19-4269; Rev 0; 10/08

EVALUATION KIT AVAILABLE

Ultra-Low Capacitance 1:2 VGA Switch with ±15kV ESD

MAX4885E

General Description

The MAX4885E integrates high-bandwidth analog switches and level-translating buffers to implement a complete 1:2 multiplexer for VGA signals. The device provides switching for RGB, display data channel (DDC).

Horizontal and vertical synchronization (HSYNC/VSYNC) inputs feature level-shifting buffers to support low-voltage CMOS or standard TTL-compatible graphics controllers, meeting the VESA requirement of ±8mA. DDC, consisting of SDA_ and SCL_, is a bidirectional active-level translating switch that reduces capacitive load. The MAX4885E features high ESD protection to ±15kV Human Body Model (HBM) on all twelve externally routed terminals. See the *Pin Description* section. All other pins are protected to ±10kV Human Body Model (HBM).

The MAX4885E is specified over the extended -40°C to +85°C temperature range, and is available in the 24-pin, 4mm x 4mm TQFN package.

Applications

Notebook Computers/Docking Stations

Digital Projectors

Computer Monitors

Servers/Storage

KVM Switches

Features

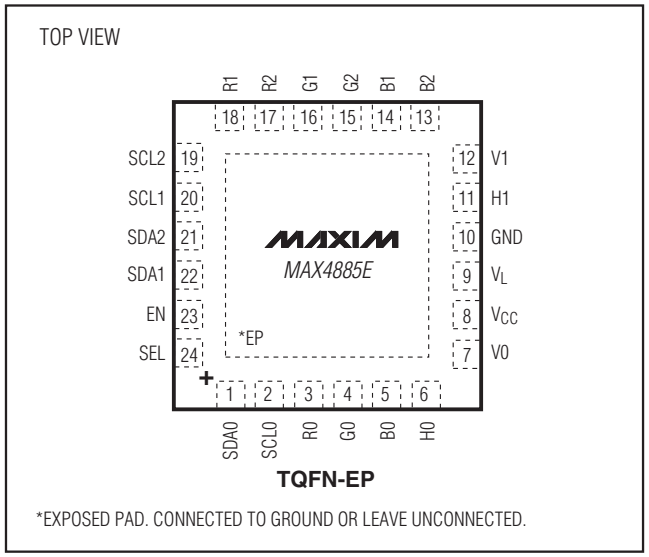
- ±15kV HBM ESD Protection on Externally Routed Terminals
- 1GHz Bandwidth
- Low 5Ω (typ) On-Resistance (R, G, B Signals)
- Low 6pF (typ) On-Capacitance (R, G, B Signals)
- Low R, G, B Skew -50ps (typ)
- Near Zero Power Consumption (< 2µA)
- Ultra-Small, 24-Pin (4mm x 4mm) TQFN Package

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4885EETG+	-40°C to +85°C	24 TQFN-EP*

*EP = Exposed pad.
+Denotes lead-free package/RoHS-compliant package.

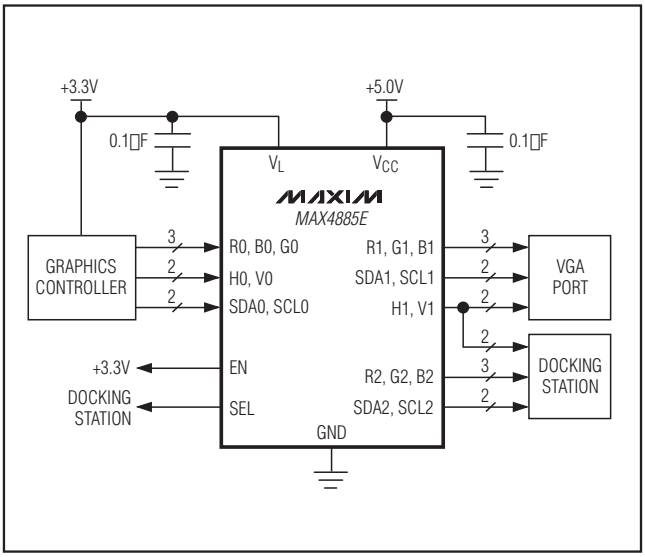
Pin Configuration



TQFN-EP

*EXPOSED PAD. CONNECTED TO GROUND OR LEAVE UNCONNECTED.

