

## VGA Port Companion Circuit

### Features

- 7 channels of ESD protection designed to meet IEC-1000-4-2 Level-4 ESD requirements (8kV contact discharge)
- Very low loading capacitance from ESD protection diodes at less than 5pF typical
- TTL to CMOS level-translating buffers for the HSYNC and VSYNC lines
- Three independent supply pins ( $V_{CC}$ ,  $V_{RGB}$  and  $V_{AUX}$ ) to facilitate operation with sub-micron Graphics Controller ICs
- High impedance pull-ups (50k $\Omega$  nominal to  $V_{AUX}$ ) for HSYNC and VSYNC inputs
- Pull-up resistors (1.8k $\Omega$  nominal to  $V_{CC}$ ) for DDC\_CLK and DDC\_DATA lines
- Compact 16-pin QSOP package
- Lead-free version available

### Applications

- ESD protection and termination resistors for VGA (video) port interfaces
- Desktop PCs
- Notebook computers
- LCD monitors

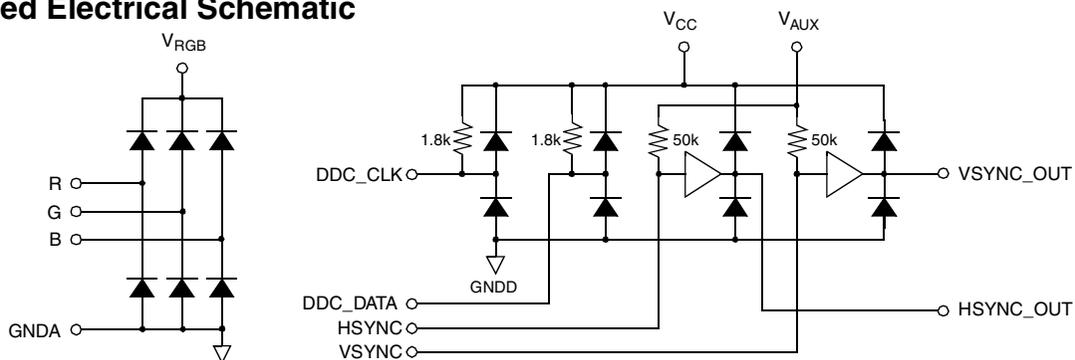
### Product Description

The PACVGA105 incorporates 7 channels of ESD protection for signal lines commonly found in a VGA port for PCs. ESD protection is implemented with current steering diodes designed to safely handle the high peak surge currents associated with the IEC-1000-4-2 Level-4 ESD Protection Standard (8kV contact discharge). When the channels are subjected to an electrostatic discharge, the ESD current pulse is diverted via the protection diodes into the positive supply rails or ground where they may be safely dissipated.

The upper ESD diodes for the R, G and B channels are connected to a separate supply rail ( $V_{RGB}$ ) to facilitate interfacing to graphics controller ICs with low voltage supplies. The remaining channels are connected to the main 5V rail ( $V_{CC}$ ). The lower diodes for the R, G and B channels are also connected to a dedicated ground pin (GNDA) to minimize crosstalk due to common ground impedance.

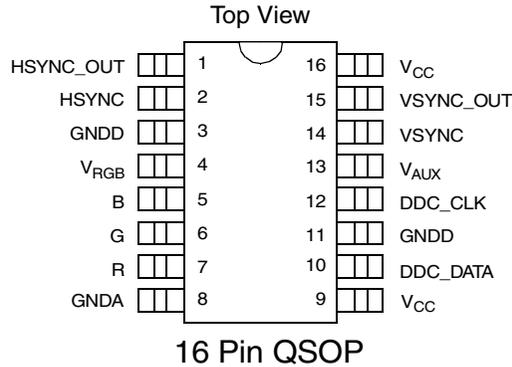
Two non-inverting buffers are also included in this IC for buffering the HSYNC and VSYNC signals from the graphics controller IC. These buffers will accept TTL input levels and convert them to CMOS output levels that swing between GND and  $V_{CC}$ . These drivers have a nominal 60 $\Omega$  output impedance to match the characteristic impedance of the HSYNC and VSYNC lines of the video cables typically used. The inputs of these drivers also have high impedance pull-ups (50k $\Omega$  nom.) pulling up to the  $V_{AUX}$  rail. In addition, the DDC\_CLOCK and DDC\_DATA channels have 1.8k $\Omega$  resistors pulling these inputs up to the main 5V ( $V_{CC}$ ) rail.

