

# MAX14895E

## Enhanced VGA Port Protector

### General Description

The MAX14895E integrates level-translating buffers and features RED, GRN, and BLU (RGB) port protection for VGA signals.

The device has horizontal sync (SYNCH\_) and vertical sync (SYNCV\_) translating buffers that convert low-level CMOS inputs from a graphics controller to meet full 5V, TTL-compatible outputs. Each output can drive  $\pm 10\text{mA}$  and meets the VESA<sup>SM</sup> specification. In addition, the device translates the direct digital control (DDC) signals to a lower level that is safe for the graphics controller.

The device features both EN and  $\overline{\text{EN}}$  inputs, accepting active-high or active-low enable inputs. The device also switches and current limits the 5V supply to a VGA connector or monitor.

The RED, GRN, and BLU terminals protect graphics controller outputs against electrostatic discharge (ESD) events. All eight outputs and  $\overline{\text{EN}}$  have high-level ESD protection.

The MAX14895E is specified over the extended  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  temperature range and is available in a 16-pin, 3mm x 3mm TQFN package with exposed pad.

### Applications

Notebook Computers	Servers
Desktops	Graphics Cards

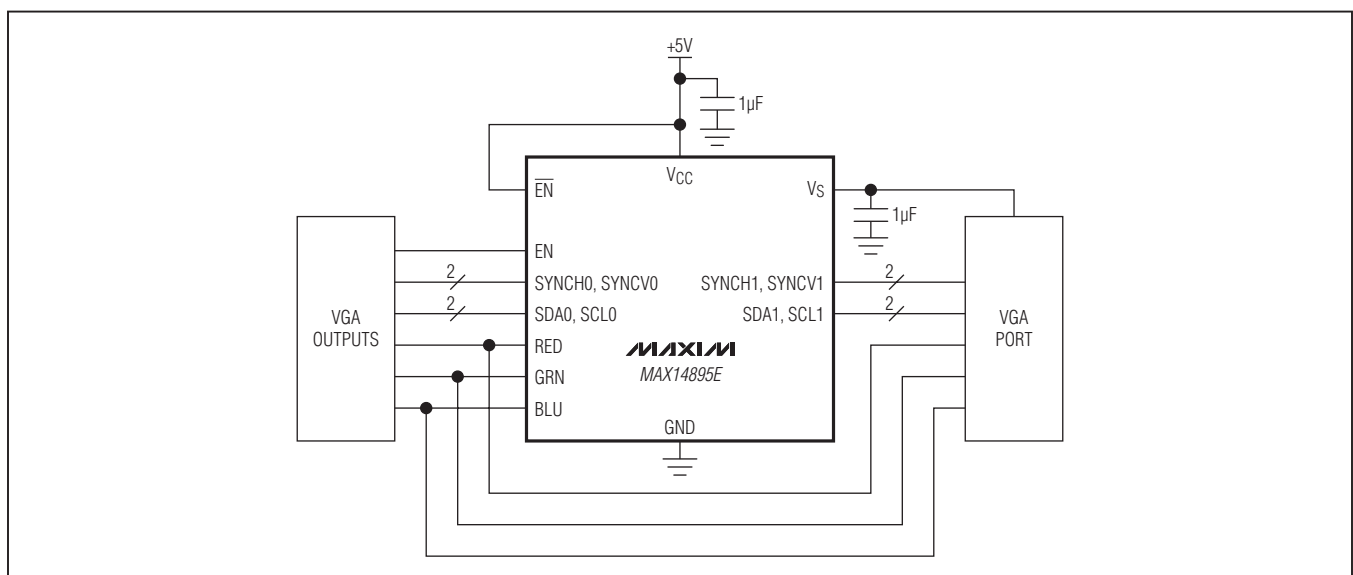
### Benefits and Features

- ◆ **Saves Power in Portable Applications**
  - ◇ Low Quiescent Supply Current: 430 $\mu\text{A}$  (typ)
- ◆ **Eliminates Need for Costly External Components**
  - ◇ High-ESD Protection on SDA1, SCL1, SYNCH1, SYNCV1, RED, GRN, BLU,  $\overline{\text{EN}}$ ,  $V_S$
  - ◇  $\pm 15\text{kV}$  Human Body Model (HBM)
  - ◇  $\pm 8\text{kV}$  IEC 61000-4-2 Contact Discharge
- ◆ **Innovative Design Enables a High Level of Integration for Performance**
  - ◇ Output Current-Limit Switch with Power-Off Protection
  - ◇ Low Capacitance on RGB Ports (2.2pF typ)
  - ◇  $\pm 10\text{mA}$  Drive on SYNCH1, SYNCV1
- ◆ **Fully Integrated Solutions Saves Space in Portable Applications**
  - ◇ DDC Outputs have Internal Pullups
  - ◇ 3mm x 3mm, 16-Pin TQFN Package

Ordering Information appears at end of data sheet.

