Application Report
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Board and System Design Considerations for the TMS320VC5503/5506/5507/5509A DSPs

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ABSTRACT

An effective system-level board design requires termination of specific pins and taking advantage of idle and power-down modes on these low power VC5503/5506/5507/5509A digital signal processors (DSPs). This can be achieved by controlling unused pins and dynamically turning off all peripherals and internal functional units when not in use. The benefit is that the DSP and application consume only as much power as needed, which also helps reduce heat, component density, and the cost of the product. This document also provides pointers to valuable information about how to terminate some of the VC5503/5506/5507/5509A peripherals' and core DSPs unused pins.

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1 Introduction

If an input is left floating every time the floating pin logic state toggles, additional input/output (I/O) current consumption will be the result. Controlling unused and floating pins can save power and maintain optimum functionality of the DSP and system level design. Idling or correctly configuring unused DSP peripherals, such as the real-time clock (RTC), analog-to-digital converter (ADC), multichannel buffered serial port (McBSP), host port interface (HPI), external memory interface (EMIF), IEEE Standard 1149.1-1990, IEEE Standard Test Access Port and Boundary-Scan Architecture (JTAG), MultiMedia Card/secure Data (MMC/SD), and universal serial bus (USB) pins, can save developer power for critical power-sensitive applications.

Even if the RTC or USB module is not used, both modules must be powered up. For the RTC and USB modules, the RDV_{DD}, RCV_{DD}, and $USBV_{DD}$ pins must be connected to their corresponding power supplies

and ground pins. Note that TMS320VC5503 does not have the USB module. For more information regarding the required connections, see the *TMS320VC5503 Fixed-Point Digital Signal Processor Data Manual* (SPRS245), *TMS320VC5506 Fixed-Point Digital Signal Processor Data Manual* (SPRS375), *TMS320VC5507 Fixed-Point Digital Signal Processor Data Manual* (SPRS244), and the *TMS320VC5509A Fixed-Point Digital Signal Processor Data Manual* (SPRS205).

2 RTC

The RTC power supply must be powered even if the RTC peripheral is not being used. The RTC module does not have a power-down mode, nor does idling of other peripherals/modules on VC5503/5506/5507/5509A affect the RTC.

The RTC is the only module that is completely isolated from the rest of the DSP. This module can be powered without any of the VC5503/5506/5507/5509A chip being powered. However, to keep the RTC power dissipation to a minimum while the RTC module is not being used, the RTC module should be powered up.

3 USB

If the USB module is not used on the VC5506/5507/5509A DSP, you must still connect its supply and ground pins to the supply and ground specified in the data sheet. You could also leave those pin unconnected if you make sure that the DP and DN pins are not subject to major noise.

As a general guideline, however, if you do not plan to use the USB:

- DP should be pulled high
- DN should be pulled low
- PU can be left floating

Finally, for power down and power consumption purposes, it is recommended that you pull the USB pin, PU, high with a 10 KΩ resistor. This ensures that the DP pin does not get toggled due to noise and wake up the on-chip oscillator from the idle mode.

4 Proper Termination of Unused Device Pins

In most systems, the main consideration for proper termination of unused device pins is to ensure that inputs are not left floating, to minimize device power dissipation; floating inputs can cause excessive power dissipation. This section discusses the proper termination of unused device pins.

A secondary consideration for proper termination of unused device pins is the logical connection of pins for various interfaces on the device when the interfaces are, or are not, being used.

As can be seen from the pin type designations in the device-specific documentation, device pins are classified in a variety of categories, such as I/O, O/Z, I/O/Z, etc. However, from the standpoint of proper termination of unused device pins, there are only three key device pin category types into which all of the other pin type categories can be classified.

The following paragraphs describe the three main pin type categories and the rules for terminating each of them.

