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## PCB Layout and Design Guide for CH7025/CH7026 TV/VGA Encoder

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### 1.0 Introduction

The CH7025/CH7026 is a device targeting handheld and similar systems which accept a digital input signal, and encodes and transmits data through three 10-bit DACs. The device is able to encode the video signals and generate synchronization signals for NTSC and PAL standards. Analog RGB output and composite SYNC signal are also supported. The device accepts different data formats including RGB and YCrCb (e.g. RGB565, RGB666, RGB888, ITU656 like YCrCb, etc.). 16Mbit SDRAM can be embedded in package, so Frame rate conversion is possible.

This application note focuses only on the basic PCB layout and design guidelines for CH7025/CH7026 SDTV/VGA encoder. Guidelines in component placement, power supply decoupling, grounding, input/output signal interface are discussed in this document.

The discussion and figures that follow reflect and describe connections based on the 80-pin LQFP and BGA package of the CH7025/CH7026. Please refer to the CH7025/CH7026 datasheet for the details of the pin assignments.

### 2.0 Component Placement and Design Considerations

Components associated with the CH7025/CH7026 should be placed as close as possible to the respective pins. The following discussion will describe guidelines on how to connect critical pins, as well as describe the guidelines for the placement and layout of components associated with these pins.

#### 2.1 Power Supply Decoupling

The optimum power supply decoupling is accomplished by placing a 0.1uF ceramic capacitor to each of the power supply pins as shown in **Figure 1**. These capacitors (C1, C2, C3, C4, C5, C6, C7) should be connected as close as possible to their respective power and ground pins using short and wide traces to minimize lead inductance. Whenever possible, a physical connecting trace should connect the ground pins of the decoupling capacitors to the CH7025/CH7026 ground pins, in addition to ground vias.

##### 2.1.1 Ground Pins

The analog and digital grounds of the CH7025/CH7026 should be connected to a common ground plane to provide a low impedance return path for the supply currents. Whenever possible, each of the CH7025/CH7026 ground pins should be connected to its respective decoupling capacitor ground lead directly, then connected to the ground plane through a ground via. Short and wide traces should be used to minimize the lead inductance. See **Table 1** and **Table 2** for the Ground pins assignment.

##### 2.1.2 Power Supply Pins

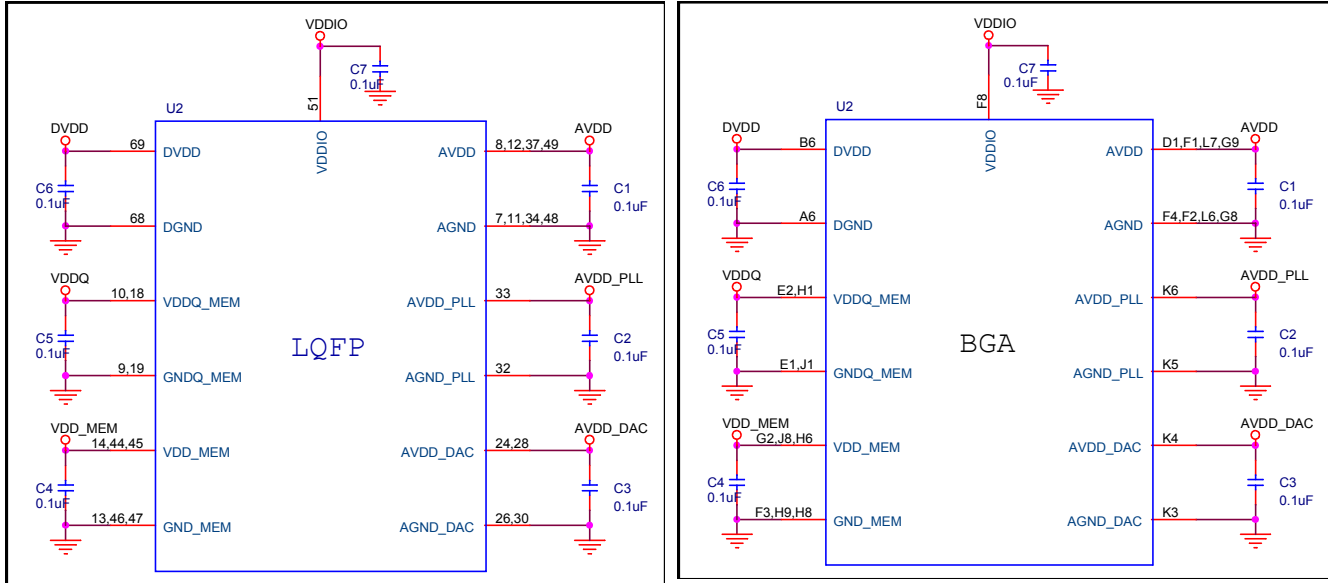
There are four power supply pins, AVDD, AVDD\_DAC, AVDD\_PLL, VDDIO, DVDD, VDDQ, VDD\_MEM. See **Table 1** for the Power supply pins assignment. See **Figure 1** for Power Supply Decoupling