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

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Ultra-Low Capacitance 1:2 VGA Switch with ±15kV ESD

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND.)
V_{CC}, V_L .....-0.3V to +6V
R_, G_, B_, SDA1, SCL1, SDA2, SCL2, H1, V1, (Note 1) .....-0.3V to V_{CC} + 0.3V
H0, V0, SDA0, SCL0, EN, SEL.....-0.3V to V_L + 0.3V
Continuous Current through RGB Switches .....±30mA
Continuous Current through DDC Switches .....±30mA
Peak Current through RGB Switches (pulsed at 1ms, 10% duty cycle).....±90mA
Peak Current through DDC Switches (pulsed at 1ms, 10% duty cycle).....±90mA

Continuous Power Dissipation (T_A = +70°C)
24-Pin TQFN (derate 27.8mW/°C above +70°C) 2222mW
Junction to Ambient Thermal Resistance (θ_{JA}) (Note 2)
24-Pin TQFN.....36°C/W
Junction to Ambient Thermal Resistance (θ_{JC}) (Note 2)
24-Pin TQFN.....3°C/W
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Junction Temperature.....+150°C
Lead Temperature (soldering, 10s) .....+300°C

Note 1: Signals exceeding V_{CC} or GND are clamped by internal diodes. Limit forward-diode current to maximum current rating.
Note 2: Package thermal resistances were obtained using the method described in JEDEC specifications. For detailed information on package thermal considerations, refer to **www.maxim-ic.com/thermal-tutorial**.

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.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +5.0V ±10%, V_L = +2V to +5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V, V_L = +3.3V and T_A = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
V_{CC} Quiescent Supply Current	I_{CC}	V_{CC} = +5.0V	EN = V_L			1	µA
			EN = GND				
V_L Quiescent Supply Current	I_{VL}	V_L = +3.3V	EN = V_L			1	µA
			EN = GND				
RGB ANALOG SWITCHES							
On-Resistance	R_{ON}	V_{CC} = +5.0V, I_{IN} = -10mA, V_{IN} = +0.7V (Note 4)			6		Ω
On-Resistance Matching	ΔR_{ON}	0 ≤ V_{IN} ≤ 0.7V, I_{IN} = -10mA			0.5		Ω
On-Resistance Flatness	$R_{FLAT(ON)}$	0 ≤ V_{IN} ≤ 0.7V, I_{IN} = -10mA			0.5		Ω
Off-Leakage Current	$I_{L(OFF)}$	V_{CC} = +5.5V, V_{IN} = +0.3V or +5.5V, V_{EN} = 0 or V_L		-1		+1	µA
On-Leakage Current	$I_{L(ON)}$	V_{CC} = +5.5V, V_{IN} = +0.3V or +5.5V, V_{EN} = V_L		-1		+1	µA
HV BUFFER							
Input Voltage Low	V_{ILHV}					0.33 x V_L	V
Input Voltage High	V_{IHHV}			0.66 x V_L			V
Input Logic Hysteresis	V_{HYST}				75		mV
Input Leakage Current	I_{INHV}	V_{CC} = +5.5V, V_L = +5.5V, V_{IN} = 0 or V_L		-1		+1	µA
High-Output Drive Current	I_{OHHV}	V_{OHHV} ≥ 3.0V		8.0			mA
Low-Output Drive Current	I_{OLHV}	V_{OLHV} ≤ 0.6V		8.0			mA

