

## MAX14983E

## Enhanced 1:2 VGA Mux with Monitor Detection and Priority Port Logic

### General Description

The MAX14983E integrates high-bandwidth analog switches, level-translating buffers, and 5V power switches to implement a complete 1:2 multiplexer for VGA monitors. The device switches graphics signals between a controller and two outputs. Integrated pullup resistors (2.2k $\Omega$ , typ) are provided on the monitor-side display data channel (DDC) signal lines.

The device features a simple power interface that operates with a single +5V supply input. Two integrated power switches with current limiting and reverse-current protection pass the +5V supply to external loads with minimal voltage drop.

The horizontal and vertical synchronization (HSYNC/VSYNC) buffers shift logic levels to support +2.5V to +5.0V CMOS or TTL-compatible graphics controllers while meeting the VESA drive capability requirement of  $\pm 8\text{mA}$ . An internal 2.5V regulator translates the DDC voltage levels to be compatible with low-voltage graphics controllers.

The device also features monitor-detect outputs and enable inputs that allow monitor switching to operate either automatically or with inputs from the graphics controller.

The MAX14983E is available in a 32-pin (5mm x 5mm) TQFN package, and is specified over the  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  extended temperature range.

### Applications

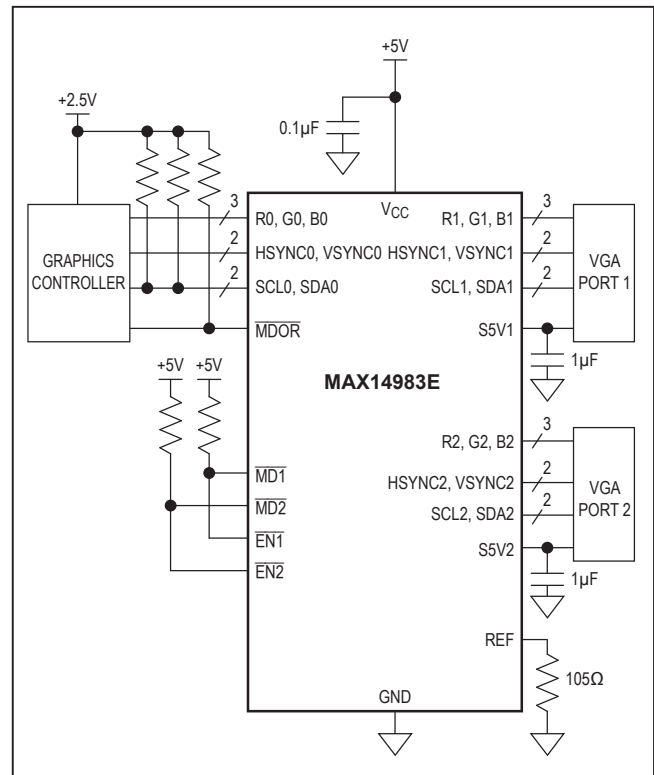
- Servers
- KVM Switches
- Computing
- Graphics Cards

**Ordering Information** appears at end of data sheet.

### Benefits and Features

- Design Flexibility
  - Graphics Controller Port is Protected when  $V_{CC} = 0\text{V}$
  - DDC Switches Limit Voltage to Low-Voltage Supply
  - Internal +2.5V Regulator
- High Level of Integration for Enhanced Performance
  - Low 5.5pF (typ) RGB Capacitance
  - 2.0ns (typ)  $t_R/t_F$  with 10pF, 2.2k $\Omega$  Load on Monitor-Side SYNC Signals
  - Source and Sink 8mA While Meeting Speed Requirements
  - $\pm 11\text{kV}$  Human Body Model (HBM)
- Saves Space on Board
  - Internal Power Switches
    - Pass +5V with 300mV (max) IR Drop
    - Short-Circuit/Thermal/Reverse-Current Protection
  - 5mm x 5mm, 32-Pin TQFN Package

### Typical Application Circuit



**Absolute Maximum Ratings**

(Voltages referenced to GND.)

V<sub>CC</sub>, S5V1, S5V2, SDA<sub>-</sub>, SCL<sub>-</sub>, REF, MD<sub>-</sub>,  
 EN<sub>-</sub>, MDOR.....-0.3V to +6V  
 HSYNC<sub>-</sub>, VSYNC<sub>-</sub>, R<sub>-</sub>, G<sub>-</sub>, B<sub>-</sub>.....-0.3V to (V<sub>CC</sub> + 0.3V)  
 Continuous Current Through R<sub>-</sub>, G<sub>-</sub>, B<sub>-</sub> Switches .....±50mA  
 Continuous Current Through SDA<sub>-</sub>, SCL<sub>-</sub> Switches.....±50mA  
 Continuous Current Through S5V<sub>-</sub>.....±750mA  
 Peak Current Through R<sub>-</sub>, G<sub>-</sub>, B<sub>-</sub>, SDA<sub>-</sub>, SCL<sub>-</sub>  
 (10% duty cycle)..... ±100mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