Table 1: Power Supply Pins Assignment of the CH7025/CH7026(LQFP )

Pin Assignment	# of Pins	Type	Symbol	Description
51	1	Power	VDDIO	IO supply voltage (1.2-3.3V)
69	1	Power	DVDD	Digital supply voltage (1.8V)
8,12,37,49	4	Power	AVDD	Analog supply voltage (2.5 – 3.3V)
33	1	Power	AVDD_PLL	PLL supply voltage (1.8V)
24,28	2	Power	AVDD_DAC	DAC power supply (2.5 – 3.3V)
10,18	2	Power	VDDQ_MEM	SDRAM output buffer supply voltage (1.8V or 2.5V)
14,44,45	3	Power	VDD_MEM	SDRAM device supply voltage (2.5V)
68	1	Ground	DGND	Digital supply ground
7,11,34,48	4	Ground	AGND	Analog supply ground
32	1	Ground	AGND_PLL	PLL supply ground
26,30	2	Ground	AGND_DAC	DAC supply ground
9,19	2	Ground	GNDQ	SDRAM output buffer supply ground
13,46,47	3	Ground	GND_MEM	SDRAM device supply ground

Table 2: Power Supply Pins Assignment of the CH7025/CH7026(BGA)

Pin Assignment	# of Pins	Type	Symbol	Description
F8	1	Power	VDDIO	IO supply voltage (1.2-3.3V)
B6	1	Power	DVDD	Digital supply voltage (1.8V)
D1, F1, L7, G9	4	Power	AVDD	Analog supply voltage (2.5 – 3.3V)
K6	1	Power	AVDD_PLL	PLL supply voltage (1.8V)
K4	1	Power	AVDD_DAC	DAC power supply (2.5 – 3.3V)
E2, H1	2	Power	VDDQ	SDRAM output buffer supply voltage (1.8V or 2.5V)
G2, J8, H6	3	Power	VDD_MEM	SDRAM device supply voltage (2.5V)
A6	1	Ground	DGND	Digital supply ground
F4, F2, L6, G8	4	Ground	AGND	Analog supply ground
K5	1	Ground	AGND_PLL	PLL supply ground
K3	1	Ground	AGND_DAC	DAC supply ground
E1, J1	2	Ground	GNDQ	SDRAM output buffer supply ground
F3, H9, H8	3	Ground	GND_MEM	SDRAM device supply ground



(a) LQFP Package

(b) BGA Package

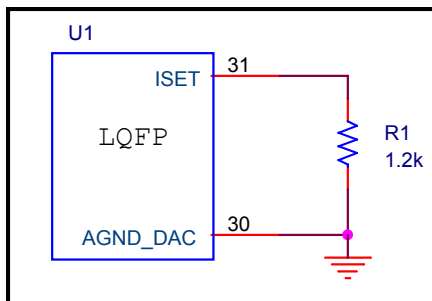
**Figure 1: Power Supply Decoupling and Distribution**

**Note:** All the Ferrite Beads described in this document are recommended to have an impedance of less than  $0.05 \Omega$  at DC;  $23 \Omega$  at 25MHz &  $47 \Omega$  at 100MHz. Please refer to Fair Rite part #2743019447 for details or an equivalent part can be used for the diagram.

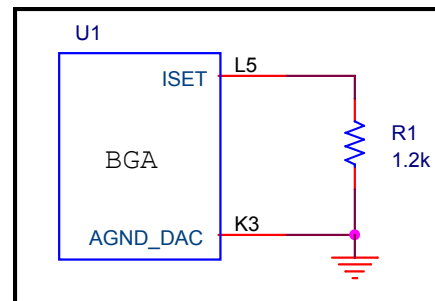
## 2.2 Internal Reference Pins

### • ISET pin

This pin sets the DAC current. A 1.2 k $\Omega$ , 1% tolerance resistor should be connected between ISET and AGND\_DAC as shown in **Figure 2**. A smaller resistance will create more DAC current, resulting brighter TV out images. This resistor should be placed with short and wide traces as much as possible to CH7025/CH7026.



(a) LQFP Package



(b) BGA Package

**Figure 2: ISET pin connection**

## 2.3 General Control Pins

### • RESETB

This pin is the chip reset pin for CH7025/CH7026. RESETB pin, which is internally pulled-up, places the device in the power on reset condition when this pin is low. A power reset switch can be placed on the RESETB pin on the PCB as a hardware reset for CH7025/CH7026 as shown in **Figure 3**. When the pin is high, the reset function can also be controlled through the serial port.