- Inputs (pins that cannot become outputs). This type of pins include the designations I and I/Z. If the particular interface in question is totally unused and the pin has bus keepers, use the bus keepers to pull the pin up. If the pin has no bus keepers and the particular interface in question is totally unused, ground the pin. If implemented, use the bus keepers If the pin must be tied high, or a pull-up resistor.
- Outputs (pins that are never inputs). This type of pins include the designations O and O/Z. Leave unconnected.
- I/O (pins that can be inputs or outputs). This type of pins include the designations I/O and I/O/Z. If possible, configure them as an output and leave unconnected. Otherwise, if the pin has bus keepers, use the bus keepers to pull the pin up. If the pin has no bus keepers, use a pull-up resistor.

5 Considerations of Pull-up Resistors

Device inputs should not be connected directly to a power supply. Any unused inputs that must be tied high should be connected to the appropriate power supply using a pull-up resistor. A pull-up resistor of 10 KΩ can be used for a single input; however, it is possible to use a single resistor to pull up several inputs with two considerations:

- None of the inputs can ever be allowed to be driven low by any means. Accordingly, common pull-up resistors should not be used on I/O or I/O/Z pins.
- The value of the resistor must be reduced inversely proportionate to the number of inputs being pulled high so that, according to ohms law, you still ultimately have a strong enough pull-up to pull high all of the inputs. The concern here is that the inputs draw a leakage current that will tend to reduce the voltage as more inputs are pulled up; therefore, a smaller resistor is required as more inputs are pulled up by a single resistor.

6 Special Considerations for JTAG Pins

If the EMU pins are not pulled high, the device can come up in test mode and may not function as desired. First, check to see if the device has internal pull-ups on EMU0/1 and a pull-down on $\overline{\text{TRST}}$; this pin is also critical.

If the device does not have internal pullups, serious problems can result without external pullups/downs. Devices can go into test modes and unpredictable behavior can result.

Next, check to see if the device is used in a noisy system environment, e.g., motors. If the device is used in a noisy environment, even the internal pullups/downs may not be enough and you need strong external pullups/downs.

For the VC5503/5506/5507/5509A devices that also have internal pullups/downs, it is recommend that you always put strong external pullups on EMU0 and EMU1 and also a strong pulldown on $\overline{\text{TRST}}$. In some extreme situations, it has been found that adding a small capacitor across EMU0/1 significantly improved noise immunity.

It is also a good idea to make sure that TCK/TMS and TDI are pulled up, just for extra safety.

In the past 99.9% of cases where issues have arisen with erratic or unreliable board behavior, this was due to EMU0/1 and $\overline{\text{TRST}}$ not being properly connected.

It is usually okay to leave pins with internal pullups/downs unconnected if the pin on the package is not connected to anything. However, pins that run out on a trace on the board should probably have external pullups/downs because the trace can act like an antenna in electrically noisy conditions and the internal pulls are usually quite weak. For the JTAG pins, it's probably fine not to include any external pulldown if these signals are not connected on the board. If the JTAG signals run across the board to a connector that is normally left unconnected, there is the risk of that conducting noise into the DSP. It is usually not a good idea to tie input buffers directly to power or ground; connecting through a pullup/down is recommended.

7 HPI Pins Consideration

If the parallel bus cannot be configured in EMIF mode and the device is configured in HPI mode but the HPI bus is not used, then for power consumption reasons you can tie this and all HPI pins to ground.