TQFN (derate 34.5mW/°C above +70°C).....2758.6mW  
 Operating Temperature Range..... -40°C to +85°C  
 Junction Temperature..... +150°C  
 Storage Temperature Range..... -65°C to +150°C  
 Lead Temperature (soldering, 10s) ..... +300°C  
 Soldering Temperature (reflow) ..... +260°C

*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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

**Package Thermal Characteristics (Note 1)**

TQFN

Junction-to-Ambient Thermal Resistance (θ<sub>JA</sub>) .....29°C/W  
 Junction-to-Case Thermal Resistance (θ<sub>JC</sub>).....1.7°C/W

**Note 1:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

**Electrical Characteristics**

(V<sub>CC</sub> = +5V ±5%, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +5V, T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER                             | SYMBOL                                | CONDITIONS   | MIN | TYP  | MAX | UNITS |
|---------------------------------------|---------------------------------------|--|-----|------|-----|-------|
| <b>POWER SUPPLY</b>                   |                                       |  |     |      |     |       |
| Quiescent Current                     | I <sub>Q</sub>                        | V <sub>CC</sub> = 5.25V, V <sub>EN1</sub> = V <sub>EN2</sub> = V <sub>CC</sub> , REF unconnected                                       |     | 50   | 150 | µA    |
| Operating Current                     | I <sub>CC</sub>                       | HSYNC0 = 50kHz, VSYNC0 = 60Hz 10% duty cycle, R <sub>L</sub> on SYNC outputs = 2kΩ, REF unconnected                                    |     | 1.5  | 2.7 | mA    |
| <b>5V SWITCH (S5V1, S5V2 OUTPUTS)</b> |                                       |  |     |      |     |       |
| S5V <sub>-</sub> Voltage Drop         | V <sub>S5V</sub>                      | I <sub>OUT</sub> = 55mA  |     |      | 0.3 | V     |
| Reverse Leakage Current               | I <sub>L</sub>                        | V <sub>CC</sub> = 0V, V <sub>EN1</sub> = V <sub>EN2</sub> = 0V, V <sub>S5V1</sub> = V <sub>S5V2</sub> = 5.25V, no load on S5V1 or S5V2 |     |      | 10  | µA    |
| Pulldown Resistor                     | R <sub>S5V1</sub> , R <sub>S5V2</sub> | V <sub>S5V1</sub> = V <sub>S5V2</sub> = 1V, V <sub>EN1</sub> = V <sub>EN2</sub> = V <sub>CC</sub>                                      |     | 250  |     | Ω     |
| Output Current Limit                  | I <sub>LIM</sub>                      |  | 55  | 300  | 500 | mA    |
| Thermal-Shutdown Threshold            | T <sub>SHDN</sub>                     |  |     | +150 |     | °C    |
| Thermal-Shutdown Hysteresis           | T <sub>SHDN</sub><br>HYS              |  |     | 25   |     | °C    |

**Electrical Characteristics (continued)**(V<sub>CC</sub> = +5V ±5%, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +5V, T<sub>A</sub> = +25°C.) (Note 2)

