



## Advance Information

### Features

- Includes ESD protection, level-shifting, buffering and sync impedance matching
- VESA VSIS Version 1 Revision 2 compatible interface
- Supports both source and sink devices
- Supports optional NAVI signaling requirements
- Seven channels of ESD protection for all VGA port connector pins meeting IEC-61000-4-2 Level 4 ESD requirements ( $\pm 8\text{kV}$  contact discharge)
- Very low loading capacitance from ESD protection diodes on VIDEO lines, 3pF maximum
- Schmitt-triggered input buffers for HSYNC and VSYNC lines
- Bi-directional level shifting N-channel FETs provided for DDC\_CLK & DDC\_DATA channels
- Backdrive protection on all lines
- RoHS-compliant, lead-free finishing in a 14-bump, 5x4x5, 0.4mm Chip Scale Package (CSP)

### Applications

- Monitors
- Video graphics controllers embedded in PCs
- Graphics adapter cards
- Set-top boxes

## Product Description

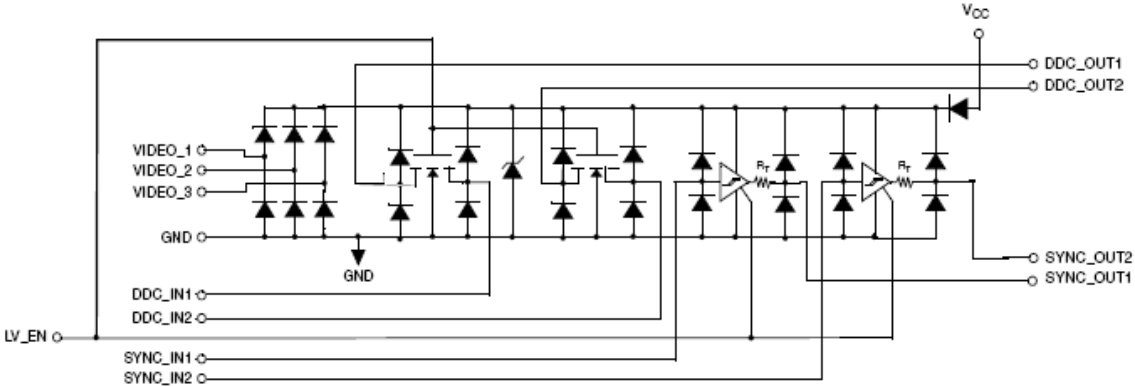
The CM2009-05CP connects between the VGA or DVI-I port connector and the internal analog or digital flat panel controller logic. It can also be used for source devices such as a set-top box. The CM2009-05CP incorporates ESD protection for all signals, level shifting for the DDC signals and buffering for the SYNC signals. ESD protection for the video, DDC and SYNC lines is implemented with low-capacitance current steering diodes.

All connector interface pins are designed to safely handle the high current spikes specified by IEC-61000-4-2 Level 4 ( $\pm 8\text{kV}$  contact discharge). The ESD protection for the DDC, SYNC and VIDEO signal pins is designed to prevent "back current" when the device is powered down while connected to a video source or a video sink that is powered up. Positive supply rails are provided for the VIDEO / SYNC signals and DDC signals to facilitate interfacing with low voltage video controller ICs and microcontrollers to provide design flexibility in multi-supply-voltage environments.

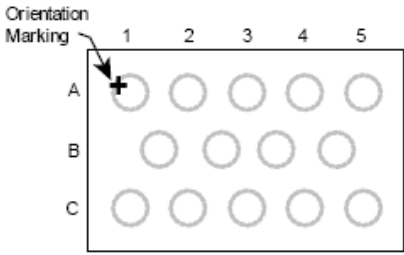
Two Schmitt-triggered non-inverting buffers redrive and condition the HSYNC and VSYNC signals from the video connector (SYNC1, SYNC2). These buffers accept VESA VSIS compliant TTL input signals and convert them to CMOS output levels that swing between ground and  $V_{CC}$ .

