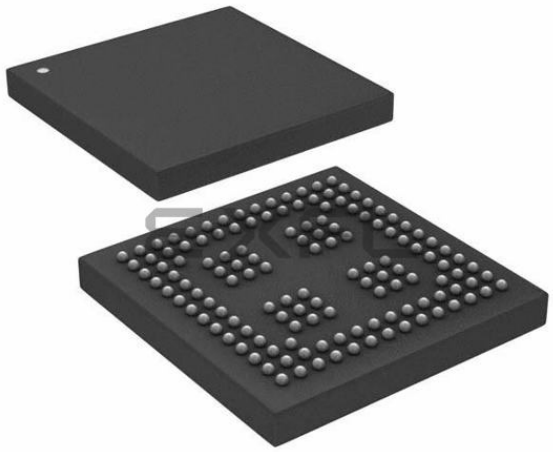

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Understanding Embedded - DSP (Digital Signal Processors)

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	Obsolete
Type	Floating Point
Interface	DAI, SPI
Clock Rate	200MHz
Non-Volatile Memory	ROM (512kB)
On-Chip RAM	256kB
Voltage - I/O	3.30V
Voltage - Core	1.20V
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	136-LFBGA, CSPBGA
Supplier Device Package	136-CSPBGA (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/analog-devices/adsp-21266skbcz-2d

elements, but each processing element operates on different data. This architecture is efficient at executing math intensive audio algorithms.

Entering SIMD mode also has an effect on the way data is transferred between memory and the processing elements. When in SIMD mode, twice the data bandwidth is required to sustain computational operation in the processing elements. Because of this requirement, entering SIMD mode also doubles the bandwidth between memory and the processing elements. When using the DAGs to transfer data in SIMD mode, two data values are transferred with each access of memory or the register file.

Independent, Parallel Computation Units

Within each processing element is a set of computational units. The computational units consist of an arithmetic/logic unit (ALU), multiplier, and shifter. These units perform all operations in a single cycle. The three units within each processing element are arranged in parallel, maximizing computational throughput. Single multifunction instructions execute parallel ALU and multiplier operations. In SIMD mode, the parallel ALU and multiplier operations occur in both processing elements. These computation units support IEEE 32-bit single precision floating-point, 40-bit extended precision floating-point, and 32-bit fixed-point data formats.

Data Register File

A general-purpose data register file is contained in each processing element. The register files transfer data between the computation units and the data buses, and store intermediate results. These 10-port, 32-register (16 primary, 16 secondary) register files, combined with the ADSP-2126x enhanced Harvard architecture, allow unconstrained data flow between computation units and internal memory. The registers in PEX are referred to as R0–R15 and in PEY as S0–S15.

Single-Cycle Fetch of Instruction and Four Operands

The ADSP-2126x features an enhanced Harvard architecture in which the data memory (DM) bus transfers data and the program memory (PM) bus transfers both instructions and data (see Figure 1 on Page 1). With the ADSP-2126x's separate program and data memory buses and on-chip instruction cache, the processor can simultaneously fetch four operands (two over each data bus) and one instruction (from the cache), all in a single cycle.

Instruction Cache

The ADSP-2126x includes an on-chip instruction cache that enables three-bus operation to fetch an instruction and four data values. The cache is selective—only the instructions whose fetches conflict with PM bus data accesses are cached. This cache allows full-speed execution of core, looped operations such as digital filter multiply-accumulates, and FFT butterfly processing.

Data Address Generators with Zero-Overhead Hardware Circular Buffer Support

The ADSP-2126x's two data address generators (DAGs) are used for indirect addressing and implementing circular data buffers in hardware. Circular buffers allow efficient programming of delay lines and other data structures required in digital signal processing, and are commonly used in digital filters and Fourier transforms. The two DAGs of the ADSP-2126x contain sufficient registers to allow the creation of up to 32 circular buffers (16 primary register sets, 16 secondary). The DAGs automatically handle address pointer wraparound, reduce overhead, increase performance, and simplify implementation. Circular buffers can start and end at any memory location.

Flexible Instruction Set

The 48-bit instruction word accommodates a variety of parallel operations for concise programming. For example, the ADSP-2126x can conditionally execute a multiply, an add, and a subtract in both processing elements while branching and fetching up to four 32-bit values from memory—all in a single instruction.

MEMORY AND I/O INTERFACE FEATURES

The ADSP-2126x adds the following architectural features to the SIMD SHARC family core:

Dual-Ported On-Chip Memory

The ADSP-21262 and ADSP-21266 contain two megabits of internal SRAM and four megabits of internal mask-programmable ROM. The ADSP-21261 contain one megabit of internal SRAM and three megabits of internal mask-programmable ROM. Each block can be configured for different combinations of code and data storage (see memory maps, Table 4 and Table 5). Each memory block is dual-ported for single-cycle, independent accesses by the core processor and I/O processor. The dual-ported memory, in combination with three separate on-chip buses, allows two data transfers from the core and one from the I/O processor, in a single cycle.

The ADSP-2126x is available with a variety of multichannel surround sound decoders, preprogrammed in ROM memory. Table 3 shows the configuration of decoder algorithms.

Table 3. Multichannel Surround Sound Decoder Algorithms in On-Chip ROM

Algorithms	B ROM	C ROM	D ROM
PCM	Yes	Yes	Yes
AC-3	Yes	Yes	Yes
DTS 96/24	v2.2	v2.3	v2.3
AAC (LC)	Yes	Yes	Coefficients only
WMAPRO 7.1 96 KHz	No	No	Yes
MPEG2 BC 2ch	Yes	Yes	No
Noise	Yes	Yes	Yes
DPL2x/EX	DPL2	Yes	Yes
Neo:6/ES (v2.5046)	Yes	Yes	Yes

The ADSP-2126x's SRAM can be configured as a maximum of 64K words of 32-bit data, 128K words of 16-bit data, 42K words of 48-bit instructions (or 40-bit data), or combinations of different word sizes up to two megabits. All of the memory can be accessed as 16-bit, 32-bit, 48-bit, or 64-bit words. A 16-bit floating-point storage format is supported that effectively doubles the amount of data that can be stored on-chip. Conversion between the 32-bit floating-point and 16-bit floating-point formats is performed in a single instruction. While each memory block can store combinations of code and data, accesses are most efficient when one block stores data using the DM bus for transfers, and the other block stores instructions and data using the PM bus for transfers.

Using the DM bus and PM buses, with one dedicated to each memory block, assures single-cycle execution with two data transfers. In this case, the instruction must be available in the cache.

DMA Controller

The ADSP-2126x's on-chip DMA controller allows zero-overhead data transfers without processor intervention. The DMA controller operates independently and invisibly to the processor core, allowing DMA operations to occur while the core is simultaneously executing its program instructions. DMA transfers can occur between the ADSP-2126x's internal memory and its serial ports, the SPI-compatible (serial peripheral interface) port, the IDP (input data port), parallel data acquisition port (PDAP), or the parallel port. Up to 22 channels of DMA are available on the ADSP-2126x—one for the SPI interface, 12 via the serial ports, eight via the input data port, and one via the processor's parallel port. Programs can be downloaded to the ADSP-2126x using DMA transfers. Other DMA features include interrupt generation upon completion of DMA transfers, and DMA chaining for automatic linked DMA transfers.