| PARAMETER   | SYMBOL                          | CONDITIONS  | MIN  | TYP | MAX | UNITS |
|---|---------------------------------|---|------|-----|-----|-------|
| <b>DDC SWITCHES (SDA_, SCL_ INPUTS/OUTPUTS)</b>             |                                 |   |      |     |     |       |
| Input Leakage Current                                       | I <sub>L</sub>                  | V <sub>EN1</sub> = V <sub>CC</sub> , V <sub>EN2</sub> = V <sub>CC</sub> , V <sub>IN</sub> = 0V or 5.25V | -1   |     | +1  | μA    |
| Off-Leakage Current   | I <sub>LOFF</sub>               | V <sub>IN</sub> = +5.25V, V <sub>CC</sub> = 0V  |      |     | 10  | μA    |
| On-Resistance   | R <sub>ON</sub>                 | V <sub>IN</sub> = 0.8V, I <sub>SDA_</sub> = I <sub>SCL_</sub> = ±10V                                    |      | 25  |     | Ω     |
| SDA1, SDA2, SCL1, SCL2<br>Internal Pullup Resistance        | R <sub>PULLUP</sub>             | V <sub>SDA_</sub> = V <sub>SCL_</sub> = 4V  |      | 2.2 |     | kΩ    |
| <b>CONTROL SIGNALS (HSYNC_, VSYNC_, EN_ INPUTS/OUTPUTS)</b> |                                 |   |      |     |     |       |
| Input Logic-Low Voltage                                     | V <sub>IL</sub>                 | HSYNC0, VSYNC0, EN1, EN2  |      |     | 0.8 | V     |
| Input Logic-High Voltage                                    | V <sub>IH</sub>                 | HSYNC0, VSYNC0, EN1, EN2  | 2    |     |     | V     |
| Output Logic-Low Voltage                                    | V <sub>OL</sub>                 | HSYNC1, HSYNC2, VSYNC1, VSYNC2,<br>I <sub>SINK</sub> = 8mA  |      |     | 0.5 | V     |
| Output Logic-High Voltage                                   | V <sub>OH</sub>                 | HSYNC1, HSYNC2, VSYNC1, VSYNC2,<br>I <sub>SOURCE</sub> = 8mA  | 2.4  |     |     | V     |
| Rise Time/Fall Time   | t <sub>R</sub> , t <sub>F</sub> | HSYNC0 input t <sub>R</sub> /t <sub>F</sub> < 5ns, 10% to 90%   |      | 2   |     | ns    |
| <b>MONITOR DETECTION OUTPUTS (MD_, MDOR)</b>                |                                 |   |      |     |     |       |
| Output-Voltage Low  | V <sub>OL</sub>                 | R <sub>PULLUP</sub> = 3.3kΩ, V <sub>PU</sub> = 3.3V (Note 3)  |      |     | 0.3 | V     |
| Input Leakage Current                                       | I <sub>LOD</sub>                | V <sub>IN</sub> = 3.3V, MD_ and MDOR deasserted   |      |     | 1   | μA    |
| <b>R_, G_, B_ SWITCH PERFORMANCE</b>                        |                                 |   |      |     |     |       |
| Bandwidth   | f <sub>MAX</sub>                | Figure 1, R <sub>S</sub> = R <sub>L</sub> = 50Ω   |      | 800 |     | MHz   |
| On-Loss   | I <sub>LOSS</sub>               | Figure 1, f = 50MHz, R <sub>S</sub> = R <sub>L</sub> = 50Ω  | -0.6 |     |     | dB    |
| On-Resistance   | R <sub>ON</sub>                 | I <sub>IN</sub> = ±10mA, V <sub>IN</sub> = 0.7V   |      | 5   | 8   | Ω     |
| On-Resistance Matching                                      | ΔR <sub>ON</sub>                | I <sub>IN</sub> = ±10mA, V <sub>IN</sub> = 0 to 0.7V  |      |     | 1   | Ω     |
| On-Resistance Flatness                                      | R <sub>FLAT(ON)</sub>           | I <sub>IN</sub> = ±10mA, V <sub>IN</sub> = 0 to 0.7V  |      | 0.5 | 1   | Ω     |
| B1, B2 Internal Pullup Resistance                           | R <sub>B</sub>                  |   |      | 2.5 |     | kΩ    |
| Off-Leakage Current   | I <sub>LOFF</sub>               | V <sub>R_</sub> = V <sub>G_</sub> = V <sub>B0</sub> = 0V or V <sub>CC</sub>                             | -1   |     | +1  | μA    |
| Off-Capacitance   | C <sub>OFF</sub>                | f = 1MHz; R0, G0, B0 to R_, G_, B_  |      | 2.5 |     | pF    |
| On-Capacitance  | C <sub>ON</sub>                 | f = 1MHz; R0, G0, B0 to R_, G_, B_  |      | 5.5 |     | pF    |
| <b>ESD PROTECTION</b>                                       |                                 |   |      |     |     |       |
| High-ESD Pins ESD Protection                                |                                 | Human Body Model (Note 4)   |      | ±11 |     | kV    |
| All Other Pins ESD Protection                               |                                 | Human Body Model (Note 4)   |      | ±2  |     | kV    |

**Note 2:** All units are production tested at T<sub>A</sub> = +25°C. Specifications over temperature are guaranteed by design.**Note 3:** V<sub>PU</sub> is the pullup voltage.**Note 4:** See the [Pin Description](#) section for the ESD status of each pin.