Two N-channel MOSFETs provide the level shifting function required when the DDC controller or EDID EEPROM is operated at a lower supply voltage than the monitor. The gate terminals for these MOSFETS should be connected to the supply rail (typically 3.3V, 2.5V etc.) that supplies power to the transceivers of the DDC controller.

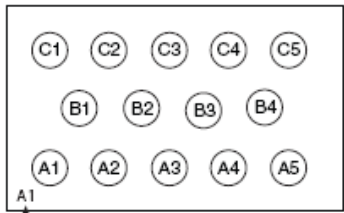
**Simplified Electrical Schematic**



**PACKAGE / PINOUT DIAGRAM**



**TOP VIEW**  
(Bumps Down View)



**BOTTOM VIEW**  
(Bumps Up View)

Note: These drawings are not to scale.

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## PIN DESCRIPTIONS

LEAD(s)	NAME	DESCRIPTION
A1	GND	Ground reference supply pin.
A2	VIDEO_1	Video signal ESD protection channel. This pin is typically tied one of the video lines between the controller device and the video connector.
A3	VIDEO_2	Video signal ESD protection channel. This pin is typically tied one of the video lines between the controller device and the video connector.
A4	VIDEO_3	Video signal ESD protection channel. This pin is typically tied one of the video lines between the controller device and the video connector.
A5	V <sub>CC</sub>	This is a supply input for the SYNC_1 and SYNC_2 level shifters, video protection and the DDC circuits.
B1	DDC_OUT1	DDC signal output. Connects to the DDC logic.
B2	DDC_OUT2	DDC signal output. Connects to the DDC logic.
B3	SYNC_OUT1	Sync signal buffer output. Connects to the monitor Sync logic. <sup>1</sup>
B4	SYNC_OUT2	Sync signal buffer output. Connects to the monitor Sync logic. <sup>1</sup>
C1	DDC_IN1	DDC signal input. Connects to the video connector side of one of the DDC lines.
C2	DDC_IN2	DDC signal input. Connects to the video connector side of one of the DDC lines.
C3	LV_EN	Disables the Sync buffer outputs when low.
C4	SYNC_IN1	Sync signal buffer input. Connects to the video connector side of one of the Sync lines. <sup>2</sup>
C5	SYNC_IN2	Sync signal buffer input. Connects to the video connector side of one of the Sync lines. <sup>2</sup>

Note 1: Can also be connected to the VGA connector side if used for a source device.

Note 2: Can also be used to connect to the Video Chip Sync Logic if it is used for a source device.

## Ordering Information

### PART NUMBERING INFORMATION

Bumps	Package	Ordering Part Number <sup>1</sup>	Part Marking
14	CSP	CM2009-05CP	TJ

Note 1: Parts are shipped in Tape and Reel form.

## Specifications

### ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNITS
V <sub>cc</sub> Supply Voltage Inputs	[GND - 0.5] to +6.0	V
DC Voltage at Inputs VIDEO_1, VIDEO_2, VIDEO_3 DDC_IN1, DDC_IN2 DDC_OUT1, DDC_OUT2 SYNC_IN1, SYNC_IN2, LV_EN	[GND - 0.5] to [V <sub>cc</sub> + 0.5] [GND - 0.5] to 6.0 [GND - 0.5] to 6.0 [GND - 0.5] to [V <sub>cc</sub> + 0.5]	V V V V
Operating Temperature Range	-40 to +85	°C
Storage Temperature Range	-40 to +150	°C
Package Power Rating (T <sub>A</sub> =25°C)	500	mW

### STANDARD OPERATING CONDITIONS

PARAMETER	RATING	UNITS
Operating Temperature Range	-40 to +85	°C
V <sub>cc</sub>	5	V