### Simplified Electrical Schematic





**PACKAGE / PINOUT DIAGRAM**



Note: This drawing is not to scale.

**PIN DESCRIPTIONS**

LEAD(s)	NAME	DESCRIPTION
1	HSYNC_OUT	Horizontal sync signal buffer output. Connects to the video connector side of the horizontal sync line.
2	HSYNC	Horizontal sync signal buffer input. Connects to the VGA Controller side of the horizontal sync line.
3, 11	GNDD	Digital ground reference supply pin.
4	V <sub>RGB</sub>	V <sub>RGB</sub> supply pin. This is an isolated supply pin for the R, G and B ESD protection circuits.
5	B	Blue signal video protection channel. This pin is typically tied to the B video line between the VGA controller device and the video connector.
6	G	Green signal video protection channel. This pin is typically tied to the G video line between the VGA controller device and the video connector.
7	R	Red signal video protection channel. This pin is typically tied to the R video line between the VGA controller device and the video connector.
8	GNDA	Analog ground reference supply pin.
9, 16	V <sub>CC</sub>	V <sub>CC</sub> supply pin. This is the main supply input for the DDC_CLK and DDC_DATA pullup resistors and ESD protection circuits. It is also connected to the sync buffers and to the ESD protection diodes present on the HSYNC_OUT and VSYNC_OUT lines.
10	DDC_DATA	DDC data pin.
12	DDC_CLK	DDC clock pin.
13	V <sub>AUX</sub>	V <sub>AUX</sub> supply pin. This is the supply input for the 50kΩ pullups connected to the HSYNC and VSYNC buffer inputs.
14	VSYNC	Vertical sync signal buffer input. Connects to the VGA Controller side of the vertical sync line.
15	VSYNC_OUT	Vertical sync signal buffer output. Connects to the video connector side of the vertical sync line.

## Ordering Information

PART NUMBERING INFORMATION					
Pins	Package	Standard Finish		Lead-free Finish	
		Ordering Part Number <sup>1</sup>	Part Marking	Ordering Part Number <sup>1</sup>	Part Marking
16	QSOP	PACVGA105Q	PACVGA105Q	PACVGA105QR	PACVGA105QR

Note 1: Parts are shipped in Tape & Reel form unless otherwise specified.

## Specifications

ABSOLUTE MAXIMUM RATINGS		
PARAMETER	RATING	UNITS
$V_{CC}, V_{RGB}, V_{AUX}$ Supply Voltage Inputs	[GND - 0.5] to +6.0	V
Diode Forward Current (one diode conducting at a time)	20	mA
DC Voltage at Inputs R, G, B	[GND - 0.5] to $[V_{RGB} + 0.5]$	V
HSYNC, VSYNC	[GND - 0.5] to $[V_{AUX} + 0.5]$	V
DDC_CLK, DDC_DATA	[GND - 0.5] to $[V_{CC} + 0.5]$	V
Operating Temperature Range	0 to +70	°C
Storage Temperature Range	-40 to +150	°C
Package Power Rating	750	mW

STANDARD OPERATING CONDITIONS				
SYMBOL	PARAMETER	MIN	MAX	UNITS
$V_{CC}$	Main Supply Voltage	4.5	5.5	V
$V_{RGB}$	RGB Supply Voltage	1.7	3.7	V
$V_{AUX}$	Auxiliary Supply Voltage	2.9	3.7	V
$V_{IH}$	Logic High Input Voltage (Note 1)	2.0		V
$V_{IL}$	Logic Low Input Voltage (Note 1)		0.8	V
$V_I$	Input Voltage RGB	0	$V_{RGB}$	V
	HSYNC, VSYNC	0	$V_{AUX}$	V
	DDC_CLK, DDC_DATA	0	$V_{CC}$	V
$I_{OH}$	High Level Output Current (Note 1)		-8	mA
$I_{OL}$	Low Level Output Current (Note 1)		8	mA
$T_A$	Free-air Operating Temperature	0	+70	°C

Note 1: These parameters apply only to the HSYNC and VSYNC signals.

