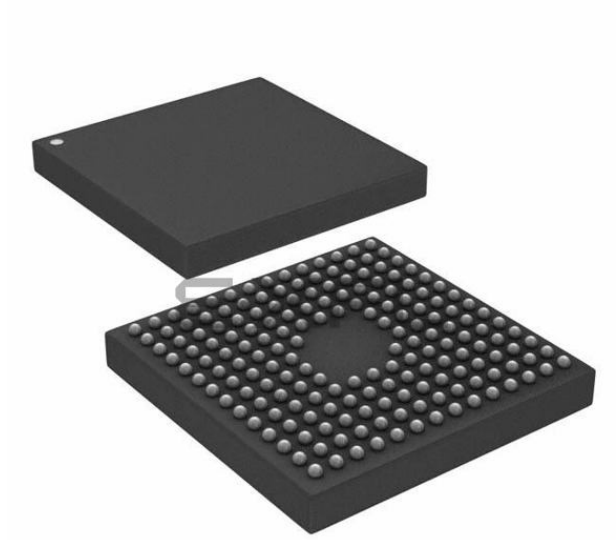

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Understanding Embedded - DSP (Digital Signal Processors)

Embedded - DSP (Digital Signal Processors) are specialized microprocessors designed to perform complex mathematical computations on digital signals in real-time. Unlike general-purpose processors, DSPs are optimized for high-speed numeric processing tasks, making them ideal for applications that require efficient and precise manipulation of digital data. These processors are fundamental in converting and processing signals in various forms, including audio, video, and communication signals, ensuring that data is accurately interpreted and utilized in embedded systems.

Applications of Embedded - DSP (Digital Signal Processors)

Details	
Product Status	Active
Type	Fixed Point
Interface	CAN, SPI, SSP, TWI, UART
Clock Rate	400MHz
Non-Volatile Memory	External
On-Chip RAM	100kB
Voltage - I/O	2.50V, 3.30V
Voltage - Core	1.20V
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	182-LFBGA, CSPBGA
Supplier Device Package	182-CSPBGA (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/analog-devices/adsp-bf536bbcz-4a

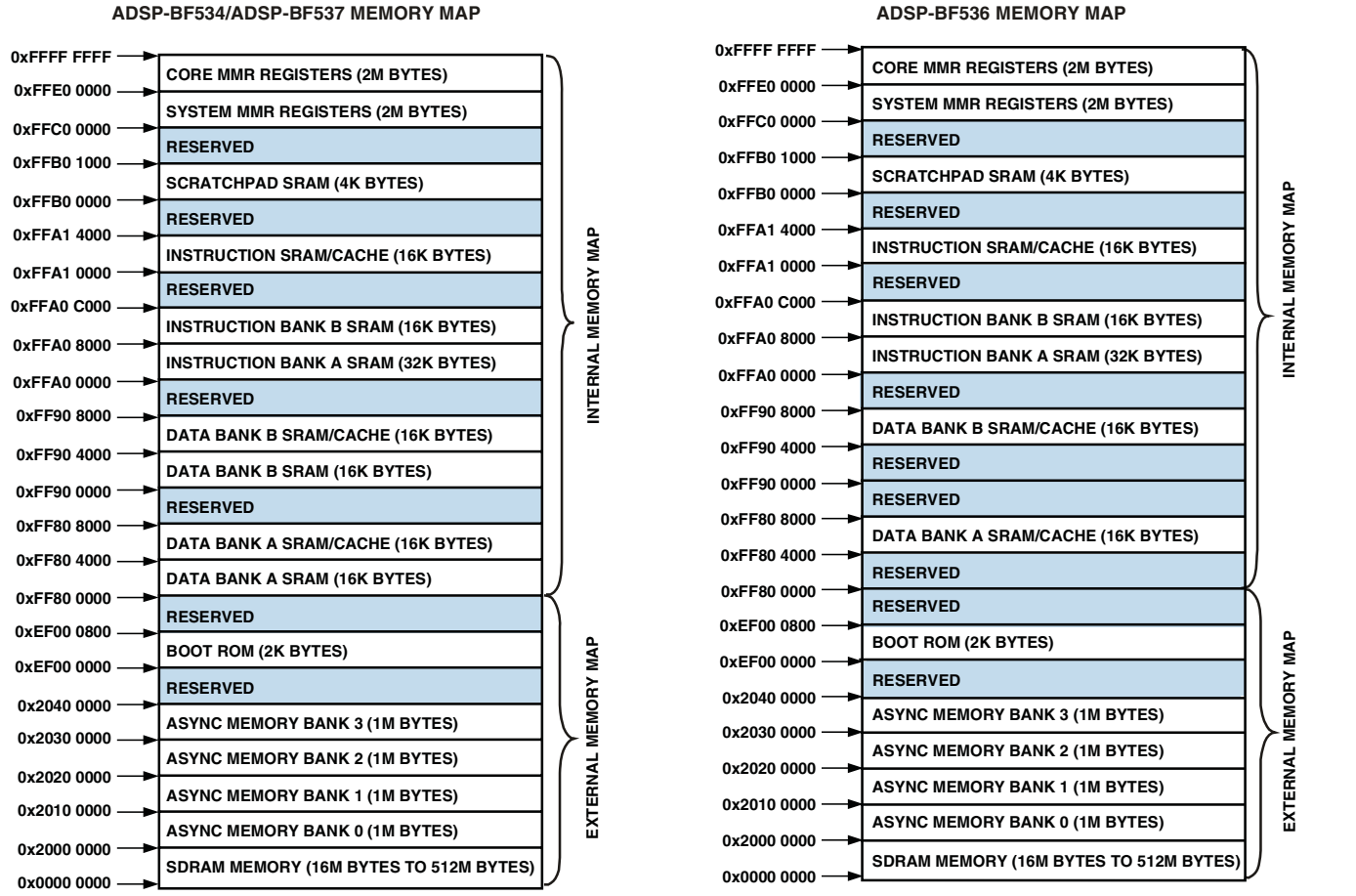


Figure 3. ADSP-BF534/ADSP-BF536/ADSP-BF537 Memory Maps

memory space, the processor starts executing from the on-chip boot ROM. For more information, see Booting Modes on Page 16.

Event Handling

The event controller on the Blackfin processor handles all asynchronous and synchronous events to the processor. The Blackfin processor provides event handling that supports both nesting and prioritization. Nesting allows multiple event service routines to be active simultaneously. Prioritization ensures that servicing of a higher priority event takes precedence over servicing of a lower priority event. The controller provides support for five different types of events:

- Emulation – An emulation event causes the processor to enter emulation mode, allowing command and control of the processor via the JTAG interface.
- Reset – This event resets the processor.
- Nonmaskable Interrupt (NMI) – The NMI event can be generated by the software watchdog timer or by the $\overline{\text{NMI}}$ input signal to the processor. The NMI event is frequently used as a power-down indicator to initiate an orderly shutdown of the system.
- Exceptions – Events that occur synchronously to program flow (in other words, the exception is taken before the instruction is allowed to complete). Conditions such as data alignment violations and undefined instructions cause exceptions.
- Interrupts – Events that occur asynchronously to program flow. They are caused by input pins, timers, and other peripherals, as well as by an explicit software instruction.

Each event type has an associated register to hold the return address and an associated return-from-event instruction. When an event is triggered, the state of the processor is saved on the supervisor stack.

The Blackfin processor event controller consists of two stages: the core event controller (CEC) and the system interrupt controller (SIC). The core event controller works with the system interrupt controller to prioritize and control all system events. Conceptually, interrupts from the peripherals enter into the SIC, and are then routed directly into the general-purpose interrupts of the CEC.

Table 3. System Interrupt Controller (SIC) (Continued)

Peripheral Interrupt Event	Default Mapping	Peripheral Interrupt ID
DMA Channels 12 and 13 (Memory DMA Stream 0)	IVG13	29
DMA Channels 14 and 15 (Memory DMA Stream 1)	IVG13	30
Software Watchdog Timer	IVG13	31
Port F Interrupt B	IVG13	31

Event Control

The Blackfin processor provides a very flexible mechanism to control the processing of events. In the CEC, three registers are used to coordinate and control events. Each register is 32 bits wide:

- CEC interrupt latch register (ILAT) – Indicates when events have been latched. The appropriate bit is set when the processor has latched the event and cleared when the event has been accepted into the system. This register is updated automatically by the controller, but it can be written only when its corresponding IMASK bit is cleared.
- CEC interrupt mask register (IMASK) – Controls the masking and unmasking of individual events. When a bit is set in the IMASK register, that event is unmasked and is processed by the CEC when asserted. A cleared bit in the IMASK register masks the event, preventing the processor from servicing the event even though the event may be latched in the ILAT register. This register can be read or written while in supervisor mode. (Note that general-purpose interrupts can be globally enabled and disabled with the STI and CLI instructions, respectively.)
- CEC interrupt pending register (IPEND) – The IPEND register keeps track of all nested events. A set bit in the IPEND register indicates the event is currently active or nested at some level. This register is updated automatically by the controller but can be read while in supervisor mode.

