

Product Brief

MPC565PB/D
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MPC565/MPC566
Product Brief



This document provides an overview of the MPC565/MPC566 microcontrollers, including a block diagram showing the major modular components, sections that list the major features, and differences between the MPC565/MPC566 and the MPC555. The MPC565 and MPC566 devices are members of the Motorola MPC500 RISC Microcontroller family. The parts herein will be referred to only as MPC565 unless specific parts need to be referenced.

Table 1. MPC565/MPC566 Features

Device	Flash	Code Compression
MPC565	1 Mbyte	Code compression not supported
MPC566	1 Mbyte	Code compression supported

1 Introduction

The MPC565 device offers the following features:

- PowerPC™ core with a floating point unit (FPU) and a burst buffer controller (BBC)
- Unified system integration unit (USIU), a flexible memory controller, and improved interrupt controller
- 1 Mbyte of Flash memory (UC3F)
 - Typical endurance of 100,000 write/erase cycles @ 25°C
 - Typical data retention of 100 years @ 25°C
- 36 Kbytes of static RAM (two CALRAM modules)
 - 8 Kbytes of normal access or overlay access (sixteen 512-byte regions)
 - 4 Kbytes in CALRAM A, 4 Kbytes in CALRAM B
- Three time processor units (TPU3)
 - TPU3 A and TPU3 B are connected to DPTRAM AB (6 Kbytes)
 - TPU3 C is connected to DPTRAM C (4 Kbytes)
- A 22-timer channel modular I/O system (MIOS14)
 - Same as MIOS1 plus a real-time clock sub-module (MRTCSM), 4 counter sub-modules (MCSM), and 4 PWM sub-modules (MPWMSM)
- Three TouCAN modules (TouCAN_A, TouCAN_B, and TouCAN_C)
- Two enhanced queued analog to digital converters (QADC64E A, QADC64E B) with analog multiplexers (AMUX) for 40 total analog channels. These modules are configured so each module can access all 40 of the analog inputs to the part.

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Block Diagram

- Two queued serial multi-channel modules (QSMCM A, QSMCM B), each of which contains a queued serial peripheral interface (QSPI) and two serial controller interfaces (SCI/UART)
- -40°C – 125°C ambient temperature, -40°C – 85°C for suffix C devices, -55°C– 125°C for suffix A devices
- Debug features:
 - A J1850 (DLCMD2) communications module
 - A Nexus debug port (class 3) – IEEE-ISTO 5001-1999
 - JTAG and background debug mode (BDM)
- Packaging and Electrical

1.1 Block Diagram

Figure 1 is a block diagram of the MPC565.