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ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +5.0V ±10%, V_L = +2V to +5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V, V_L = +3.3V and T_A = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SDA_, SCL_						
Supply Voltage	V_L		2.0		5.5	V
On-Resistance	R_{ON}	V_{IN} = +0.4V, I_{IN} = ±2mA, V_L = +2.0V		10		Ω
On-Capacitance	C_{ON}	f = 100kHz		15		pF
High-Impedance Input Leakage Current	I_{INHIZ}	EN = GND, V_{CC} = +5.5V, V_L = +3.6V, SCL0, SDA0, SCL1, SCL2, SDA1, SDA2 = GND or V_{VL} (Note 5)	-1		+1	µA
Off-Input Leakage Current	I_{INOFF}	EN = V_L, V_L = +3.6V, V_{IN} = V_L - 0.2V	-1		+1	µA
CONTROL LOGIC (SEL, EN)						
Input Voltage Low	V_{ILLOG}				0.33 x V_L	V
Input Voltage High	V_{IHLOG}		0.66 x V_L			V
Input Logic Hysteresis	V_{HYST}			75		mV
Input Leakage Current	I_{INLEK}	V_{CC} = +5.5V, V_L = +3.6V, V_{IN} = 0 or V_L	-1		+1	µA
ESD PROTECTION						
ESD Protection		Human Body Model; R1, G1, B1, R2, G2, B2, SDA1, SCL1, SDA2, SCL2, H1, V1		±15		kV
		Human Body Model; all other pins		±10		

AC ELECTRICAL CHARACTERISTICS

(V_{CC} = +5.0V ±10%, V_L = +2V to +5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V, V_L = +3.3V and T_A = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Bandwidth	f_{MAX}	R_S = R_L = 50Ω		1		GHz
Insertion Loss	I_{LOS}	f = 1MHz, R_S = R_L = 50Ω, Figure 1		0.6		dB
Crosstalk	V_{CT}	f = 50MHz, R_S = R_L = 50Ω, Figure 1		-40		dB
Off-Capacitance	C_{OFF}	f = 250MHz		4.5		pF
On-Capacitance	C_{ON}	f = 250MHz		6.4		pF

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Ultra-Low Capacitance 1:2 VGA Switch with ±15kV ESD

TIMING CHARACTERISTICS

(V_{CC} = +5.0V ±10%, V_L = +2V to +5.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V, V_L = +3.3V and T_A = +25°C.) (Note 3)

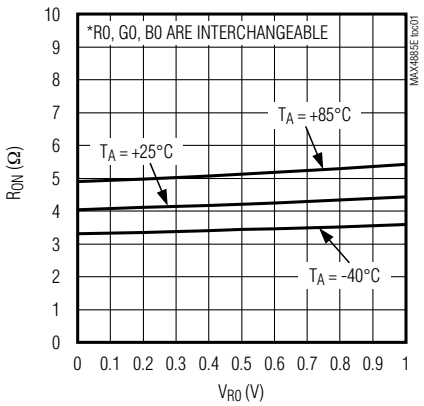
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RGB ANALOG SWITCHES						
Output Skew Between Ports	t_{SKEW}	Skew between any two ports: R_, G_, B_, Figure 2		50		ps
HV BUFFER						
Propagation Delay	t_{PD}	R_L = 1kΩ, C_L = 10pF, Figure 2		15		ns

Note 3: All devices are 100% production tested at T_A = +25°C. Specifications over the full temperature range are guaranteed by design.
Note 4: On-resistance guarantees the low-static logic level.
Note 5: SDA_, SCL_ off-input leakage current guarantees the high-static logic level.

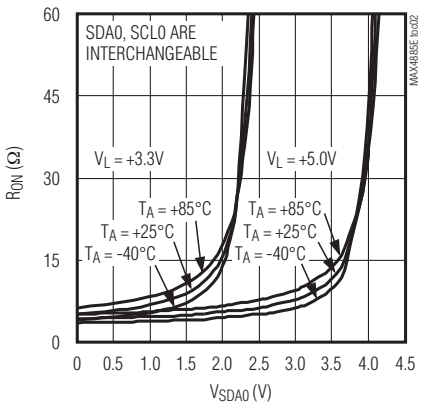
Typical Operating Characteristics

(V_{CC} = +5.0V, V_L = +3.3V and T_A = +25°C, unless otherwise noted.)