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
			Parallel Bus				
A[13:0]		I/O/Z	Parallel address bus A13-A0 of the C55x™ DSP core bonded to external pins.			BK	GPIO0 = 1: Output, EMIF.A[13:0] GPIO0 = 0: Input, HPI.HA[13:0]
	HPI.HA[13:0]	I	HPI address bus. HPI.HA[13:0]	Use the on-chip bus keepers. Or if HPI is not used, the parallel bus can be configured for EMIF mode or pins can be tied to ground.	To minimize power consumption		
	EMIF.A[13:0]	O/Z	EMIF address bus. EMIF.A[13:0]	Output pins. Leave unconnected	None	BK	GPIO0 = 1: Output, EMIF.A[13:0] GPIO0 = 0: Input, HPI.HA[13:0]
	GPIO.A[13:0]	I/O/Z	General-purpose I/O address bus. GPIO.A[13:0]	Unused GPIOs can be left floating if configured as outputs or can be pulled high with 10 KΩ resistors.	To minimize power consumption		
A'[0] (BGA only)	EMIF.A'[0]	O/Z	EMIF address bus A'[0].	Output pin. Leave unconnected	None		Output
A[15:14] (BGA only)		I/O/Z	A subset of the parallel address bus A15-A14 of the C55x DSP core bonded to external pins.			BK	GPIO0 = 1: Output, EMIF.A[15:14] GPIO0 = 0: Input, GPIO.A[15:14]
	EMIF.A[15:14]	O/Z	EMIF address bus. EMIF.A[15:14]	Output pins. Leave unconnected	None		
	GPIO.A[15:14]	I/O/Z	General-purpose I/O addresses bus. GPIO.A[15:14]	Unused GPIOs can be left floating if configured as outputs or can be pulled high with 10 KΩ resistors.	To minimize power consumption.		
A[20:16] (BGA only)	EMIF.A[20:16]	O/Z	EMIF address bus	Output pins. Leave unconnected	None		Output
D[15:0]		I/O/Z	A subset of the parallel bidirectional data bus D31-D0 of the C55x DSP core			BK	GPIO0 = 1: Input, EMIF.D[15:0] GPIO0 = 0: Input, HPI.HD[15:0]
	EMIF.D[15:0]	I/O/Z	EMIF data bus. EMIF.D[15:0]	Use the on-chip Bus Keepers	To minimize power consumption		
	HPI.HD[15:0]	I/O/Z	HPI data bus. HPI.HD[15:0]	Use the on-chip bus keepers. Or if HPI is not used, pins can tied to ground or the parallel bus can be configured for EMIF mode.	To minimize power consumption		
C0		I/O/Z	EMIF asynchronous memory read enable or general-purpose IO8			BK	GPIO0 = 1: Output, EMIF.$\overline{\text{ARE}}$ GPIO0 = 0: Input, GPIO8
	EMIF.$\overline{\text{ARE}}$	O/Z	Active-low EMIF asynchronous memory read enable	Output pin. Leave unconnected	None		
	GPIO8	I/O/Z	General-purpose IO8. GPIO8	Configure pin as an output. Then it can be left unconnected or can be pulled high with 10 KΩ resistor.	To minimize power consumption		

(1) I = Input, O = Output, S = Supply, Hi–Z = High-impedance
(2) BK = Bus keeper (the bus keeper maintains the previous voltage level during reset or while the output pin is not driven), PU = Pullup, PD = Pulldown, H = hysteresis input buffer, FS = Fail–safe buffer