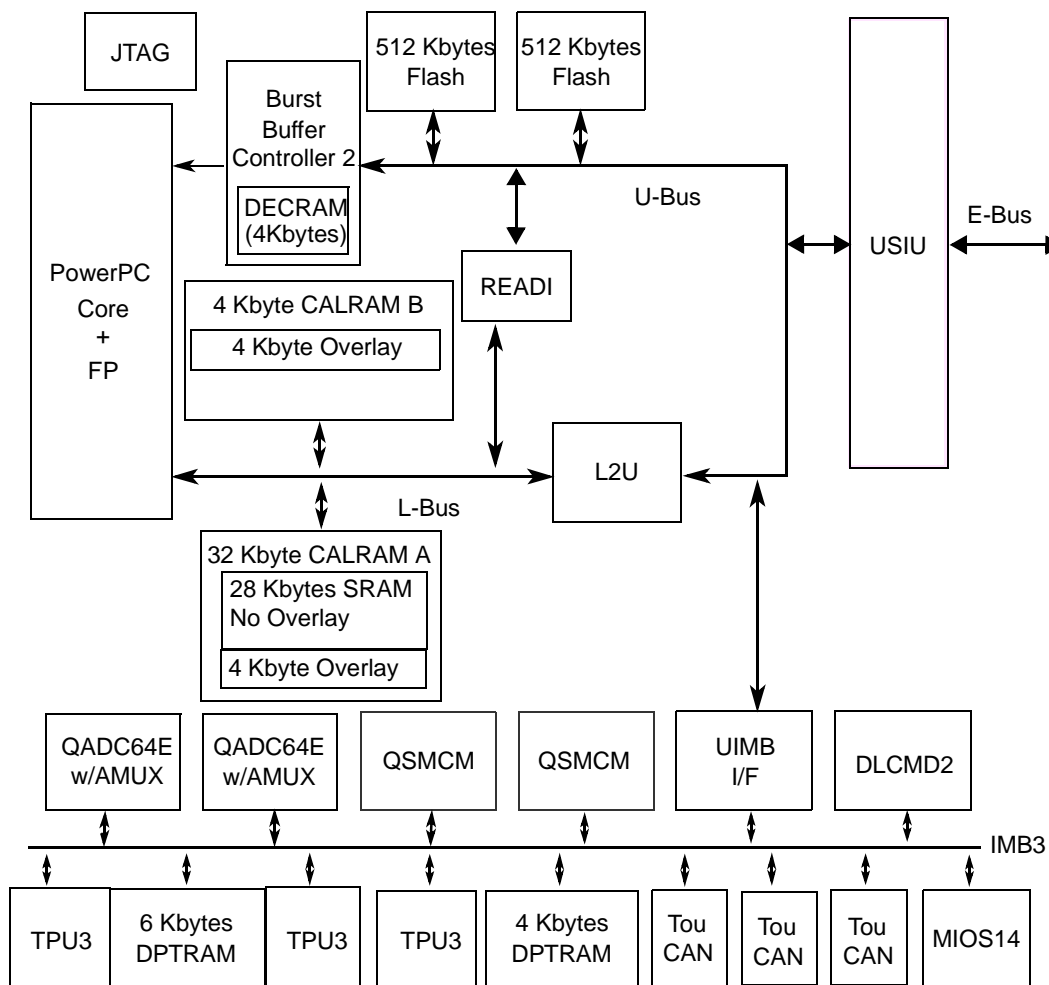


Figure 1. MPC565 Block Diagram

1.2 Detailed Feature List

The MPC565 key features are explained in the following sections.

1.2.1 High Performance CPU System

- Fully static design
- Four major power saving modes
 - On, doze, sleep, deep-sleep and power-down

1.2.2 RISC MCU Central Processing Unit (RCPU)

- High-performance core
 - PowerPC single issue integer core
 - Precise exception model
 - Floating point
 - Code compression (MPC566 only)
 - Compression reduces usage of internal or external Flash memory
 - Compression optimized for automotive (non-cached) applications
 - New compression scheme decreases code size to 40% –50% of source

1.2.3 MPC500 System Interface (USIU)

- MPC500 system interface (USIU, BBC, L2U)
- Periodic interrupt timer, bus monitor, clocks, decremter and time base
- Clock synthesizer, power management, reset controller
- External bus tolerates 5-V inputs, provides 2.6-V outputs
- Enhanced interrupt controller supports a separate interrupt vector for up to eight external and 40 internal interrupts
- IEEE 1149.1 JTAG test access port
- Bus supports multiple master designs
- USIU supports dual-mapping of Flash to move part of internal Flash memory to external bus for development
- External bus, supporting non-wraparound burst for instruction fetches, with up to 8 instructions per memory cycle

1.2.4 Burst Buffer Controller (BBC) Module

- Exception vector table relocation features allow exception table to be relocated to following locations:
 - 0x0000 0000 - 0x0000 1FFF (normal MPC500 exception table location)
 - 0x0001 0000 - 0x0001 1FFF (0 + 64 Kbytes; second page of internal Flash)
 - Second internal Flash module
 - Internal SRAM
 - 0x0FFF_0100 (external memory space; normal MPC500 exception table location)

1.2.5 Flexible Memory Protection Unit

- Flexible memory protection units in BBC (IMPU) and L2U (DMPU)
- Default attributes available in one global entry
- Attribute support for speculative accesses

1.2.6 Memory Controller

- Flexible chip selects via memory controller
- 24-bit address and 32-bit data buses
- 4- to 16-Mbyte (data) or 4-Gbyte (instruction) region size support
- Four-beat transfer bursts, two-clock minimum bus transactions
- Use with SRAM, EPROM, Flash and other peripherals
- Byte selects or write enables
- 32-bit address decodes with bit masks
- Four instruction regions
- Four data regions

1.2.7 1 Mbyte of CDR3 Flash EEPROM Memory (UC3F)

