

## HDMI Transmitter Port Protection and Interface Device

### Features

- 0.05pF matching capacitance between the TMDS intra-pair
- Overcurrent output protection
- Level shifting/isolation circuitry
- Provides ESD protection to IEC61000-4-2 Level 4
  - 8kV contact discharge
  - 15kV air discharge
- Matched 0.5mm trace spacing (TSSOP)
- Simplified layout for HDMI connectors
- Backdrive protection
- Lead-free version available

### Product Description

The CM2020 HDMI Transmitter Port Protection and Interface Device is specifically designed for next generation HDMI Source interface protection.

An integrated package provides all ESD, level shift, overcurrent output protection and backdrive protection for an HDMI port in a single 38-Pin TSSOP package.

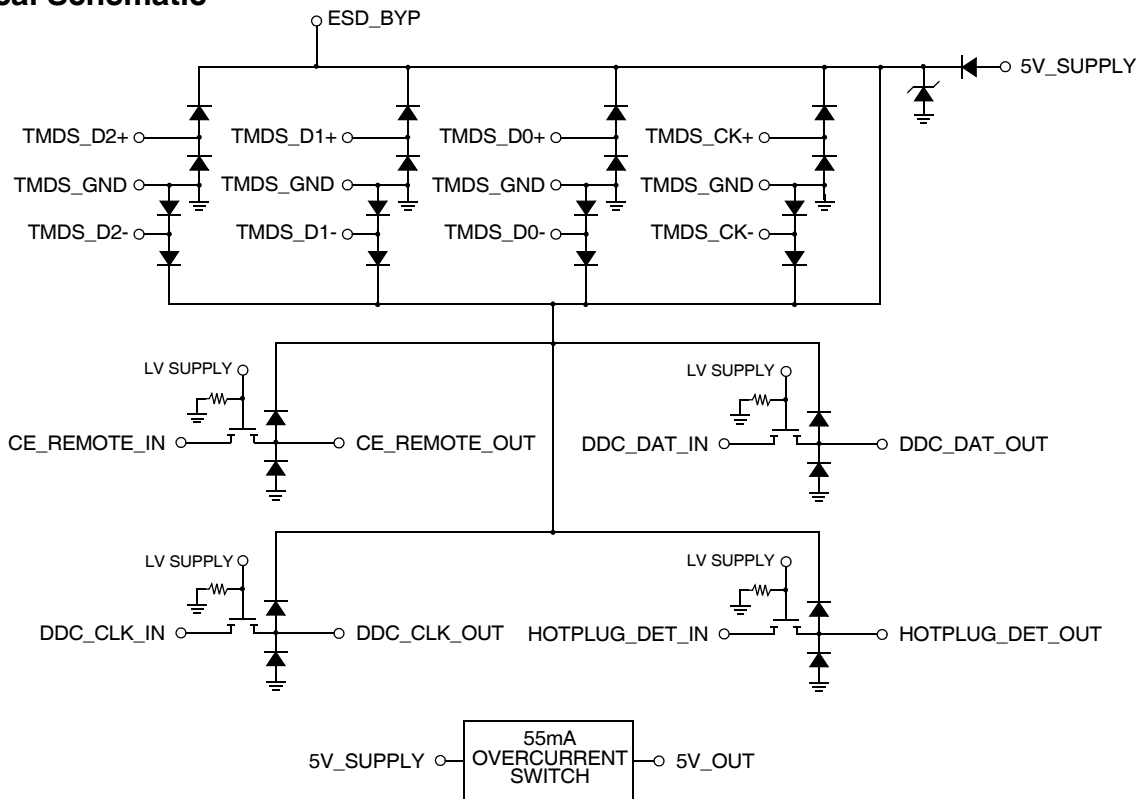
The CM2020 part is specifically designed to complement the CM2021 protection part in HDMI receivers (Displays, DTV, CE devices, etc.)

The CM2020 also incorporates a silicon overcurrent protection device for +5V supply voltage output to the connector.