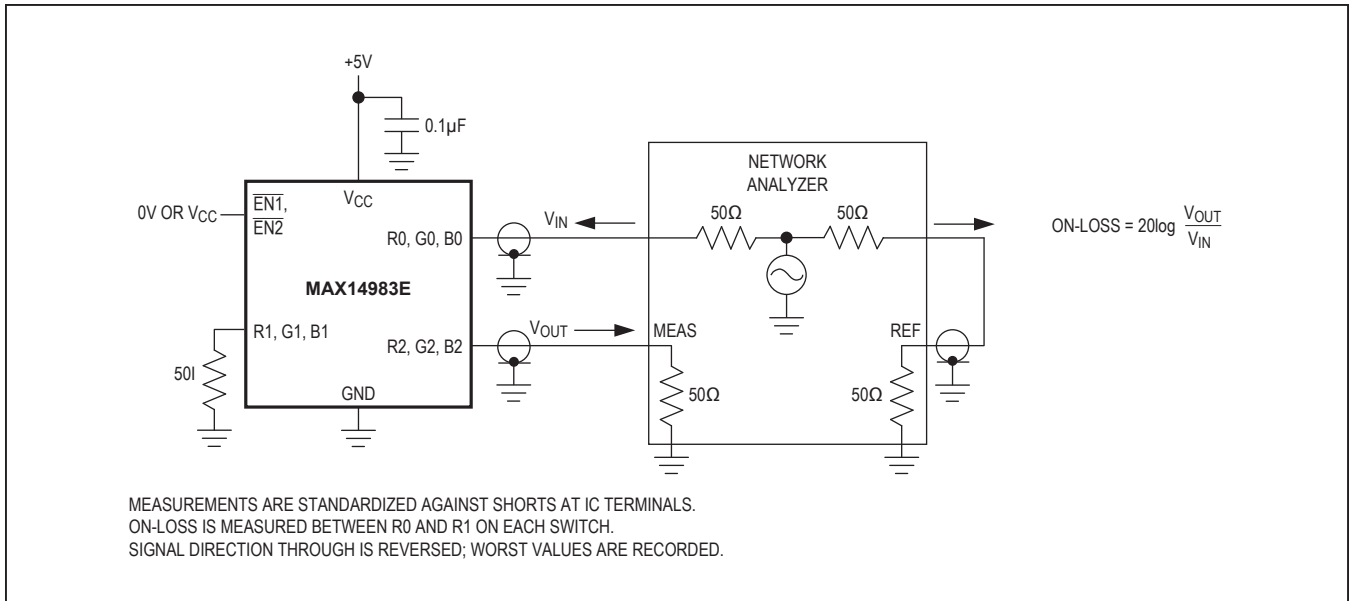
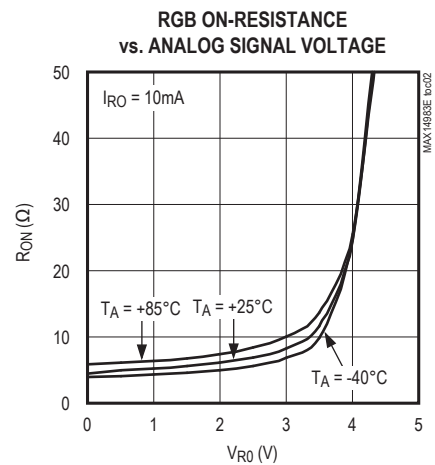
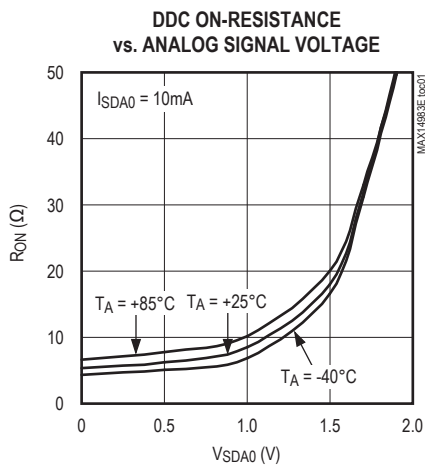


Figure 1. On-Loss

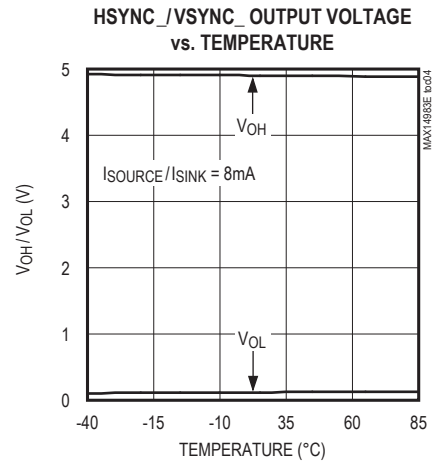
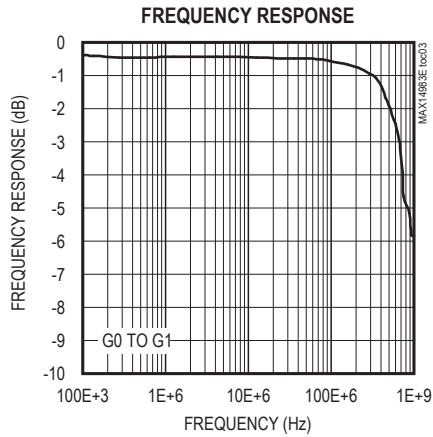
### Typical Operating Characteristics

(V<sub>CC</sub> = +5.0V, T<sub>A</sub> = +25°C, unless otherwise noted.)

