

TMS320C5515/C5514
Fixed-Point Digital Signal Processor
Silicon Revision 2.0

Silicon Errata



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TMS320C551x Silicon Revision 2.0

1 Introduction

This document describes the known exceptions to the functional specifications for the TMS320C551x devices (i.e., TMS320C5515, and TMS320C5514). For more detailed information on these devices, see the device-specific data manual:

- *TMS320C5514 Fixed-Point Digital Signal Processor* data manual (Literature Number [SPRS645](#))
- *TMS320C5515 Fixed-Point Digital Signal Processor* data manual (Literature Number [SPRS646](#))

Throughout this document, unless otherwise specified, TMS320C551x and C551x, refer to the TMS320C5515, and TMS320C5514 devices.

The advisory numbers in this document are not sequential. Some advisory numbers have been moved to the next revision and others have been removed and documented in the user's guide. When items are moved or deleted, the remaining numbers remain the same and are not resequenced.

1.1 Device and Development-Support Tool Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all DSP devices and support tools. Each DSP commercial family member has one of three prefixes: TMX, TMP, or TMS (e.g., TMS320C5515AZCHA12). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMX/TMDX) through fully qualified production devices/tools (TMS/TMDS).

Device development evolutionary flow:

TMX — Experimental device that is not necessarily representative of the final device's electrical specifications.

TMP — Final silicon die that conforms to the device's electrical specifications but has not completed quality and reliability verification.

TMS — Fully-qualified production device.

Support tool development evolutionary flow:

TMDX — Development-support product that has not yet completed Texas Instruments internal qualification testing.

TMDS — Fully qualified development-support product.

TMX and TMP devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

TMS devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (TMX or TMP) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, ZCH), the temperature range (for example, "Blank" is the commercial temperature range), and the device speed range in megahertz (for example, "10" is the default 100 MHz device).

1.2 Revision Identification

Figure 1 provides an example(s) of the TMS320C551x device markings. The device revision can be determined by the symbols marked on the top of the package.

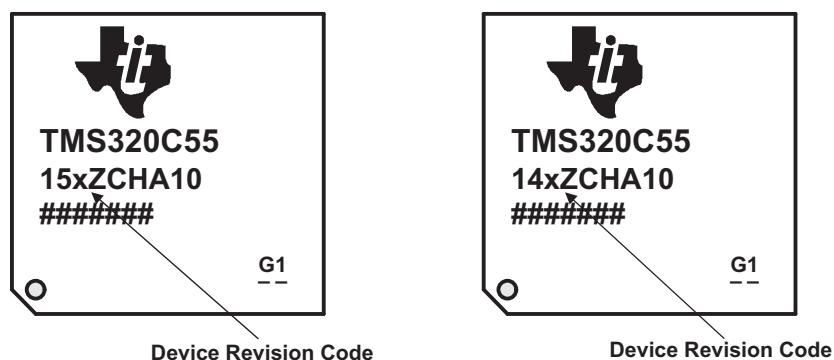


Figure 1. Example and Device Revision Codes

Silicon revision is identified by a device revision code marked on the package and through software. The code on the package is of the format C5515x or C5514x, where "x" denotes the silicon revision. If x is "A" in the device part number, it represents Silicon Revision 2.0 TMS devices. Table 1 lists the information associated with each silicon revision.

Table 1. C5515 and C5514 Device Revision Codes

DEVICE PART NUMBER DEVICE REVISION CODE (x)	SILICON REVISION	PART NUMBERS/COMMENTS
A	2.0	This silicon revision is available as TMS <i>only</i> . TMS320C5515ZCH, TMS320C5514ZCH

Through software, the user can read bits 15-12 of the I/O space Die ID Register 3 (DIEIDR3) [1C43h].

2 Silicon Revision 2.0 Usage Notes and Known Design Exceptions to Functional Specifications

This section describes the usage notes and advisories that apply to silicon revision 2.0 of the TMS320C5515 and TMS320C5514 devices.

2.1 Usage Notes for Silicon Revision 2.0

Usage notes highlight and describe particular situations where the device's behavior may not match presumed or documented behavior. This may include behaviors that affect device performance or functional correctness. These usage notes will be incorporated into future documentation updates for the device (such as the device-specific data sheet), and the behaviors they describe will not be altered in future silicon revisions.