### Applications

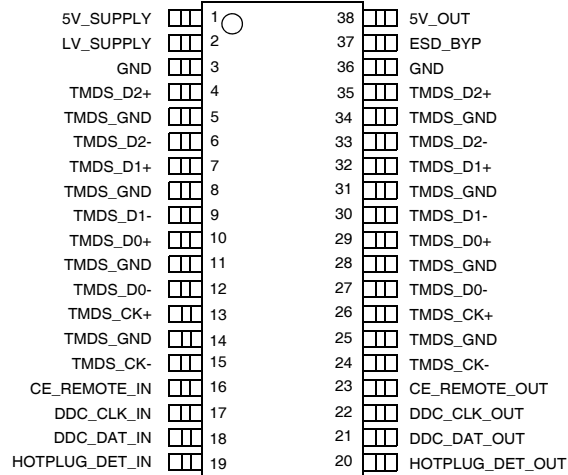
- PC
- Consumer Electronics
- Set Top Box
- DVDRW Players

### Electrical Schematic



**PACKAGE / PINOUT DIAGRAM**

## TOP VIEW



Note: This drawing is not to scale.

38-PIN TSSOP PACKAGE

**Pin Descriptions**
**PIN DESCRIPTIONS**

PINS	NAME	ESD Level	DESCRIPTION
4, 35	TMDS_D2+	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
6, 33	TMDS_D2-	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
7, 32	TMDS_D1+	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
9, 30	TMDS_D1-	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
10, 29	TMDS_D0+	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
12, 27	TMDS_D0-	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
13, 26	TMDS_CK+	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
15, 24	TMDS_CK-	8kV <sup>3</sup>	TMDS 0.9pF ESD protection <sup>1</sup> .
16	CE_REMOTE_IN	2kV <sup>4</sup>	LV_SUPPLY referenced logic level into ASIC.
23	CE_REMOTE_OUT	8kV <sup>3</sup>	5V_SUPPLY referenced logic level out plus 3.5pF ESD to connector.
17	DDC_CLK_IN	2kV <sup>4</sup>	LV_SUPPLY referenced logic level into ASIC.
22	DDC_CLK_OUT	8kV <sup>3</sup>	5V_SUPPLY referenced logic level out plus 3.5pF ESD to connector.
18	DDC_DAT_IN	2kV <sup>4</sup>	LV_SUPPLY referenced logic level into ASIC.
21	DDC_DAT_OUT	8kV <sup>3</sup>	5V_SUPPLY referenced logic level out plus 3.5pF ESD to connector.
19	HOTPLUG_DET_IN	2kV <sup>4</sup>	LV_SUPPLY referenced logic level into ASIC.
20	HOTPLUG_DET_OUT	8kV <sup>3</sup>	5V_SUPPLY referenced logic level out plus 3.5pF ESD <sup>2</sup> to connector
2	LV_SUPPLY	2kV <sup>4</sup>	Bias for CE / DDC / HOTPLUG level shifters.
1	5V_SUPPLY	2kV <sup>4</sup>	Current source for 5V_OUT.
38	5V_OUT	8kV <sup>3</sup>	55mA minimum overcurrent protected 5V output. This output must be bypassed with a 0.1μF ceramic capacitor.
37	ESD_BYP	2kV <sup>4</sup>	This pin must be connected to a 0.1μF ceramic capacitor.

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PIN DESCRIPTIONS			
3, 36	GND	N/A	Supply GND reference.
5, 34, 8, 31, 11, 28, 14, 25	TMDS_GND	N/A	TMDS ESD and Parasitic GND return. <sup>5</sup>

Note 1: These 2 pins need to be connected together in-line on the PCB.

Note 2: This output can be connected to an external 0.1 $\mu$ F ceramic capacitor, resulting in an increased ESD withstand voltage rating.

Note 3: Standard IEC 61000-4-2, C<sub>DISCHARGE</sub>=150pF, R<sub>DISCHARGE</sub>=330 $\Omega$ , 5V\_SUPPLY and LV\_SUPPLY within recommended operating conditions, GND=0V and ESD\_BYP (pin 37), 5V\_OUT (pin 38), and HOTPLUG\_DET\_OUT (pin 20) each bypassed with a 0.1 $\mu$ F ceramic capacitor connected to GND.