Table 4. Internal Memory Space (ADSP-21261)

IOP Registers 0x0000 0000–0003 FFFF			
Long Word (64 Bits)	**Extended Precision Normal or Instruction Word (48 Bits)**	**Normal Word (32 Bits)**	**Short Word (16 Bits)**
Block 0 SRAM 0x0004 0000–0x0004 1FFF	Block 0 SRAM 0x0008 0000–0x0008 2AAA	Block 0 SRAM 0x0008 0000–0x0008 3FFF	Block 0 SRAM 0x0010 0000–0x0010 7FFF
Reserved 0x0004 2000–0x0005 7FFF	Reserved	Reserved 0x0008 4000–0x000A FFFF	Reserved 0x0010 8000–0x0015 FFFF
Block 0 ROM 0x0005 8000–0x0005 DFFF	Block 0 ROM 0x000A 0000–0x000A 7FFF	Block 0 ROM 0x000B 0000–0x000B BFFF	Block 0 ROM 0x0016 0000–0x0017 7FFF
Reserved 0x0005 E000–0x0005 FFFF	Reserved	Reserved 0x000B C000–0x000B FFFF	Reserved 0x0017 8FFF–0x0017 FFFF
Block 1 SRAM 0x0006 0000–0x0006 1FFF	Block 1 SRAM 0x000C 0000–0x000C 2AAA	Block 1 SRAM 0x000C 0000–0x000C 3FFF	Block 1 SRAM 0x0018 0000–0x0018 7FFF
Reserved 0x0006 2000–0x0007 7FFF	Reserved	Reserved 0x000C 4000–0x000E FFFF	Reserved 0x0018 8000–0x001D FFFF
Block 1 ROM 0x0007 8000–0x0007 DFFF	Block 1 ROM 0x000E 0000–0x000E 7FFF	Block 1 ROM 0x000F 0000–0x000F BFFF	Block 1 ROM 0x001E 0000–0x001F 7FFF
Reserved 0x0007 E000–0x0007 FFFF	Reserved	Reserved 0x000F C000–0x000F FFFF	Reserved 0x0000

Table 5. Internal Memory Space (ADSP-21262/ADSP-21266)

IOP Registers 0x0000 0000–0003 FFFF			
Long Word (64 Bits)	**Extended Precision Normal or Instruction Word (48 Bits)**	**Normal Word (32 Bits)**	**Short Word (16 Bits)**
Block 0 SRAM 0x0004 0000–0x0004 3FFF	Block 0 SRAM 0x0008 0000–0x0008 5555	Block 0 SRAM 0x0008 0000–0x0008 7FFF	Block 0 SRAM 0x0010 0000–0x0010 FFFF
Reserved 0x0004 4000–0x0005 7FFF	Reserved	Reserved 0x0008 8000–0x000A FFFF	Reserved 0x0011 0000–0x0015 FFFF
Block 0 ROM 0x0005 8000–0x0005 FFFF	Block 0 ROM 0x000A 0000–0x000A AAAA	Block 0 ROM 0x000B 0000–0x000B FFFF	Block 0 ROM 0x0016 0000–0x0017 FFFF
Block 1 SRAM 0x0006 0000–0x0006 3FFF	Block 1 SRAM 0x000C 0000–0x000C 5555	Block 1 SRAM 0x000C 0000–0x000C 7FFF	Block 1 SRAM 0x0018 0000–0x0018 FFFF
Reserved 0x0006 4000–0x0007 7FFF	Reserved	Reserved 0x000C 8000–0x000E FFFF	Reserved 0x0019 0000–0x001D FFFF
Block 1 ROM 0x0007 8000–0x0007 FFFF	Block 1 ROM 0x000E 0000–0x000E AAAA	Block 1 ROM 0x000F 0000–0x000F FFFF	Block 1 ROM 0x001E 0000–0x001F FFFF

Digital Application Interface (DAI)

The Digital application interface provides the ability to connect various peripherals to any of the SHARC DSP's DAI pins (DAI_P20–1).

Connections are made using the signal routing unit (SRU, shown in the block diagram on Page 1).

The SRU is a matrix routing unit (or group of multiplexers) that enables the peripherals provided by the DAI to be interconnected under software control. This allows easy use of the DAI associated peripherals for a much wider variety of applications by using a larger set of algorithms than is possible with nonconfigurable signal paths.

The DAI also includes six serial ports, two precision clock generators (PCGs), an input data port (IDP), six flag outputs and six flag inputs, and three timers. The IDP provides an additional input path to the ADSP-2126x core, configurable as either eight channels of I^2S or serial data, or as seven channels plus a single 20-bit wide synchronous parallel data acquisition port. Each data channel has its own DMA channel that is independent from the ADSP-2126x's serial ports.

For complete information on using the DAI, see the *ADSP-2126x SHARC DSP Peripherals Manual*.

Serial Ports

The ADSP-2126x features six full duplex synchronous serial ports that provide an inexpensive interface to a wide variety of digital and mixed-signal peripheral devices such as the Analog Devices AD183x family of audio codecs, ADCs, and DACs. The serial ports are made up of two data lines, a clock, and frame sync. The data lines can be programmed to either transmit or receive and each data line has its own dedicated DMA channel.

Serial ports are enabled via 12 programmable and simultaneous receive or transmit pins that support up to 24 transmit or 24 receive channels of audio data when all six SPORTs are enabled, or six full duplex TDM streams of 128 channels per frame.

The serial ports operate at up to one-quarter of the DSP core clock rate, providing each with a maximum data rate of 50M bits/sec for a 200 MHz core and 37.5M bits/sec for a 150 MHz core. Serial port data can be automatically transferred to and from on-chip memory via a dedicated DMA. Each of the serial ports can work in conjunction with another serial port to provide TDM support. One SPORT provides two transmit signals while the other SPORT provides two receive signals. The frame sync and clock are shared.

Serial ports operate in four modes:

- Standard DSP serial mode
- Multichannel (TDM) mode
- I^2S mode
- Left-justified sample pair mode

Left-justified sample pair mode is a mode where in each frame sync cycle, two samples of data are transmitted/received—one sample on the high segment of the frame sync, the other on the low segment of the frame sync. Programs have control over various attributes of this mode.

Each of the serial ports supports the left-justified sample-pair and I^2S protocols (I^2S is an industry-standard interface commonly used by audio codecs, ADCs, and DACs) with two data pins, allowing four left-justified sample-pair or I^2S channels (using two stereo devices) per serial port with a maximum of up to 24 audio channels. The serial ports permit little-endian or big-endian transmission formats and word lengths selectable from 3 bits to 32 bits. For the left-justified sample pair and I^2S modes, data-word lengths are selectable between 8 bits and 32 bits. Serial ports offer selectable synchronization and transmit modes as well as optional μ-law or A-law companding selection on a per channel basis. Serial port clocks and frame syncs can be internally or externally generated.

PIN FUNCTION DESCRIPTIONS

The ADSP-2126x pin definitions are listed below. Inputs identified as synchronous (S) must meet timing requirements with respect to CLKIN (or with respect to TCK for TMS, TDI). Inputs identified as asynchronous (A) can be asserted asynchronously to CLKIN (or to TCK for $\overline{\text{TRST}}$). Tie or pull unused inputs to V_{DDEXT} or GND, except for the following:

DAI_Px, SPICLK, MISO, MOSI, $\overline{\text{EMU}}$, TMS,$\overline{\text{TRST}}$, TDI and AD15–0 (NOTE: These pins have internal pull-up resistors.)

The following symbols appear in the Type column of Table 6: A = asynchronous, G = ground, I = input, O = output, P = power supply, S = synchronous, (A/D) = active drive, (O/D) = open-drain, and T = three-state.