For related parts and recommended products to use with this part, refer to [www.maxim-ic.com/MAX14895E.related](http://www.maxim-ic.com/MAX14895E.related).

### Typical Operating Circuit



VESA is a service mark of the Video Electronics Standards Association Corporation.

## Enhanced VGA Port Protector

### ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND.)

$V_{CC}$ , $V_S$ , EN, SDA0, SCL0 .....	-0.3V to +6V
SDA1, SCL1 .....	-0.3V to ( $V_S + 0.3V$ )
$\overline{EN}$ , RED, GRN, BLU, SYNCH0, SYNCH1, SYNCV0, SYNCV1 .....	-0.3V to ( $V_{CC} + 0.3V$ )
Continuous Current through SDA <sub>-</sub> , SCL <sub>-</sub> .....	±30mA
Continuous Short-Circuit Current SYNCH1, SYNCV1 .....	±20mA

Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )

TQFN (derate 20.8mW/°C above +70°C) .....	1667mW
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 ( $\theta_{JA}$ ) ..... 48°C/W

Junction-to-Case Thermal Resistance ( $\theta_{JC}$ ) ..... 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.maxim-ic.com/thermal-tutorial](http://www.maxim-ic.com/thermal-tutorial).

### ELECTRICAL CHARACTERISTICS\*

( $V_{CC} = +4.75V$  to  $+5.25V$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$ ,  $T_A = +25^\circ\text{C}$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>POWER SUPPLY</b>						
Power-Supply Range	$V_{CC}$		4.75		5.25	V
Quiescent Supply Current	$I_Q$	EN = $V_{CC}$ , $\overline{EN}$ = GND, SYNCH0 = SYNCV0 = GND, SDA0 = SCL0 = unconnected		430	800	μA
Shutdown Supply Current	$I_{SHDN}$	EN = GND, $\overline{EN}$ = $V_{CC}$ , SYNCH0 = SYNCV0 = GND, SDA0 = SCL0 = unconnected			8	μA
Undervoltage Lockout Threshold	$V_{UVLO}$	$V_{CC}$ rising			4.3	V
Undervoltage Lockout Hysteresis				0.1		V
Internal Logic Supply Voltage	$V_L$	$V_{CC} = +4.75V$ to $+5.25V$ , SDA1/SCL1 = unconnected, measure SDA0/SCL0	1.6		2.9	V
		$V_{CC} = +4.75V$ to $+5.25V$ , SDA0/SCL0 = 200kΩ to GND, measure SDA0/SCL0, SDA1/SCL1 = unconnected	1.6		2.8	
<b>RED, GRN, BLU</b>						
RED, GRN, BLU Capacitance	$C_{OUT}$	f = 1MHz, $V_{RED, GRN, BLU} = 1V_{P-P}$		2.2		pF
RED, GRN, BLU Leakage Current			-1		+1	μA
<b>SYNCH0, SYNCV0, EN, <math>\overline{EN}</math></b>						
Input Logic-High	$V_{IH}$		2.0			V
Input Logic-Low	$V_{IL}$				0.8	V