2.1.1 Master Clock Gating With WAKEUP, $\overline{\text{INT0}}$, or $\overline{\text{INT1}}$ Asserted

On silicon revision 2.0, the C551x DSP can disable the Master Clock by setting bit 15 of the PCGCR register (0x1C02). Once the master clock is disabled, it can only be re-enabled by one of the following events:

- Hardware reset being asserted ($\overline{\text{RESET}}$ = low)
- An enabled RTC alarm or periodic interrupt occurring
- The $\overline{\text{INT0}}$ or $\overline{\text{INT1}}$ pins being asserted (low) (level-sensitive)
- The WAKEUP pin being asserted (high) (level-sensitive)

When the master clock is disabled, there are no clocks for edge detection and therefore the $\overline{\text{INT0}}$, $\overline{\text{INT1}}$, and WAKEUP pins are level-sensitive. This means that a low on either the $\overline{\text{INT0}}$ or $\overline{\text{INT1}}$ or a high on the WAKEUP pin will force bit 15 of the PCGCR register to "0", enabling the master clock. Attempting to write a "1" to bit 15 of the PCGCR register while $\overline{\text{INT0}}$, $\overline{\text{INT1}}$, or WAKEUP are asserted will be unsuccessful since re-enabling the clocks has a higher priority than disabling them.

When the WAKEUP pin is configured as an output-pin, the WAKEUP pin only functions as a GPO and no longer functions as a WAKEUP pin to re-enable the master clocks. When the WAKEUP pin is configured as an input-pin, the WAKEUP pin's state must be low to disable the master clocks.

2.1.2 Serial Boot Modes Only Support 16-bit Address Mode

On silicon revision 2.0, the C551x DSP supports the following boot modes: NOR Flash, NAND Flash, SPI EEPROM, and I2C EEPROM. The SPI EEPROM boot supports both 16-bit and 24-bit address modes, while the I2C EEPROM boot mode *only* supports 16-bit address mode.

2.1.3 Reserved Bits in the RTC Oscillator Register (RTCOSC) [0x192C]

For proper C551x device operation on silicon revision 2.0, the "RESERVED" bits in the RTCOSC register (0x192C) should always be set to "zero".

2.1.4 Two 1149.1 JTAG Tap Controllers for JTAG Pins ($\overline{\text{TRST}}$, TCK, TMS, TDI, TDO)

The silicon revision 2.0 C551x devices have two internal 1149.1 JTAG Tap controllers but only one set of corresponding JTAG pins ($\overline{\text{TRST}}$, TCK, TMS, TDI, TDO). One TAP controller supports emulation and the other supports JTAG 1149.1 Boundary Scan. Only one of the two TAPs is internally connected to the pins at a time and it is the latched state of the EMU0 pin that determines which TAP is connected. The EMU0 pin is latched on the rising edge of $\overline{\text{TRST}}$ and from that time forward the selected tap is connected to the pins. If the latched state of EMU0 is "0", the boundary scan tap is selected and customers may perform boundary scan testing. If the latched state of EMU0 is "1", the DSP's emulation tap is selected and customers may perform emulation with TI's Code Composer Studio™ IDE Emulation Debugger.

Note: Because of the C551x device's internal (and recommended external) pullup on the EMU0 pin and the fact that the emulation pods (e.g., XDS560) do not drive the EMU0 pin while $\overline{\text{TRST}}$ is driven low-to-high, the emulation tap will normally be the one selected. However, customers who wish to do boundary scan testing will need to have an external pulldown (2 k Ω is recommended), with sufficient strength to overcome the internal pullup, so that the C551x boundary scan tap is connected to the JTAG pins.

2.1.5 Bootloader Disables Peripheral Clocks

After hardware reset on silicon revision 2.0 C551x devices, the DSP boots via the bootloader code in ROM. During the boot process, the bootloader queries each peripheral to determine if it can boot from the peripheral. At that time, the required peripheral's clock will be enabled for the query and then disabled when the bootloader is finished with the peripheral. By the time the bootloader releases control to the user code, all peripheral clocks will be off and all domains in the ICR, except the CPU domain, will be idled. After the boot process is complete, the user is responsible for enabling and programming the required clock configuration for the DSP.

