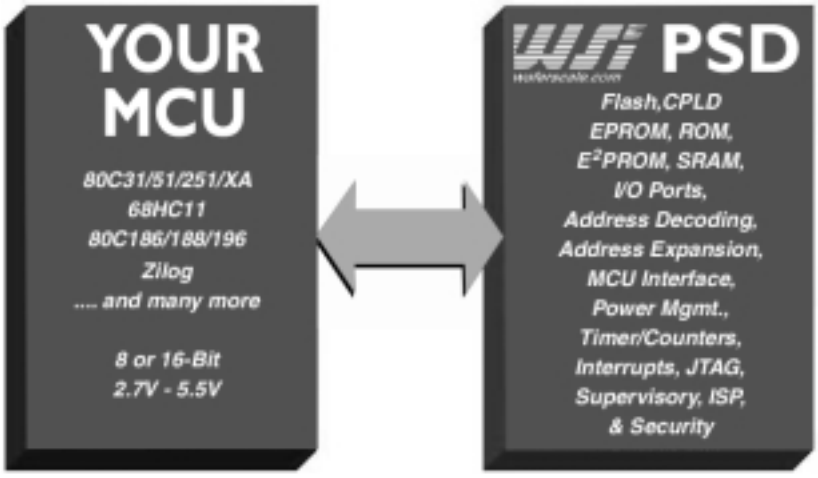
Revision A Flash PSD
PSD813F2-A PSD813F3-A
PSD813F4-A PSD813F5-A

PSD833F2 PSD834F2
PSD853F2 PSD854F2
Flash In-System-Programmable Microcontroller Peripherals

"ZPSD For Free" – All of the power saving features of our ZPSD family have been integrated into the standard Rev. A PSD813, PSD833F2, and PSD834F2.

November, 2000
Preliminary Information



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PSD8XXF2 PSD8XXF3
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Flash In-System-Programmable Microcontroller Peripherals

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Programmable Peripheral

PSD813F2-A, PSD813F3-A
PSD813F4-A, PSD813F5-A

PSD833F2, PSD834F2
PSD853F2, PSD854F2

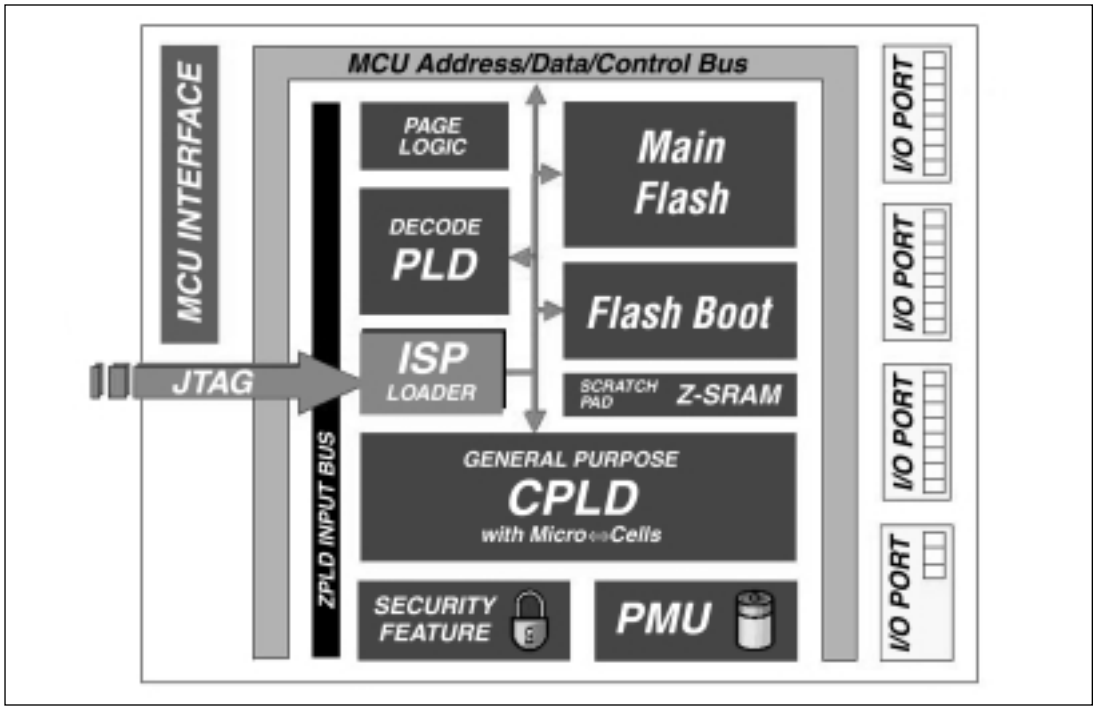
Flash In-System-Programmable Microcontroller Peripherals

Preliminary Information

1.0 Introduction

The PSD8XXF family of Programmable Microcontroller (MCU) Peripherals brings In-System-Programmability (ISP) to Flash memory and programmable logic. The result is a simple and flexible solution for embedded designs. PSD8XXF devices combine many of the peripheral functions found in MCU based applications:

- Up to 2 Mbit of Flash memory
- A second Flash Boot memory
- Over 3,000 gates of Flash programmable logic
- Up to 256 Kbit SRAM
- Reconfigurable I/O ports
- Programmable power management.



PSD8XXF devices integrate an optimized "**micro**controller macro**cell**" logic architecture called the Micro⇔Cell™. The Micro⇔Cell was created to address the unique requirements of embedded system designs. It allows direct connection between the system address/data bus and the internal PSD registers to simplify communication between the MCU and other supporting devices.

1.0 Introduction (Cont.)

The PSD8XXF family includes a JTAG serial programming interface to allow in-system-programming of the **entire device**. This feature reduces development time, simplifies the manufacturing flow, and dramatically lowers the cost of field upgrades. Using ST's special Fast-JTAG programming, a design can be programmed into the PSD8XXF in as little as seven seconds.

The innovative Flash PSD8XXF family solves key problems faced by designers when managing discrete Flash memory devices, such as:

- First-time programming
- Complex address decoding
- Simultaneous read and write to Flash.

The PSD8XXF's serial JTAG interface allows in-system-programming and eliminates the need for a boot EPROM or an external programmer. To simplify Flash updates, the devices perform program execution out of a Flash Boot block while the main Flash memory is being updated. This solution avoids the complicated overhead circuitry and software necessary to implement in-system Flash memory updates.

PSDsoft — ST's software development tool — now has the ability to generate ANSI-C compliant code for use with your target MCU. The code generated allows you to manipulate the non-volatile memory (NVM) within the PSD. Code examples are also provided for:

- Flash ISP via the UART of the host MCU
- Memory paging to execute code across several PSD memory pages
- Loading, reading, and manipulation of PSD Micro⇔Cells by the MCU

The PSD8XXF is available in 52-pin PLCC and PQFP package, and a 64-pin plastic Thin Quad Flatpack (TQFP) package.

2.0 Key Features

❑ A simple interface to 8-bit microcontrollers that use either multiplexed or non-multiplexed busses. The bus interface logic uses the control signals generated by the microcontroller automatically when the address is decoded and a read or write is performed. A partial list of the MCU families supported include:

- Intel 8031, 80196, 80186, 80C251, and 80386EX
- Motorola 68HC11, 68HC16, 68HC12, and 683XX
- Philips 8031 and 8051XA
- Zilog Z80 and Z8

❑ Internal 1 or 2 Mbit Flash memory. This is the main Flash memory. It is divided into eight equal-sized blocks that can be accessed with user-specified addresses.

❑ Internal secondary 256 Kbit Flash boot memory. It is divided into four equal-sized blocks that can be accessed with user-specified addresses. This secondary memory brings the ability to execute code and update the main Flash **concurrently.**

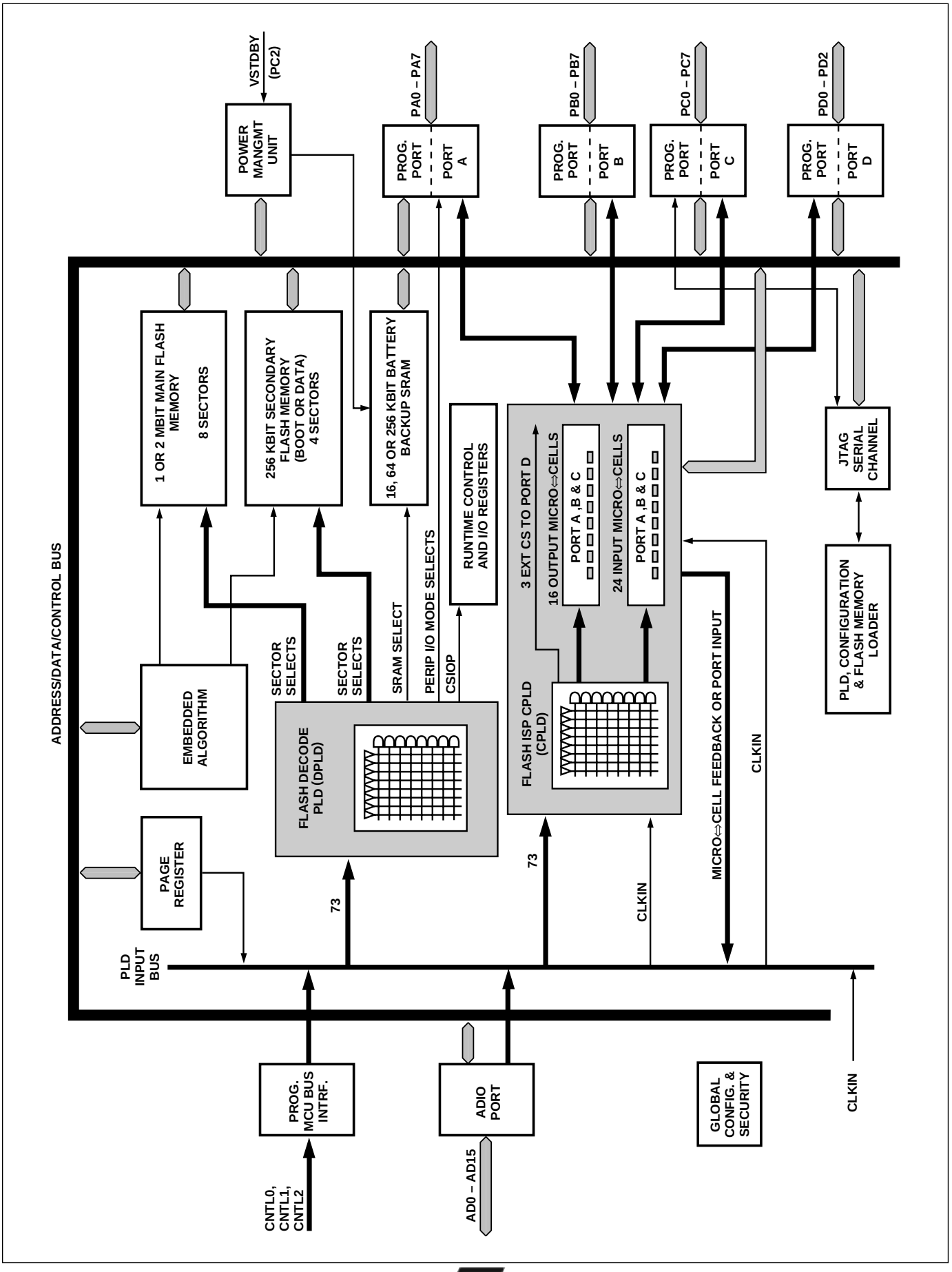
❑ Optional 16, 64 or 256 Kbit SRAM. The SRAM's contents can be protected from a power failure by connecting an external battery.

Please refer to the revision block at the end of this document for updated information.

2.0 Key Features (cont.)

- ❑ CPLD with 16 Output Micro⇔Cells (OMCs) and 24 Input Micro⇔Cells (IMCs). The CPLD may be used to efficiently implement a variety of logic functions for internal and external control. Examples include state machines, loadable shift registers, and loadable counters.
- ❑ Decode PLD (DPLD) that decodes address for selection of internal memory blocks.
- ❑ 27 individually configurable I/O port pins that can be used for the following functions:
  - MCU I/Os
  - PLD I/Os
  - Latched MCU address output
  - Special function I/Os.
  - 16 of the I/O ports may be configured as open-drain outputs.
- ❑ Standby current as low as 50 µA for 5 V devices.
- ❑ Built-in JTAG compliant serial port allows full-chip In-System Programmability (ISP). With it, you can program a blank device or reprogram a device in the factory or the field.
- ❑ Internal page register that can be used to expand the microcontroller address space by a factor of 256.
- ❑ Internal programmable Power Management Unit (PMU) that supports a low power mode called Power Down Mode. The PMU can automatically detect a lack of microcontroller activity and put the PSD8XXF into Power Down Mode.
- ❑ Erase/Write cycles:
  - Flash memory – 100,000 minimum
  - PLD – 1,000 minimum
  - Data Retention: 15 year minimum (for Main Flash, Boot, PLD and Configuration bits)

Figure 1. PSD8XXF Block Diagram



3.0 General Information

The PSD8XXF series architecture allows In-System Programming of all Memory, PLD Logic and Device Configuration. The embedded Input and Output Micro⇔Cells enable efficient implementation of user defined logic functions that require both software and hardware interaction. The devices eliminate the need for discrete 'glue' logic, and allow the development of entire systems using only a few highly integrated devices.

4.0 PSD8XXF Family

There are 5 variants in the PSD8XXF family. All PSD8XXF devices provide these base features: 1 or 2 Mbit main Flash Memory, JTAG port, CPLD, DPLD, power management, and 27 I/O pins. The following table summarizes all the devices in the PSD8XXF family.

Table 1. PSD8XXF Product Matrix

Part #		I/O Pins	No. of Micro⇔Cells Input/Output	Serial ISP JTAG/ISC Port	Flash Main Memory Kbit (8 Sectors)	Flash Boot Memory Kbit (4 Sectors)	SRAM Kbit	Turbo Mode
PSD8XXF Family	Device							
PSD8XXFX	PSD813F2	27	24/16	Yes	1024	256	16	Yes
	PSD813F3	27	24/16	Yes	1024	none	16	Yes
	PSD813F4	27	24/16	Yes	1024	256	none	Yes
	PSD813F5	27	24/16	Yes	1024	none	none	Yes
	PSD833F2	27	24/16	Yes	1024	256	64	Yes
	PSD834F2	27	24/16	Yes	2048	256	64	Yes
	PSD853F2	27	24/16	Yes	1024	256	256	Yes
	PSD854F2	27	24/16	Yes	2048	256	256	Yes

5.0 PSD8XXF Architectural Overview

PSD8XXF devices contain several major functional blocks. Figure 1 on page 3 shows the architecture of the PSD8XXF device family. The functions of each block are described briefly in the following sections. Many of the blocks perform multiple functions and are user configurable.

5.1 Memory

The PSD8XXF contains the following memories:

- A 1 or 2 Mbit Flash
- A secondary 256 Kbit Flash boot memory
- An optional 16, 64 or 256 Kbit SRAM.

Each of the memories is briefly discussed in the following paragraphs. A more detailed discussion can be found in section 9.

The 1 or 2 Mbit Flash is the main memory of the PSD8XXF. It is divided into eight equally-sized sectors that are individually selectable.

The 256 Kbit Flash Boot memory is divided into four equally-sized sectors. Each sector is individually selectable.

The optional SRAM is intended for use as a scratchpad memory or as an extension to the microcontroller SRAM. If an external battery is connected to the PSD8XXF's Vstby pin, data will be retained in the event of a power failure.

Each block of memory can be located in a different address space as defined by the user. The access times for all memory types includes the address latching and DPLD decoding time.

5.2 Page Register

The eight-bit Page Register expands the address range of the microcontroller by up to 256 times.The paged address can be used as part of the address space to access external memory and peripherals or internal memory and I/O. The Page Register can also be used to change the address mapping of blocks of Flash memory into different memory spaces for in-circuit reprogramming.

5.3 PLDs

The device contains two PLD blocks, each optimized for a different function, as shown in Table 2. The functional partitioning of the PLDs reduces power consumption, optimizes cost/performance, and eases design entry.

The Decode PLD (DPLD) is used to decode addresses and generate chip selects for the PSD8XXF internal memory and registers. The CPLD can implement user-defined logic functions. The DPLD has combinatorial outputs. The CPLD has 16 Output Micro⇔Cells and 3 combinatorial outputs. The PSD8XXF also has 24 Input Micro⇔Cells that can be configured as inputs to the PLDs. The PLDs receive their inputs from the PLD Input Bus and are differentiated by their output destinations, number of Product Terms, and Micro⇔Cells.

The PLDs consume minimal power by using Zero-Power design techniques. The speed and power consumption of the PLD is controlled by the Turbo Bit in the PMMR0 register and other bits in the PMMR2 registers. These registers are set by the microcontroller at runtime. There is a slight penalty to PLD propagation time when invoking the non-Turbo bit.

Table 2. PLD I/O Table

Name	Abbreviation	Inputs	Outputs	Product Terms
Decode PLD	DPLD	73	17	42
Complex PLD	CPLD	73	19	140

PSD8XXF Architectural Overview (cont.)

5.4 I/O Ports

The PSD8XXF has 27 I/O pins divided among four ports (Port A, B, C, and D). Each I/O pin can be individually configured for different functions. Ports A, B, C and D can be configured as standard MCU I/O ports, PLD I/O, or latched address outputs for microcontrollers using multiplexed address/data busses.

The JTAG pins can be enabled on Port C for In-System Programming (ISP).

Ports A and B can also be configured as a data port for a non-multiplexed bus.

5.5 Microcontroller Bus Interface

The PSD8XXF easily interfaces with most 8-bit microcontrollers that have either multiplexed or non-multiplexed address/data busses. The device is configured to respond to the microcontroller's control signals, which are also used as inputs to the PLDs. Section 9.3.5 contains microcontroller interface examples.

5.6 JTAG Port

In-System Programming can be performed through the JTAG pins on Port C. This serial interface allows complete programming of the entire PSD8XXF device. A blank device can be completely programmed. The JTAG signals (TMS, TCK, $\overline{\text{TSTAT}}$, $\overline{\text{TERR}}$, TDI, TDO) can be multiplexed with other functions on Port C. Table 3 indicates the JTAG signals pin assignments.

Table 3. JTAG Signals on Port C

Port C Pins	JTAG Signal
PC0	TMS
PC1	TCK
PC3	$\overline{\text{TSTAT}}$
PC4	$\overline{\text{TERR}}$
PC5	TDI
PC6	TDO

PSD8XXF Architectural Overview (cont.)

5.7 In-System Programming

Using the JTAG signals on Port C, the entire PSD8XXF device can be programmed or erased without the use of the microcontroller. The main Flash memory can also be programmed in-system by the microcontroller executing the programming algorithms out of the Flash Boot memory, or SRAM. The Flash Boot memory can be programmed the same way by executing out of the main Flash memory. The PLD logic or other PSD8XXF configuration can be programmed through the JTAG port or a device programmer. Table 4 indicates which programming methods can program different functional blocks of the PSD8XXF.

Table 4. Methods of Programming Different Functional Blocks of the PSD8XXF

Functional Block	JTAG Programming	Device Programmer	In-System Parallel Programming
Main Flash memory	Yes	Yes	Yes
Flash Boot memory	Yes	Yes	Yes
PLD Array (DPLD and CPLD)	Yes	Yes	No
PSD Configuration	Yes	Yes	No

5.8 Power Management Unit

The Power Management Unit (PMU) in the PSD8XXF gives the user control of the power consumption on selected functional blocks based on system requirements. The PMU includes an Automatic Power Down unit (APD) that will turn off device functions due to microcontroller inactivity. The APD unit has a Power Down Mode that helps reduce power consumption.

The PSD8XXF also has some bits that are configured at run-time by the MCU to reduce power consumption of the CPLD. The turbo bit in the PMMR0 register can be turned off and the CPLD will latch its outputs and go to sleep until the next transition on its inputs. Additionally, bits in the PMMR2 register can be set by the MCU to block signals from entering the CPLD to reduce power consumption. See section 9.5.

6.0 Development System

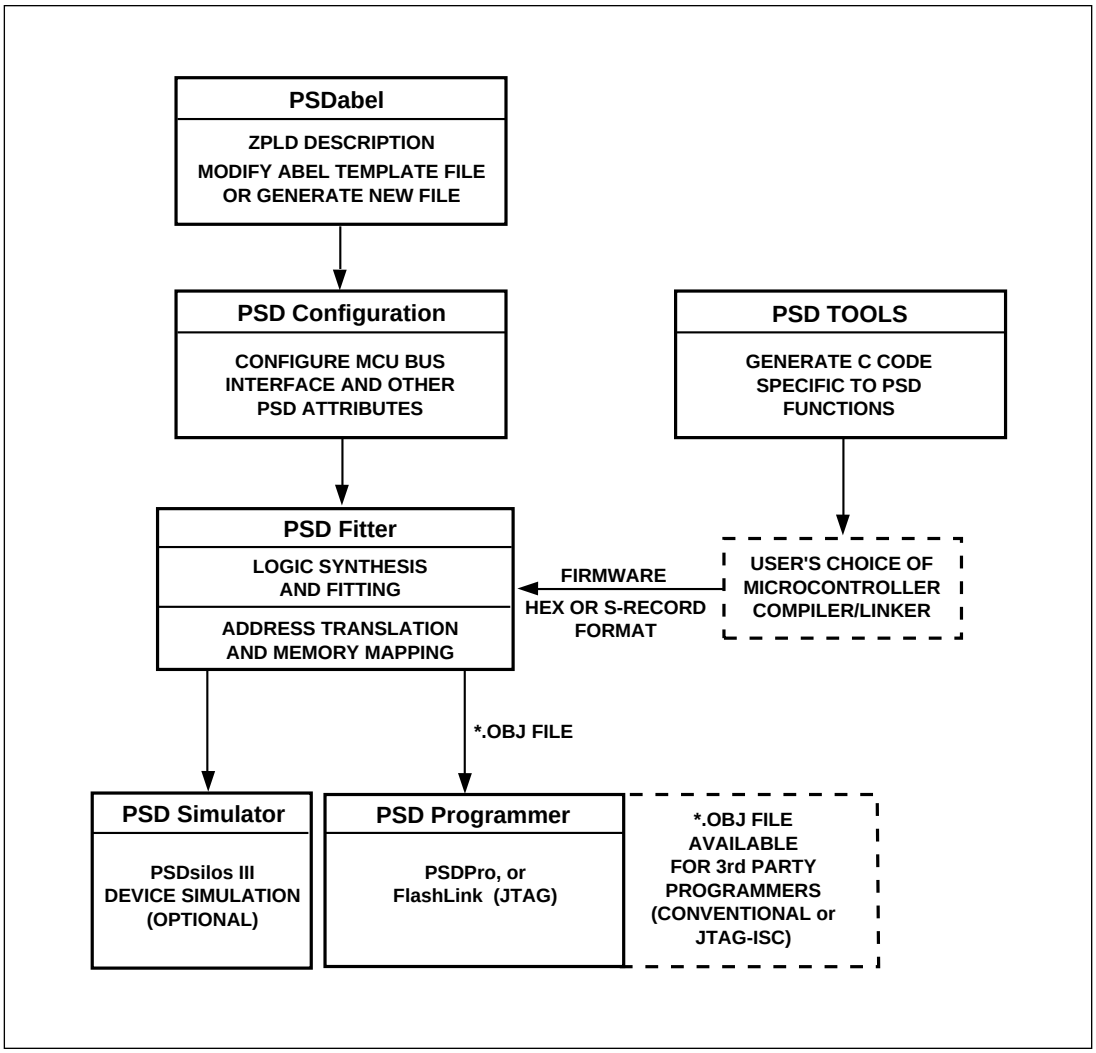
The PSD8XXF family is supported by the Windows-based PSDsoft Development System. The PSDsoft design flow is shown in Figure 2. The PLD design entry is done using PSDabel, which creates a minimized logic implementation, and provides logic simulation of the PLDs. The PSD8XXF MCU Bus Interface and I/O Port configuration are entered in PSD Configuration.

PSDsoft can generate ANSI C functions specific to the PSD. The user can merge these C functions with their own, and then compile and link it using any embedded C compiler on the market.

PSD Fitter is comprised of a fitter and address translator. It generates a programming data file (.obj) based on PSD configuration data, the PSDabel file, and the microcontroller firmware. The object file can be downloaded to a programmer or to PSD Simulator for device-level simulation.

PSDsoft offers direct support for two ST device programmers, PSDpro, and FlashLink (JTAG). PSDsoft makes available a file to support third party programmers. The *.obj file is in Intel hex format, and is compatible with conventional device programmers.

Figure 2. PSDsoft Development Tools



7.0 Table 5. PSD8XXF Pin Descriptions

The following table describes the pin names and pin functions of the PSD8XXF. Pins that have multiple names and/or functions are defined using PSD Configuration.

Pin Name	Pin*	Type	Description
ADIO0-7	30-37	I/O	This is the lower Address/Data port. Connect your MCU address or address/data bus according to the following rules: 1. If your MCU has a multiplexed address/data bus where the data is multiplexed with the lower address bits, connect AD[0:7] to this port. 2. If your MCU does not have a multiplexed address/data bus, or you are using an 80C251 in page mode, connect A[0:7] to this port. 3. If you are using an 80C51XA in burst mode, connect A4/D0 through A11/D7 to this port. ALE or AS latches the address. The PSD drives data out only if the read signal is active and one of the PSD functional blocks was selected. The addresses on this port are passed to the PLDs.
ADIO8-15	39-46	I/O	This is the upper Address/Data port. Connect your MCU address or address/data bus according to the following rules: 1. If your MCU has a multiplexed address/data bus where the data is multiplexed with the lower address bits, connect A[8:15] to this port. 2. If your MCU does not have a multiplexed address/data bus, connect A[8:15] to this port. 3. If you are using an 80C251 in page mode, connect AD[8:15] to this port. 4. If you are using an 80C51XA in burst mode, connect A12/D8 through A19/D15 to this port. ALE or AS latches the address. The PSD drives data out only if the read signal is active and one of the PSD functional blocks was selected. The addresses on this port are passed to the PLDs.
CNTL0	47	I	The following control signals can be connected to this port, based on your MCU: 1. $\overline{WR}$ — active-low write input. 2. R_$\overline{W}$ — active-high read/active low write input. This pin is connected to the PLDs. Therefore, these signals can be used in decode and other logic equations.
CNTL1	50	I	The following control signals can be connected to this port, based on your MCU: 1. $\overline{RD}$ — active-low read input. 2. E — E clock input. 3. $\overline{DS}$ — active-low data strobe input. 4. $\overline{PSEN}$ — connect PSEN to this port when it is being used as an active-low read signal. For example, when the 80C251 outputs more than 16 address bits, PSEN is actually the read signal. This pin is connected to the PLDs. Therefore, these signals can be used in decode and other logic equations.

Table 5. PSD8XXF Pin Descriptions (cont.)

Pin Name	Pin*	Type	Description
CNTL2	49	I	This pin can be used to input the $\overline{PSEN}$ (Program Select Enable) signal from any MCU that uses this signal for code exclusively. If your MCU does not output a Program Select Enable signal, this port can be used as a generic input. This port is connected to the PLDs.
$\overline{Reset}$	48	I	Active low reset input. Resets I/O Ports, PLD Micro⇔Cells and some of the configuration registers. Must be active at power up.
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7	29 28 27 25 24 23 22 21	I/O	These pins make up Port A. These port pins are configurable and can have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellAB0-7) outputs. 3. Inputs to the PLDs. 4. Latched address outputs (see Table 6). 5. Address inputs. For example, PA0-3 could be used for A[0:3] when using an 80C51XA in burst mode. 6. As the data bus inputs D[0:7] for non-multiplexed address/data bus MCUs. 7. D0/A16-D3/A19 in M37702M2 mode. 8. Peripheral I/O mode. **Note:** PA0-3 can only output CMOS signals with an option for high slew rate. However, PA4-7 can be configured as CMOS or Open Drain Outputs.
PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7	7 6 5 4 3 2 52 51	I/O	These pins make up Port B. These port pins are configurable and can have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellAB0-7 or McellBC0-7) outputs. 3. Inputs to the PLDs. 4. Latched address outputs (see Table 6). **Note:** PB0-3 can only output CMOS signals with an option for high slew rate. However, PB4-7 can be configured as CMOS or Open Drain Outputs.
PC0	20	I/O	PC0 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC0) output. 3. Input to the PLDs. 4. TMS Input** for the JTAG Interface. This pin can be configured as a CMOS or Open Drain output.
PC1	19	I/O	PC1 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC1) output. 3. Input to the PLDs. 4. TCK Input** for the JTAG Interface. This pin can be configured as a CMOS or Open Drain output.

Table 5. PSD8XXF Pin Descriptions (cont.)

Pin Name	Pin*	Type	Description
PC2	18	I/O	PC2 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC2) output. 3. Input to the PLDs. 4. Vstby — SRAM standby voltage input for SRAM battery backup. This pin can be configured as a CMOS or Open Drain output.
PC3	17	I/O	PC3 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC3) output. 3. Input to the PLDs. 4. $\overline{\text{TSTAT}}$ output** for the JTAG interface. 5. Rdy/Bsy output for in-system parallel programming. This pin can be configured as a CMOS or Open Drain output.
PC4	14	I/O	PC4 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC4) output. 3. Input to the PLDs. 4. $\overline{\text{TERR}}$ output** for the JTAG interface. 5. Vbaton — battery backup indicator output. Goes high when power is being drawn from an external battery. This pin can be configured as a CMOS or Open Drain output.
PC5	13	I/O	PC5 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC5) output. 3. Input to the PLDs. 4. TDI input** for the JTAG interface. This pin can be configured as a CMOS or Open Drain output.
PC6	12	I/O	PC6 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC6) output. 3. Input to the PLDs. 4. TDO output** for the JTAG interface. This pin can be configured as a CMOS or Open Drain output.

Table 5. PSD8XXF Pin Descriptions (cont.)

Pin Name	Pin*	Type	Description
PC7	11	I/O	PC7 pin of Port C. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. CPLD Micro⇔Cell (McellBC7) output. 3. Input to the PLDs. 4. DBE — active-low Data Byte Enable input from 68HC912 type MCUs. This pin can be configured as a CMOS or Open Drain output.
PD0	10	I/O	PD0 pin of Port D. This port pin can be configured to have the following functions: 1. ALE/AS input latches address output from the MCU. 2. MCU I/O — write or read from a standard output or input port. 3. Input to the PLDs. 4. CPLD output (external chip select).
PD1	9	I/O	PD1 pin of Port D. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. Input to the PLDs. 3. CPLD output (external chip select). 4. CLKIN — clock input to the CPLD Micro⇔Cells, the automatic power-down unit's power-down counter, and the CPLD AND array.
PD2	8	I/O	PD2 pin of Port D. This port pin can be configured to have the following functions: 1. MCU I/O — write to or read from a standard output or input port. 2. Input to the PLDs. 3. CPLD output (external chip select). 4. $\overline{CSI}$ — chip select input. When low, the MCU can access the PSD memory and I/O. When high, the PSD memory blocks are disabled to conserve power.
V_{CC}	15, 38		Power pins
GND	1,16,26		Ground pins

*The pin numbers in this table are for the PLCC package only. See the package information section for pin numbers on other package types.

**These functions can be multiplexed with other functions.

Table 6. I/O Port Latched Address Output Assignments*

Microcontroller	Port A		Port B	
	Port A (3:0)	Port A (7:4)	Port B (3:0)	Port B (7:4)
8051XA (8-bit)	N/A	Address [7:4]	Address [11:8]	N/A
80C251 (page mode)	N/A	N/A	Address [11:8]	Address [15:12]
All other 8-bit multiplexed	Address [3:0]	Address [7:4]	Address [3:0]	Address [7:4]
8-bit non-multiplexed bus	N/A	N/A	Address [3:0]	Address [7:4]

N/A = Not Applicable

*Refer to the I/O Port Section on how to enable the Latched Address Output function.

8.0 PSD8XXF Register Description and Address Offset

Table 7 shows the offset addresses to the PSD8XXF registers relative to the CSIOP base address. The CSIOP space is the 256 bytes of address that is allocated by the user to the internal PSD8XXF registers. Table 7 provides brief descriptions of the registers in CSIOP space. For a more detailed description, refer to section 9.

Table 7. Register Address Offset

Register Name	Port A	Port B	Port C	Port D	Other*	Description
Data In	00	01	10	11		Reads Port pin as input, MCU I/O input mode
Control	02	03				Selects mode between MCU I/O or Address Out
Data Out	04	05	12	13		Stores data for output to Port pins, MCU I/O output mode
Direction	06	07	14	15		Configures Port pin as input or output
Drive Select	08	09	16	17		Configures Port pins as either CMOS or Open Drain on some pins, while selecting high slew rate on other pins.
Input Micro⇔Cell	0A	0B	18			Reads Input Micro⇔Cells
Enable Out	0C	0D	1A	1B		Reads the status of the output enable to the I/O Port driver
Output Micro⇔Cells AB	20	20				Read – reads output of Micro⇔Cells AB Write – loads Micro⇔cell Flip-Flops
Output Micro⇔Cells BC		21	21			Read – reads output of Micro⇔Cells BC Write – loads Micro⇔cell Flip-Flops
Mask Micro⇔Cells AB	22	22				Blocks writing to the Output Micro⇔Cells AB
Mask Micro⇔Cells BC		23	23			Blocks writing to the Output Micro⇔Cells BC
Flash Protection					C0	Read only – Flash Sector Protection
Flash Boot Protection					C2	Read only – PSD Security and Flash Boot Sector Protection
JTAG Enable					C7	Enables JTAG Port
PMMR0					B0	Power Management Register 0
PMMR2					B4	Power Management Register 2
Page					E0	Page Register
VM					E2	Places PSD memory areas in Program and/or Data space on an individual basis.

*Other registers that are not part of the I/O ports.