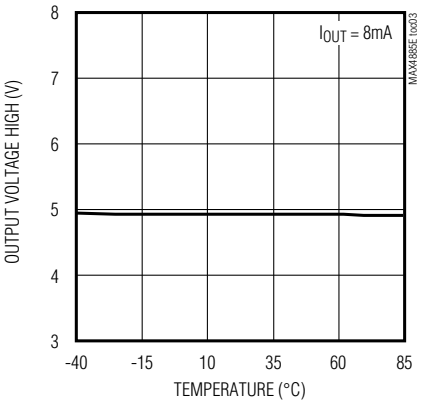
R_{ON} vs. V_{R0}* (RGB SWITCHES)



R_{ON} vs. V_{SDA0}* (DDC SWITCHES)



HV BUFFER OUTPUT VOLTAGE HIGH vs. TEMPERATURE



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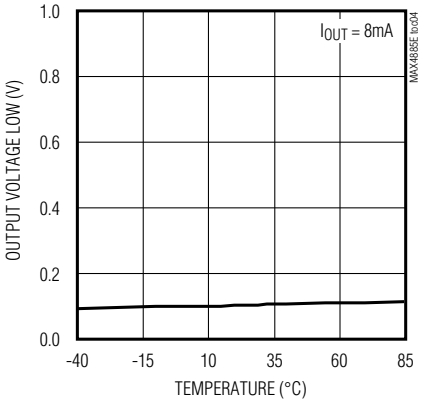
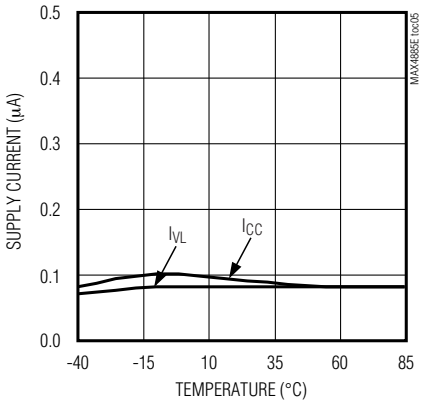
Typical Operating Characteristics (continued)

(V_{CC} = +5.0V, V_L = +3.3V and T_A = +25°C, unless otherwise noted.)

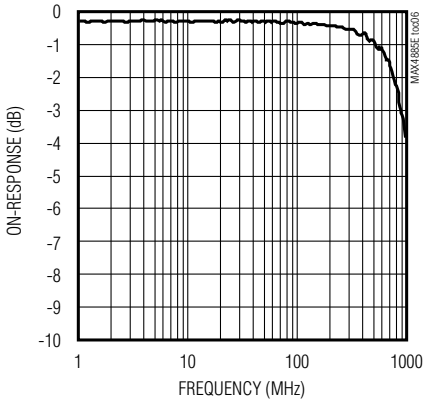
HV BUFFER OUTPUT VOLTAGE LOW vs. TEMPERATURE



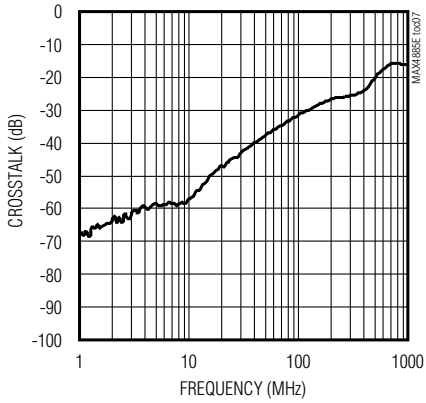
SUPPLY CURRENT vs. TEMPERATURE



ON-RESPONSE vs. FREQUENCY



CROSSTALK vs. FREQUENCY



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Ultra-Low Capacitance 1:2 VGA Switch with ±15kV ESD