For example on the C5515 device, the bootloader disables both the MPORT and FFTHWA. To enable the MPORT and FFT HWA, write 0x000E to the ICR registers and issue an "idle" command.

Assembly Code Example:

```
*port(#0x0001) = #(0x000E)
idle
```

C Code Example:

```
*(ioport volatile unsigned *)0x0001 = 0x000E;
asm("    idle");    // must add at least one blank before idle in " ".
```

For example on the C5514 device, the bootloader disables the MPORT. To enable the MPORT, write 0x0002E to the ICR registers and issue an "idle" command.

Assembly Code Example:

```
*port(#0x0001) = #(0x0002E)
idle
```

C Code Example:

```
*(ioport volatile unsigned *)0x0001 = 0x0002E;
asm("    idle");    // must add at least one blank before idle in " ".
```

2.1.6 SPI Booting Does Not Support 24-Bit Encrypted Reauthoring and Bound to Device

On silicon revision 2.0, C551x devices do not support 24-bit SPI encrypted reauthoring and bound to device boot mode. The user must use 16-bit SPI in order to use encrypted reauthoring and bound to device boot mode. See [Table 2](#) for the supported boot modes for 16- and 24-bit SPI.

Table 2. Supported Boot Modes for SPI

Boot Mode	Unencrypted	Encrypted	Encrypted and Bound to Device	Encrypted Reauthoring and Bound to Device
16-Bit SPI	Supported	Supported	Supported	Supported
24-Bit SPI	Supported	Supported	Supported	Not Supported

2.1.7 SPI Enters a Reset State When Writing to the SPICDR Register

On silicon revision 2.0, the SPI enters a reset state when writing to the SPICDR register. When software writes to the SPICDR register at 0x3000, the software also evaluates and applies the content of the SPICCR register at 0x3001. Thus, if the RST bit (bit 14) of SPICCR is set to a "1" inadvertently, a SPI reset will occur.

Before writing to the SPICDR register, the user must read the SPICCR register and mask out the RST bit with the rest of the bits preserved and write back to SPICCR. Next, write to the SPICDR register.

Following is an example sequence:

- Read SPICCR.
- Mask with 0xBFFF.
- Write back to SPICCR.
- Write to SPICDR.

C Code Example:

```
#define SPICDR      *(volatile ioport Uint16*)      (0x3000)
#define SPICCR      *(volatile ioport Uint16*)      (0x3001)
Uint16 temp;
temp = SPICCR;
SPICCR = temp & 0xBFFF;
SPICDR = 0x18;
```

2.1.8 SPI Clock State Is Changed When Writing to the SPICDR Register

On silicon revision 2.0, software writes to the SPICCR register (0x3001) when writing to the SPICDR register (0x3000). As a result, the CLKEN bit (bit 15) of SPICCR is set when writing to SPICDR.

The user is responsible for reading the SPICCR register, writing the appropriate value of CLKEN, and preserving the remaining bits back to SPICCR **before** writing to the SPICDR register.

2.1.9 HWAFFT Data and Scratch Buffers Must Reside at Data Locations Less Than 0x10000

On silicon revision 2.0, the HWAFFT uses two data buffers, data and scratch, to pass data to the FFT coprocessor, to store intermediate results, and to store the FFT output. The `hwafft_Npts` routines available in ROM contain pointers to the data and scratch buffers. These pointers are copied as 16-bit addresses instead of 23-bit addresses. When a buffer resides in word address 0x10000 or greater, 23 bits are required to address these memory locations. The `hwafft_Npts` routine incorrectly copies just the 16 least significant bits, leading to incorrect FFT results and potential corruption of data incorrectly addressed by the HWAFFT.