Note 4: Human Body Model per MIL-STD-883, Method 3015, C<sub>DISCHARGE</sub>=100pF, R<sub>DISCHARGE</sub>=1.5k $\Omega$ , 5V\_SUPPLY and LV\_SUPPLY within recommended operating conditions, GND=0V and ESD\_BYP (pin 37), 5V\_OUT (pin 38), and HOTPLUG\_DET\_OUT (pin 20) each bypassed with a 0.1 $\mu$ F ceramic capacitor connected to GND.

Note 5: These pins should be routed directly to the associated GND pins on the HDMI connector with single point ground vias at the connector

## 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
38	TSSOP-38	CM2020-00TS	CM2020-00TS	CM2020-00TR	CM2020-00TR

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

## Backdrive protection

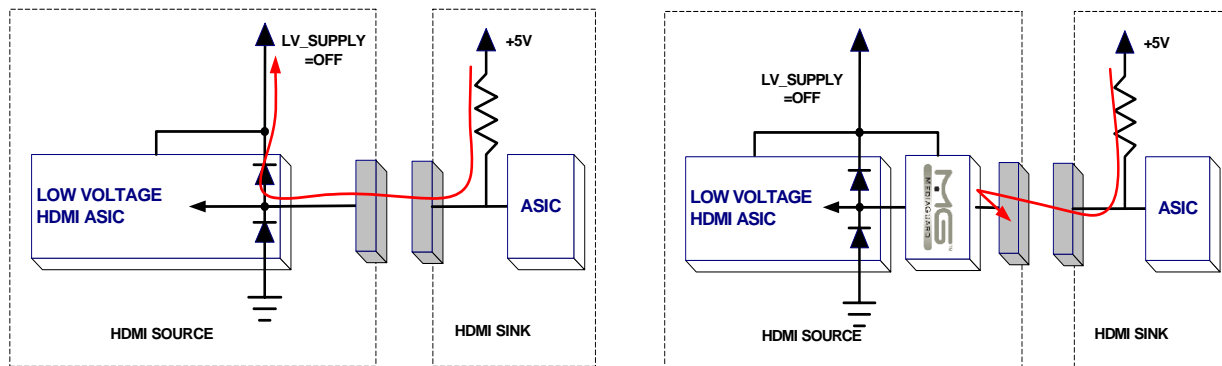
Below, two scenarios are discussed to illustrate what can happen when a powered device is connected to an unpowered device via a HDMI interface, substantiating the need for backdrive protection on this type of interface.

In the first example a DVD player is connected to a TV via an HDMI interface. If the DVD player is switched off and the TV is left on, there is a possibility of reverse current flow back into the main power supply rail of the DVD player. Typically, the DVD's power supply has some form of bulk supply capacitance associated with it. Because all CMOS logic exhibits a very high impedance on the power rail node when "off", if there may be very little parasitic shunt resistance, and even with as little as a few milliamps of "backdrive" current flowing into the power rail, it is possible over time to charge that bulk supply capacitance to some intermediate level. If this level rises above the power-on-reset (POR) voltage level of some of the integrated circuits in

the DVD player, these devices may not reset properly when the DVD player is turned back on.

In a more serious scenario, if any SOC devices are incorporated in the design which have built-in level shifter and DRC diodes for ESD protection, there is even a risk for permanent damage. In this case, if there is a pullup resistor (such as with DDC) on the other end of the cable, then that resistance will pull the SOC chips "output" up to a high level. This will forward bias the upper ESD diode in the DRC and charge the bulk capacitance in a similar fashion as described in the first example. If this current flow is high enough, even as little as a few milliamps, it could destroy one of the SOC chip's internal DRC diodes, as they are not designed for passing DC.

To avoid either of these situations, the CM2020 was designed to block backdrive current, guaranteeing no more than 5µA on any I/O pin when the I/O pin voltage is greater than the CM2020 supply voltage.