Table 6. Pin Descriptions

Pin	Type	State During and After Reset	Function
AD15–0	I/O/T	Rev. 0.1 silicon—AD15–0 pins are driven low both during and after reset. Rev. 0.2 silicon—AD15–0 pins are three-stated and pulled high both during and after reset.	**Parallel Port Address/Data.** The parallel port and its corresponding DMA unit output addresses and data for peripherals on these multiplexed pins. The multiplex state is determined by the ALE pin. The parallel port can operate in either 8-bit or 16-bit mode. Each AD pin has a 22.5 kΩ internal pull-up resistor. See Address Data Modes on Page 13 for details of the AD pin operation. For 8-bit mode: ALE is automatically asserted whenever a change occurs in the upper 16 external address bits, A23–8; ALE is used in conjunction with an external latch to retain the values of the A23–8. For 16-bit mode: ALE is automatically asserted whenever a change occurs in the address bits, A15–0; ALE is used in conjunction with an external latch to retain the values of the A15–0. To use these pins as flags (FLAG15–0), set (= 1) Bit 20 of the SYSCTL register and disable the parallel port. See Table 7 on Page 13 for a list of how the AD15–0 pins map to the flag pins. When configured in the IDP_PDAP_CTL register, the IDP Channel 0 can use these pins for parallel input data.
$\overline{\text{RD}}$	O	Output only, driven high[1]	**Parallel Port Read Enable.** $\overline{\text{RD}}$ is asserted low whenever the DSP reads 8-bit or 16-bit data from an external memory device. When AD15–0 are flags, this pin remains deasserted.
$\overline{\text{WR}}$	O	Output only, driven high[1]	**Parallel Port Write Enable.** $\overline{\text{WR}}$ is asserted low whenever the DSP writes 8-bit or 16-bit data to an external memory device. When AD15–0 are flags, this pin remains deasserted.
ALE	O	Output only, driven low[1]	**Parallel Port Address Latch Enable.** ALE is asserted whenever the DSP drives a new address on the parallel port address pin. On reset, ALE is active high. However, it can be reconfigured using software to be active low. When AD15–0 are flags, this pin remains deasserted.
FLAG3–0	I/O/A	Three-state	**Flag Pins.** Each FLAG pin is configured via control bits as either an input or output. As an input, it can be tested as a condition. As an output, it can be used to signal external peripherals. These pins can be used as an SPI interface slave select output during SPI mastering. These pins are also multiplexed with the $\overline{\text{IRQx}}$ and the TIMEXP signals. In SPI master boot mode, FLAG0 is the slave select pin that must be connected to an SPI EPROM. FLAG0 is configured as a slave select during SPI master boot. When Bit 16 is set (= 1) in the SYSCTL register, FLAG0 is configured as $\overline{\text{IRQ0}}$. When Bit 17 is set (= 1) in the SYSCTL register, FLAG1 is configured as $\overline{\text{IRQ1}}$. When Bit 18 is set (= 1) in the SYSCTL register, FLAG2 is configured as $\overline{\text{IRQ2}}$. When Bit 19 is set (= 1) in the SYSCTL register, FLAG3 is configured as TIMEXP, which indicates that the system timer has expired.
DAI_P20–1	I/O/T	Three-state with programmable pull-up	**Digital Application Interface Pins**. These pins provide the physical interface to the SRU. The SRU configuration registers define the combination of on-chip peripheral inputs or outputs connected to the pin and to the pin's output enable. The configuration registers of these peripherals then determine the exact behavior of the pin. Any input or output signal present in the SRU can be routed to any of these pins. The SRU provides the connection from the serial ports, input data port, precision clock generators, and timers to the DAI_P20–1 pins. These pins have internal 22.5 kΩ pull-up resistors which are enabled on reset. These pull-ups can be disabled in the DAI_PIN_PULLUP register.

Table 6. Pin Descriptions (Continued)

Pin	Type	State During and After Reset	Function
SPICLK	I/O	Three-state with pull-up enabled, driven high in SPI-master boot mode	**Serial Peripheral Interface Clock Signal**. Driven by the master, this signal controls the rate at which data is transferred. The master can transmit data at a variety of baud rates. SPICLK cycles once for each bit transmitted. SPICLK is a gated clock that is active during data transfers, only for the length of the transferred word. Slave devices ignore the serial clock if the slave select input is driven inactive (HIGH). SPICLK is used to shift out and shift in the data driven on the MISO and MOSI lines. The data is always shifted out on one clock edge and sampled on the opposite edge of the clock. Clock polarity and clock phase relative to data are programmable into the SPICTL control register and define the transfer format. SPICLK has a 22.5 kΩ internal pull-up resistor. If SPI master boot mode is selected, MOSI and SPICLK pins are driven during reset. These pins are not three-stated during reset in SPI master boot mode.
$\overline{\text{SPIDS}}$	I	Input only	**Serial Peripheral Interface Slave Device Select**. An active low signal used to select the DSP as an SPI slave device. This input signal behaves like a chip select, and is provided by the master device for the slave devices. In multimaster mode, the DSP's $\overline{\text{SPIDS}}$ signal can be driven by a slave device to signal to the DSP (as SPI master) that an error has occurred, as some other device is also trying to be the master device. If asserted low when the device is in master mode, it is considered a multimaster error. For a single master, multiple-slave configuration where flag pins are used, this pin must be tied or pulled high to V_{DDEXT} on the master device. For ADSP-2126x to ADSP-2126x SPI interaction, any of the master ADSP-2126x's flag pins can be used to drive the $\overline{\text{SPIDS}}$ signal on the ADSP-2126x SPI slave device.
MOSI	I/O (O/D)	Three-state with pull-up enabled, driven low in SPI-master boot mode	**SPI Master Out Slave In**. If the ADSP-2126x is configured as a master, the MOSI pin becomes a data transmit (output) pin, transmitting output data. If the ADSP-2126x is configured as a slave, the MOSI pin becomes a data receive (input) pin, receiving input data. In an ADSP-2126x SPI interconnection, the data is shifted out from the MOSI output pin of the master and shifted into the MOSI input(s) of the slave(s). MOSI has a 22.5 kΩ internal pull-up resistor. If SPI master boot mode is selected, MOSI and SPICLK pins are driven during reset. These pins are not three-stated during reset in SPI master boot mode.
MISO	I/O (O/D)	Three-state with pull-up enabled	**SPI Master In Slave Out**. If the ADSP-2126x is configured as a master, the MISO pin becomes a data receive (input) pin, receiving input data. If the ADSP-2126x is configured as a slave, the MISO pin becomes a data transmit (output) pin, transmitting output data. In an ADSP-2126x SPI interconnection, the data is shifted out from the MISO output pin of the slave and shifted into the MISO input pin of the master. MISO has a 22.5 kΩ internal pull-up resistor. MISO can be configured as O/D by setting the OPD bit in the SPICTL register. **Note:** *Only one slave is allowed to transmit data at any given time.* To enable broadcast transmission to multiple SPI slaves, the DSP's MISO pin can be disabled by setting (= 1) Bit 5 (DMISO) of the SPICTL register.
BOOT_CFG1–0	I	Input only	**Boot Configuration Select**. Selects the boot mode for the DSP. The BOOT_CFG pins must be valid before reset is asserted. See Table 8 on Page 13 for a description of the boot modes.
CLKIN	I	Input only	**Local Clock In**. Used in conjunction with XTAL. CLKIN is the ADSP-2126x clock input. It configures the ADSP-2126x to use either its internal clock generator or an external clock source. Connecting the necessary components to CLKIN and XTAL enables the internal clock generator. Connecting the external clock to CLKIN while leaving XTAL unconnected configures the ADSP-2126x to use the external clock source such as an external clock oscillator. The core is clocked either by the PLL output or this clock input depending on the CLK_CFG1–0 pin settings. CLKIN should not be halted, changed, or operated below the specified frequency.
XTAL	O	Output only[2]	**Crystal Oscillator Terminal**. Used in conjunction with CLKIN to drive an external crystal.