**ELECTRICAL OPERATING CHARACTERISTICS** (SEE NOTE 1)

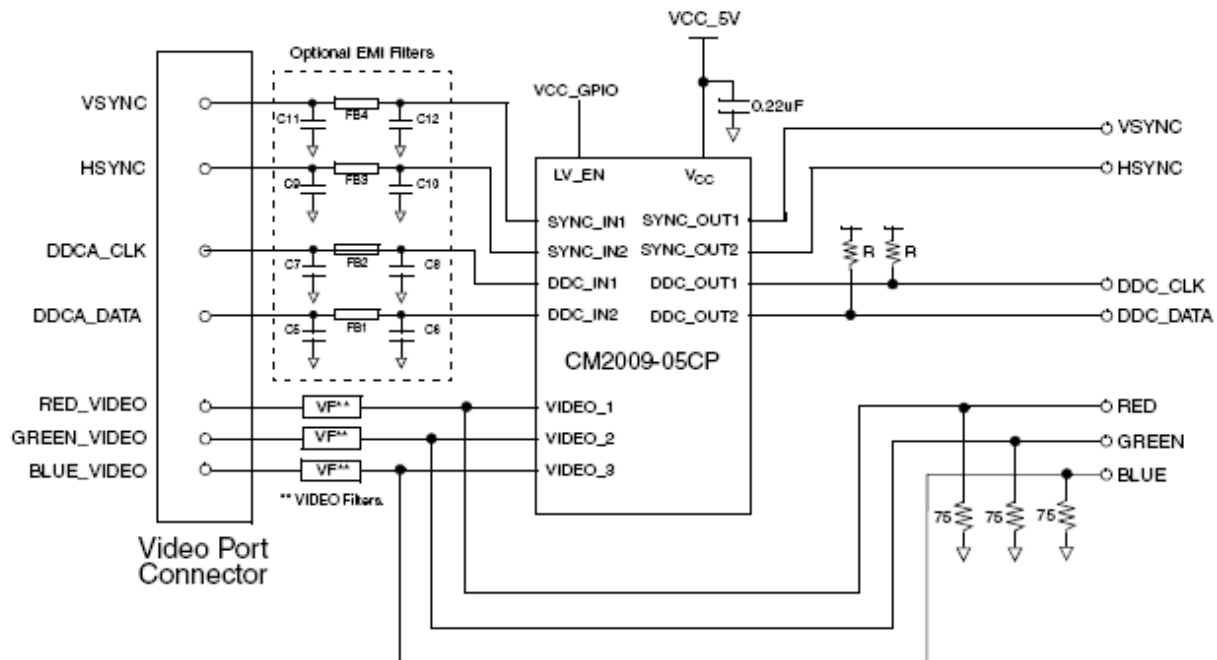
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
I <sub>CC</sub>	V <sub>CC</sub> Supply Current	V <sub>CC</sub> = 5V; SYNC inputs at GND or V <sub>CC</sub> ; SYNC outputs unloaded, DDC_In and DDC_OUT floating			1.0	mA
		V <sub>CC</sub> = 5V; SYNC inputs at 3.0V; SYNC outputs unloaded, DDC_In and DDC_OUT floating			2.0	mA
V <sub>F</sub>	ESD Diode Forward Voltage	I <sub>F</sub> = 10mA			1.1	V
V <sub>IH</sub>	Logic High Input Voltage	V <sub>CC</sub> = 5.0V; Note 2	2.0			V
V <sub>IL</sub>	Logic Low Input Voltage	V <sub>CC</sub> = 5.0V; Note 2			0.55	V
V <sub>HYS</sub>	Hysteresis Voltage	V <sub>CC</sub> = 5.0V; Note 2		450		mV
V <sub>OH</sub>	Logic High Output Voltage	I <sub>OH</sub> = 0mA, V <sub>CC</sub> = 5.0V; Note 2	4.0			V
V <sub>OL</sub>	Logic Low Output Voltage	I <sub>OL</sub> = 0mA, V <sub>CC</sub> = 5.0V; Note 2			0.15	V
R <sub>OUT</sub>	SYNC Driver Output Resistance	V <sub>CC</sub> = 5.0V; SYNC Inputs at GND or 3.0V		65		Ω
I <sub>IN</sub>	Input Current VIDEO Inputs	V <sub>CC</sub> = 5.0V; V <sub>IN</sub> = V <sub>CC</sub> or GND			±10	μA
	SYNC_IN1, SYNC_IN2 Inputs	V <sub>CC</sub> = 5.0V; V <sub>IN</sub> = V <sub>CC</sub> or GND			±10	μA
I <sub>OFF</sub>	Level Shifting N-MOSFET "OFF" State Leakage Current	(LV_EN - V <sub>DDC_IN</sub> ) 0.4V; V <sub>DDC_OUT</sub> = LV_EN			10	μA
		(LV_EN - V <sub>DDC_OUT</sub> ) 0.4V; V <sub>DDC_IN</sub> = LV_EN			10	μA
I <sub>BACKDRIVE</sub>	Current conducted from input pins when V <sub>CC</sub> is powered down.	V <sub>CC</sub> < V <sub>INPUT_PIN</sub>		10		μA
V <sub>ON</sub>	Voltage Drop Across Level-shifting N-MOSFET when "ON"	LV_EN = 2.5V; V <sub>S</sub> = GND; I <sub>DS</sub> = 3mA			0.18	V
C <sub>IN_VID</sub>	VIDEO Input Capacitance	V <sub>CC</sub> = 5.0V; V <sub>IN</sub> = 2.5V; f = 1MHz			3	pF
		V <sub>CC</sub> = 2.5V; V <sub>IN</sub> = 1.25V; f = 1MHz			3.5	pF
t <sub>PLH</sub>	SYNC Driver L => H Propagation Delay	C <sub>L</sub> = 50pF; V <sub>CC</sub> = 5.0V; Input t <sub>r</sub> and t <sub>f</sub> 5ns			12	ns
t <sub>PHL</sub>	SYNC Driver H => L Propagation Delay	C <sub>L</sub> = 50pF; V <sub>CC</sub> = 5.0V; Input t <sub>r</sub> and t <sub>f</sub> 5ns			12	ns
t <sub>R</sub> , t <sub>F</sub>	SYNC Driver Output Rise & Fall Times	V <sub>CC</sub> = 5V		7		ns
V <sub>ESD</sub>	ESD Withstand Voltage	V <sub>CC</sub> = 5V; Note 3	±8			kV