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
C1		O/Z	EMIF asynchronous memory output enable or HPI interrupt output				GPIO0 = 1: Output, EMIF.$\overline{\text{AOE}}$ GPIO0 = 0: Output, HPI.$\overline{\text{HINT}}$
	EMIF.$\overline{\text{AOE}}$	O/Z	Active-low asynchronous memory output enable	Output pin. Leave unconnected.	None		
	HPI.$\overline{\text{HINT}}$	O/Z	Active-low HPI interrupt output	Output pin. Leave unconnected.	None		
C2		I/O/Z	EMIF asynchronous memory write enable or HPI read/write			BK	GPIO0 = 1: Output, EMIF.$\overline{\text{AWE}}$ GPIO0 = 0: Input, HPI.HR/$\overline{\text{W}}$
	EMIF.$\overline{\text{AWE}}$	O/Z	Active-low EMIF asynchronous memory write enable.	Output pin. Leave unconnected	None		
	HPI.HR/$\overline{\text{W}}$	I	HPI read/write	Pull high with 10 KΩ resistor or if HPI is not used, the parallel bus can be either configured for EMIF mode or this pin can be tied to ground.	For functional protection and/or low power		
C3		I/O/Z	EMIF data ready input or HPI ready output			H	GPIO0 = 1: Input, EMIF.ARDY GPIO0 = 0: Output, HPI.HRDY
	EMIF.ARDY	I	EMIF data ready input	Pull high with 2.2 KΩ resistor	For functional protection and/or low power		
	HPI.HRDY	O	HPI ready output	Output pin. Leave unconnected	None		
C4		I/O/Z	EMIF chip select for memory space CE0 or general-purpose IO9			BK	GPIO0 = 1: Output, EMIF.$\overline{\text{CE0}}$ GPIO0 = 0: Input, GPIO9
	EMIF.$\overline{\text{CE0}}$	O/Z	Active-low EMIF chip select for memory space CE0	Output pin. Leave unconnected	None		
	GPIO9	I/O/Z	General-purpose IO9	Configure pin as an output. Then it can be left unconnected or can be pulled high with 10 KΩ resistor.	To minimize power consumption		
C5		I/O/Z	EMIF chip select for memory space CE1 or general-purpose IO10			BK	GPIO0 = 1: Output, EMIF.$\overline{\text{CE1}}$ GPIO0 = 0: Input, GPIO10
	EMIF.$\overline{\text{CE1}}$	O/Z	Active-low EMIF chip select for memory space CE1	Output pin. Leave unconnected	None		
	GPIO10	I/O/Z	General-purpose IO10	Configure pin as an output. Then it can be left unconnected or can be pulled high with 10 KΩ resistor.	To minimize power consumption		

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
C6		I/O/Z	EMIF chip select for memory space CE2 or HPI control input 0			BK	GPIO0 = 1: Output, EMIF.$\overline{CE2}$ GPIO0 = 0: Input, HPI.HCNTL0
	EMIF.$\overline{CE2}$	O/Z	Active-low EMIF chip select for memory space CE2	Output pin. Leave unconnected	None		
	HPI.HCNTL0	I	HPI control input 0	Pull high with 10 KΩ resistor or if HPI is not used, the parallel bus can be either configured for EMIF mode or pin can be tied to ground.	For functional protection and/or low power		
C7		I/O/Z	EMIF chip select for memory space CE3, general-purpose IO11, or HPI control input 1			BK	GPIO0 = 1: Output, EMIF.$\overline{CE3}$ GPIO0 = 0: Input, HPI.HCNTL1
	EMIF.$\overline{CE3}$	O/Z	Active-low EMIF chip select for memory space CE3	Output pin. Leave unconnected	None		
	GPIO11	I/O/Z	General-purpose IO11	Configure pin as an output. Then it can be left unconnected or it can be pulled high with 10 KΩ resistor.	To minimize power consumption		
	HPI.HCNTL1	I	HPI control input 1	Pull high with 10 KΩ resistor	For functional protection and/or low power		
C8		I/O/Z	EMIF byte enable 0 control or HPI byte identification			BK	GPIO0 = 1: Output, EMIF.$\overline{BE0}$ GPIO0 = 0: Input, HPI.$\overline{HBE0}$
	EMIF.$\overline{BE0}$	O/Z	Active–low EMIF byte enable 0 control	Output pin. Leave unconnected	None		
	HPI.$\overline{HBE0}$	I	HPI byte identification	Pull high with 10 KΩ resistor	For functional protection and/or low power		
C10		I/O/Z	EMIF SDRAM row strobe, HPI addresses strobe, or general-purpose IO12		BK		GPIO0 = 1: Output, EMIF.$\overline{SDRAS}$ GPIO0 = 0: Input, HPI.$\overline{HAS}$
	EMIF.$\overline{SDRAS}$	O/Z	Active-low EMIF SDRAM row strobe	Output pin. Leave unconnected	None		
	HPI.$\overline{HAS}$	I	Active-low HPI address strobe	Pull high with 10 KΩ resistor	For functional protection and/or low power		
	GPIO12	I/O/Z	General-purpose IO12	Configure pin as an output. Then it can be left unconnected or it can be pulled high with 10 KΩ resistor.	To minimize power consumption		
C11		I/O/Z	EMIF SDRAM column strobe or HPI chip select input			BK	GPIO0 = 1: Output, EMIF.$\overline{SDCAS}$ GPIO0 = 0: Input, HPI.$\overline{HCS}$
	EMIF.$\overline{SDCAS}$	O/Z	Active-low EMIF SDRAM column strobe	Output pin. Leave unconnected	None		
	HPI.$\overline{HCS}$	I	HPI chip select input	Pull high with 10 KΩ resistor	For functional protection and/or low power		