The user is responsible for following one of the following workarounds:

- Execute `hwafft_Npts` from RAM or from ROM with data and scratch buffers located entirely in word addresses less than 0x10000.
- Execute `hwafft_Npts` from RAM using the updated `hwafft.asm` with bug fixes. The `hwafft.asm` file included with [SPRABB6.zip](#) incorporates bug fixes for this errata. The HWAFFT routines stored in ROM cannot be updated and do not incorporate these bug fixes. For reference, `hwafft_rom.asm` is included in [SPRABB6.zip](#) and contains the HWAFFT routines exactly as they exist in the ROM of the affected revisions.
- Execute `hwafft_Npts` from RAM or from ROM while passing duplicate pointers to the scratch and data buffers. The data and scratch buffers can be located in word addresses greater than 0x10000, but the buffers must not cross 16-bit address boundaries (that is, address bits 22–16 must not change). Additionally, if `hwafft_512pts` is used, data and scratch must not reside at the beginning of a page boundary (that is, word address 0x10000 or 0x20000). This workaround initializes the most significant bits of internal registers XAR2 and XAR3 such that when the 16-bit address is copied from XAR0 and XAR1, and provided the assumptions above are satisfied, the full 23-bit address remains correct throughout HWAFFT execution.

In the user program wherever `hwafft_Npts` is called, replace:

```
out_sel = hwafft_Npts(data, scratch, fft_flag, scale_flag);
```

With:

```
out_sel = hwafft_Npts(data, scratch, scratch, data, fft_flag, scale_flag);
```

In `hwafft.h`, replace:

```
Uint16 hwafft_Npts(
    Int32 *data,
    Int32 *scratch,
    Uint16 fft_flag,
    Uint16 scale_flag
);
```

With:

```
Uint16 hwafft_Npts(
    Int32 *data,
    Int32 *scratch,
    Int32 *duplicate_scratch,
    Int32 *duplicate_data,
    Uint16 fft_flag,
    Uint16 scale_flag
);
```

2.1.10 USB Oscillator Consumes Power When Core Voltage Is Removed

On silicon revision 2.0, the USB oscillator is disabled by writing a '1' to the USBOSCDIS bit of the USBSCR register. Whenever voltage to the core is removed (for example, during RTC-only mode), the value written to the USBOSCDIS register is lost. If the USB I/O supplies are supplied, the USB oscillator reactivates and consumes power.

To disable the USB oscillator when core voltage is removed, the user must power down all USB I/O supplies (USB_V_{DDOSC}, USB_V_{DDA3P3}, and USB_V_{DDPLL}).

2.2 Silicon Revision 2.0 Known Design Exceptions to Functional Specifications

Table 3. Silicon Revision 2.0 Advisory List

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Advisory 2.0.1 *USB: Endianness Incompatibility*

Revision(s) Affected 2.0

Details

The C551x CPU is a word addressable and big endian architecture. The CPU interfaces to the rest of the system through several ports: MPORT, XPORT, DPORT, and IPORT. The DMA transfers data from peripherals to on-chip memory through the MPORT in 32-bit packets. The CPU accesses the peripherals through the XPORT in 8- or 16-bit packets. The CPU accesses external memory in 8-bit (configured through a system register setting), 16-bit (through CPU single word access), or 32-bit (through CPU double-word access). External data accesses occur through the DPORT and the EMIF. The CPU fetches code from external memory through the IPORT in the EMIF in 32-bit packets.

Some C551x peripherals (e.g., EMIF, USB, LCD, and MMC/SD) have sensitivity to the data endianness. EMIF: Endianness is hardcoded to big endian. LCD: Endianness is controlled through software. Default is little endian. MMC/SD: Endianness is controlled through software. Default is big endian. USB: DMA transfer to/from USB buffer is big endian. CPU XPORT access to USB buffer is little endian. USB endianness is not software controllable. The two endiannesses of the USB could result in inter byte swap.

Figure 2 shows data paths that could create byte/word swaps.