**Figure 1. Backdrive Protection Diagram.**

## Specifications

### ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNITS
$V_{CC5V}$ , $V_{CCLV}$	6.0	V
DC Voltage at any Channel Input	6.0	V
Storage Temperature Range	-65 to +150	°C

### STANDARD (RECOMMENDED) OPERATING CONDITIONS

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS
5V_SUPPLY	Operating Supply Voltage	GND	5	5.5	V
LV_SUPPLY	Bias Supply Voltage	1	3.3	5.5	V
	Operating Temperature Range	-40		85	°C

### ELECTRICAL OPERATING CHARACTERISTICS (SEE NOTE 1)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$I_{CC5V}$	Operating Supply Current	5V_SUPPLY = 5.0V		110	130	μA
$I_{CCLV}$	Bias Supply Current	LV_SUPPLY = 3.3V		1	5	μA
$V_{DROP}$	5V_OUT Overcurrent Output Drop	5V_SUPPLY = 5.0V, $I_{OUT} = 55mA$		65	100	mV
$I_{SC}$	5V_OUT Short Circuit Current Limit	5V_SUPPLY = 5.0V, 5V_OUT = GND	90	135	175	mA
$I_{OFF}$	OFF state leakage current, level shifting NFET	LV_SUPPLY = 0V		0.1	5	μA
$I_{BACKDRIVE}$	Current conducted from output pins to V_SUPPLY rails when powered down	5V_SUPPLY < $V_{CH\_OUT}$ ; Signal pins: TMDS_[2:0]±/±, TMDS_CK±/±, CE_REMOTE_OUT, DDC_DAT_OUT, DDC_CLK_OUT, HOTPLUG_DET_OUT, 5V_OUT Only		0.1	5	μA
$V_{ON}$	VOLTAGE drop across level shifting NFET when ON	LV_SUPPLY = 2.5V, $V_S = GND$ , $I_{DS} = 3mA$	75	95	140	mV
$V_F$	Diode Forward Voltage Top Diode Bottom Diode	$I_F = 8mA$ , $T_A = 25°C$ , Note 2	0.6 0.6	0.85 0.85	0.95 0.95	V V
$V_{ESD}$	ESD Withstand Voltage, contact discharge per IEC 61000-4-2 standard (IEC)	Pins 4, 7, 10, 13, 20, 21, 22, 23, 24, 27, 30, 33, 38; Notes 2, 3 and 5; $T_A = 25°C$	±8			kV
$V_{ESD}$	ESD Withstand Voltage, Human Body Model (HBM), MIL-STD-883, Method 3015	Pins 1, 2, 16, 17, 18, 19, 37 Notes 2, 4 and 5; $T_A = 25°C$	±2			kV
$V_{CL}$	Channel Clamp Voltage Positive Transients Negative Transients	$T_A = 25°C$ , $I_{PP} = 1A$ , $t_p = 8/20\mu S$ ; Notes 2, & 5		10.8 -2.1		V V

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

$R_{DYN}$	Dynamic Resistance Positive Transients Negative Transients	$I_{PP} = 1A$ , $t_p = 8/20\mu S$ ; Notes 2 and 5; $T_A = 25^\circ C$		1.4 0.9		$\Omega$ $\Omega$
$I_{LEAK}$	TMDS Channel Leakage Current	$T_A = 25^\circ C$ , Note 2		0.01	1	$\mu A$
$C_{IN, TMDS}$	TMDS Channel Input Capacitance	$5V\_SUPPLY = 5.0V$ , Measured at 1MHz, $V_{BIAS} = 2.5V$ , Note 2		0.9	1.2	pF
$\Delta C_{IN, TMDS}$	TMDS Channel Input Capacitance Matching	$5V\_SUPPLY = 5.0V$ , Measured at 1MHz, $V_{BIAS} = 2.5V$ , Note 2, 6		0.05		pF
$C_{MUTUAL}$	Mutual Capacitance between signal pin and adjacent signal pin	$5V\_SUPPLY = 0V$ , Measured at 1MHz, $V_{BIAS} = 2.5V$ , Note 2		0.07		pF
$C_{IN, DDC}$	Level Shifting Input Capacitance, Capacitance to GND	$5V\_SUPPLY = 0V$ , Measured at 100KHz, $V_{BIAS} = 2.5V$ , Note 2		3.5	4	pF
$C_{IN, CEC}$	Level Shifting Input Capacitance, Capacitance to GND	$5V\_SUPPLY = 0V$ , Measured at 100KHz, $V_{BIAS} = 2.5V$ , Note 2		3.5	4	pF
$C_{IN, HP}$	Level Shifting Input Capacitance, Capacitance to GND	$5V\_SUPPLY = 0V$ , Measured at 100KHz, $V_{BIAS} = 2.5V$ , Note 2		3.5	4	pF