Timing Circuits/Timing Diagrams

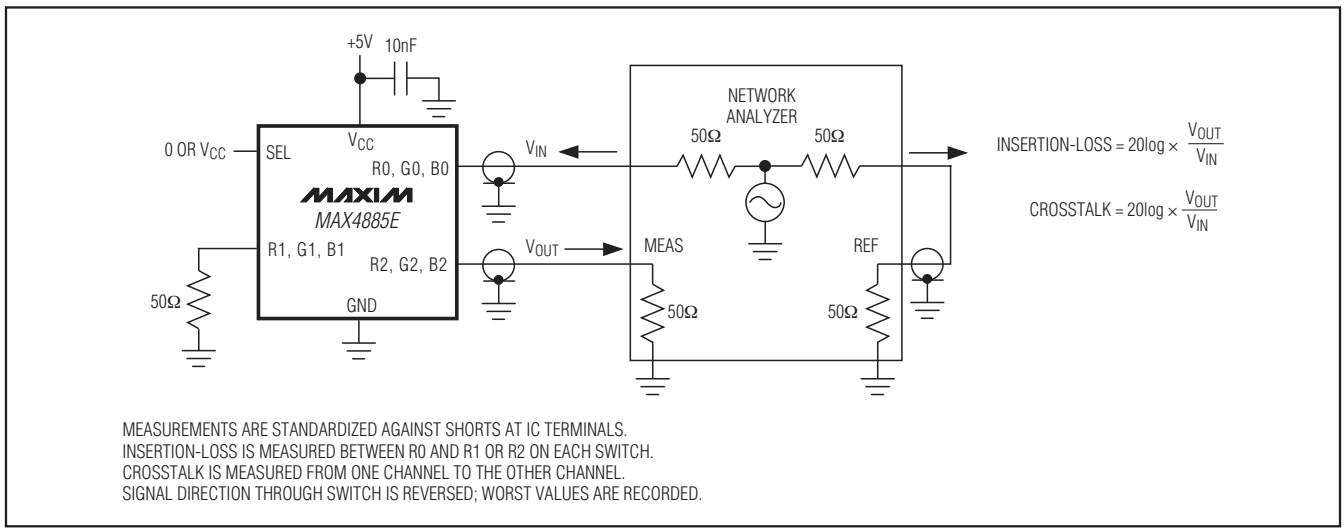

Figure 1. Insertion-Loss and Crosstalk

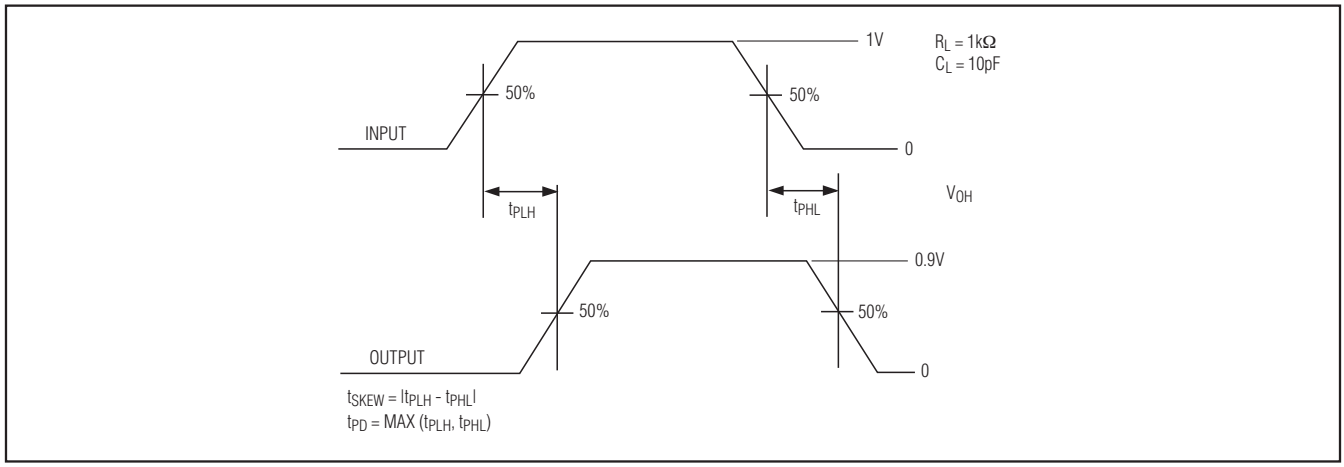

Figure 2. Propagation Delay and Skew Waveforms

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Pin Description

PIN	NAME	FUNCTION
1	SDA0	SDA I/O
2	SCL0	SCL I/O
3	R0	RGB Analog I/O
4	G0	RGB Analog I/O
5	B0	RGB Analog I/O
6	H0	Horizontal Sync Input
7	V0	Vertical Sync Input
8	V_{CC}	Supply Voltage. V_{CC} = +5.0V ±10%. Bypass V_{CC} to GND with a 0.1µF or larger ceramic capacitor.
9	V_L	Supply Voltage. +2V ≤ V_L ≤ +5.5V. Bypass V_L to GND with a 0.1µF or larger ceramic capacitor.
10	GND	Ground
11	H1	Horizontal Sync Output*
12	V1	Vertical Sync Output*
13	B2	RGB Analog I/O*
14	B1	RGB Analog I/O*
15	G2	RGB Analog I/O*
16	G1	RGB Analog I/O*
17	R2	RGB Analog I/O*
18	R1	RGB Analog I/O*
19	SCL2	SCL I/O*
20	SCL1	SCL I/O*
21	SDA2	SDA I/O*
22	SDA1	SDA I/O*
23	EN	Enable Input. Drive EN high for normal operation. Drive EN low to disable the device.
24	SEL	Select Input. Logic input for switching RGB and DDC swiches.
—	EP	Exposed Pad. Connect exposed pad to ground or leave unconnected.

**Terminal as ±15kV ESD protection—Human Body Model.*

Detailed Description

The MAX4885E integrates high-bandwidth analog switches and level-translating buffers to implement a complete 1:2 multiplexer for VGA signals. The device provides switching for RGB, HSYNC, VSYNC, SDA_ and SCL_ signals.