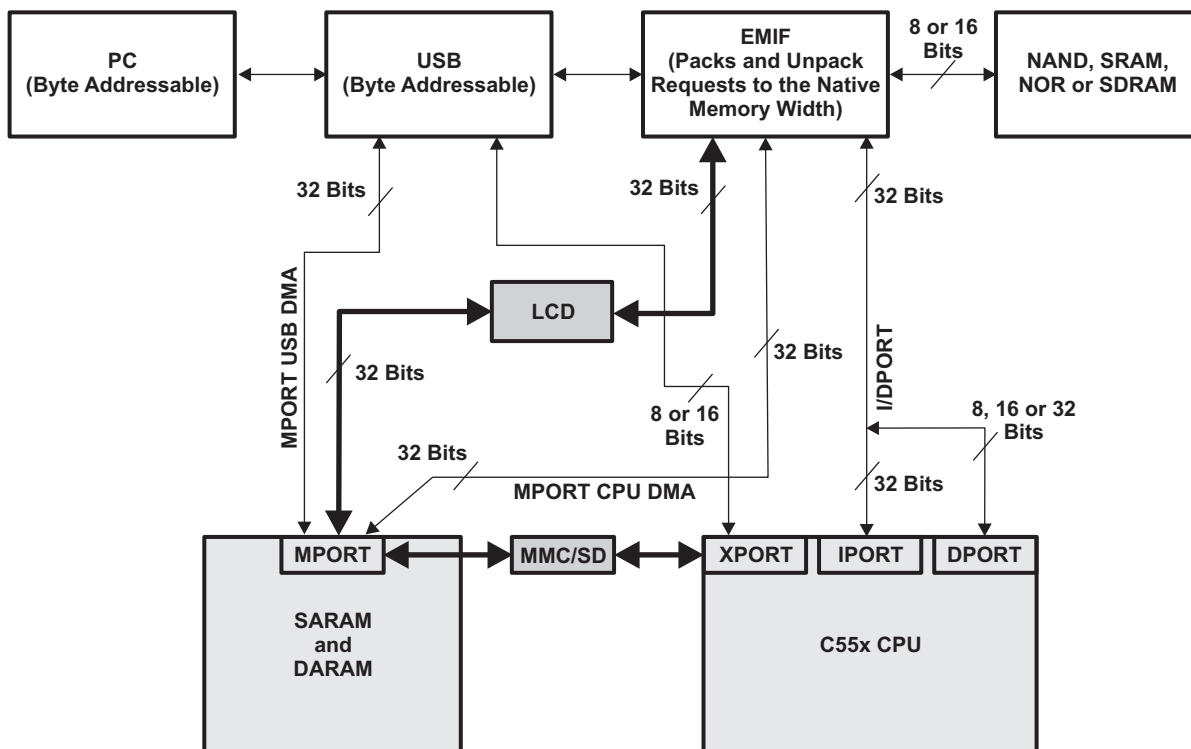


Figure 2. CPU, USB, EMIF LCD, and MMC/SD Data Paths

Example Case: Data transfer between the USB and CPU (see [Figure 3](#) and [Figure 4](#)).

Data can be read from the USB by the USB DMA or CPU. The USB DMA accesses on-chip memory through the MPORT and only performs a 32-bit read while the CPU can perform a 16-bit read via the XPORT. When USB DMA transfers data from the USB buffers to on-chip memory, the data transfer is 32-bits and is handled in big endian fashion, so no data swap occurs (see [Figure 3](#)). However, when the CPU, through the XPORT, accesses the USB buffers, the data is accessed 16-bits at a time in little endian fashion resulting in an inter byte swap (see the [Figure 4](#)).

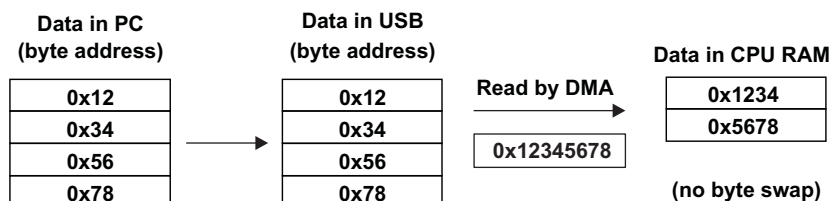


Figure 3. USB DMA Read

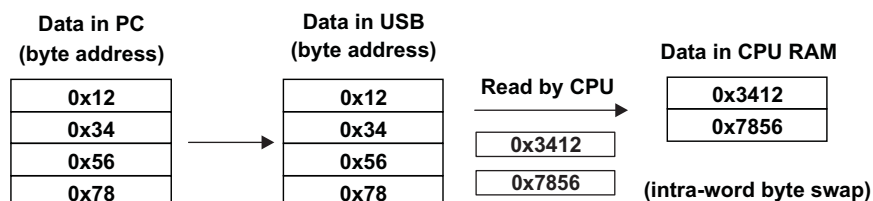


Figure 4. CPU Read From USB

Workaround(s)

To correct this issue, software is required to fix the intra-word byte swap on the data prior to processing on the C551x CPU.

