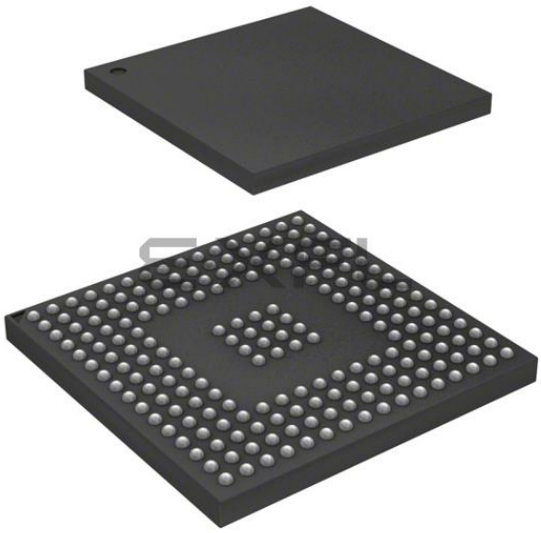
Infineon Technologies - SAF-TC1115-L150EB-G BB Datasheet



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"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	TriCore™
Core Size	32-Bit Single-Core
Speed	150MHz
Connectivity	CANbus, EBI/EMI, FIFO, I²C, IrDA, SPI, UART/USART
Peripherals	DMA, POR, PWM, WDT
Number of I/O	72
Program Memory Size	-
Program Memory Type	ROMless
EEPROM Size	-
RAM Size	144K x 8
Voltage - Supply (Vcc/Vdd)	1.43V ~ 1.58V
Data Converters	-
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	208-LBGA
Supplier Device Package	P-LBGA-208-2
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/saf-tc1115-l150eb-g-bb

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2 General Device Information