Note 1: Operating Characteristics are over Standard Operating Conditions unless otherwise specified.

Note 2: This parameter is guaranteed by design and verified by device characterization.

Note 3: Standard IEC 61000-4-2,  $C_{DISCHARGE} = 150pF$ ,  $R_{DISCHARGE} = 330\Omega$ ,  $5V\_SUPPLY$  and  $LV\_SUPPLY$  within recommended operating conditions,  $GND = 0V$  and  $ESD\_BYP$  (pin 37),  $5V\_OUT$  (pin 38), and  $HOTPLUG\_DET\_OUT$  (pin 20) each bypassed with a  $0.1\mu F$  ceramic capacitor connected to GND.

Note 4: Human Body Model per MIL-STD-883, Method 3015,  $C_{DISCHARGE} = 100pF$ ,  $R_{DISCHARGE} = 1.5k\Omega$ ,  $5V\_SUPPLY$  and  $LV\_SUPPLY$  within recommended operating conditions,  $GND = 0V$  and  $ESD\_BYP$  (pin 37),  $5V\_OUT$  (pin 38), and  $HOTPLUG\_DET\_OUT$  (pin 20) each bypassed with a  $0.1\mu F$  ceramic capacitor connected to GND.

Note 5: These measurements performed with no external capacitor on  $ESD\_BYP$ .

Note 6: Intra-pair matching, each TMDS pair (i.e. D+, D-)

**Performance Information**

Typical Filter Performance (T<sub>A</sub>=25°C, DC Bias=0V, 50 Ohm Environment)