The SIC allows further control of event processing by providing three 32-bit interrupt control and status registers. Each register contains a bit corresponding to each of the peripheral interrupt events shown in Table 3 on Page 7.

- SIC interrupt mask register (SIC_IMASK) – Controls the masking and unmasking of each peripheral interrupt event. When a bit is set in the register, that peripheral event is unmasked and is processed by the system when asserted. A cleared bit in the register masks the peripheral event, preventing the processor from servicing the event.
- SIC interrupt status register (SIC_ISR) – As multiple peripherals can be mapped to a single event, this register allows the software to determine which peripheral event source triggered the interrupt. A set bit indicates the peripheral is asserting the interrupt, and a cleared bit indicates the peripheral is not asserting the event.
- SIC interrupt wake-up enable register (SIC_IWR) – By enabling the corresponding bit in this register, a peripheral can be configured to wake up the processor, should the core be idled when the event is generated. (For more information, see Dynamic Power Management on Page 13.)

Because multiple interrupt sources can map to a single general-purpose interrupt, multiple pulse assertions can occur simultaneously, before or during interrupt processing for an interrupt event already detected on this interrupt input. The IPEND register contents are monitored by the SIC as the interrupt acknowledgement.

The appropriate ILAT register bit is set when an interrupt rising edge is detected (detection requires two core clock cycles). The bit is cleared when the respective IPEND register bit is set. The IPEND bit indicates that the event has entered into the processor pipeline. At this point the CEC recognizes and queues the next rising edge event on the corresponding event input. The minimum latency from the rising edge transition of the general-purpose interrupt to the IPEND output asserted is three core clock cycles; however, the latency can be much higher, depending on the activity within and the state of the processor.

DMA CONTROLLERS

The Blackfin processors have multiple, independent DMA channels that support automated data transfers with minimal overhead for the processor core. DMA transfers can occur between the processor's internal memories and any of its DMA-capable peripherals. Additionally, DMA transfers can be accomplished between any of the DMA-capable peripherals and external devices connected to the external memory interfaces, including the SDRAM controller and the asynchronous memory controller. DMA-capable peripherals include the Ethernet MAC (ADSP-BF536 and ADSP-BF537 only), SPORTs, SPI port, UARTs, and PPI. Each individual DMA-capable peripheral has at least one dedicated DMA channel.

The DMA controller supports both one-dimensional (1-D) and two-dimensional (2-D) DMA transfers. DMA transfer initialization can be implemented from registers or from sets of parameters called descriptor blocks.

The 2-D DMA capability supports arbitrary row and column sizes up to 64K elements by 64K elements, and arbitrary row and column step sizes up to ±32K elements. Furthermore, the column step size can be less than the row step size, allowing implementation of interleaved data streams. This feature is especially useful in video applications where data can be de-interleaved on the fly.

Examples of DMA types supported by the DMA controller include

- A single, linear buffer that stops upon completion
- A circular, auto-refreshing buffer that interrupts on each full or fractionally full buffer
- 1-D or 2-D DMA using a linked list of descriptors
- 2-D DMA using an array of descriptors, specifying only the base DMA address within a common page.

In addition to the dedicated peripheral DMA channels, there are two memory DMA channels provided for transfers between the various memories of the processor system. This enables transfers of blocks of data between any of the memories—including external SDRAM, ROM, SRAM, and flash memory—with minimal processor intervention. Memory DMA transfers can be controlled by a very flexible descriptor-based methodology or by a standard register-based autobuffer mechanism.

The ADSP-BF534/ADSP-BF536/ADSP-BF537 processors also have an external DMA controller capability via dual external DMA request pins when used in conjunction with the external bus interface unit (EBIU). This functionality can be used when a high speed interface is required for external FIFOs and high bandwidth communications peripherals such as USB 2.0. It allows control of the number of data transfers for memDMA. The number of transfers per edge is programmable. This feature can be programmed to allow memDMA to have an increased priority on the external bus relative to the core.

REAL-TIME CLOCK

The real-time clock (RTC) provides a robust set of digital watch features, including current time, stopwatch, and alarm. The RTC is clocked by a 32.768 kHz crystal external to the processor. The RTC peripheral has dedicated power supply pins so that it can remain powered up and clocked even when the rest of the processor is in a low power state. The RTC provides several programmable interrupt options, including interrupt per second, minute, hour, or day clock ticks, interrupt on programmable stopwatch countdown, or interrupt at a programmed alarm time.

The 32.768 kHz input clock frequency is divided down to a 1 Hz signal by a prescaler. The counter function of the timer consists of four counters: a 60-second counter, a 60-minute counter, a 24-hour counter, and an 32,768-day counter.

When enabled, the alarm function generates an interrupt when the output of the timer matches the programmed value in the alarm control register. There are two alarms: The first alarm is for a time of day, while the second alarm is for a day and time of that day.

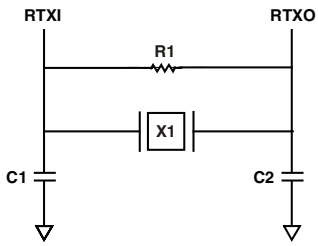
The stopwatch function counts down from a programmed value, with one-second resolution. When the stopwatch is enabled and the counter underflows, an interrupt is generated.

Like the other peripherals, the RTC can wake up the processor from sleep mode upon generation of any RTC wake-up event. Additionally, an RTC wake-up event can wake up the processor from deep sleep mode, and wake up the on-chip internal voltage regulator from the hibernate operating mode.

Connect RTC pins RTXI and RTXO with external components as shown in Figure 4.

WATCHDOG TIMER

The ADSP-BF534/ADSP-BF536/ADSP-BF537 processors include a 32-bit timer that can be used to implement a software watchdog function. A software watchdog can improve system availability by forcing the processor to a known state through generation of a system reset, nonmaskable interrupt (NMI), or general-purpose interrupt, if the timer expires before being reset by software. The programmer initializes the count value of the timer, enables the appropriate interrupt, then enables the timer. Thereafter, the software must reload the counter before it counts to zero from the programmed value. This protects the system from remaining in an unknown state where software, which would normally reset the timer, has stopped running due to an external noise condition or software error.



SUGGESTED COMPONENTS:
X1 = ECLIPTEK EC38J (THROUGH-HOLE PACKAGE) OR
EPSON MC405 12 pF LOAD (SURFACE-MOUNT PACKAGE)
C1 = 22 pF
C2 = 22 pF
R1 = 10 MΩ

NOTE: C1 AND C2 ARE SPECIFIC TO CRYSTAL SPECIFIED FOR X1. CONTACT CRYSTAL MANUFACTURER FOR DETAILS. C1 AND C2 SPECIFICATIONS ASSUME BOARD TRACE CAPACITANCE OF 3 pF.

Figure 4. External Components for RTC

If configured to generate a hardware reset, the watchdog timer resets both the core and the processor peripherals. After a reset, software can determine if the watchdog was the source of the hardware reset by interrogating a status bit in the watchdog timer control register.

The timer is clocked by the system clock (SCLK), at a maximum frequency of f_{SCLK}.

TIMERS

There are nine general-purpose programmable timer units in the processor. Eight timers have an external pin that can be configured either as a pulse-width modulator (PWM) or timer output, as an input to clock the timer, or as a mechanism for measuring pulse widths and periods of external events. These timers can be synchronized to an external clock input to the several other associated PF pins, to an external clock input to the PPI_CLK input pin, or to the internal SCLK.

The timer units can be used in conjunction with the two UARTs and the CAN controller to measure the width of the pulses in the data stream to provide a software auto-baud detect function for the respective serial channels.

The timers can generate interrupts to the processor core providing periodic events for synchronization, either to the system clock or to a count of external signals.

In addition to the eight general-purpose programmable timers, a ninth timer is also provided. This extra timer is clocked by the internal processor clock and is typically used as a system tick clock for generating periodic interrupts in an operating system.

(VCO) and the system clock. SCLK divider values are 1 through 15. Table 6 illustrates typical system clock ratios.

Table 6. Example System Clock Ratios

Signal Name SSEL3–0	Divider Ratio VCO:SCLK	Example Frequency Ratios (MHz)	
		VCO	SCLK
0001	1:1	100	100
0110	6:1	300	50
1010	10:1	500	50

Note that the divisor ratio must be chosen to limit the system clock frequency to its maximum of f_{SCLK}. The SSEL value can be changed dynamically without any PLL lock latencies by writing the appropriate values to the PLL divisor register (PLL_DIV).

The core clock (CCLK) frequency can also be dynamically changed by means of the CSEL1–0 bits of the PLL_DIV register. Supported CCLK divider ratios are 1, 2, 4, and 8, as shown in Table 7. This programmable core clock capability is useful for fast core frequency modifications.