2.1 Block Diagram

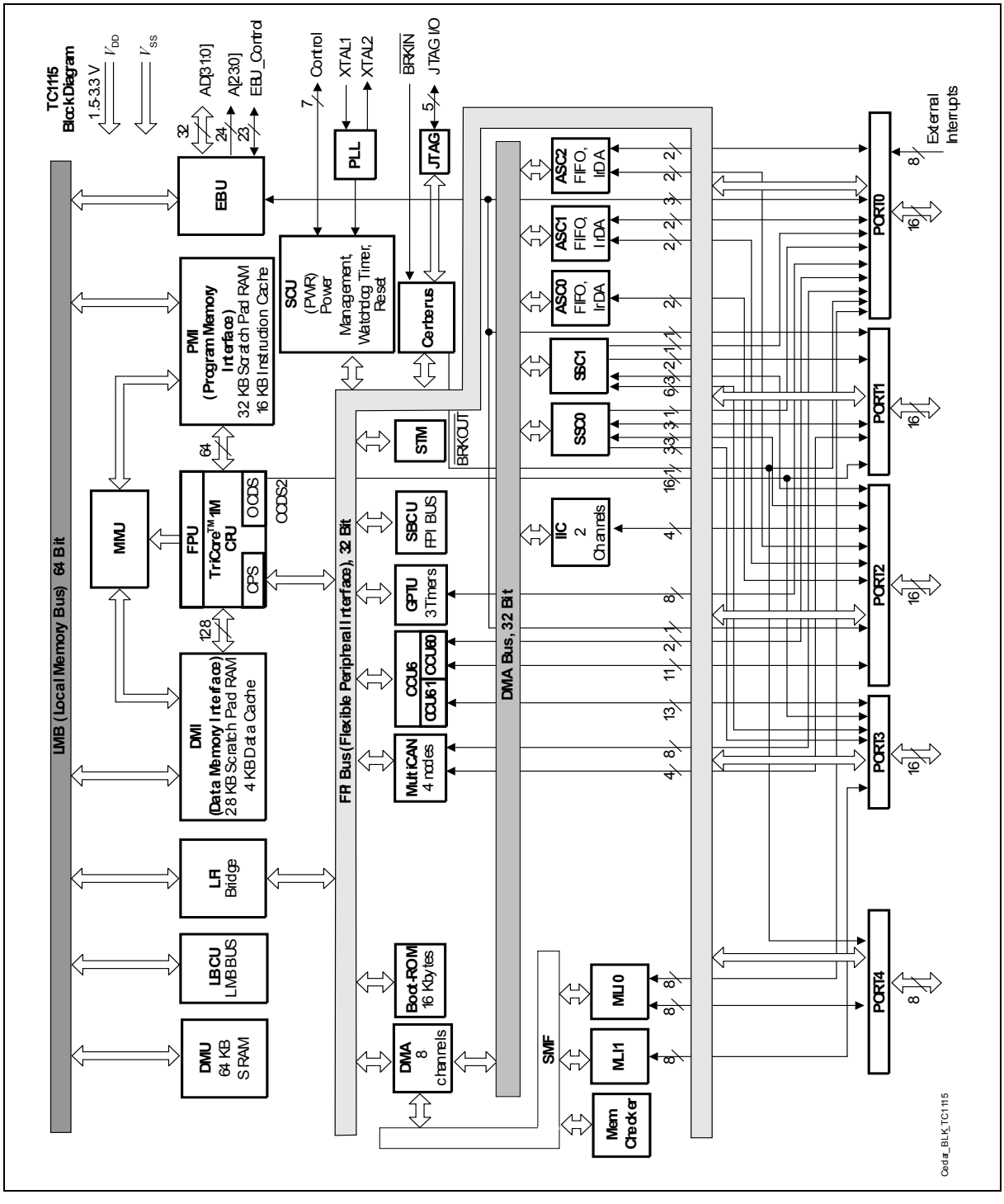

Figure 2-1 TC1115 Block Diagram

2.3 Pin Configuration

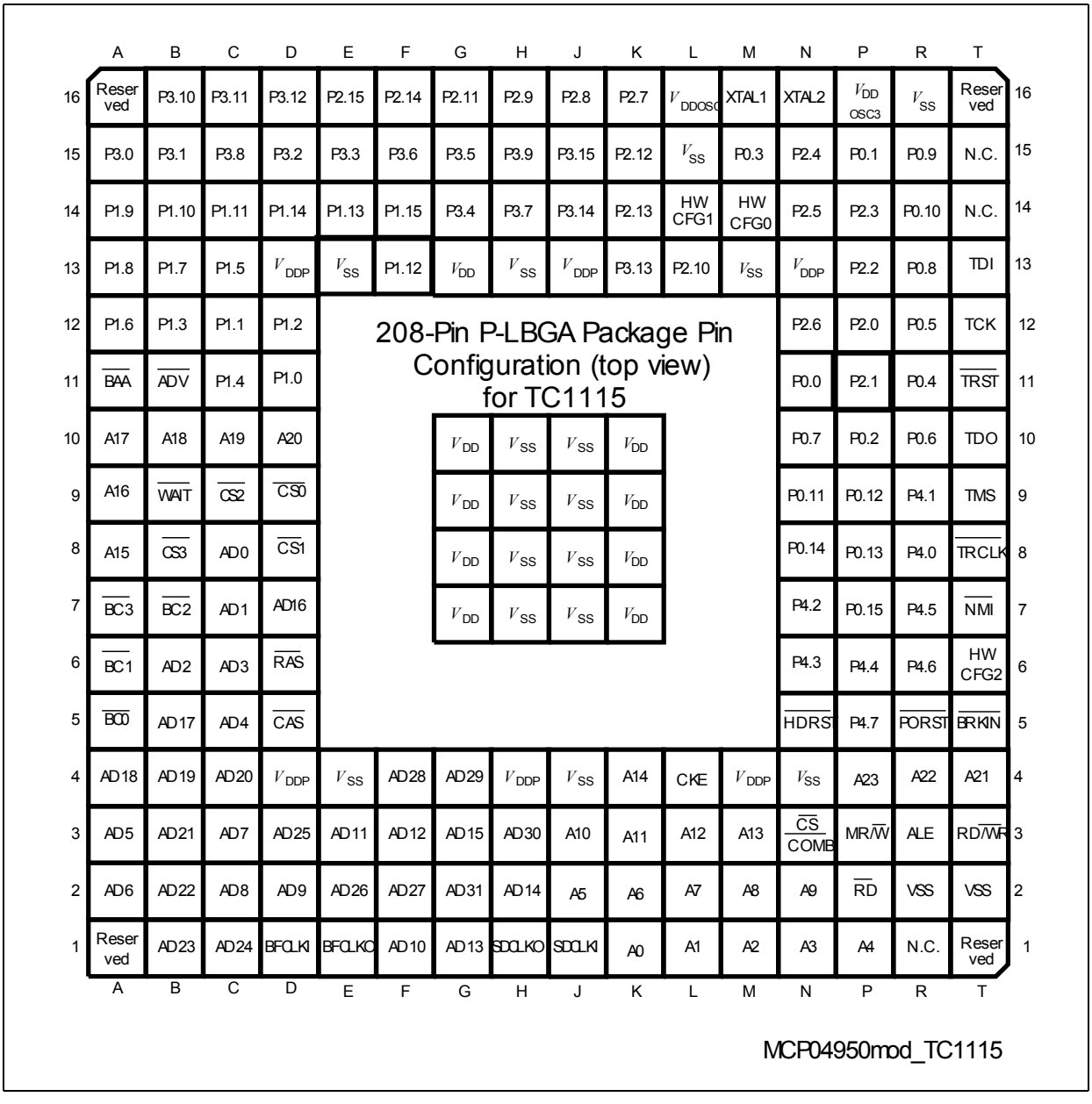

Figure 2-3 TC1115 Pins: P-BGA-208 Package (top view)

Table 2-1 Pin Definitions and Functions (cont'd)

Symbol	Pin	In Out	PU/ PD[1)]	Functions	
P1.7	B13	I	PUC	SWCFG7	Software configuration 7
		O		OCDSA_7	OCDS L2 Debug Line A7
P1.8	A13	I	PUC	SWCFG8	Software configuration 8
		O		OCDSA_8	OCDS L2 Debug Line A8
P1.9	A14	I	PUC	SWCFG9	Software configuration 9
		O		OCDSA_9	OCDS L2 Debug Line A9
P1.10	B14	I	PUC	SWCFG10	Software configuration 10
		O		OCDSA_10	OCDS L2 Debug Line A10
P1.11	C14	I	PUC	SWCFG11	Software configuration 11
		O		OCDSA_11	OCDS L2 Debug Line A1
		O		SLSO0_1	SSC0 Slave Select output 1
P1.12	F13	I	PUC	SWCFG12	Software configuration 12
		O		OCDSA_12	OCDS L2 Debug Line A12
		O		SLSO1_1	SSC1 Slave Select output 1
P1.13	E14	I	PUC	SWCFG13	Software configuration 13
		O		OCDSA_13	OCDS L2 Debug Line A13
		O		SLSO0_2	SSC0 Slave Select output 2
P1.14	D14	O	PUC	SLSO1_2	SSC1 Slave Select output 2
		I		SWCFG14	Software configuration 14
		O		OCDSA_14	OCDS L2 Debug Line A14
P1.15	F14	I	PUC	SLSI0	SSC0 Slave Select Input
		O		RMW	EBU Read Modify Write
		I		SWCFG15	Software configuration 15
		O		OCDSA_15	OCDS L2 Debug Line A15

Table 2-1 Pin Definitions and Functions (cont'd)