Table 6. Pin Descriptions (Continued)

Pin	Type	State During and After Reset	Function
CLK_CFG1–0	I	Input only	**Core/CLKIN Ratio Control**. These pins set the start up clock frequency. See Table 9 for a description of the clock configuration modes. Note that the operating frequency can be changed by programming the PLL multiplier and divider in the PMCTL register at any time after the core comes out of reset.
$\overline{\text{RESETOUT}}$	O	Output only	**Reset Out**. Drives out the core reset signal to an external device.
$\overline{\text{RESET}}$	I/A	Input only	**Processor Reset**. Resets the ADSP-2126x to a known state. Upon deassertion, there is a 4096 CLKIN cycle latency for the PLL to lock. After this time, the core begins program execution from the hardware reset vector address. The $\overline{\text{RESET}}$ input must be asserted (low) at power-up.
TCK	I	Input only[3]	**Test Clock (JTAG)**. Provides a clock for JTAG boundary scan. TCK must be asserted (pulsed low) after power-up or held low for proper operation of the ADSP-2126x.
TMS	I/S	Three-state with pull-up enabled	**Test Mode Select (JTAG)**. Used to control the test state machine. TMS has a 22.5 kΩ internal pull-up resistor.
TDI	I/S	Three-state with pull-up enabled	**Test Data Input (JTAG)**. Provides serial data for the boundary scan logic. TDI has a 22.5 kΩ internal pull-up resistor.
TDO	O	Three-state[4]	**Test Data Output (JTAG)**. Serial scan output of the boundary scan path.
$\overline{\text{TRST}}$	I/A	Three-state with pull-up enabled	**Test Reset (JTAG)**. Resets the test state machine. $\overline{\text{TRST}}$ must be asserted (pulsed low) after power-up or held low for proper operation of the ADSP-2126x. $\overline{\text{TRST}}$ has a 22.5 kΩ internal pull-up resistor.
$\overline{\text{EMU}}$	O (O/D)	Three-state with pull-up enabled	**Emulation Status**. Must be connected to the ADSP-2126x Analog Devices DSP Tools product line of JTAG emulators target board connector only. $\overline{\text{EMU}}$ has a 22.5 kΩ internal pull-up resistor.
V_{DDINT}	P		**Core Power Supply**. Nominally +1.2 V dc and supplies the DSP's core processor (13 pins on the BGA package, 32 pins on the LQFP package).
V_{DDEXT}	P		**I/O Power Supply**. Nominally +3.3 V dc (6 pins on the BGA package, 10 pins on the LQFP package).
A_{VDD}	P		**Analog Power Supply**. Nominally +1.2 V dc and supplies the DSP's internal PLL (clock generator). This pin has the same specifications as V_{DDINT}, except that added filtering circuitry is required. For more information, see Power Supplies on Page 7.
A_{VSS}	G		**Analog Power Supply Return**.
GND	G		**Power Supply Return**. (54 pins on the BGA package, 39 pins on the LQFP package).

[1] $\overline{\text{RD}}$, $\overline{\text{WR}}$, and ALE are continuously driven by the DSP and will not be three-stated.
[2] Output only is a three-state driver with its output path always enabled.
[3] Input only is a three-state driver, with both output path and pull-up disabled.
[4] Three-state is a three-state driver, with pull-up disabled.

PRODUCT SPECIFICATIONS

OPERATING CONDITIONS

Parameter[1]	Description	Min	Max	Unit
V_{DDINT}	Internal (Core) Supply Voltage	1.14	1.26	V
A_{VDD}	Analog (PLL) Supply Voltage	1.14	1.26	V
V_{DDEXT}	External (I/O) Supply Voltage	3.13	3.47	V
V_{IH}	High Level Input Voltage[2] @ V_{DDEXT} = Max	2.0	V_{DDEXT} + 0.5	V
V_{IL}	Low Level Input Voltage[2] @ V_{DDEXT} = Min	–0.5	+0.8	V
V_{IH_CLKIN}	High Level Input Voltage[3] @ V_{DDEXT} = Max	1.74	V_{DDEXT} + 0.5	V
V_{IL_CLKIN}	Low Level Input Voltage @ V_{DDEXT} = Min	–0.5	+1.19	V
T_{AMB} K Grade	Ambient Operating Temperature[4, 5]	0	+70	°C
T_{AMB} B Grade	Ambient Operating Temperature[4, 5]	–40	+85	°C

[1] Specifications subject to change without notice.
[2] Applies to input and bidirectional pins: AD15–0, FLAG3–0, DAI_Px, SPICLK, MOSI, MISO, $\overline{SPIDS}$, BOOT_CFGx, CLK_CFGx, $\overline{RESET}$, TCK, TMS, TDI, $\overline{TRST}$.
[3] Applies to input pin CLKIN.
[4] See Thermal Characteristics on Page 38 for information on thermal specifications.
[5] See Engineer-to-Engineer Note (No. EE-216) for further information.

ELECTRICAL CHARACTERISTICS

Parameter[1]	Description	Test Conditions	Min	Max	Unit
V_{OH}	High Level Output Voltage[2]	@ V_{DDEXT} = Min, I_{OH} = –1.0 mA[3]	2.4		V
V_{OL}	Low Level Output Voltage[2]	@ V_{DDEXT} = Min, I_{OL} = 1.0 mA[3]		0.4	V
I_{IH}	High Level Input Current[4, 5]	@ V_{DDEXT} = Max, V_{IN} = V_{DDEXT} Max		10	µA
I_{IL}	Low Level Input Current[4]	@ V_{DDEXT} = Max, V_{IN} = 0 V		10	µA
I_{ILPU}	Low Level Input Current Pull-Up[5]	@ V_{DDEXT} = Max, V_{IN} = 0 V		200	µA
I_{OZH}	Three-State Leakage Current [6, 7, 8]	@ V_{DDEXT} = Max, V_{IN} = V_{DDEXT} Max		10	µA
I_{OZL}	Three-State Leakage Current[6]	@ V_{DDEXT} = Max, V_{IN} = 0 V		10	µA
I_{OZLPU}	Three-State Leakage Current Pull-Up[7]	@ V_{DDEXT} = Max, V_{IN} = 0 V		200	µA
$I_{DD-INTYP}$	Supply Current (Internal)[9, 10, 11]	t_{CCLK} = 5.0 ns, V_{DDINT} = 1.2 V, T_{AMB} = +25°C		500	mA
I_{AVDD}	Supply Current (Analog)[11]	A_{VDD} = Max		10	mA
C_{IN}	Input Capacitance[12, 13]	f_{IN} = 1 MHz, T_{CASE} = 25°C, V_{IN} = 1.2 V		4.7	pF

[1] Specifications subject to change without notice.
[2] Applies to output and bidirectional pins: AD15–0, $\overline{RD}$, $\overline{WR}$, ALE, FLAG3–0, DAI_Px, SPICLK, MOSI, MISO, $\overline{EMU}$, TDO, CLKOUT, XTAL.
[3] See Output Drive Currents on Page 37 for typical drive current capabilities.
[4] Applies to input pins: $\overline{SPIDS}$, BOOT_CFGx, CLK_CFGx, TCK, $\overline{RESET}$, CLKIN.
[5] Applies to input pins with 22.5 kΩ internal pull-ups: $\overline{TRST}$, TMS, TDI.
[6] Applies to three-statable pins: FLAG3–0.
[7] Applies to three-statable pins with 22.5 kΩ pull-ups: AD15–0, DAI_Px, SPICLK, MISO, MOSI.
[8] Applies to open-drain output pins: $\overline{EMU}$, MISO, MOSI.
[9] Typical internal current data reflects nominal operating conditions.
[10] See Engineer-to-Engineer Note (EE-216) for further information.
[11] Characterized, but not tested.
[12] Applies to all signal pins.
[13] Guaranteed, but not tested.

PACKAGE INFORMATION

The information presented in Figure 3 provides details about the package branding for the ADSP-21266 processors. For a complete listing of product availability, see Ordering Guide on Page 45.