### • XI and XO

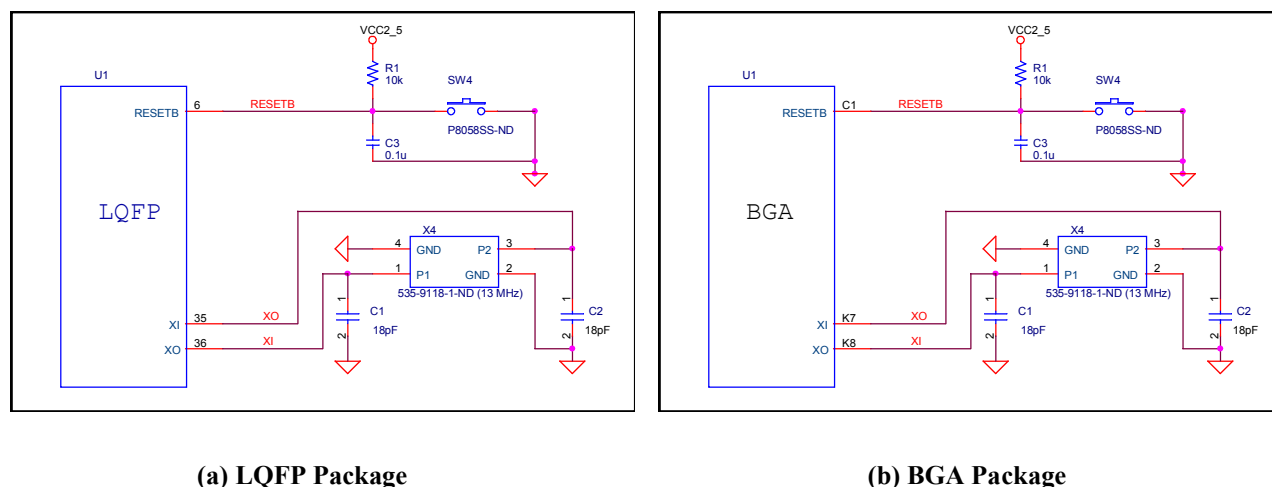
CH7025/CH7026 has capability to accept external clocks with frequencies from 0.7 MHz to 71.6 MHz. However, we recommend predefined crystal frequencies as stated in the CH7025/CH7026 datasheet for the crystal or oscillator.

Predefined crystal frequencies used for CH7025/CH7026 are shown in **Table 3**. The crystal selection register is located at Register 41h.

**Table 3: Predefined Crystal Frequencies**

XTAL[3:0]	Frequency
0	3.6864MHz
1	3.579545MHz
2	4MHz
3	12MHz
4	13MHz
5	13.5MHz
6	14.318MHz
7	14.7456MHz
8	16MHz
9	18.432MHz
10	20MHz
11	26MHz
12	27MHz
13	32MHz
14	40MHz
15	49MHz

The crystal load capacitance,  $C_L$ , is usually specified in the crystal spec from the vendor. As an example to show the load capacitors **Figure 3** gives a reference design for crystal circuit design.



**Figure 3: General Control Pins**

### • Reference Crystal Oscillator

CH7025/CH7026 includes an oscillator circuit that allows a predefined-frequency crystal to be connected directly. Alternatively, an externally generated clock source may be supplied to CH7025/CH7026. If an external clock source is used, it should have CMOS level specifications. The clock should be connected to the

XI pin, and the XO pin should be left open. The external source must exhibit  $\pm 20$ ppm or better frequency accuracy, and have low jitter characteristics.

If a crystal is used, the designer should ensure that the following conditions are met:

The crystal is specified to be predefined-frequency,  $\pm 20$  ppm fundamental type and in parallel resonance (NOT series resonance). The crystal should also have a load capacitance equal to its specified value ( $C_L$ ).

External load capacitors have their ground connection very close to CH7025/CH7026 ( $C_{ext}$ ).

To be able to tune, a variable capacitor may be connected from XI to ground.

Note that the XI and XO pins each has approximately 10 pF ( $C_{int}$ ) of shunt capacitance internal to the device. To calculate the proper external load capacitance to be added to the XI and XO pins, the following calculation should be used:

$$C_{ext} = (2 \times C_L) - C_{int} - 2C_S$$

where

$C_{ext}$  = external load capacitance required on XI and XO pins.

$C_L$  = crystal load capacitance specified by crystal manufacturer.

$C_{int}$  = capacitance internal to CH7025/CH7026 (approximately 10-15 pF on each of XI and XO pins).