9.0 The PSD8XXF Functional Blocks

As shown in Figure 1, the PSD8XXF consists of six major types of functional blocks:

- ❑ **Memory Blocks**
- ❑ **PLD Blocks**
- ❑ **Bus Interface**
- ❑ **I/O Ports**
- ❑ **Power Management Unit**
- ❑ **JTAG Interface**

The functions of each block are described in the following sections. Many of the blocks perform multiple functions, and are user configurable.

9.1 Memory Blocks

The PSD8XXF has the following memory blocks:

- The main Flash memory
- Flash boot memory
- Optional SRAM.

The memory select signals for these blocks originate from the Decode PLD (DPLD) and are user-defined in PSDsoft.

Table 8 summarizes which versions of the PSD8XXF contain which memory blocks.

Table 8. Memory Blocks

Device	Main Flash		Flash Boot Block		SRAM
	Flash Size	Sector Size	Block Size	Sector Size	
PSD813F2	128KB	16KB	32KB	8KB	2KB
PSD813F3	128KB	16KB	none	–	2KB
PSD813F4	128KB	16KB	32KB	8KB	none
PSD813F5	128KB	16KB	none	–	none
PSD833F2	128KB	16KB	32KB	8KB	8KB
PSD834F2	256KB	32KB	32KB	8KB	8KB
PSD853F2	128KB	16KB	32KB	8KB	32KB
PSD854F2	256KB	32KB	32KB	8KB	32KB

9.1.1 Main Flash and Flash Boot Memory Description

The main Flash memory block is divided evenly into eight sectors. The Flash Boot memory is divided into four sectors of eight Kbytes each. Each sector of either memory can be separately protected from program and erase operations.

Flash memory may be erased on a sector-by-sector basis and programmed byte-by-byte. Flash sector erasure may be suspended while data is read from other sectors of memory and then resumed after reading.

During a program or erase of Flash, the status can be output on the Rdy/Bsy pin of Port C3. This pin is set up using PSDsoft Configuration.

The PSD8XXF Functional Blocks (cont.)

9.1.1.1 Memory Block Selects

The decode PLD in the PSD8XXF generates the chip selects for all the internal memory blocks (refer to the PLD section). Each of the eight Flash memory sectors have a Flash Select signal (FS0-FS7) which can contain up to three product terms. Each of the four Flash Boot memory sectors have a Select signal (CSBOOT0-3) which can contain up to three product terms. Having three product terms for each sector select signal allows a given sector to be mapped in different areas of system memory. When using a microcontroller with separate Program and Data space, these flexible select signals allow dynamic re-mapping of sectors from one space to the other.

9.1.1.2 The Ready/Busy Pin (PC3)

Pin PC3 can be used to output the Ready/Busy status of the PSD8XXF. The output on the pin will be a '0' (Busy) when Flash memory blocks are being written to, **or** when the Flash memory block is being erased. The output will be a '1' (Ready) when no write or erase operation is in progress.

9.1.1.3 Memory Operation

The main Flash and Flash Boot memories are addressed through the microcontroller interface on the PSD8XXF device. The microcontroller can access these memories in one of two ways:

- The microcontroller can execute a typical bus write or read **operation** just as it would if accessing a RAM or ROM device using standard bus cycles.
- The microcontroller can execute a specific **instruction** that consists of several write and read operations. This involves writing specific data patterns to special addresses within the Flash to invoke an embedded algorithm. These instructions are summarized in Table 9.

Typically, Flash memory can be read by the microcontroller using read operations, just as it would read a ROM device. However, Flash memory can only be erased and programmed with specific instructions. For example, the microcontroller cannot write a single byte directly to Flash memory as one would write a byte to RAM. To program a byte into Flash memory, the microcontroller must execute a program instruction sequence, then test the status of the programming event. This status test is achieved by a read operation or polling the Rdy/Busy pin (PC3).

The Flash memory can also be read by using special instructions to retrieve particular Flash device information (sector protect status and ID).

The PSD8XXF Functional Blocks (cont.)

9.1.1.3.1 Instructions

An instruction is defined as a sequence of specific operations. Each received byte is sequentially decoded by the PSD and not executed as a standard write operation. The instruction is executed when the correct number of bytes are properly received and the time between two consecutive bytes is shorter than the time-out value. Some instructions are structured to include read operations after the initial write operations.

The sequencing of any instruction must be followed exactly. Any invalid combination of instruction bytes or time-out between two consecutive bytes while addressing Flash memory will reset the device logic into a read array mode (Flash memory reads like a ROM device).

The PSD8XXF main Flash and Boot Flash support these instructions (see Table 9):

- ❑ Erase memory by chip or sector
- ❑ Suspend or resume sector erase
- ❑ Program a byte
- ❑ Reset to read array mode
- ❑ Read Main Flash Identifier value
- ❑ Read sector protection status
- ❑ Bypass Instruction (PSD833/834/853/854F only)

These instructions are detailed in Table 9. For efficient decoding of the instructions, the first two bytes of an instruction are the coded cycles and are followed by a command byte or confirmation byte. The coded cycles consist of writing the data AAh to address X555h during the first cycle and data 55h to address XAAAh during the second cycle. Address lines A15-A12 are don't care during the instruction write cycles. However, the appropriate sector select signal (FSi or CSBOOTi) must be selected.

The main Flash and the Flash Boot Block have the same set of instructions (except Read main Flash ID). The chip selects of the Flash memory will determine which Flash will receive and execute the instruction. The main Flash is selected if any one of the FS0-7 is active, and the Flash Boot Block is selected if any one of the CS BOOT0-3 is active.

The PSD8XXF Functional Blocks (cont.)

Table 9. Instructions

Instruction	FS0-7 or CSBOOT0-3	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle5	Cycle 6	Cycle 7
Read (Note 5)	1	"Read" RA RD						
Read Main Flash ID (Notes 6,13)	1	AAh @555h	55h @AAAh	90h @555h	"Read" ID @x01h			
Read Sector Protection (Notes 6,8,13)	1	AAh @555h	55h @AAAh	90h @555h	"Read" 00h or 01h @x02h			
Program a Flash Byte	1	AAh @555h	55h @AAAh	A0h @555h	PD@PA			
Erase One Flash Sector	1	AAh @555h	55h @AAAh	80h @555h	AAh @555h	55h @AAAh	30h @SA	30h @next SA (Note 7)
Erase Flash Block (Bulk Erase)	1	AAh @555h	55h @AAAh	80h @555h	AAh @555h	55h @AAAh	10h @555h	
Suspend Sector Erase (Note 11)	1	B0h @xxxh						
Resume Sector Erase (Note 12)	1	30h @xxxh						
Reset (Note 6)	1	F0 @ any address						
Unlock Bypass (Note 14)	1	AAh @555h	55h @AAAh	20h @555h				
Unlock Bypass Program (Note 9,14)	1	A0h @xxxh	PD@PA					
Unlock Bypass Reset (Note 10,14)	1	90h @xxxh	00h @xxxh					

X = Don't Care.
RA = Address of the memory location to be read.
RD = Data read from location RA during read operation.
PA = Address of the memory location to be programmed. Addresses are latched on the falling edge of the WR# (CNTL0) pulse.
PD = Data to be programmed at location PA. Data is latched o the rising edge of WR# (CNTL0) pulse.
SA = Address of the sector to be erased or verified. The chip select (FS0-7 or CSBOOT0-3) of the sector to be erased must be active (high).

NOTES:
1. All bus cycles are write bus cycle except the ones with the "read" label.
2. All values are in hexadecimal.
3. FS0-7 and CSBOOT0-3 are active high and are defined in PSDsoft.
4. Only Address bits A11-A0 are used in Instruction decoding. A15-12 (or A16-A12) are don't care.
5. No unlock or command cycles required when device is in read mode.
6. The Reset command is required to return to the read mode after reading the Flash ID, Sector Protect status or if DQ5 (error flag) goes high.
7. Additional sectors to be erased must be entered within 80µs.
8. The data is 00h for an unprotected sector and 01h for a protected sector. In the fourth cycle, the sector chip select is active and (A1 = 1, A0 = 0).
9. The Unlock Bypass command is required prior to the Unlock Bypass Program command.
10. The Unlock Bypass Reset command is required to return to reading array data when the device is in the Unlock Bypass mode.
11. The system may read and program functions in non-erasing sectors, read the Flash ID or read the Sector Protect status, when in the Erase Suspend mode. The erase Suspend command is valid only during a sector erase operation.
12. The Erase Resume command is valid only during the Erase Suspend mode.
13. The MCU cannot invoke these instructions while executing code from the same Flash memory for which the instruction is intended. The MCU must fetch, for example, codes from the Boot block when reading the Sector Protection Status of the main Flash.
14. Available to PSD833/834/853/854F devices only.

The PSD8XXF Functional Blocks (cont.)

9.1.1.4 Power-Up Condition

The PSD8XXF internal logic is reset upon power-up to the read array mode. The FSi and CSBOOTi select signals, along with the write strobe signal, must be in the false state during power-up for maximum security of the data contents and to remove the possibility of a byte being written on the first edge of a write strobe signal. Any write cycle initiation is locked when V_{CC} is below VLKO.

9.1.1.5 Read

Under typical conditions, the microcontroller may read the Flash, or Flash Boot memories using read operations just as it would a ROM or RAM device. Alternately, the microcontoller may use read operations to obtain status information about a program or erase operation in progress. Lastly, the microcontroller may use instructions to read special data from these memories. The following sections describe these read functions.

9.1.1.5.1 Read the Contents of Memory

Main Flash and Flash Boot memories are placed in the read array mode after power-up, chip reset, or a Reset Flash instruction (see Table 9). The microcontroller can read the memory contents of main Flash or Flash Boot by using read operations any time the read operation is not part of an instruction sequence.

9.1.1.5.2 Read the Main Flash Memory Identifier

The main Flash memory identifier is read with an instruction composed of 4 operations: 3 specific write operations and a read operation (see Table 9). During the read operation, address bits A6, A1, and A0 must be 0,0,1, respectively, and the appropriate sector select signal (FSi) must be active. The PSD8XXF main Flash memory ID is E7h. (PSD833/834/853/854F) and E4h (PSD813FX).

9.1.1.5.3 Read the Flash Memory Sector Protection Status

The Flash memory sector protection status is read with an instruction composed of 4 operations: 3 specific write operations and a read operation (see Table 9). During the read operation, address bits A6, A1, and A0 must be 0,1,0, respectively, while the chip select (FSi or CSBOOTi) designates the Flash sector whose protection has to be verified. The read operation will produce 01h if the Flash sector is protected, or 00h if the sector is not protected.

The sector protection status for all NVM blocks (main Flash or Boot Flash) can also be read by the microcontroller accessing the Flash Protection and Flash Boot Protection registers in PSD I/O space. See section 9.1.1.9.1 for register definitions.

9.1.1.5.4 Read the Erase/Program Status Bits

The PSD8XXF provides several status bits to be used by the microcontroller to confirm the completion of an erase or programming instruction of Flash memory. These status bits minimize the time that the microcontroller spends performing these tasks and are defined in Table 10. The status bits can be read as many times as needed.

Table 10. Status Bits

	FSi/ CSBOOTi	DQ7	DQ6	DQ5	DQ4	DQ3	DQ2	DQ1	DQ0
Flash	V_{IH}	Data Polling	Toggle Flag	Error Flag	X	Erase Time-out	X	X	X

NOTES: 1. X = Not guaranteed value, can be read either 1 or 0.
2. DQ7-DQ0 represent the Data Bus bits, D7-D0.
3. FSi/CSBOOTi are active high.

For Flash memory, the microcontroller can perform a read operation to obtain these status bits while an erase or program instruction is being executed by the embedded algorithm. See section 9.1.1.7 for details.

The PSD8XXF Functional Blocks (cont.)

9.1.1.5.5 Data Polling Flag DQ7

When Erasing or Programming the Flash memory bit DQ7 outputs the complement of the bit being entered for Programming/Writing on DQ7. Once the Program instruction or the Write operation is completed, the true logic value is read on DQ7 (in a Read operation). Flash memory specific features:

- Data Polling is effective after the fourth Write pulse (for programming) or after the sixth Write pulse (for Erase). It must be performed at the address being programmed or at an address within the Flash sector being erased.
- During an Erase instruction, DQ7 outputs a '0'. After completion of the instruction, DQ7 will output the last bit programmed (it is a '1' after erasing).
- If the byte to be programmed is in a protected Flash sector, the instruction is ignored.
- If all the Flash sectors to be erased are protected, DQ7 will be set to '0' for about 100 µs, and then return to the previous addressed byte. No erasure will be performed.

9.1.1.5.6 Toggle Flag DQ6

The PSD8XXF offers another way for determining when the Flash memory Program instruction is completed. During the internal Write operation and when either the FSi or CSBOOTi is true, the DQ6 will toggle from '0' to '1' and '1' to '0' on subsequent attempts to read any byte of the memory.

When the internal cycle is complete, the toggling will stop and the data read on the Data Bus D0-7 is the addressed memory byte. The device is now accessible for a new Read or Write operation. The operation is finished when two successive reads yield the same output data. Flash memory specific features:

- The Toggle bit is effective after the fourth Write pulse (for programming) or after the sixth Write pulse (for Erase).
- If the byte to be programmed belongs to a protected Flash sector, the instruction is ignored.
- If all the Flash sectors selected for erasure are protected, DQ6 will toggle to '0' for about 100 µs and then return to the previous addressed byte.

9.1.1.5.7 Error Flag DQ5

During a correct Program or Erase, the Error bit will set to '0'. This bit is set to '1' when there is a failure during Flash byte programming, Sector erase, or Bulk Erase.

In the case of Flash programming, the Error Bit indicates the attempt to program a Flash bit(s) from the programmed state (0) to the erased state (1), which is not a valid operation. The Error bit may also indicate a timeout condition while attempting to program a byte.

In case of an error in Flash sector erase or byte program, the Flash sector in which the error occurred or to which the programmed byte belongs must no longer be used. Other Flash sectors may still be used. The Error bit resets after the Reset instruction.

9.1.1.5.8 Erase Time-out Flag DQ3

The Erase Timer bit reflects the time-out period allowed between two consecutive Sector Erase instructions. The Erase timer bit is set to '0' after a Sector Erase instruction for a time period of 100 µs + 20% unless an additional Sector Erase instruction is decoded. After this time period or when the additional Sector Erase instruction is decoded, DQ3 is set to '1'.

The PSD8XXF Functional Blocks (cont.)

9.1.1.6 Programming Flash Memory

Flash memory must be erased prior to being programmed. The MCU may erase Flash memory all at once or by-sector, but not byte-by-byte. A byte of Flash memory erases to all logic ones (FF hex), and its bits are programmed to logic zeros. Although erasing Flash memory occurs on a sector basis, programming Flash memory occurs on a byte basis.

The PSD8XXF main Flash and boot Flash memories require the MCU to send an instruction to program a byte or perform an erase function (see Table 9).

Once the MCU issues a Flash memory program or erase instruction, it must check for the status of completion. The embedded algorithms that are invoked inside the PSD8XXF support several means to provide status to the MCU. Status may be checked using any of three methods: Data Polling, Data Toggle, or the Ready/Busy output pin.

9.1.1.6.1 Data Polling

Polling on DQ7 is a method of checking whether a Program or Erase instruction is in progress or has completed. Figure 3 shows the Data Polling algorithm.

When the MCU issues a programming instruction, the embedded algorithm within the PSD8XXF begins. The MCU then reads the location of the byte to be programmed in Flash to check status. Data bit DQ7 of this location becomes the compliment of data bit 7of the original data byte to be programmed. The MCU continues to poll this location, comparing DQ7 and monitoring the Error bit on DQ5. When the DQ7 matches data bit 7 of the original data, and the Error bit at DQ5 remains ‘0’, then the embedded algorithm is complete.
If the Error bit at DQ5 is ‘1’, the MCU should test DQ7 again since DQ7 may have changed simultaneously with DQ5 (see Figure 3).

The Error bit at DQ5 will be set if either an internal timeout occurred while the embedded algorithm attempted to program the byte or if the MCU attempted to program a ‘1’ to a bit that was not erased (not erased is logic ‘0’).

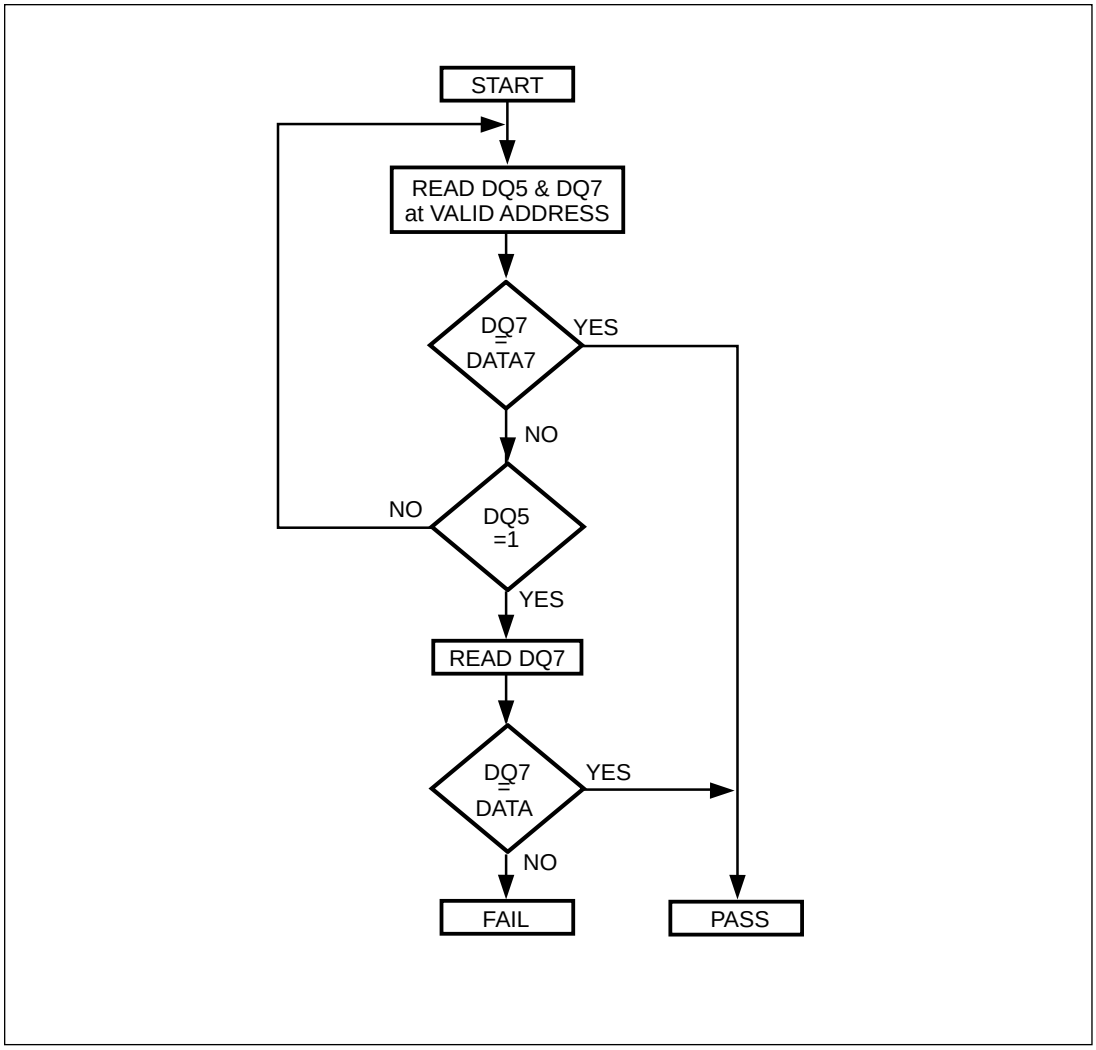
It is suggested (as with all Flash memories) to read the location again after the embedded programming algorithm has completed to compare the byte that was written to Flash with the byte that was intended to be written.

When using the Data Polling method after an erase instruction, Figure 3 still applies. However, DQ7 will be ‘0’ until the erase operation is complete. A ‘1’ on DQ5 will indicate a timeout failure of the erase operation, a ‘0’ indicates no error. The MCU can read any location within the sector being erased to get DQ7 and DQ5.

PSDsoft will generate ANSI C code functions which implement these Data Polling algorithms.

The PSD8XXF Functional Blocks (cont.)

Figure 3. Data Polling Flow Chart



9.1.1.6.2 Data Toggle

Checking the Data Toggle bit on DQ6 is a method of determining whether a Program or Erase instruction is in progress or has completed. Figure 4 shows the Data Toggle algorithm.

When the MCU issues a programming instruction, the embedded algorithm within the PSD8XXF begins. The MCU then reads the location of the byte to be programmed in Flash to check status. Data bit DQ6 of this location will toggle each time the MCU reads this location until the embedded algorithm is complete. The MCU continues to read this location, checking DQ6 and monitoring the Error bit on DQ5. When DQ6 stops toggling (two consecutive reads yield the same value), and the Error bit on DQ5 remains '0', then the embedded algorithm is complete. If the Error bit on DQ5 is '1', the MCU should test DQ6 again, since DQ6 may have changed simultaneously with DQ5 (see Figure 4).

The Error bit at DQ5 will be set if either an internal timeout occurred while the embedded algorithm attempted to program the byte, or if the MCU attempted to program a '1' to a bit that was not erased (not erased is logic '0').

The PSD8XXF Functional Blocks (cont.)

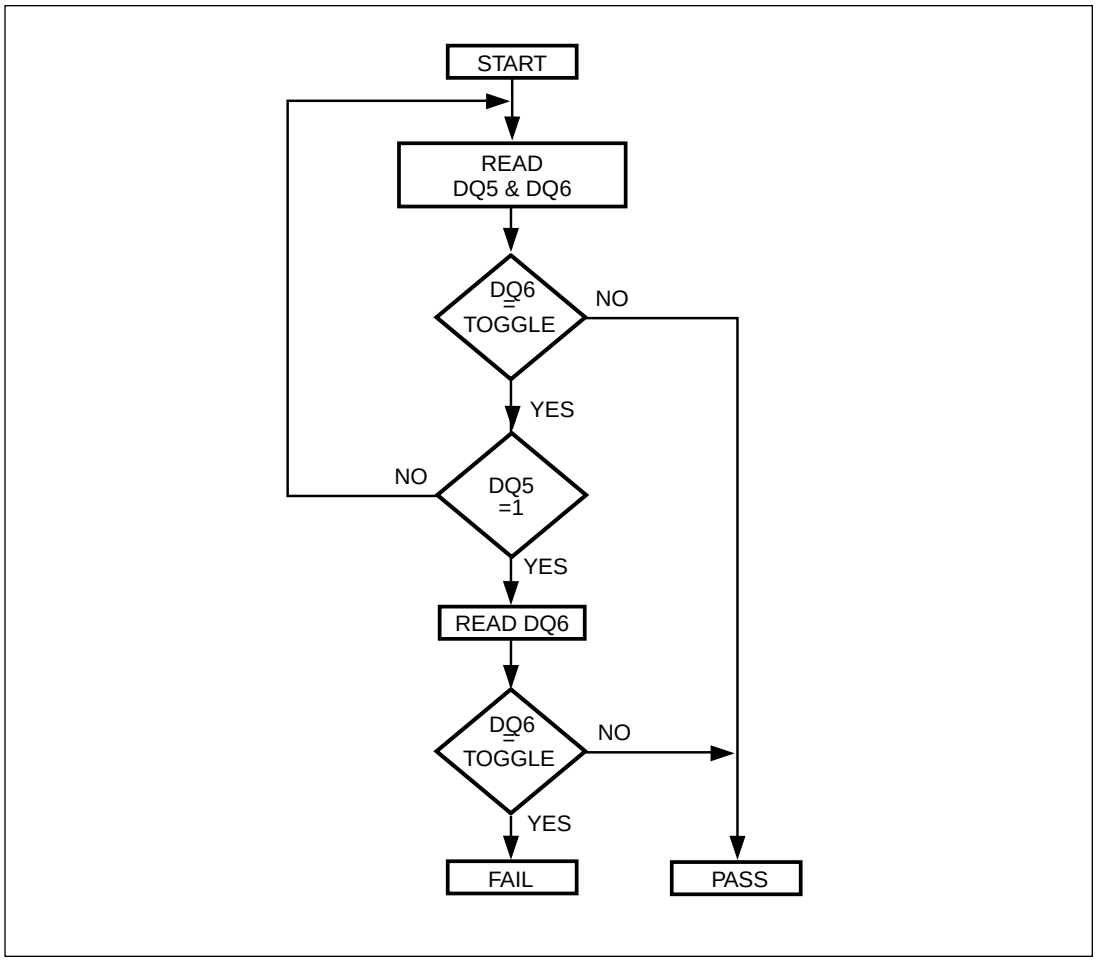
9.1.1.6.2 Data Toggle (cont.)

It is suggested (as with all Flash memories) to read the location again after the embedded programming algorithm has completed to compare the byte that was written to Flash with the byte that was intended to be written.

When using the Data Toggle method after an erase instructin, Figure 4 still applies. DQ6 will toggle until the erase operation is complete. A '1' on DQ5 will indicate a timeout failure of the erase operation, a '0' indicates no error. The MCU can read any location within the sector being erased to get DQ6 and DQ5.

PSDsoft will generate ANSI C code functions which implement these Data Toggling algorithms.

Figure 4. Data Toggle Flow Chart



The PSD8XXF Functional Blocks (cont.)

9.1.1.7 Unlock Bypass Instruction (PSD833/834/853/854F only)

The unlock bypass feature allows the system to program bytes to the flash memories faster than using the standard program instruction. The unlock bypass instruction is initiated by first writing two unlock cycles. This is followed by a third write cycle containing the unlock bypass command, 20h (see Table 9). The flash memory then enters the unlock bypass mode. A two-cycle Unlock Bypass Program instruction is all that is required to program in this mode. The first cycle in this instruction contains the unlock bypass programm command, A0h; the second cycle contains the program address and data. Additional data is programmed in the same manner. This mode dispenses with the initial two unlock cycles requiredc in the standard program instruction, resulting in faster total programming time. During the unlock bypass mode, only the Unlock Bypass Program and Unlock Bypass Reset instructions are valid. To exit the unlock bypass mode, the system must issue the two-cycle unlock bypass reset instruction. The first cycle must contain the data 90h; the second cycle the data 00h. Addresses are don't care for both cycles. The falsh memory then returns to reading array data mode.

9.1.1.8 Erasing Flash Memory

9.1.1.8.1. Flash Bulk Erase Instruction

The Flash Bulk Erase instruction uses six write operations followed by a Read operation of the status register, as described in Table 9. If any byte of the Bulk Erase instruction is wrong, the Bulk Erase instruction aborts and the device is reset to the Read Flash memory status.

During a Bulk Erase, the memory status may be checked by reading status bits DQ5, DQ6, and DQ7, as detailed in section 9.1.1.6. The Error bit (DQ5) returns a '1' if there has been an Erase Failure (maximum number of erase cycles have been executed).

It is not necessary to program the array with 00h because the PSD8XXF will automatically do this before erasing to 0FFh.

During execution of the Bulk Erase instruction, the Flash memory will not accept any instructions.

9.1.1.8.2 Flash Sector Erase Instruction

The Sector Erase instruction uses six write operations, as described in Table 9. Additional Flash Sector Erase confirm commands and Flash sector addresses can be written subsequently to erase other Flash sectors in parallel, without further coded cycles, if the additional instruction is transmitted in a shorter time than the timeout period of about 100 µs. The input of a new Sector Erase instruction will restart the time-out period.

The status of the internal timer can be monitored through the level of DQ3 (Erase time-out bit). If DQ3 is '0', the Sector Erase instruction has been received and the timeout is counting. If DQ3 is '1', the timeout has expired and the PSD8XXF is busy erasing the Flash sector(s). Before and during Erase timeout, any instruction other than Erase suspend and Erase Resume will abort the instruction and reset the device to Read Array mode. It is not necessary to program the Flash sector with 00h as the PSD8XXF will do this automatically before erasing (byte=FFh).

During a Sector Erase, the memory status may be checked by reading status bits DQ5, DQ6, and DQ7, as detailed in section 9.1.1.6.

During execution of the erase instruction, the Flash block logic accepts only Reset and Erase Suspend instructions. Erasure of one Flash sector may be suspended, in order to read data from another Flash sector, and then resumed.

The PSD8XXF Functional Blocks (cont.)

9.1.1.8.3 Flash Erase Suspend Instruction

When a Flash Sector Erase operation is in progress, the Erase Suspend instruction will suspend the operation by writing 0B0h to any address when an appropriate Chip Select (FSi or CSBOOTi) is true. (See Table 9). This allows reading of data from another Flash sector after the Erase operation has been suspended. Erase suspend is accepted only during the Flash Sector Erase instruction execution and defaults to read array mode. An Erase Suspend instruction executed during an Erase timeout will, in addition to suspending the erase, terminate the time out.

The Toggle Bit DQ6 stops toggling when the PSD8XXF internal logic is suspended. The toggle Bit status must be monitored at an address within the Flash sector being erased. The Toggle Bit will stop toggling between 0.1 µs and 15 µs after the Erase Suspend instruction has been executed. The PSD8XXF will then automatically be set to Read Flash Block Memory Array mode.

If an Erase Suspend instruction was executed, the following rules apply:

- Attempting to read from a Flash sector that was being erased will output invalid data.
- Reading from a Flash sector that was **not** being erased is valid.
- The Flash memory **cannot** be programmed, and will only respond to Erase Resume and Reset instructions (read is an operation and is OK).
- If a Reset instruction is received, data in the Flash sector that was being erased will be invalid.

9.1.1.8.4 Flash Erase Resume Instruction

If an Erase Suspend instruction was previously executed, the erase operation may be resumed by this instruction. The Erase Resume instruction consists of writing 030h to any address while an appropriate Chip Select (FSi or CSBOOTi) is true. (See Table 9.)

9.1.1.9 Specific Features

9.1.1.9.1 Flash and Flash Boot Sector Protect

Each Flash and Flash Boot sector can be separately protected against Program and Erase functions. Sector Protection provides additional data security because it disables all program or erase operations. This mode can be activated through the JTAG Port or a Device Programmer.

Sector protection can be selected for each sector using the PSDsoft Configuration program. This will automatically protect selected sectors when the device is programmed through the JTAG Port or a Device Programmer. Flash sectors can be unprotected to allow updating of their contents using the JTAG Port or a Device Programmer. The microcontroller can read (but cannot change) the sector protection bits.

Any attempt to program or erase a protected Flash sector will be ignored by the device. The Verify operation will result in a read of the protected data. This allows a guarantee of the retention of the Protection status.

The sector protection status can be read by the MCU through the Flash protection and Flash Boot protection registers (CSIOP). See Table 11.

The PSD8XXF Functional Blocks (cont.)

Table 11. Sector Protection/Security Bit Definition

Flash Protection Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sec7_Prot	Sec6_Prot	Sec5_Prot	Sec4_Prot	Sec3_Prot	Sec2_Prot	Sec1_Prot	Sec0_Prot

Bit Definitions:

Sec<i>_Prot 1 = Main Flash Sector <i> is write protected.
Sec<i>_Prot 0 = Main Flash Sector <i> is not write protected.

Flash Boot Protection Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Security_ Bit	*	*	*	Sec3_Prot	Sec2_Prot	Sec1_Prot	Sec0_Prot

*: Not used.

Bit Definitions:

Sec<i>_Prot 1 = Flash Boot Sector <i> is write protected.
Sec<i>_Prot 0 = Flash Boot Sector <i> is not write protected.

Security_Bit 0 = Security Bit in device has not been set.
1 = Security Bit in device has been set.

9.1.1.9.2 Reset Instruction – PSD813FX

The Reset instruction consists of one write cycle (see Table 9). It can also be optionally preceded by the standard two write decoding cycles (writing AAh to 555h and 55h to AAAh).

The Reset instruction must be executed after:

1. Reading the Flash Protection status or Flash ID
2. When an error condition occurs (DQ5 goes high) during a Flash programming or erase cycle.

The Reset instruction will reset the Flash to normal Read Mode. It may take the Flash memory up to few mSeconds to complete the reset cycle.

The Reset instruction is ignored when it is issued during a Flash programming or Bulk Erase cycle. During Sector Erase cycle, the Reset instruction will abort the on going sector erase cycle and return the Flash to normal Read Mode in up to few mSeconds.

9.1.1.9.2 Reset Instruction – PSD833/834/853/854F

The Reset instruction consists of one write cycle (see Table 9). It can also be optionally preceded by the standard two write decoding cycles (writing AAh to 555h and 55h to AAAh).

The Reset instruction must be executed after:

1. Reading the Flash Protection status or Flash ID
2. When an error condition occurs (DQ5 goes high) during a Flash programming or erase cycle.

The Reset instruction will reset the Flash to normal Read Mode. However, if there is an error condition (DQ5 goes high), the Flash memory will return to the Read Mode in 25 µSeconds after the Reset instruction is issued.

The Reset instruction is ignored when it is issued during a Flash programming or Bulk Erase cycle. The Reset instruction will abort the on going sector erase cycle and return the Flash memory to normal Read Mode in 25 µSeconds.

The PSD8XXF Functional Blocks (cont.)

9.1.1.9.3 Reset Pin Input – PSD833/834/853/854F

The reset pulse input from the pin will abort any operation in progress and reset the Flash memory to Read Mode. When the reset occurs during a programming or erase cycle, the Flash memory will take up to 25 µSeconds to return to Read Mode. It is recommended that the reset pulse (except power on reset, see Reset Section) be at least 25 µSeconds such that the Flash memory will always be ready for the MCU to fetch the boot codes after reset is over.

9.1.2 SRAM

The SRAM is enabled when RS0—the SRAM chip select output from the DPLD—is high. RS0 can contain up to two product terms, allowing flexible memory mapping.

The SRAM can be backed up using an external battery. The external battery should be connected to the Vstby pin (PC2). If you have an external battery connected to the PSD8XXF, the contents of the SRAM will be retained in the event of a power loss. The contents of the SRAM will be retained so long as the battery voltage remains at 2V or greater. If the supply voltage falls below the battery voltage, an internal power switchover to the battery occurs.