Figure 3. Typical Package Brand

Table 11. Package Brand Information

Brand Key	Field Description
t	Temperature Range
pp	Package Type
Z	RoHS Compliant Option (optional)
cc	See Ordering Guide
vvvvvv.x	Assembly Lot Code
n.n	Silicon Revision
#	RoHS Compliant Designation
yyww	Date Code

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

MAXIMUM POWER DISSIPATION

See *Estimating Power for the ADSP-21262 SHARC Processors (EE-216)* for detailed thermal and power information regarding maximum power dissipation. For information on package thermal specifications, see Thermal Characteristics on Page 38.

ABSOLUTE MAXIMUM RATINGS

Stresses greater than those listed in Table 12 may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions greater than those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 12. Absolute Maximum Ratings

Parameter	Rating
Internal (Core) Supply Voltage (V_{DDINT})	–0.3 V to +1.4 V
Analog (PLL) Supply Voltage (A_{VDD})	–0.3 V to +1.4 V
External (I/O) Supply Voltage (V_{DDEXT})	–0.3 V to +3.8 V
Input Voltage –0.5 V to V_{DDEXT}	+0.5 V
Output Voltage Swing –0.5 V to V_{DDEXT}	+0.5 V
Load Capacitance	200 pF
Storage Temperature Range	–65°C to +150°C
Junction Temperature Under Bias	125°C

TIMING SPECIFICATIONS

Use the exact timing information given. Do not attempt to derive parameters from the addition or subtraction of others. While addition or subtraction would yield meaningful results for an individual device, the values given in this data sheet reflect statistical variations and worst cases. Consequently, it is not meaningful to add parameters to derive longer times.

Timing requirements apply to signals that are controlled by circuitry external to the processor, such as the data input for a read operation. Timing requirements guarantee that the processor operates correctly with other devices.

Switching characteristics specify how the processor changes its signals. Circuitry external to the processor must be designed for compatibility with these signal characteristics. Switching characteristics describe what the processor will do in a given circumstance. Use switching characteristics to ensure that any timing requirement of a device connected to the processor (such as memory) is satisfied.

Core Clock Requirements

The processor's internal clock (a multiple of CLKIN) provides the clock signal for timing internal memory, processor core, serial ports, and parallel port (as required for read/write strobes in asynchronous access mode). During reset, program the ratio between the DSP's internal clock frequency and external (CLKIN) clock frequency with the CLK_CFG1–0 pins. To determine switching frequencies for the serial ports, divide down the internal clock, using the programmable divider control of each port (DIVx for the serial ports).

The processor's internal clock switches at higher frequencies than the system input clock (CLKIN). To generate the internal clock, the DSP uses an internal phase-locked loop (PLL). This PLL-based clocking minimizes the skew between the system clock (CLKIN) signal and the DSP's internal clock (the clock source for the parallel port logic and I/O pads).

Clock Input

See Table 16 and Figure 6.

Table 16. Clock Input

Parameter		150 MHz[1] Min	150 MHz[1] Max	200 MHz[2] Min	200 MHz[2] Max	Unit
Timing Requirements						
t_{CK}	CLKIN Period	20[3]	160[4]	15[3]	160[4]	ns
t_{CKL}	CLKIN Width Low	7.5[3]	80[4]	6[3]	80[4]	ns
t_{CKH}	CLKIN Width High	7.5[3]	80[4]	6[3]	80[4]	ns
t_{CKRF}	CLKIN Rise/Fall (0.4 V to 2.0 V)		3		3	ns
f_{VCO}[5]	VCO Frequency	200	800	200	800	MHz
t_{CCLK}	CCLK Period[6]	6.66	10	5	10	ns

[1] Applies to all 150 MHz models. See Ordering Guide on Page 45.
[2] Applies to all 200 MHz models. See Ordering Guide on Page 45.
[3] Applies only for CLK_CFG1–0 = 00 and default values for PLL control bits in PMCTL.
[4] Applies only for CLK_CFG1–0 = 01 and default values for PLL control bits in PMCTL.
[5] See Figure 4 on Page 16 for VCO diagram.
[6] Any changes to PLL control bits in the PMCTL register must meet core clock timing specification t_{CCLK}.

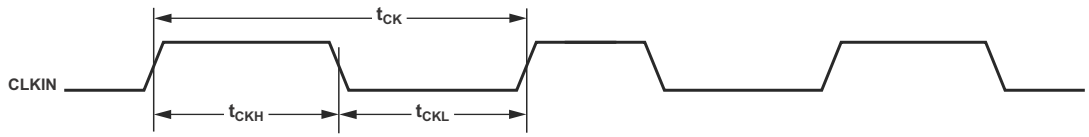
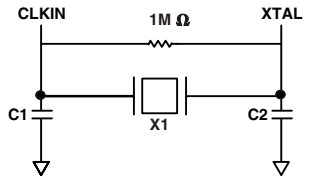


Figure 6. Clock Input

Clock Signals

The ADSP-2126x can use an external clock or a crystal. See CLKIN pin description. The programmer can configure the ADSP-2126x to use its internal clock generator by connecting the necessary components to CLKIN and XTAL. Figure 7 shows the component connections used for a crystal operating in fundamental mode. Note that the 200 MHz clock rate is achieved using a 12.5 MHz crystal and a PLL multiplier ratio 16:1 (CCLK:CLKIN).



NOTE: C1 AND C2 ARE SPECIFIC TO CRYSTAL SPECIFIED FOR X1. CONTACT CRYSTAL MANUFACTURER FOR DETAILS. CRYSTAL SELECTION MUST COMPLY WITH CLKCFG1-0 = 10 OR = 01.

Figure 7. 150 MHz or 200 MHz Operation with a 12.5 MHz Fundamental Mode Crystal

Reset

See Table 17 and Figure 8.

Table 17. Reset

Parameter		Min	Max	Unit
Timing Requirements				
t_{WRST}	$\overline{\text{RESET}}$ Pulse Width Low[1]	$4 \times t_{CK}$		ns
t_{SRST}	$\overline{\text{RESET}}$ Setup Before CLKIN Low	8		ns

[1] Applies after the power-up sequence is complete. At power-up, the processor's internal phase-locked loop requires no more than 100 µs while $\overline{\text{RESET}}$ is low, assuming stable VDD and CLKIN (not including start-up time of external clock oscillator).

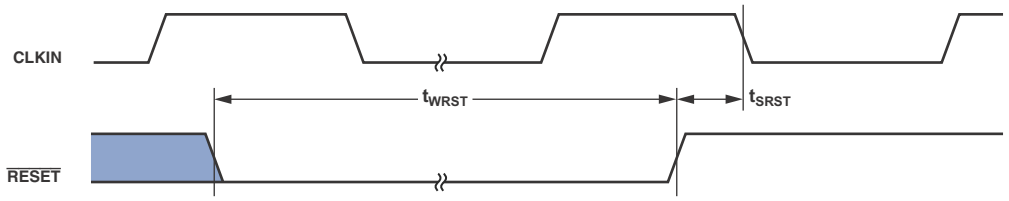


Figure 8. Reset

Interrupts

The timing specification in Table 18 and Figure 9 applies to the FLAG0, FLAG1, and FLAG2 pins when they are configured as $\overline{\text{IRQ0}}$, $\overline{\text{IRQ1}}$, and $\overline{\text{IRQ2}}$ interrupts. Also applies to DAI_P20–1 pins when configured as interrupts.

Table 18. Interrupts

Parameter		Min	Max	Unit
Timing Requirements				
t_{IPW}	$\overline{\text{IRQx}}$ Pulse Width	$2\ t_{CCLK} + 2$		ns

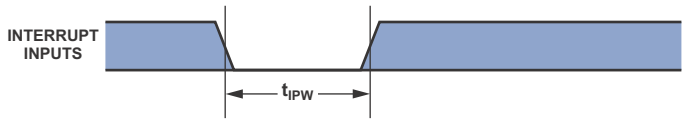


Figure 9. Interrupts

Core Timer

The timing specification in Table 19 and Figure 10 applies to FLAG3 when it is configured as the core timer (CTIMER).