- 1 Mbyte Flash
 - Two UC3F modules, 512 Kbytes each
- Page mode read
- Block (64-Kbyte) erasable
- External 4.75- to 5.25-V VPP program and erase power supply
- Typical endurance of 100,000 write/erase cycles @ 25°C
- Typical data retention of 100 years @ 25°C

1.2.8 36-Kbyte Static RAM (CALRAM)

- 36-Kbyte static calibration RAM
 - Composed of 4-Kbyte and 32-Kbyte CALRAM modules
- Fast access: one clock
- Keep-alive power
- Soft defect detection (SDD)
- 4 Kbyte calibration (overlay) RAM per module (8 Kbytes total)
- Eight 512-byte overlay regions per module (16 regions total)

1.2.9 General Purpose I/O Support (GPIO)

- General-purpose I/O support
- Address (24) and data (32) pins can be used as GPIO in single-chip mode
- 16 GPIO in MIOS14
- Many peripheral pins can be used as GPIO when not used as primary functions
- 5-V outputs with slew rate control

1.2.10 Debug Features

- Extensive system debug support
- On-chip watchpoints and breakpoints
- Program flow tracking
- Background debug mode (BDM)

1.2.10.1 Nexus Debug Port (Class 3)

- Nexus/IEEE – ISTO 5001-1999 debug port (Class 3)
- Nine- or 16-pin interface

1.2.10.2 Message Data Link Controller (DLCMD2) Module

- Two pins muxed with QSMCMB pins. Muxing controlled by QSMCMB PCS3 pin assignment register
- SAE J1850 Class B data communications network interface compatible and ISO compatible for low-speed (<125 Kbps) serial data communications in automotive applications
- 10.4 Kbps variable pulse width (VPW) bit format
- Digital noise filter, collision detection
- Hardware cyclical redundancy check (CRC) generation and checking
- Block mode receive and transmit supported
- 4x receive mode supported (41.6 Kbps)
- Digital loopback mode
- In-frame response (IFR) types 0, 1, 2, and 3 supported
- Dedicated register for symbol timing adjustments
- Inter-module bus 3 (IMB3) slave interface
- Power-saving IMB3 stop mode with automatic wakeup on network activity
- Power-saving IMB3 CLOCKDIS mode
- Debug mode available through IMB3 FREEZE signal or user controllable SOFT_FRZ bit
- Polling and IMB3 interrupt generation with vector lookup available

1.2.11 Integrated I/O System

- True 5-V I/O

1.2.11.1 Time Processor Units (TPU3)

- Three time processing units (TPU3)
 - 16 channels each
- Each TPU3 is a microcoded timer subsystem
- One 6-Kbyte and one 4-Kbyte dual-port TPU RAM (DPTRAM), one (6-Kbyte) shared by two TPU3 modules for TPU microcode and the 4-Kbyte dedicated to the third TPU3 for microcode.

1.2.11.2 22-Channel Modular I/O System (MIOS14)

- 22-channel MIOS timer (MIOS14)
- Six modulus counter submodules (MCSM)
 - Four additional MCSM submodules compared to MIOS1
- 10 double action submodules (DASM).
- 12 dedicated PWM submodules (PWMSM)
 - Four additional PWM submodules compared to MIOS1 (shared with MIOS GPIO pins)
- MIOS real-time clock submodule (MRTCOSM) provides low power clock/counter
 - Requires external 32-KHz crystal
 - Uses four pins: two for 32-KHz crystal, two for power/ground.

1.2.12 Two Enhanced Queued Analog-to-Digital Converter Modules (QADC64E)

- Two enhanced queued analog to digital converters (QADC64E A, QADC64E B) with AMUXes for 40 total analog channels.
- 10 bit A/D converter with internal sample/hold
 - Typical conversion time is 4 μ s (250-Kbyte samples/sec)
 - Two conversion command queues of variable length
- Automated queue modes initiated by:
 - External edge trigger/level gate
 - Software command
 - Periodic/interval timer, assignable to both queue 1 and 2
- 64 result registers in each QADC64E module
 - Output data is right or left justified, signed or unsigned
- Synchronized clock mode allows both QADC64Es to see the same conversion clock. This allows the two modules to look like one large QADC with four queues.
- Conversions alternate reference (ALTREF) pin. This pin can be connected to a different reference voltage