$C_S$  = stray capacitance of the circuit (i.e. routing capacitance on the PCB, associated capacitance of crystal holder from pin to pin etc.).

In general,

$$C_{int-XI} = C_{int-XO} = C_{int}$$

$$C_{ext-XI} = C_{ext-XO} = C_{ext}$$

such that

$$C_L = (C_{int} + C_{ext}) / 2 + C_S \text{ and } C_{ext} = 2(C_L - C_S) - C_{int} = 2C_L - (2C_S + C_{int})$$

Therefore  $C_L$  must be specified greater than  $C_{int} / 2 + C_S$  in order to select  $C_{ext}$  properly.

After  $C_L$  (crystal load capacitance) is properly selected, care should be taken to make sure the crystal is not operating in an excessive drive level specified by the crystal manufacturer. Otherwise, the crystal will age quickly and that in turn will affect the operating frequency of the crystal.

For detail considerations of crystal oscillator design, please refer to **AN-06**.

## 2.4 Serial Port Control for CH7025/CH7026

### • SPC and SPD

SPD and SPC function as a serial interface where SPD is bi-directional data and SPC is an input only serial clock. In the reference design, SPD and SPC pins are pulled up to VDDIO (+1.2V ~ +3.3V) with 6.8k $\Omega$  resistors as shown in **Figure 4**.

### • AS

This pin determines the serial port address of CH7025/CH7026. Address = 75h when AS is high. Address = 76h when AS is low. See **Figure 4** for detail.

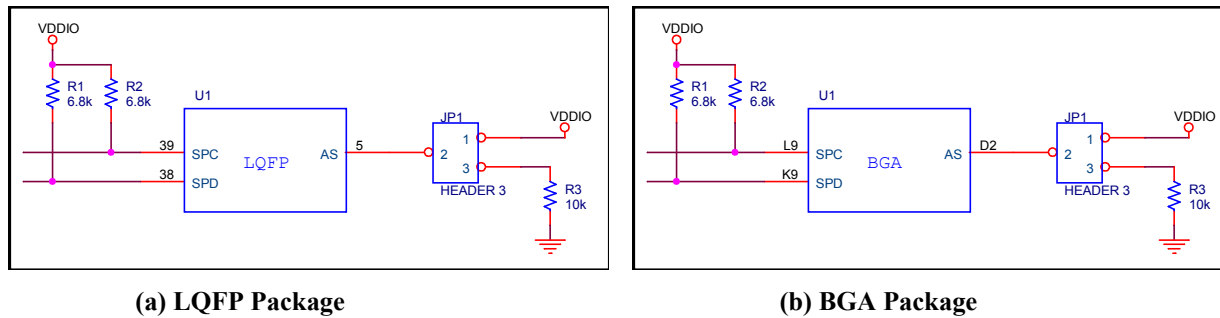


Figure 4: Serial Port Control

## 2.5 Input Pins

### • Data Inputs

CH7025/CH7026 can accept up to 24 data inputs, as shown in **Figure 5**, from a digital video port of a graphics controller. The swing is defined by VDDIO (1.2 ~ 3.3V).

Unused Data input pins can leave them open or pull down with 10k $\Omega$  resistors.

### • H/V Sync Pins

The horizontal/vertical sync pins can be used as inputs when the sync slave mode is used as shown in **Figure 5**.

### • DE/CSB

The DE/CSB pin is used as a data input indicator (See **Figure 5**). When the pin is high, the input data is active. When the pin is low, the input data is blanking.

### • GCLK

The GCLK input is the clock signal input to the device for use with the H, V, DE and D[23:0] data.