Symbol	Pin	In Out	PU/ PD[1)]	Functions	
P2		I/O		**Port 2** Port 2 is a 16-bit bi-directional general purpose I/O port which can be alternatively used for ASC0/1/2, SSC0/1, CCU60, IIC, EBU and SCU.	
P2.0	P12	I/O	PUC	RXD0	ASC0 receiver input/output line
		O		CSEMU	EBU Chip Select Output for Emulator Region
P2.1	P11	O	PUC	TXD0	ASC0 transmitter output line
		I		TESTMODE	Test Mode Select Input
P2.2	P13	I/O	PUC	MRST0	SSC0 master receive/slave transmit input/output
P2.3	P14	I/O	PUC	MTSR0	SSC0 master transmit/slave receive input/output
P2.4	N15	I/O	PUC	SCLK0	SSC0 clock input/output line
P2.5	N14	O	PUC	COUT60_3	CCU60 compare channel 3 output
		I/O		MRST1A	SSC1 master receive/slave transmit input/output A
P2.6	N12	I/O	PUC	CC60_0	CCU60 input/output of capture/ compare channel 0
		I/O		MTSR1A	SSC1 master transmit/slave receive input/output A
P2.7	K16	O	PUC	COUT60_0	CCU60 output of capture/compare channel 0
		I/O		SCLK1A	SSC1 clock input/output line A
P2.8	J16	I/O	PUC	CC60_1	CCU60 input/output of capture/ compare channel 1
		I/O		RXD1A	ASC1 receiver input/output line A
P2.9	H16	O	PUC	COUT60_1	CCU60 output of capture/compare channel 1
		O		TXD1A	ASC1 transmitter output line A
P2.10	L13	I/O	PUC	CC60_2	CCU60 input/output of capture/ compare channel 2
		I/O		RXD2A	ASC2 receiver input/output line A
P2.11	G16	O	PUC	COUT60_2	CCU60 output of capture/compare channel 2
		O		TXD2A	ASC2 transmitter output line A
P2.12	K15	I/O	—	SDA0	IIC Serial Data line 0
		I		CTRAP0	CCU60 trap input
		O		SLSO0_3	SSC0 Slave Select output 3

Table 2-1 Pin Definitions and Functions (cont'd)

Symbol	Pin	In Out	PU/ PD[1)]	Functions
HDRST	N5	I/O	PUA	**Hardware Reset Input/Reset Indication Output** Assertion of this bi-directional open-drain pin causes a synchronous reset of the chip through external circuitry. This pin must be driven for a minimum 4 f_{CPU} clock cycles. The internal reset circuitry drives this pin in response to a power-on, hardware, watchdog and power-down wake-up reset for a specific period of time. For a software reset, activation of this pin is programmable.
PORST	R5	I	PUC	**Power-on Reset Input** A low level on PORST causes an asynchronous reset of the entire chip. PORST is a fully asynchronous level sensitive signal.
NMI	T7	I	PUC	**Non-Maskable Interrupt Input** A high-to-low transition on this pin causes an NMI-Trap request to the CPU.
TRST	T11	I	PDC	**JTAG Module Reset/Enable Input** A low level at this pin resets and disables the JTAG module. A high level enables the JTAG module.
TCK	T12	I	PUC	**JTAG Module Clock Input**
TDI	T13	I	PUC	**JTAG Module Serial Data Input**
TDO	T10	O	—	**JTAG Module Serial Data Output**
TMS	T9	I	PUC	**JTAG Module State Machine Control Input**
TRCLK	T8	O	—	**Trace Clock for OCDS_L2 Lines**
HWCFG0 **HWCFG1** **HWCFG2**	M14 L14 T6	I I I	PUC PUC PDC	**Hardware Configuration Inputs** The Configuration Inputs define the boot options of the TC1115 after a hardware invoked reset operation.
BRKIN	T5	I	PUC	**OCDS Break Input** A low level on this pin causes a break in the chip's execution when the OCDS is enabled. In addition, the level of this pin during power-on reset determines the boot configuration.

3.3 Memory Protection System

The TC1115 memory protection system specifies the addressable range and read/write permissions of memory segments available to the currently executing task. The memory protection system controls the position and range of addressable segments in memory. It also controls the types of read and write operations allowed within addressable memory segments. Any illegal memory access is detected by the memory protection hardware, which then invokes the appropriate Trap Service Routine (TSR) to handle the error. Thus, the memory protection system protects critical system functions against both software and hardware errors. The memory protection hardware can also generate signals to the Debug Unit to facilitate tracing illegal memory accesses.

In TC1115, TriCore™ supports two address spaces: the virtual address space and the physical address space. Both address space are 4 Gbytes in size and divided into 16 segments with each segment being 256 Mbytes. The upper 4 bits of the 32-bit address are used to identify the segment. Virtual segments are numbered 0 - 15. But a virtual address is always translated into a physical address before accessing memory. The virtual address is translated into a physical address using one of two translation mechanisms: (a) direct translation, and (b) Page Table Entry (PTE) based translation. If the virtual address belongs to the upper half of the virtual address space then the virtual address is directly used as the physical address (direct translation). If the virtual address belongs to the lower half of the address space, then the virtual address is used directly as the physical address if the processor is operating in physical mode (direct translation) or translated using a Page Table Entry if the processor is operating in virtual mode (PTE translation). These are managed by Memory Management Unit (MMU).

Memory protection is enforced using separate mechanisms for the two translation paths.

3.3.1 Protection for Direct translation

Memory protection for addresses that undergo direct translation is enforced using the range based protection that has been used in the previous generation of the TriCore™ architecture. The range based protection mechanism provides support for protecting memory ranges from unauthorized read, write, or instruction fetch accesses. The TriCore™ architecture provides up to four protection register sets with the PSW.PRS field controlling the selection of the protection register set. Because the TC1115 uses a Harvard-style memory architecture, each Memory Protection Register Set is broken down into a Data Protection Register Set and a Code Protection Register Set. Each Data Protection Register Set can specify up to four address ranges to receive particular protection modes. Each Code Protection Register Set can specify up to two address ranges to receive particular protection modes.