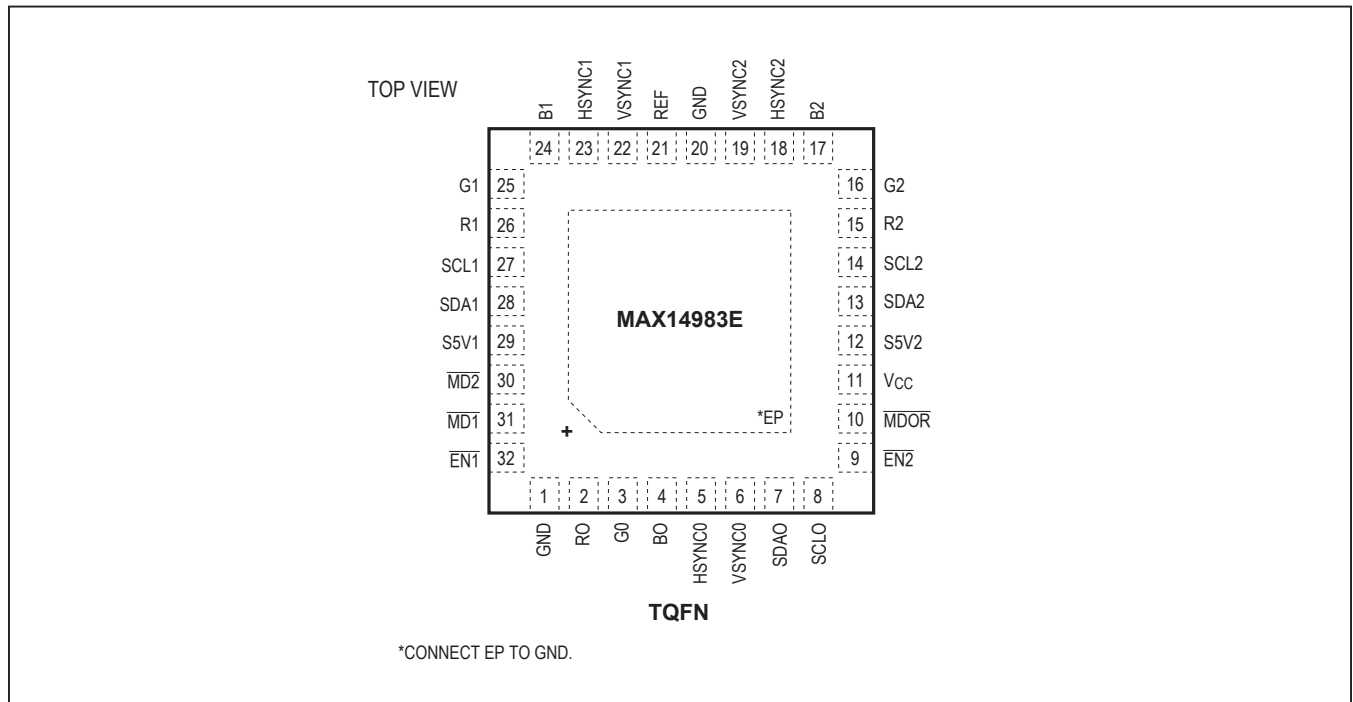


Typical Operating Characteristics (continued)

(V<sub>CC</sub> = +5.0V, T<sub>A</sub> = +25°C, unless otherwise noted.)