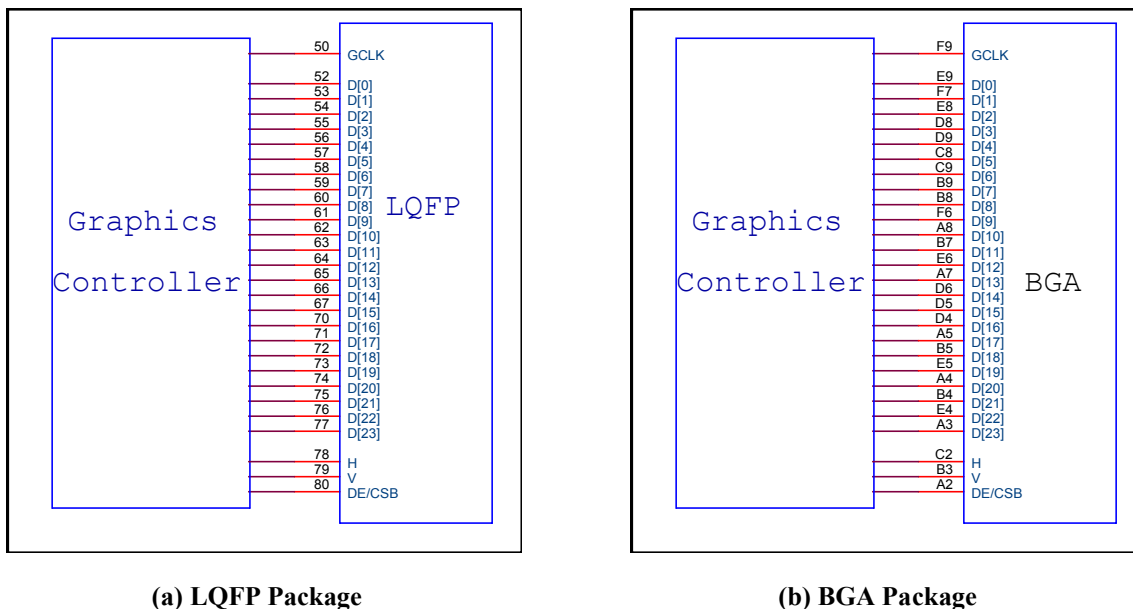


Figure 5: CH7025/CH7026 Input Pins

## 2.6 Miscellaneous Pins

### • ATPG

The ATPG pin should be left open or pulled low with a 10k  $\Omega$  resistor in the application as shown in **Figure 6**.

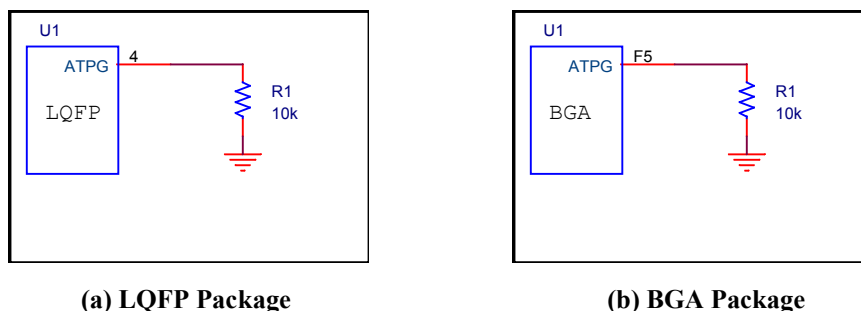
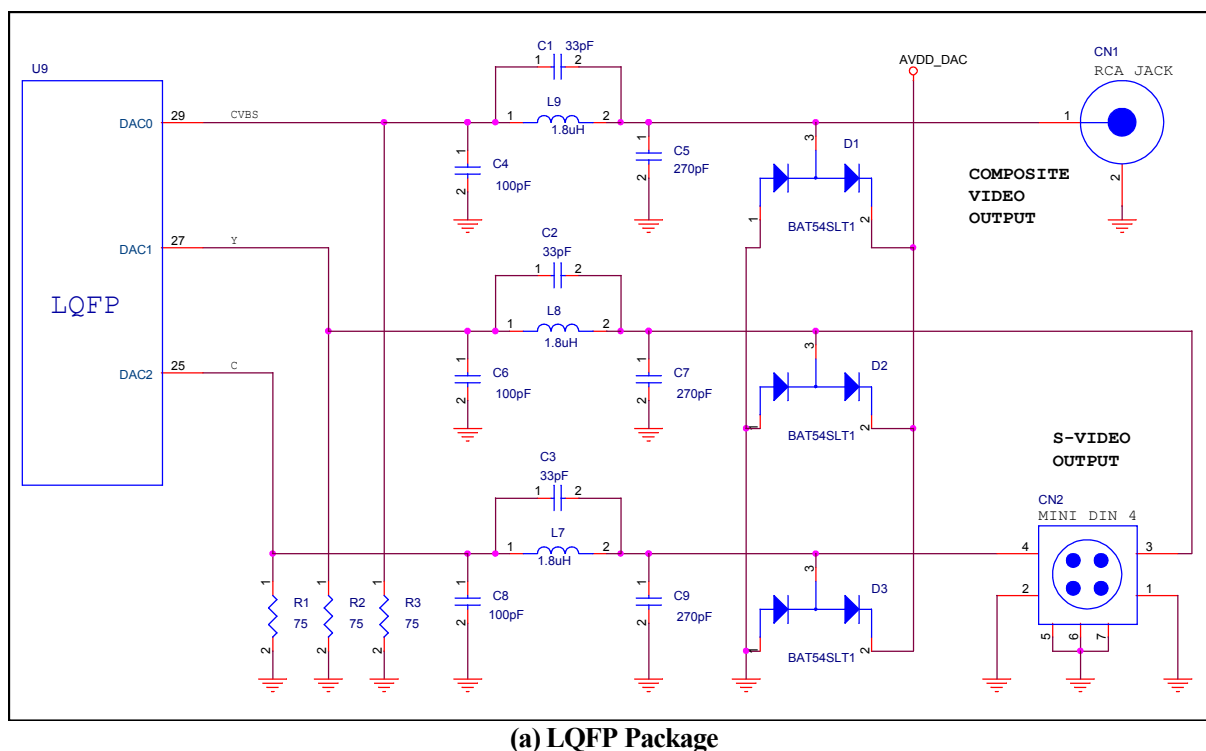