1.2.13 Three CAN 2.0B Controller (TouCAN) Modules

- Three TouCAN modules (TouCAN_A, TouCAN_B, and TouCAN_C)
- 16 message buffers each, programmable I/O modes
- Maskable interrupts
- Programmable loopback for self-test operation
- Independent of the transmission medium (external transceiver is assumed)
- Open network architecture, multimaster concept
- High immunity to EMI
- Short latency time for high-priority messages
- Low power sleep mode, with programmable wake up on bus activity
- TouCAN_C pins shared with MIOS14 GPIO pins

1.2.14 Queued Serial Multi-Channel Modules (QSMCM)

- Two queued serial modules with one queued-SPI and two SCI each (QSMCM_A, QSMCM_B)
 - QSMCM_A matches full MPC555 QSMCM functionality
 - QSMCM_B has pins muxed with DLCMD2 module
 - Two pins are muxed with DLCMD2 (J1850) transmit and receive pins (B_PCS3_J1850_TX and B_RXD2_J1850_RX)
 - QSMCM B vs J1850 mux control provided by QPAPCS3 bit in QSMCM pin assignment register (PQSPAR)
- Queued-SPI
 - Provides full-duplex communication port for peripheral expansion or interprocessor communication
 - Up to 32 preprogrammed transfers, reducing overhead
 - Synchronous serial interface with baud rate of up to system clock / 4
 - Four programmable peripheral-select pins support up to 16 devices
 - Special wrap-around mode allows continuous sampling of a serial peripheral for efficient interfacing to serial analog-to-digital (A/D) converters
- SCI
 - UART mode provides NRZ format and half- or full-duplex interface
 - 16 register receive buffer and 16 register transmit buffer on one SCI
 - Advanced error detection, and optional parity generation and detection
 - Word length programmable as 8 or 9 bits
 - Separate transmitter and receiver enable bits, and double buffering of data
 - Wake-up functions allow the CPU to run uninterrupted until either a true idle line is detected, or a new address byte is received

1.2.15 Electrical Specifications and Packaging

- 40 MHz operation (56 MHz operation is optional for the MPC566)
- -40°C – 125°C ambient temperature, -40°C – 85°C for suffix C device, -55°C– 125°C for suffix A devices
- 2.6 V \pm 0.1 V external bus
 - External bus is compatible with external memory devices operating from 2.5 V to 3.4 V.
 - Extended voltage range (2.7 – 3.4 V) degrades data drive timing by 1.1 ns on data writes.
- 2.6 \pm 0.1 V internal logic
- 5-V I/O (5.0 \pm 0.25 V)
- Available in package or bumped die
- Plastic ball grid array (PBGA) packaging
 - 388 ball PBGA
 - 27 mm x 27 mm body size
- 1.0 mm ball pitch

1.3 MPC565 Optional Features

The following features of the MPC565 are optional features and may not appear in certain configurations:

- 56-MHz operation (40-MHz is default)
- MPC566 supports code compression

2 Differences between the MPC565 and the MPC555

The MPC565 is an enhanced version of the MPC555. Most functional features of the MPC555 are unchanged on the MPC565. Table 2 shows the high level differences.

Table 2. Differences Between Modules of the MPC555 and the MPC565

Module	MPC555	MPC565
CPU Core	No Change	
BBC	BBC	BBC with improved code compression ¹
L2U	No Change	
SRAM	26-Kbytes	36-Kbyte CALRAM with overlay features
Flash	448-Kbyte CMF	1-Mbyte UC3F (new programming, etc.)
USIU	USIU	USIU with enhanced interrupt controller
JTAG	No Change	
READI	None	New Module
UIMB	No Change	
QADC64	2 QADC64 (16 channels on each QADC for 32 total channels)	2 QADC64E w/AMUXes (40 channels accessible from either QADC64E)
QSMCM	(1) No Change (2)	
DLCMD2 (J1850)	None	1
MIOS	MIOS1	MIOS14: MIOS1 with real-time clock (MRTC SM), 4 more PWMSMs and 4 more MCSMs
TouCAN	(2) No Change (3)	
TPU3	(2) No Change (3)	
DPTRAM	(6-Kbytes) No Change (6-Kbytes, 4-Kbytes)	
Power Supplies		
—	40 MHz with two power supplies: nominal 3.3-V to 5.0-V power supplies	56 MHz with two power supplies: 5.0-V I/O, 2.6-V internal logic

¹ Available on some options.

2.1 Additional MPC565 Differences

The following are additional differences between the MPC555 and the MPC565.