## Enhanced VGA Port Protector

### ELECTRICAL CHARACTERISTICS\* (continued)

( $V_{CC} = +4.75V$  to  $+5.25V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +5V$ ,  $T_A = +25^{\circ}C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SYNCH0, SYNCV0 Leakage Current		SYNCH0/SYNCV0 = GND or $V_{CC}$	-1		+1	$\mu A$
EN, $\overline{EN}$ Input Resistance		EN = $V_{CC}$ , $\overline{EN}$ = GND	200		800	$k\Omega$
<b>SYNCH1, SYNCV1</b>						
Output Logic-High	$V_{OH}$	$V_{CC} = +4.75V$ , source 10mA	2.4			V
Output Logic-Low	$V_{OL}$	$V_{CC} = +4.75V$ , sink 10mA			0.5	V
Rising Time	$t_R$	$R_L = 2.2k\Omega$ , $C_L = 10pF$ , 10% to 90% of $V_{CC}$ (Note 3)			4	ns
Falling Time	$t_F$	$R_L = 2.2k\Omega$ , $C_L = 10pF$ , 90% to 10% of $V_{CC}$ (Note 3)			4	ns
Propagation Delay	$t_{PD}$	$R_L = 2.2k\Omega$ , $C_L = 10pF$ , EN = $V_{CC}$ , $\overline{EN}$ = GND (Figure 1)		16		ns
Enable Time	$t_{EN}$	$R_L = 2.2k\Omega$ , $C_L = 10pF$ , $V_{SYNCH1}$ , $V_{SYNCV1} = +4.75V$ (Figure 1)		17		$\mu s$
<b>SDA_, SCL_ (DDC)</b>						
On-Resistance	$R_{ON}$	$V_{SDA0} = V_{SCL0} = 0.5V$ , $I_{LOAD} = 10mA$			55	$\Omega$
SDA0, SCL0 Off-Leakage Current		EN = GND, $\overline{EN} = V_{CC}$ , SDA0 = SCL0 = $V_{CC}$ , SDA1 = SCL1 = GND	-1		+1	$\mu A$
SDA1, SCL1 Reverse-Leakage Current		$V_{CC} = 0V$ , $V_S = +5.25V$ , $V_{SDA1} = V_{SCL1} = +5.25V$	-10		+10	$\mu A$
SDA1, SCL1 Pullup Resistor	$R_{PULLUP}$	$V_{CC} = +4.75V$ , SDA0 = SCL0 = unconnected, EN = $V_{CC}$ , $\overline{EN}$ = GND, $I_{LOAD} = 100\mu A$	1.25	2.5	4.0	$k\Omega$
<b><math>V_S</math> OUTPUT</b>						
Forward Voltage Drop		$I_{LOAD} = 60mA$ , $V_{CC} = 5V$			0.25	V
Reverse-Leakage Current		$V_{CC} = 0V$ , $V_S = 5.25V$			10	$\mu A$
Current Limit	$I_{LIM}$		200		600	mA
Discharge Resistor	$R_{VS}$	$I_{LOAD} = 1mA$		300	500	$\Omega$
<b>THERMAL SHUTDOWN</b>						
Thermal Shutdown Threshold				+150		$^{\circ}C$
Thermal Shutdown Hysteresis				10		$^{\circ}C$
<b>ESD PROTECTION</b>						
SDA1, SCL1, SYNCH1, SYNCV1, RED, GRN, BLU, $\overline{EN}$ , $V_S$		HBM		$\pm 15$		kV
		IEC 61000-4-2 Contact		$\pm 8$		kV

**Note 2:** All devices are 100% production tested at  $T_A = +25^{\circ}C$ . Limits over the operating temperature range are guaranteed by design and not production tested.