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

Note 2: These parameters apply only to the SYNC drivers. Note that R<sub>OUT</sub> = R<sub>T</sub> + R<sub>BUFFER</sub>.

Note 3: Per the IEC-61000-4-2 International ESD Standard, Level 4 contact discharge method. V<sub>CC</sub> must be bypassed to GND via a low impedance ground plane with a 0.22μF, low inductance, chip ceramic capacitor at each supply pin. ESD pulse is applied between the applicable pins and GND. ESD pulses can be positive or negative with respect to GND.

## Application Information



**Figure 1. Typical Application Connection Diagram**

### NOTES:

- 1 The CM2009-05CP should be placed as close to the VGA or DVI-I connector as possible.
- 2 The ESD protection channels VIDEO\_1, VIDEO\_2, VIDEO\_3 may be used interchangeably between the R, G, B signals.
- 3 If differential video signal routing is used, the RED, BLUE, and GREEN signal lines should be terminated with external 37.5 ohm resistors.
- 4 "VF" are external video filters for the RGB signals.
- 5 Supply bypass capacitors C1 and C2 must be placed immediately adjacent to the corresponding Vcc pins. Connections to the Vcc pins and ground plane must be made with minimal length copper traces (preferably less than 5mm) for best ESD protection.
- 6 The bypass capacitor for the BYP pin has been omitted in this diagram. This results in a reduction in the maximum ESD withstand voltage at the DDC\_OUT pins from  $\pm 8\text{kV}$  to  $\pm 2\text{kV}$ . If 8kV ESD protection is required, a  $0.22\mu\text{F}$  ceramic bypass capacitor should be connected between BYP and ground.
- 7 The SYNC buffers may be used interchangeably between HSYNC and VSYNC.
- 8 The EMI filters at the SYNC\_OUT and DDC\_OUT pins (C5 to C12, and Ferrite Beads FB1 to FB4) are for reference only. The component values and filter configuration may be changed to suit the application.
- 9 The DDC level shifters DDC\_IN, DDC\_OUT, may be used interchangeably between DDCA\_CLK and DDCA\_DATA.
- 10 R1, R2 are optional. They may be used, if required, to pull the DDC\_CLK and DDC\_DATA lines to VCC\_5V when no monitor is connected to the VGA connector. If used, it should be noted that "back current" may flow between the DDC pins and VCC\_5V via these resistors when VCC\_5V is powered down.