- SPI (MISO, MOSI, and SCK) pin drive.
 - MPC565 provides 21-ns rise/fall with 200-pf load using CMOS (20%/70%) levels
- GPIO on MODCK1 pin outputs only 2.6 V
 - MODCK1 pin is in keep-alive power section with no 5-V rail available
 - 5.0-V compatibility modes
 - Input is 5-V friendly
 - 2.6-V output has less slew rate control
 - 2.6-V: V_{OH} = 2.3 V
- Power supplies for external bus pins
 - QVDDL is quiet supply to hold non-switching outputs quiet even when noisy supply (NVDDL) sags
 - QVDDL supplies pre-drive and other pad logic
 - NVDDL only supplies final PMOS driver stage
 - QVDDL and NVDDL shorted on customer board after filtering
- Pull-up and pull-down changes during PORESET and HRESET
 - All 2.6-V/5-V pads (external bus: address/data/control) pull down at reset
 - All 5-V pads pull up at reset
 - Additional control granularity in the PDMCR register
- No pull-ups on QSMCM SCI receive pads
- A_RXD1_QGPI1, A_RXD2_QGPI2, B_RXD1_QGPI1 pins do not have weak pull-up during reset or any other time
- CLKOUT has 3 drive strength options
 - Better matches drive to requirements to reduce EMI
 - 25, 50, 100 pf instead of 45 and 90 pf
- Change reset value of ENGCLK to maximum divide (crystal/128)
 - For a 4-MHz crystal, this is 31.25 KHz
 - ENGCLK is selectable between 2.6 V and 5 V
- A daisy chain between UC3F modules allows either module to provide the reset configuration word (RCW)
- Censorship operation
 - A RCW bit controls whether or not the entire UC3F can be erased while censorship is violated
- BBC SPRs (PPC regs) access in two clocks instead of one clock
- CALRAM internal protection block size is 8 Kbytes
 - Instead of 4 Kbytes on MPC555 LRAM
- CALRAM causes machine check exception instead of data storage interrupt (DSI) exception in certain cases
 - For non-overlay CPU core accesses, a DSI exception is taken
 - For overlay accesses and any non-core access (slave mode), a machine check exception is taken

- CALRAM causes DSI exception only if the data relocation (DR) bit in the core machine state register, MSR[DR], is set.
 - L2U on MPC555 already followed this protocol, but the LRAM did not. Now all L-bus peripherals follow this protocol.
 - The MSR[DR] bit is described in the reference manual for more information.
- Four additional PRDS control bits were added to the USIU to allow more granularity of PRDS control on a part
- BBC includes a 4-Kbyte DECRAM that can be used if compression is not used or is not available.

3 SRAM Keep-Alive Power Behavior

The SRAM has three keep-alive power pins (VDDSRAM1, VDDSRAM2, and VDDSRAM3). These pins provide keep-alive power to the SRAM arrays in the CALRAM modules and the DPTRAM modules.

The VDDSRAM1 pin powers the 32-Kbyte CALRAM A during keep-alive while power is off to the MPC565 (except for the keep-alive power supplies). CALRAM A keeps all of its 32 Kbytes powered during power down.

The VDDSRAM2 pin powers the 4-Kbyte CALRAM B module. The VDDSRAM3 pin powers the DPTRAM modules during keep-alive as well as during normal operation. The CALRAM modules only power their arrays from the VDDSRAM pins during keep-alive. During normal operation, they are powered by the normal internal VDD of the part.

The DPTRAM modules (6 Kbytes and 4 Kbytes) and the 4-Kbyte DECRAM in the BBC module power their arrays via the VDDSRAM3 pin during keep-alive and are supplied by VDD during normal operation.

4 MPC565 Memory Map

The internal memory map is organized as a single 4-Mbyte block. This is shown in Figure 3. This block can be moved to one of eight different locations. The internal memory space is divided into the following sections:

- Flash memory (1 Mbyte) — U-bus memory
- Static RAM memory (36 Kbytes CALRAM) — L-bus memory
- Control registers and IMB3 modules (64 Kbytes), partitioned as
 - USIU and flash control registers
 - UIMB interface and IMB3 modules
 - CALRAM and READI control registers (L-bus control register space)

The internal memory block can reside in one of eight possible 4-Mbyte memory spaces. These eight locations are the first eight 4-Mbyte memory blocks starting with address 0x0000 0000, as shown in Figure 2. There is a user programmable register in the USIU to configure the internal memory map to one of the eight possible locations. Programmability of internal memory map location allows multiple chip system.