Table 19. Core Timer

Parameter		Min	Max	Unit
Switching Characteristics				
t_{WCTIM}	CTIMER Pulse Width	$4 \times t_{CCLK} - 1$		ns

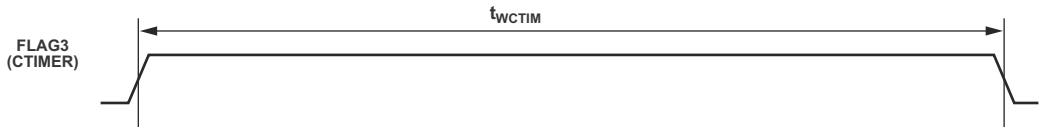


Figure 10. Core Timer

Timer PWM_OUT Cycle Timing

The timing specification in Table 20 and Figure 11 applies to Timer in PWM_OUT (pulse-width modulation) mode. Timer signals are routed to the DAI_P20–1 pins through the SRU. Therefore, the timing specifications provided below are valid at the DAI_P20–1 pins.

Table 20. Timer PWM_OUT Timing

Parameter		Min	Max	Unit
Switching Characteristics				
t_{PWMO}	Timer Pulse Width Output	$2 \times t_{CCLK} - 1$	$2(2^{31} - 1) \times t_{CCLK}$	ns

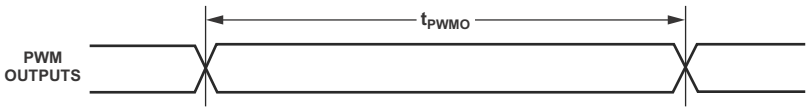


Figure 11. Timer PWM_OUT Timing

Flags

The timing specifications in Table 24 and Figure 15 apply to the FLAG3–0 and DAI_P20–1 pins, the parallel port, and the serial peripheral interface. See Table 6 on Page 10 for more information on flag use.

Table 24. Flags

Parameter		Min	Max	Unit
Timing Requirements				
t_{FIPW}	FLAG3–0 IN Pulse Width	$2 \times t_{CCLK} + 3$		ns
Switching Characteristics				
t_{FOPW}	FLAG3–0 OUT Pulse Width	$2 \times t_{CCLK} - 1$		ns

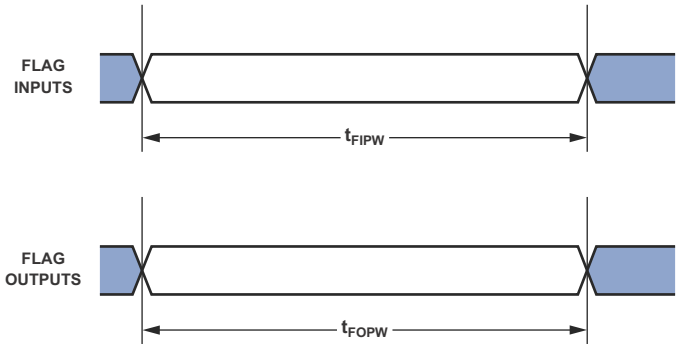


Figure 15. Flags

Table 26. 16-Bit Memory Read Cycle

Parameter		Min	Max	Unit
Timing Requirements				
t_{DRS}	Address/Data 15–0 Setup Before $\overline{RD}$ high	3.3		ns
t_{DRH}	Address/Data 15–0 Hold After $\overline{RD}$ high	0		ns
Switching Characteristics				ns
t_{ALEW}	ALE Pulse Width	$2 \times t_{CCLK} - 2$		ns
t_{ALERW}	ALE Deasserted to Read/Write Asserted	$1 \times t_{CCLK} - 0.5$		ns
t_{ADAS}[1]	Address/Data 15–0 Setup Before ALE Deasserted	$2.5 \times t_{CCLK} - 2.0$		ns
t_{ADAH}1	Address/Data 15–0 Hold After ALE Deaserted	$0.5 \times t_{CCLK} - 0.8$		ns
t_{ALEHZ}[1]	ALE Deasserted to Address/Data 15–0 in High-Z	$0.5 \times t_{CCLK} - 0.8$	$0.5 \times t_{CCLK} + 2.0$	ns
t_{RW}	$\overline{RD}$ Pulse Width	D – 2		ns

D = (The value set by the PPDUR Bits (5–1) in the PPCTL register) × t_{CCLK}
H = t_{CCLK} (if a hold cycle is specified, else H = 0)

[1] On reset, ALE is an active high cycle. However, it can be reconfigured by software to be active low.

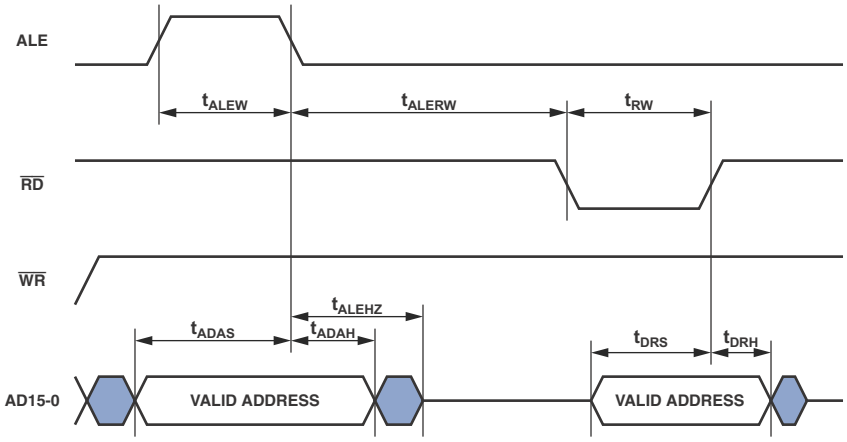


Figure 17. 16-Bit Memory Read Cycle

Memory Write—Parallel Port

Use the specifications in Table 27, Table 28, Figure 18, and Figure 19 for asynchronous interfacing to memories (and memory-mapped peripherals) when the ADSP-2126x is accessing external memory space.

Table 27. 8-Bit Memory Write Cycle

Parameter		Min	Max	Unit
Switching Characteristics				
t_{ALEW}	ALE Pulse Width	$2 \times t_{CCLK} - 2$		ns
t_{ALERW}	ALE Deasserted to Read/Write Asserted	$1 \times t_{CCLK} - 0.5$		ns
t_{ADAS}[1]	Address/Data 15–0 Setup Before ALE Deasserted	$2.5 \times t_{CCLK} - 2.0$		ns
t_{ADAH}[1]	Address/Data 15–0 Hold After ALE Deasserted	$0.5 \times t_{CCLK} - 0.8$		ns
t_{WW}	$\overline{WR}$ Pulse Width	D – 2		ns
t_{ADWL}	Address/Data 15–8 to $\overline{WR}$ Low	$0.5 \times t_{CCLK} - 1.5$		ns
t_{ADWH}	Address/Data 15–8 Hold After $\overline{WR}$ High	$0.5 \times t_{CCLK} - 1 + H$		ns
t_{ALEHZ}	ALE Deasserted to Address/Data 15–0 in High-Z	$0.5 \times t_{CCLK} - 0.8$	$0.5 \times t_{CCLK} + 2.0$	ns
t_{DWS}	Address/Data 7–0 Setup Before $\overline{WR}$ High	D		ns
t_{DWH}	Address/Data 7–0 Hold After $\overline{WR}$ High	$0.5 \times t_{CCLK} - 1.5 + H$		ns
t_{DAWH}	Address/Data to $\overline{WR}$ High	D		ns

D = (The value set by the PPDUR Bits (5–1) in the PPCTL register) × t_{CCLK}
H = t_{CCLK} (if a hold cycle is specified, else H = 0)

[1] On reset, ALE is an active high cycle. However, it can be reconfigured by software to be active low.