Pin PC4 can be configured as an output that indicates when power is being drawn from the external battery. This Vbaton signal will be high with the supply voltage falls below the battery voltage and the battery on PC2 is supplying power to the internal SRAM.

The chip select signal (RS0) for the SRAM, Vstby, and Vbaton are all configured using PSDsoft Configuration.

9.1.3 Memory Select Signals

The main Flash (FSi), Flash Boot (CSBOOTi), and SRAM (RS0) memory select signals are all outputs of the DPLD. They are setup by writing equations for them in PSDabel. The following rules apply to the equations for the internal chip select signals:

1. Main Flash memory and Flash Boot memory sector select signals must **not** be larger than the physical sector size.
2. Any main Flash memory sector must **not** be mapped in the same memory space as another Main Flash sector.
3. A Flash Boot memory sector must **not** be mapped in the same memory space as another Flash Boot sector.
4. SRAM, I/O, and Peripheral I/O spaces must **not** overlap.
5. A Flash Boot memory sector **may** overlap a main Flash memory sector. In case of overlap, priority will be given to the Flash Boot sector.
6. SRAM, I/O, and Peripheral I/O spaces **may** overlap any other memory sector. Priority will be given to the SRAM, I/O, or Peripheral I/O.

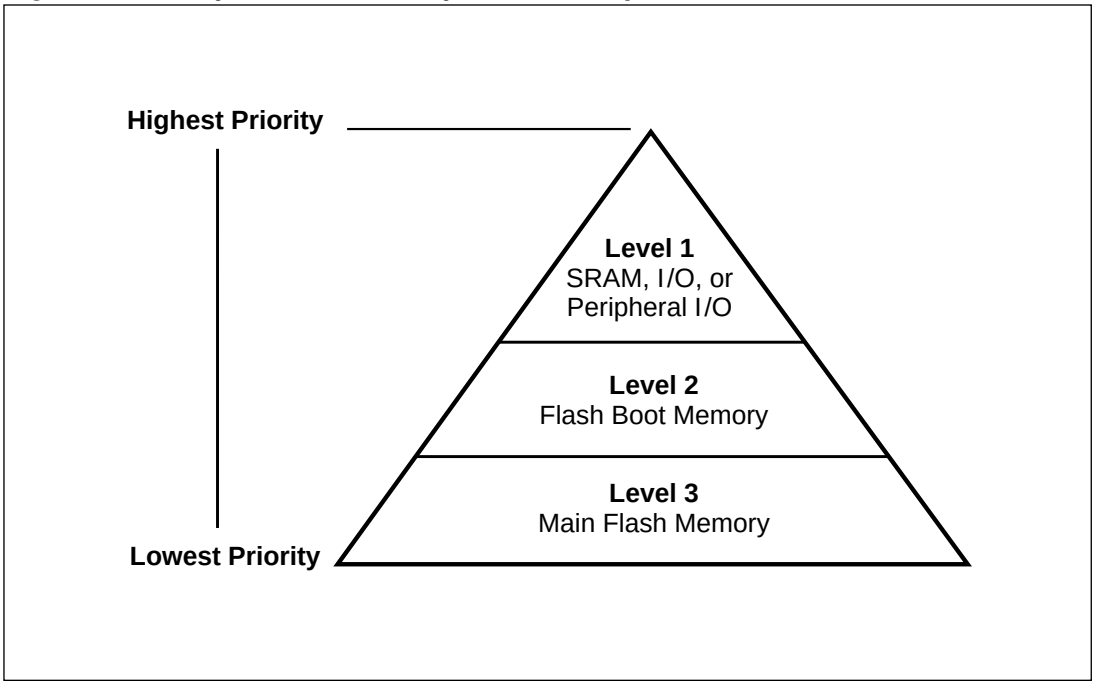
Example

FS0 is valid when the address is in the range of 8000h to BFFFh, CSBOOT0 is valid from 8000h to 9FFFh, and RS0 is valid from 8000h to 87FFh. Any address in the range of RS0 will always access the SRAM. Any address in the range of CSBOOT0 greater than 87FFh (and less than 9FFFh) will automatically address Boot memory segment 0. Any address greater than 9FFFh will access the Flash memory segment 0. You can see that half of the Flash memory segment 0 and one-fourth of Boot segment 0 can not be accessed in this example. Also note that an equation that defined FS1 to anywhere in the range of 8000h to BFFFh would **not** be valid.

Figure 5 shows the priority levels for all memory components. Any component on a higher level can overlap and has priority over any component on a lower level. Components on the same level must **not** overlap. Level one has the highest priority and level 3 has the lowest.

The PSD8XXF Functional Blocks (cont.)

Figure 5. Priority Level of Memory and I/O Components



9.1.3.1. Memory Select Configuration for MCUs with Separate Program and Data Spaces

The 8031 and compatible family of microcontrollers, which includes the 80C51, 80C151, 80C251, and 80C51XA, have separate address spaces for code memory (selected using PSEN) and data memory (selected using RD). Any of the memories within the PSD8XXF can reside in either space or both spaces. This is controlled through manipulation of the VM register that resides in the PSD's CSIOP space.

The VM register is set using PSDsoft to have an initial value. It can subsequently be changed by the microcontroller so that memory mapping can be changed on-the-fly. For example, you may wish to have SRAM and Flash in Data Space at boot, and Boot Block in Program Space at boot, and later swap Boot Block and Flash. This is easily done with the VM register by using PSDsoft Configuration to configure it for boot up and having the microcontroller change it when desired.

Table 13 describes the VM Register.

Table 13. VM Register

Bit 7 PIO_EN	Bit 6*	Bit 5*	Bit 4 FL_Data	Bit 3 Boot_Data	Bit 2 FL_Code	Bit 1 Boot_Code	Bit 0 SRAM_Code
0 = disable PIO mode	*	*	0 = RD can't access Flash	0 = RD can't access Boot Flash	0 = PSEN can't access Flash	0 = PSEN can't access Boot Flash	0 = PSEN can't access SRAM
1= enable PIO mode	*	*	1 = RD access Flash	1 = RD access Boot Flash	1 = PSEN access Flash	1 = PSEN access Boot Flash	1 = PSEN access SRAM

NOTE: Bits 6-5 are not used.

The PSD8XXF Functional Blocks (cont.)

9.1.3.2 Configuration Modes for MCUs with Separate Program and Data Spaces

9.1.3.2.1 Separate Space Modes

Code memory space is separated from data memory space. For example, the PSEN signal is used to access the program code from the Flash Memory, while the RD signal is used to access data from the Boot memory, SRAM and I/O Ports. This configuration requires the VM register to be set to 0Ch.

9.1.3.2.2 . Combined Space Modes

The program and data memory spaces are combined into one space that allows the main Flash Memory, Boot memory, and SRAM to be accessed by either PSEN or RD. For example, to configure the main Flash memory in combined space mode, bits 2 and 4 of the VM register are set to “1”.

9.1.3.3 80C31 Memory Map Example

See Application Note 57 and 64 for examples.

Figure 6. 8031 Memory Modes – Separate Space Mode

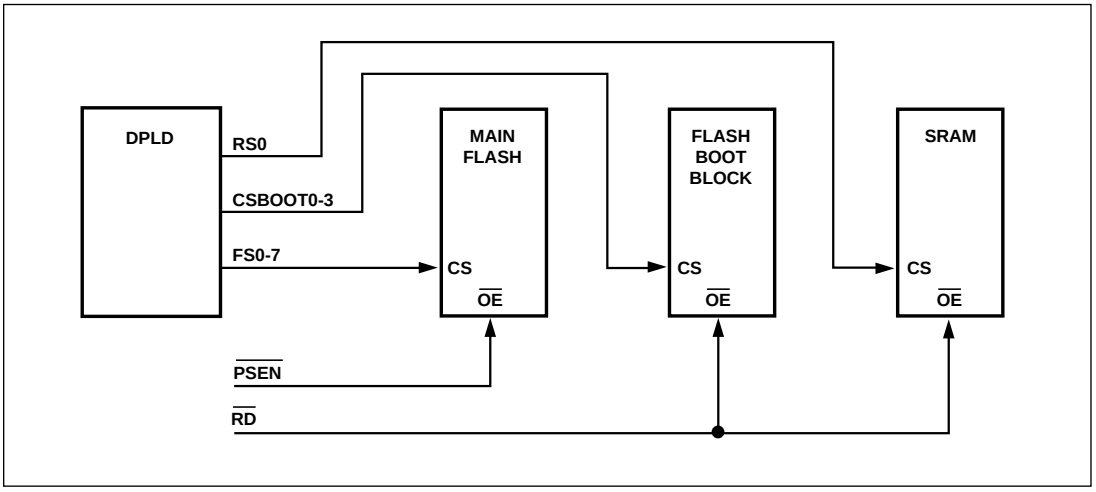
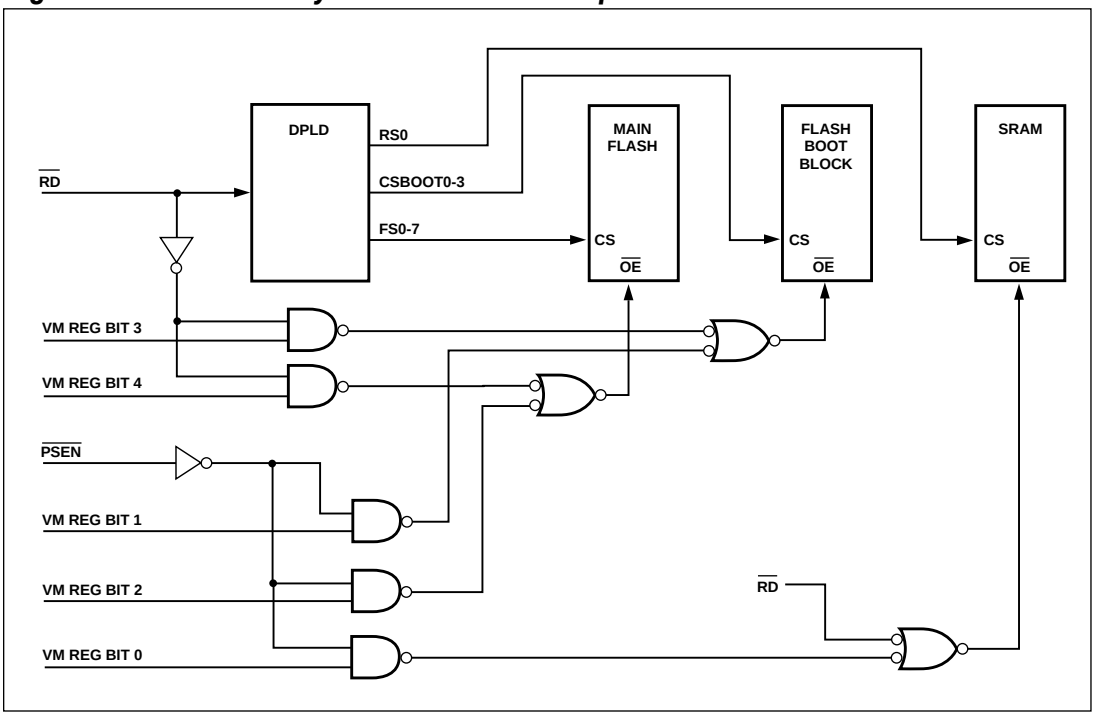


Figure 7. 80C31 Memory Mode – Combined Space Mode



The PSD8XXF Functional Blocks (cont.)

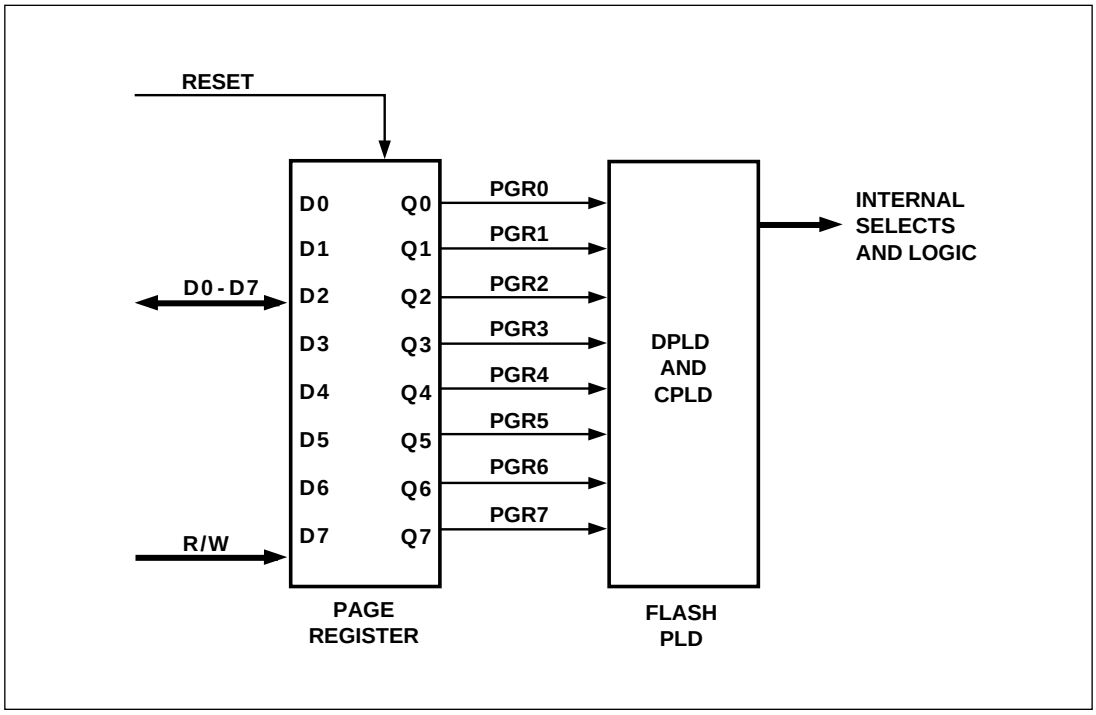
9.1.4 Page Register

The eight bit Page Register increases the addressing capability of the microcontroller by a factor of up to 256. The contents of the register can also be read by the microcontroller. The outputs of the Page Register (PGR0-PGR7) are inputs to the DPLD decoder and can be included in the Flash Memory, Flash Boot Block, and SRAM chip select equations.

If memory paging is not needed, or if not all 8 page register bits are needed for memory paging, then these bits may be used in the CPLD for general logic. See Application Note 57.

Figure 8 shows the Page Register. The eight flip flops in the register are connected to the internal data bus D0-D7. The microcontroller can write to or read from the Page Register. The Page Register can be accessed at address location CSIOP + E0h.

Figure 8. Page Register



The PSD8XXF Functional Blocks (cont.)

9.2 PLDs

The PLDs bring programmable logic functionality to the PSD8XXF. After specifying the logic for the PLDs using the PSDabel tool in PSDsoft, the logic is programmed into the device and available upon power-up.

The PSD8XXF contains two PLDs: the Decode PLD (DPLD), and the Complex PLD (CPLD). The PLDs are briefly discussed in the next few paragraphs, and in more detail in sections 9.2.1 and 9.2.2. Figure 10 shows the configuration of the PLDs.

The DPLD performs address decoding for internal components, such as memory, registers, and I/O port selects.

The CPLD can be used for logic functions, such as loadable counters and shift registers, state machines, and encoding and decoding logic. These logic functions can be constructed using the 16 Output Micro⇔Cells (OMCs), 24 Input Micro⇔Cells (IMCs), and the AND array. The CPLD can also be used to generate external chip selects.

The AND array is used to form product terms. These product terms are specified using PSDabel. An Input Bus consisting of 73 signals is connected to the PLDs. The signals are shown in Table 15.

Table 15. DPLD and CPLD Inputs

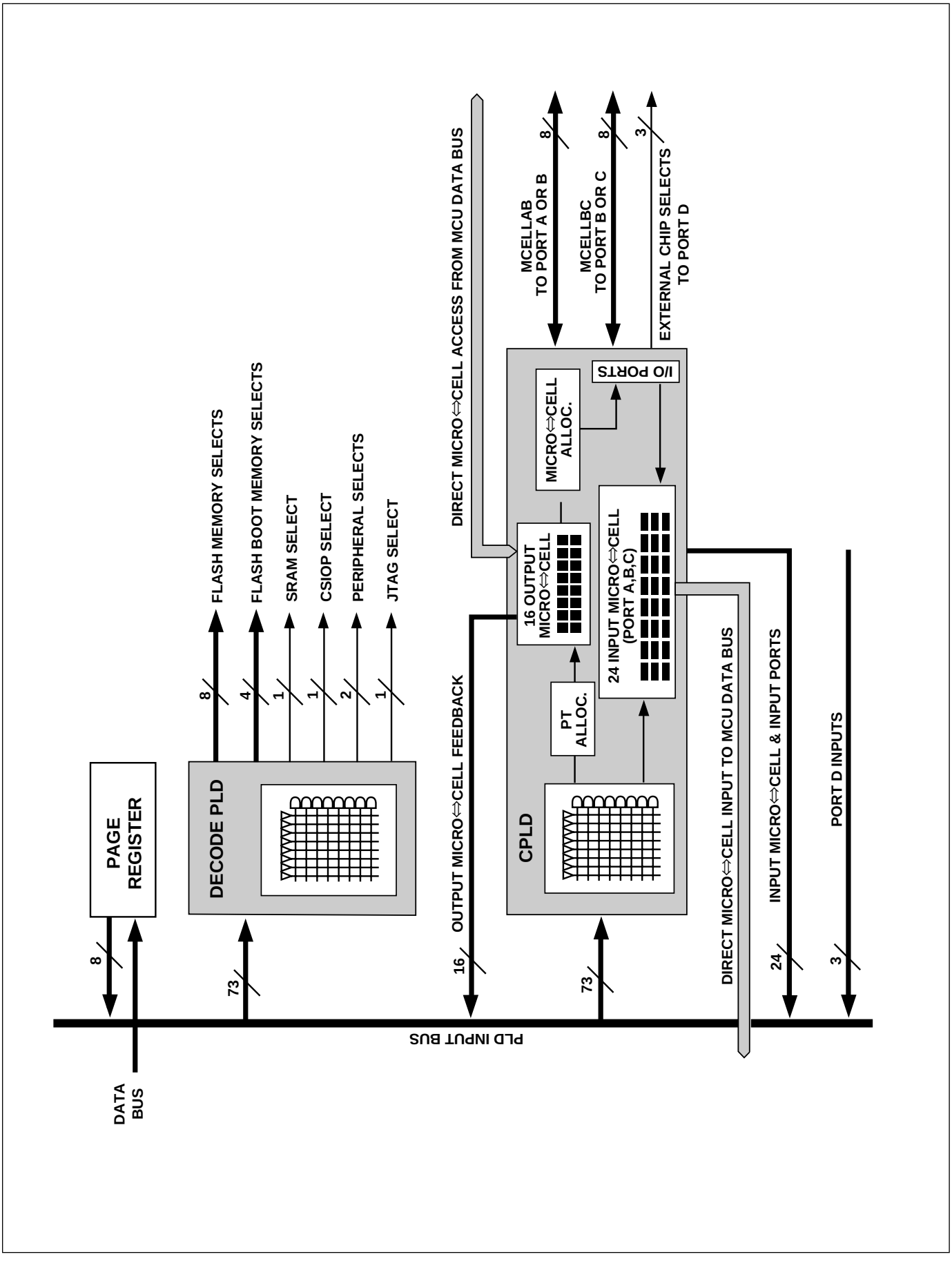
Input Source	Input Name	Number of Signals
MCU Address Bus	A[15:0]*	16
MCU Control Signals	CNTL[2:0]	3
Reset	RST	1
Power Down	PDN	1
Port A Input Micro⇔Cells	PA[7-0]	8
Port B Input Micro⇔Cells	PB[7-0]	8
Port C Input Micro⇔Cells	PC[7-0]	8
Port D Inputs	PD[2:0]	3
Page Register	PGR(7:0)	8
Micro⇔Cell AB Feedback	MCELLAB.FB[7:0]	8
Micro⇔Cell BC Feedback	MCELLBC.FB[7:0]	8
Boot Flash Programming Status Bit	Rdy/Bsy	1

NOTE: The address inputs are A[19:4] in 80C51XA mode.

The Turbo Bit

The PLDs in the PSD8XXF can minimize power consumption by switching off when inputs remain unchanged for an extended time of about 70 ns. Setting the Turbo mode bit to off (Bit 3 of the PMMR0 register) automatically places the PLDs into standby if no inputs are changing. Turbo-off mode increases propagation delays while reducing power consumption. Refer to the Power Management Unit section on how to set the Turbo Bit. Additionally, five bits are available in the PMMR2 register to block MCU control signals from entering the PLDs. This reduces power consumption and can be used only when these MCU control signals are not used in PLD logic equations.

Figure 9. PLD Block Diagram



The PSD8XXF Functional Blocks (cont.)

Each of the two PLDs has unique characteristics suited for its applications They are described in the following sections.

9.2.1 Decode PLD (DPLD)

The DPLD, shown in Figure 10, is used for decoding the address for internal and external components. The DPLD can generate the following decode signals:

- 8 sector selects for the main Flash memory (three product terms each)
- 4 sector selects for the Flash Boot memory (three product terms each)
- 1 internal SRAM select signal (two product terms)
- 1 internal CSIOP (PSD configuration register) select signal
- 1 JTAG select signal (enables JTAG on Port C)
- 2 internal peripheral select signals (peripheral I/O mode).

9.2.2 Complex PLD (CPLD)

The CPLD can be used to implement system logic functions, such as loadable counters and shift registers, system mailboxes, handshaking protocols, state machines, and random logic. The CPLD can also be used to generate 3 external chip selects, routed to Port D. Although external chip selects can be produced by any Output Micro⇔Cell, these three external chip selects on Port D do not consume any Output Micro⇔Cells.

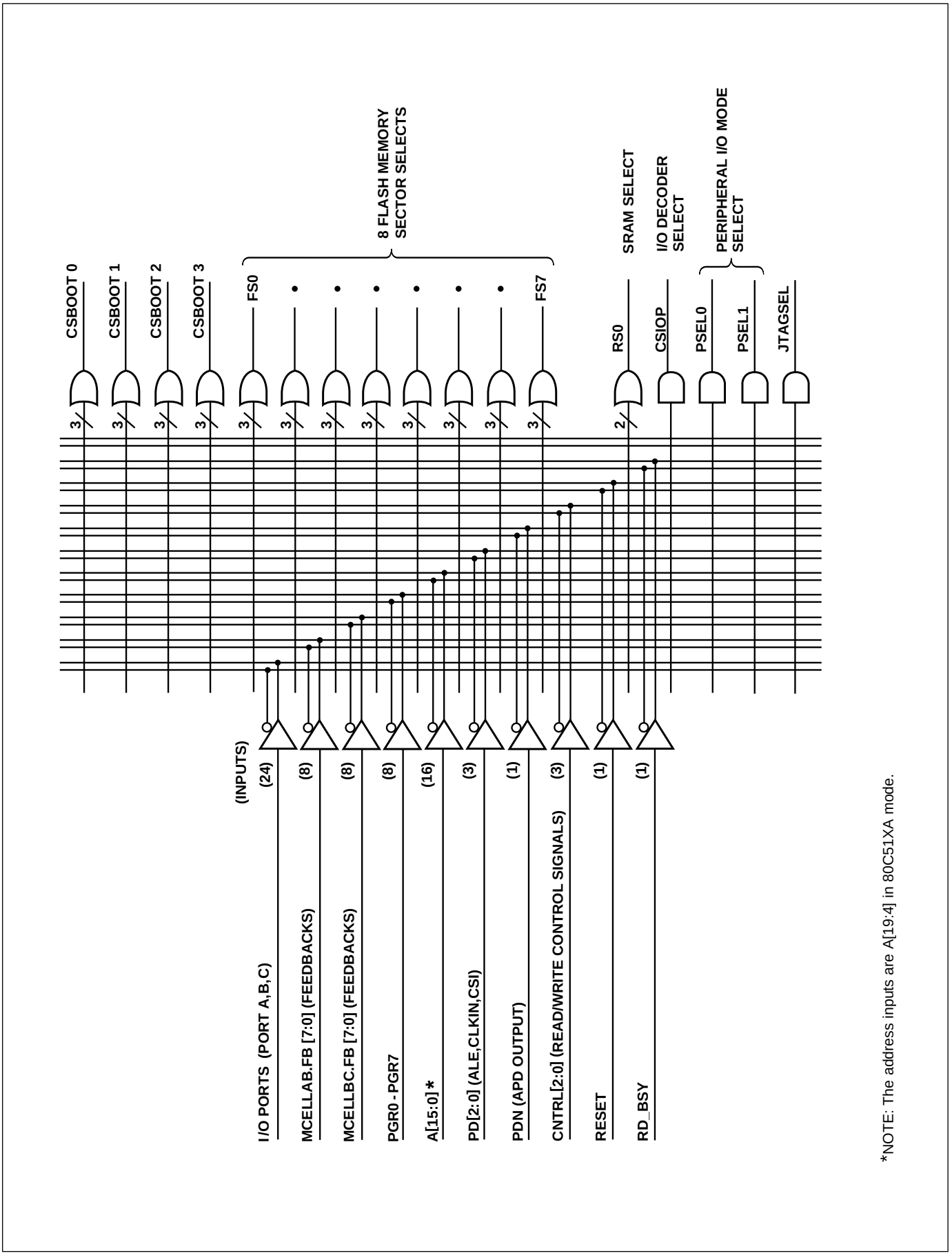
As shown in Figure 9, the CPLD has the following blocks:

- 24 Input Micro⇔Cells (IMCs)
- 16 Output Micro⇔Cells (OMCs)
- Micro⇔Cell Allocator
- Product Term Allocator
- AND array capable of generating up to 137 product terms
- Four I/O ports.

Each of the blocks are described in the subsections that follow.

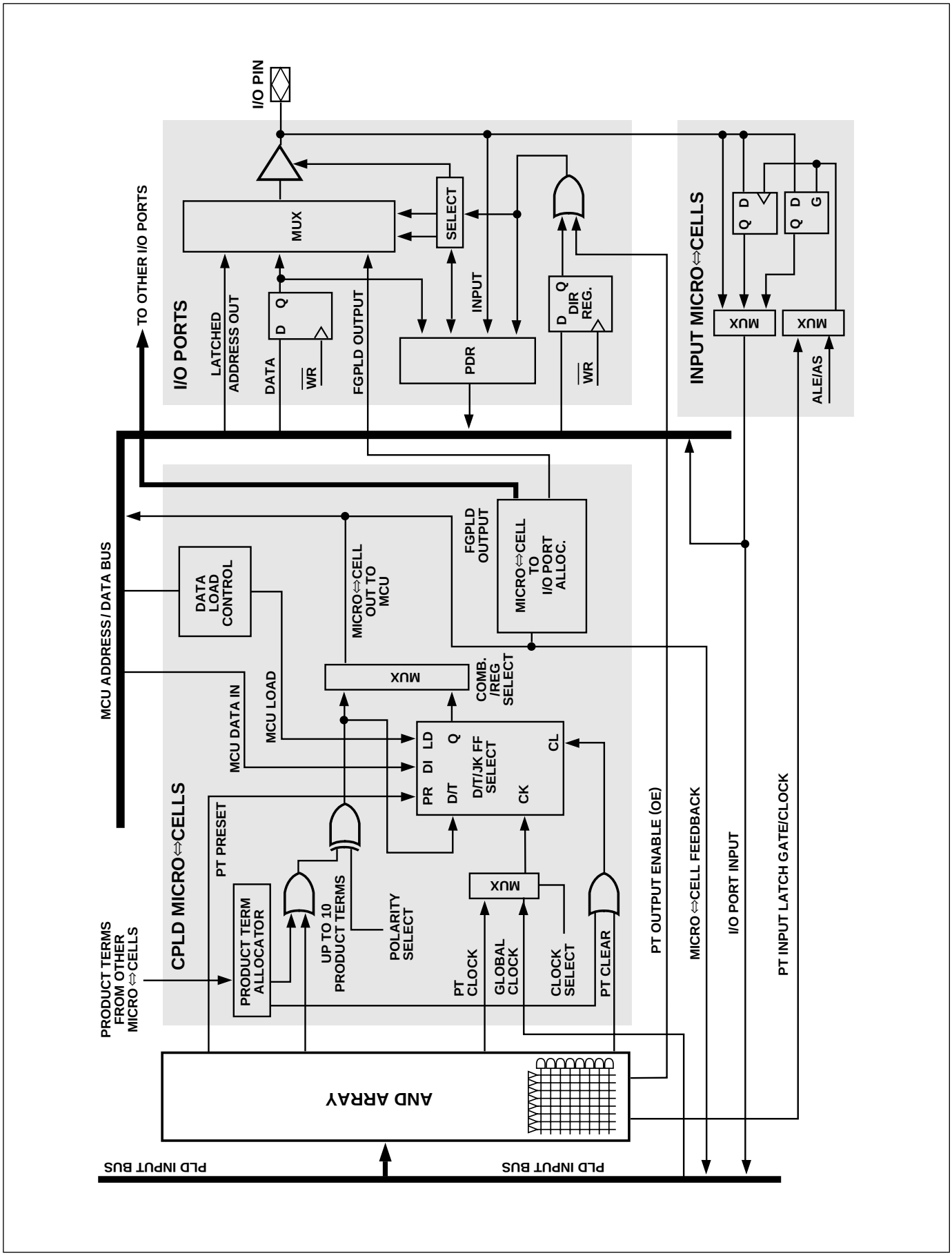
The Input and Output Micro⇔Cells are connected to the PSD8XXF internal data bus and can be directly accessed by the microcontroller. This enables the MCU software to load data into the Output Micro⇔Cells or read data from both the Input and Output Micro⇔Cells. This feature allows efficient implementation of system logic and eliminates the need to connect the data bus to the AND logic array as required in most standard PLD macrocell architectures.

Figure 10. DPLD Logic Array



*NOTE: The address inputs are A[19:4] in 80C51XA mode.

Figure 11. The Micro⇔Cell and I/O Port



The PSD8XXF Functional Blocks (cont.)

9.2.2.1 Output Micro⇔Cell

Eight of the Output Micro⇔Cells are connected to Ports A and B pins and are named as McellAB0-7. The other eight Micro⇔Cells are connected to Ports B and C pins and are named as McellBC0-7. If an McellAB output is not assigned to a specific pin in PSDabel, the Micro⇔Cell Allocator will assign it to either Port A or B. The same is true for a McellBC output on Port B or C. Table 16 shows the Micro⇔Cells and Port assignment.

Table 16. Output Micro⇔Cell Port and Data Bit Assignments

Output Micro⇔Cell	Port Assignment	Native Product Terms	Maximum Borrowed Product Terms	Data Bit for Loading or Reading
McellAB0	Port A0, B0	3	6	D0
McellAB1	Port A1, B1	3	6	D1
McellAB2	Port A2, B2	3	6	D2
McellAB3	Port A3, B3	3	6	D3
McellAB4	Port A4, B4	3	6	D4
McellAB5	Port A5, B5	3	6	D5
McellAB6	Port A6, B6	3	6	D6
McellAB7	Port A7, B7	3	6	D7
McellBC0	Port B0, C0	4	5	D0
McellBC1	Port B1, C1	4	5	D1
McellBC2	Port B2, C2	4	5	D2
McellBC3	Port B3, C3	4	5	D3
McellBC4	Port B4, C4	4	6	D4
McellBC5	Port B5, C5	4	6	D5
McellBC6	Port B6, C6	4	6	D6
McellBC7	Port B7, C7	4	6	D7

The Output Micro⇔Cell (OMC) architecture is shown in Figure 12. As shown in the figure, there are native product terms available from the AND array, and borrowed product terms available (if unused) from other OMCs. The polarity of the product term is controlled by the XOR gate. The OMC can implement either sequential logic, using the flip-flop element, or combinatorial logic. The multiplexer selects between the sequential or combinatorial logic outputs. The multiplexer output can drive a Port pin and has a feedback path to the AND array inputs.

The flip-flop in the OMC can be configured as a D, T, JK, or SR type in the PSDabel program. The flip-flop's clock, preset, and clear inputs may be driven from a product term of the AND array. Alternatively, the external CLKIN signal can be used for the clock input to the flip-flop. The flip-flop is clocked on the rising edge of the clock input. The preset and clear are active-high inputs. Each clear input can use up to two product terms.

The PSD8XXF Functional Blocks (cont.)

9.2.2.2 The Product Term Allocator

The CPLD has a Product Term Allocator. The PSDabel compiler uses the Allocator to borrow and place product terms from one Micro⇔Cell to another. The following list summarizes how product terms are allocated:

- McellAB0-7 all have three native product terms and may borrow up to six more
- McellBC0-3 all have four native product terms and may borrow up to five more
- McellBC4-7 all have four native product terms and may borrow up to six more.

Each Micro⇔Cell may only borrow product terms from certain other Micro⇔Cells. Product terms already in use by one Micro⇔Cell will not be available for a different Micro⇔Cell.

If an equation requires more product terms than what is available to it, then “external” product terms will be required, which will consume other OMCs. If external product terms are used, extra delay will be added for the equation that required the extra product terms. This is called product term expansion. PSDsoft will perform this expansion as needed.

9.2.2.3 Loading and Reading the Output Micro⇔Cells (OMCs)

The OMCs occupy a memory location in the MCU address space, as defined by the CSIOP (refer to the I/O section). The flip-flops in each of the 16 OMCs can be loaded from the data bus by a microcontroller. Loading the OMCs with data from the MCU takes priority over internal functions. As such, the preset, clear, and clock inputs to the flip-flop can be overridden by the MCU. The ability to load the flip-flops and read them back is useful in such applications as loadable counters and shift registers, mailboxes, and handshaking protocols.

Data can be loaded to the OMCs on the trailing edge of the WR signal (edge loading) or during the time that the WR signal is active (level loading). The method of loading is specified in PSDsoft Configuration.