The IMB3 address space block in Figure 3 shows memory allocation for IMB3 modules. It does not show the actual memory space required for individual modules. All modules are mapped to the low address, numerically, of the memory allocated for that module in the IMB3 address space.

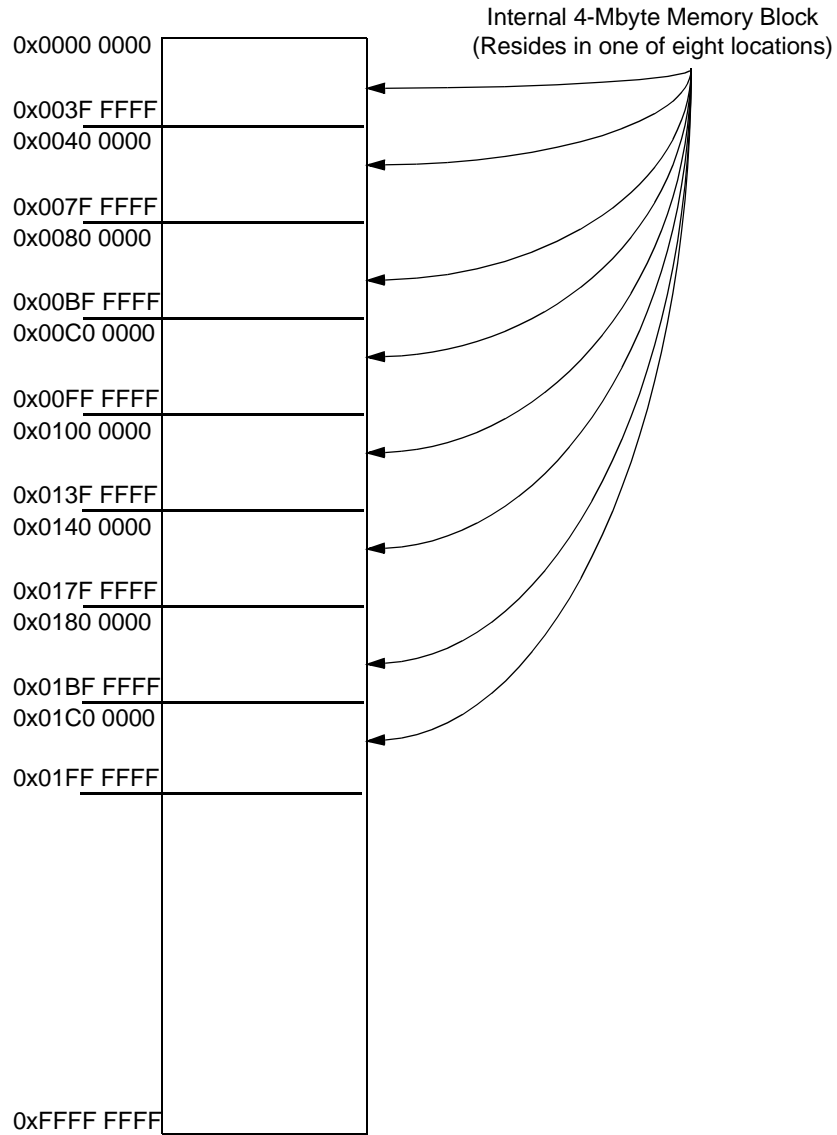


Figure 2. Memory Map

0x00 0000	UC3F_A Flash 512 Kbytes	USIU Control Registers	0x2F C000
0x07 FFFF			
0x08 0000	UC3F_B Flash 512 Kbytes		UC3F_A Control (64 bytes)
0x0F FFFF		UC3F_B Control (64 bytes)	0x2F C840
0x10 0000	Reserved for Flash (2,016 Kbytes)		0x2F C87F
0x2F 7FFF		DPTRAM_AB Registers (64 bytes)	0x30 0000
0x2F 8000	DECRAM 4 Kbytes	DPTRAM_C Registers (64 bytes)	0x30 0040
0x2F 8FFF		DLCMD2 (16 bytes)	0x30 0080
0x2F 9000	Reserved	Reserved (3952 bytes)	0x30 0090
0x2F 9FFF			
0x2F A000	BBC Control Registers 8 Kbytes	DPTRAM_C (4 Kbytes)	0x30 1000
0x2F BFFF		DPTRAM_AB (6 Kbytes)	0x30 2000
0x2F C000	USIU & Flash Control 16 Kbytes	Reserved (2 Kbytes)	0x30 3800
0x2F FFFF		TPU3_A (1 Kbytes)	0x30 4000
0x30 0000	UIMB I/F & IMB Modules 32 Kbytes	TPU3_B (1 Kbytes)	0x30 4400
0x30 7FFF		QADC64_A (1 Kbytes)	0x30 4800
0x30 8000	Reserved for IMB 480 Kbytes	QADC64_B (1 Kbytes)	0x30 4C00
0x37 FFFF		QSMCM_A (1 Kbytes)	0x30 5000
0x38 0000	CALRAM/ Readi Control 256 bytes	QSMCM_B (1 Kbytes)	0x30 5400
0x38 00FF		Reserved (1 Kbytes)	0x30 5800
0x38 0100	Reserved (L-bus Control) ~32 Kbytes	TPU3_C (1 Kbytes)	0x30 5C00
0x38 3FFF		MIOS14 (4 Kbytes)	0x30 6000
0x38 4000	Reserved (L-bus Mem) 444 Kbytes	TOUCAN_A (1 Kbytes)	0x30 7000
0x3F 6FFF		TOUCAN_B (1 Kbytes)	0x30 7400
0x3F 7000	All 4-Kbytes can be Overlay Section	TOUCAN_C (1 Kbytes)	0x30 7800
0x3F 7FFF	CALRAM_B (4 Kbyte)	Reserved (896 bytes)	0x30 7900
0x3F 8000		UIMB Control Registers (128 bytes)	0x30 7F80
	CALRAM_A (32 Kbyte)		0x30 7FFF
0x3F FFFF	4-Kbyte Overlay Section		