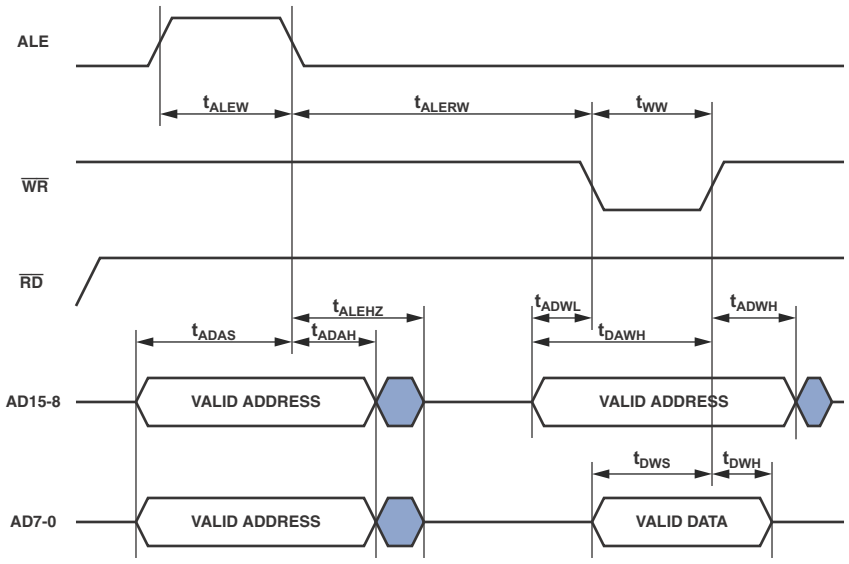


Figure 18. 8-Bit Memory Write Cycle

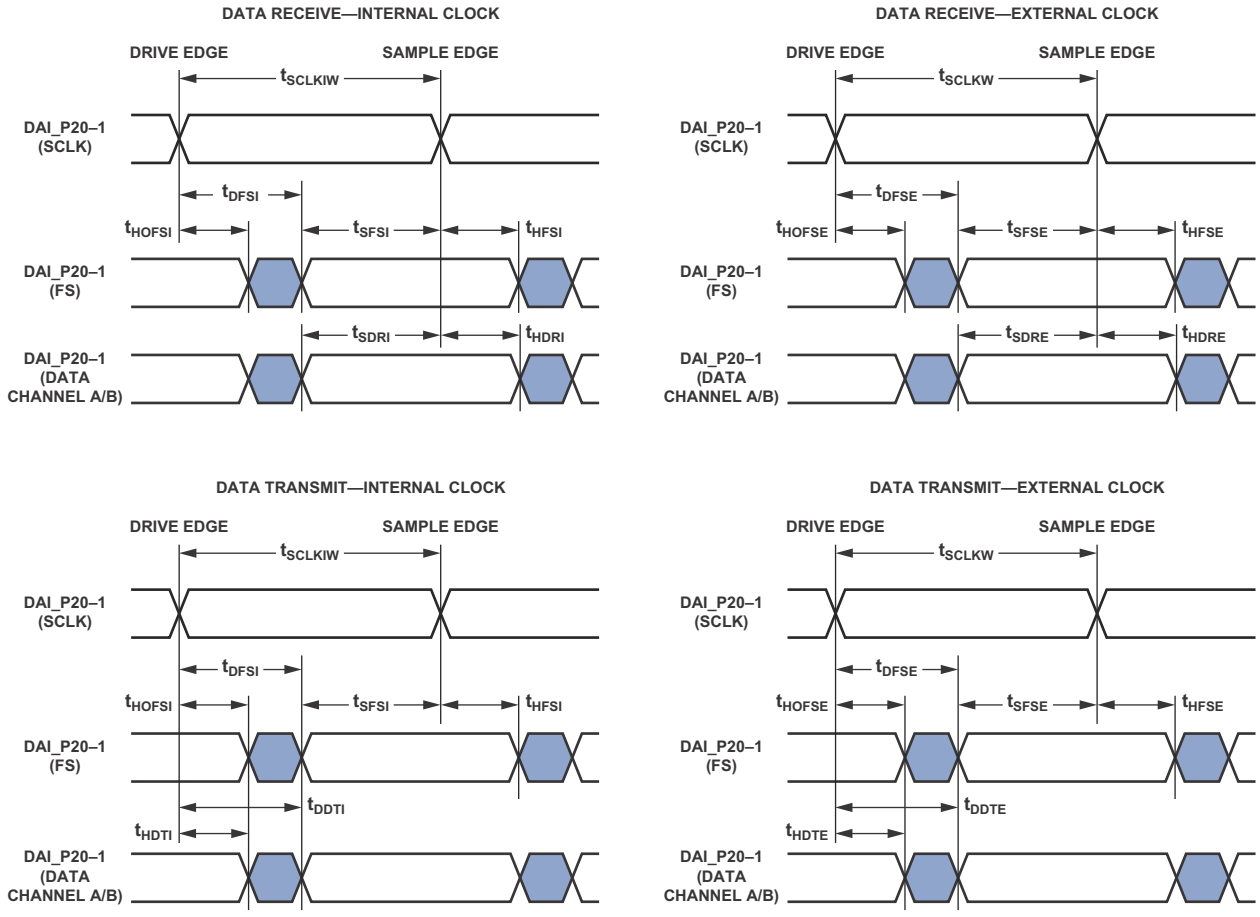


Figure 20. Serial Ports

Table 32. Serial Ports—External Late Frame Sync

Parameter		Min	Max	Unit
Switching Characteristics				
$t_{DDTLFSE}$	Data Delay from Late External Transmit FS or External Receive FS with MCE = 1, MFD = 0[1]		7	ns
$t_{DDTENFS}$	Data Enable for MCE = 1, MFD = 0[1]	0.5		ns

[1] The $t_{DDTLFSE}$ and $t_{DDTENFS}$ parameters apply to left-justified sample pair mode as well as DSP serial mode, and MCE = 1, MFD = 0.