9.2.2.4 The OMC Mask Register

There is one Mask Register for each of the two groups of eight OMCs. The Mask Registers can be used to block the loading of data to individual OMCs. The default value for the Mask Registers is 00h, which allows loading of the OMCs. When a given bit in a Mask Register is set to a ‘1’, the MCU will be blocked from writing to the associated OMC. For example, suppose McellAB0-3 are being used for a state machine. You would not want a MCU write to McellAB to overwrite the state machine registers. Therefore, you would want to load the Mask Register for McellAB (Mask Micro⇔Cell AB) with the value 0Fh.

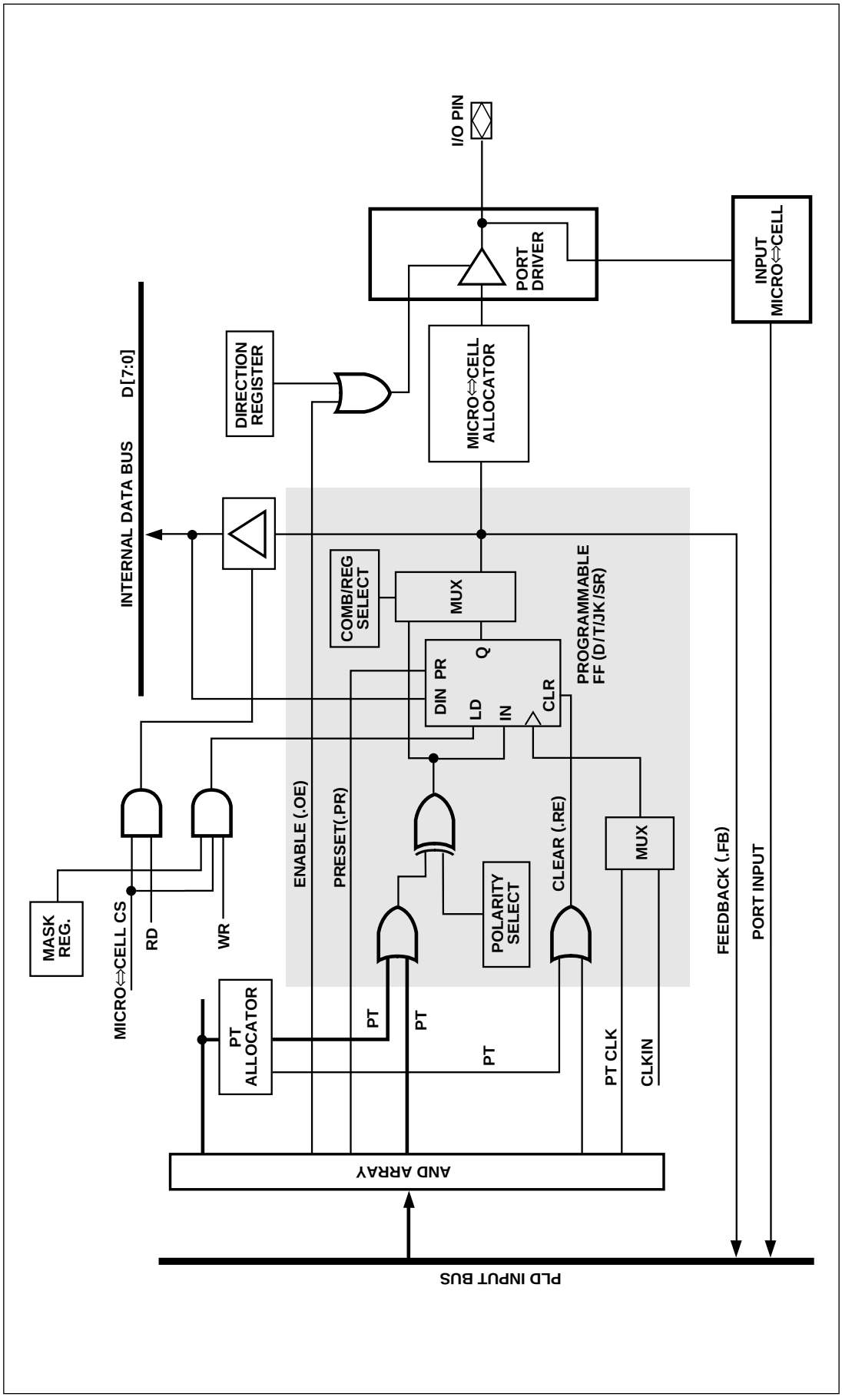
9.2.2.5 The Output Enable of the OMC

The OMC can be connected to an I/O port pin as a PLD output. The output enable of each Port pin driver is controlled by a single product term from the AND array, ORed with the Direction Register output. The pin is enabled upon power up if no output enable equation is defined and if the pin is declared as a PLD output in PSDsoft.

If the OMC output is declared as an internal node and not as a Port pin output in the PSDabel file, then the Port pin can be used for other I/O functions. The internal node feedback can be routed as an input to the AND array.

The PSD8XXF Functional Blocks (cont.)

Figure 12. CPLD Output Micro⇔Cell



The PSD8XXF Functional Blocks (cont.)

9.2.2.6 Input Micro⇔Cells (IMCs)

The CPLD has 24 IMCs, one for each pin on Ports A, B, and C. The architecture of the IMC is shown in Figure 13. The IMCs are individually configurable, and can be used as a latch, register, or to pass incoming Port signals prior to driving them onto the PLD input bus. The outputs of the IMCs can be read by the microcontroller through the internal data bus.

The enable for the latch and clock for the register are driven by a multiplexer whose inputs are a product term from the CPLD AND array or the MCU address strobe (ALE/AS). Each product term output is used to latch or clock four IMCs. Port inputs 3-0 can be controlled by one product term and 7-4 by another.

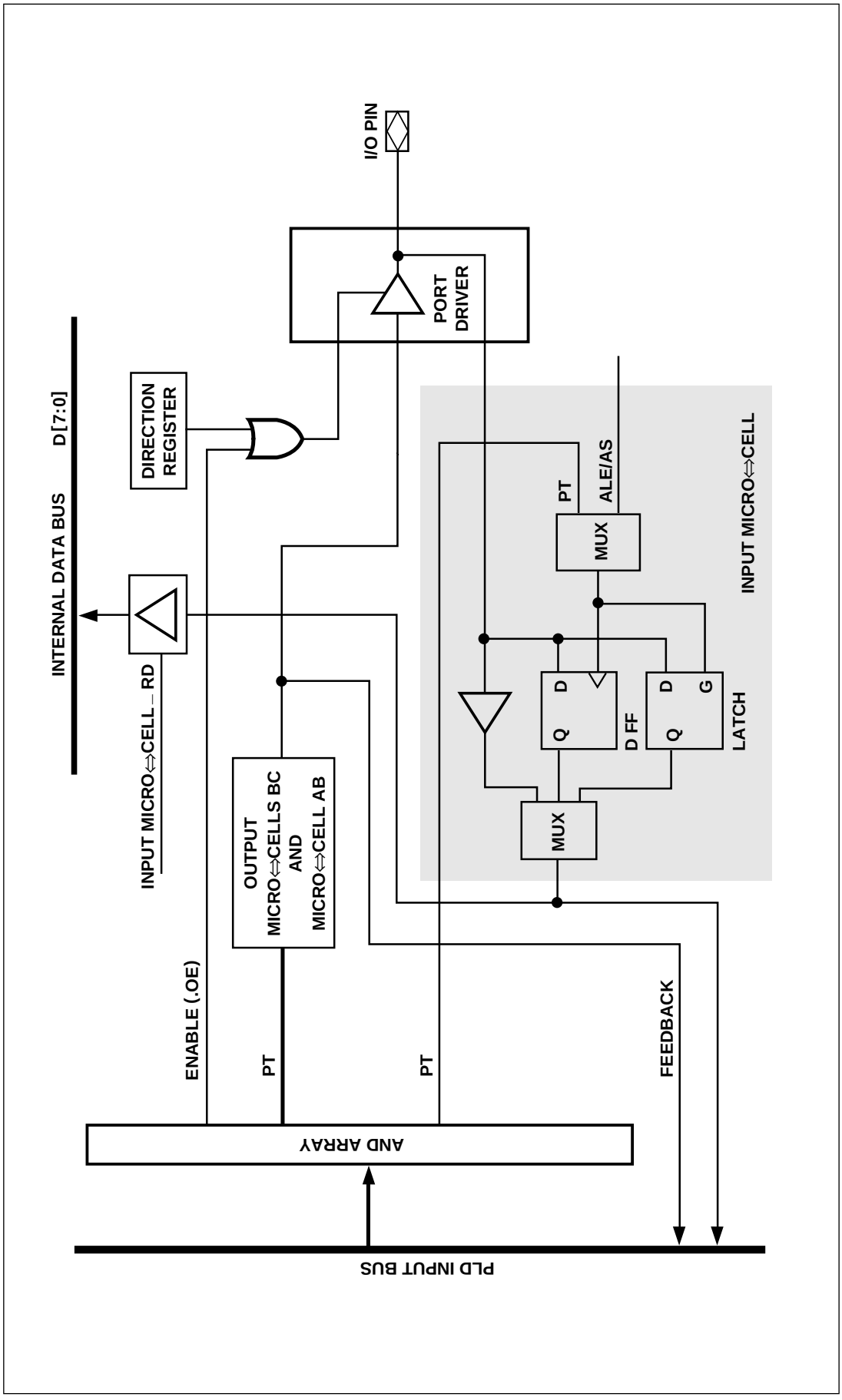
Configurations for the IMCs are specified by equations written in PSDabel (see Application Note 55). Outputs of the IMCs can be read by the MCU via the IMC buffer. See the I/O Port section on how to read the IMCs.

IMCs can use the address strobe to latch address bits higher than A15. Any latched addresses are routed to the PLDs as inputs.

IMCs are particularly useful with handshaking communication applications where two processors pass data back and forth through a common mailbox. Figure 14 shows a typical configuration where the Master MCU writes to the Port A Data Out Register. This, in turn, can be read by the Slave MCU via the activation of the “Slave-Read” output enable product term. The Slave can also write to the Port A IMCs and the Master can then read the IMCs directly. Note that the “Slave-Read” and “Slave-Wr” signals are product terms that are derived from the Slave MCU inputs RD, WR, and Slave_CS.

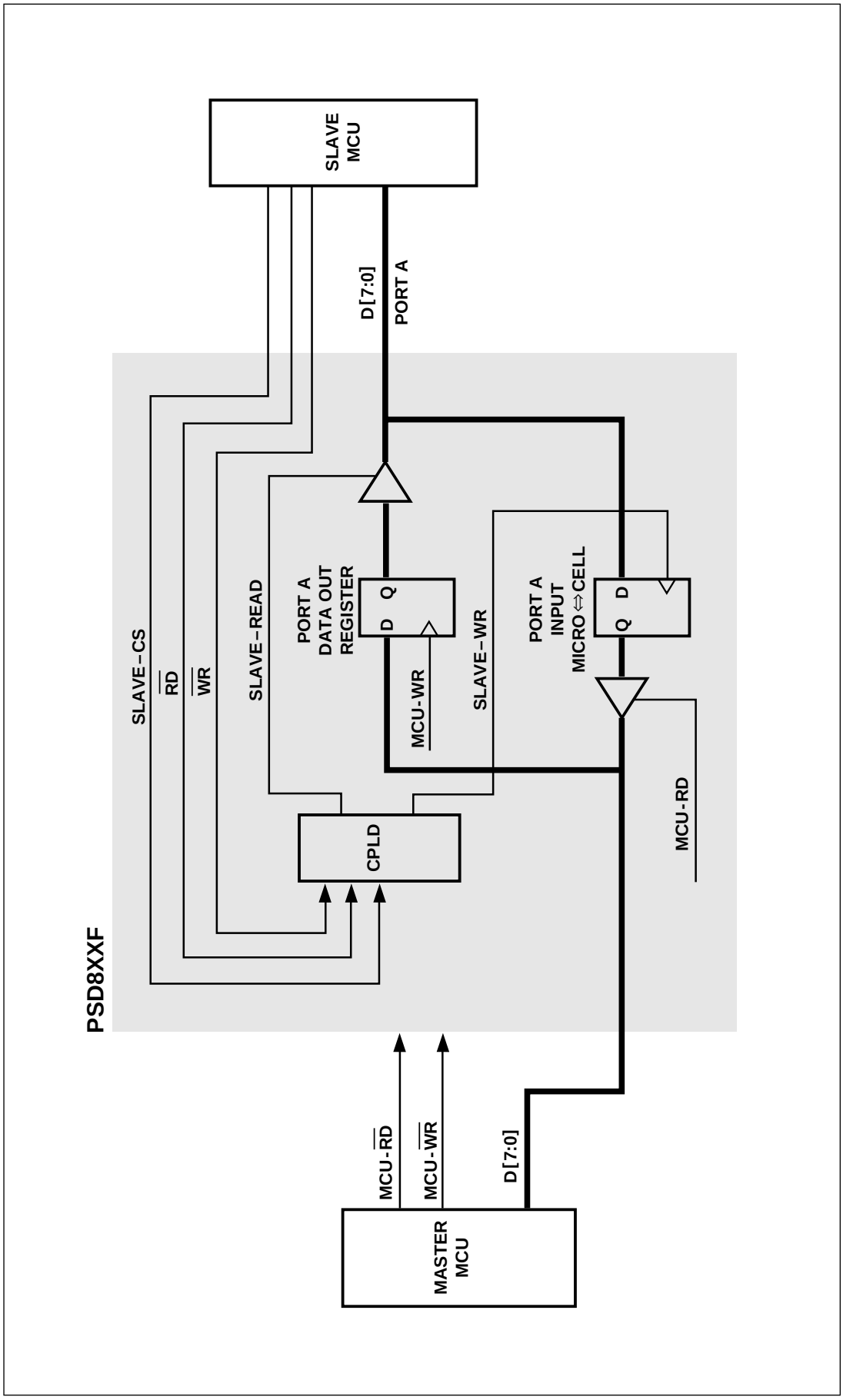
The PSD8XXF Functional Blocks (cont.)

Figure 13. Input Micro⇔Cell



The PSD8XXF Functional Blocks (cont.)

Figure 14. Handshaking Communication Using Input Micro⇔Cells



The PSD8XXF Functional Blocks (cont.)

9.3 Microcontroller Bus Interface

The “no-glue logic” PSD8XXF Microcontroller Bus Interface can be directly connected to most popular microcontrollers and their control signals. Key 8-bit microcontrollers with their bus types and control signals are shown in Table 17. The interface type is specified using the PSDsoft Configuration.

Table 17. Microcontrollers and their Control Signals

MCU	Data Bus Width	CNTL0	CNTL1	CNTL2	PC7	PD0**	ADIO0	PA3-PA0	PA7-PA4
8031	8	$\overline{WR}$	$\overline{RD}$	$\overline{PSEN}$	*	ALE	A0	*	*
80C51XA	8	$\overline{WR}$	$\overline{RD}$	$\overline{PSEN}$	*	ALE	A4	A3-A0	*
80C251	8	$\overline{WR}$	$\overline{PSEN}$	*	*	ALE	A0	*	*
80C251	8	$\overline{WR}$	$\overline{RD}$	$\overline{PSEN}$	*	ALE	A0	*	*
80198	8	$\overline{WR}$	$\overline{RD}$	*	*	ALE	A0	*	*
68HC11	8	R/$\overline{W}$	E	*	*	AS	A0	*	*
68HC912	8	R/$\overline{W}$	E	*	$\overline{DBE}$	AS	A0	*	*
Z80	8	$\overline{WR}$	$\overline{RD}$	*	*	*	A0	D3-D0	D7-D4
Z8	8	R/$\overline{W}$	$\overline{DS}$	*	*	$\overline{AS}$	A0	*	*
68330	8	R/$\overline{W}$	$\overline{DS}$	*	*	AS	A0	*	*
M37702M2	8	R/$\overline{W}$	$\overline{E}$	*	*	ALE	A0	D3-D0	D7-D4

*Unused CNTL2 pin can be configured as CPLD input. Other unused pins (PC7, PD0, PA3-0) can be configured for other I/O functions.

**ALE/AS input is optional for microcontrollers with a non-multiplexed bus

9.3.1. PSD8XXF Interface to a Multiplexed 8-Bit Bus

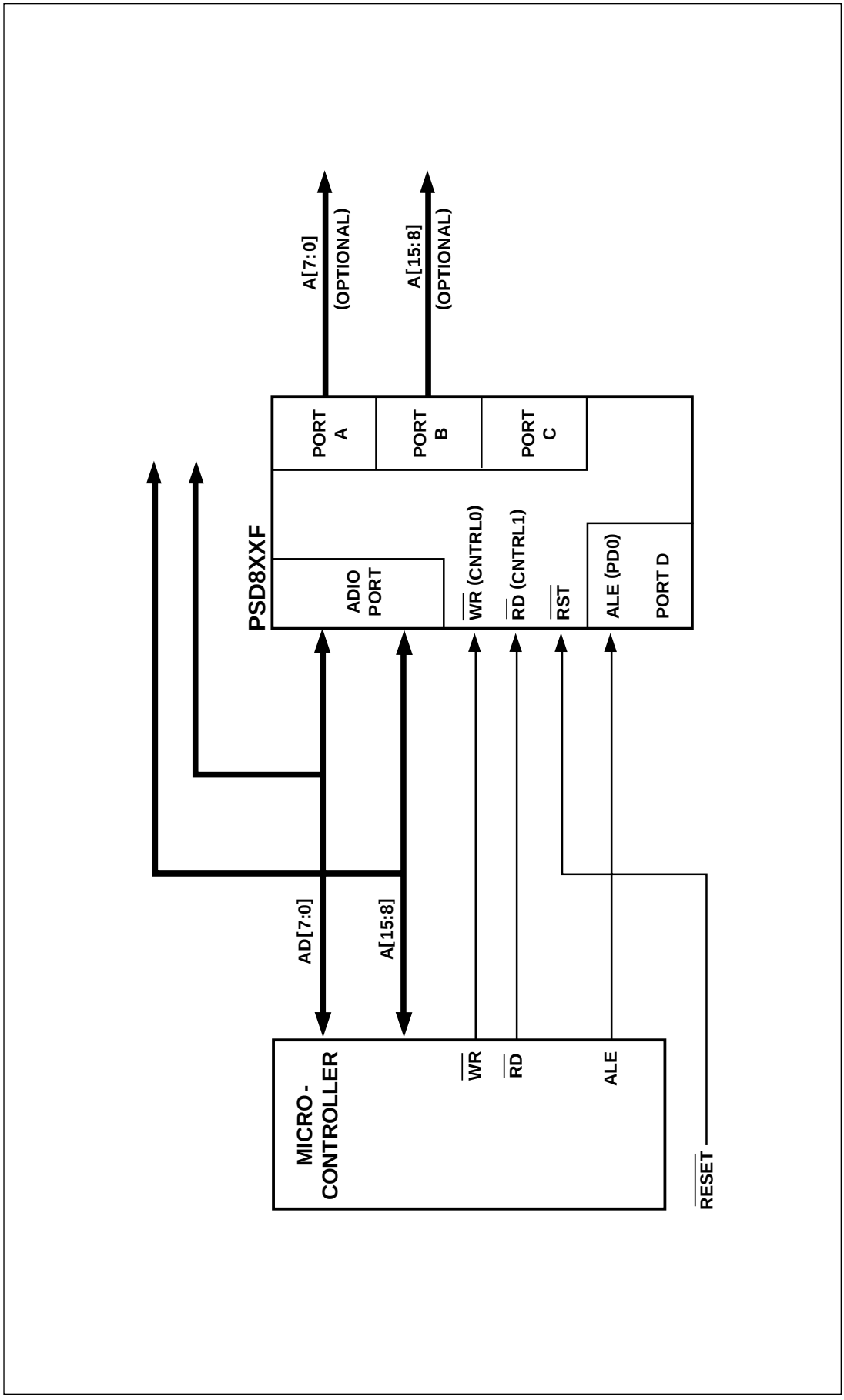
Figure 15 shows an example of a system using a microcontroller with an 8-bit multiplexed bus and a PSD8XXF. The ADIO port on the PSD8XXF is connected directly to the microcontroller address/data bus. ALE latches the address lines internally. Latched addresses can be brought out to Port A or B. The PSD8XXF drives the ADIO data bus only when one of its internal resources is accessed and the RD input is active. Should the system address bus exceed sixteen bits, Ports A, B, C, or D may be used as additional address inputs.

9.3.2. PSD8XXF Interface to a Non-Multiplexed 8-Bit Bus

Figure 16 shows an example of a system using a microcontroller with an 8-bit non-multiplexed bus and a PSD8XXF. The address bus is connected to the ADIO Port, and the data bus is connected to Port A. Port A is in tri-state mode when the PSD8XXF is not accessed by the microcontroller. Should the system address bus exceed sixteen bits, Ports B, C, or D may be used for additional address inputs.

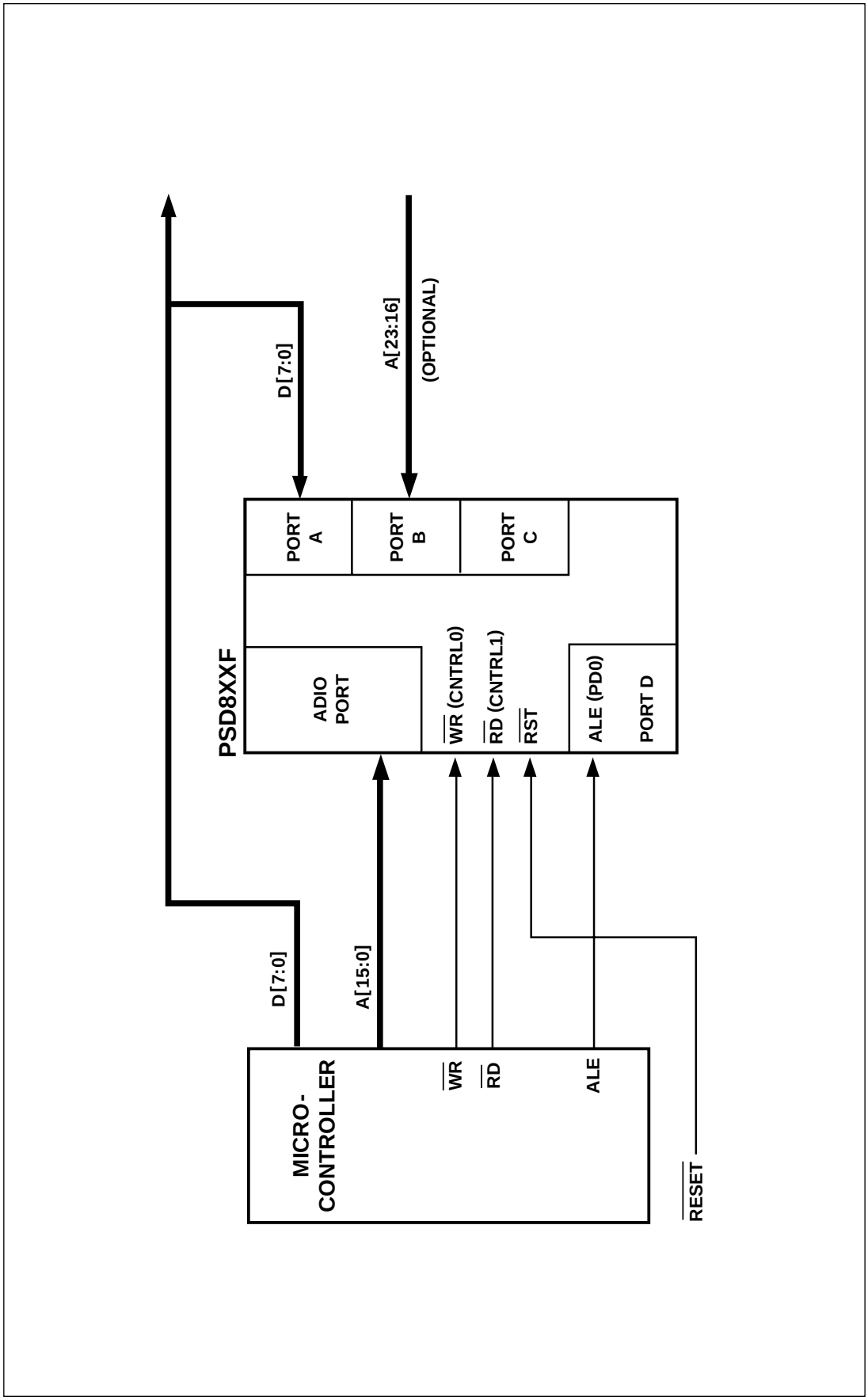
The PSD8XXF Functional Blocks (cont.)

Figure 15. An Example of a Typical 8-Bit Multiplexed Bus Interface



The PSD8XXF Functional Blocks (cont.)

Figure 16. An Example of a Typical 8-Bit Non-Multiplexed Bus Interface



The PSD8XXF Functional Blocks (cont.)

9.3.3 Data Byte Enable Reference

Microcontrollers have different data byte orientations. The following table shows how the PSD8XXF interprets byte/word operations in different bus write configurations. Even-byte refers to locations with address A0 equal to zero and odd byte as locations with A0 equal to one.

Table 18. Eight-Bit Data Bus

BHE	A0	D7-D0
X	0	Even Byte
X	1	Odd Byte

9.3.4 Microcontroller Interface Examples

Figures 17 through 21 show examples of the basic connections between the PSD8XXF and some popular microcontrollers. The PSD8XXF Control input pins are labeled as to the microcontroller function for which they are configured. The MCU interface is specified using the PSDsoft Configuration.

9.3.4.1 80C31

Figure 17 shows the interface to the 80C31, which has an 8-bit multiplexed address/data bus. The lower address byte is multiplexed with the data bus. The microcontroller control signals PSEN, RD, and WR may be used for accessing the internal memory components and I/O Ports. The ALE input (pin PD0) latches the address.

9.3.4.2 80C251

The Intel 80C251 microcontroller features a user-configurable bus interface with four possible bus configurations, as shown in Table 19.

Configuration 1 is 80C31 compatible, and the bus interface to the PSD8XXF is identical to that shown in Figure 17. Configurations 2 and 3 have the same bus connection as shown in Figure 18. There is only one read input (PSEN) connected to the CntI1 pin on the PSD8XXF. The A16 connection to the PA0 pin allows for a larger address input to the PSD8XXF. Configuration 4 is shown in Figure 19. The RD signal is connected to CntI1 and the PSEN signal is connected to the CNTL2.

The 80C251 has two major operating modes: Page Mode and Non-Page Mode. In Non-Page Mode, the data is multiplexed with the lower address byte, and ALE is active in every bus cycle. In Page Mode, data D[7:0] is multiplexed with address A[15:8]. In a bus cycle where there is a Page hit, the ALE signal is not active and only addresses A[7:0] are changing. The PSD8XXF supports both modes. In Page Mode, the PSD bus timing is identical to Non-Page Mode except the address hold time and setup time with respect to ALE is not required. The PSD access time is measured from address A[7:0] valid to data in valid.

The PSD8XXF Functional Blocks (cont.)

Table 19. 80C251 Configurations

Configuration	80C251 Read/Write Pins	Connecting to PSD8XXF Pins	Page Mode
1	$\overline{WR}$ $\overline{RD}$ $\overline{PSEN}$	CNTL0 CNTL1 CNTL2	Non-Page Mode, 80C31 compatible A[7:0] multiplex with D[7:0}
2	$\overline{WR}$ $\overline{PSEN}$ only	CNTL0 CNTL1	Non-Page Mode A[7:0] multiplex with D[7:0}
3	$\overline{WR}$ $\overline{PSEN}$ only	CNTL0 CNTL1	Page Mode A[15:8] multiplex with D[7:0}
4	$\overline{WR}$ $\overline{RD}$ $\overline{PSEN}$	CNTL0 CNTL1 CNTL2	Page Mode A[15:8] multiplex with D[7:0}

9.3.4.3 80C51XA

The Philips 80C51XA microcontroller family supports an 8- or 16-bit multiplexed bus that can have burst cycles. Address bits A[3:0] are not multiplexed, while A[19:4] are multiplexed with data bits D[15:0] in 16-bit mode. In 8-bit mode, A[11:4] are multiplexed with data bits D[7:0].

The 80C51XA can be configured to operate in eight-bit data mode. (shown in Figure 20). The 80C51XA improves bus throughput and performance by executing Burst cycles for code fetches. In Burst Mode, address A19-4 are latched internally by the PSD8XXF, while the 80C51XA changes the A3-0 lines to fetch up to 16 bytes of code. The PSD access time is then measured from address A3-A0 valid to data in valid. The PSD bus timing requirement in Burst Mode is identical to the normal bus cycle, except the address setup and hold time with respect to ALE does not apply.

9.3.4.4 68HC11

Figure 21 shows an interface to a 68HC11 where the PSD8XXF1 is configured in 8-bit multiplexed mode with E and R/W settings. The DPLD can generate the READ and WR signals for external devices.

Figure 17. Interfacing the PSD8XXF with an 80C31

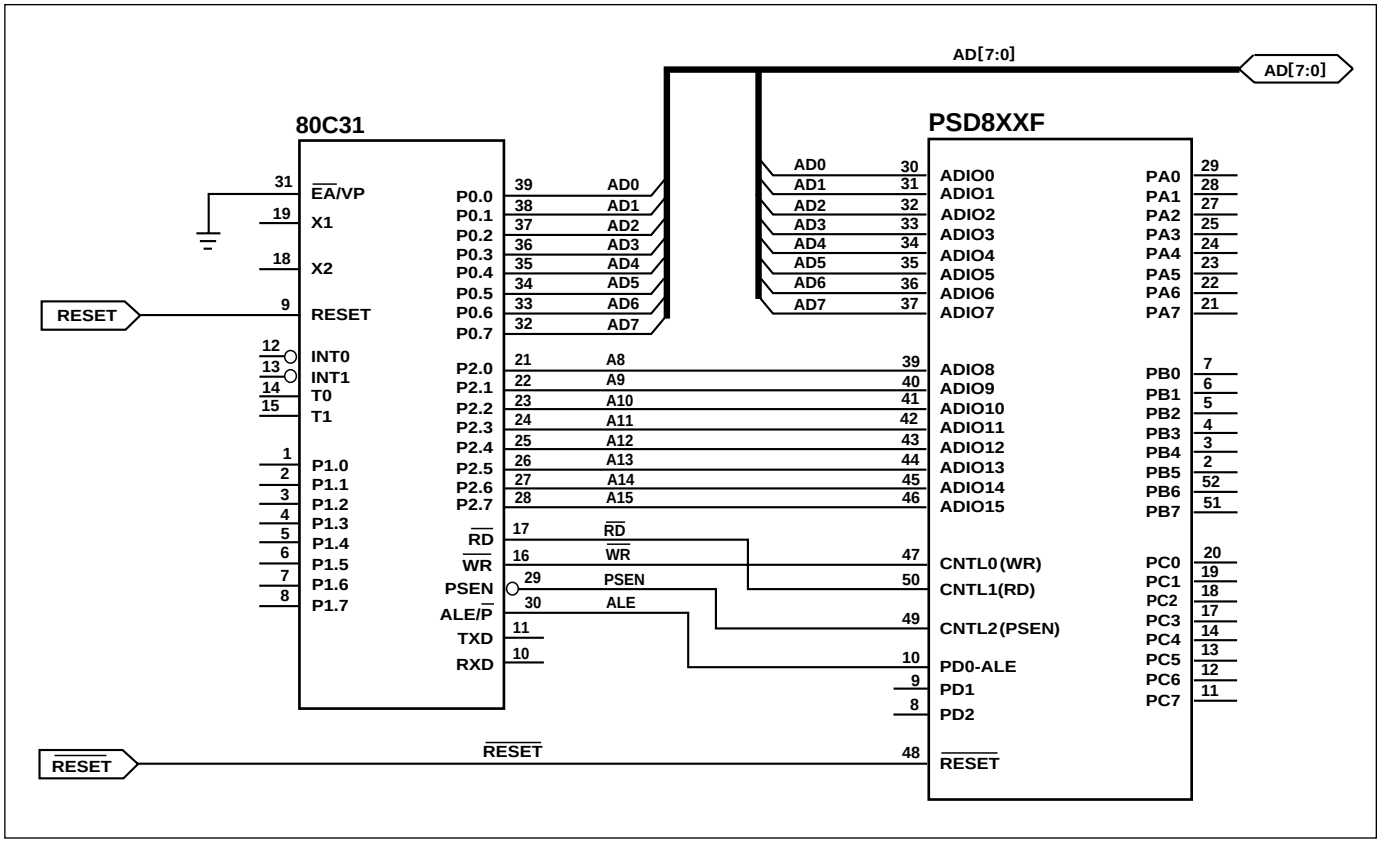
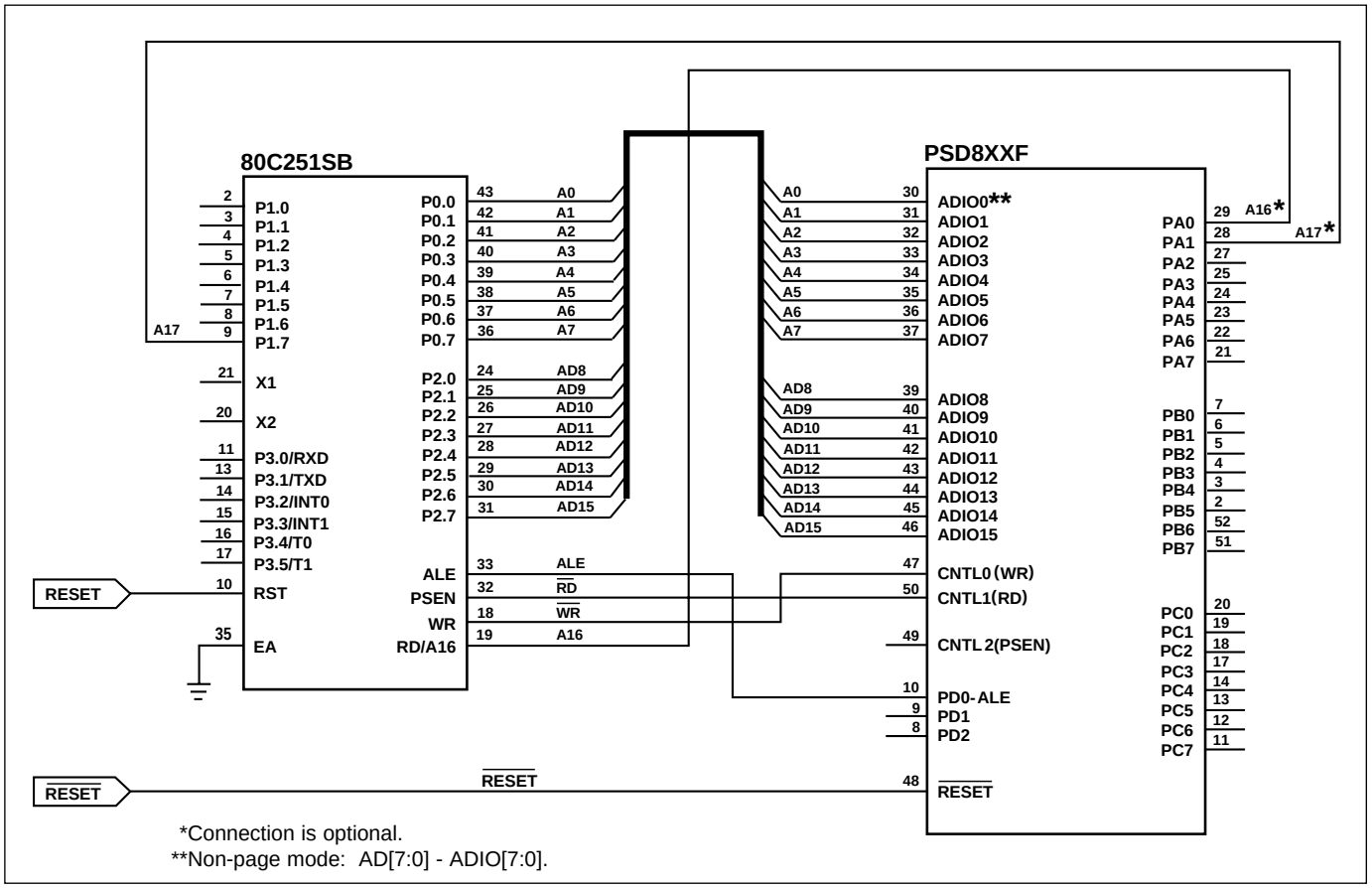


Figure 18. Interfacing the PSD8XXF to the 80C251, with One Read Input



*Connection is optional.
**Non-page mode: AD[7:0] - ADIO[7:0].