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
C12		I/O/Z	EMIF SDRAM write enable or HPI data strobe 1 input			BK	GPIO0 = 1: Output, EMIF.$\overline{\text{SDWE}}$ GPIO0 = 0: Input, HPI.$\overline{\text{HDS1}}$
	EMIF.$\overline{\text{SDWE}}$	O/Z	EMIF SDRAM write enable	Output pin. Leave unconnected	None		
	HPI.$\overline{\text{HDS1}}$	I	HPI data strobe 1 input	Pull high with 10 KΩ resistor	For functional protection and/or low power		
C13		I/O/Z	SDRAM A10 address line or general-purpose IO13			BK	GPIO0 = 1: Output, EMIF.SDA10 GPIO0 = 0: Input, GPIO13
	EMIF.SDA10	O/Z	SDRAM A10 address line	Output pin. Leave unconnected			
	GPIO13	I/O/Z	General-purpose IO13	Configure pin as an output. Then it can be left unconnected or it can be pulled high with 10 KΩ resistor.			
C14		I/O/Z	Memory interface clock for SDRAM, HPI data strobe 2 input, or general-purpose IO14			BK	GPIO0 = 1: Output, EMIF.CLKMEM GPIO0 = 0: Input, HPI.$\overline{\text{HDS2}}$
	EMIF.CLKMEM	O/Z	Memory interface clock for SDRAM	Output pin. Leave unconnected	None		
	HPI.$\overline{\text{HDS2}}$	I	HPI data strobe 2 input	Pull high with 10 KΩ resistor	For functional protection and/or low power		
Interrupt and Reset Pins							
$\overline{\text{INT}}$[4:0]		I	Active-low external user interrupt inputs	If unmasked, pull up high with 10 KΩ resistor. If masked, connect to ground.	For functional protection and/or low power	H, FS	Input
$\overline{\text{RESET}}$		I	Active-low reset	This pin always is used and connected, but for functional protection, use an external 10 KΩ pull-up resistor on this pin.	For functional protection	H, FS	Input
Bit I/O Signals							
GPIO[7:6,4:0] (LQFP) GPIO[7:0] (BGA)		I/O/Z	7-bit (LQFP package) or 8-bit (BGA package) input/output lines			BK (GPIO5 only) H (except GPIO5)	Input
	EMIF.CKE (GPIO4)	O/Z	SDRAM CKE signal	Output pin. Leave unconnected.	None		Input (GPIO4)
XF		O/Z	External flag	Output pin. Leave unconnected.	None		Output
	EMIF.CKE	O/Z	SDRAM CKE signal	Output pin. Leave unconnected.	None		Output (XF)
Oscillator/Clock Signals							
CLKOUT		O/Z	DSP clock output signal	None. Leave floating or connect to TP for debug purposes	None		Output
X2/CLKIN		I/O	System clock/oscillator input	None. This pin is always used.	None		Oscillator Input
X1		O	Output pin from the internal system oscillator for the crystal	Output pin. Leave unconnected.	To minimize power consumption		Oscillator Output
Timer Signals							
TIN/TOUT0		I/O/Z	Timer0 input/output	If not configured as output, pull up high with 10 KΩ resistor	To minimize power consumption	H	Input