**Specifications (cont'd)**

<b>ELECTRICAL OPERATING CHARACTERISTICS (SEE NOTE 1)</b>						
<b>SYMBOL</b>	<b>PARAMETER</b>	<b>CONDITIONS</b>	<b>MIN</b>	<b>TYP</b>	<b>MAX</b>	<b>UNITS</b>
V <sub>F</sub>	Diode Forward Voltage	I <sub>F</sub> = 10mA			1.0	V
V <sub>OH</sub>	Logic High Output Voltage	I <sub>OH</sub> = -4mA, V <sub>CC</sub> = 4.5V	4.0			V
V <sub>OL</sub>	Logic Low Output Voltage	I <sub>OL</sub> = 4mA, V <sub>CC</sub> = 4.5V			0.4	V
I <sub>IN</sub>	Input Current R, G and B pins HSYNC, VSYNC pins HSYNC, VSYNC pins	V <sub>RGB</sub> = 3.63V, V <sub>IN</sub> = V <sub>RGB</sub> or GND V <sub>AUX</sub> = 3.63V, V <sub>IN</sub> = V <sub>AUX</sub> V <sub>AUX</sub> = 3.63V, V <sub>IN</sub> = GND	-30	-72.5	±1 ±1 -95	μA μA μA
I <sub>CC</sub>	V <sub>CC</sub> Supply Current	V <sub>CC</sub> = 5.5V; V <sub>AUX</sub> = V <sub>RGB</sub> = 2.97V; All inputs and outputs floating		35	100	μA
I <sub>RGB</sub>	V <sub>RGB</sub> Supply Current	R, G and B pins at V <sub>CC</sub> or GND; All inputs and outputs floating			10	μA
C <sub>IN</sub>	Input Capacitance R, G and B pins HSYNC, VSYNC pins DDC_DATA, DDC_CLK pins	Note 2 applies for all cases		5 10 5		pF pF pF
R <sub>PU</sub>	Pull-up Resistance DDC_DATA, DDC_CLK pins		1.62	1.8	1.98	kΩ
V <sub>ESD</sub>	ESD Withstand Voltage	V <sub>CC</sub> = 5V; V <sub>RGB</sub> = 3.3V; V <sub>AUX</sub> = 3.3V; Note 3	±8			kV
t <sub>PLH</sub>	SYNC Buffer L => H Propagation Delay	C <sub>L</sub> = 50pF; V <sub>CC</sub> = 5.0V; R <sub>L</sub> = 500Ω; Note 4		7.0	15.0	ns
t <sub>PHL</sub>	SYNC Buffer H => L Propagation Delay	C <sub>L</sub> = 50pF; V <sub>CC</sub> = 5.0V; R <sub>L</sub> = 500Ω; Note 4		7.0	15.0	ns
t <sub>R</sub> , t <sub>F</sub>	SYNC Buffer Output Rise & Fall Times	C <sub>L</sub> = 50pF; V <sub>CC</sub> = 5.0V; R <sub>L</sub> = 500Ω; Note 4		7.0		ns