**Note 3:** Guaranteed by design.

## Enhanced VGA Port Protector

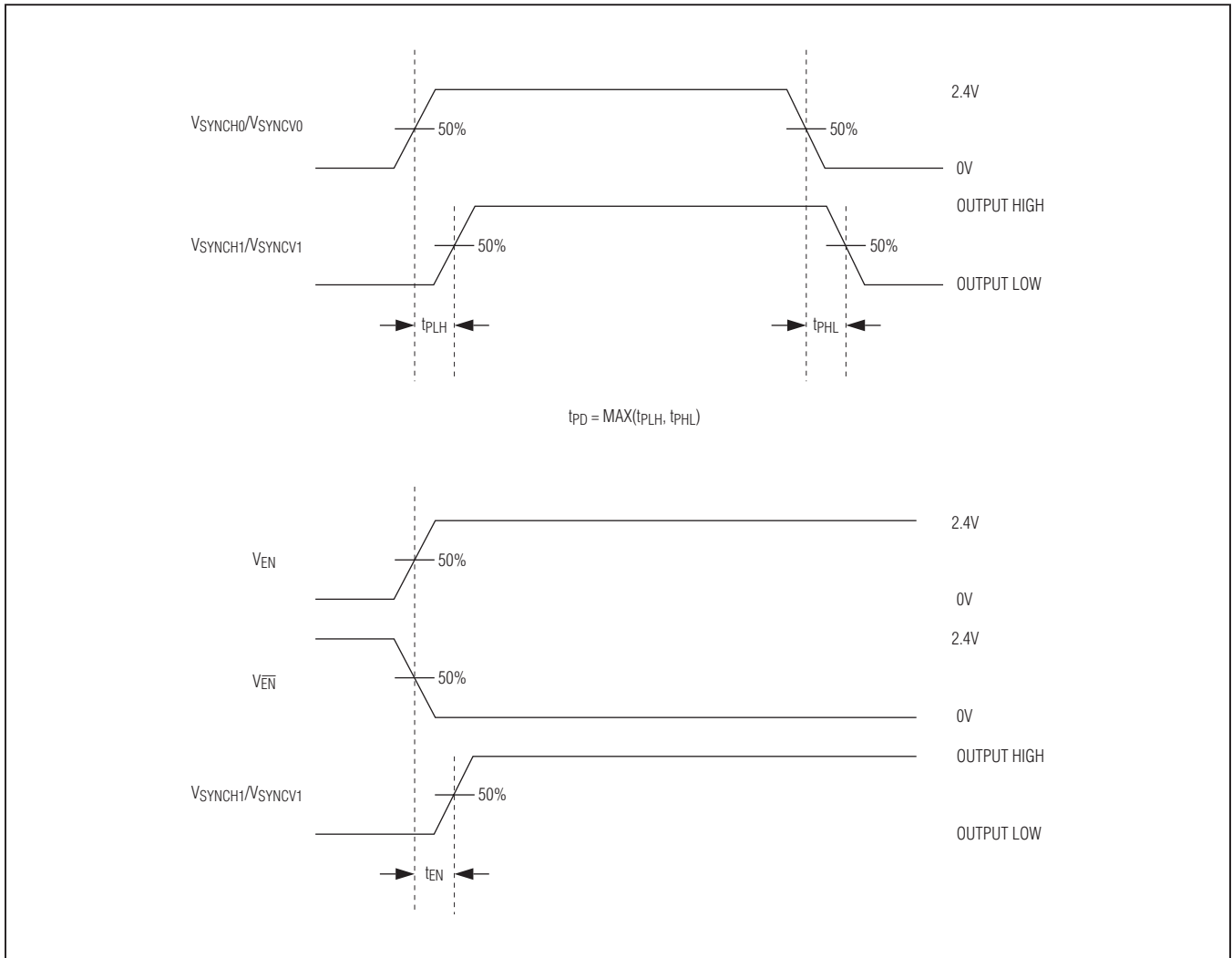
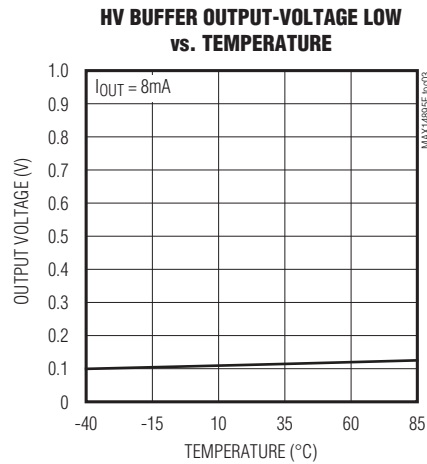
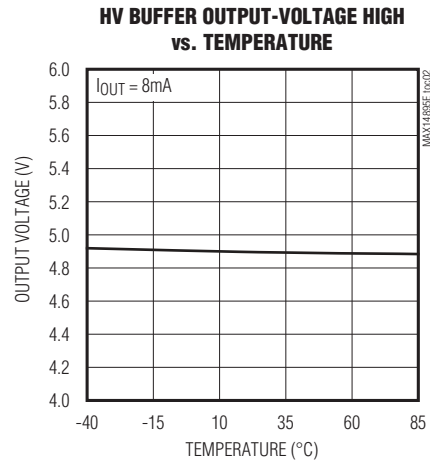
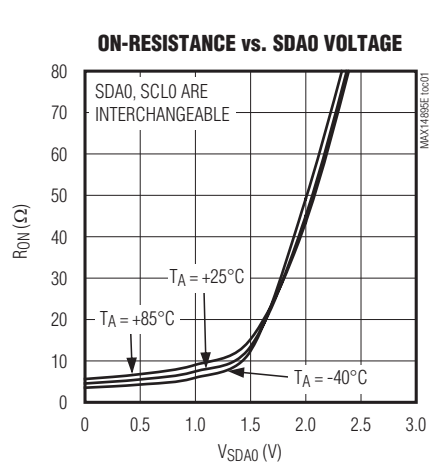