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
			Real-Time Clock				
RTCINX1		I	Real-time clock oscillator input	Pull down low	To minimize power consumption		Input
RTCINX2		O	Real-time clock oscillator output	Output pin. Leave unconnected	None		Output
			I2C				
SDA		I/O/Z	I2C (bidirectional) data	Pull up high with 10 KΩ resistor	To minimize power consumption	H	Hi-Z
SCL		I/O/Z	I2C (bidirectional) data	Pull up high with 10 KΩ resistor	To minimize power consumption	H	Hi-Z
			Multichannel Buffered Serial Port (McBSP) Signals				
CLKR0		I/O/Z	McBSP0 receive clock	Configure as an output and leave floating or pull up high with 10 KΩ resistor	To minimize power consumption	H	Hi-Z
DR0		I	McBSP0 receive data	Pull up high with 10 KΩ resistor	To minimize power consumption	FS	Input
FSR0		I/O/Z	McBSP0 receive frame synchronization	Configure as an output and leave floating or pull up high with 10 KΩ resistor.	To minimize power consumption		Hi-Z
CLKX0		I/O/Z	McBSP0 transmit clock	Configure as an output and leave floating or pull up high with 10 KΩ resistor.	To minimize power consumption	H	Input
DX0		O/Z	McBSP0 transmit data	Output pin. Leave unconnected	None		Hi-Z
FSX0		I/O/Z	McBSP0 transmit frame synchronization	Configure as an output and leave floating or pull up high with 10 KΩ resistor.	To minimize power consumption		Input
S10		I/O/Z	McBSP1 receive clock or MultiMedia Card/Secure Digital1 command/response. At reset, this pin is configured as McBSP1.CLKR.			H	Input
	McBSP1.CLKR	I/O/Z	McBSP1 receive clock. McBSP1.CLKR serves as the serial shift clock for the serial port receiver. McBSP1.CLKR is selected when the External Bus Selection Register has 00 in the Serial Port1 Mode bit field or following reset.	Configure as an output and leave floating or pull up high with 10 KΩ resistor.	To minimize power consumption		
	MMC1.CMD SD1.CMD	I/O/Z	MMC1 or SD1 command/response	If the serial bus is configured for MMC or SD mode, and MMC or SD interface is not used, configure bus for McBSP mode.	To minimize power consumption		

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
S11		I/O/Z	McBSP1 data receive or Secure Digital1 data1				Input
	McBSP1.DR	I/Z	McBSP1 serial data receive	Pull up high with 10 KΩ resistor	To minimize power consumption		
	SD1.DAT1	I/O/Z	SD1 data1	If the serial bus is configured for SD mode, and SD interface is not used, configure bus for McBSP mode.	To minimize power consumption		
S12		I/O/Z	McBSP1 receive frame synchronization or Secure Digital1 data2				Input
	McBSP1.FSR	I/Z	McBSP1 receive frame synchronization	Pull up high with 10 KΩ resistor	To minimize power consumption		
	SD1.DAT2	I/O/Z	SD1 data2	If the serial bus is configured for SD mode, and SD interface is not used, configure bus for McBSP mode.	To minimize power consumption		
S13		O/Z	McBSP1 serial data transmit or Multimedia Card/Secure Digital1 serial clock			BK	Hi-Z
	McBSP1.DX	O/Z	McBSP1 serial data transmit	Output pin. Leave unconnected.	None		
	MMC1.CLK SD1.CLK	O	MMC1 or SD1 serial clock	Output pin. Leave unconnected.	None		
S14		I/O/Z	McBSP1 transmit clock or Multimedia Card/Secure Digital1 data0			H	Input
	McBSP1.CLKX	I/O/Z	McBSP1 transmit clock	Pull up high with 10 KΩ resistor	To minimize power consumption		
	MMC1.DAT SD1.DAT0	I/O/Z	MMC1 or SD1 data0	If the serial bus is configured for MMC or SD mode, and MMC or SD interface is not used, configure bus for McBSP mode.	To minimize power consumption		
S15		I/O/Z	McBSP1 transmit frame synchronization or Secure Digital1 data3				Input
	McBSP1.FSX	I/O/Z	McBSP1 transmit frame synchronization	Pull up high with 10 KΩ resistor			
	SD1.DAT3	I/O/Z	SD1 data3	If the serial bus is configured for MMC or SD mode, and MMC or SD interface is not used, configure bus for McBSP mode.			