The HSYNC and VSYNC inputs feature level-shifting buffers to support TTL output logic levels from low-voltage graphics controllers. These buffered switches may be driven from as little as +2.0V up to +5.5V. RGB signals are routed with the same high-performance analog switches, and SDA_, SCL_ signals are voltage clamped to a diode drop less than V_L. Voltage clamping provides protection and compatibility with SDA_ and SCL_ signals and low-voltage ASICs. In keyboard/video/mouse (KVM) applications, V_L is normally set to +5V because low-voltage clamping is not required, as specified by the VESA standard.

Drive EN logic-low to shut down the MAX4885E. In shutdown mode, all switches are high impedance, providing high-signal rejection. The RGB, HSYNC, VSYNC, SDA_, and SCL_ outputs are ESD protected to ±15kV by the Human Body Model.

RGB Switches

The MAX4885E provides three SPDT high-bandwidth switches to route standard VGA R, G, and B signals (see 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.

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Table 1. RGB Truth Table

EN	SEL	FUNCTION
1	0	R0 to R1 G0 to G1 B0 to B1
1	1	R0 to R2 G0 to G2 B0 to B2
0	X	R_, B_, and G_, high impedance

X = Don't care.

Table 2. HV Truth Table

EN	FUNCTION
0	H_, V_ = 0

X = Don't care.

Table 3. DDC Truth Table

EN	SEL	FUNCTION
1	0	SDA0 to SDA1 SCL0 to SCL1
1	1	SDA0 to SDA2 SCL0 to SCL2
0	X	SDA_, SCL_, high impedance

X = Don't care.