Advisory 2.0.4 *I2S: I2S Internal Data Delay*

Revision(s) Affected 2.0

Details

The I2S module has an internal delay for the data transmit/receive path that varies depending on the settings of the Pack bit and Word Length in the I2S Control Register and the FSDIV in the Sample Rate Generator Register.

[Table 4](#) shows the transmit path internal data delays. Feedback path refers to an I2S transmit pin that is externally connected to the I2S receive pin.

Table 4. Transmit Path Internal Data Delays

PACK	DATA DELAY
1	The first five transmit frames will be zero data. On the sixth transmit frame, the data written to the transmit register will be shifted out on the DX pin.
0	The first three transmit frames will be zero data. On the fourth transmit frame, the data written to the transmit register will be shifted out on the DX pin.

[Table 5](#) shows the receive path internal data delays:

Table 5. Receive Path Internal Data Delays

WORD LENGTH	DATA DELAY
8-bit	The RX data registers will contain zero data for the first two frames.
10, 12, 14, and 16-bit	The RX data registers will contain zero data for the first three frames.
18, 20, 24, and 32-bit	The RX data registers will contain zero data for the first two frames.

[Table 6](#) shows the feedback path internal data delays:

Table 6. Feedback Path Internal Data Delays

PACK	WORD LENGTH	FSDIV BITS I2SSRATE.[5:3]	DATA DELAY
1	8-bit	000	Data received on the 7th sample
	8-bit	001 – 101	Data received on the 6th sample
	10-, 12-, 14-, and 16-bit	001	Data received on the 5th sample
	10-, 12-, 14-, and 16-bit	010 – 101	Data received on the 4th sample
0	8-, 10-, 12-, 14-, 16-, 18-, 20-, 24-, and 32-bit	000 – 101	Data received on the 3rd interrupt

Workaround(s) Zero data should be Ignored.

Advisory 2.0.5 *USB: USB Queue Manager Reads Only 16-bit Address of USB Descriptors*

Revision(s) Affected 2.0

Details The C551x has 23-bit address space but the USB Queue Manager (QMGR) is a 32-bit register that holds the address of the USB descriptors. A descriptor itself is a structure with information about the addresses of the source/destination data buffers and their sizes. The address of a particular descriptor is written to the QMGR register for a particular DMA endpoint. The CPU writes the address of a descriptor to the QMGR register for a for a DMA endpoint. The QMGR fires the USB DMA to read the descriptor at the address pointed to in the QMGR register and sets up the DMA endpoints for future transfers. When a USB host connects and performs a transfer, the QMGR copies the address of the descriptor to a completed queue. Upon receiving the USB interrupt, the USB driver should read the 32-bit descriptor address in the QMGR completion queue to determine which DMA endpoint has completed transferring data. Even though the CPU can write a 32-bit value into the QMGR register, it can only read the lower 16-bits of this register. Thus, the descriptor can only be allocated in the CPU memory map to the same lower 16-bit address and all descriptors must be placed in one contiguous block of 64K words in SARAM.

For example:

- USB descriptor A is located at 0x008000
- USB descriptor B is located at 0x018000

The descriptor A and B will be considered the same descriptor.

Workaround(s) The USB descriptors should be placed in ONE CONTIGUOUS BLOCK of 64K words (2^{16}) in memory.

Advisory 2.0.8
DMA: DMA Transfer Length Must be a Multiple of $4 \times 2^{(\text{Burst Mode})}$
Revision(s) Affected

2.0

Details

If the transfer length register has a value that is zero or *not* a multiple of $4 \times 2^{(\text{Burst Mode})}$ when the DMA transfer begins, it will cause an unexpected operation of DMA.