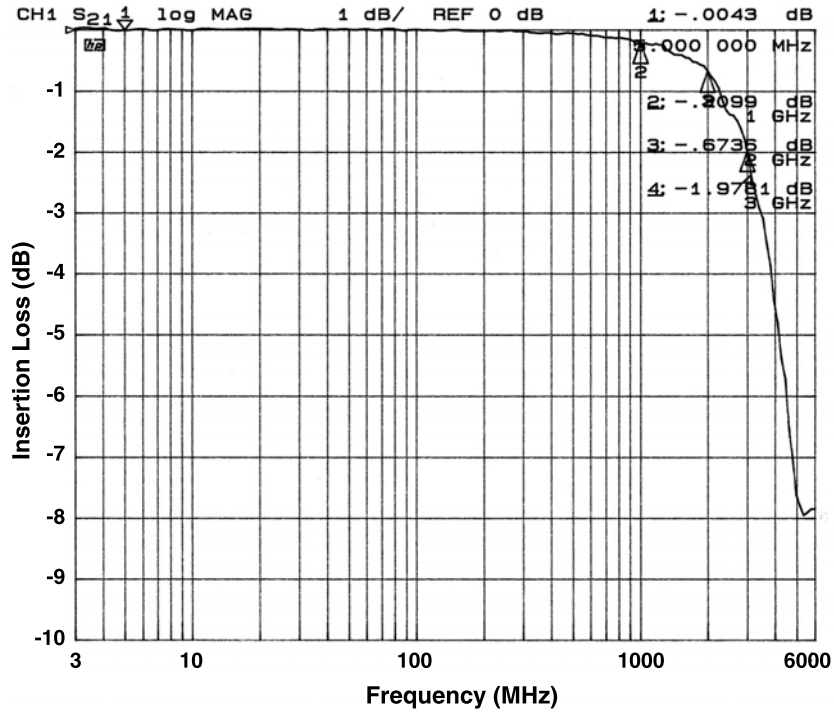
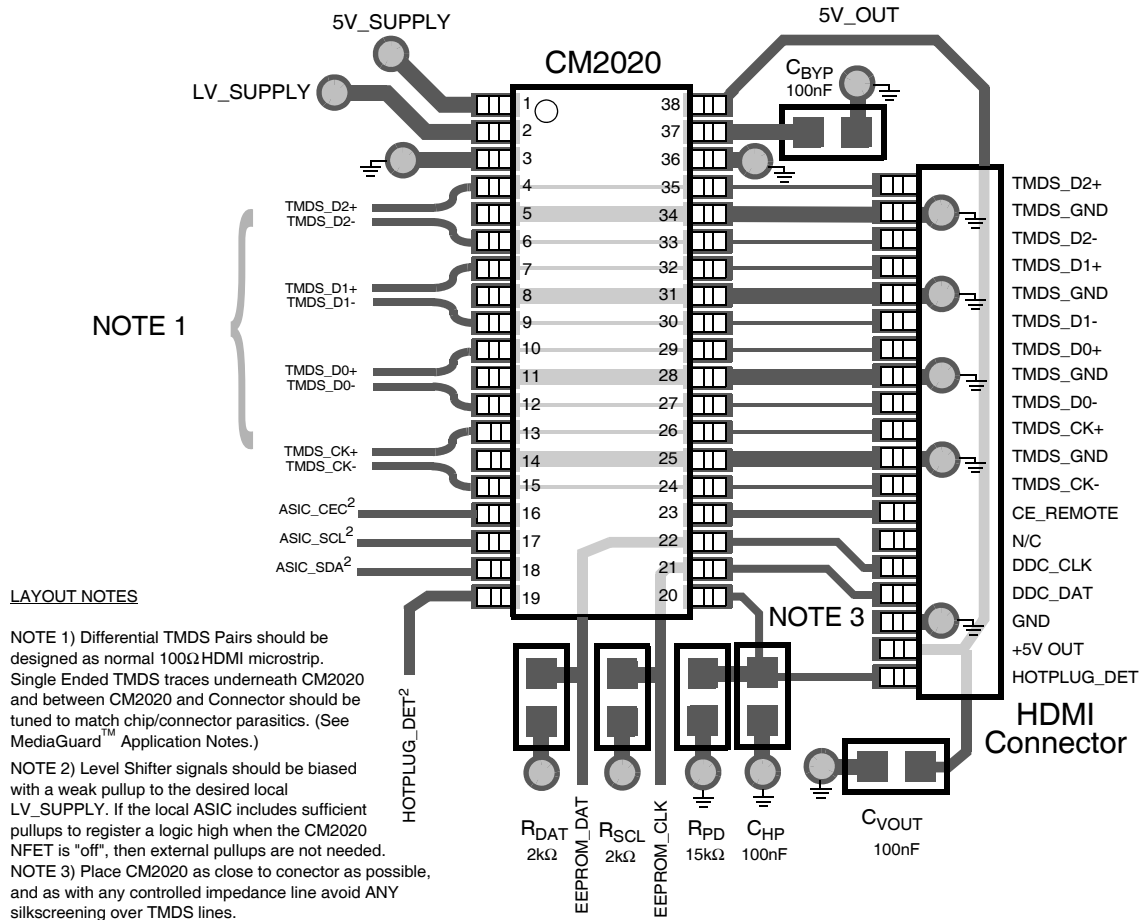


Figure 2. Insertion Loss vs. Frequency (TMDS\_D1- to GND)

**Application Information**



**Figure 3. Typical Application for CM2020**

## Application Information (cont'd)

### Design Considerations

#### ESD Bypass

Pin 37 (ESD\_BYP) is provided for an optional external ESD bypass capacitor only (i.e. 0.1 $\mu$ F ceramic.) It should not be connected to any supply rail.