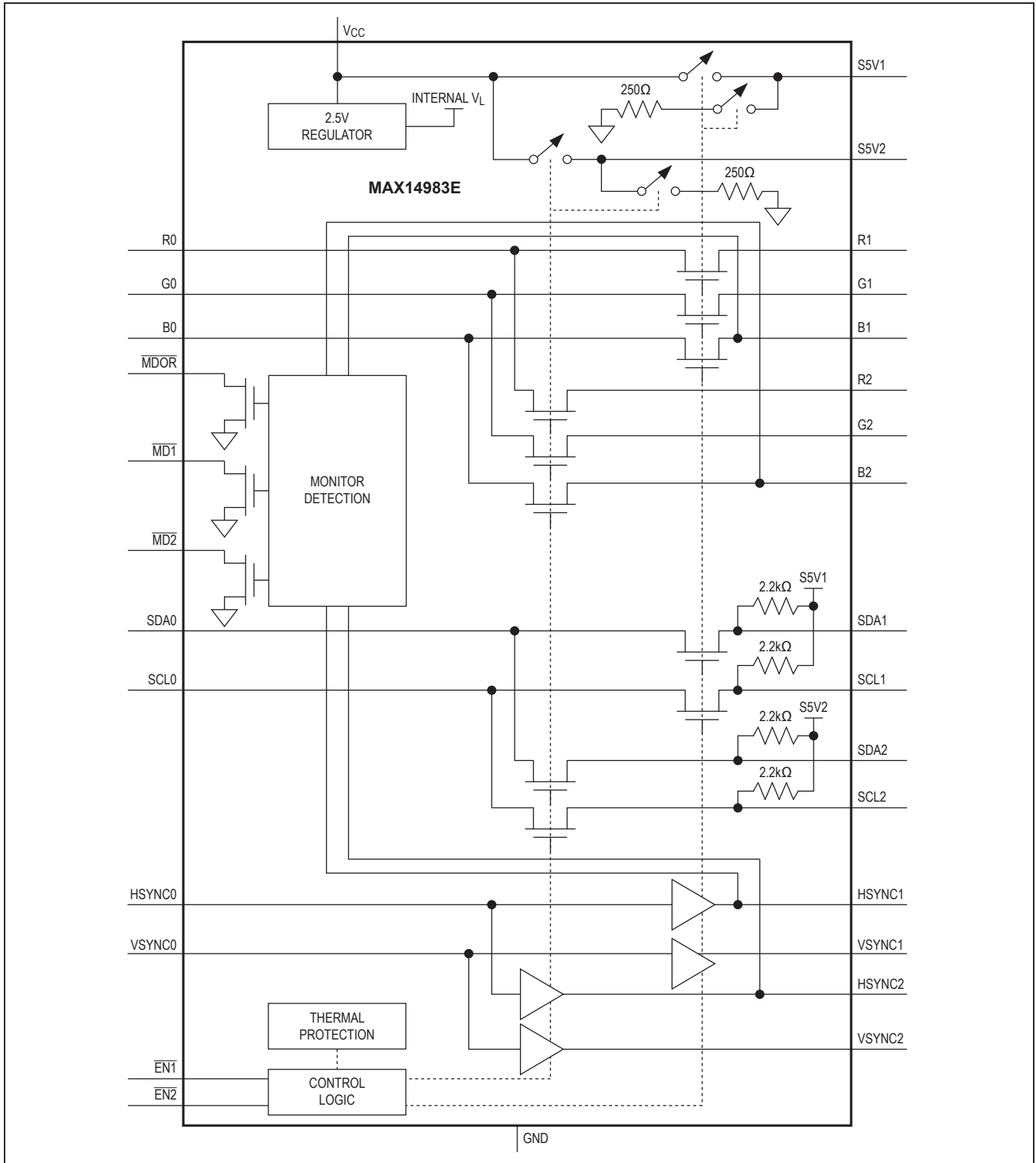
Pin Configuration



## Pin Description

| PIN   | NAME                     | FUNCTION  | ESD      |
|-------|--------------------------|---|----------|
| 1, 20 | GND                      | Ground  | —        |
| 2     | R0                       | RGB Analog Input  | Standard |
| 3     | G0                       | RGB Analog Input  | Standard |
| 4     | B0                       | RGB Analog Input  | Standard |
| 5     | HSYNC0                   | Horizontal Sync Input   | Standard |
| 6     | VSYNC0                   | Vertical Sync Input   | Standard |
| 7     | SDA0                     | DDC Input/Output  | Standard |
| 8     | SCL0                     | DDC Input/Output  | Standard |
| 9     | $\overline{\text{EN2}}$  | Active-Low Enable Input 2. Assert $\overline{\text{EN2}}$ to connect the graphics controller to the monitor on port 2 (see Table 1).  | Standard |
| 10    | $\overline{\text{MDOR}}$ | Logic NOR Output of $\overline{\text{MD1}}$ and $\overline{\text{MD2}}$ . $\overline{\text{MDOR}}$ asserts whenever a monitor is detected on either port. $\overline{\text{MDOR}}$ is an active-low, open-drain output. | Standard |
| 11    | V <sub>CC</sub>          | Supply Voltage. V <sub>CC</sub> = +5.0V ±5%. Bypass V <sub>CC</sub> to GND with a 1µF or larger ceramic capacitor as close as possible to V <sub>CC</sub> .   | Standard |
| 12    | S5V2                     | Switched 5V Out 2. S5V2 is internally pulled down when not connected. Bypass S5V2 to GND with a 1µF or larger capacitor as close as possible to S5V2.   | High     |
| 13    | SDA2                     | DDC Input/Output. SDA2 has a 2.2kΩ (typ) internal pullup resistor to S5V2.  | High     |
| 14    | SCL2                     | DDC Input/Output. SCL2 has a 2.2kΩ (typ) internal pullup resistor to S5V2.  | High     |
| 15    | R2                       | RGB Analog Output for Port 2  | High     |
| 16    | G2                       | RGB Analog Output for Port 2  | High     |
| 17    | B2                       | RGB Analog Output for Port 2  | High     |
| 18    | HSYNC2                   | Horizontal Sync Output for Port 2   | High     |
| 19    | VSYNC2                   | Vertical Sync Output for Port 2   | High     |
| 21    | REF                      | Monitor-Detection Reference. Connect a 105Ω ±1% resistor from REF to ground.  | Standard |
| 22    | VSYNC1                   | Vertical Sync Output for Port 1   | High     |
| 23    | HSYNC1                   | Horizontal Sync Output for Port 1   | High     |
| 24    | B1                       | RGB Analog Output for Port 1  | High     |
| 25    | G1                       | RGB Analog Output for Port 1  | High     |
| 26    | R1                       | RGB Analog Output for Port 1  | High     |
| 27    | SCL1                     | DDC Input/Output. SCL1 has a 2.2kΩ (typ) internal pullup resistor to S5V1.  | High     |
| 28    | SDA1                     | DDC Input/Output. SDA1 has a 2.2kΩ (typ) internal pullup resistor to S5V1.  | High     |
| 29    | S5V1                     | Switched 5V Out 1. S5V1 is internally pulled down when not connected. Bypass S5V1 to GND with a 1µF or larger capacitor as close as possible to S5V1.   | High     |
| 30    | $\overline{\text{MD2}}$  | Monitor-Detect Output 2. $\overline{\text{MD2}}$ asserts when a monitor is detected on port 2. $\overline{\text{MD2}}$ is an active-low, open-drain output.   | Standard |
| 31    | $\overline{\text{MD1}}$  | Monitor-Detect Output 1. $\overline{\text{MD1}}$ asserts when a monitor is detected on port 1. $\overline{\text{MD1}}$ is an active-low, open-drain output.   | Standard |
| 32    | $\overline{\text{EN1}}$  | Enable Input 1. Assert $\overline{\text{EN1}}$ to connect the graphics controller to the monitor on port 1 (see Table 1).   | Standard |
| —     | EP                       | Exposed Pad. Connect exposed pad to GND.  | —        |