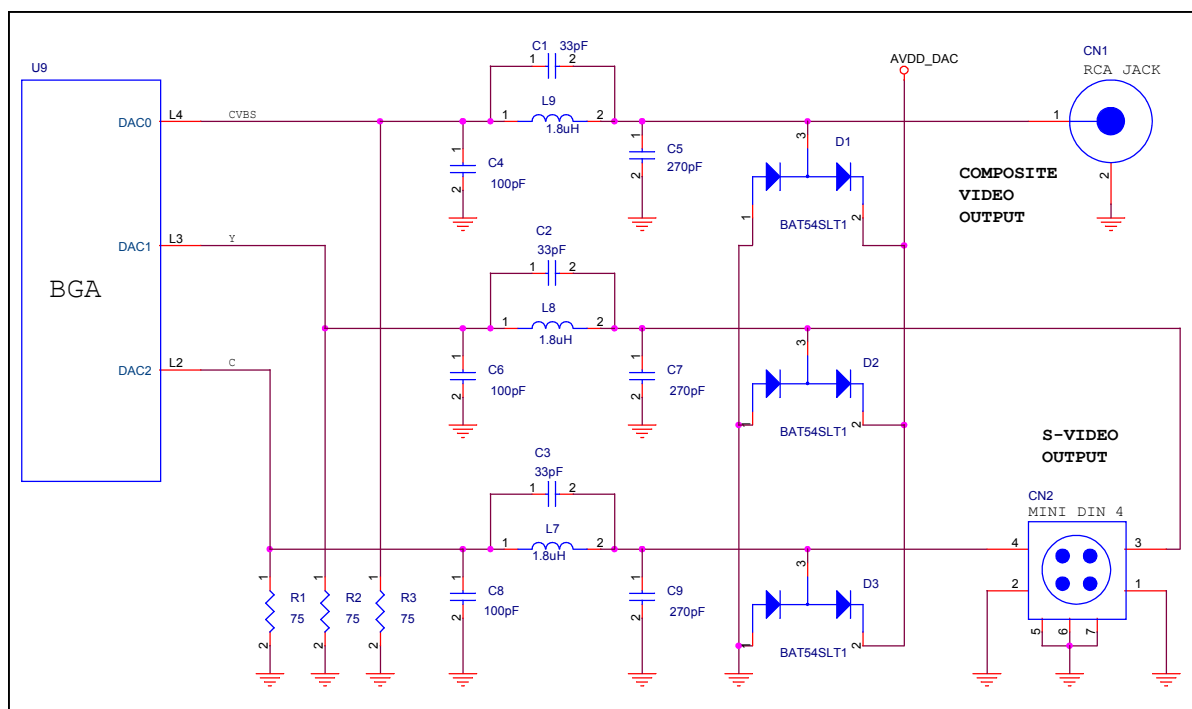
Figure 6: ATPG Pin

## 2.7 TV Video Outputs

### • DAC0~2

Three on-chip 10-bit high speed DACs providing flexible output capabilities. Such as single, double or triple CVBS output, YPbPR output, RGB output and simultaneous CVBS and S-video output. If the DAC requires a double termination, a 75  $\Omega$  resistor should be placed between the CVBS pin and the ground as shown in **Figure 7**.