Figure 3. Internal Memory Block

5 MPC565 Pinout Diagram

Figure 4 shows the pinout for the MPC565.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
A	ANV_B_PCB0	VDD	VRL	ANB	ANB0	ANB_A_PCB1	ANB_A_PCB0	ANB_A_PCB1	VSSA	ANV_B_PCB1	ANV_B_PCB0	ANV_B_PCB1	ANV_B_PCB0	ODDL	A_TRU00	A_TRU01	A_TRU02	A_TRU03	A_TRU04	A_TRU05	A_TRU06	A_TRU07	A_TRU08	A_TRU09	VSS
B	VSS	ANV_A_PCB1	ALTRF	ANB	ANB1	ANV_A_PCB0	ANV_A_PCB1	ANV_A_PCB0	ANV_A_PCB1	ANV_B_PCB1	ANV_B_PCB0	ANV_B_PCB1	ANV_B_PCB0	ODDL	ETR02	ETR03	ETR04	ETR05	ETR06	ETR07	ETR08	ETR09	ETR10	VDD	
C	VDRTC	VSS	VDD	ANV_A_PCB1	ANB	ANV_A_PCB0	ANV_A_PCB1	ANV_A_PCB0	ANV_A_PCB1	ANV_B_PCB1	ANV_B_PCB0	ANV_B_PCB1	ANV_B_PCB0	ODDL	ETR01	B_CNTR0	ETR06	ETR07	ETR08	ETR09	ETR10	ETR11	ETR12	VDD	
D	EXTAL32	VDRSMR2	VSS	VDD	ANB6	ANV_A_PCB1	ANV_A_PCB0	ANV_A_PCB1	ANV_A_PCB0	ANV_B_PCB1	ANV_B_PCB0	ANV_B_PCB1	ANV_B_PCB0	ODDL	VDDH	A_TRU05	A_TRU06	A_TRU07	A_TRU08	A_TRU09	A_TRU10	A_TRU11	A_TRU12	VDD	
E	XTAL32	B_CNTR0	VDRSMR1	VSS																				VDD	
F	VSRBTC	C_TRU04	C_TRU05	MODL																				MDA13	
G	C_TRU08	C_TRU09	C_TRU10	VDRSAM0																				MDA14	
H	C_TRU14	C_TRU15	C_TRU16	C_TRU17																				MDA15	
J	C_TRU18	C_TRU19	C_TRU20	C_TRU21																				MDA16	
K	C_TRU22	C_TRU23	C_TRU24	C_TRU25																				MDA17	
L	MDL0	TRC_DSEK	MDL1	MDL2																				MDA18	
M	TALDSS	EVTL_B	RSTL_B	INSEL_B																				MDA19	
N	TRIS	MDL0	MDL1	MDL2																				MDA20	
P	MDL3	JCOMP	MCKO	MDL0																				MDA21	
R	MDL1	TRD_DSS0	MDL2	IMP1																				MDA22	
T	MDL3	MSIO_B	IMP1	FRZ																				MDA23	
U	SEPH016	SEPH017	SEPH018	SEPH019	SEPH020	SEPH021	SEPH022	SEPH023	SEPH024	SEPH025	SEPH026	SEPH027	SEPH028	SEPH029	SEPH030	SEPH031	SEPH032	SEPH033	SEPH034	SEPH035	SEPH036	SEPH037	SEPH038	SEPH039	