Figure 19. Interfacing the PSD8XXF to the 80C251, with Read and PSEN Inputs

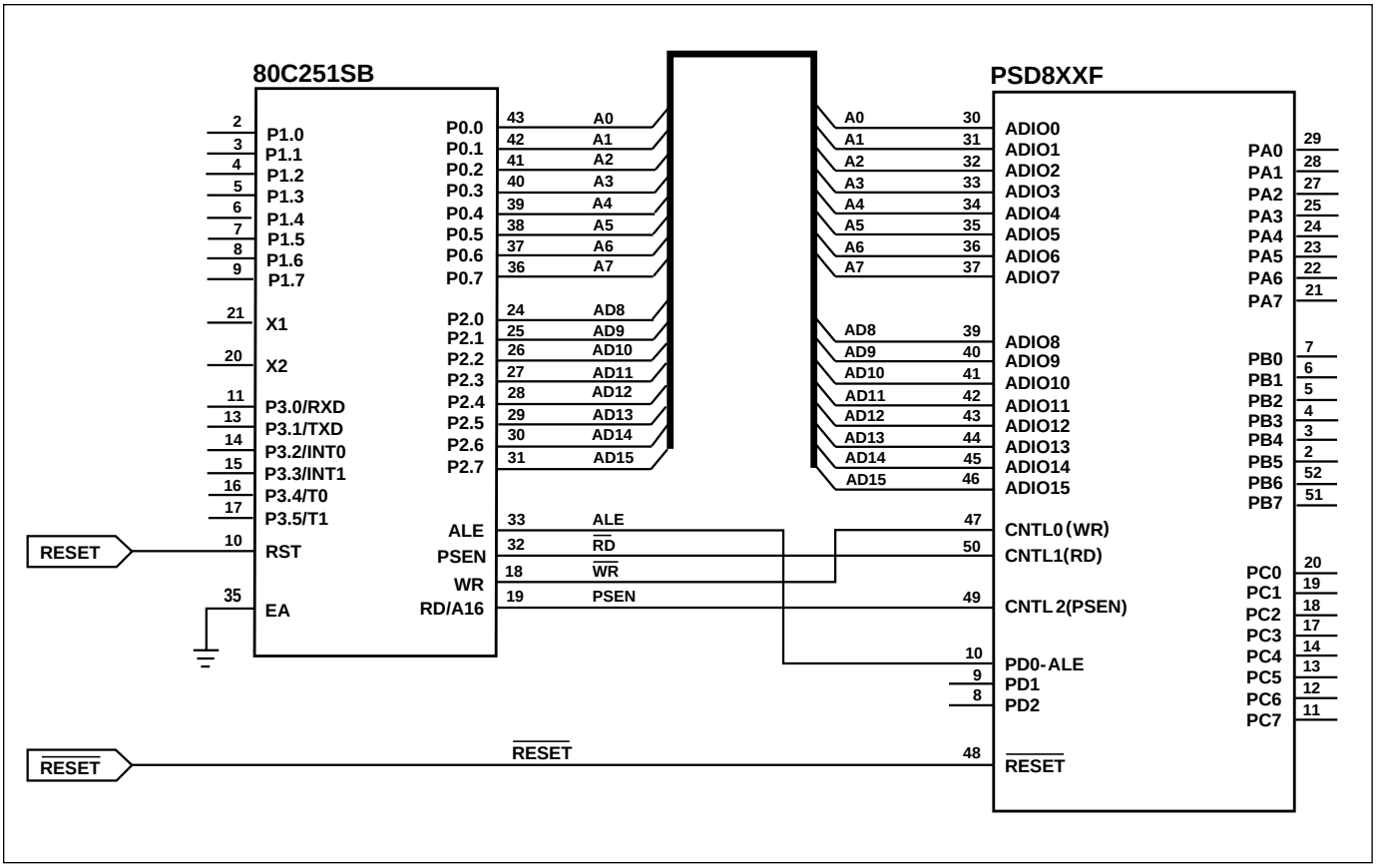


Figure 20. Interfacing the PSD8XXF to the 80C51XA, 8-Bit Data Bus

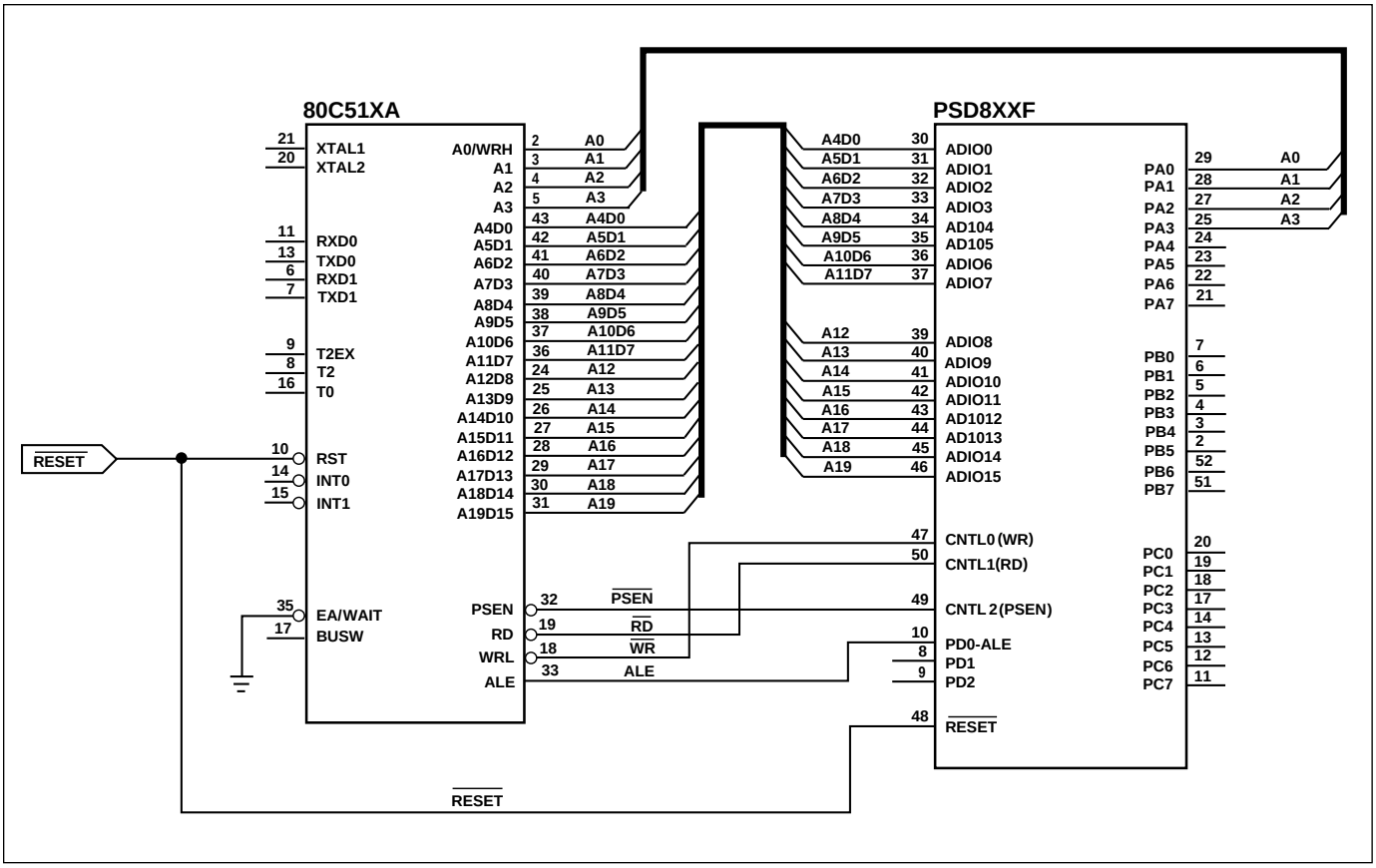
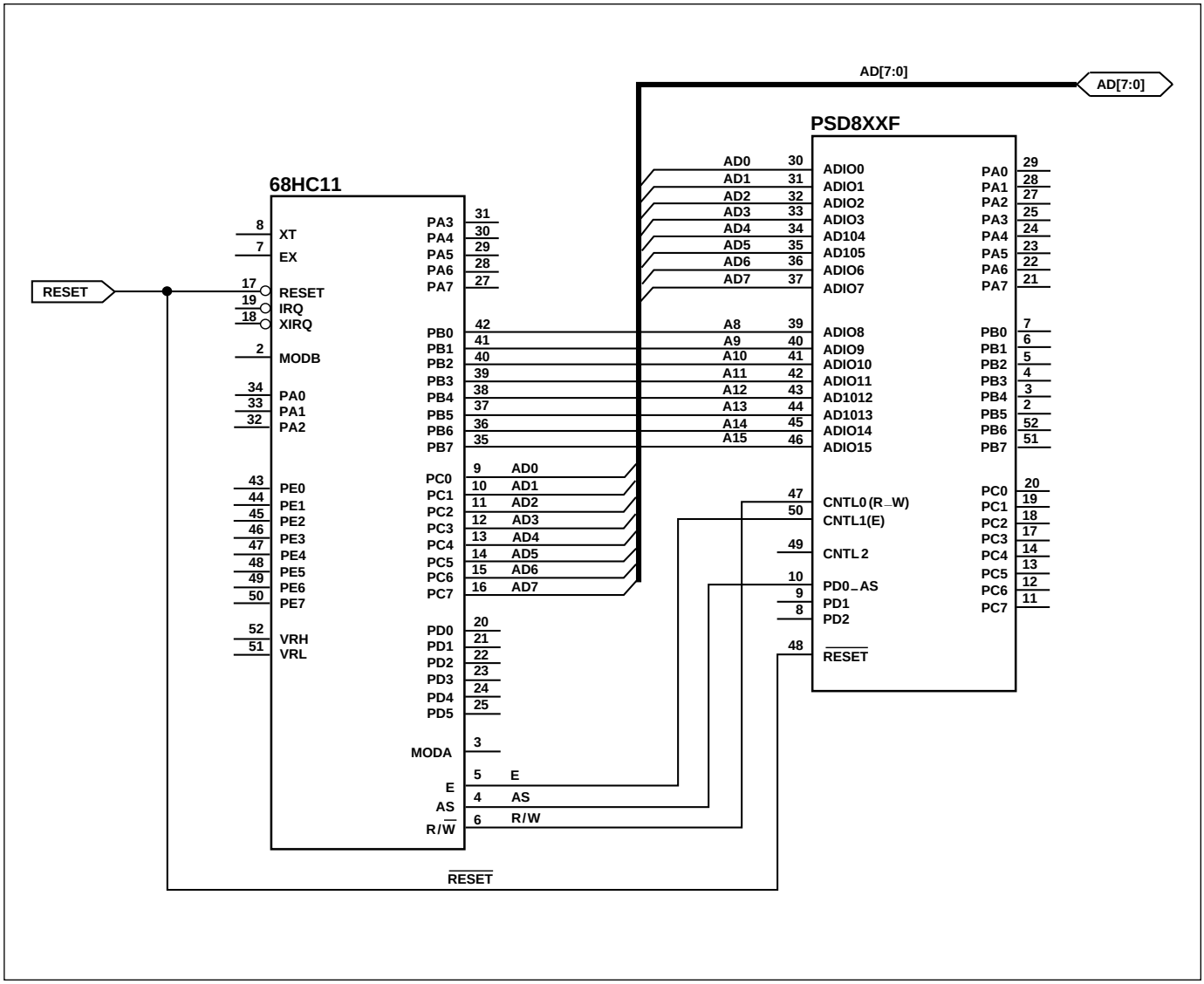


Figure 21. Interfacing the PSD8XXF with a 68HC11



The PSD8XXF Functional Blocks (cont.)

9.4 I/O Ports

There are four programmable I/O ports: Ports A, B, C, and D. Each of the ports is eight bits except Port D, which is 3 bits. Each port pin is individually user configurable, thus allowing multiple functions per port. The ports are configured using PSDsoft Configuration or by the microcontroller writing to on-chip registers in the CSIOP address space.

The topics discussed in this section are:

- General Port Architecture
- Port Operating Modes
- Port Configuration Registers
- Port Data Registers
- Individual Port Functionality.

9.4.1 General Port Architecture

The general architecture of the I/O Port is shown in Figure 22. Individual Port architectures are shown in Figures 24 through 27. In general, once the purpose for a port pin has been defined, that pin will no longer be available for other purposes. Exceptions will be noted.

As shown in Figure 22, the ports contain an output multiplexer whose selects are driven by the configuration bits in the Control Registers (Ports A and B only) and PSDsoft Configuration. Inputs to the multiplexer include the following:

- ❑ Output data from the Data Out Register
- ❑ Latched address outputs
- ❑ CPLD Micro⇔Cell output
- ❑ External Chip Select from CPLD.

The Port Data Buffer (PDB) is a tri-state buffer that allows only one source at a time to be read. The PDB is connected to the Internal Data Bus for feedback and can be read by the microcontroller. The Data Out and Micro⇔Cell outputs, Direction and Control Registers, and port pin input are all connected to the PDB.

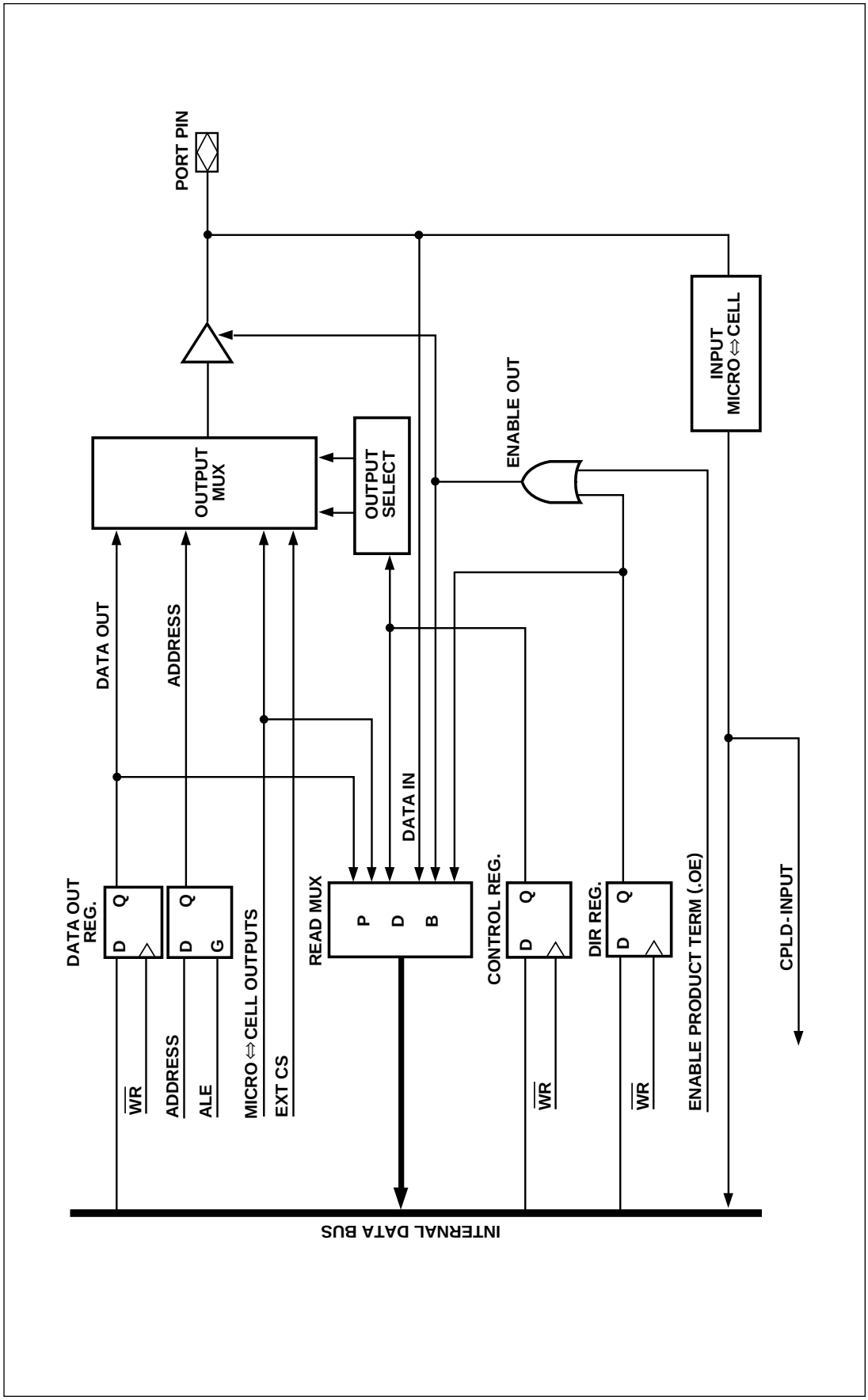
The Port pin's tri-state output driver enable is controlled by a two input OR gate whose inputs come from the CPLD AND array enable product term and the Direction Register. If the enable product term of any of the array outputs are not defined and that port pin is not defined as a CPLD output in the PSDabel file, then the Direction Register has sole control of the buffer that drives the port pin.

The contents of these registers can be altered by the microcontroller. The PDB feedback path allows the microcontroller to check the contents of the registers.

Ports A, B, and C have embedded Input Micro⇔Cells (IMCs). The IMCs can be configured as latches, registers, or direct inputs to the PLDs. The latches and registers are clocked by the address strobe (AS/ALE) or a product term from the PLD AND array. The outputs from the IMCs drive the PLD input bus and can be read by the microcontroller. Refer to the IMC subsection of the PLD section.

The PSD8XXF Functional Blocks (cont.)

Figure 22. General I/O Port Architecture



The PSD8XXF Functional Blocks (cont.)

9.4.2 Port Operating Modes

The I/O Ports have several modes of operation. Some modes can be defined using PSDabel, some by the microcontroller writing to the Control Registers in CSIOP space, and some by both. The modes that can only be defined using PSDsoft must be programmed into the device and cannot be changed unless the device is reprogrammed. The modes that can be changed by the microcontroller can be done so dynamically at run-time. The PLD I/O, Data Port, Address Input, and Peripheral I/O modes are the only modes that must be defined before programming the device. All other modes can be changed by the microcontroller at run-time. See Application Note 55 for more detail.

Table 20 summarizes which modes are available on each port. Table 23 shows how and where the different modes are configured. Each of the port operating modes are described in the following subsections.

Table 20. Port Operating Modes

Port Mode	Port A	Port B	Port C	Port D
MCU I/O	Yes	Yes	Yes	Yes
PLD I/O				
McellAB Outputs	Yes	Yes	No	No
McellBC Outputs	No	Yes	Yes	No
Additional Ext. CS Outputs	No	No	No	Yes
PLD Inputs	Yes	Yes	Yes	Yes
Address Out	Yes (A7 – 0)	Yes (A7 – 0) or A15 – 8)	No	No
Address In	Yes	Yes	Yes	Yes
Data Port	Yes (D7 – 0)	No	No	No
Peripheral I/O	Yes	No	No	No
JTAG ISP	No	No	Yes*	No

*Can be multiplexed with other I/O functions.

The PSD8XXF Functional Blocks (cont.)

Table 21. Port Operating Mode Settings

Mode	Defined In PSDabel	Defined In PSDconfiguration	Control Register Setting	Direction Register Setting	VM Register Setting	JTAG Enable
MCU I/O	Declare pins only	NA*	0	1 = output, 0 = input (Note 1)	NA	NA
PLD I/O	Logic equations	NA	NA	(Note 1)	NA	NA
Data Port (Port A)	NA	Specify bus type	NA	NA	NA	NA
Address Out (Port A,B)	Declare pins only	NA	1	1 (Note 1)	NA	NA
Address In (Port A,B,C,D)	Logic equation for Input Micro⇔Cells	NA	NA	NA	NA	NA
Peripheral I/O (Port A)	Logic equations (PSEL0 & 1)	NA	NA	NA	PIO bit = 1	NA
JTAG ISP (Note 2)	JTAGSEL	JTAG Configuration	NA	NA	NA	JTAG_ Enable

*NA = Not Applicable

NOTE: 1. The direction of the Port A,B,C, and D pins are controlled by the Direction Register ORed with the individual output enable product term (.oe) from the CPLD AND array.

2. Any of these three methods will enable JTAG pins on Port C.

9.4.2.1 MCU I/O Mode

In the MCU I/O Mode, the microcontroller uses the PSD8XXF ports to expand its own I/O ports. By setting up the CSIOP space, the ports on the PSD8XXF are mapped into the microcontroller address space. The addresses of the ports are listed in Table 7.

A port pin can be put into MCU I/O mode by writing a '0' to the corresponding bit in the Control Register. The MCU I/O direction may be changed by writing to the corresponding bit in the Direction Register, or by the output enable product term. See the subsection on the Direction Register in the "Port Registers" section. When the pin is configured as an output, the content of the Data Out Register drives the pin. When configured as an input, the microcontroller can read the port input through the Data In buffer. See Figure 22.

Ports C and D do not have Control Registers, and are in MCU I/O mode by default. They can be used for PLD I/O if equation are written for them in PSDabel.

9.4.2.2 PLD I/O Mode

The PLD I/O Mode uses a port as an input to the CPLD's Input Micro⇔Cells, and/or as an output from the CPLD's Output Micro⇔Cells. The output can be tri-stated with a control signal. This output enable control signal can be defined by a product term from the PLD, or by setting the corresponding bit in the Direction Register to '0'. The corresponding bit in the Direction Register must not be set to '1' if the pin is defined as a PLD input pin in PSDabel. The PLD I/O Mode is specified in PSDabel by declaring the port pins, and then writing an equation assigning the PLD I/O to a port.

The PSD8XXF Functional Blocks (cont.)

9.4.2.3 Address Out Mode

For microcontrollers with a multiplexed address/data bus, Address Out Mode can be used to drive latched addresses onto the port pins. These port pins can, in turn, drive external devices. Either the output enable or the corresponding bits of both the Direction Register and Control Register must be set to a '1' for pins to use Address Out Mode. This must be done by the MCU at run-time. See Table 22 for the address output pin assignments on Ports A and B for various MCUs.

For non-multiplexed 8 bit bus mode, address lines A[7:0] are available to Port B in Address Out Mode.

Note: do not drive address lines with Address Out Mode to an external memory device if it is intended for the MCU to boot from the external device. The MCU must first boot from PSD memory so the Direction and Control register bits can be set.

Table 22. I/O Port Latched Address Output Assignments

Microcontroller	Port A (3:0)	Port A (7:4)	Port B (3:0)	Port B (7:4)
8051XA (8-Bit)	N/A*	Address (7:4)	Address (11:8)	N/A
80C251 (Page Mode)	N/A	N/A	Address (11:8)	Address (15:12)
All Other 8-Bit Multiplexed	Address (3:0)	Address (7:4)	Address (3:0)	Address (7:4)
8-Bit Non-Multiplexed Bus	N/A	N/A	Address [3:0]	Address [7:4]

N/A = Not Applicable.

9.4.2.4 Address In Mode

For microcontrollers that have more than 16 address lines, the higher addresses can be connected to Port A, B, C, and D. The address input can be latched in the Input Micro⇔Cell by the address strobe (ALE/AS). Any input that is included in the DPLD equations for the Main Flash, Boot Flash, or SRAM is considered to be an address input.

9.4.2.5 Data Port Mode

Port A can be used as a data bus port for a microcontroller with a non-multiplexed address/data bus. The Data Port is connected to the data bus of the microcontroller. The general I/O functions are disabled in Port A if the port is configured as a Data Port.

9.4.2.6 Peripheral I/O Mode

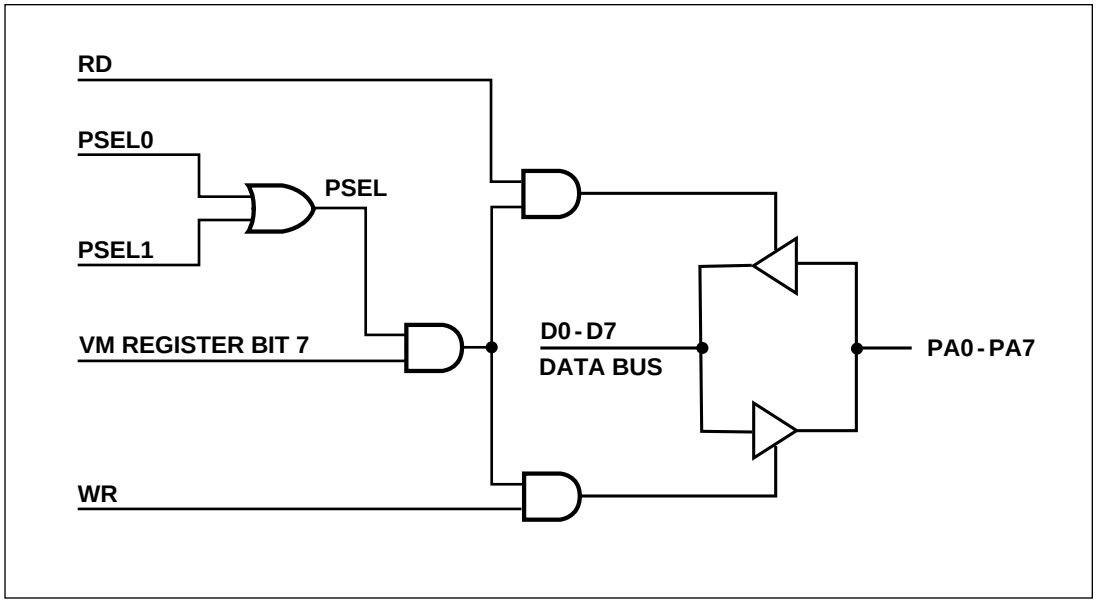
Peripheral I/O Mode can be used to interface with external peripherals. In this mode, all of Port A serves as a tri-stateable, bi-directional data buffer for the microcontroller. Peripheral I/O Mode is enabled by setting Bit 7 of the VM Register to a '1'. Figure 23 shows how Port A acts as a bi-directional buffer for the microcontroller data bus if Peripheral I/O Mode is enabled. An equation for PSEL0 and/or PSEL1 must be written in PSDabel. The buffer is tri-stated when PSEL 0 or 1 is not active.

9.4.2.7 JTAG ISP

Port C is JTAG compliant, and can be used for In-System Programming (ISP). You can multiplex JTAG operations with other functions on Port C because ISP is not performed during normal system operation. For more information on the JTAG Port, refer to section 9.6.

The PSD8XXF Functional Blocks (cont.)

Figure 23. Peripheral I/O Mode



9.4.3 Port Configuration Registers (PCRs)

Each port has a set of PCRs used for configuration. The contents of the registers can be accessed by the microcontroller through normal read/write bus cycles at the addresses given in Table 7. The addresses in Table 7 are the offsets in hex from the base of the CSIOP register.

The pins of a port are individually configurable and each bit in the register controls its respective pin. For example, Bit 0 in a register refers to Bit 0 of its port. The three PCRs, shown in Table 23, are used for setting the port configurations. The default power-up state for each register in Table 23 is 00h.

Table 23. Port Configuration Registers

Register Name	Port	MCU Access
Control	A,B	Write/Read
Direction	A,B,C,D	Write/Read
Drive Select*	A,B,C,D	Write/Read

***NOTE:** See Table 27 for Drive Register bit definition.

The PSD8XXF Functional Blocks (cont.)

9.4.3.1 Control Register

Any bit set to ‘0’ in the Control Register sets the corresponding Port pin to MCU I/O Mode, and a ‘1’ sets it to Address Out Mode. The default mode is MCU I/O. Only Ports A and B have an associated Control Register.

9.4.3.2 Direction Register

The Direction Register, in conjunction with the output enable (except for Port D), controls the direction of data flow in the I/O Ports. Any bit set to ‘1’ in the Direction Register will cause the corresponding pin to be an output, and any bit set to ‘0’ will cause it to be an input. The default mode for all port pins is input.

Figures 24 and 26 show the Port Architecture diagrams for Ports A/B and C, respectively. The direction of data flow for Ports A, B, and C are controlled not only by the direction register, but also by the output enable product term from the PLD AND array. If the output enable product term is not active, the Direction Register has sole control of a given pin’s direction.

An example of a configuration for a port with the three least significant bits set to output and the remainder set to input is shown in Table 26. Since Port D only contains three pins, the Direction Register for Port D has only the three least significant bits active.

Table 24. Port Pin Direction Control, Output Enable P.T. Not Defined

Direction Register Bit	Port Pin Mode
0	Input
1	Output

Table 25. Port Pin Direction Control, Output Enable P.T. Defined

Direction Register Bit	Output Enable P.T.	Port Pin Mode
0	0	Input
0	1	Output
1	0	Output
1	1	Output

Table 26. Port Direction Assignment Example

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	1	1	1

The PSD8XXF Functional Blocks (cont.)

9.4.3.3 Drive Select Register

The Drive Select Register configures the pin driver as Open Drain or CMOS for some port pins, and controls the slew rate for the other port pins. An external pull-up resistor should be used for pins configured as Open Drain.

A pin can be configured as Open Drain if its corresponding bit in the Drive Select Register is set to a '1'. The default pin drive is CMOS.

Aside: the slew rate is a measurement of the rise and fall times of an output. A higher slew rate means a faster output response and may create more electrical noise. A pin operates in a high slew rate when the corresponding bit in the Drive Register is set to '1'. The default rate is slow slew.

Table 27 shows the Drive Register for Ports A, B, C, and D. It summarizes which pins can be configured as Open Drain outputs and which pins the slew rate can be set for.

Table 27. Drive Register Pin Assignment

Drive Register	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Port A	Open Drain	Open Drain	Open Drain	Open Drain	Slew Rate	Slew Rate	Slew Rate	Slew Rate
Port B	Open Drain	Open Drain	Open Drain	Open Drain	Slew Rate	Slew Rate	Slew Rate	Slew Rate
Port C	Open Drain	Open Drain	Open Drain	Open Drain	Open Drain	Open Drain	Open Drain	Open Drain
Port D	NA	NA	NA	NA	NA	Slew Rate	Slew Rate	Slew Rate

NOTE: NA = Not Applicable.

The PSD8XXF Functional Blocks (cont.)

9.4.4 Port Data Registers

The Port Data Registers, shown in Table 28, are used by the microcontroller to write data to or read data from the ports. Table 28 shows the register name, the ports having each register type, and microcontroller access for each register type. The registers are described below.

9.4.4.1 Data In

Port pins are connected directly to the Data In buffer. In MCU I/O input mode, the pin input is read through the Data In buffer.

9.4.4.2 Data Out Register

Stores output data written by the MCU in the MCU I/O output mode. The contents of the Register are driven out to the pins if the Direction Register or the output enable product term is set to “1”. The contents of the register can also be read back by the microcontroller.

9.4.4.3 Output Micro⇔Cells (OMCs)

The CPLD OMCs occupy a location in the microcontroller’s address space. The microcontroller can read the output of the OMCs. If the Mask Micro⇔Cell Register bits are not set, writing to the Micro⇔Cell loads data to the Micro⇔Cell flip flops. Refer to the PLD section for more details.

9.4.4.4 Mask Micro⇔Cell Register

Each Mask Register bit corresponds to an OMC flip flop. When the Mask Register bit is set to a “1”, loading data into the OMC flip flop is blocked. The default value is “0” or unblocked.

9.4.4.5 Input Micro⇔Cells (IMCs)

The IMCs can be used to latch or store external inputs. The outputs of the IMCs are routed to the PLD input bus, and can be read by the microcontroller. Refer to the PLD section for a detailed description.