Table 7. Core Clock Ratios

Signal Name CSEL1–0	Divider Ratio VCO:CCLK	Example Frequency Ratios (MHz)	
		VCO	CCLK
00	1:1	300	300
01	2:1	300	150
10	4:1	500	125
11	8:1	200	25

The maximum CCLK frequency not only depends on the part's speed grade (see Ordering Guide on Page 67), it also depends on the applied V_{DDINT} voltage (see Table 10, Table 11, and Table 12 on Page 24 for details). The maximal system clock rate (SCLK) depends on the chip package and the applied V_{DDEXT} voltage (see Table 14 on Page 24).

BOOTING MODES

The ADSP-BF534/ADSP-BF536/ADSP-BF537 processor has six mechanisms (listed in Table 8) for automatically loading internal and external memory after a reset. A seventh mode is provided to execute from external memory, bypassing the boot sequence.

Table 8. Booting Modes

BMODE2–0	Description
000	Execute from 16-bit external memory (bypass boot ROM)
001	Boot from 8-bit or 16-bit memory (EPROM/flash)
010	Reserved
011	Boot from serial SPI memory (EEPROM/flash)
100	Boot from SPI host (slave mode)
101	Boot from serial TWI memory (EEPROM/flash)
110	Boot from TWI host (slave mode)
111	Boot from UART host (slave mode)

The BMODE pins of the reset configuration register, sampled during power-on resets and software-initiated resets, implement the following modes:

- Execute from 16-bit external memory – Execution starts from address 0x2000 0000 with 16-bit packing. The boot ROM is bypassed in this mode. All configuration settings are set for the slowest device possible (3-cycle hold time; 15-cycle R/W access times; 4-cycle setup).
- Boot from 8-bit and 16-bit external flash memory – The 8-bit or 16-bit flash boot routine located in Boot ROM memory space is set up using asynchronous memory bank 0. All configuration settings are set for the slowest device possible (3-cycle hold time; 15-cycle R/W access times; 4-cycle setup). The Boot ROM evaluates the first byte of the boot stream at address 0x2000 0000. If it is 0x40, 8-bit boot is performed. A 0x60 byte assumes a 16-bit memory device and performs 8-bit DMA. A 0x20 byte also assumes 16-bit memory but performs 16-bit DMA.
- Boot from serial SPI memory (EEPROM or flash) – 8-, 16-, or 24-bit addressable devices are supported as well as AT45DB041, AT45DB081, AT45DB161, AT45DB321, AT45DB642, and AT45DB1282 DataFlash® devices from Atmel. The SPI uses the PF10/SPI SSEL1 output pin to select a single SPI EEPROM/flash device, submits a read command and successive address bytes (0x00) until a valid 8-, 16-, or 24-bit, or Atmel addressable device is detected, and begins clocking data into the processor.
- Boot from SPI host device – The Blackfin processor operates in SPI slave mode and is configured to receive the bytes of the .LDR file from an SPI host (master) agent. To hold off the host device from transmitting while the boot ROM is busy, the Blackfin processor asserts a GPIO pin, called host wait (HWAIT), to signal the host device not to send any more bytes until the flag is deasserted. The flag is chosen by the user and this information is transferred to the Blackfin processor via bits 10:5 of the FLAG header.
- Boot from UART – Using an autobaud handshake sequence, a boot-stream-formatted program is downloaded by the host. The host agent selects a baud rate within the UART's clocking capabilities. When performing the autobaud, the UART expects an "@" (boot stream) character (8 bits data, 1 start bit, 1 stop bit, no parity bit) on the RXD pin to determine the bit rate. It then replies with an acknowledgement that is composed of 4 bytes: 0xBF, the value of UART_DLL, the value of UART_DLH, and 0x00. The host can then download the boot stream. When the processor needs to hold off the host, it deasserts CTS. Therefore, the host must monitor this signal.

suite to emulate the on-board processor in-circuit. This permits the customer to download, execute, and debug programs for the EZ-KIT Lite system. It also supports in-circuit programming of the on-board Flash device to store user-specific boot code, enabling standalone operation. With the full version of CrossCore Embedded Studio or VisualDSP++ installed (sold separately), engineers can develop software for supported EZ-KITs or any custom system utilizing supported Analog Devices processors.

Software Add-Ins for CrossCore Embedded Studio

Analog Devices offers software add-ins which seamlessly integrate with CrossCore Embedded Studio to extend its capabilities and reduce development time. Add-ins include board support packages for evaluation hardware, various middleware packages, and algorithmic modules. Documentation, help, configuration dialogs, and coding examples present in these add-ins are viewable through the CrossCore Embedded Studio IDE once the add-in is installed.

Board Support Packages for Evaluation Hardware

Software support for the EZ-KIT Lite evaluation boards and EZ-Extender daughter cards is provided by software add-ins called Board Support Packages (BSPs). The BSPs contain the required drivers, pertinent release notes, and select example code for the given evaluation hardware. A download link for a specific BSP is located on the web page for the associated EZ-KIT or EZ-Extender product. The link is found in the *Product Download* area of the product web page.

Middleware Packages

Analog Devices separately offers middleware add-ins such as real time operating systems, file systems, USB stacks, and TCP/IP stacks. For more information see the following web pages:

- www.analog.com/ucos3
- www.analog.com/ucfs
- www.analog.com/ucusbd
- www.analog.com/lwip

Algorithmic Modules

To speed development, Analog Devices offers add-ins that perform popular audio and video processing algorithms. These are available for use with both CrossCore Embedded Studio and VisualDSP++. For more information visit www.analog.com and search on “Blackfin software modules” or “SHARC software modules”.

Designing an Emulator-Compatible DSP Board (Target)

For embedded system test and debug, Analog Devices provides a family of emulators. On each JTAG DSP, Analog Devices supplies an IEEE 1149.1 JTAG Test Access Port (TAP). In-circuit emulation is facilitated by use of this JTAG interface. The emulator accesses the processor’s internal features via the processor’s TAP, allowing the developer to load code, set breakpoints, and view variables, memory, and registers. The processor must be halted to send data and commands, but once an operation is completed by the emulator, the DSP system is set to run at full speed with no impact on system timing. The emulators require the target board to include a header that supports connection of the DSP’s JTAG port to the emulator.

For details on target board design issues including mechanical layout, single processor connections, signal buffering, signal termination, and emulator pod logic, see the Engineer-to-Engineer Note *“Analog Devices JTAG Emulation Technical Reference”* (EE-68) on the Analog Devices website (www.analog.com)—use site search on “EE-68.” This document is updated regularly to keep pace with improvements to emulator support.

ADDITIONAL INFORMATION

The following publications that describe the ADSP-BF534/ADSP-BF536/ADSP-BF537 processors (and related processors) can be ordered from any Analog Devices sales office or accessed electronically on our website:

- *Getting Started with Blackfin Processors*
- *ADSP-BF537 Blackfin Processor Hardware Reference*
- *ADSP-BF53x/ADSP-BF56x Blackfin Processor Programming Reference*
- *ADSP-BF534/ADSP-BF536/ADSP-BF537 Blackfin Processor Anomaly List*

RELATED SIGNAL CHAINS

A *signal chain* is a series of signal-conditioning electronic components that receive input (data acquired from sampling either real-time phenomena or from stored data) in tandem, with the output of one portion of the chain supplying input to the next. Signal chains are often used in signal processing applications to gather and process data or to apply system controls based on analysis of real-time phenomena. For more information about this term and related topics, see the "signal chain" entry in Wikipedia or the Glossary of EE Terms on the Analog Devices website.

Analog Devices eases signal processing system development by providing signal processing components that are designed to work together well. A tool for viewing relationships between specific applications and related components is available on the www.analog.com website.

The Application Signal Chains page in the Circuits from the Lab™ site (http://www.analog.com/signalchains) provides:

- Graphical circuit block diagram presentation of signal chains for a variety of circuit types and applications
- Drill down links for components in each chain to selection guides and application information
- Reference designs applying best practice design techniques

PIN DESCRIPTIONS

The ADSP-BF534/ADSP-BF536/ADSP-BF537 processors pin definitions are listed in Table 9. In order to maintain maximum functionality and reduce package size and pin count, some pins have dual, multiplexed functions. In cases where pin function is reconfigurable, the default state is shown in plain text, while the alternate function is shown in italics. Pins shown with an asterisk after their name (*) offer high source/high sink current capabilities.

All pins are three-stated during and immediately after reset, with the exception of the external memory interface, asynchronous and synchronous memory control, and the buffered XTAL output pin (CLKBUF). On the external memory interface, the control and address lines are driven high, with the exception of CLKOUT, which toggles at the system clock rate. If $\overline{BR}$ is active (whether or not $\overline{RESET}$ is asserted), the memory pins are also three-stated. During hibernate, all outputs are three-stated unless otherwise noted in Table 9.

All I/O pins have their input buffers disabled with the exception of the pins noted in the data sheet that need pull-ups or pull-downs if unused.

The SDA (serial data) and SCL (serial clock) pins are open drain and therefore require a pull-up resistor. Consult version 2.1 of the I^2C specification for the proper resistor value.