Figure 1. Timing Diagram

## Enhanced VGA Port Protector

### Typical Operating Characteristics

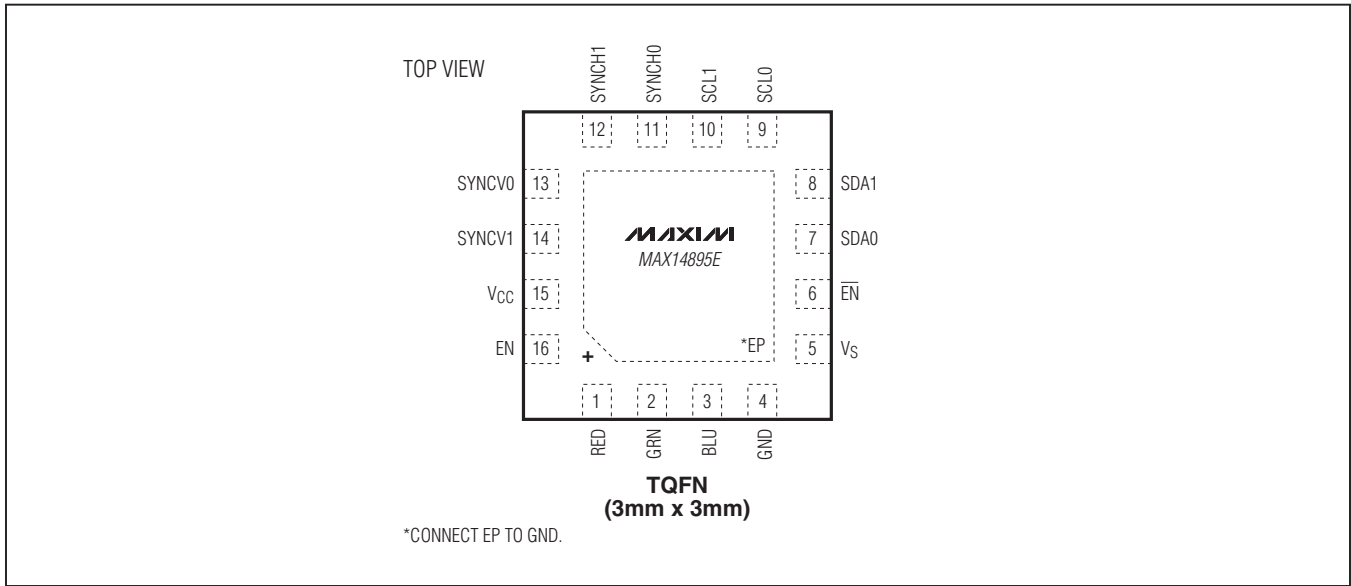
( $V_{CC} = +5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# MAX14895E

