | 0.469     | 0.488 | 11.90       | 12.40 | 3, 4  |
| L      | 0.028     | 0.043 | 0.70        | 1.10  | -     |
| N      | 48        |       | 48          |       | 6     |
| e      | 0.032 BSC |       | 0.80 BSC    |       | -     |

Rev. 0 2/96

## NOTES:

1. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.
2. Dimensions D and E to be determined at seating plane -C-.
3. Dimensions D1 and E1 to be determined at datum plane -H-.
4. Dimensions D1 and E1 do not include mold protrusion.
5. Dimension B does not include dambar protrusion.
6. "N" is the number of terminal positions.

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