Horizontal/Vertical Sync Level Shifter

HSYNC/VSYNC are buffered to provide level shifting and drive capability to meet the VESA specification.

Display-Data Channel Multiplexer

The MAX4885E provides two voltage-clamped switches to route DDC signals (see Table 3). Each switch clamps signals to a diode drop less than the voltage applied on V_L. Supply +3.3V on V_L to provide voltage clamping for VESA I^2C-compatible signals. If voltage clamping is not required, connect V_L to V_{CC}. The SDA_ and SCL_ switches are identical, and each switch can be used to route either SDA_ and SCL_ signals.

ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. Additionally, the MAX4885E is protected to ±15kV on RGB, HSYNC, VSYNC, SDA_ and SCL_ outputs by the Human Body Model (HBM). See the *Pin Description* section. For optimum ESD performance, bypass each V_{CC} pin to ground with a 0.1µF or larger ceramic capacitor.

Human Body Model (HBM)

Several ESD testing standards exist for measuring the robustness of ESD structures. The ESD protection of the MAX4885E is characterized with the Human Body Model. Figure 3 shows the model used to simulate an ESD event resulting from contact with the human body. The model consists of a 100pF storage capacitor that is charged to a high voltage, then discharged through a 1.5kΩ resistor. Figure 4 shows the current waveform when the storage capacitor is discharged into a low impedance.

ESD Test Conditions

ESD performance depends on a variety of conditions. Please contact Maxim for a reliability report documenting test setup, methodology, and results.

Applications Information

The MAX4885E provides the level shifting necessary to drive two standard VGA ports from a graphics controller as low as +2.2V. Internal buffers drive the HSYNC and VSYNC signals to VGA standard TTL levels. The DDC multiplexer provides level shifting by clamping signals to a diode drop less than V_L (see the *Typical Operating Circuit*). Connect V_L to +3.3V for normal operation, or to V_{CC} to disable voltage clamping for DDC signals.

Power-Supply Decoupling

Bypass each V_{CC} pin and V_L to ground with a 0.1µF or larger ceramic capacitor as close as possible to the device.

PCB Layout

High-speed switches such as the MAX4885E 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.

Chip Information

PROCESS: BiCMOS

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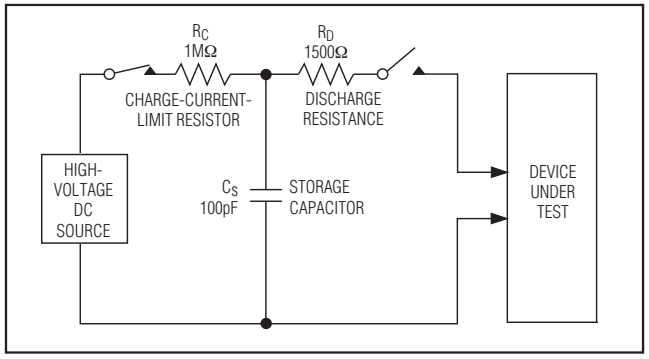