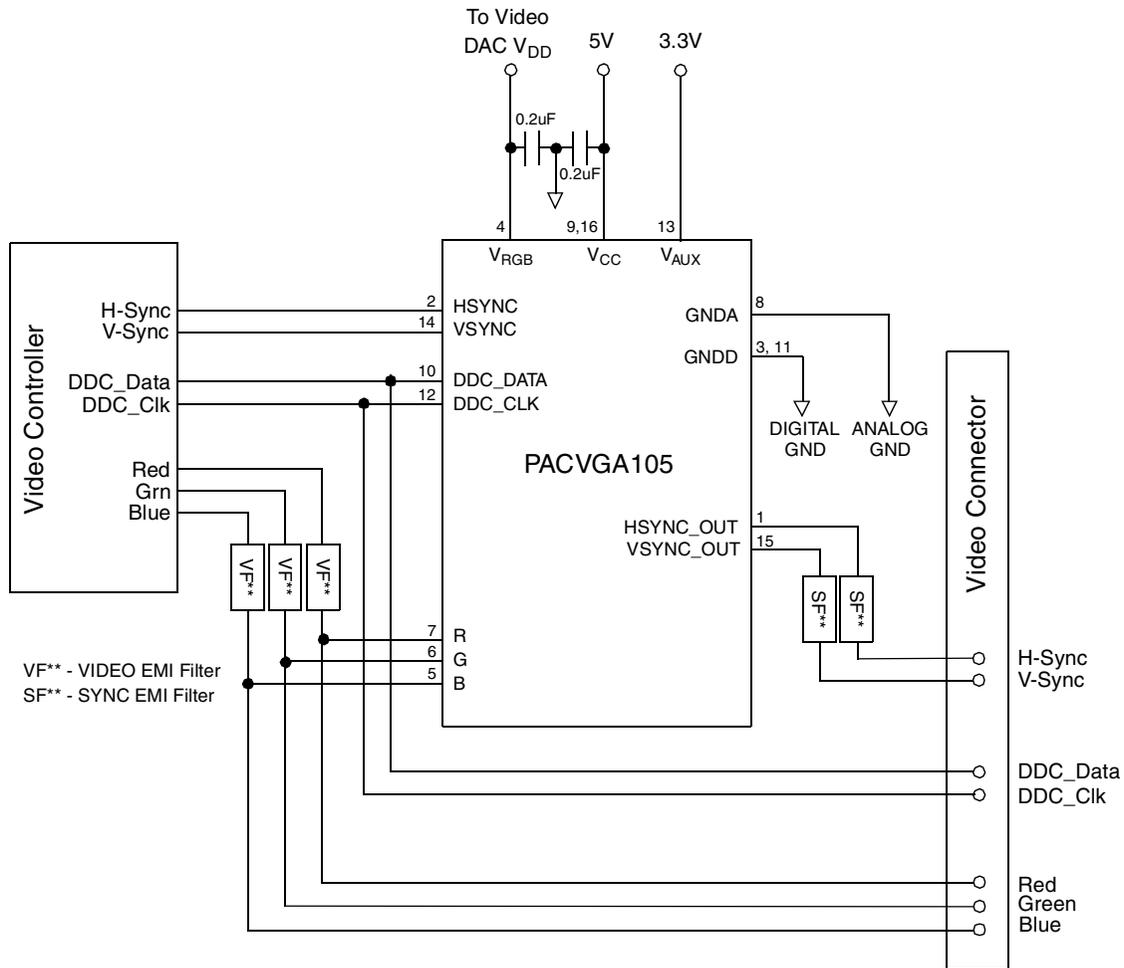
Note 1: All parameters specified over standard operating conditions unless otherwise noted.

Note 2: Measured at 1MHz. R/G/B inputs biased at 1.65V with V<sub>RGB</sub> = 3.3V. DDC\_CLK and DDC\_DATA biased at 2.5V with V<sub>CC</sub>=5V. HSYNC and VSYNC inputs biased at V<sub>AUX</sub> or GND with V<sub>AUX</sub> = 3.3V and V<sub>CC</sub> = 5V. These parameters are guaranteed by design and characterization

Note 3: Per the IEC-61000-4-2 International ESD Standard, Level 4 contact discharge method. V<sub>RGB</sub> and V<sub>CC</sub> must be bypassed to GND via a low impedance ground plane with a 0.2μF, low inductance, chip ceramic capacitor at each supply pin. ESD pulse is applied between the applicable pins and GND. ESD pulse can be positive or negative with respect to GND. Applicable pins are: R, G, B, HSYNC\_OUT, VSYNC\_OUT, DDC\_CLK and DDC\_DATA. The HSYNC and VSYNC inputs are ESD protected to the industry standard 2kV per the Human Body Model (MIL-STD-883, Method 3015).