## Mechanical Specification

### Package Specification

The CM2009-05CP is supplied in 14-bump, 5-4-5 Chip Scale Package (CSP).

PACKAGE DIMENSIONS						
Package	Custom CSP					
Bumps	14					
Dim	Millimeters			Inches		
	Min	Nom	Max	Min	Nom	Max
A1	1.955	2.000	2.045	0.0770	0.0787	0.0805
A2	1.055	1.100	1.145	0.0415	0.0433	0.0451
B1	0.395	0.400	0.405	0.0156	0.0157	0.0159
B2	0.195	0.200	0.205	0.0077	0.0079	0.0081
B3	0.342	0.347	0.352	0.0135	0.0137	0.0139
B4	0.342	0.347	0.352	0.0135	0.0137	0.0139
C1	0.150	0.200	0.250	0.0059	0.0079	0.0098
C2	0.153	0.203	0.253	0.0060	0.0080	0.0100
D1	0.530	0.580	0.630	0.0209	0.0228	0.0248
D2	0.363	0.391	0.419	0.0143	0.0154	0.0165
# per tape and reel	3500					
Controlling dimension: millimeters						

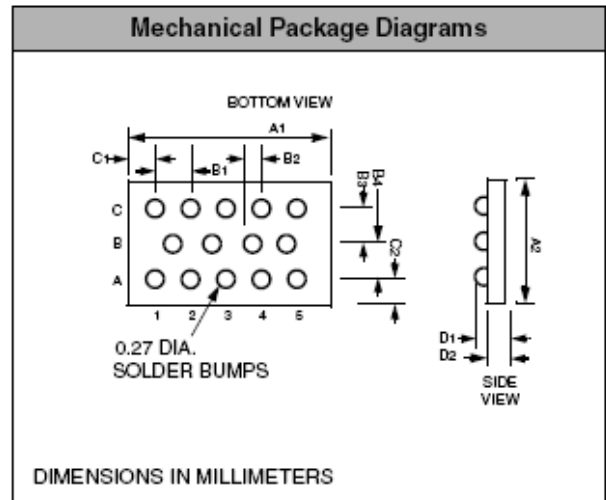
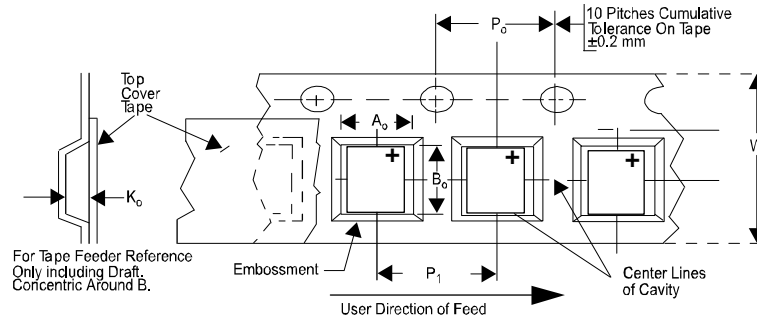



Figure 2. Package Dimensions for CM2009-05CP 14-bump Chip Scale Package

**CSP Tape and Reel Specifications**

PART NUMBER	CHIP SIZE (mm)	POCKET SIZE (mm) $B_0 \times A_0 \times K_0$	TAPE WIDTH W	REEL DIAMETER	QTY PER REEL	$P_0$	$P_1$
CM2009-05CP	2.00 x 1.10 x 0.58	2.20 x 1.22 x 0.73	8mm	178mm (7")	3500	4mm	4mm



**Figure 3. Tape and Reel Mechanical Data**

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