While the DMA transfers 32-bit words from a source address to a destination address, the value in the DMA transfer length register is the length in bytes. For example, if the total DMA transfer length is 4 32-bit words and the burst size = 1, $4 \times 4 = 16$ should be written to the DMA transfer length register. The burst size should also be considered. Burst size is the minimum data transfer size; therefore, the total DMA Transfer Length should be $4 \times 2^{(\text{Burst Mode})}$. For more details, see [Table 7](#)

Table 7. DMA Transfer Lengths

BURST MODE	BURST SIZE (32-BIT WORD)	DMA TRANSFER LENGTH (BYTES)
0	1	Multiple of 4 (minimum 4)
1	2	Multiple of 8 (minimum 8)
2	4	Multiple of 16 (minimum 16)
3	8	Multiple of 32 (minimum 32)
4	16	Multiple of 64 (minimum 64)

Workaround(s)

Write only a multiple of $4 \times 2^{(\text{Burst Mode})}$ to the DMA transfer register before the DMA starts.

Advisory 2.0.9 *USB Boot Does Not Work if the On-Chip USB_LDO Supplies Power to the USB Core*

Revision(s) Affected 2.0

Details The on-chip USB_LDO is intended to power the USB_ V_{DD1P3} and USB_ V_{DDA1P3} pins. At reset, the USB_LDO is turned off and can be turned on via the USBLDOEN bit (bit 0) in the LDOCNTL register (0x7004). However, the C5515/14 on-chip Bootloader does not enable the USB_LDO before attempting USB boot, so USB boot will not work if the USB_LDO supplies power to the USB_ V_{DD1P3} or USB_ V_{DDA1P3} pins.

Workaround(s) For the applications that require USB boot, the USB Core (USB_ V_{DD1P3} , USB_ V_{DDA1P3}) must be powered externally.

Advisory 2.0.10 *USB CPPI Receive Starvation Interrupt*

Revision(s) Affected 2.0

Details

When an endpoint is enabled for receive transfer(s) that will be serviced via CPPI DMA and data has been received prior to allocating the DMA resource, the DMA will generate a starvation interrupt to notify the application a lack of resource (starvation) in anticipation that the application will furnish the required resource. Once the starvation occurs, the CPPI DMA continues generating interrupts periodically whenever the host tries to send data. It does not stop until the application furnishes a resource.

The USB starvation interrupt is always enabled and cannot be masked off at the USB controller level. Since the DMA continues to generate the starvation interrupt periodically and there exists no capability to mask the starvation interrupt at the USB controller level, the CPU is forced either to fully service the DMA interrupt as it is received or disable all USB interrupts at the CPU level. Disabling the entire USB interrupt might not be the desired option since the CPU needs to be aware of other USB interrupts that are more critical.

Workaround(s)

Dedicated data receiving buffers are recommended. The data buffers should be allocated and available to the CPPI DMA during USB initialization. The required data buffer size is highly dependent on USB host applications. For Windows XP USB Mass Storage device driver, it is recommended to allocate at least 64 KB (128 descriptors; 128*512 = 64 KB) of data buffer space.

Revision History

This silicon errata revision history highlights the technical changes made to the SPRZ308A version to make it an SPRZ308B revision.

Scope: Applicable updates relating to the TMS320C5515/C5514 devices have been incorporated. Added device-specific information supporting the TMS320C551x Silicon Revision 2.0 devices, which are now in the production data (PD) stage of development.

Revision History

SEE	ADDITIONS/MODIFICATIONS/DELETIONS
Entire document	Changed phrasing "secure boot mode" to "encrypted boot mode".
Section 2.1 Usage Notes for Silicon Revision 2.0	Added the following usage notes: <ul style="list-style-type: none"> • Section 2.1.6, <i>SPI Booting Does Not Support 24-Bit Encrypted Reauthoring and Bound to Device</i> • Section 2.1.7, <i>SPI Enters a Reset State When Writing to the SPICDR Register</i> • Section 2.1.8, <i>SPI Clock State Is Changed When Writing to the SPICDR Register</i> • Section 2.1.9, <i>HWAFFT Data and Scratch Buffers Must Reside at Data Locations Less Than 0x10000</i> • Section 2.1.10, <i>USB Oscillator Consumes Power When Core Voltage Is Removed</i>

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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