(b) BGA Package

Figure 7: CH7025/CH7026 Video Output

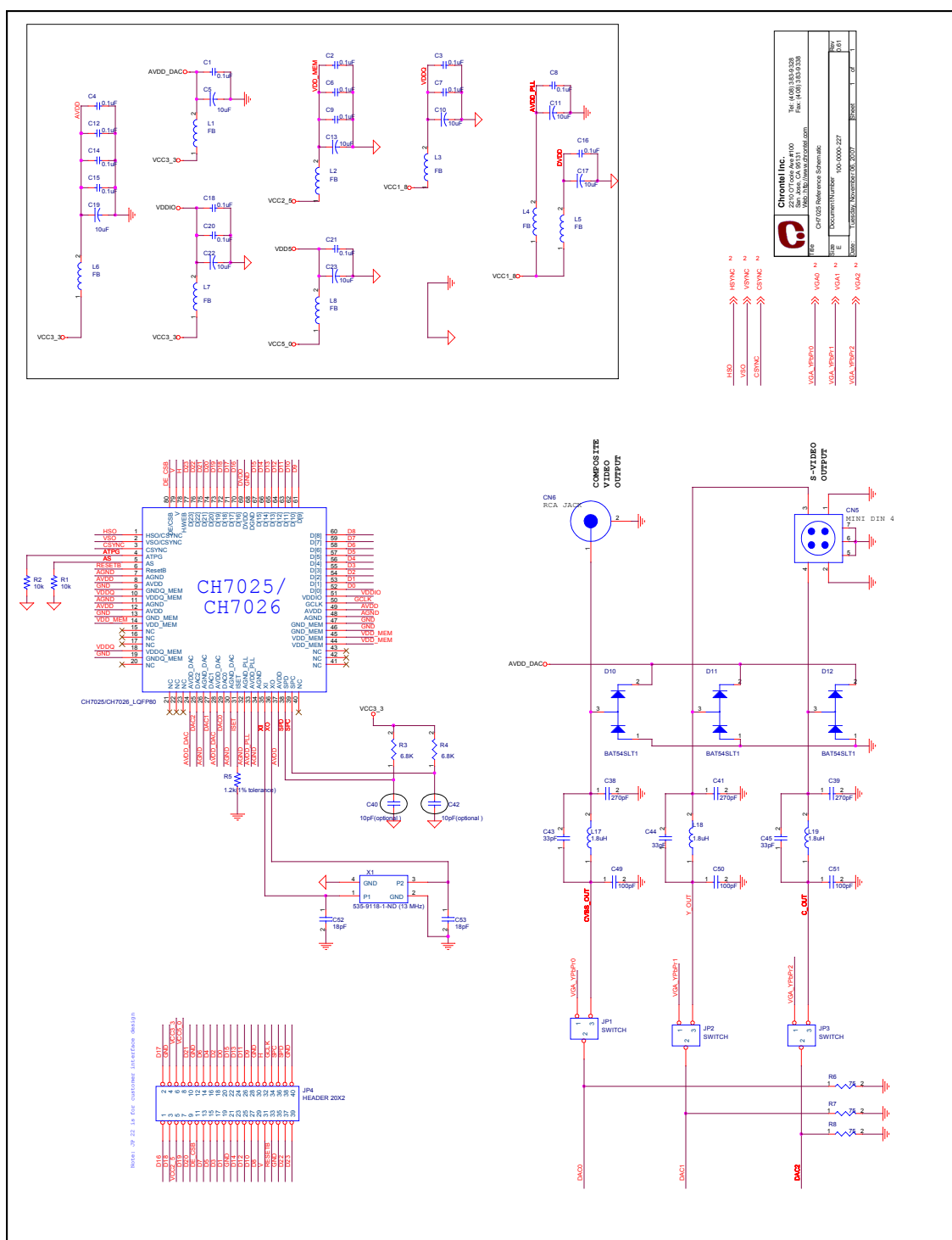
**In order to minimize the hazard of ESD, a set of protection diodes are highly recommended for each DAC Output.**