9.4.4.6 Enable Out

The Enable Out register can be read by the microcontroller. It contains the output enable values for a given port. A “1” indicates the driver is in output mode. A “0” indicates the driver is in tri-state and the pin is in input mode.

Table 28. Port Data Registers

Register Name	Port	MCU Access
Data In	A,B,C,D	Read – input on pin
Data Out	A,B,C,D	Write/Read
Output Micro⇔Cell	A,B,C	Read – outputs of Micro⇔Cells Write – loading Micro⇔Cells Flip-Flop
Mask Micro⇔Cell	A,B,C	Write/Read – prevents loading into a given Micro⇔Cell
Input Micro⇔Cell	A,B,C	Read – outputs of the Input Micro⇔Cells
Enable Out	A,B,C	Read – the output enable control of the port driver

The PSD8XXF Functional Blocks (cont.)

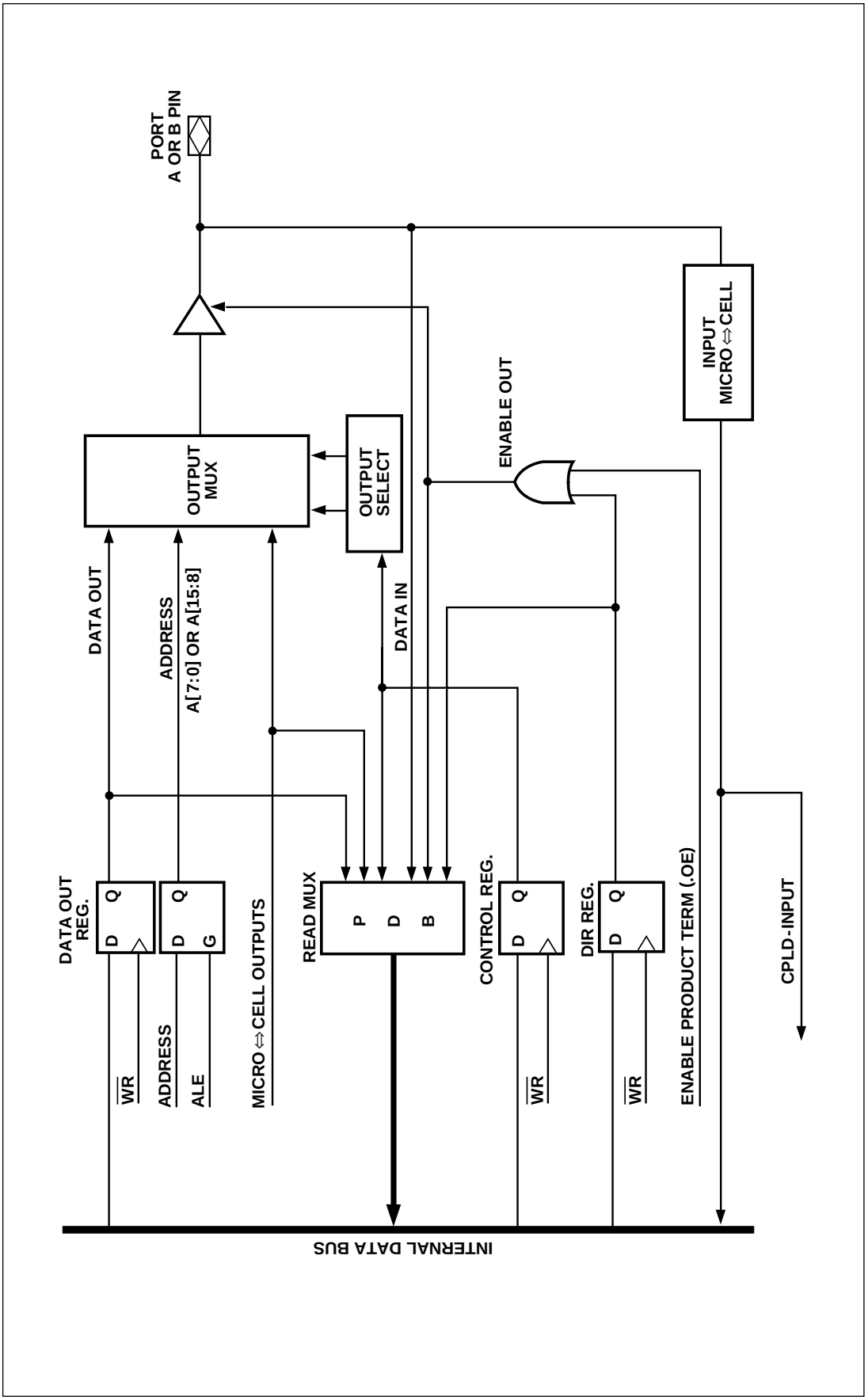
9.4.5 Ports A and B – Functionality and Structure

Ports A and B have similar functionality and structure, as shown in Figure 24. The two ports can be configured to perform one or more of the following functions:

- ❑ MCU I/O Mode
- ❑ CPLD Output – Micro⇔Cells McellAB[7:0] can be connected to Port A or Port B. McellBC[7:0] can be connected to Port B or Port C.
- ❑ CPLD Input – Via the input Micro⇔Cells.
- ❑ Latched Address output – Provide latched address output per Table 30.
- ❑ Address In – Additional high address inputs using the Input Micro⇔Cells.
- ❑ Open Drain/Slew Rate – pins PA[3:0] and PB[3:0] can be configured to fast slew rate, pins PA[7:4] and PB[7:4] can be configured to Open Drain Mode.
- ❑ Data Port – Port A to D[7:0] for 8 bit non-multiplexed bus
- ❑ Multiplexed Address/Data port for certain types of microcontroller interfaces.
- ❑ Peripheral Mode – Port A only

The PSD8XXF Functional Blocks (cont.)

Figure 24. Ports A and B Structure



The PSD8XXF Functional Blocks (cont.)

9.4.6 Port C – Functionality and Structure

Port C can be configured to perform one or more of the following functions (see Figure 25):

- ❑ MCU I/O Mode
- ❑ CPLD Output – McellBC[7:0] outputs can be connected to Port B or Port C.
- ❑ CPLD Input – via the Input Micro⇔Cells
- ❑ Address In – Additional high address inputs using the Input Micro⇔Cells.
- ❑ In-System Programming – JTAG port can be enabled for programming/erase of the PSD8XXF device. (See Section 9.6 for more information on JTAG programming.)
- ❑ Open Drain – Port C pins can be configured in Open Drain Mode
- ❑ Battery Backup features – PC2 can be configured as a Battery Input (Vstby) pin. PC4 can be configured as a Battery On Indicator output pin, indicating when Vcc is less than Vbat.

Port C does not support Address Out mode, and therefore no Control Register is required. Pin PC7 may be configured as the DBE input in certain microcontroller interfaces.

9.4.7 Port D – Functionality and Structure

Port D has three I/O pins. See Figure 26. This port does not support Address Out mode, and therefore no Control Register is required. Port D can be configured to perform one or more of the following functions:

- ❑ MCU I/O Mode
- ❑ CPLD Output – (external chip select)
- ❑ CPLD Input – direct input to CPLD, no Input Micro⇔Cells
- ❑ Slew rate – pins can be set up for fast slew rate

Port D pins can be configured in PSDsoft as input pins for other dedicated functions:

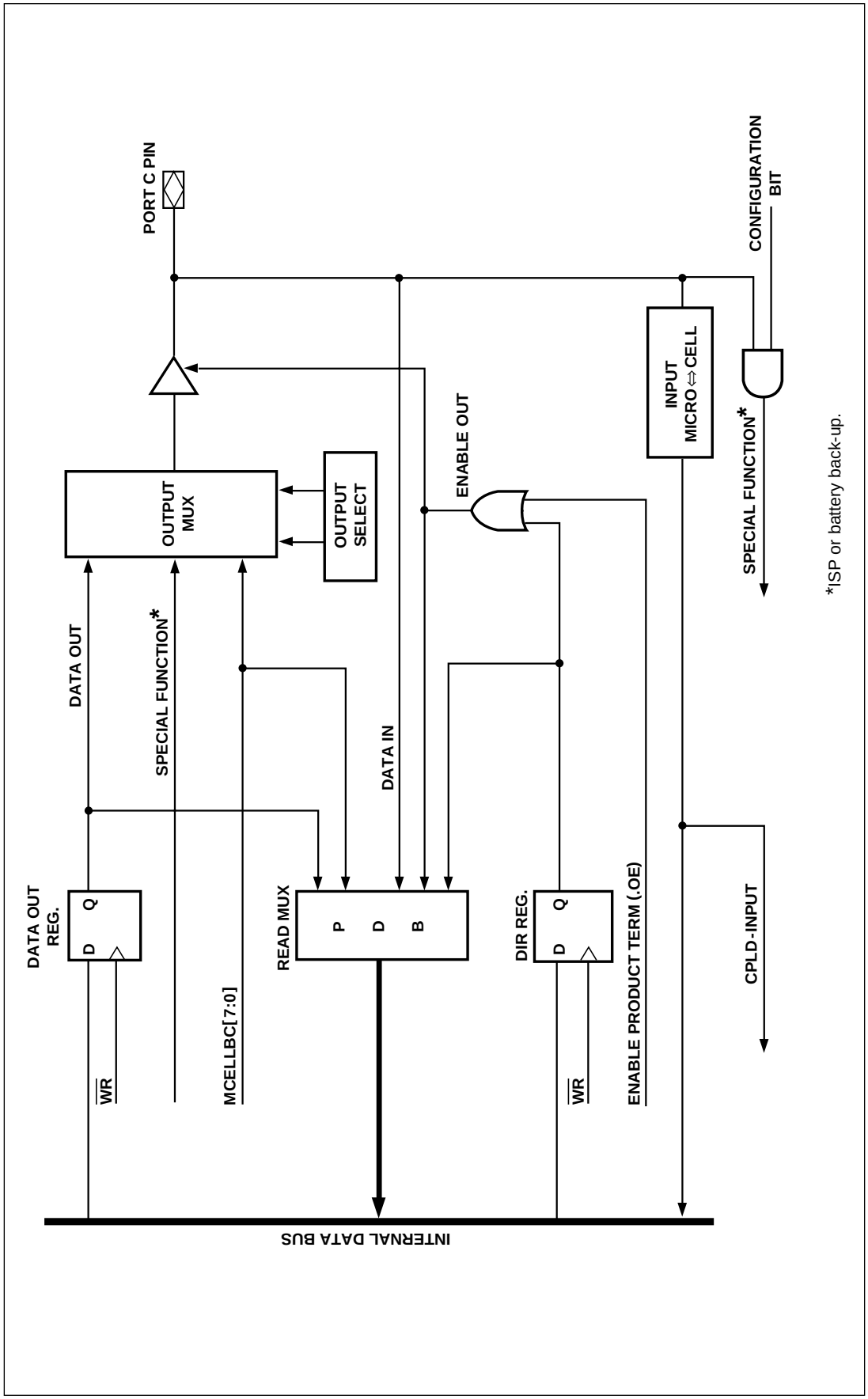
- ❑ PD0 – ALE, as address strobe input
- ❑ PD1 – CLKIN, as clock input to the Micro⇔Cells Flip Flops and APD counter
- ❑ PD2 – CSI, as active low chip select input. A high input will disable the Flash/SRAM and CSIOP.

9.4.7.1 External Chip Select

The CPLD also provides three chip select outputs on Port D pins that can be used to select external devices. Each chip select (ECS0-2) consists of one product term that can be configured active high or low. The output enable of the pin is controlled by either the output enable product term or the Direction Register. (See Figure 27.)

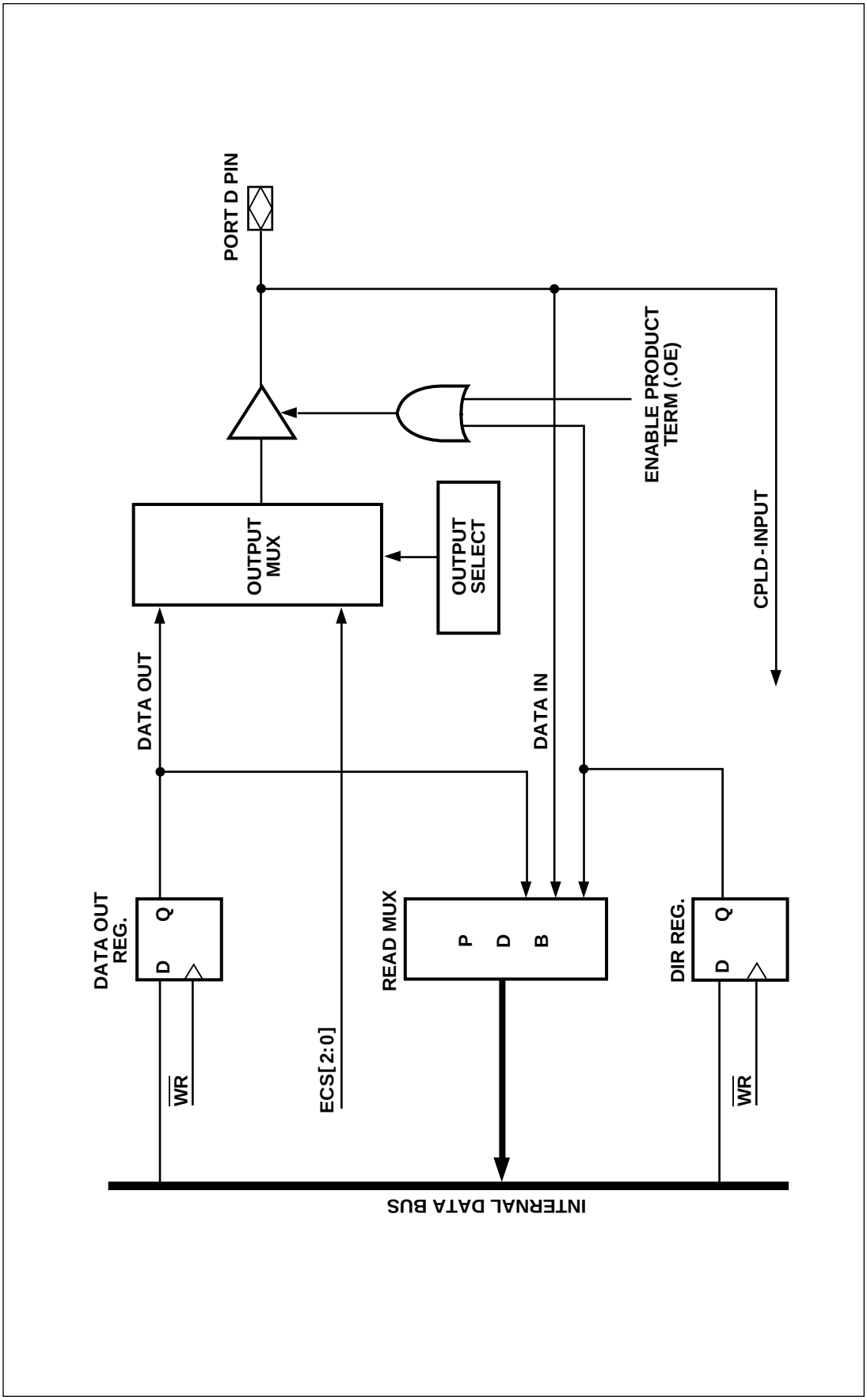
The PSD8XXF Functional Blocks (cont.)

Figure 25. Port C Structure



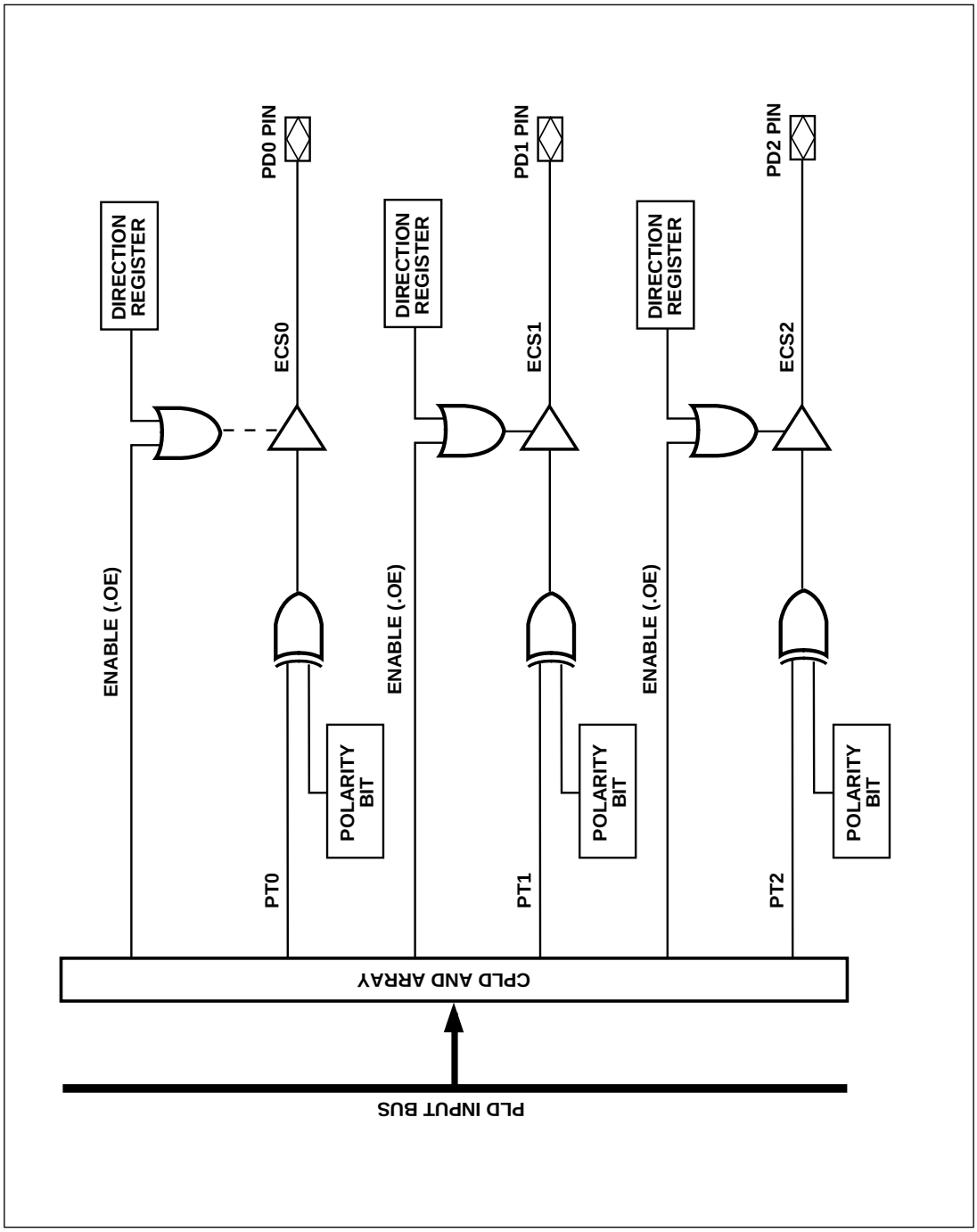
The PSD8XXF Functional Blocks (cont.)

Figure 26. Port D Structure



The PSD8XXF Functional Blocks (cont.)

Figure 27. Port D External Chip Selects



The PSD8XXF Functional Blocks (cont.)

9.5 Power Management

The PSD8XXF offers configurable power saving options. These options may be used individually or in combinations, as follows:

- All memory types in a PSD (Flash, Flash Boot Block, and SRAM) are built with Zero-Power technology. In addition to using special silicon design methodology, Zero-Power technology puts the memories into standby mode when address/data inputs are not changing (zero DC current). As soon as a transition occurs on an input, the affected memory “wakes up”, changes and latches its outputs, then goes back to standby. The designer does **not** have to do anything special to achieve memory standby mode when no inputs are changing—it happens automatically.

  The PLD sections can also achieve standby mode when its inputs are not changing, see PMMR registers below.

- Like the Zero-Power feature, the Automatic Power Down (APD) logic allows the PSD to reduce to standby current automatically. The APD will block MCU address/data signals from reaching the memories and PLDs. This feature is available on all PSD8XXF devices. The APD unit is described in more detail in section 9.5.1.

  Built in logic will monitor the address strobe of the MCU for activity. If there is no activity for a certain time period (MCU is asleep), the APD logic initiates Power Down Mode (if enabled). Once in Power Down Mode, all address/data signals are blocked from reaching PSD memories and PLDs, and the memories are deselected internally. This allows the memories and PLDs to remain in standby mode even if the address/data lines are changing state externally (noise, other devices on the MCU bus, etc.). Keep in mind that any unblocked PLD input signals that are changing states keeps the PLD out of standby mode, but not the memories.

- The PSD Chip Select Input (CSI) on all families can be used to disable the internal memories, placing them in standby mode even if inputs are changing. This feature does not block any internal signals or disable the PLDs. This is a good alternative to using the APD logic, especially if your MCU has a chip select output. There is a slight penalty in memory access time when the CSI signal makes its initial transition from deselected to selected.

- The PMMR registers can be written by the MCU at run-time to manage power. All PSD devices support “blocking bits” in these registers that are set to block designated signals from reaching both PLDs. Current consumption of the PLDs is directly related to the composite frequency of the changes on their inputs (see Figures 31 and 31a). Significant power savings can be achieved by blocking signals that are not used in DPLD or CPLD logic equations.

  The PSD8XXF devices have a Turbo Bit in the PMMR0 register. This bit can be set to disable the Turbo Mode feature (default is Turbo Mode on). While Turbo Mode is disabled, the PLDs can achieve standby current when no PLD inputs are changing (zero DC current). Even when inputs do change, significant power can be saved at lower frequencies (AC current), compared to when Turbo Mode is enabled. Conversely, when the Turbo Mode is enabled, there is a significant DC current component and the AC component is higher.

9.5.1 Automatic Power Down (APD) Unit and Power Down Mode

The APD Unit, shown in Figure 28, puts the PSD into Power Down Mode by monitoring the activity of the address strobe (ALE/AS). If the APD unit is enabled, as soon as activity on the address strobe stops, a four bit counter starts counting. If the address strobe remains inactive for fifteen clock periods of the CLKIN signal, the Power Down (PDN) signal becomes active, and the PSD will enter into Power Down Mode, discussed next.

The PSD8XXF Functional Blocks (cont.)

9.5.1 Automatic Power Down (APD) Unit and Power Down Mode (cont.)

Power Down Mode

By default, if you enable the PSD APD unit, Power Down Mode is automatically enabled. The device will enter Power Down Mode if the address strobe (ALE/AS) remains inactive for fifteen CLKIN (pin PD1) clock periods.

The following should be kept in mind when the PSD is in Power Down Mode:

- If the address strobe starts pulsing again, the PSD will return to normal operation. The PSD will also return to normal operation if either the CSI input returns low or the Reset input returns high.
- The MCU address/data bus is blocked from all memories and PLDs.
- Various signals can be blocked (prior to Power Down Mode) from entering the PLDs by setting the appropriate bits in the PMMR registers. The blocked signals include MCU control signals and the common clock (CLKIN). Note that blocking CLKIN from the PLDs will not block CLKIN from the APD unit.
- All PSD memories enter Standby Mode and are drawing standby current. However, the PLDs and I/O ports do **not** go into Standby Mode because you don't want to have to wait for the logic and I/O to "wake-up" before their outputs can change. See table 29 for Power Down Mode effects on PSD ports.
- Typical standby current is in µA range. This standby current value assumes that there are no transitions on any PLD input.

Table 29. Power Down Mode's Effect on Ports

Port Function	Pin Level
MCU I/O	No Change
PLD Out	No Change
Address Out	Undefined
Data Port	Three-State
Peripheral I/O	Three-State

Table 30. PSD8XXF Timing and Standby Current During Power Down Mode

Mode	PLD Propagation Delay	Memory Access Time	Access Recovery Time to Normal Access	5V V_{CC}, Typical Standby Current
Power Down	Normal tpd (Note 1)	No Access	tLVDV	75 µA (Note 2)

NOTES: 1. Power Down does not affect the operation of the PLD. The PLD operation in this mode is based only on the Turbo Bit.
2. Typical current consumption assuming no PLD inputs are changing state and the PLD Turbo bit is off.

HC11 (or compatible) Users Note

The HC11 turns off its E clock when it sleeps. Therefore, if you are using an HC11 (or compatible) in your design, and you wish to use the Power Down, you must not connect the E clock to the CLKIN input (PD1). You should instead connect an independent clock signal to the CLKIN input. The clock frequency must be **less than** 15 times the frequency of AS. The reason for this is that if the frequency is greater than 15 times the frequency of AS, the PSD8XXF will keep going into Power Down Mode.

The PSD8XXF Functional Blocks (cont.)

Figure 28. APD Logic Block

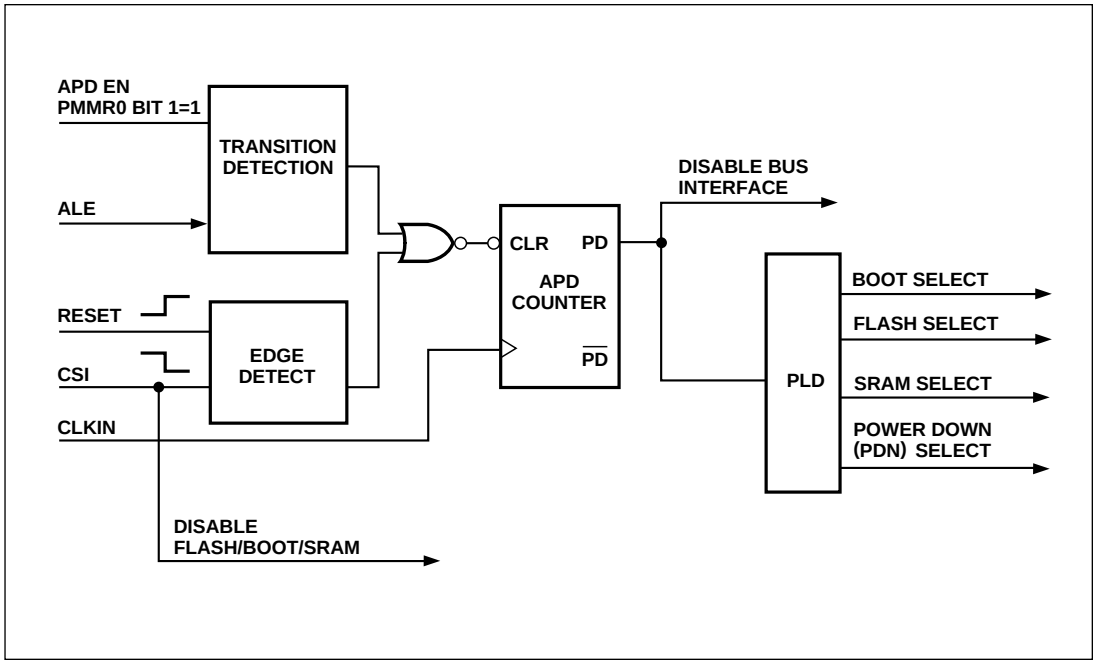
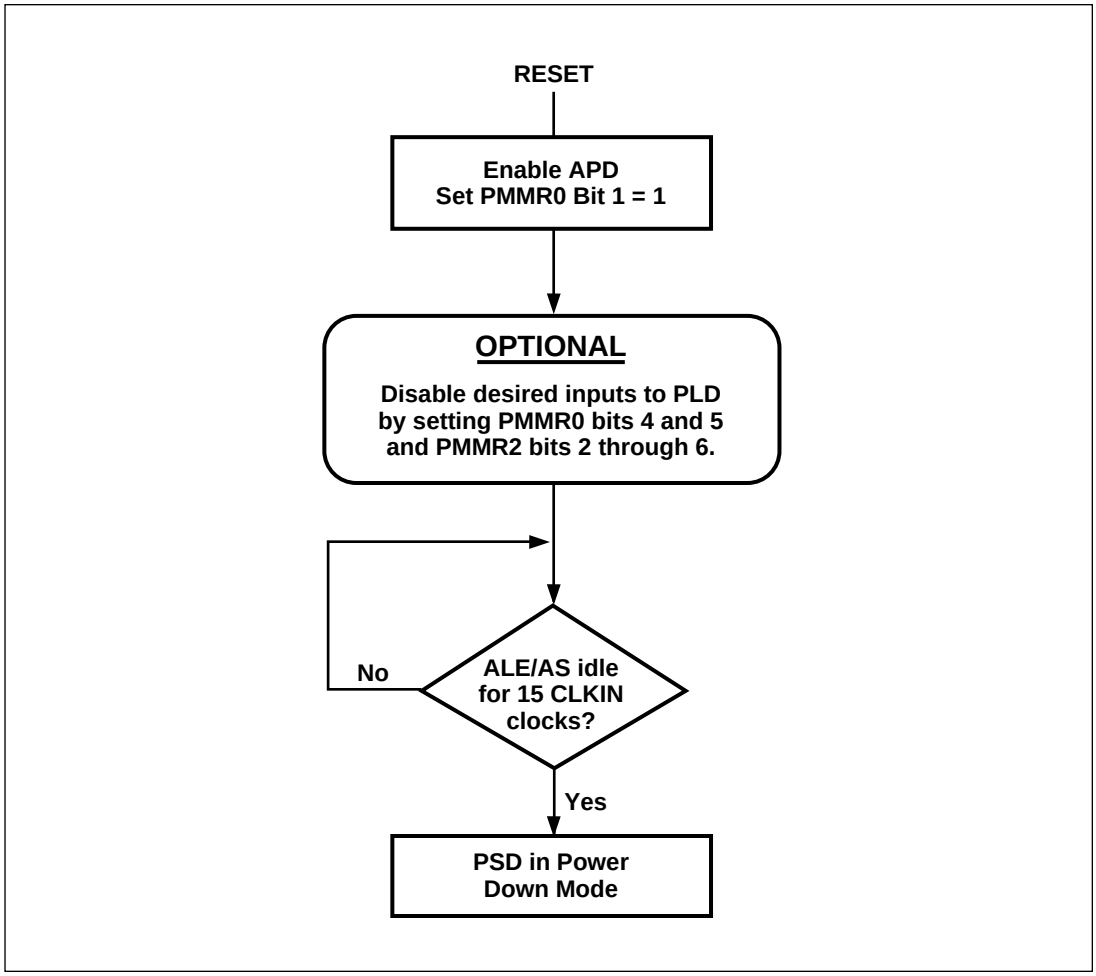


Figure 29. Enable Power Down Flow Chart



The PSD8XXF Functional Blocks (cont.)

Table 31. Power Management Mode Registers (PMMR0, PMMR2)**

PMMR0

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
*	*	PLD Mcell clk	PLD Array clk	PLD Turbo	*	APD Enable	*
		1 = off	1 = off	1 = off		1 = on	

*Bits 0, 2, 6, and 7 are not used, and should be set to 0.

**The PMMR0, and PMMR2 register bits are cleared to zero following power up. Subsequent reset pulses will not clear the registers.

Bit 1 0 = Automatic Power Down (APD) is disabled.
1 = Automatic Power Down (APD) is enabled.

Bit 3 0 = PLD Turbo is on.
1 = PLD Turbo is off, saving power.

Bit 4 0 = CLKIN input to the PLD AND array is connected.
Every CLKIN change will power up the PLD when Turbo bit is off.
1 = CLKIN input to PLD AND array is disconnected, saving power.

Bit 5 0 = CLKIN input to the PLD Micro⇔Cells is connected.
1 = CLKIN input to PLD Micro⇔Cells is disconnected, saving power.

PMMR2

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
*	PLD array DBE	PLD array ALE	PLD** array CNTL2	PLD** array CNTL1	PLD** array CNTL0	*	*
	1 = off	1 = off	1 = off	1 = off	1 = off		

*Unused bits should be set to 0.

**Refer to Table 17 the signals that are blocked on pins CNTL0-2.

Bit 2 0 = Cntl0 input to the PLD AND array is connected.
1 = Cntl0 input to PLD AND array is disconnected, saving power.

Bit 3 0 = Cntl1 input to the PLD AND array is connected.
1 = Cntl1 input to PLD AND array is disconnected, saving power.

Bit 4 0 = Cntl2 input to the PLD AND array is connected.
1 = Cntl2 input to PLD AND array is disconnected, saving power.

Bit 5 0 = ALE input to the PLD AND array is connected.
1 = ALE input to PLD AND array is disconnected, saving power.

Bit 6 0 = DBE input to the PLD AND array is connected.
1 = DBE input to PLD AND array is disconnected, saving power.

The PSD8XXF Functional Blocks (cont.)

Table 32. APD Counter Operation

APD Enable Bit	ALE PD Polarity	ALE Level	APD Counter
0	X	X	Not Counting
1	X	Pulsing	Not Counting
1	1	1	Counting (Generates PDN after 15 Clocks)
1	0	0	Counting (Generates PDN after 15 Clocks)

9.5.2 Other Power Saving Options

The PSD8XXF offers other reduced power saving options that are independent of the Power Down Mode. Except for the SRAM Standby and CSI input features, they are enabled by setting bits in the PMMR0 and PMMR2 registers.

9.5.2.1 Zero Power PLD

The power and speed of the PLDs are controlled by the Turbo bit (bit 3) in the PMMR0. By setting the bit to “1”, the Turbo mode is disabled and the PLDs consume Zero Power current when the inputs are not switching for an extended time of 70 ns. The propagation delay time will be increased by 10 ns after the Turbo bit is set to “1” (turned off) when the inputs change at a composite frequency of less than 15 MHz. When the Turbo bit is set to a “0” (turned on), the PLDs run at full power and speed. The Turbo bit affects the PLD’s D.C. power, AC power, and propagation delay.

Note: Blocking MCU control signals with PMMR2 bits can further reduce PLD AC power consumption.

9.5.2.2 SRAM Standby Mode (Battery Backup)

The PSD8XXF supports a battery backup operation that retains the contents of the SRAM in the event of a power loss. The SRAM has a Vstby pin (PC2) that can be connected to an external battery. When V_{CC} becomes lower than Vstby then the PSD will automatically connect to Vstby as a power source to the SRAM. The SRAM Standby Current (Istby) is typically 0.5 µA. The SRAM data retention voltage is 2 V minimum. The battery-on indicator (Vbaton) can be routed to PC4. This signal indicates when the V_{CC} has dropped below the Vstby voltage.