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
S20		I/O/Z	McBSP2 receive clock or Multimedia Card/Secure Digital2 command/response			H	Input
	McBSP2.CLKR	I/O/Z	McBSP2 receive clock	Configured as an output and leave floating or pull up high with 10 KΩ resistor	To minimize power consumption		
	MMC2.CMD SD2.CMD	I/O/Z	MMC2 or SD2 command/response	If the serial bus is configured for MMC or SD mode, and MMC or SD interfaces is not used, configure bus for McBSP mode.	To minimize power consumption		
S21		I/O/Z	McBSP2 data receive or Secure Digital2 data1				Input
	McBSP2.DR	I	McBSP2 serial data receive	Pull up high with 10 KΩ resistor			
	SD2.DAT1	I/O/Z	SD2 data1	If the serial bus is configured for MMC or SD mode, and MMC or SD interfaces is not used, configure bus for McBSP mode.			
S22		I/O/Z	McBSP2 receive frame synchronization or Secure Digital2 data2				Input
	McBSP2.FSR	I	McBSP2 receive frame synchronization	Pull up high with 10 KΩ resistor			
	SD2.DAT2	I/O/Z	SD2 data2	If the serial bus is configured for MMC or SD mode, and MMC or SD interfaces is not used, configure bus for McBSP mode.			
S23		O/Z	McBSP2 data transmit or Multimedia Card/Secure Digital2 serial clock			BK	Hi-Z
	McBSP2.DX	O/Z	McBSP2 serial data transmit	Output pin. Leave unconnected.	None		
	MMC2.CLK SD2.CLK	O	MMC2 or SD2 serial clock	Output pin. Leave unconnected.	None		
S24		I/O/Z	McBSP2 transmit clock or Multimedia Card/Secure Digital2 data0			H	Input
	McBSP2.CLKX	I/O/Z	McBSP2 transmit clock	Configured as an output and leave floating or pull up high with 10 KΩ resistor	To minimize power consumption		
	MMC2.DAT SD2.DAT0	I/O/Z	MMC2 or SD2 data0 pin	If the serial bus is configured for MMC or SD mode, and MMC or SD interfaces is not used, configure bus for McBSP mode.	To minimize power consumption		