## Enhanced VGA Port Protector

### Pin Configuration

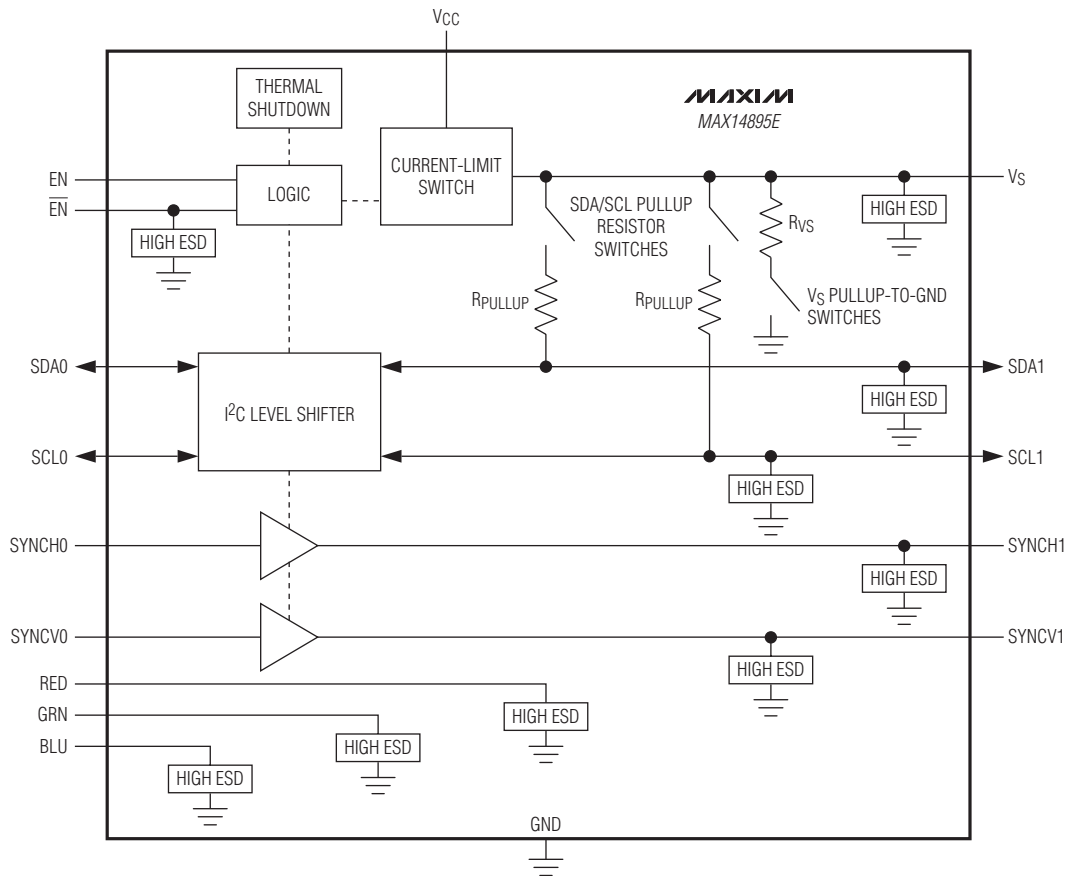


### Pin Description

PIN	NAME	FUNCTION
1	RED	High-ESD Protection Diodes for RGB Signals
2	GRN	High-ESD Protection Diodes for RGB Signals
3	BLU	High-ESD Protection Diodes for RGB Signals
4	GND	Ground
5	V <sub>S</sub>	Supply Voltage Output with Current-Limit Switch. V <sub>S</sub> provides a current-limited voltage from V <sub>CC</sub> when the device is enabled. Bypass V <sub>S</sub> to GND with a 1μF or larger ceramic capacitor as close as possible to the device.
6	$\overline{\text{EN}}$	Active-Low Enable Input. Drive $\overline{\text{EN}}$ high and EN low to disable the device. $\overline{\text{EN}}$ is weakly pulled up internally.
7	SDA0	DDC Data Input from Graphics Controller
8	SDA1	DDC Data Output to VGA Monitor. Internally pulled up to V <sub>CC</sub> .
9	SCL0	DDC Clock Input from Graphics Controller
10	SCL1	DDC Clock Output to VGA Monitor. Internally pulled up to V <sub>CC</sub> .
11	SYNCH0	Horizontal Sync Input
12	SYNCH1	Horizontal Sync Output
13	SYNCO	Vertical Sync Input
14	SYNCO	Vertical Sync Output
15	V <sub>CC</sub>	Supply Voltage Input. Apply a voltage between +4.75V and +5.25V to V <sub>CC</sub> to power the device. Bypass V <sub>CC</sub> to GND with a 1μF or larger ceramic capacitor as close as possible to the device.
16	EN	Active-High Enable Input. Drive EN low and $\overline{\text{EN}}$ high to disable the device. EN is weakly pulled down internally.
—	EP	Exposed Pad. Connect EP to GND. For enhanced thermal dissipation, connect EP to a large ground plane. Do not use EP as the only ground connection.

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### Functional Diagram/Truth Table



EN	EN̄	DEVICE LOGIC
0	0	Enable
0	1	Disable
1	0	Enable
1	1	Enable

DEVICE LOGIC/ EVENT	SYNCH_/SYNCV_ BUFFER	I <sup>2</sup> C LEVEL SHIFTER	CURRENT-LIMIT SWITCH	SDA/SCL PULLUP RESISTOR SWITCHES	V <sub>S</sub> PULL-TO-GND SWITCH
Enable No Overcurrent	On	On	On	On	Off
Enable Overcurrent	On	On	Current Limit	On	Off
Enable Overcurrent Thermal Shutdown	Output 0V	Off	Off	Off	On
Disable	Output 0V	Off	Off	Off	On
V <sub>CC</sub> = 0V	Off	Off	Off	Off	Off

## Enhanced VGA Port Protector

### Detailed Description

The MAX14895E integrates level-translating buffers and features RED, GRN, and BLU port protection for VGA signals. Horizontal and vertical synchronization (SYNCH0, SYNCV0) inputs feature level-shifting buffers to support low-voltage CMOS or standard TTL-compatible graphics controllers. Each output can drive  $\pm 10\text{mA}$  and meets VESA specifications. The device also features I<sup>2</sup>C level shifting using two nMOS devices.

The device generates its own internal bias supply to clamp SCL0 and SDA0 to a safe level, removing the need for another external supply. The device also provides a current-limited V<sub>CC</sub> output with power-off protection. This output can be used to switch power to a VGA connector or the VGA interface of a monitor.

#### Horizontal/Vertical Sync Level Shifter

SYNCH0 and SYNCV0 are buffered to provide level shifting and drive capability to meet the VESA specification. The level-shifted outputs (SYNCH1, SYNCV1) are pulled low when EN is low and  $\overline{\text{EN}}$  is high, or when the device is in thermal shutdown (see the [Functional Diagram/Truth Table](#)). Logic-level outputs (V<sub>OL</sub>, V<sub>OH</sub>) are 5V TTL-compatible. These two buffers are identical and each can drive either the horizontal or the vertical synch signal.