Each of the Data Protection Register Sets and Code Protection Register Sets determines the range and protection modes for a separate memory area. Each contains register pairs which determine the address range (the Data Segment Protection Registers and Code Segment Protection Registers) and one register (Data Protection

3.5 LMB External Bus Unit

The LMB External Bus Control Unit (EBU) of the TC1115 is the interface between external resources, like memories and peripheral units, and the internal resources connected to on-chip buses if enabled. The basic structure and external interconnections of the EBU are shown in **Figure 3-1**.

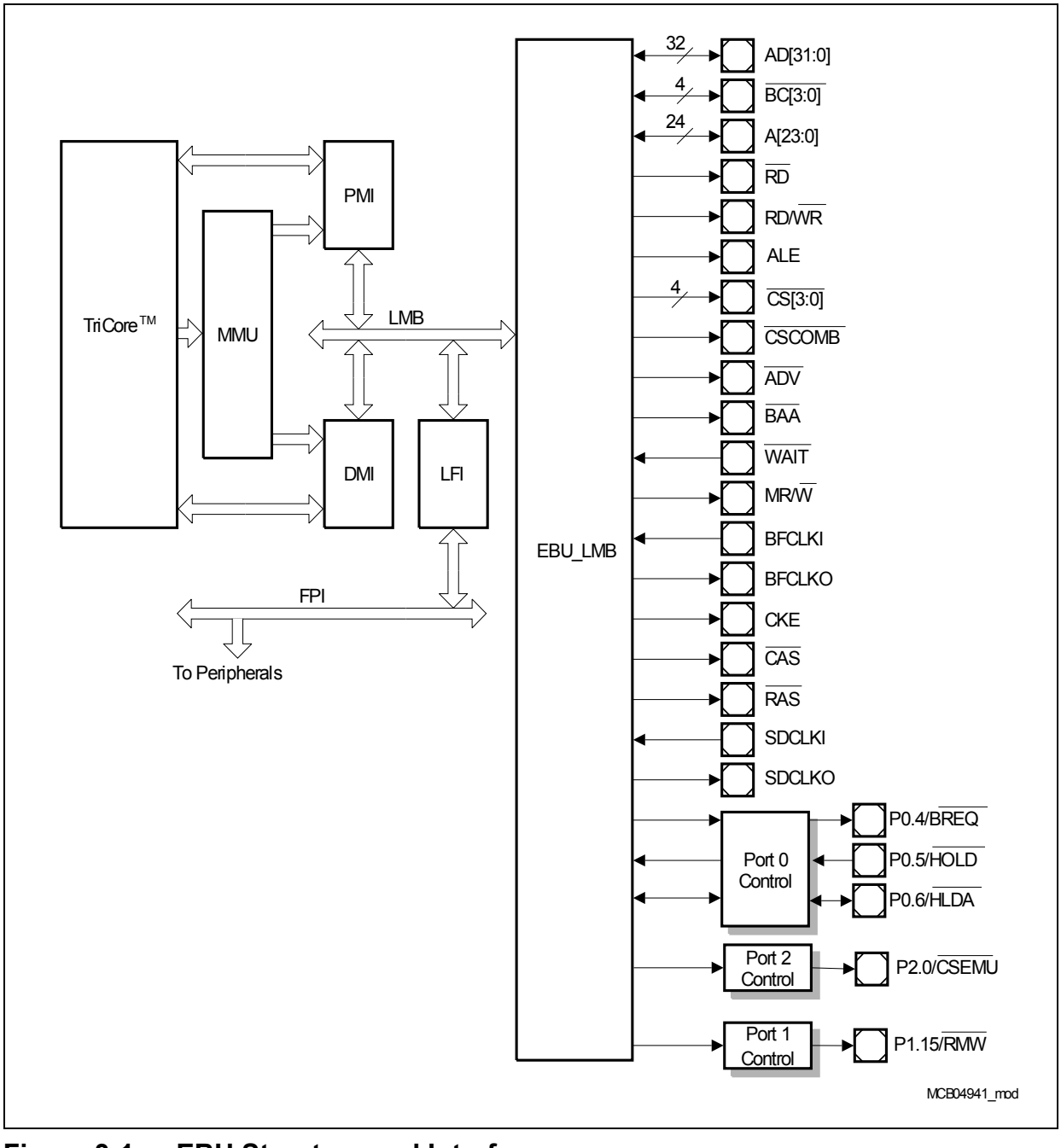

Figure 3-1 EBU Structure and Interface

The basic structure and external interconnections of the DMA are shown in **Figure 3-2**.