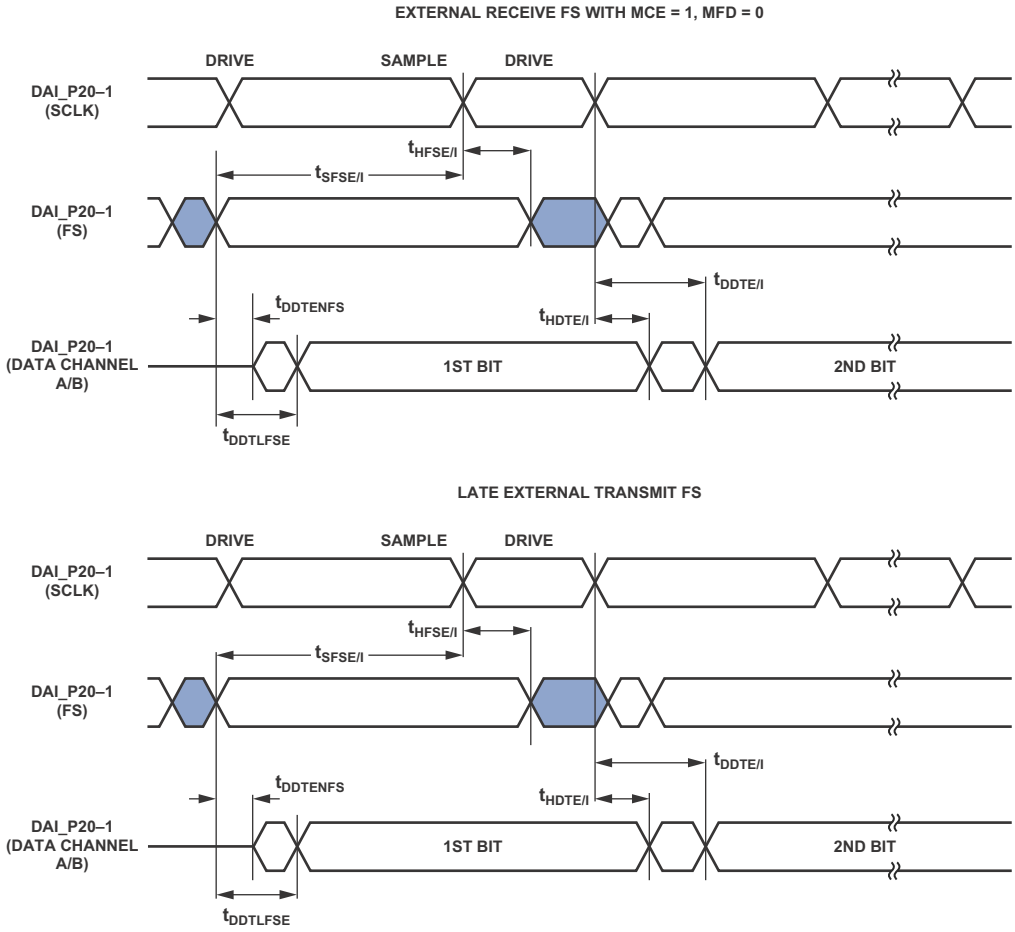


Figure 22. External Late Frame Sync[1]

[1] This figure reflects changes made to support left-justified sample pair mode.

144-LEAD LQFP PIN CONFIGURATIONS

Table 40 shows the ADSP-2126x's pin names and their default function after reset (in parentheses).

Table 40. 144-Lead LQFP Pin Assignments

Pin Name	LQFP Pin No.	Pin Name	LQFP Pin No.	Pin Name	LQFP Pin No.	Pin Name	LQFP Pin No.
V_{DDINT}	1	V_{DDINT}	37	V_{DDEXT}	73	GND	109
CLK_CFG0	2	GND	38	GND	74	V_{DDINT}	110
CLK_CFG1	3	$\overline{RD}$	39	V_{DDINT}	75	GND	111
BOOT_CFG0	4	ALE	40	GND	76	V_{DDINT}	112
BOOT_CFG1	5	AD15	41	DAI_P10 (SD2B)	77	GND	113
GND	6	AD14	42	DAI_P11 (SD3A)	78	V_{DDINT}	114
V_{DDEXT}	7	AD13	43	DAI_P12 (SD3B)	79	GND	115
GND	8	GND	44	DAI_P13 (SCLK23)	80	V_{DDEXT}	116
V_{DDINT}	9	V_{DDEXT}	45	DAI_P14 (SFS23)	81	GND	117
GND	10	AD12	46	DAI_P15 (SD4A)	82	V_{DDINT}	118
V_{DDINT}	11	V_{DDINT}	47	V_{DDINT}	83	GND	119
GND	12	GND	48	GND	84	V_{DDINT}	120
V_{DDINT}	13	AD11	49	GND	85	$\overline{RESET}$	121
GND	14	AD10	50	DAI_P16 (SD4B)	86	$\overline{SPIDS}$	122
FLAG0	15	AD9	51	DAI_P17 (SD5A)	87	GND	123
FLAG1	16	AD8	52	DAI_P18 (SD5B)	88	V_{DDINT}	124
AD7	17	DAI_P1 (SD0A)	53	DAI_P19 (SCLK45)	89	SPICLK	125
GND	18	V_{DDINT}	54	V_{DDINT}	90	MISO	126
V_{DDINT}	19	GND	55	GND	91	MOSI	127
GND	20	DAI_P2 (SD0B)	56	GND	92	GND	128
V_{DDEXT}	21	DAI_P3 (SCLK0)	57	V_{DDEXT}	93	V_{DDINT}	129
GND	22	GND	58	DAI_P20 (SFS45)	94	V_{DDEXT}	130
V_{DDINT}	23	V_{DDEXT}	59	GND	95	A_{VDD}	131
AD6	24	V_{DDINT}	60	V_{DDINT}	96	A_{VSS}	132
AD5	25	GND	61	FLAG2	97	GND	133
AD4	26	DAI_P4 (SFS0)	62	FLAG3	98	$\overline{RESETOUT}$	134
V_{DDINT}	27	DAI_P5 (SD1A)	63	V_{DDINT}	99	$\overline{EMU}$	135
GND	28	DAI_P6 (SD1B)	64	GND	100	TDO	136
AD3	29	DAI_P7 (SCLK1)	65	V_{DDINT}	101	TDI	137
AD2	30	V_{DDINT}	66	GND	102	$\overline{TRST}$	138
V_{DDEXT}	31	GND	67	V_{DDINT}	103	TCK	139
GND	32	V_{DDINT}	68	GND	104	TMS	140
AD1	33	GND	69	V_{DDINT}	105	GND	141
AD0	34	DAI_P8 (SFS1)	70	GND	106	CLKIN	142
$\overline{WR}$	35	DAI_P9 (SD2A)	71	V_{DDINT}	107	XTAL	143
V_{DDINT}	36	V_{DDINT}	72	V_{DDINT}	108	V_{DDEXT}	144

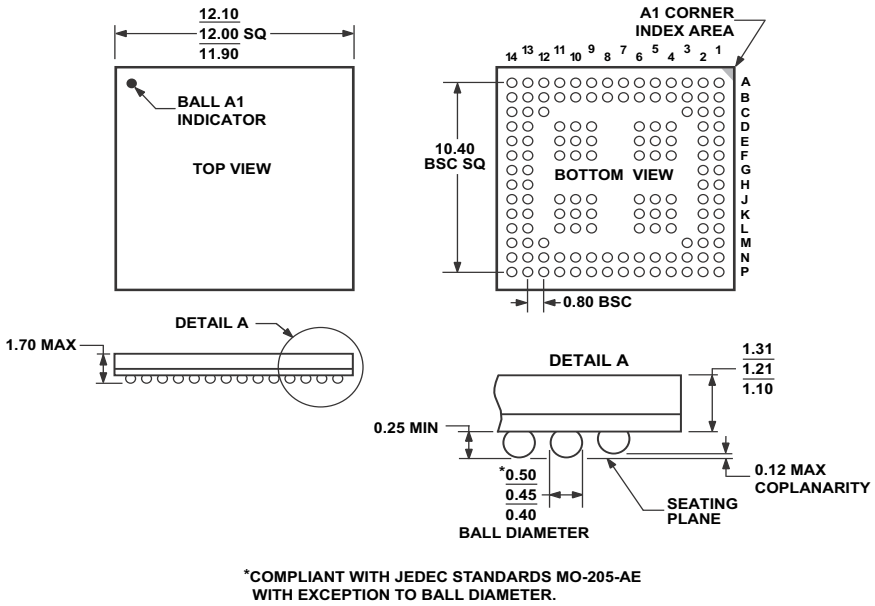


Figure 36. 136-Ball Chip Scale Package Ball Grid Array [CSP_BGA]
(BC-136-1)
Dimensions shown in millimeters

SURFACE-MOUNT DESIGN

Table 42 is provided as an aide to PCB design. For industry-standard design recommendations, refer to IPC-7351, *Generic Requirements for Surface-Mount Design and Land Pattern Standard*.

Table 42. BGA_ED Data for Use with Surface-Mount Design

Package	Ball Attach Type	Solder Mask Opening	Ball Pad Size
136-Ball CSP_BGA (BC-136-1)	Solder Mask Defined (SMD)	0.4 mm	0.53 mm