Table 9. Pin Descriptions

Pin Name	Type	Function	Driver Type[1]
Memory Interface			
ADDR19–1	O	Address Bus for Async Access	A
DATA15–0	I/O	Data Bus for Async/Sync Access	A
$\overline{ABE1–0}$/SDQM1–0	O	Byte Enables/Data Masks for Async/Sync Access	A
$\overline{BR}$	I	Bus Request (This pin should be pulled high when not used.)	
$\overline{BG}$	O	Bus Grant	A
$\overline{BGH}$	O	Bus Grant Hang	A
Asynchronous Memory Control			
$\overline{AMS3–0}$	O	Bank Select (Require pull-ups if hibernate is used.)	A
ARDY	I	Hardware Ready Control	
$\overline{AOE}$	O	Output Enable	A
$\overline{ARE}$	O	Read Enable	A
$\overline{AWE}$	O	Write Enable	A
Synchronous Memory Control			
$\overline{SRAS}$	O	Row Address Strobe	A
$\overline{SCAS}$	O	Column Address Strobe	A
$\overline{SWE}$	O	Write Enable	A
SCKE	O	Clock Enable(Requires a pull-down if hibernate with SDRAM self-refresh is used.)	A
CLKOUT	O	Clock Output	B
SA10	O	A10 Pin	A
$\overline{SMS}$	O	Bank Select	A

Table 9. Pin Descriptions (Continued)

Pin Name	Type	Function	Driver Type[1]
Clock			
CLKIN	I	Clock/Crystal Input	
XTAL	O	Crystal Output (If CLKBUF is enabled, does not three-state during hibernate.)	
CLKBUF	O	Buffered XTAL Output (If enabled, does not three-state during hibernate.)	E
Mode Controls			
$\overline{\text{RESET}}$	I	Reset	
$\overline{\text{NMI}}$	I	Nonmaskable Interrupt (This pin should be pulled high when not used.)	
BMODE2–0	I	Boot Mode Strap 2-0 (These pins must be pulled to the state required for the desired boot mode.)	
Voltage Regulator			
VROUT1–0	O	External FET Drive (These pins should be left unconnected when not used and are driven high during hibernate.)	
Supplies			
V_{DDEXT}	P	I/O Power Supply	
V_{DDINT}	P	Internal Power Supply	
V_{DDRTC}	P	Real-Time Clock Power Supply (This pin should be connected to V_{DDEXT} when not used and should remain powered at all times.)	
GND	G	External Ground	

[1] See Output Drive Currents on Page 50 for more information about each driver types.

Table 10 through Table 12 describe the voltage/frequency requirements for the ADSP-BF534/ADSP-BF536/ADSP-BF537 processor clocks. Take care in selecting MSEL, SSEL, and CSEL ratios so as not to exceed the maximum core clock and system clock. Table 13 describes phase-locked loop operating conditions.

Table 10. Core Clock Requirements—500 MHz, 533 MHz, and 600 MHz Speed Grades[1]

Parameter		Internal Regulator Setting	Max	Unit
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.30 V Minimum)[2]	1.30 V	600	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.20 V Minimum)[3]	1.25 V	533	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.14 V Minimum)	1.20 V	500	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.045 V Minimum)	1.10 V	444	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.95 V Minimum)	1.00 V	400	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.85 V Minimum)	0.90 V	333	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.8 V Minimum)	0.85 V	250	MHz

[1] See Ordering Guide on Page 67.
[2] Applies to 600 MHz models only. See Ordering Guide on Page 67.
[3] Applies to 533 MHz and 600 MHz models only. See Ordering Guide on Page 67.

Table 11. Core Clock Requirements—400 MHz Speed Grade[1]

Parameter		Internal Regulator Setting	120°C ≥ T_J > 105°C Max	All[2] Other T_J Max	Unit
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.14 V Minimum)	1.20 V	400	400	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.045 V Minimum)	1.10 V	333	363	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.95 V Minimum)	1.00 V	295	333	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.85 V Minimum)	0.90 V		280	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.8 V Minimum)	0.85 V		250	MHz

[1] See Ordering Guide on Page 67.
[2] See Operating Conditions on Page 23.

Table 12. Core Clock Requirements—300 MHz Speed Grade[1]

Parameter		Internal Regulator Setting	Max	Unit
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.14 V Minimum)	1.20 V	300	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 1.045 V Minimum)	1.10 V	255	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.95 V Minimum)	1.00 V	210	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.85 V Minimum)	0.90 V	180	MHz
f_{CCLK}	Core Clock Frequency (V_{DDINT} = 0.8 V Minimum)	0.85 V	160	MHz

[1] See Ordering Guide on Page 67.

Table 13. Phase-Locked Loop Operating Conditions

Parameter		Min	Max	Unit
f_{VCO}	Voltage Controlled Oscillator (VCO) Frequency	50	Max f_{CCLK}	MHz

Table 14. System Clock Requirements

Parameter	Condition	Max	Unit
f_{SCLK}[1]	V_{DDEXT} = 3.3 V or 2.5 V, V_{DDINT} ≥ 1.14 V	133[2]	MHz
f_{SCLK}[1]	V_{DDEXT} = 3.3 V or 2.5 V, V_{DDINT} < 1.14 V	100	MHz

[1] f_{SCLK} must be less than or equal to f_{CCLK} and is subject to additional restrictions for SDRAM interface operation. See Table 27 on Page 34.
[2] Rounded number. Actual test specification is SCLK period of 7.5 ns. See Table 27 on Page 34.

Parameter		Test Conditions	300 MHz/400 MHz[1] Min	Typ	Max	500 MHz/533 MHz/600 MHz[2] Min	Typ	Max	Unit
C_{IN}	Input Capacitance[13, 14]	f_{IN} = 1 MHz, $T_{AMBIENT}$ = 25°C, V_{IN} = 2.5 V			8			8	pF
$I_{DD-IDLE}$	V_{DDINT} Current in Idle	V_{DDINT} = 1.0 V, f_{CCLK} = 50 MHz, T_J = 25°C, ASF = 0.43		14			24		mA
I_{DD-TYP}	V_{DDINT} Current	V_{DDINT} = 1.14 V, f_{CCLK} = 300 MHz, T_J = 25°C, ASF = 1.00		100			113		mA
I_{DD-TYP}	V_{DDINT} Current	V_{DDINT} = 1.14 V, f_{CCLK} = 400 MHz, T_J = 25°C, ASF = 1.00		125			138		mA
$I_{DDDEEPSLEEP}$[15]	V_{DDINT} Current in Deep Sleep Mode	V_{DDINT} = 1.0 V, f_{CCLK} = 0 MHz, T_J = 25°C, ASF = 0.00		6			16		mA
$I_{DDSLEEP}$	V_{DDINT} Current in Sleep Mode	V_{DDINT} = 1.0 V, f_{SCLK} = 25 MHz, T_J = 25°C		9.5			19.5		mA
I_{DD-TYP}	V_{DDINT} Current	V_{DDINT} = 1.20 V, f_{CCLK} = 533 MHz, T_J = 25°C, ASF = 1.00					185		mA
I_{DD-TYP}	V_{DDINT} Current	V_{DDINT} = 1.30 V, f_{CCLK} = 600 MHz, T_J = 25°C, ASF = 1.00					227		mA
$I_{DDHIBERNATE}$[15, 16]	V_{DDEXT} Current in Hibernate State	V_{DDEXT} = 3.60 V, CLKIN=0 MHz, T_J = maximum, with voltage regulator off (V_{DDINT} = 0 V)		50	100		50	100	µA
I_{DDRTC}	V_{DDRTC} Current	V_{DDRTC} = 3.3 V, T_J= 25°C		20			20		µA
$I_{DDDEEPSLEEP}$[15]	V_{DDINT} Current in Deep Sleep Mode	f_{CCLK} = 0 MHz, f_{SCLK} =0 MHz			Table 16			Table 15	mA
$I_{DDSLEEP}$[15, 17]	V_{DDINT} Current in Sleep Mode	f_{CCLK} = 0 MHz, f_{SCLK} > 0 MHz			$I_{DDDEEPSLEEP}$ + (0.14 × V_{DDINT} × f_{SCLK})			$I_{DDDEEPSLEEP}$ + (0.14 × V_{DDINT} × f_{SCLK})	mA
I_{DDINT}[18]	V_{DDINT} Current	f_{CCLK} > 0 MHz, f_{SCLK} > 0 MHz			$I_{DDSLEEP}$ + (Table 18 × ASF)			$I_{DDSLEEP}$ + (Table 18 × ASF)	mA

[1] Applies to all 300 MHz and 400 MHz speed grade models. See Ordering Guide on Page 67.
[2] Applies to all 500 MHz, 533 MHz, and 600 MHz speed grade models. See Ordering Guide on Page 67.
[3] Applies to all output and bidirectional pins except port F pins, port G pins, and port H pins.
[4] Applies to port F pins PF7–0.
[5] Applies to port F pins PF15–8, all port G pins, and all port H pins.
[6] Maximum combined current for Port F7–0.
[7] Maximum total current for all port F, port G, and port H pins.
[8] Applies to all input pins except PJ4.
[9] Applies to input pin PJ4 only.
[10] Applies to JTAG input pins (TCK, TDI, TMS, $\overline{\text{TRST}}$).
[11] Applies to three-statable pins.
[12] Applies to bidirectional pins PJ2 and PJ3.
[13] Applies to all signal pins.
[14] Guaranteed, but not tested.
[15] See the *ADSP-BF537 Blackfin Processor Hardware Reference Manual* for definition of sleep, deep sleep, and hibernate operating modes.
[16] CLKIN must be tied to V_{DDEXT} or GND during hibernate.
[17] In the equations, the f_{SCLK} parameter is the system clock in MHz.
[18] See Table 17 for the list of I_{DDINT} power vectors covered.