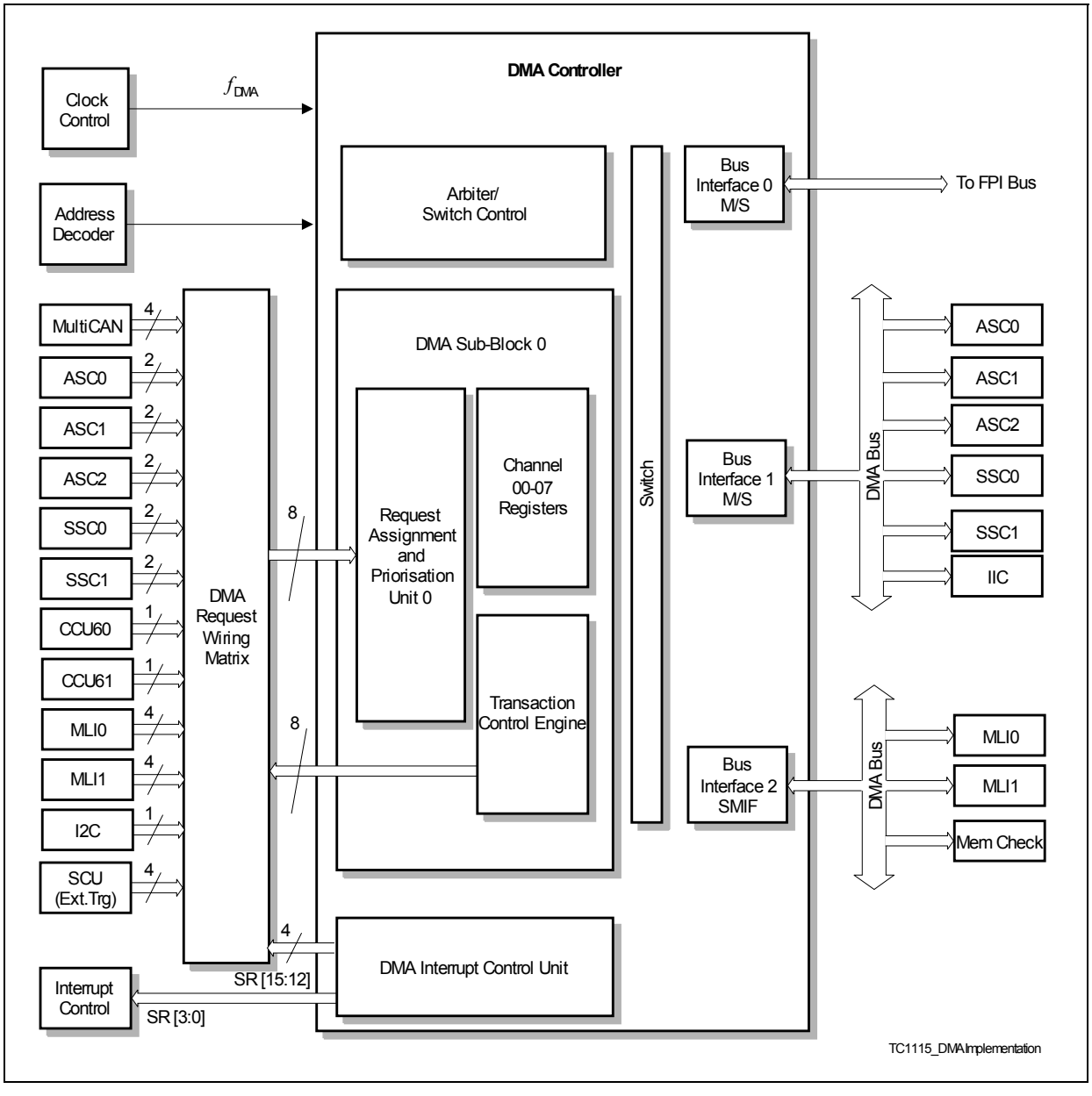

Figure 3-2 DMA Controller Structure and Interconnections

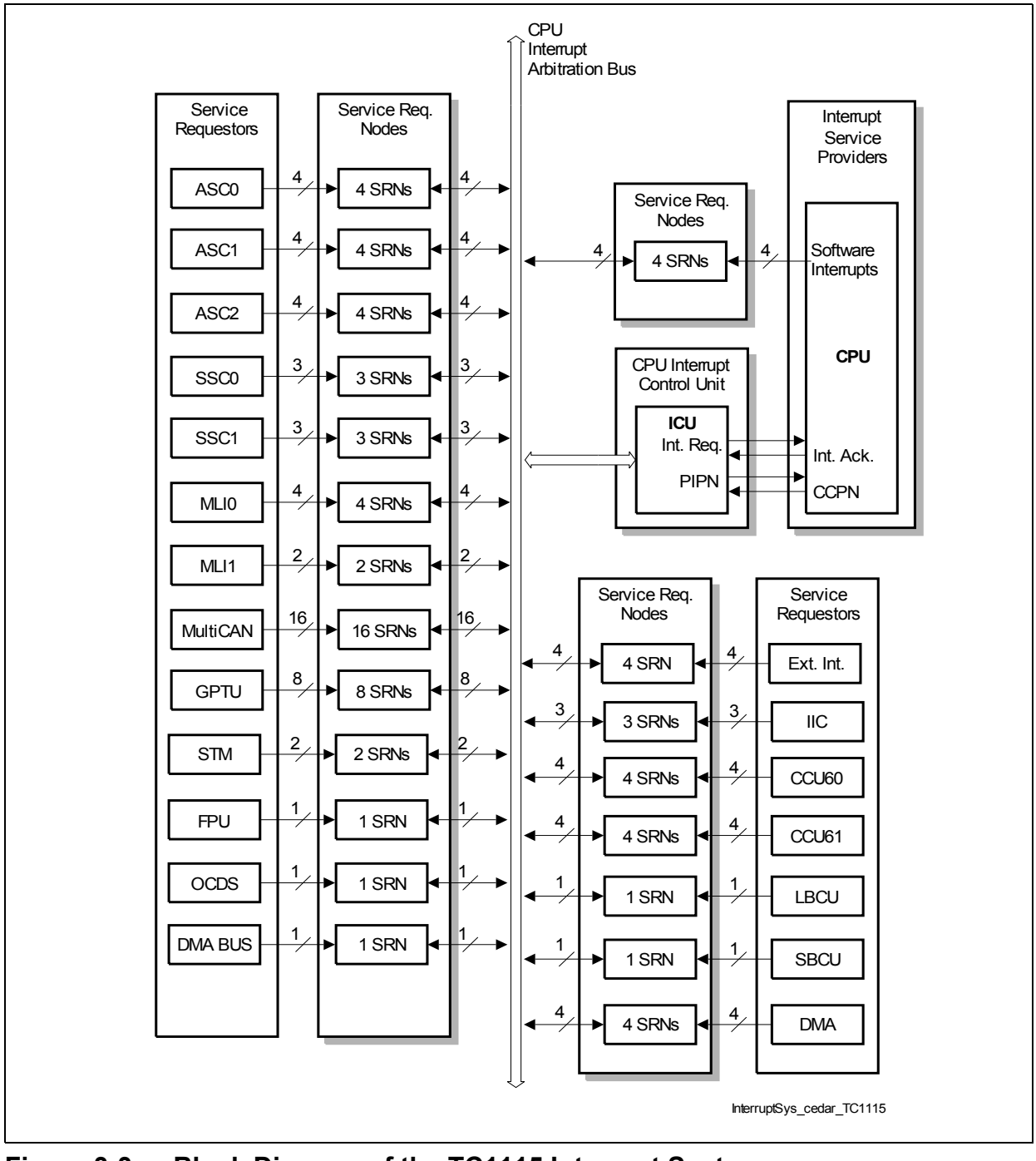

Figure 3-3 Block Diagram of the TC1115 Interrupt System

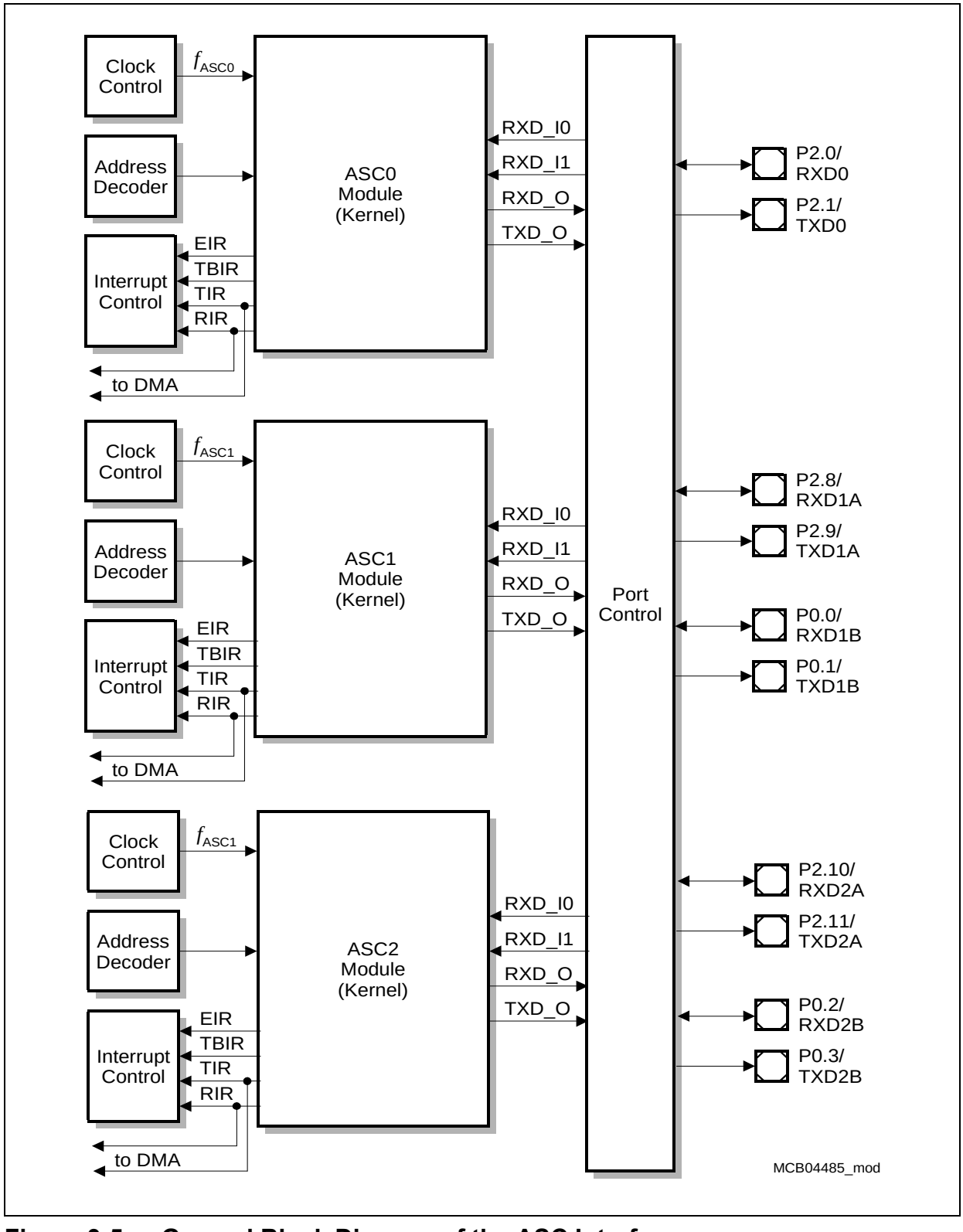

Figure 3-5 General Block Diagram of the ASC Interfaces

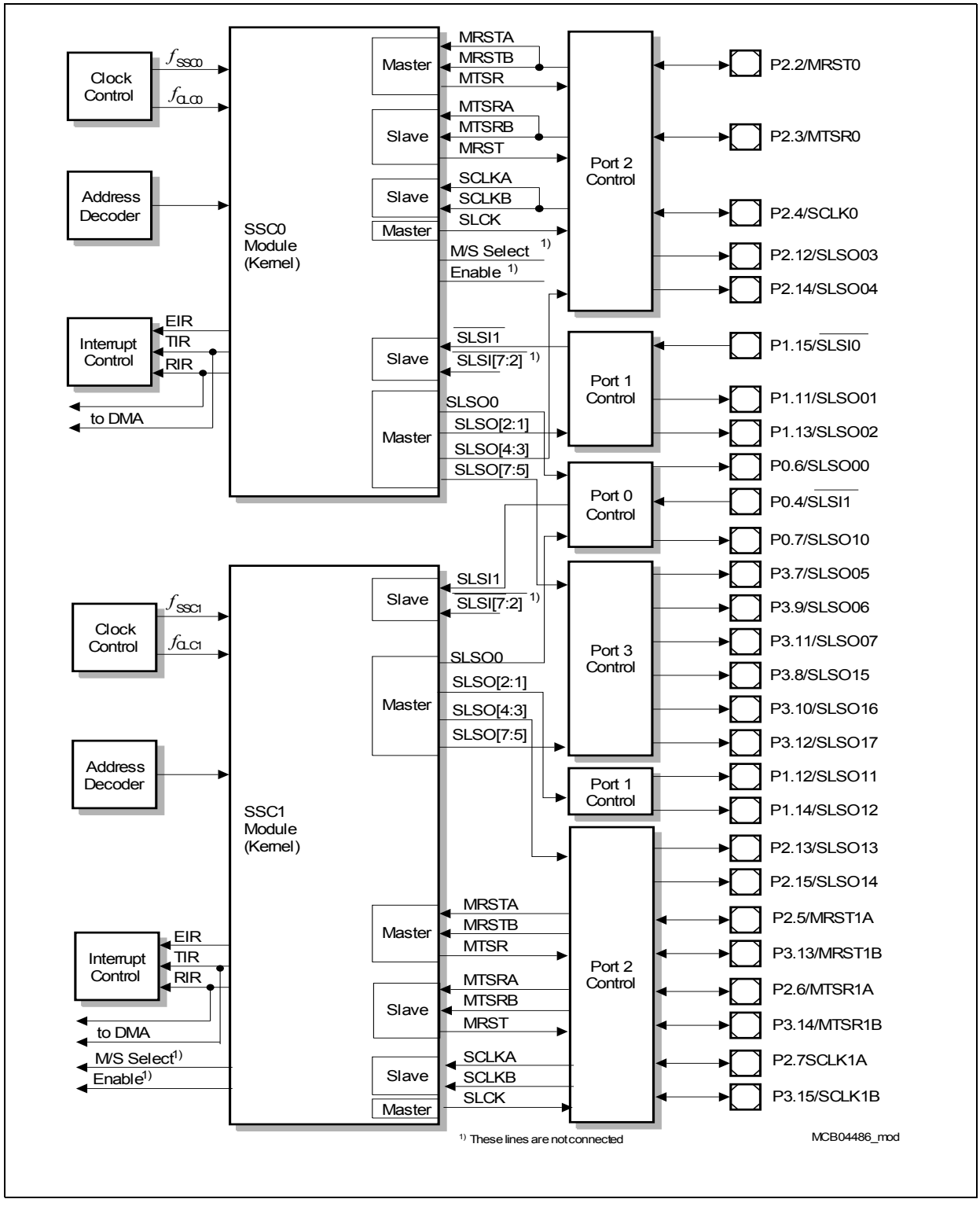

Figure 3-6 General Block Diagram of the SSC Interfaces

The bit timings for the CAN nodes are derived from the peripheral clock (f_{CAN}) and are programmable up to a data rate of 1 MBaud. A pair of receive and transmit pins connects each CAN node to a bus transceiver.

Features:

- Compliant to ISO 11898
- CAN functionality according to CAN specification V2.0 B (active)
- Dedicated control registers are provided for each CAN node
- A data transfer rate up to 1 MBaud is supported
- Flexible and powerful message transfer control and error handling capabilities are implemented
- Advanced CAN bus bit timing analysis and baud rate detection can be performed for each CAN node via the frame counter
- Full-CAN functionality: A set of 128 message objects can be individually
  - allocated (assigned) to any CAN node
  - configured as transmit or receive object
  - setup to handle frames with 11-bit or 29-bit identifier
  - counted or assigned a timestamp via a frame counter
  - configured to remote monitoring mode
- Advanced Acceptance Filtering:
  - Each message object provides an individual acceptance mask to filter incoming frames.