9.5.2.3 The CSI Input

Pin PD2 of Port D can be configured in PSDsoft as the CSI input. When low, the signal selects and enables the internal Flash, Boot Block, SRAM, and I/O for read or write operations involving the PSD8XXF. A high on the CSI pin will disable the Flash memory, Boot Block, and SRAM, and reduce the PSD power consumption. However, the PLD and I/O pins remain operational when CSI is high. **Note:** there may be a timing penalty when using the CSI pin depending on the speed grade of the PSD that you are using. See the timing parameter t_{SLQV} in the AC/DC specs.

9.5.2.4 Input Clock

The PSD8XXF provides the option to turn off the CLKIN input to the PLD to save AC power consumption. The CLKIN is an input to the PLD AND array and the Output Micro⇔Cells. During Power Down Mode, or, if the CLKIN input is not being used as part of the PLD logic equation, the clock should be disabled to save AC power. The CLKIN will be disconnected from the PLD AND array or the Micro⇔Cells by setting bits 4 or 5 to a “1” in PMMR0.

9.5.2.5 Input Control Signals

The PSD8XXF provides the option to turn off the input control signals (CNTL0-2, ALE, and DBE) to the PLD to save AC power consumption. These control signals are inputs to the PLD AND array. During Power Down Mode, or, if any of them are not being used as part of the PLD logic equation, these control signals should be disabled to save AC power. They will be disconnected from the PLD AND array by setting bits 2, 3, 4, 5, and 6 to a “1” in the PMMR2.

The PSD8XXF Functional Blocks (cont.)

9.5.3 Reset and Power On Requirement

9.5.3.1 Power On Reset

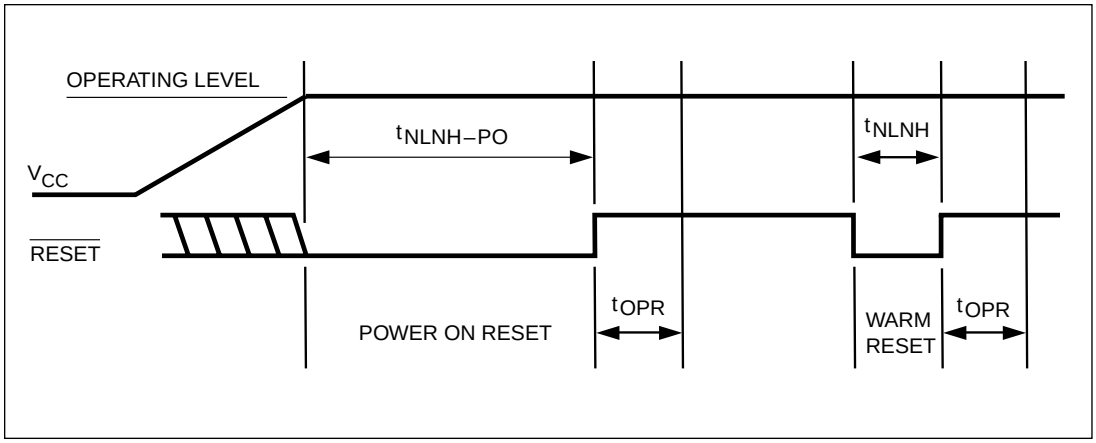
Upon power up the PSD8XXF requires a reset pulse of tNLNH-PO (minimum 1 ms) after V_{CC} is steady. During this time period the device loads internal configurations, clears some of the registers and sets the Flash into operating mode. After the rising edge of reset, the PSD8XXF remains in the reset state for an additional tOPR (minimum 120 ns) nanoseconds before the first memory access is allowed.

The PSD8XXF Flash memory is reset to the read array mode upon power up. The FSi and CSBOOTi select signals along with the write strobe signal must be in the false state during power-up reset for maximum security of the data contents and to remove the possibility of a byte being written on the first edge of a write strobe signal. Any Flash memory write cycle initiation is prevented automatically when V_{CC} is below VLKO.

9.5.3.2 Warm Reset

Once the device is up and running, the device can be reset with a much shorter pulse of tNLNH (minimum 150 ns). The same tOPR time is needed before the device is operational after warm reset. Figure 30 shows the timing of the power on and warm reset.

Figure 30. Power On and Warm Reset Timing



9.5.3.3 I/O Pin, Register and PLD Status at Reset

Table 33 shows the I/O pin, register and PLD status during power on reset, warm reset and power down mode. PLD outputs are always valid during warm reset, and they are valid in power on reset once the internal PSD configuration bits are loaded. This loading of PSD is completed typically long before the V_{CC} ramps up to operating level. Once the PLD is active, the state of the outputs are determined by the PSDabel equations.

The PSD8XXF Functional Blocks (cont.)

Table 33. Status During Power On Reset, Warm Reset and Power Down Mode

Port Configuration	Power On Reset	Warm Reset	Power Down Mode
MCU I/O	Input Mode	Input Mode	Unchanged
PLD Output	Valid after internal PSD configuration bits are loaded	Valid	Depend on inputs to PLD (address are blocked in PD mode)
Address Out	Tri-stated	Tri-stated	Not defined
Data Port	Tri-stated	Tri-stated	Tri-stated
Peripheral I/O	Tri-stated	Tri-stated	Tri-stated

Register	Power On Reset	Warm Reset	Power Down Mode
PMMR0, 2	Cleared to “0”	Unchanged	Unchanged
Micro⇔Cells Flip Flop status	Cleared to “0” by internal power on reset	Depend on .re and .pr equations	Depend on .re and .pr equations
VM Register*	Initialized based on the selection in PSDsoft Configuration Menu.	Initialized based on the selection in PSDsoft Configuration Menu.	Unchanged
All other registers	Cleared to “0”	Cleared to “0”	Unchanged

*SR_cod and Periph Mode bits in the VM Register are always cleared to zero on power on or warm reset.

9.5.3.4 Reset of Flash Erase and Programming Cycles (PSD833/834/853/854F Only)

An external reset on the RESET pin will also reset the internal Flash memory state machine. When the Flash is in programming or erase mode, the RESET pin will terminate the programming or erase operation and return the Flash back to read mode in tNLNH-A (minimum 25 µs) time.

9.6 Programming In-Circuit using the JTAG Interface

The JTAG interface on the PSD8XXF can be enabled on Port C (see Table 34). All memory (Flash and Flash Boot Block), PLD logic, and PSD configuration bits may be programmed through the JTAG interface. A blank part can be mounted on a printed circuit board and programmed using JTAG.

The standard JTAG signals (IEEE 1149.1) are TMS, TCK, TDI, and TDO. Two additional signals, $\overline{\text{TSTAT}}$ and $\overline{\text{TERR}}$, are optional JTAG extensions used to speed up program and erase operations.

By default, on a blank PSD (as shipped from factory or after erasure), four pins on Port C are enabled for the basic JTAG signals TMS, TCK, TDI, and TDO.

See Application Note 54 for more details on JTAG In-System-Programming.

Table 34. JTAG Port Signals

Port C Pin	JTAG Signals	Description
PC0	TMS	Mode Select
PC1	TCK	Clock
PC3	$\overline{\text{TSTAT}}$	Status
PC4	$\overline{\text{TERR}}$	Error Flag
PC5	TDI	Serial Data In
PC6	TDO	Serial Data Out

The PSD8XXF Functional Blocks (cont.)

9.6.1 Standard JTAG Signals

The standard JTAG signals (TMS, TCK, TDI, and TDO) can be enabled by any of three different conditions that are logically ORed. When enabled, TDI, TDO, TCK, and TMS are inputs, waiting for a serial command from an external JTAG controller device (such as FlashLink or Automated Test Equipment). When the enabling command is received from the external JTAG controller, TDO becomes an output and the JTAG channel is fully functional inside the PSD. The same command that enables the JTAG channel may optionally enable the two additional JTAG pins, TSTAT and TERR.

The following symbolic logic equation specifies the conditions enabling the four basic JTAG pins (TMS, TCK, TDI, and TDO) on their respective Port C pins. For purposes of discussion, the logic label JTAG_ON will be used. When JTAG_ON is true, the four pins are enabled for JTAG. When JTAG_ON is false, the four pins can be used for general PSD I/O.

```
JTAG_ON =   PSDsoft_enabled  +
                    /* An NVM configuration bit inside the PSD is set by the designer
                       in the PSDsoft Configuration utility.  This dedicates the pins for
                       JTAG at all times (compliant with IEEE 1149.1) */

            Microcontroller_enabled  +
                    /* The microcontroller can set a bit at run-time by writing to the
                       PSD register, JTAG Enable. This register is located at address
                       CSIOP + offset C7h. Setting the JTAG_ENABLE bit in this
                       register will enable the pins for JTAG use. This bit is cleared
                       by a PSD reset or the microcontroller. See Table 35 for bit
                       definition. */

            PSD_product_term_enabled;
                    /* A dedicated product term (PT) inside the PSD can be used to
                       enable the JTAG pins. This PT has the reserved name
                       JTAGSEL. Once defined as a node in PSDabel, the designer
                       can write an equation for JTAGSEL. This method is used when
                       the Port C JTAG pins are multiplexed with other I/O signals.
                       It is recommended to logically tie the node JTAGSEL to the
                       JEN\ signal on the Flashlink cable when multiplexing JTAG
                       signals. See Application Note 54 for details.
```

Table 35. JTAG Enable Register

JTAG Enable

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
*	*	*	*	*	*	*	JTAG_ENABLE

*Bits 1-7 are not used and should set to 0.

Bit definitions:

JTAG_ENABLE 1 = JTAG Port is Enabled.
0 = JTAG Port is Disabled.

NOTE:
The state of the PSD reset input signal will not interrupt (or prevent) JTAG operations if the JTAG pins are dedicated by an NVM configuration bit (via PSDsoft). However, the PSD reset input will prevent or interrupt JTAG operations if the JTAG enable register is used to enable the JTAG pins.

The PSD8XXF Functional Blocks (cont.)

9.6.1 Standard JTAG Signals (cont.)

The PSD8XXF supports JTAG In-System-Configuration (ISC) commands, but not Boundary Scan. A definition of these JTAG-ISC commands and sequences are defined in a supplemental document available from ST. ST's PSDsoft software tool and FlashLink JTAG programming cable implement these JTAG-ISC commands. This document is needed only as a reference for designers who use a FlashLink to program their PSD8XXF.

9.6.2 JTAG Extensions

$\overline{\text{TSTAT}}$ and $\overline{\text{TERR}}$ are two JTAG extension signals enabled by an "ISC_ENABLE" command received over the four standard JTAG pins (TMS, TCK, TDI, and TDO). They are used to speed programming and erase functions by indicating status on PSD pins instead of having to scan the status out serially using the standard JTAG channel. See Application Note 54.

$\overline{\text{TERR}}$ will indicate if an error has occurred when erasing a sector or programming a byte in Flash memory. This signal will go low (active) when an error condition occurs, and stay low until an "ISC_CLEAR" command is executed or a chip reset pulse is received after an "ISC-DISABLE" command.

$\overline{\text{TSTAT}}$ behaves the same as the Rdy/Bsy signal described in section 9.1.1.2. $\overline{\text{TSTAT}}$ will be high when the PSD8XXF device is in read array mode (Flash memory and Boot Block contents can be read). $\overline{\text{TSTAT}}$ will be low when Flash memory programming or erase cycles are in progress, and also when data is being written to the Flash Boot Block.

$\overline{\text{TSTAT}}$ and $\overline{\text{TERR}}$ can be configured as open-drain type signals during an "ISC_ENABLE" command. This facilitates a wired-OR connection of $\overline{\text{TSTAT}}$ signals from several PSD8XXF devices and a wired-OR connection of $\overline{\text{TERR}}$ signals from those same devices. This is useful when several PSD8XXF devices are "chained" together in a JTAG environment.

9.6.3 Security and Flash Memories Protection

When the security bit is set, the device cannot be read on a device programmer or through the JTAG Port. When using the JTAG Port, only a full chip erase command is allowed. All other program/erase/verify commands are blocked. Full chip erase returns the part to a non-secured blank state. The Security Bit can be set in PSDsoft Configuration.

All Flash Memory and Boot sectors can individually be sector protected against erasures. The sector protect bits can be set in PSDsoft Configuration.

Absolute Maximum Ratings

Symbol	Parameter	Condition	Min	Max	Unit
T_{STG}	Storage Temperature	PLDCC	– 65	+ 125	°C
	Operating Temperature	Commercial	0	+ 70	°C
		Industrial	– 40	+ 85	°C
	Voltage on any Pin	With Respect to GND	– 0.6	+ 7	V
V_{PP}	Device Programmer Supply Voltage	With Respect to GND	– 0.6	+ 14	V
V_{CC}	Supply Voltage	With Respect to GND	– 0.6	+ 7	V
	ESD Protection		>2000		V

NOTE: Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not recommended. Exposure to Absolute Maximum Rating conditions for extended periods of time may affect device reliability.

Operating Range

Range	Temperature	V_{CC} Tolerance
Commercial	0° C to +70°C	+ 5 V ± 10%
Industrial	–40° C to +85°C	+ 5 V ± 10%
Commercial	0° C to +70°C	3.0 V to 3.6 V
Industrial	–40° C to +85°C	3.0 V to 3.6 V

Recommended Operating Conditions

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{CC}	Supply Voltage	All Speeds	4.5	5	5.5	V
V_{CC}	Supply Voltage	V-Versions All Speeds	3.0 V to 3.6 V		3.6	V

AC/DC Parameters

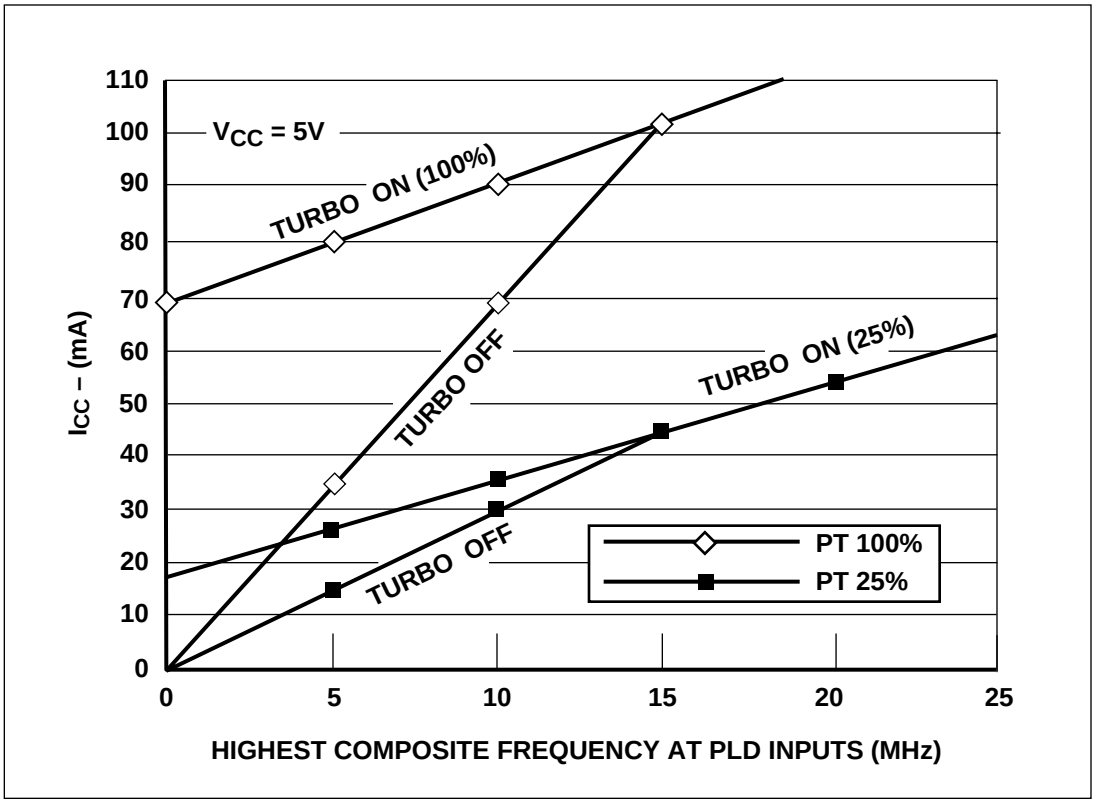
The following tables describe the AD/DC parameters of the PSD8XXF family:

- ❑ DC Electrical Specification
- ❑ AC Timing Specification
  - PLD Timing
    - – Combinatorial Timing
    - – Synchronous Clock Mode
    - – Asynchronous Clock Mode
    - – Input Micro⇔Cell Timing
  - Microcontroller Timing
    - – Read Timing
    - – Write Timing
    - – Peripheral Mode Timing
    - – Power Down and Reset Timing

Following are issues concerning the parameters presented:

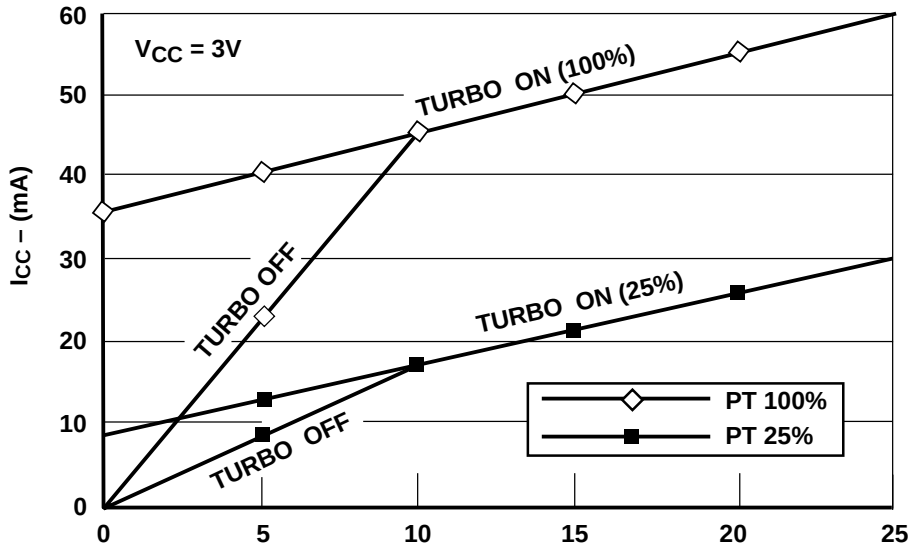
- ❑ In the DC specification the supply current is given for different modes of operation. Before calculating the total power consumption, determine the percentage of time that the PSD8XXF is in each mode. Also, the supply power is considerably different if the Turbo bit is "OFF".
- ❑ The AC power component gives the PLD, Flash memory, and SRAM mA/MHz specification. Figures 31 and 31a show the PLD mA/MHz as a function of the number of Product Terms (PT) used.
- ❑ In the PLD timing parameters, add the required delay when Turbo bit is "OFF".

Figure 31. PLD I_{CC}/FrequencyConsumption (V_{CC} = 5 V ± 10%)



AC/DC Parameters (cont.)

Figure 31a. PLD I_{CC}/Frequency Consumption (PSD8XXFV Versions, V_{CC} = 3 V)



Example of PSD8XXF Typical Power Calculation at V_{CC} = 5.0 V

Conditions		
Highest Composite PLD input frequency (Freq PLD)	=	8 MHz
MCU ALE frequency (Freq ALE)	=	4 MHz
% Flash Access	=	80%
% SRAM access	=	15%
% I/O access	=	5% (no additional power above base)
Operational Modes		
% Normal	=	10%
% Power Down Mode	=	90%
Number of product terms used (from fitter report)	=	45 PT
% of total product terms	=	45/182 = 24.7%
Turbo Mode	=	ON

Calculation (typical numbers used)

I_{CC} total = Ipwrdown x %pwrdown + %normal x (I_{CC} (ac) + I_{CC} (dc))
= Ipwrdown x %pwrdown + % normal x (%flash x 2.5 mA/MHz x Freq ALE
+ %SRAM x 1.5 mA/MHz x Freq ALE
+ % PLD x 2 mA/MHz x Freq PLD
+ #PT x 400 µA/PT
= 50 µA x 0.90 + 0.1 x (0.8 x 2.5 mA/MHz x 4 MHz
+ 0.15 x 1.5 mA/MHz x 4 MHz
+2 mA/MHz x 8 MHz
+ 45 x 0.4 mA/PT)
= 45 µA + 0.1 x (8 + 0.9 + 16 + 18 mA)
= 45 µA + 0.1 x 42.9
= 45 µA + 4.29 mA
= 4.34 mA

This is the operating power with no Flash writes or erases. Calculation is based on I_{OUT} = 0 mA.

AC/DC Parameters (cont.)

Example of Typical Power Calculation at V_{CC} = 5.0 V in Turbo Off Mode

Conditions

Highest Composite PLD input frequency (Freq PLD)	=	8 MHz
MCU ALE frequency (Freq ALE)	=	4 MHz
% Flash Access	=	80%
% SRAM access	=	15%
% I/O access	=	5% (no additional power above base)
Operational Modes		
% Normal	=	10%
% Power Down Mode	=	90%
Number of product terms used (from fitter report)	=	45 PT
% of total product terms	=	45/182 = 24.7%
Turbo Mode	=	Off

Calculation (typical numbers used)

I_{CC} total = Ipwrdown x %pwrdown + %normal x (I_{CC} (ac) + I_{CC} (dc))
= Ipwrdown x %pwrdown + % normal x (%flash x 2.5 mA/MHz x Freq ALE
+ %SRAM x 1.5 mA/MHz x Freq ALE
+ % PLD x (from graph using Freq PLD))
= 50 µA x 0.90 + 0.1 x (0.8 x 2.5 mA/MHz x 4 MHz
+ 0.15 x 1.5 mA/MHz x 4 MHz
+ 24 mA)
= 45 µA + 0.1 x (8 + 0.9 + 24)
= 45 µA + 0.1 x 32.9
= 45 µA + 3.29 mA

= 3.34 mA

This is the operating power with no Flash writes or erases. Calculation is based on I_{OUT} = 0 mA.

PSD8XXF DC Characteristics (5 V ± 10% Versions)

Symbol	Parameter		Conditions	Min	Typ	Max	Unit
V_{CC}	Supply Voltage		All Speeds	4.5	5	5.5	V
V_{IH}	High Level Input Voltage		4.5 V < V_{CC} < 5.5 V	2		V_{CC} +.5	V
V_{IL}	Low Level Input Voltage		4.5 V < V_{CC} < 5.5 V	–.5		0.8	V
V_{IH1}	Reset High Level Input Voltage		(Note 1)	.8 V_{CC}		V_{CC} +.5	V
V_{IL1}	Reset Low Level Input Voltage		(Note 1)	–.5		.2 V_{CC} –.1	V
V_{HYS}	Reset Pin Hysteresis			0.3			V
V_{LKO}	V_{CC} Min for Flash Erase and Program			2.5		4.2	V
V_{OL}	Output Low Voltage		I_{OL} = 20 µA, V_{CC} = 4.5 V		0.01	0.1	V
			I_{OL} = 8 mA, V_{CC} = 4.5 V		0.25	0.45	V
V_{OH}	Output High Voltage Except V_{STBY} On		I_{OH} = –20 µA, V_{CC} = 4.5 V	4.4	4.49		V
			I_{OH} = –2 mA, V_{CC} = 4.5 V	2.4	3.9		V
V_{OH_1}	Output High Voltage V_{STBY} On		I_{OH_1} = 1 µA	V_{SBY} – 0.8			V
V_{SBY}	SRAM Standby Voltage			2.0		V_{CC}	V
I_{SBY}	SRAM Standby Current (V_{STBY} Pin)		V_{CC} = 0 V		0.5	1	µA
I_{IDLE}	Idle Current (V_{STBY} Pin)		V_{CC} > V_{SBY}	–0.1		0.1	µA
V_{DF}	SRAM Data Retention Voltage		Only on V_{STBY}	2			V
I_{SB}	Standby Supply Current for Power Down Mode		CSI > V_{CC} –0.3 V (Notes 2 and 3)		75	200	µA
I_{LI}	Input Leakage Current		V_{SS} < V_{IN} < V_{CC}	–1	±.1	1	µA
I_{LO}	Output Leakage Current		0.45 < V_{IN} < V_{CC}	–10	±5	10	µA
I_{CC} (DC) (Note 5)	Operating Supply Current	ZPLD Only	ZPLD_TURBO = OFF, f = 0 MHz (Note 5)		0		mA
			ZPLD_TURBO = ON, f = 0 MHz		400	700	µA/PT
		Flash	During Flash Write/Erase Only		15	30	mA
			Read Only, f = 0 MHz		0	0	mA
		SRAM	f = 0 MHz		0	0	mA
I_{CC} (AC) (Note 5)	ZPLD AC Adder					(Note 4)	Fig. 31
	FLASH AC Adder				2.5	3.5	mA/MHz
	SRAM AC Adder				1.5	3.0	mA/MHz

NOTE: 1. Reset input has hysteresis. V_{IL1} is valid at or below .2V_{CC} –.1. V_{IH1} is valid at or above .8V_{CC}.
2. CSI deselected or internal Power Down mode is active.
3. PLD is in non-turbo mode and none of the inputs are switching
4. Refer to Figure 32 for PLD current calculation.
5. I_{OUT} = 0 mA

PSD8XXF AC/DC Parameters – CPLD Timing Parameters

(5 V ± 10% Versions)

CPLD Combinatorial Timing (5 V ± 10%)

Symbol	Parameter	Conditions	-70		-90		-15		Fast PT Aloc	TURBO OFF	Slew Rate (Note 1)	Unit
			Min	Max	Min	Max	Min	Max				
t_{PD}	CPLD Input Pin/Feedback to CPLD Combinatorial Output			20		25		32	Add 2	Add 10	Sub 2	ns
t_{EA}	CPLD Input to CPLD Output Enable			21		26		32		Add 10	Sub 2	ns
t_{ER}	CPLD Input to CPLD Output Disable			21		26		32		Add 10	Sub 2	ns
t_{ARP}	CPLD Register Clear or Preset Delay			21		26		33		Add 10	Sub 2	ns
t_{ARPW}	CPLD Register Clear or Preset Pulse Width		10		20		29			Add 10		ns
t_{ARD}	CPLD Array Delay	Any Micro⇔Cell		11		16		22	Add 2			ns

NOTE: 1. Fast Slew Rate output available on PA[3:0], PB[3:0], and PD[2:0].

CPLD Micro⇔Cell Synchronous Clock Mode Timing (5 V ± 10% Versions)

Symbol	Parameter	Conditions	-70		-90		-15		Fast PT Aloc	TURBO OFF	Slew Rate (Note 1)	Unit
			Min	Min	Max	Max	Min	Max				
f_{MAX}	Maximum Frequency External Feedback	$1/(t_S+t_{CO})$		40.0		30.30		25.00				MHz
	Maximum Frequency Internal Feedback (f_{CNT})	$1/(t_S+t_{CO}-10)$		66.6		43.48		31.25				MHz
	Maximum Frequency Pipelined Data	$1/(t_{CH}+t_{CL})$		83.3		50.00		35.71				MHz
t_S	Input Setup Time		12		15		20		Add 2	Add 10		ns
t_H	Input Hold Time		0		0		0					ns
t_{CH}	Clock High Time	Clock Input	6		10		15					ns
t_{CL}	Clock Low Time	Clock Input	6		10		15					ns
t_{CO}	Clock to Output Delay	Clock Input		13		18		22			Sub 2	ns
t_{ARD}	CPLD Array Delay	Any Micro⇔Cell		11		16		22	Add 2			ns
t_{MIN}	Minimum Clock Period	$t_{CH}+t_{CL}$ (Note 2)	12		20		30					ns

NOTES: 1. Fast Slew Rate output available on PA[3:0], PB[3:0], and PD[2:0].
2. CLKIN $t_{CLCL} = t_{CH} + t_{CL}$.

PSD8XXF AC/DC Parameters – CPLD Timing Parameters

(5 V ± 10% Versions)

CPLD Micro⇔Cell Asynchronous Clock Mode Timing (5 V ± 10% Versions)

Symbol	Parameter	Conditions	-70		-90		-15		PT Aloc	TURBO OFF	Slew Rate	Unit
			Min	Max	Min	Max	Min	Max				
f_{MAXA}	Maximum Frequency External Feedback	$1/(t_{SA}+t_{COA})$		38.4		26.32		21.27				MHz
	Maximum Frequency Internal Feedback (f_{CNTA})	$1/(t_{SA}+t_{COA}–10)$		62.5		35.71		27.78				MHz
	Maximum Frequency Pipelined Data	$1/(t_{CHA}+t_{CLA})$		71.4		41.67		35.71				MHz
t_{SA}	Input Setup Time		7		8		12		Add 2	Add 10		ns
t_{HA}	Input Hold Time		8		12		14					ns
t_{CHA}	Clock Input High Time		9		12		15			Add 10		ns
t_{CLA}	Clock Input Low Time		9		12		15			Add 10		ns
t_{COA}	Clock to Output Delay			21		30		37		Add 10	Sub 2	ns
t_{ARDA}	CPLD Array Delay	Any Micro⇔Cell		11		16		22	Add 2			ns
t_{MINA}	Minimum Clock Period	$1/f_{CNTA}$	16		28		43					ns

Input Micro⇔Cell Timing (5 V ± 10% Versions)

Symbol	Parameter	Conditions	-70		-90		-15		PT Aloc	TURBO OFF	Unit
			Min	Max	Min	Max	Min	Max			
t_{IS}	Input Setup Time	(Note 1)	0		0		0				ns
t_{IH}	Input Hold Time	(Note 1)	15		20		26			Add 10	ns
t_{INH}	NIB Input High Time	(Note 1)	9		12		18				ns
t_{INL}	NIB Input Low Time	(Note 1)	9		12		18				ns
t_{INO}	NIB Input to Combinatorial Delay	(Note 1)		34		46		59	Add 2	Add 10	ns

NOTE: 1. Inputs from Port A, B, and C relative to register/latch clock from the PLD. ALE/AS latch timings refer to t_{AVLX} and t_{LXAX}.

Microcontroller Interface – AC/DC Parameters

(5V ± 10% Versions)

AC Symbols for PLD Timing.

Example: t_{AVLX} – Time from Address Valid to ALE Invalid.

Signal Letters

A – Address Input
C – CEout Output
D – Input Data
E – E Input
G – Internal WDOG_ON signal
I – Interrupt Input
L – ALE Input
N – Reset Input or Output
P – Port Signal Output
Q – Output Data
R – $\overline{WR}$, $\overline{UDS}$, $\overline{LDS}$, $\overline{DS}$, IORD, $\overline{PSEN}$ Inputs
S – Chip Select Input
T – R/$\overline{W}$ Input
W – Internal PDN Signal
B – Vstby Output
M – Output Micro⇔Cell

Signal Behavior

t – Time
L – Logic Level Low or ALE
H – Logic Level High
V – Valid
X – No Longer a Valid Logic Level
Z – Float
PW – Pulse Width

Microcontroller Interface – PSD8XXF AC/DC Parameters

(5V ± 10% Versions)

Read Timing (5 V ± 10% Versions)

Symbol	Parameter	Conditions	-70		-90		-15		Turbo Off	Unit
			Min	Max	Min	Max	Min	Max		
t_{LVLX}	ALE or AS Pulse Width		15		20		28			ns
t_{AVLX}	Address Setup Time	(Note 3)	4		6		10			ns
t_{LXAX}	Address Hold Time	(Note 3)	7		8		11			ns
t_{AVQV}	Address Valid to Data Valid	(Note 3)		70		90		150	Add 10	ns
t_{SLQV}	CS Valid to Data Valid			75		100		150		ns
t_{RLQV}	$\overline{RD}$ to Data Valid 8-Bit Bus	(Note 5)		24		32		40		ns
	$\overline{RD}$ or $\overline{PSEN}$ to Data Valid 8-Bit Bus, 8031, 80251	(Note 2)		31		38		45		ns
t_{RHQX}	$\overline{RD}$ Data Hold Time	(Note 1)	0		0		0			ns
t_{RLRH}	$\overline{RD}$ Pulse Width	(Note 1)	27		32		38			ns
t_{RHQZ}	$\overline{RD}$ to Data High-Z	(Note 1)		20		25		30		ns
t_{EHEL}	E Pulse Width		27		32		38			ns
t_{THEH}	R/$\overline{W}$ Setup Time to Enable		6		10		18			ns
t_{ELTL}	R/$\overline{W}$ Hold Time After Enable		0		0		0			ns
t_{AVPV}	Address Input Valid to Address Output Delay	(Note 4)		20		25		30		ns

NOTES: 1. $\overline{RD}$ timing has the same timing as $\overline{DS}$, $\overline{LDS}$, $\overline{UDS}$, and $\overline{PSEN}$ signals.
2. $\overline{RD}$ and $\overline{PSEN}$ have the same timing.
3. Any input used to select an internal PSD8XXF function.
4. In multiplexed mode, latched addresses generated from ADIO delay to address output on any Port.
5. $\overline{RD}$ timing has the same timing as $\overline{DS}$, $\overline{LDS}$, and $\overline{UDS}$ signals.