#### Display Data Channel Switches

The device incorporates two nMOS switches for I<sup>2</sup>C level shifting. The SDA0 and SCL0 terminals are voltage clamped to a diode drop less than the internal V<sub>L</sub> voltage. Voltage clamping provides protection and compatibility with the SDA0 and SCL0 signals and low-voltage ASICs. When power is off (V<sub>CC</sub> = 0V), SDA1 and SCL1 are protected against reverse-leakage current up to V<sub>S</sub> = +5.25V. The SDA\_ and SCL\_ switches are identical, and each switch can be used to route SDA\_ or SCL\_ signals.

#### RGB Ports

The device includes three terminals for RED, GRN, and BLU signals. These terminals provide high-level ESD protection to the RGB lines while keeping the capacitance on the RGB lines to a minimum. The RED, GRN, BLU terminals are identical, and any of the three terminals can be used to protect red, green, or blue video signals.

#### EN, $\overline{\text{EN}}$

The device has dual complementary EN and  $\overline{\text{EN}}$  enable inputs and can accept either active-low or active-high enable signals. Pull EN low and  $\overline{\text{EN}}$  high to place the device in shutdown (see the [Functional Diagram/Truth Table](#)).

#### V<sub>S</sub> Output

The device provides a current-limited voltage on V<sub>S</sub> when the part is enabled. V<sub>S</sub> is used as the pullup voltage for internal pullup resistors on SDA1 and SCL1, and can be used as an external supply. The internal pullup resistors from SDA1 and SCL1 to V<sub>S</sub> are active when the device is enabled, and are disabled when the device is in thermal shutdown (see the [Functional Diagram/Truth Table](#)).

The V<sub>S</sub> supply includes an internal resistor to discharge the supply when the device is in thermal shutdown or is disabled (see the [Functional Diagram/Truth Table](#)). V<sub>S</sub> is current limited to prevent damage to host devices. When power is off (V<sub>CC</sub> = 0V), V<sub>S</sub> is protected against reverse-leakage current up to V<sub>S</sub> = +5.25V.

#### Thermal Shutdown

Thermal-shutdown circuitry protects the device from overheating. The device enters thermal shutdown when the junction temperature exceeds +150°C (typ) and returns to normal operation when the temperature drops by approximately +10°C (typ) below the thermal-shutdown threshold. When the device is in thermal shutdown, both SYNCH1 and SYNCV1 are pulled down to ground, the I<sup>2</sup>C level shifters are disabled, the SDA1 and SCL1 pullups are off, and the V<sub>S</sub> discharge resistor is on (see the [Functional Diagram/Truth Table](#)).

### Applications Information

#### Power-Supply Decoupling

Bypass V<sub>CC</sub> and V<sub>S</sub> to ground with 1 $\mu\text{F}$  ceramic capacitors as close as possible to the device.

#### PCB Layout

High-speed switches such as the MAX14895E require proper PCB layout for optimum performance. Ensure that impedance-controlled PCB traces for high-speed signals are matched in length and are as short as possible. Connect the exposed pad to a solid ground plane.

#### ESD Protection

As with all Maxim devices, ESD protection structures are incorporated on all terminals to protect against electrostatic discharges encountered during handling and assembly. Additionally, the device is protected to  $\pm 15\text{kV}$  on the RED, GRN, BLU,  $\overline{\text{EN}}$ , V<sub>S</sub>, SYNCH1, SYNCV1, SCL1, and SDA1 terminals by the HBM. For optimum ESD performance, bypass V<sub>CC</sub> to ground with a 1 $\mu\text{F}$  ceramic capacitor.



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ESD protection can be tested in various ways. The RED, GRN, BLU,  $\overline{EN}$ ,  $V_S$ , SYNCH1, SYNCV1, SCL1, and SDA1 terminals of the device are characterized for protection to the following limits:

- $\pm 15\text{kV}$  using the HBM
- $\pm 8\text{kV}$  using IEC 61000-4-2 Contact Discharge

### Human Body Model

Figure 2 shows the HBM. Figure 3 shows the current waveform it generates when discharged into a low-impedance state. 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.