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
S25		I/O/Z	McBSP2 transmit frame synchronization or Secure Digital2 data3				Input
	McBSP2.FSX	I/O/Z	McBSP2 frame synchronization	Configured as an output and leave floating or pull up high with 10 KΩ resistor	To minimize power consumption		
	SD2.DAT3	I/O/Z	SD2 data3	If the serial bus is configured for SD mode, and SD interface is not used, configure bus for McBSP mode.	To minimize power consumption		
A/D							
AIN0		I	Analog input channel 0	Analog input. Leave unconnected.	None		Input
AIN1		I	Analog input channel 1	Analog input. Leave unconnected.	None		Input
AIN2 (BGA only)		I	Analog input channel 2 (BGA package only)	Analog input. Leave unconnected.	None		Input
AIN3 (BGA only)		I	Analog input channel 3. (BGA package only)	Analog input. Leave unconnected.	None		Input
Test/Emulation Pins (Use or not use, terminate as below)							
TCK		I	IEEE standard 1149.1 test clock			PUH	Input
TDI		I	IEEE standard 1149.1 test clock			PU	Input
TDO		O/Z	IEEE standard 1149.1 test clock				Hi-Z
TMS		I	IEEE standard 1149.1 test clock			PU	Input
$\overline{TRST}$		I	IEEE standard 1149.1 test clock	Pull down to ground via 10 KΩ resistor	For functional protection	PDFS	Input
EMU0		I/O/Z	Emulator 0 pin	Pull up high with 4.7 KΩ resistor	For functional protection	PU	Input
EMU1/$\overline{OFF}$		I/O/Z	Emulator 1 pin/disable all outputs	Pull up high with 4.7 KΩ resistor	For functional protection	PU	Input
Supply Pins							
CV_{DD}		S	Digital power, + V_{DD}. Dedicated power supply for the core CPU.	Always need to be connected.	None		
DV_{DD}		S	Digital power, + V_{DD}. Dedicated power supply for the core CPU.	Always need to be connected.	None		
$USBV_{DD}$		S	Digital power, + V_{DD}. Dedicated power supply for the I/O of the USB module (DP, DN , and PU).	Always need to be connected.	None		
RDV_{DD}		S	Digital power, + V_{DD}. Dedicated power supply for the I/O pins of the RTC module.	Always need to be connected.	None		
RCV_{DD}		S	Digital power, + V_{DD}. Dedicated power supply for the RTC module.	Always need to be connected.	None		

Table 1. Suggested Guidelines for Terminating Emulation and Unused Pins on the VC5503/5506/5507/5509A DSPs (continued)

Terminal Name	Multiplexed Signal Name	I/O/Z [1]	Function	How to Control if Pins are Not Used	Reason	BK [2]	Reset Condition
AV_{DD}		S	Analog power, + V_{DD}. Dedicated power supply for the 10-bit A/D.	Always need to be connected.	None		
ADV_{DD}		S	Analog digital Power, + V_{DD}. Dedicated power supply for the digital portion of the 10-bit A/D.	Always need to be connected.	None		
$USBPLLV_{DD}$		S	Digital power, + V_{DD}. Dedicated power supply pin for the USB PLL.	Always need to be connected.	None		
V_{SS}		S	Digital ground. Dedicated ground for the I/O and core pins.	Always need to be connected.	None		
AV_{SS}		S	Analog ground. Dedicated ground for the 10–bit A/D.	Always need to be connected.	None		
ADV_{SS}		S	Analog digital ground. Dedicated ground for the digital portion of the10-bit A/D.	Always need to be connected.	None		
$USBPLLV_{SS}$		S	Digital ground. Dedicated ground for the USB PLL.	Always need to be connected.	None		
			Miscellaneous				
NC			No connection	None	None		

8 Summary

The information provided in this document and the reference documentation listed inSection 9 will help DSP designers optimize their VC5503/5506/5507/5509A board power consumption and assist with system-level issues.

9 References

- *TMS320VC5503 Fixed-Point Digital Signal Processor Data Manual* (SPRS245)
- *TMS320VC5506 Fixed-Point Digital Signal Processor Data Manual* (SPRS375)
- *TMS320VC5507 Fixed-Point Digital Signal Processor Data Manual* (SPRS244)
- *TMS320VC5509A Fixed-Point Digital Signal Processor Data Manual* (SPRS205)
- *TMS320VC5507/5509 DSP Universal Serial Bus (USB) Module Reference Guide* (SPRU596)
- *TMS320VC5503/5507/5509 DSP Real-Time Clock (RTC) Reference Guide* (SPRU594)
- *TMS320VC5501/5502/5503/5507/5509 DSP Inter-Integrated Circuit Module Reference Guide* (SPRU146)
- *TMS320VC5503/5507/5509 DSP Host Port Interface (HPI) Reference Guide* (SPRU619)
- *TMS320VC5503/5507/5509 DSP External Memory Interface (EMIF) Reference Guide* (SPRU670)
- *TMS320VC5501/5502/5503/5507/5509/5510 DSP Multichannel Buffered Serial Port (McBSP) Reference Guide* (SPRU592)

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