V	SEPH040	SEPH041	SEPH042	SEPH043	SEPH044	SEPH045	SEPH046	SEPH047	SEPH048	SEPH049	SEPH050	SEPH051	SEPH052	SEPH053	SEPH054	SEPH055	SEPH056	SEPH057	SEPH058	SEPH059	SEPH060	SEPH061	SEPH062	SEPH063	
W	SEPH064	SEPH065	SEPH066	SEPH067	SEPH068	SEPH069	SEPH070	SEPH071	SEPH072	SEPH073	SEPH074	SEPH075	SEPH076	SEPH077	SEPH078	SEPH079	SEPH080	SEPH081	SEPH082	SEPH083	SEPH084	SEPH085	SEPH086	SEPH087	
Y	SEPH088	SEPH089	SEPH090	SEPH091	SEPH092	SEPH093	SEPH094	SEPH095	SEPH096	SEPH097	SEPH098	SEPH099	SEPH100	SEPH101	SEPH102	SEPH103	SEPH104	SEPH105	SEPH106	SEPH107	SEPH108	SEPH109	SEPH110	SEPH111	
AA	SEPH112	SEPH113	SEPH114	SEPH115	SEPH116	SEPH117	SEPH118	SEPH119	SEPH120	SEPH121	SEPH122	SEPH123	SEPH124	SEPH125	SEPH126	SEPH127	SEPH128	SEPH129	SEPH130	SEPH131	SEPH132	SEPH133	SEPH134		
AB	SEPH135	SEPH136	SEPH137	SEPH138	SEPH139	SEPH140	SEPH141	SEPH142	SEPH143	SEPH144	SEPH145	SEPH146	SEPH147	SEPH148	SEPH149	SEPH150	SEPH151	SEPH152	SEPH153	SEPH154	SEPH155	SEPH156	SEPH157		
AC	SEPH158	SEPH159	SEPH160	SEPH161	SEPH162	SEPH163	SEPH164	SEPH165	SEPH166	SEPH167	SEPH168	SEPH169	SEPH170	SEPH171	SEPH172	SEPH173	SEPH174	SEPH175	SEPH176	SEPH177	SEPH178	SEPH179	SEPH180		
AD	SEPH181	SEPH182	SEPH183	SEPH184	SEPH185	SEPH186	SEPH187	SEPH188	SEPH189	SEPH190	SEPH191	SEPH192	SEPH193	SEPH194	SEPH195	SEPH196	SEPH197	SEPH198	SEPH199	SEPH200	SEPH201	SEPH202	SEPH203		
AE	SEPH204	SEPH205	SEPH206	SEPH207	SEPH208	SEPH209	SEPH210	SEPH211	SEPH212	SEPH213	SEPH214	SEPH215	SEPH216	SEPH217	SEPH218	SEPH219	SEPH220	SEPH221	SEPH222	SEPH223	SEPH224	SEPH225	SEPH226		
AF	SEPH227	SEPH228	SEPH229	SEPH230	SEPH231	SEPH232	SEPH233	SEPH234	SEPH235	SEPH236	SEPH237	SEPH238	SEPH239	SEPH240	SEPH241	SEPH242	SEPH243	SEPH244	SEPH245	SEPH246	SEPH247	SEPH248	SEPH249		

NOTE: This is a top down view of the balls.

VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS	VSS
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