  - A message object can be configured to accept only standard or only extended frames or to accept both standard and extended frames.
  - Message objects can be grouped into 4 priority classes.
  - The selection of the message to be transmitted first can be performed on the basis of frame identifier, IDE bit and RTR bit according to CAN arbitration rules.
- Advanced Message Object Functionality:
  - Message objects can be combined to build FIFO message buffers of arbitrary size, which is only limited by the total number of message objects.
  - Message objects can be linked to form a gateway to automatically transfer frames between two different CAN buses. A single gateway can link any two CAN nodes. An arbitrary number of gateways may be defined.
- Advanced Data Management:
  - The Message objects are organized in double chained lists.
  - List reorganizations may be performed at any time, even during full operation of the CAN nodes.
  - A powerful, command driven list controller manages the organization of the list structure and ensures consistency of the list.
  - Message FIFOs are based on the list structure and can easily be scaled in size during CAN operation.

- Important debugging support is provided through the reset prewarning operation by first issuing an NMI to the CPU before finally resetting the device after a certain period of time.

3.20 Power Management System

The TC1115 power management system allows software to configure the various processing units to adjust automatically in order to draw the minimum necessary power for the application.

There are four power management modes:

- Run Mode
- Idle Mode
- Sleep Mode
- Deep Sleep Mode

Table 3-4 describes the features of the power management modes.

Table 3-4 Power Management Mode Summary

Mode	Description
Run	The system is fully operational. All clocks and peripherals are enabled, as determined by software.
Idle	The CPU clock is disabled, waiting for a condition to return it to run mode. Idle mode can be entered by software when the processor has no active tasks to perform. All peripherals remain powered and clocked. Processor memory is accessible to peripherals. A reset, Watchdog Timer event, a falling edge on the $\overline{\text{NMI}}$ pin, or any enabled interrupt event will return the system to run mode.
Sleep	The system clock continues to be distributed only to those peripherals programmed to operate in sleep mode. The other peripheral modules will be shut down by the suspend signal. Interrupts from operating peripherals, the Watchdog Timer, a falling edge on the $\overline{\text{NMI}}$ pin, or a reset event will return the system to run mode. Entering this state requires an orderly shut-down controlled by the Power Management State Machine.
Deep Sleep	The system clock is shut off; only an external signal will restart the system. Entering this state requires an orderly shut-down controlled by the Power Management State Machine (PMSM).