Figure 3. Human Body ESD Test Model

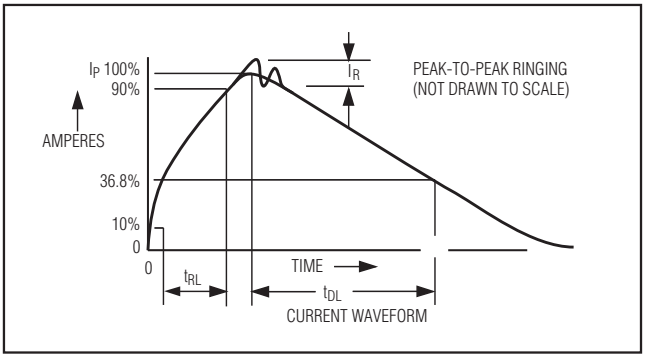
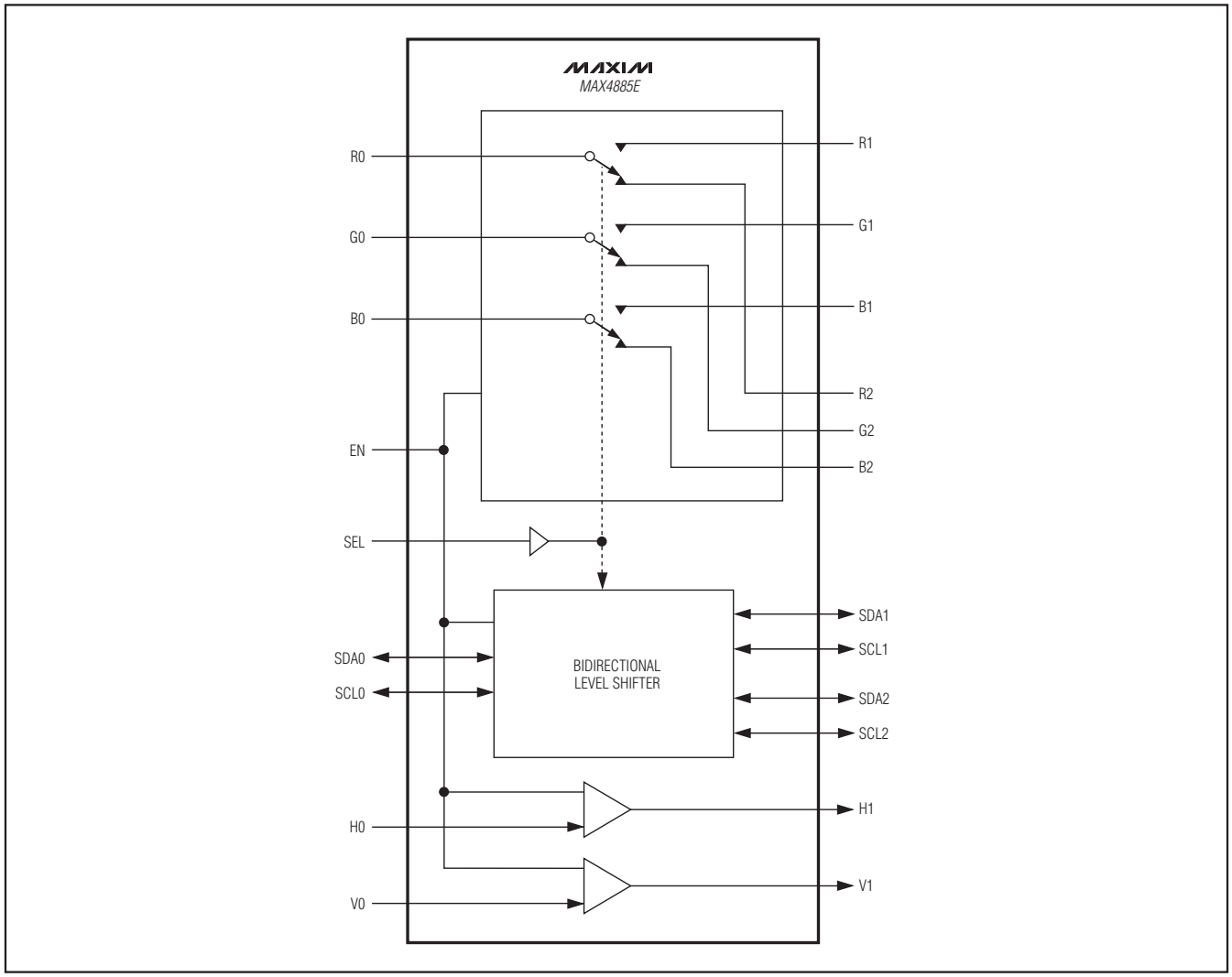


Figure 4. HBM Discharge Current Waveform

Functional Diagram



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Ultra-Low Capacitance 1:2 VGA Switch with ±15kV ESD

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
24 TQFN-EP	T2444-4	**21-0139**

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