#### 5V Overcurrent Output

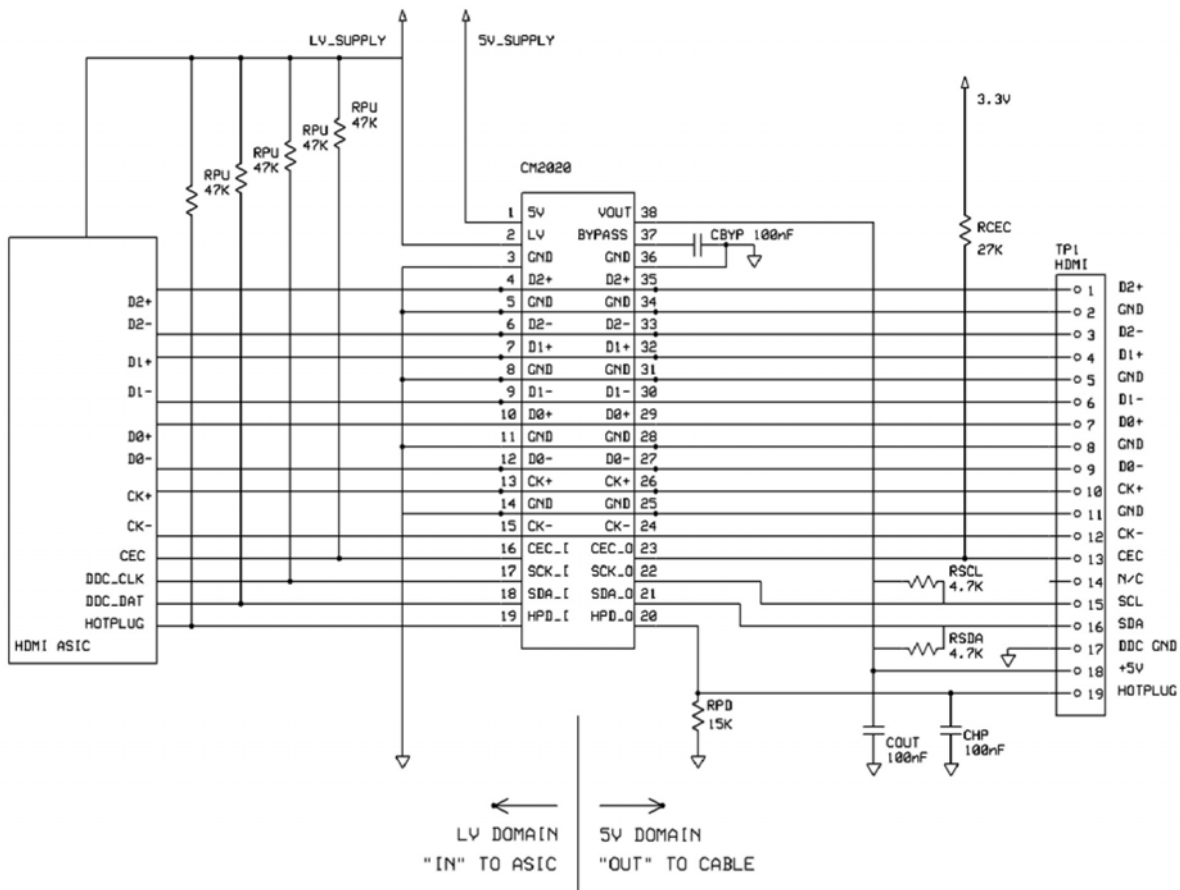
Maximum Overcurrent Protection output drop at 55mA on 5V\_OUT is 100mV. To meet HDMI output requirements of 4.8-5.3V, an input of greater than 4.9V should be used (i.e. 5.1V +/- 4%). A 0.1 $\mu$ F ceramic bypass capacitor on this output is also recommended.