Functional Diagram



## Truth Tables

**Table 1. Channel Selection**

| $\overline{EN1}$ | $\overline{EN2}$ | VGA CONTROLLER CONNECTED TO |
|------------------|------------------|-----------------------------|
| 0                | 0                | Port 1                      |
| 0                | 1                | Port 1                      |
| 1                | 0                | Port 2                      |
| 1                | 1                | Not Connected               |

**Note:** The  $B_{-}$  switches are unconnected if the  $HSYNC_{-}$  input is idle.

**Table 2. Monitor Detection**

| MONITOR 1 DETECTED | MONITOR 2 DETECTED | $\overline{MD1}$ | $\overline{MD2}$ | $\overline{MDOR}$ |
|--------------------|--------------------|------------------|------------------|-------------------|
| No                 | No                 | 1                | 1                | 1                 |
| No                 | Yes                | 1                | 0                | 0                 |
| Yes                | No                 | 0                | 1                | 0                 |
| Yes                | Yes                | 0                | 0                | 0                 |

**Note:**  $\overline{MD1}$ ,  $\overline{MD2}$ , and  $\overline{MDOR}$  function regardless of the state of the  $EN_{-}$  inputs.

## Detailed Description

The MAX14983E integrates high-bandwidth analog switches and level-translating buffers to implement a complete 1:2 multiplexer for VGA signals. The device provides switching for red-green-blue (RGB) signals, horizontal and vertical synchronization (HSYNC/VSYNC) pulses, display data channel (DDC) signals, and 5V power supplies. The power switches provide +5V power with current limiting and reverse-voltage protection.

The device uses a simplified power-supply interface that operates from a single +5V supply. An internal 2.5V regulator limits the voltage passed by the DDC switches to provide compatibility with low-voltage graphics controllers.

The device features two enable inputs and three monitor-detection outputs. This interface signals to the graphics controller when a monitor is inserted or removed from either of the VGA ports and allows it to switch between them. Alternatively, these signals can be connected

together to automatically select the port when a monitor is plugged in. A dedicated output ( $\overline{MDOR}$ ) signals the graphics controller when any monitor is detected.

### 5V Power Switches (S5V1, S5V2)

The device provides a switched +5V output in addition to the regular VGA signals (S5V1 and S5V2). Each output can supply 55mA with less than 300mV drop from  $V_{CC}$ . The S5V\_ outputs tolerate +5V while turned off.

The power switches are protected against overcurrent and overtemperature faults. The device limits current supplied to each monitor side to 300mA (typ). Thermal protection circuitry shuts off the switch when the temperature exceeds +150°C. The device is re-enabled once the temperature has fallen below +125°C.

Each power switch output has a 250Ω (typ) pulldown resistor to discharge filter capacitors when the switch is off.

### RGB Switches

The device provides three single-pole/double-throw (SPDT) high-bandwidth switches to route the standard VGA R, G, and B signals (Table 1). The R, G, and B analog switches are identical, and any of the three switches can be used to route red, green, or blue video signals.

### Horizontal/Vertical Sync Multiplexer

The  $HSYNC_{-}/VSYNC_{-}$  signals are buffered to provide level shifting and drive capability to meet the VESA specification.  $HSYNC_{-}/VSYNC_{-}$  signals are only routed to the port selected by  $EN2$  and  $EN1$  (Table 1).  $HSYNC_{-}$  and  $VSYNC_{-}$  are not interchangeable.