Besides these explicit software-controlled power-saving modes, special attention has been paid in the TC1115 to automatic power-saving in operating units that are currently not required or idle. In this case, they are shut off automatically until their operation is required again.

4 Electrical Parameters

4.1 General Parameters

4.1.1 Parameter Interpretation

The parameters listed in this section represent partly the characteristics of the TC1115 and partly its requirements on the system. To aid interpreting the parameters easily when evaluating them for design purposes, they are indicated by the abbreviations in the “Symbol” column:

- **CC**
  These parameters indicate **C**ontroller **C**haracteristics, which are distinctive features of the TC1115 and must be considered for system design.
- **SR**
  These parameters indicate **S**ystem **R**equirements, which must be provided by the microcontroller system in which the TC1115 is included.

4.1.3 Operating Condition

The following operating conditions must be complied with in order to ensure correct operation of the TC1115. All parameters specified in the following table refer to these operating conditions, unless otherwise indicated.

Parameter	Symbol	Limit Values		Unit	Notes Conditions
		min.	max.		
Digital supply voltage	V_{DD}	1.43	1.58	V	–
	V_{DDP}	3.14	3.47	V	–
Digital ground voltage	V_{SS}	0		V	–
Digital core supply current	I_{DD}	–	525	mA	–
Ambient temperature under bias	T_A	-40	+85	°C	–
CPU clock	f_{SYS}	–[1]	150	MHz	–
Overload current	I_{OV}	-1	1	mA	[2][3]
		-3	3		duty cycle ≤ 25%
Short circuit current	I_{SC}	-1	1	mA	[4]
		-3	3		duty cycle ≤ 25%
Absolute sum of overload + short circuit currents	$\Sigma\|I_{OV}\| + \|I_{SC}\|$	–	|50|	mA	[3]
			|100|		duty cycle ≤ 25%
Inactive device pin current (V_{DD} = V_{DDP} = 0)	I_{ID}	-1	1	mA	–
External load capacitance	C_L	–	50	pF	–
ESD strength	–	2000	–	V	Human Body Model (HBM)

[1] The TC1115 uses a static design, so the minimum operation frequency is 0 MHz. However, due to test time restriction no lower frequency boundary is tested.

[2] Overload conditions occur if the standard operating conditions are exceeded, i.e. the voltage on any pin exceeds the specified range (i.e. $V_{OV} > V_{DDP}$ + 0.5 V or $V_{OV} < V_{SS}$ - 0.5 V). The absolute sum of input overload currents on all digital I/O pins may not exceed **50 mA**. The supply voltage must remain within the specified limits.

[3] Not subject to production test, verified by design/characterization.

[4] Applicable for digital inputs.

4.3.8 EBU Timings

4.3.8.1 SDCLKO Output Clock Timing

(Operating Conditions apply; CL = 50 pF)

Parameter	Symbol		Limits[1]		Limits[2]		Unit
			min	max	min	max	
SDCLKO period	t_1	CC	10	–	8.3	–	ns
SDCLKO high time	t_2	CC	3	–	2.5	–	ns
SDCLKO low time	t_3	CC	3	–	2.5	–	ns
SDCLKO rise time	t_4	CC	–	2.5	–	2.5	ns
SDCLKO fall time	t_5	CC	–	2.5	–	2.5	ns

1) The parameters are applicable for PC100 SDRAM access and the maximum SDCLKO is up to 100 MHz.

2) The parameters are applicable for PC133 SDRAM access and the maximum SDCLKO is up to 120 MHz.

4.3.8.2 BFCLKO Output Clock Timing

(Operating Conditions apply; C_L = 50 pF)

Parameter	Symbol		Limit [1]		Limit [2]		Unit
			min	max	min	max	
Clock period	t_1	CC	20	–	16.7	–	ns
BFCLKO high time	t_2	CC	6.6	–	7.5	–	ns
BFCLKO low time	t_3	CC	6.6	–	7.5	–	ns
BFCLKO rise time	t_4	CC	–	3.5	–	3.5	ns
BFCLKO fall time	t_5	CC	–	2.5	–	2.5	ns

1) The CPU runs at 150 MHz and the Burst Flash runs at divided by 3 clock.

2) The CPU runs at 120 MHz and the Burst Flash runs at divided by 2 clock.

4.3.8.4 Timing for Burst Flash Access Signals

(Operating Conditions apply; C_L = 50 pF)

Parameter	Symbol		Limits		Unit
			min	max	
Address output valid time from BFCLKO	t_1	CC	–	11.0	ns
Address output hold time from BFCLKO	t_2	CC	10.0	–	ns
$\overline{\text{CSx}}$ output valid time from BFCLKO	t_3	CC	–	9.0	ns
$\overline{\text{RD}}$ output valid time from BFCLKO	t_4	CC	–	10.0	ns
$\overline{\text{ADV}}$ output valid time from BFCLKO	t_5	CC	–	10.0	ns
$\overline{\text{ADV}}$ output hold time from BFCLKO	t_6	CC	3.0	–	ns
$\overline{\text{BAA}}$ output valid time from BFCLKO	t_7	CC	–	10.0	ns
$\overline{\text{BAA}}$ output hold time from BFCLKO	t_8	CC	3.0	–	ns
AD(31:0) input setup time to BFCLKO	t_9	SR	5.0	–	ns
AD(31:0) input hold time from BFCLKO	t_{10}	SR	3.0	–	ns
$\overline{\text{WAIT}}$ input setup time to BFCLKO	t_{11}	SR	5.0	–	ns
$\overline{\text{WAIT}}$ input hold time from BFCLKO	t_{12}	SR	3.0	–	ns

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