#### Hotplug Detect Input

To meet the requirements of HDMI CTS TID7-12, the following pullup/pulldown configuration is recommended for a 3.3V+/-10% internal VCC rail (See Figure 4 below). A 0.1 $\mu$ F ceramic capacitor is recommended for additional edge debounce and ESD bypass.

#### DUT On vs. DUT Off

Many HDMI CTS tests require a power off condition on the System Under Test. Many Dual Rail Clamp (DRC) ESD diode configurations will be forward biased when their VDD rail is lower than the I/O pin bias, thereby exhibiting extremely high apparent capacitance measurements, for example. The MediaGuard<sup>TM</sup> back-drive isolation circuitry limits this current to <5 $\mu$ A, and will help ensure compliance.



**Figure 4. Design Example.**

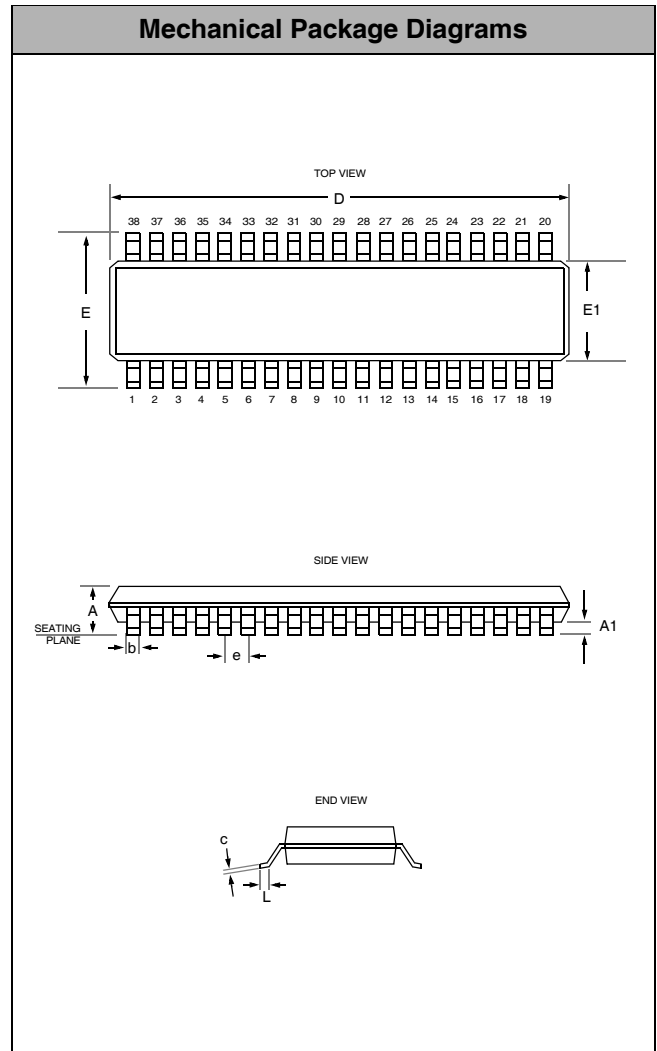
## Mechanical Details

### TSSOP-38 Mechanical Specifications

CM2020 devices are supplied in 38-pin TSSOP packages. Dimensions are presented below.

For complete information on the TSSOP-38, see the California Micro Devices TSSOP Package Information document.

PACKAGE DIMENSIONS				
Package	TSSOP			
JEDEC No.	MO-153 (Variation BD-1)			
Pins	38			
Dimensions	Millimeters		Inches	
	Min	Max	Min	Max
A	—	1.20	—	0.047
A1	0.05	0.15	0.002	0.006
b	0.17	0.27	0.007	0.011
c	0.09	0.20	0.004	0.008
D	9.60	9.80	0.378	0.386
E	6.40 BSC		0.252 BSC	
E1	4.30	4.50	0.169	0.177
e	0.50 BSC		0.020 BSC	
L	0.45	0.75	0.018	0.030
# per tape and reel	2500 pieces			
Controlling dimension: millimeters				



Package Dimensions for TSSOP-38