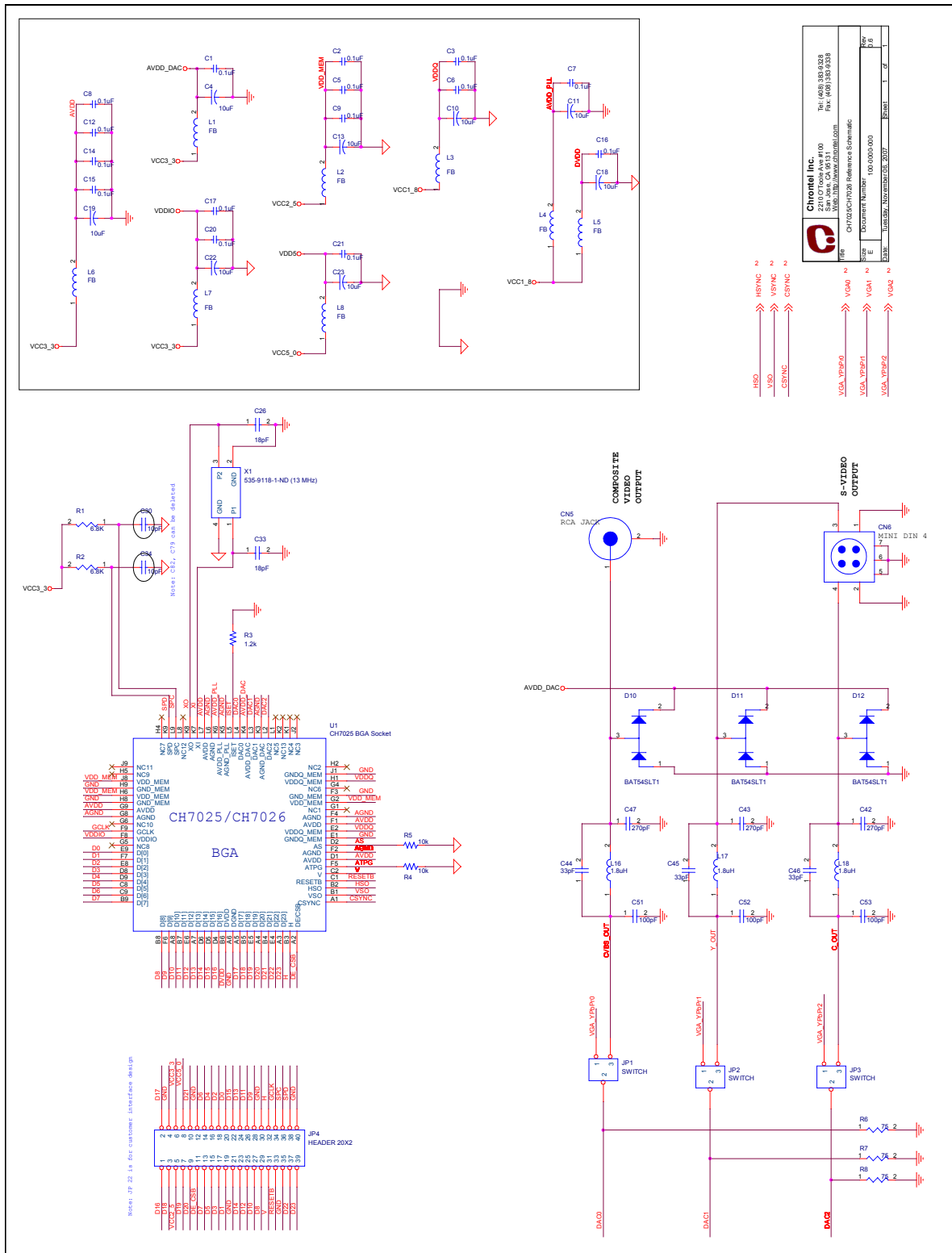
### 3.0 Reference Design Example

### 3.1 Reference Schematic

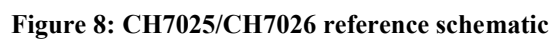
**Figure 8** is the reference schematic of CH7025/CH7026. This schematic is provided here for design reference only. We encourage those who will engage in an application design with CH7025/CH7026 to contact Chrontel Applications group. **Table 4** provides the BOM list for **Figure 8** reference schematic.



### (a) LQFP Package



(b) BGA Package



### 3.2 Reference Board Preliminary BOM

Table 4: CH7025/CH7026 Reference Design BOM List

Item	Quantity	Reference	Part
1	5	CN1, CN2, CN3, CN4, CN6	RCA Jack
2	1	CN5	4-pin Mini DIN
3	15	C1, C2, C3, C4, C6, C7, C8, C9, C12, C14, C15, C16, C18, C20, C21	0.1uF
4	8	C5, C10, C11, C13, C17, C19, C22, C23	10uF
5	8	C24, C25, C35, C36, C37, C54, C55, C56	22pF
6	3	C26, C27, C28	68pF
7	6	C32, C33, C34, C49, C50, C51	100pF
8	3	C38, C39, C41	270pF
9	2	C40, C42	10pF(optional )
10	9	C43, C44, C45, C46, C47, C48, C32, C33, C34,	33pF
11	2	C52, C53	18pF
12	3	C29, C30, C31,	6.8pF
13	12	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12	BAT54SLT1
14	3	JP1, JP2, JP3, JP5, JP6, JP7	SWITCH
15	1	JP4	HEADER 20X2
16	8	L1, L2, L3, L4, L5, L6, L7, L8	FB
17	2	L9, L10	150-220R 100MHz
18	3	L11, L12, L13	0.5uH
19	6	L14, L15, L16, L20, L21, L22	0.082uH
20	3	L17, L18, L19	1.8uH
21	1	P1	VGA
22	2	R1, R2	10k
23	2	R3, R4	6.8K
24	1	R5	1.2k(1% tolerance)
25	3	R6, R7, R8	75ohm
26	1	U1	CH7025/CH7026_LQFP80
37	1	U2	74ACT08
38	1	X1	535-9118-1-ND (13 MHz)

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