System designers should refer to *Estimating Power for the ADSP-BF534/BF536/BF537 Blackfin Processors (EE-297)*, which provides detailed information for optimizing designs for lowest power. All topics discussed in this section are described in detail in EE-297. Total power dissipation has two components:

1. Static, including leakage current
2. Dynamic, due to transistor switching characteristics

Many operating conditions can also affect power dissipation, including temperature, voltage, operating frequency, and processor activity. Electrical Characteristics on Page 25 shows the current dissipation for internal circuitry (V_{DDINT}). $I_{DDDEEPSLEEP}$ specifies static power dissipation as a function of voltage (V_{DDINT}) and temperature (see Table 16 or Table 15), and I_{DDINT} specifies the total power specification for the listed test conditions, including the dynamic component as a function of voltage (V_{DDINT}) and frequency (Table 18).

The dynamic component is also subject to an Activity Scaling Factor (ASF) which represents application code running on the processor (Table 17).

Table 15. Static Current–500 MHz, 533 MHz, and 600 MHz Speed Grade Devices (mA)[1]

	Voltage (V_{DDINT})													
T_J (°C)	0.80 V	0.85 V	0.90 V	0.95 V	1.00 V	1.05 V	1.10 V	1.15 V	1.20 V	1.25 V	1.30 V	1.32 V	1.375 V	1.43 V
–40	3.9	4.7	6.8	8.2	9.9	12.0	14.6	17.3	20.3	24.1	27.1	28.6	36.3	44.4
0	17.0	19.2	21.9	25.0	28.2	32.1	36.9	41.8	47.7	53.8	61.0	63.8	73.2	84.1
25	35.0	39.2	44.3	50.8	56.1	63.3	69.1	76.4	84.7	93.5	104.5	109.1	123.4	138.8
40	53.0	59.2	65.3	71.9	79.1	88.0	96.6	108.0	120.0	130.7	142.6	148.5	166.5	185.6
55	76.7	84.6	93.6	103.1	113.7	123.9	136.3	148.3	162.8	178.4	194.4	201.4	223.7	247.5
70	110.1	120.0	130.9	142.2	156.5	171.3	185.2	201.7	220.6	239.7	259.8	268.8	295.9	325.2
85	150.1	164.5	178.7	193.2	210.4	228.9	247.7	268.8	291.4	314.1	341.1	351.2	384.6	420.3
100	202.3	219.2	236.5	255.8	277.8	299.8	323.8	351.2	378.8	407.5	440.4	453.4	494.3	538.2
105	223.8	241.4	260.4	282.0	303.4	328.7	354.5	381.7	410.8	443.6	477.8	492.2	535.1	581.5

[1] Values are guaranteed maximum $I_{DDDEEPSLEEP}$ specifications.

Table 16. Static Current–300 MHz and 400 MHz Speed Grade Devices (mA)[1]

	Voltage (V_{DDINT})											
T_J (°C)	0.80 V	0.85 V	0.90 V	0.95 V	1.00 V	1.05 V	1.10 V	1.15 V	1.20 V	1.25 V	1.30 V	1.32 V
–40	2.6	3.2	3.7	4.5	5.5	6.6	7.9	9.3	10.5	12.5	13.9	14.8
0	6.6	7.8	8.4	9.9	10.9	12.3	13.8	15.5	17.5	19.6	21.7	23.1
25	12.2	13.5	14.8	16.4	18.2	19.9	22.7	25.6	28.4	31.8	35.7	37.2
40	17.2	19.0	20.6	22.9	25.9	28.2	31.6	34.9	38.9	42.9	47.6	49.5
55	25.7	27.8	30.9	33.7	37.3	41.4	44.8	50.0	54.8	59.4	66.1	68.4
70	37.6	41.3	44.8	48.9	53.9	58.6	63.9	69.7	76.9	84.0	92.2	94.9
85	53.7	58.3	63.7	69.0	75.9	82.9	90.5	98.4	106.4	115.3	124.6	128.1
100	75.1	82.3	88.5	95.8	104.0	112.5	121.8	130.6	141.3	153.2	164.8	169.7
105	84.5	91.2	98.2	106.0	114.2	123.0	132.4	143.3	155.0	167.4	179.8	185.4
115[2]	103.8	111.8	120.3	127.6	138.0	148.5	159.6	171.4	184.6	198.8	213.4	219.6
120[2]	115.5	123.6	132.2	141.9	152.3	163.7	175.6	189.3	202.8	217.7	232.3	238.6

[1] Values are guaranteed maximum $I_{DDDEEPSLEEP}$ specifications.
[2] Applies to automotive grade models only.

TIMING SPECIFICATIONS

Component specifications are subject to change without notice.

Clock and Reset Timing

Table 22. Clock Input and Reset Timing

Parameter		Min	Max	Unit
Timing Requirements				
t_{CKIN}	CLKIN Period[1, 2, 3, 4]	20.0	100.0	ns
t_{CKINL}	CLKIN Low Pulse	8.0		ns
t_{CKINH}	CLKIN High Pulse	8.0		ns
$t_{BUFDLAY}$	CLKIN to CLKBUF Delay		10	ns
t_{WRST}	$\overline{\text{RESET}}$ Asserted Pulse Width Low	$11 \times t_{CKIN}$		ns
t_{NOBOOT}	$\overline{\text{RESET}}$ Deassertion to First External Access Delay[5]	$3 \times t_{CKIN}$	$5 \times t_{CKIN}$	ns

[1] Combinations of the CLKIN frequency and the PLL clock multiplier must not exceed the allowed f_{VCO}, f_{CCLK}, and f_{SCLK} settings discussed in Table 10 through Table 14. Since by default the PLL is multiplying the CLKIN frequency by 10 MHz, 300 MHz, and 400 MHz speed grade parts can not use the full CLKIN period range.
[2] Applies to PLL bypass mode and PLL non bypass mode.
[3] CLKIN frequency must not change on the fly.
[4] If the DF bit in the PLL_CTL register is set, then the maximum t_{CKIN} period is 50 ns.
[5] Applies when processor is configured in No Boot Mode (BMODE2-0 = b#000).

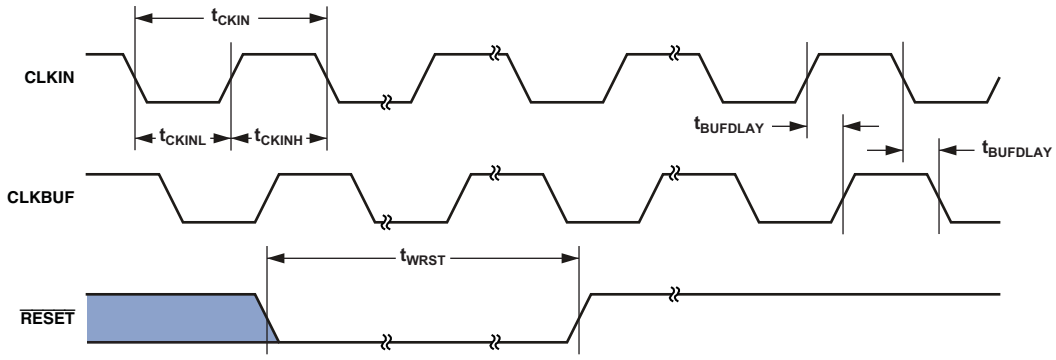
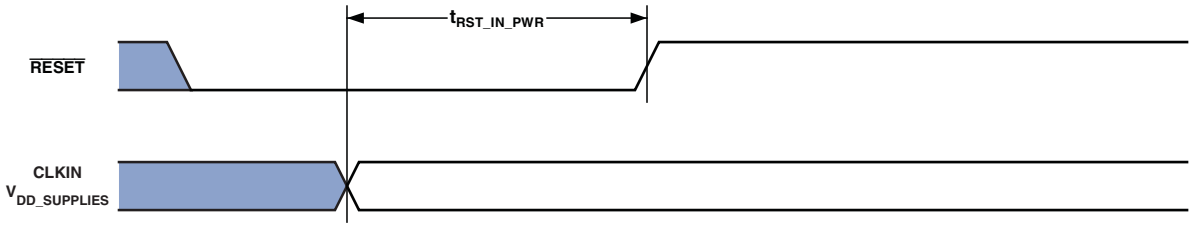