Note 4: Applicable to the SYNC buffers only. Input signals swing between 0V and 3.0V, with rise and fall times ≤ 5ns. Guaranteed by correlation to buffer output drive currents.

**Application Information**



**Figure 1. Typical Connection Diagram**

GNDA, the negative voltage rail for the R, G and B diodes is not connected internally to GNDD. GNDA should ideally be connected to the ground of the video DAC IC. This will prevent any ground bounce caused by digital signals from injecting noise onto the R, G and B signals. Analog GND and digital GND are typically connected on the printed circuit board.



### Mechanical Details

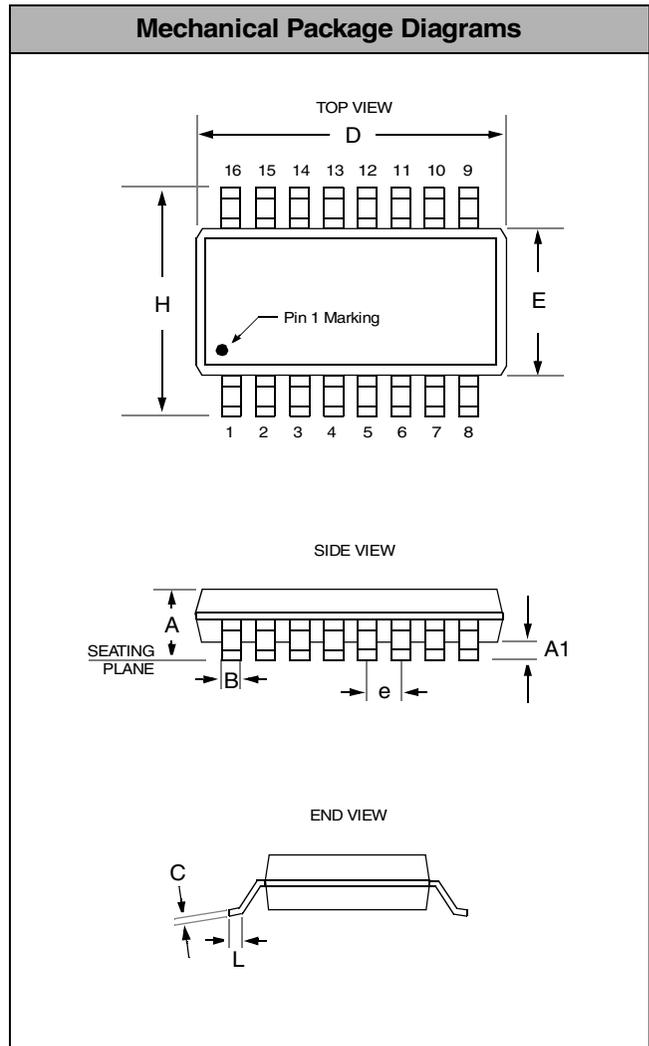
#### QSOP Mechanical Specifications

PACVGA105 devices are packaged in 16-pin QSOP packages. Dimensions are presented below.

For complete information on the QSOP-16 package, see the California Micro Devices QSOP Package Information document.

PACKAGE DIMENSIONS				
Package	QSOP (JEDEC name is SSOP)			
Pins	16			
Dimensions	Millimeters		Inches	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
B	0.20	0.30	0.008	0.012
C	0.18	0.25	0.007	0.010
D	4.80	5.00	0.189	0.197
E	3.81	3.98	0.150	0.157
e	0.64 BSC		0.025 BSC	
H	5.79	6.19	0.228	0.244
L	0.40	1.27	0.016	0.050
# per tube	100 pcs*			
# per tape and reel	2500 pcs			
Controlling dimension: inches				

\* This is an approximate number which may vary.



Package Dimensions for QSOP-16