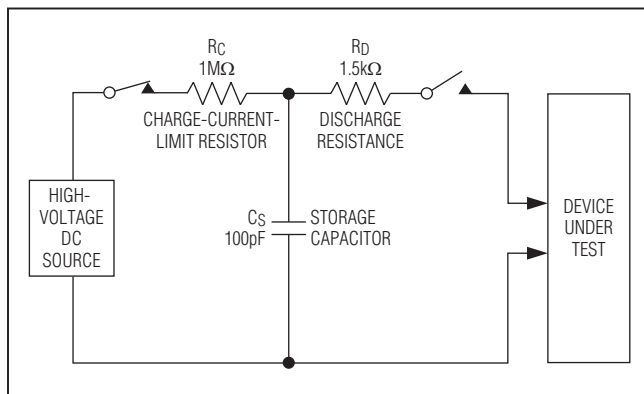


Figure 2. Human Body ESD Test Model

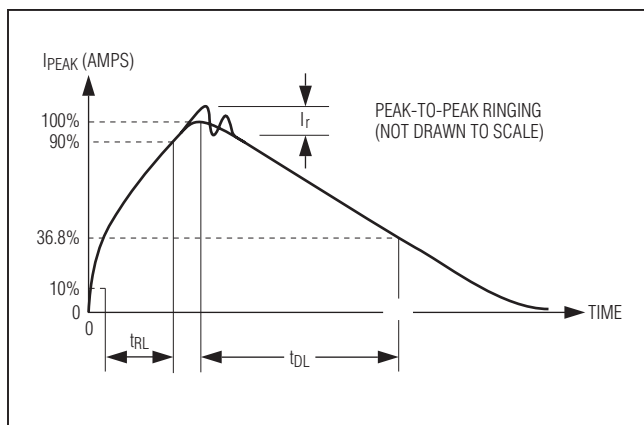


Figure 3. Human Body Current Waveform

### IEC 61000-4-2

The IEC 6100-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The device assists in designing equipment to meet IEC 61000-4-2 without the need for additional ESD protection components.

The major difference between tests done using the HBM and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the HBM. Figure 4 shows the IEC 61000-4-2 model, and Figure 5 shows the current waveform for the IEC 61000-4-2 ESD Contact Discharge test.

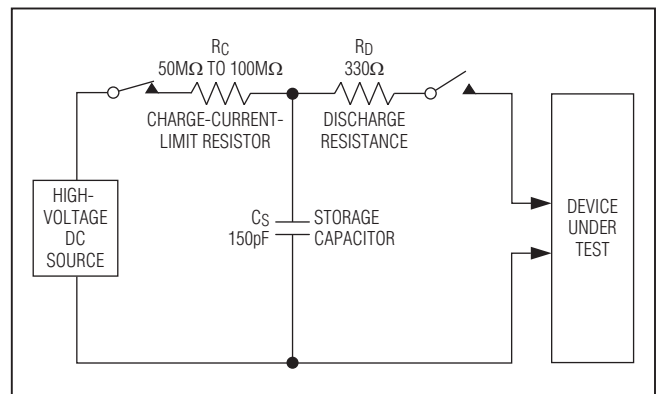


Figure 4. IEC 61000-4-2 ESD Test Model

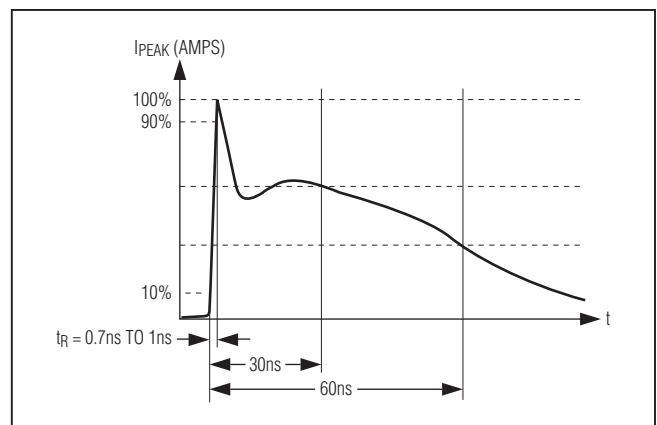


Figure 5. IEC 61000-4-2 ESD Generator Current Waveform

# MAX14895E

## Enhanced VGA Port Protector

### Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX14895EETE+T	-40°C to +85°C	16 TQFN-EP*

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

T = Tape and reel.

\*EP = Exposed pad.

### Chip Information

PROCESS: BiCMOS

### Package Information

For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.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.
16 TQFN-EP	T1633+4	<a href="#">21-0136</a>	<a href="#">90-0031</a>

# MAX14895E

## Enhanced VGA Port Protector

### *Revision History*

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/11	Initial release	—

*Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.*

**Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 \_\_\_\_\_ 11**