Figure 9. Clock and Reset Timing

Table 23. Power-Up Reset Timing

Parameter		Min	Max	Unit
Timing Requirements				
$t_{RST\_IN\_PWR}$	$\overline{\text{RESET}}$ Deasserted After the V_{DDINT}, V_{DDEXT}, V_{DDRTC}, and CLKIN Pins Are Stable and Within Specification	$3500 \times t_{CKIN}$		ns



In Figure 10, $V_{DD\_SUPPLIES}$ is V_{DDINT}, V_{DDEXT}, V_{DDRTC}

Figure 10. Power-Up Reset Timing

Asynchronous Memory Write Cycle Timing

Table 25. Asynchronous Memory Write Cycle Timing

Parameter		Min	Max	Unit
Timing Requirements				
t_{SARDY}	ARDY Setup Before CLKOUT	4.0		ns
t_{HARDY}	ARDY Hold After CLKOUT	0.0		ns
Switching Characteristics				
t_{DDAT}	DATA15–0 Disable After CLKOUT		6.0	ns
t_{ENDAT}	DATA15–0 Enable After CLKOUT	1.0		ns
t_{DO}	Output Delay After CLKOUT[1]		6.0	ns
t_{HO}	Output Hold After CLKOUT[1]	0.8		ns

[1] Output pins include $\overline{AMS3-0}$, $\overline{ABE1-0}$, ADDR19–1, $\overline{AOE}$, $\overline{AWE}$.

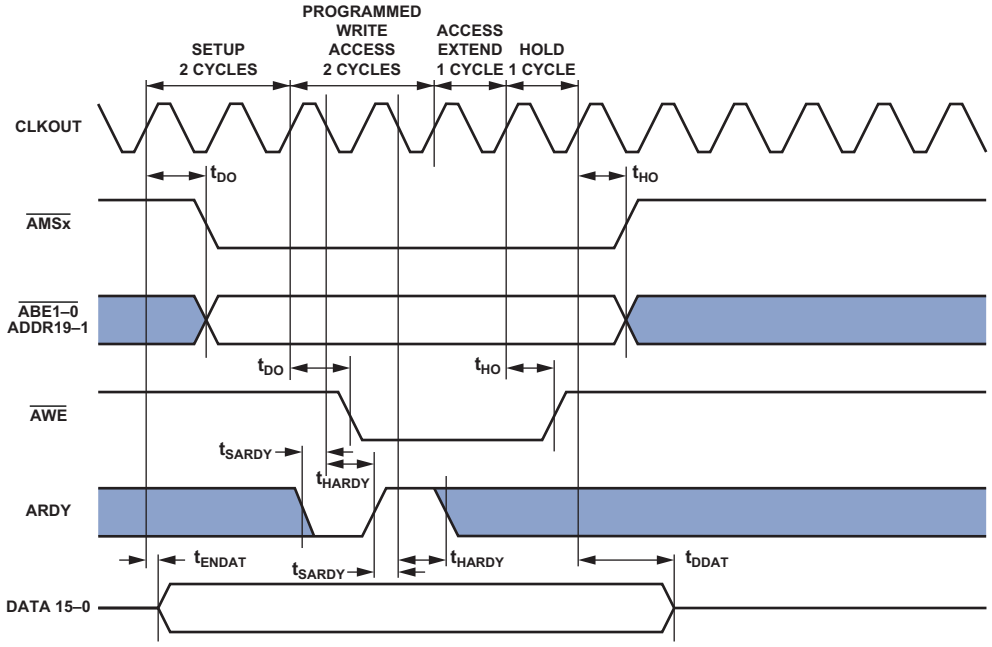


Figure 12. Asynchronous Memory Write Cycle Timing

Timer Clock Timing

Table 37 and Figure 27 describe timer clock timing.

Table 37. Timer Clock Timing

Parameter		Min	Max	Unit
Switching Characteristic				
t_{TODP}	Timer Output Update Delay After PPI_CLK High		12	ns

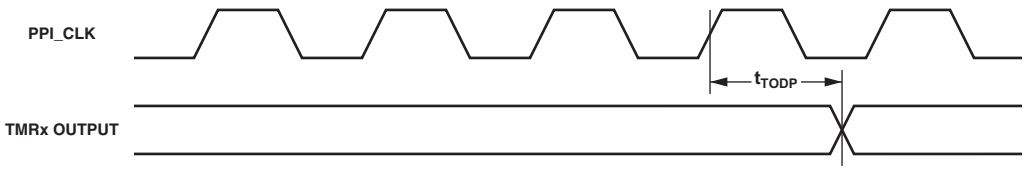


Figure 27. Timer Clock Timing

Timer Cycle Timing

Table 38 and Figure 28 describe timer expired operations. The input signal is asynchronous in "width capture mode" and "external clock mode" and has an absolute maximum input frequency of (f_{SCLK}/2) MHz.

Table 38. Timer Cycle Timing

Parameter		2.25 V ≤ V_{DDEXT} < 2.70 V or 0.80 V ≤ V_{DDINT} < 0.95 V[1]		2.70 V ≤ V_{DDEXT} ≤ 3.60 V and 0.95 V ≤ V_{DDINT} ≤ 1.43 V[2, 3]		Unit
		Min	Max	Min	Max	
Timing Characteristics						
t_{WL}	Timer Pulse Width Input Low (Measured In SCLK Cycles)[4]	1 × t_{SCLK}		1 × t_{SCLK}		ns
t_{WH}	Timer Pulse Width Input High (Measured In SCLK Cycles)[4]	1 × t_{SCLK}		1 × t_{SCLK}		ns
t_{TIS}	Timer Input Setup Time Before CLKOUT Low[5]	5.5		5.0		ns
t_{TIH}	Timer Input Hold Time After CLKOUT Low[5]	1.5		1.5		ns
Switching Characteristics						
t_{HTO}	Timer Pulse Width Output (Measured In SCLK Cycles)	1 × t_{SCLK}	(2^{32}–1) × t_{SCLK}	1 × t_{SCLK}	(2^{32}–1) × t_{SCLK}	ns
t_{TOD}	Timer Output Update Delay After CLKOUT High		6.5		6.0	ns

[1] Applies to all nonautomotive-grade devices when operated within either of these voltage ranges.
[2] Applies to all nonautomotive-grade devices when operated within these voltage ranges.
[3] All automotive-grade devices are within these specifications.
[4] The minimum pulse widths apply for TMRx signals in width capture and external clock modes. They also apply to the PF15 or PPI_CLK signals in PWM output mode.
[5] Either a valid setup and hold time or a valid pulse width is sufficient. There is no need to resynchronize programmable flag inputs.

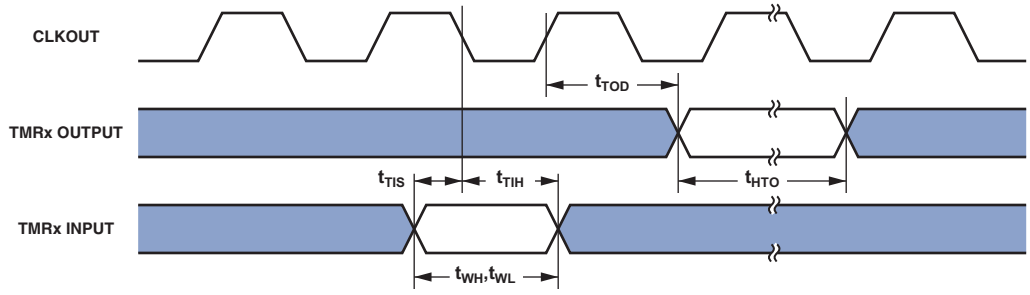


Figure 28. Timer Cycle Timing

10/100 Ethernet MAC Controller Timing

Table 40 through Table 45 and Figure 30 through Figure 35 describe the 10/100 Ethernet MAC controller operations. This feature is only available on the ADSP-BF536 and ADSP-BF537 processors.

Table 40. 10/100 Ethernet MAC Controller Timing: MII Receive Signal

Parameter[1]		Min	Max	Unit
f_{ERXCLK}	ERxCLK Frequency (f_{SCLK} = SCLK Frequency)	None	25 + 1% f_{SCLK} + 1%	MHz
$t_{ERXCLKW}$	ERxCLK Width (t_{ERxCLK} = ERxCLK Period)	t_{ERxCLK} × 35%	t_{ERxCLK} × 65%	ns
$t_{ERXCLKIS}$	Rx Input Valid to ERxCLK Rising Edge (Data In Setup)	7.5		ns
$t_{ERXCLKIH}$	ERxCLK Rising Edge to Rx Input Invalid (Data In Hold)	7.5		ns

[1] MII inputs synchronous to ERxCLK are ERxD3–0, ERxDV, and ERxER.