### Display Data Channel Multiplexer (SDA\_, SCL\_)

The device provides two voltage-limited SPDT switches to route DDC signals ( $SDA_{-}$ ,  $SCL_{-}$ ). These switches limit the voltage that can be passed through to the graphics controller to less than 2.5V. Internal pullup resistors on the monitor side of the switches translate the graphics controller signals to 5V compatible logic. Connect pullup resistors on  $SCL0$  and  $SDA0$  to define the logic level of the graphics controller.

The  $SDA_{-}$  and  $SCL_{-}$  switches are identical, and either of these two switches can be used to route  $SDA$  or  $SCL$  I<sup>2</sup>C signals.



**Applications Information**

**1:2 Multiplexer for Low-Voltage Graphics Controllers**

The device provides the level shifting necessary to drive two standard VGA ports using a single graphics controller. Internal buffers drive the HSYNC\_ and VSYNC\_ signals to VGA standard TTL levels. The DDC multiplexer provides level shifting by limiting signal levels to less than 2.5V.

**Power-Supply Decoupling**

Bypass  $V_{CC}$  to ground with a 1 $\mu$ F or larger ceramic capacitor as close as possible to the device.

**PCB Layout**

High-speed switches such as the MAX14983E require proper PCB layout for optimum performance. Ensure that impedance-controlled PCB traces for high-speed signals are matched in length and as short as possible. Connect the exposed pad to a solid ground plane.

**High-ESD Protection**

Electrostatic discharge (ESD)-protection structures are incorporated on all pins to protect against electrostatic discharges up to  $\pm 2$ kV Human Body Model (HBM) encountered during handling and assembly. All outputs are further protected against ESD up to  $\pm 11$ kV (HBM) without damage (see the [Pin Description](#)).

The ESD structures withstand high ESD both in normal operation and when the device is powered down. After an ESD event, the device continues to function without latchup.

**ESD Test Conditions**

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test methodology and results.

**Human Body Model**

[Figure 2](#) shows the Human Body Model. [Figure 3](#) shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest that is then discharged into the device through a 1.5k $\Omega$  resistor.

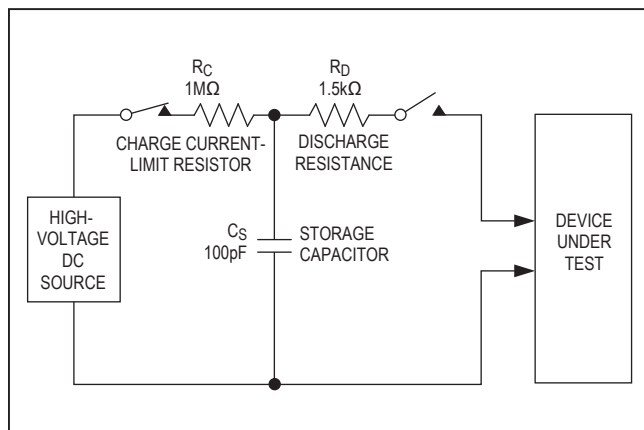


Figure 2. Human Body ESD Test Model

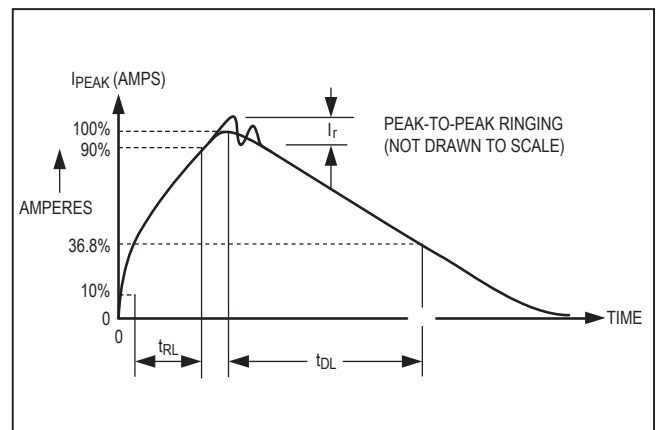


Figure 3. Human Body Current Waveform

MAX14983E

## Enhanced 1:2 VGA Mux with Monitor Detection and Priority Port Logic

### Ordering Information

| PART          | TEMP RANGE     | PIN-PACKAGE |
|---------------|----------------|-------------|
| MAX14983EETJ+ | -40°C to +85°C | 32 TQFN-EP* |

+Denotes a lead(Pb)-free/RoHS-compliant package.

\*EP = Exposed paddle.

### Chip Information

PROCESS: BICMOS

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO.             | LAND PATTERN NO.        |
|--------------|--------------|-------------------------|-------------------------|
| 32 TQFN-EP   | T3255+4      | <a href="#">21-0140</a> | <a href="#">90-0012</a> |

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION   | PAGES CHANGED |
|-----------------|---------------|---|---------------|
| 0               | 6/11          | Initial release   | —             |
| 1               | 9/17          | Updated <i>Typical Operating Circuit</i> and <i>Pin Description</i> table | 1, 6          |

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at [www.maximintegrated.com](http://www.maximintegrated.com).

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