Table 41. 10/100 Ethernet MAC Controller Timing: MII Transmit Signal

Parameter[1]		Min	Max	Unit
f_{ETXCLK}	ETxCLK Frequency (f_{SCLK} = SCLK Frequency)	None	25 + 1% f_{SCLK} + 1%	MHz
$t_{ETXCLKW}$	ETxCLK Width (t_{ETXCLK} = ETxCLK Period)	t_{ETxCLK} × 35%	t_{ETxCLK} × 65%	ns
$t_{ETXCLKOV}$	ETxCLK Rising Edge to Tx Output Valid (Data Out Valid)		20	ns
$t_{ETXCLKOH}$	ETxCLK Rising Edge to Tx Output Invalid (Data Out Hold)	0		ns

[1] MII outputs synchronous to ETxCLK are ETxD3–0.

Table 42. 10/100 Ethernet MAC Controller Timing: RMII Receive Signal

Parameter[1]		Min	Max	Unit
f_{REFCLK}	REF_CLK Frequency (f_{SCLK} = SCLK Frequency)	None	50 + 1% 2 × f_{SCLK} + 1%	MHz
$t_{REFCLKW}$	REF_CLK Width (t_{REFCLK} = REFCLK Period)	t_{REFCLK} × 35%	t_{REFCLK} × 65%	ns
$t_{REFCLKIS}$	Rx Input Valid to RMII REF_CLK Rising Edge (Data In Setup)	4		ns
$t_{REFCLKIH}$	RMII REF_CLK Rising Edge to Rx Input Invalid (Data In Hold)	2		ns

[1] RMII inputs synchronous to RMII REF_CLK are ERxD1–0, RMII CRS_DV, and ERxER.

Table 43. 10/100 Ethernet MAC Controller Timing: RMII Transmit Signal

Parameter[1]		Min	Max	Unit
$t_{REFCLKOV}$	RMII REF_CLK Rising Edge to Tx Output Valid (Data Out Valid)		7.5	ns
$t_{REFCLKOH}$	RMII REF_CLK Rising Edge to Tx Output Invalid (Data Out Hold)	2		ns

[1] RMII outputs synchronous to RMII REF_CLK are ETxD1–0.

Table 44. 10/100 Ethernet MAC Controller Timing: MII/RMII Asynchronous Signal

Parameter[1, 2]		Min	Max	Unit
t_{ECOLH}	COL Pulse Width High	$t_{ETxCLK} \times 1.5$		ns
		$t_{ERxCLK} \times 1.5$		ns
t_{ECOLL}	COL Pulse Width Low	$t_{ETxCLK} \times 1.5$		ns
		$t_{ERxCLK} \times 1.5$		ns
t_{ECRSH}	CRS Pulse Width High	$t_{ETxCLK} \times 1.5$		ns
t_{ECRSL}	CRS Pulse Width Low	$t_{ETxCLK} \times 1.5$		ns

[1] MII/RMII asynchronous signals are COL, CRS. These signals are applicable in both MII and RMII modes. The asynchronous COL input is synchronized separately to both the ETxCLK and the ERxCLK, and must have a minimum pulse width high or low at least 1.5 times the period of the slower of the two clocks.
[2] The asynchronous CRS input is synchronized to the ETxCLK, and must have a minimum pulse width high or low at least 1.5 times the period of ETxCLK.

Table 45. 10/100 Ethernet MAC Controller Timing: MII Station Management

Parameter[1]		Min	Max	Unit
t_{MDIOS}	MDIO Input Valid to MDC Rising Edge (Setup)	10		ns
t_{MDCIH}	MDC Rising Edge to MDIO Input Invalid (Hold)	10		ns
t_{MDCOV}	MDC Falling Edge to MDIO Output Valid	25		ns
t_{MDCOH}	MDC Falling Edge to MDIO Output Invalid (Hold)	–1		ns

[1] MDC/MDIO is a 2-wire serial bidirectional port for controlling one or more external PHYs. MDC is an output clock whose minimum period is programmable as a multiple of the system clock SCLK. MDIO is a bidirectional data line.

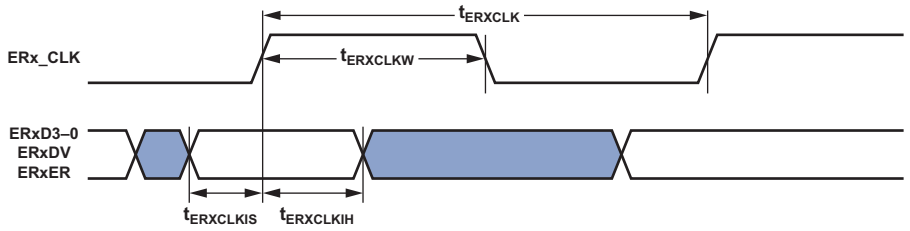


Figure 30. 10/100 Ethernet MAC Controller Timing: MII Receive Signal

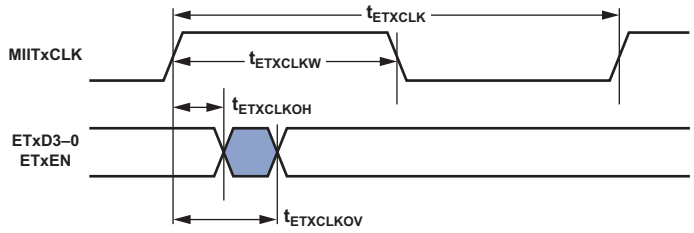


Figure 31. 10/100 Ethernet MAC Controller Timing: MII Transmit Signal

182-BALL CSP_BGA BALL ASSIGNMENT

Table 49 lists the CSP_BGA ball assignment by signal mnemonic. Table 50 on Page 58 lists the CSP_BGA ball assignment by ball number.

Table 49. 182-Ball CSP_BGA Ball Assignment (Alphabetically by Signal Mnemonic)

Mnemonic	Ball No.	Mnemonic	Ball No.	Mnemonic	Ball No.	Mnemonic	Ball No.	Mnemonic	Ball No.
$\overline{ABE0}$	H13	CLKOUT	B14	GND	L6	PG8	E3	$\overline{SRAS}$	D13
$\overline{ABE1}$	H12	DATA0	M9	GND	L8	PG9	E4	$\overline{SWE}$	D12
ADDR1	J14	DATA1	N9	GND	L10	PH0	C2	TCK	P2
ADDR10	M13	DATA10	N6	GND	M4	PH1	C3	TDI	M3
ADDR11	M14	DATA11	P6	GND	M10	PH10	B6	TDO	N3
ADDR12	N14	DATA12	M5	GND	P14	PH11	A2	TMS	N2
ADDR13	N13	DATA13	N5	$\overline{NMI}$	B10	PH12	A3	$\overline{TRST}$	N1
ADDR14	N12	DATA14	P5	PF0	M1	PH13	A4	V_{DDEXT}	A1
ADDR15	M11	DATA15	P4	PF1	L1	PH14	A5	V_{DDEXT}	C12
ADDR16	N11	DATA2	P9	PF10	J2	PH15	A6	V_{DDEXT}	E6
ADDR17	P13	DATA3	M8	PF11	J3	PH2	C4	V_{DDEXT}	E11
ADDR18	P12	DATA4	N8	PF12	H1	PH3	C5	V_{DDEXT}	F4
ADDR19	P11	DATA5	P8	PF13	H2	PH4	C6	V_{DDEXT}	F12
ADDR2	K14	DATA6	M7	PF14	H3	PH5	B1	V_{DDEXT}	H5
ADDR3	L14	DATA7	N7	PF15	H4	PH6	B2	V_{DDEXT}	H10
ADDR4	J13	DATA8	P7	PF2	L2	PH7	B3	V_{DDEXT}	J11
ADDR5	K13	DATA9	M6	PF3	L3	PH8	B4	V_{DDEXT}	J12
ADDR6	L13	$\overline{EMU}$	M2	PF4	L4	PH9	B5	V_{DDEXT}	K7
ADDR7	K12	GND	A10	PF5	K1	PJ0	C7	V_{DDEXT}	K9
ADDR8	L12	GND	A14	PF6	K2	PJ1	B7	V_{DDEXT}	L7
ADDR9	M12	GND	D4	PF7	K3	PJ10	D10	V_{DDEXT}	L9
$\overline{AMS0}$	E14	GND	E7	PF8	K4	PJ11	D11	V_{DDEXT}	L11
$\overline{AMS1}$	F14	GND	E9	PF9	J1	PJ2	B11	V_{DDEXT}	P1
$\overline{AMS2}$	F13	GND	F5	PG0	G1	PJ3	C11	V_{DDINT}	E5
$\overline{AMS3}$	G12	GND	F6	PG1	G2	PJ4	D7	V_{DDINT}	E8
$\overline{AOE}$	G13	GND	F10	PG10	D1	PJ5	D8	V_{DDINT}	E10
ARDY	E13	GND	F11	PG11	D2	PJ6	C8	V_{DDINT}	G10
$\overline{ARE}$	G14	GND	G4	PG12	D3	PJ7	B8	V_{DDINT}	K5
$\overline{AWE}$	H14	GND	G5	PG13	D5	PJ8	D9	V_{DDINT}	K8
$\overline{BG}$	P10	GND	G11	PG14	D6	PJ9	C9	V_{DDINT}	K10
$\overline{BGH}$	N10	GND	H11	PG15	C1	$\overline{RESET}$	C10	V_{DDRTC}	B9
BMODE0	N4	GND	J4	PG2	G3	RTXO	A8	VROUT0	A13
BMODE1	P3	GND	J5	PG3	F1	RTXI	A9	VROUT1	B12
BMODE2	L5	GND	J9	PG4	F2	SA10	E12	XTAL	A11
$\overline{BR}$	D14	GND	J10	PG5	F3	$\overline{SCAS}$	C14		
CLKBUF	A7	GND	K6	PG6	E1	SCKE	B13		
CLKIN	A12	GND	K11	PG7	E2	$\overline{SMS}$	C13		

Table 52 lists the CSP_BGA ball assignment by ball number. Table 51 on Page 60 lists the CSP_BGA ball assignment by signal mnemonic.

Table 52. 208-Ball CSP_BGA Ball Assignment (Numerically by Ball Number)

Ball No.	Mnemonic	Ball No.	Mnemonic	Ball No.	Mnemonic	Ball No.	Mnemonic	Ball No.	Mnemonic
A1	GND	C19	PJ11	J9	GND	M19	$\overline{AMS1}$	W1	TCK
A2	PG12	C20	$\overline{NMI}$	J10	GND	M20	$\overline{AMS0}$	W2	GND
A3	PG13	D1	PG7	J11	GND	N1	PF5	W3	DATA15
A4	PG15	D2	PG8	J12	GND	N2	PF6	W4	DATA13
A5	PH1	D19	PJ2	J13	GND	N7	V_{DDEXT}	W5	DATA11
A6	PH3	D20	$\overline{RESET}$	J14	V_{DDINT}	N8	V_{DDEXT}	W6	DATA9
A7	PH5	E1	PG5	J19	ARDY	N9	GND	W7	DATA7
A8	PH7	E2	PG6	J20	$\overline{SMS}$	N10	GND	W8	DATA5
A9	PH9	E19	PJ3	K1	PF11	N11	GND	W9	DATA3
A10	PH11	E20	VROUT0	K2	PF12	N12	GND	W10	DATA1
A11	PH13	F1	PG3	K7	V_{DDEXT}	N13	GND	W11	BMODE2
A12	PH15	F2	PG4	K8	V_{DDEXT}	N14	V_{DDINT}	W12	BMODE1
A13	GND	F19	$\overline{BR}$	K9	GND	N19	$\overline{ARE}$	W13	BMODE0
A14	RTXI	F20	VROUT1	K10	GND	N20	$\overline{AOE}$	W14	ADDR18
A15	RTXO	G1	PG1	K11	GND	P1	PF3	W15	ADDR16
A16	V_{DDRTC}	G2	PG2	K12	GND	P2	PF4	W16	ADDR14
A17	XTAL	G7	V_{DDEXT}	K13	GND	P7	V_{DDEXT}	W17	ADDR12
A18	CLKIN	G8	V_{DDEXT}	K14	V_{DDINT}	P8	V_{DDEXT}	W18	ADDR10
A19	PJ5	G9	V_{DDEXT}	K19	$\overline{SRAS}$	P9	V_{DDEXT}	W19	GND
A20	GND	G10	V_{DDEXT}	K20	$\overline{SCAS}$	P10	V_{DDEXT}	W20	ADDR8
B1	PG11	G11	GND	L1	PF9	P11	GND	Y1	GND
B2	GND	G12	V_{DDINT}	L2	PF10	P12	V_{DDINT}	Y2	TDO
B3	PG14	G13	V_{DDINT}	L7	V_{DDEXT}	P13	V_{DDINT}	Y3	DATA14
B4	PH0	G14	V_{DDINT}	L8	V_{DDEXT}	P14	V_{DDINT}	Y4	DATA12
B5	PH2	G19	$\overline{AMS3}$	L9	GND	P19	$\overline{ABE0}$	Y5	DATA10
B6	PH4	G20	$\overline{AMS2}$	L10	GND	P20	$\overline{ABE1}$	Y6	DATA8
B7	PH6	H1	PF15	L11	GND	R1	PF1	Y7	DATA6
B8	PH8	H2	PG0	L12	GND	R2	PF2	Y8	DATA4
B9	PH10	H7	V_{DDEXT}	L13	GND	R19	ADDR1	Y9	DATA2
B10	PH12	H8	V_{DDEXT}	L14	V_{DDINT}	R20	$\overline{AWE}$	Y10	DATA0
B11	PH14	H9	GND	L19	$\overline{SWE}$	T1	$\overline{EMU}$	Y11	$\overline{BG}$
B12	PJ0	H10	GND	L20	SA10	T2	PF0	Y12	$\overline{BGH}$
B13	PJ1	H11	GND	M1	PF7	T19	ADDR3	Y13	GND
B14	CLKBUF	H12	GND	M2	PF8	T20	ADDR2	Y14	ADDR19
B15	PJ6	H13	GND	M7	V_{DDEXT}	U1	$\overline{TRST}$	Y15	ADDR17
B16	PJ7	H14	V_{DDINT}	M8	V_{DDEXT}	U2	TMS	Y16	ADDR15
B17	PJ8	H19	CLKOUT	M9	GND	U19	ADDR5	Y17	ADDR13
B18	PJ4	H20	SCKE	M10	GND	U20	ADDR4	Y18	ADDR11
B19	PJ10	J1	PF13	M11	GND	V1	TDI	Y19	ADDR9
B20	PJ9	J2	PF14	M12	GND	V2	GND	Y20	GND
C1	PG9	J7	V_{DDEXT}	M13	GND	V19	ADDR7		
C2	PG10	J8	V_{DDEXT}	M14	V_{DDINT}	V20	ADDR6		

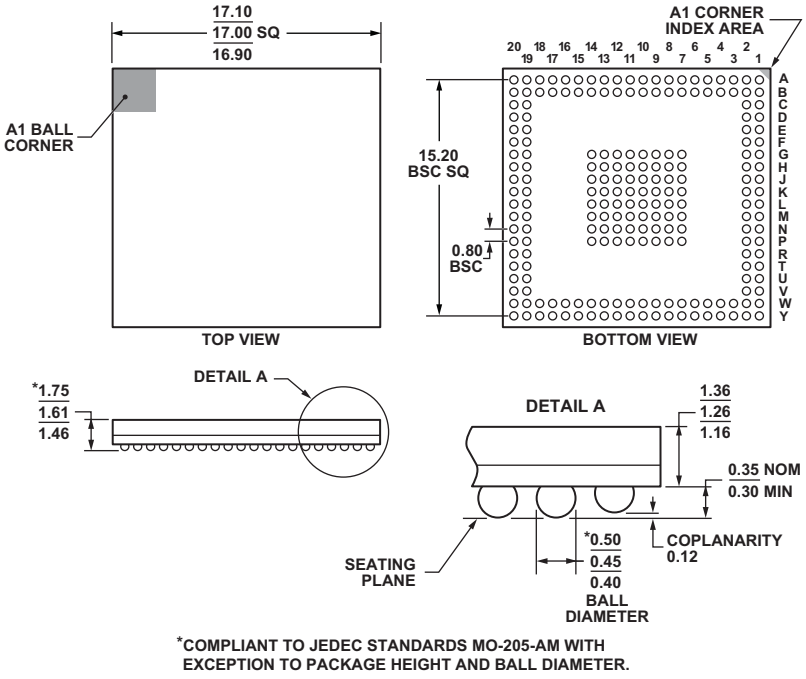


Figure 68. 208-Ball Chip Scale Package Ball Grid Array [CSP_BGA]
(BC-208-2)
Dimensions shown in millimeters

AUTOMOTIVE PRODUCTS

The ADBF534W model is available with controlled manufacturing to support the quality and reliability requirements of automotive applications. Note that these automotive models may have specifications that differ from the commercial models and designers should review the Specifications section of this data sheet carefully. Only the automotive grade products shown in Table 53 are available for use in automotive applications. Contact your local ADI account representative for specific product ordering information and to obtain the specific Automotive Reliability reports for these models.

Table 53. Automotive Products

Product Family[1,2]	Temperature Range[3]	Speed Grade (Max)	Package Description	Package Option
ADBF534WBBCZ4Axx	–40°C to +85°C	400 MHz	182-Ball CSP_BGA	BC-182
ADBF534WBBCZ4Bxx	–40°C to +85°C	400 MHz	208-Ball CSP_BGA	BC-208-2
ADBF534WYBCZ4Bxx	–40°C to +105°C	400 MHz	208-Ball CSP_BGA	BC-208-2

[1] Z = RoHS compliant part.
[2] xx denotes silicon revision.
[3] Referenced temperature is ambient temperature.

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