Microcontroller Interface – PSD8XXF AC/DC Parameters

(5V ± 10% Versions)

Write Timing (5 V ± 10% Versions)

Symbol	Parameter	Conditions	-70		-90		-15		Unit
			Min	Max	Min	Max	Min	Max	
t_{LVLX}	ALE or AS Pulse Width		15		20		28		
t_{AVLX}	Address Setup Time	(Note 1)	4		6		10		ns
t_{LXAX}	Address Hold Time	(Note 1)	7		8		11		ns
t_{AVWL}	Address Valid to Leading Edge of $\overline{WR}$	(Notes 1 and 3)	8		15		20		ns
t_{SLWL}	$\overline{CS}$ Valid to Leading Edge of $\overline{WR}$	(Note 3)	12		15		20		ns
t_{DVWH}	$\overline{WR}$ Data Setup Time	(Note 3)	25		35		45		ns
t_{WHDX}	$\overline{WR}$ Data Hold Time	(Notes 3 and 7)	4		5		5		ns
t_{WLWH}	$\overline{WR}$ Pulse Width	(Note 3)	31		35		45		ns
t_{WHAX1}	Trailing Edge of $\overline{WR}$ to Address Invalid	(Note 3)	6		8		10		ns
t_{WHAX2}	Trailing Edge of $\overline{WR}$ to DPLD Address Input Invalid	(Note 3 and 6)	0		0		0		ns
t_{WHPV}	Trailing Edge of $\overline{WR}$ to Port Output Valid Using I/O Port Data Register	(Note 3)		27		30		38	ns
t_{WLMV}	$\overline{WR}$ Valid to Port Output Valid Using Micro⇔Cell Register Preset/Clear	(Notes 3 and 4)		48		55		65	ns
t_{DVMV}	Data Valid to Port Output Valid Using Micro⇔Cell Register Preset/Clear	(Notes 3 and 5)		42		55		65	ns
t_{AVPV}	Address Input Valid to Address Output Delay	(Note 2)		20		25		30	ns

NOTES:
1. Any input used to select an internal PSD8XXF function.
2. In multiplexed mode, latched addresses generated from ADIO delay to address output on any Port.
3. WR timing has the same timing as E, LDS, UDS, WRL, and WRH signals.
4. Assuming data is stable before active write signal.
5. Assuming write is active before data becomes valid.
6. Address Hold Time for DPLD inputs that are used to generate chip selects for internal PSD memory.
7. t_{WHDX} is 6ns when writing to the Output Micro-Cell Registers.

Microcontroller Interface – PSD8XXF AC/DC Parameters

(5V ±10% Versions)

Port A Peripheral Data Mode Read Timing (5 V ± 10%)

Symbol	Parameter	Conditions	-70		-90		-15		Turbo Off	Unit
			Min	Max	Min	Max	Min	Max		
$t_{AVQV (PA)}$	Address Valid to Data Valid	(Note 3)		37		39		45	Add 10	ns
$t_{SLQV (PA)}$	$\overline{CSI}$ Valid to Data Valid			27		35		45	Add 10	ns
$t_{RLQV (PA)}$	$\overline{RD}$ to Data Valid	(Notes 1 and 4)		21		32		40		ns
	$\overline{RD}$ to Data Valid 8031 Mode			32		38		45		ns
$t_{DVQV (PA)}$	Data In to Data Out Valid			22		30		38		ns
$t_{QXRH (PA)}$	$\overline{RD}$ Data Hold Time		0		0		0			ns
$t_{RLRH (PA)}$	$\overline{RD}$ Pulse Width	(Note 1)	27		32		38			ns
$t_{RHQZ (PA)}$	$\overline{RD}$ to Data High-Z	(Note 1)		23		25		30		ns

Port A Peripheral Data Mode Write Timing (5 V ± 10%)

Symbol	Parameter	Conditions	-70		-90		-15		Unit
			Min	Max	Min	Max	Min	Max	
$t_{WLQV (PA)}$	$\overline{WR}$ to Data Propagation Delay	(Note 2)		25		35		40	ns
$t_{DVQV (PA)}$	Data to Port A Data Propagation Delay	(Note 5)		22		30		38	ns
$t_{WHQZ (PA)}$	$\overline{WR}$ Invalid to Port A Tri-state	(Note 2)		20		25		33	ns

NOTES:
1. $\overline{RD}$ timing has the same timing as $\overline{DS}$, $\overline{LDS}$, $\overline{UDS}$, and $\overline{PSEN}$ (in 8031 combined mode) signals.
2. $\overline{WR}$ timing has the same timing as E, $\overline{LDS}$, $\overline{UDS}$, $\overline{WRL}$, and $\overline{WRH}$ signals.
3. Any input used to select Port A Data Peripheral Mode.
4. Data is already stable on Port A.
5. Data stable on ADIO pins to data on Port A.

Microcontroller Interface – PSD8XXF AC/DC Parameters

(5V ± 10% Versions)

Power Down Timing (5 V ± 10%)

Symbol	Parameter	Conditions	-70		-90		-15		Unit
			Min	Max	Min	Max	Min	Max	
t_{LVDV}	ALE Access Time from Power Down			80		90		150	ns
t_{CLWH}	Maximum Delay from APD Enable to Internal PDN Valid Signal	Using CLKIN Input			15 * t_{CLCL} (µs) (Note 1)				µs

NOTE: 1. t_{CLCL} is the CLKIN clock period.

V_{stbyon} Timing (5 V ± 10%)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{BVBH}	Vstby Detection to Vstbyon Output High	(Note 1)		20		µs
t_{BXBL}	V_{stby} Off Detection to V_{stbyon} Output Low	(Note 1)		20		µs

NOTE: 1. Vstbyon is measured at V_{CC} ramp rate of 2 ms.

Reset Pin Timing (5 V ± 10%)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{NLNH}	Warm RESET Active Low Time (Note 1)		150			ns
t_{OPR}	RESET High to Operational Device				120	ns
$t_{NLNH-PO}$	Power On Reset Active Low Time		1			ms
t_{NLNH-A}	Warm Reset, will abort and reset Flash programming/erase cycles to Read mode. (Note 2)		25			µs

NOTE: 1. RESET will not reset Flash programming/erase cycles.
2. RESET will abort Flash programming or erase cycle. For PSD833/834/853/854 only.

Microcontroller Interface – PSD8XXF AC/DC Parameters

(5V ±10% Versions)

Flash Program, Write and Erase Times (5 V ± 10%)

Symbol	Parameter	Min	Typ	Max	Unit
	Flash Bulk Erase (Preprogrammed to 00) (Note 1)		3	30	sec
	Flash Bulk Erase (Not Preprogrammed)		5		sec
t_{WHQV3}	Sector Erase (Preprogrammed to 00)		1	30	sec
t_{WHQV2}	Sector Erase (Not Preprogrammed)		2.2		sec
t_{WHQV1}	Byte Program		14	1200	µs
	Program/Erase Cycles (Per Sector)	100,000			cycles
t_{WHWLO}	Sector Erase Time-Out		100		µs
t_{Q7VQV}	DQ7 Valid to Output (DQ7-0) Valid (Data Polling) (Note 2)			30	ns

NOTE: 1. Programmed to all zeros before erase.
2. The polling status DQ7 is valid tQ7VQV ns before the data byte DQ0-7 is valid for reading.

ISC Timing (5 V ± 10%)

Symbol	Parameter	Conditions	-70		-90		-15		Unit
			Min	Max	Min	Max	Min	Max	
t_{ISCCF}	TCK Clock Frequency (except for PLD)	(Note 1)		20		18		14	MHz
t_{ISCCH}	TCK Clock High Time	(Note 1)	23		26		31		ns
t_{ISCCL}	TCK Clock Low Time	(Note 1)	23		26		31		ns
$t_{ISCCF-P}$	TCK Clock Frequency (for PLD only)	(Note 2)		2		2		2	MHz
$t_{ISCCH-P}$	TCK Clock High Time(for PLD only)	(Note 2)	240		240		240		ns
$t_{ISCCL-P}$	TCK Clock Low Time(for PLD only)	(Note 2)	240		240		240		ns
t_{ISCPSU}	ISC Port Set Up Time		7		8		10		ns
t_{ISCPH}	ISC Port Hold Up Time		5		5		5		ns
t_{ISCPCO}	ISC Port Clock to Output			21		23		25	ns
t_{ISCPZV}	ISC Port High-Impedance to Valid Output			21		23		25	ns
t_{ISCPVZ}	ISC Port Valid Output to High-Impedance			21		23		25	ns

NOTES: 1. For “non-PLD” programming, erase or in ISC by-pass mode.
2. For program or erase PLD only.

PSD8XXFV DC Characteristics (3.0 V to 3.6 V Versions) Advance Information

Symbol	Parameter		Conditions	Min	Typ	Max	Unit
V_{CC}	Supply Voltage		All Speeds	3.0		3.6	V
V_{IH}	High Level Input Voltage		3.0 V < V_{CC} < 3.6 V	.7 V_{CC}		V_{CC} +.5	V
V_{IL}	Low Level Input Voltage		3.0 V < V_{CC} < 3.6 V	–.5		0.8	V
V_{IH1}	Reset High Level Input Voltage		(Note 1)	.8 V_{CC}		V_{CC} +.5	V
V_{IL1}	Reset Low Level Input Voltage		(Note 1)	–.5		.2 V_{CC} –.1	V
V_{HYS}	Reset Pin Hysteresis			0.3			V
V_{LKO}	V_{CC} Min for Flash Erase and Program			1.5		2.2	V
V_{OL}	Output Low Voltage		I_{OL} = 20 µA, V_{CC} = 3.0 V		0.01	0.1	V
			I_{OL} = 4 mA, V_{CC} = 3.0 V		0.15	0.45	V
V_{OH}	Output High Voltage Except V_{STBY} On		I_{OH} = –20 µA, V_{CC} = 3.0 V	2.9	2.99		V
			I_{OH} = –2 mA, V_{CC} = 3.0 V	2.7	2.8		V
V_{OH_1}	Output High Voltage V_{STBY} On		I_{OH_1} = –1 µA	V_{SBY} – 0.8			V
V_{SBY}	SRAM Standby Voltage			2.0		V_{CC}	V
I_{SBY}	SRAM Standby Current (V_{STBY} Pin)		V_{CC} = 0 V		0.5	1	µA
I_{IDLE}	Idle Current (V_{STBY} Pin)		V_{CC} > V_{SBY}	–0.1		0.1	µA
V_{DF}	SRAM Data Retention Voltage		Only on V_{STBY}	2			V
I_{SB}	Standby Supply Current for Power Down Mode		$\overline{CSI}$ >V_{CC} –0.3 V (Notes 2 and 3)		25	100	µA
I_{LI}	Input Leakage Current		V_{SS} < V_{IN} < V_{CC}	–1	±.1	1	µA
I_{LO}	Output Leakage Current		0.45 < V_{IN} < V_{CC}	–10	±5	10	µA
I_{CC} (DC) (Note 5)	Operating Supply Current	ZPLD Only	ZPLD_TURBO = OFF, f = 0 MHz (Note 3)		0		mA
			ZPLD_TURBO = ON, f = 0 MHz		200	400	µA/PT
		FLASH	During FLASH or Write/Erase Only		10	25	mA
			Read Only, f = 0 MHz		0	0	mA
		SRAM	f = 0 MHz		0	0	mA
I_{CC} (AC) (Note 5)	ZPLD AC Adder				(Note 4)		Figure 31a
	FLASH AC Adder				1.5	2.0	mA/MHz
	SRAM AC Adder				0.8	1.5	mA/MHz

NOTES:
1. Reset input has hysteresis. V_{IL1} is valid at or below .2V_{CC} –.1. V_{IH1} is valid at or above .8V_{CC}.
2. $\overline{CSI}$ deselected or internal PD is active.
3. PLD is in non-turbo mode and none of the inputs are switching.
4. Refer to Figure 31a for PLD current calculation.
5. I_{OUT} = 0 mA.

PSD8XXFV AC/DC Parameters – CPLD Timing Parameters

(3 V Versions)

CPLD Combinatorial Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		PT Aloc	TURBO OFF	Slew Rate (Note 1)	Unit
			Min	Max	Min	Max	Min	Max				
t_{PD}	CPLD Input Pin/Feedback to CPLD Combinatorial Output			40		45		50	Add 4	Add 20	Sub 6	ns
t_{EA}	CPLD Input to CPLD Output Enable			43		45		50		Add 20	Sub 6	ns
t_{ER}	CPLD Input to CPLD Output Disable			43		45		50		Add 20	Sub 6	ns
t_{ARP}	CPLD Register Clear or Preset Delay			40		43		48		Add 20	Sub 6	ns
t_{ARPW}	CPLD Register Clear or Preset Pulse Width		25		30		35			Add 20		ns
t_{ARD}	CPLD Array Delay	Any Micro⇔Cell		25		29		33	Add 4			ns

NOTE: 1. Fast Slew Rate output available on PA[3:0], PB[3:0], and PD[2:0].

CPLD Micro⇔Cell Synchronous Clock Mode Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		PT Aloc	TURBO OFF	Slew Rate (Note 1)	Unit
			Min	Max	Min	Max	Min	Max				
f_{MAX}	Maximum Frequency External Feedback	$1/(t_S+t_{CO})$		22.2		18.8		15.8				MHz
	Maximum Frequency Internal Feedback (f_{CNT})	$1/(t_S+t_{CO}-10)$		28.5		23.2		18.8				MHz
	Maximum Frequency Pipelined Data	$1/(t_{CH}+t_{CL})$		40.0		33.3		31.2				MHz
t_S	Input Setup Time		20		25		30		Add 4	Add 20		ns
t_H	Input Hold Time		0		0		0					ns
t_{CH}	Clock High Time	Clock Input	15		15		16					ns
t_{CL}	Clock Low Time	Clock Input	10		15		16					ns
t_{CO}	Clock to Output Delay	Clock Input		25		28		33			Sub 6	ns
t_{ARD}	CPLD Array Delay	Any Micro⇔Cell		25		29		33	Add 4			ns
t_{MIN}	Minimum Clock Period	$t_{CH}+t_{CL}$ (Note 2)	25		29		32					ns

NOTES: 1. Fast Slew Rate output available on PA[3:0], PB[3:0], and PD[2:0].
2. CLKIN $t_{CLCL} = t_{CH} + t_{CL}$.

PSD8XXFV AC/DC Parameters – CPLD Timing Parameters

(3 V Versions)

CPLD Micro⇔Cell Asynchronous Clock Mode Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		PT Aloc	TURBO OFF	Slew Rate	Unit
			Min	Max	Min	Max	Min	Max				
f_{MAXA}	Maximum Frequency External Feedback	$1/(t_{SA}+t_{COA})$		21.7		19.2		16.9				MHz
	Maximum Frequency Internal Feedback (f_{CNTA})	$1/(t_{SA}+t_{COA}–10)$		27.8		23.8		20.4				MHz
	Maximum Frequency Pipelined Data	$1/(t_{CHA}+t_{CLA})$		33.3		27		24.4				MHz
t_{SA}	Input Setup Time		10		12		13		Add 4	Add 20		ns
t_{HA}	Input Hold Time		12		15		17					ns
t_{CHA}	Clock High Time		17		22		25			Add 20		ns
t_{CLA}	Clock Low Time		13		15		16			Add 20		ns
t_{COA}	Clock to Output Delay			36		40		46		Add 20	Sub 6	ns
t_{ARD}	CPLD Array Delay	Any Micro⇔Cell		25		29		33	Add 4			ns
t_{MINA}	Minimum Clock Period	$1/f_{CNTA}$	36		42		49					ns

Input Micro⇔Cell Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		PT Aloc	TURBO OFF	Unit
			Min	Max	Min	Max	Min	Max			
t_{IS}	Input Setup Time	(Note 1)	0		0		0				ns
t_{IH}	Input Hold Time	(Note 1)	25		25		30			Add 20	ns
t_{INH}	NIB Input High Time	(Note 1)	12		13		15				ns
t_{INL}	NIB Input Low Time	(Note 1)	12		13		15				ns
t_{INO}	NIB Input to Combinatorial Delay	(Note 1)		46		62		70	Add 4	Add 20	ns

NOTE: 1. Inputs from Port A, B, and C relative to register/latch clock from the PLD. ALE latch timings refer to t_{AVLX} and t_{LXAX}.

Microcontroller Interface – PSD8XXFV AC/DC Parameters

(3 V Versions)

AC Symbols for PLD Timing.

Example: t_{AVLX} – Time from Address Valid to ALE Invalid.

Signal Letters

A – Address Input
C – CEout Output
D – Input Data
E – E Input
G – Internal WDOG_ON signal
I – Interrupt Input
L – ALE Input
N – Reset Input or Output
P – Port Signal Output
Q – Output Data
R – $\overline{WR}$, $\overline{UDS}$, $\overline{LDS}$, $\overline{DS}$, IORD, $\overline{PSEN}$ Inputs
S – Chip Select Input
T – R/$\overline{W}$ Input
W – Internal PDN Signal
B – Vstby Output
M – Output Micro⇔Cell

Signal Behavior

t – Time
L – Logic Level Low or ALE
H – Logic Level High
V – Valid
X – No Longer a Valid Logic Level
Z – Float
PW – Pulse Width

Microcontroller Interface – PSD8XXFV AC/DC Parameters

(3 V Versions)

Read Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		Turbo Off	Unit
			Min	Max	Min	Max	Min	Max		
t_{LVLX}	ALE or AS Pulse Width		26		26		30			ns
t_{AVLX}	Address Setup Time	(Note 3)	9		10		12			ns
t_{LXAX}	Address Hold Time	(Note 3)	9		12		14			ns
t_{AVQV}	Address Valid to Data Valid	(Note 3)		120		150		200	Add 20	ns
t_{SLQV}	$\overline{CS}$ Valid to Data Valid			120		150		200		ns
t_{RLQV}	$\overline{RD}$ to Data Valid 8-Bit Bus	(Note 5)		35		35		40		ns
	$\overline{RD}$ or $\overline{PSEN}$ to Data Valid 8-Bit Bus, 8031, 80251	(Note 2)		45		50		55		ns
t_{RHQX}	$\overline{RD}$ Data Hold Time	(Note 1)	0		0		0			ns
t_{RLRH}	$\overline{RD}$ Pulse Width	(Note 1)	38		40		45			ns
t_{RHQZ}	$\overline{RD}$ to Data High-Z	(Note 1)		38		40		45		ns
t_{EHEL}	E Pulse Width		40		45		52			ns
t_{THEH}	R/$\overline{W}$ Setup Time to Enable		15		18		20			ns
t_{ELTL}	R/$\overline{W}$ Hold Time After Enable		0		0		0			ns
t_{AVPV}	Address Input Valid to Address Output Delay	(Note 4)		33		35		40		ns

NOTES: 1. $\overline{RD}$ timing has the same timing as $\overline{DS}$, $\overline{LDS}$, $\overline{UDS}$, and $\overline{PSEN}$ signals.
2. $\overline{RD}$ and $\overline{PSEN}$ have the same timing for 8031.
3. Any input used to select an internal PSD813F function.
4. In multiplexed mode latched address generated from ADIO delay to address output on any Port.
5. RD timing has the same timing as $\overline{DS}$, $\overline{LDS}$, and $\overline{UDS}$ signals.

Microcontroller Interface – PSD8XXFV AC/DC Parameters

(3 V Versions)

Write Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		Unit
			Min	Max	Min	Max	Min	Max	
t_{LVLX}	ALE or AS Pulse Width		26		26		30		
t_{AVLX}	Address Setup Time	(Note 1)	9		10		12		ns
t_{LXAX}	Address Hold Time	(Note 1)	9		12		14		ns
t_{AVWL}	Address Valid to Leading Edge of $\overline{WR}$	(Notes 1 and 3)	17		20		25		ns
t_{SLWL}	$\overline{CS}$ Valid to Leading Edge of $\overline{WR}$	(Note 3)	17		20		25		ns
t_{DVWH}	$\overline{WR}$ Data Setup Time	(Note 3)	45		45		50		ns
t_{WHDX}	$\overline{WR}$ Data Hold Time	(Note 3)	7		8		10		ns
t_{WLWH}	$\overline{WR}$ Pulse Width	(Note 3)	46		48		53		ns
t_{WHAX1}	Trailing Edge of $\overline{WR}$ to Address Invalid	(Note 3)	10		12		17		ns
t_{WHAX2}	Trailing Edge of $\overline{WR}$ to DPLD Address Input Invalid	(Notes 3 and 6)	0		0		0		ns
t_{WHPV}	Trailing Edge of $\overline{WR}$ to Port Output Valid Using I/O Port Data Register	(Note 3)		33		35		40	ns
t_{WLMV}	$\overline{WR}$ Valid to Port Output Valid Using Micro⇔Cell Register Preset/Clear	(Notes 3 and 4)		70		70		80	ns
t_{DVMV}	Data Valid to Port Output Valid Using Micro⇔Cell Register Preset/Clear	(Notes 3 and 5)		70		70		80	ns
t_{AVPV}	Address Input Valid to Address Output Delay	(Note 2)		33		35		40	ns

NOTES: 1. Any input used to select an internal PSD813F function.
2. In multiplexed mode, latched addresses generated from ADIO delay to address output on any Port.
3. WR timing has the same timing as E, LDS, UDS, WRL, and WRH signals.
4. Assuming data is stable before active write signal.
5. Assuming write is active before data becomes valid.
6. Address hold time for DPLD inputs that are used to generate chip selects for internal PSD memory.

Microcontroller Interface – PSD8XXFV AC/DC Parameters

(3 V Versions)

Port A Peripheral Data Mode Read Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		Turbo Off	Unit
			Min	Max	Min	Max	Min	Max		
$t_{AVQV\ (PA)}$	Address Valid to Data Valid	(Note 3)		50		50		50	Add 20	ns
$t_{SLQV\ (PA)}$	$\overline{CSI}$ Valid to Data Valid			37		45		50	Add 20	ns
$t_{RLQV\ (PA)}$	$\overline{RD}$ to Data Valid	(Notes 1 and 4)		37		40		45		ns
	$\overline{RD}$ to Data Valid 8031 Mode			45		45		50		ns
$t_{DVQV\ (PA)}$	Data In to Data Out Valid			38		40		45		ns
$t_{QXRH\ (PA)}$	$\overline{RD}$ Data Hold Time		0		0		0			ns
$t_{RLRH\ (PA)}$	$\overline{RD}$ Pulse Width	(Note 1)	36		36		46			ns
$t_{RHQZ\ (PA)}$	$\overline{RD}$ to Data High-Z	(Note 1)		36		40		45		ns

Port A Peripheral Data Mode Write Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		Unit
			Min	Max	Min	Max	Min	Max	
$t_{WLQV\ (PA)}$	$\overline{WR}$ to Data Propagation Delay	(Note 2)		42		45		55	ns
$t_{DVQV\ (PA)}$	Data to Port A Data Propagation Delay	(Note 5)		38		40		45	ns
$t_{WHQZ\ (PA)}$	$\overline{WR}$ Invalid to Port A Tri-state	(Note 2)		33		33		35	ns

NOTES:
1. $\overline{RD}$ timing has the same timing as $\overline{DS}$, $\overline{LDS}$, $\overline{UDS}$, and $\overline{PSEN}$ (in 8031 combined mode) signals.
2. $\overline{WR}$ timing has the same timing as E, $\overline{LDS}$, $\overline{UDS}$, $\overline{WRL}$, and $\overline{WRH}$ signals.
3. Any input used to select Port A Data Peripheral Mode.
4. Data is already stable on Port A.
5. Data stable on ADIO pins to data on Port A.

Microcontroller Interface – PSD8XXFV AC/DC Parameters

(3 V Versions)

Power Down Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		Unit
			Min	Max	Min	Max	Min	Max	
t_{LVDV}	ALE Access Time from Power Down			145		150		200	ns
t_{CLWH}	Maximum Delay from APD Enable to Internal PDN Valid Signal	Using CLKIN Input			15 * t_{CLCL} (µs) (Note 1)				µs

NOTE: 1. t_{CLCL} is the CLKIN clock period.

V_{stbyon} Timing (3 V Versions)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{BVBH}	V_{stby} Detection to V_{stbyon} Output High	(Note 1)		20		µs
t_{BXBL}	V_{stby} Off Detection to V_{stbyon} Output Low	(Note 1)		20		µs

NOTE: 1. Vstbyon is measured at V_{CC} ramp rate of 2 ms.

Reset Pin Timing (3 V Versions)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{NLNH}	Warm RESET Active Low Time (Note 1)		300			ns
t_{OPR}	RESET High to Operational Device				300	ns
$t_{NLNH-PO}$	Power On Reset Active Low Time		1			ms
t_{NLNH-A}	Warm Reset, will abort and reset Flash programming/erase cycles to Read mode (Note 2).		25			µs

NOTE: 1. RESET will not reset Flash programming/erase cycles.
2. RESET will abort Flash programming or erase cycle. For PSD833/834/853/854 only.

Microcontroller Interface – PSD8XXFV AC/DC Parameters

(3 V Versions)

Flash Program, Write and Erase Times (3 V Versions)

Symbol	Parameter	Min	Typ	Max	Unit
	Flash Bulk Erase (Preprogrammed) (Note 1)		3	30	sec
	Flash Bulk Erase (Not Preprogrammed)		5		sec
t_{WHQV3}	Sector Erase (Preprogrammed)		1	30	sec
t_{WHQV2}	Sector Erase (Not Preprogrammed)		2.2		sec
t_{WHQV1}	Byte Program		14	1200	µs
	Program/Erase Cycles (Per Sector)	100,000			cycles
t_{WHWLO}	Sector Erase Time-Out		100		µs
t_{Q7VQV}	DQ7 Valid to Output (DQ7-0) Valid (Data Polling) (Note 2)			30	ns

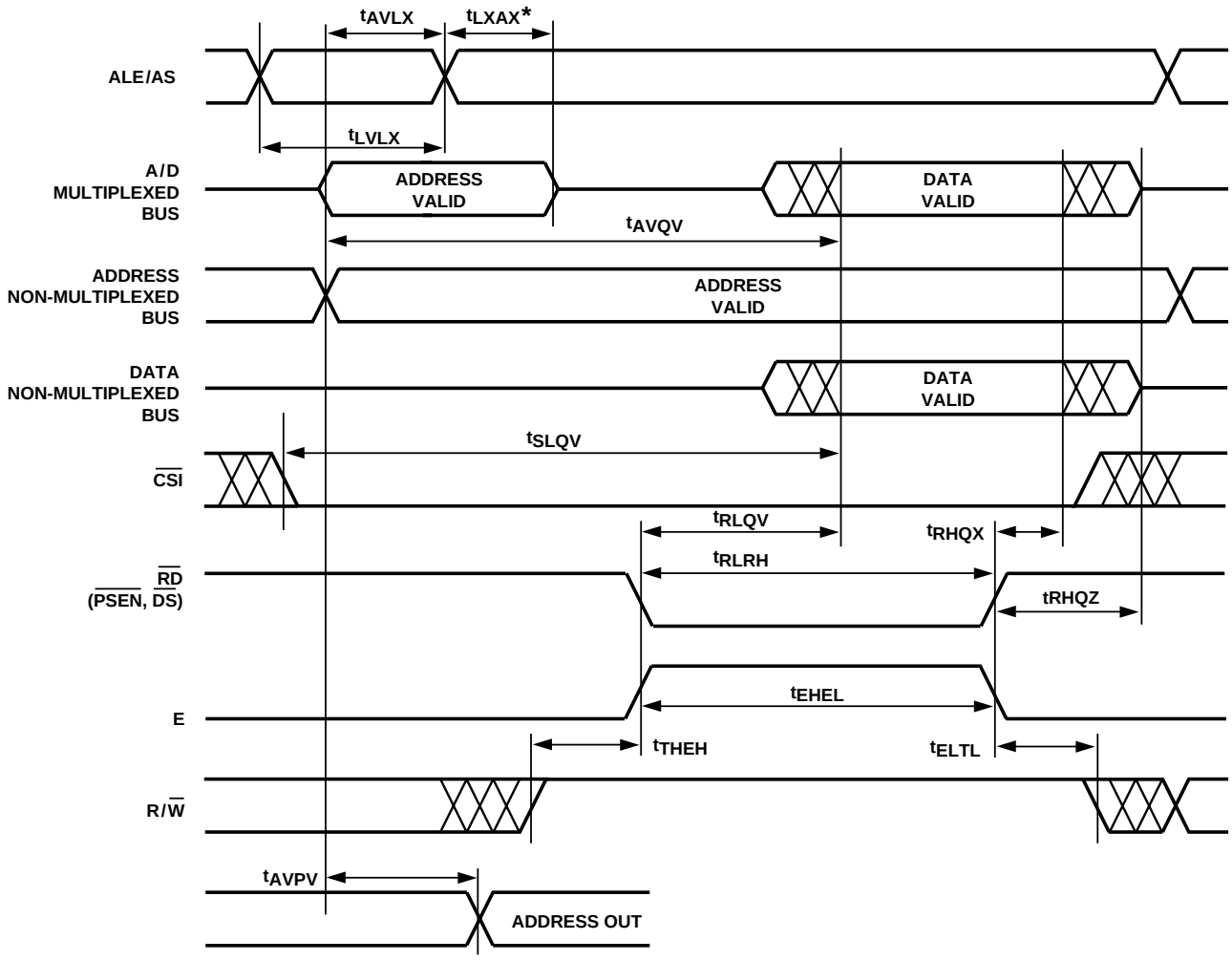
NOTES: 1. Programmed to all zeros before erase.
2. The polling status DQ7 is valid tQ7VQV ns before the data byte DQ0-7 is valid for reading.

ISC Timing (3 V Versions)

Symbol	Parameter	Conditions	-12		-15		-20		Unit
			Min	Max	Min	Max	Min	Max	
t_{ISCCF}	TCK Clock Frequency (except for PLD)	(Note 1)		12		10		9	MHz
t_{ISCCH}	TCK Clock High Time	(Note 1)	40		45		51		ns
t_{ISCCL}	TCK Clock Low Time	(Note 1)	40		45		51		ns
$t_{ISCCF-P}$	TCK Clock Frequency (for PLD only)	(Note 2)		2		2		2	MHz
$t_{ISCCH-P}$	TCK Clock High Time (for PLD only)	(Note 2)	240		240		240		ns
$t_{ISCCL-P}$	TCK Clock Low Time (for PLD only)	(Note 2)	240		240		240		ns
t_{ISCPSU}	ISC Port Set Up Time		12		13		15		ns
t_{ISCPH}	ISC Port Hold Up Time		5		5		5		ns
t_{ISCPCO}	ISC Port Clock to Output			30		36		40	ns
t_{ISCPZV}	ISC Port High-Impedance to Valid Output			30		36		40	ns
t_{ISCPVZ}	ISC Port Valid Output to High-Impedance			30		36		40	ns

NOTES: 1. For “non-PLD” programming, erase or in ISC by-pass mode.
2. For program or erase PLD only.

Figure 32. Read Timing



*t_{AVLX} and t_{LXAX} are not required for 80C251 in Page Mode or 80C51XA in Burst Mode.

Figure 33. Write Timing

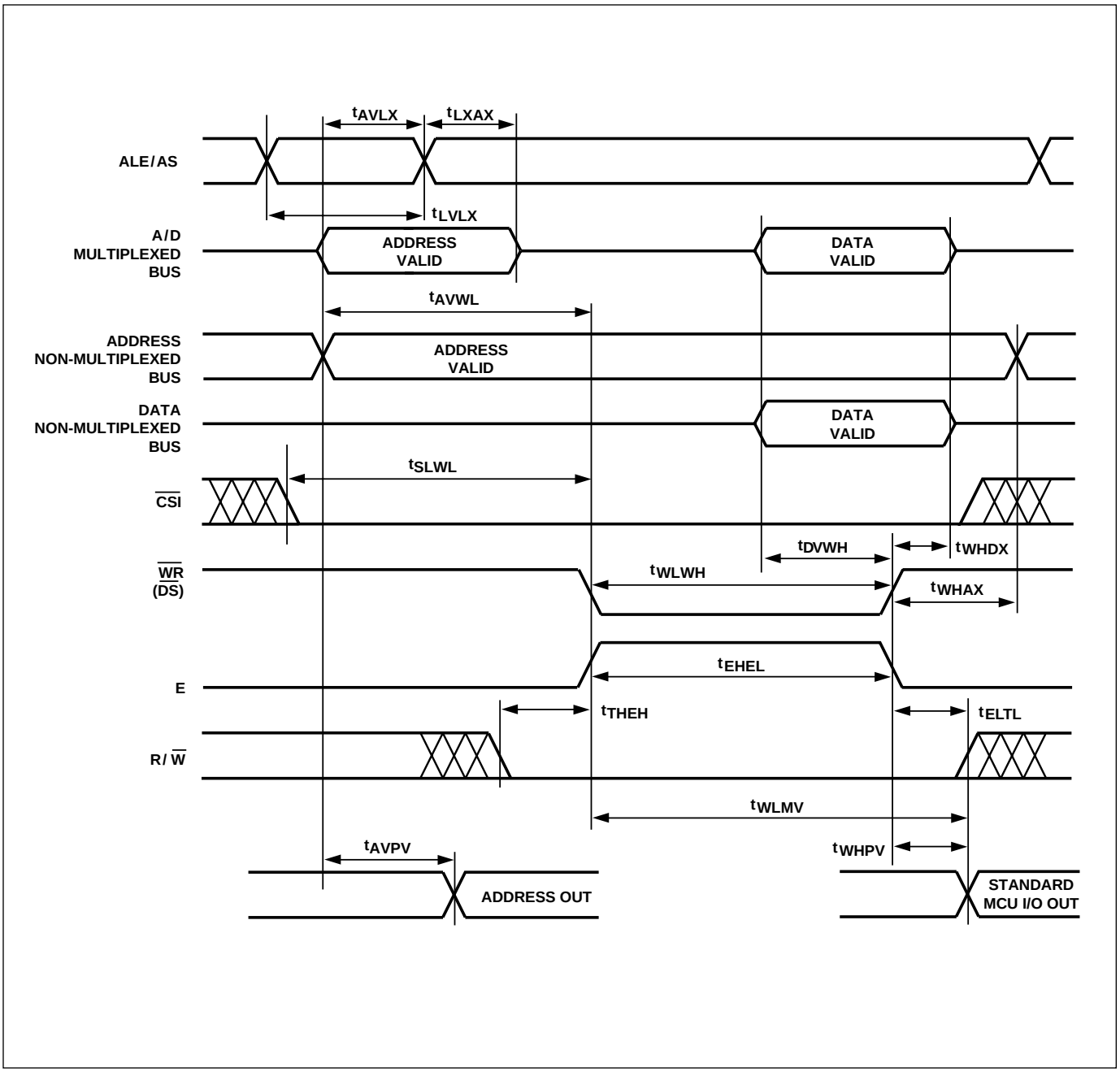


Figure 34. Peripheral I/O Read Timing

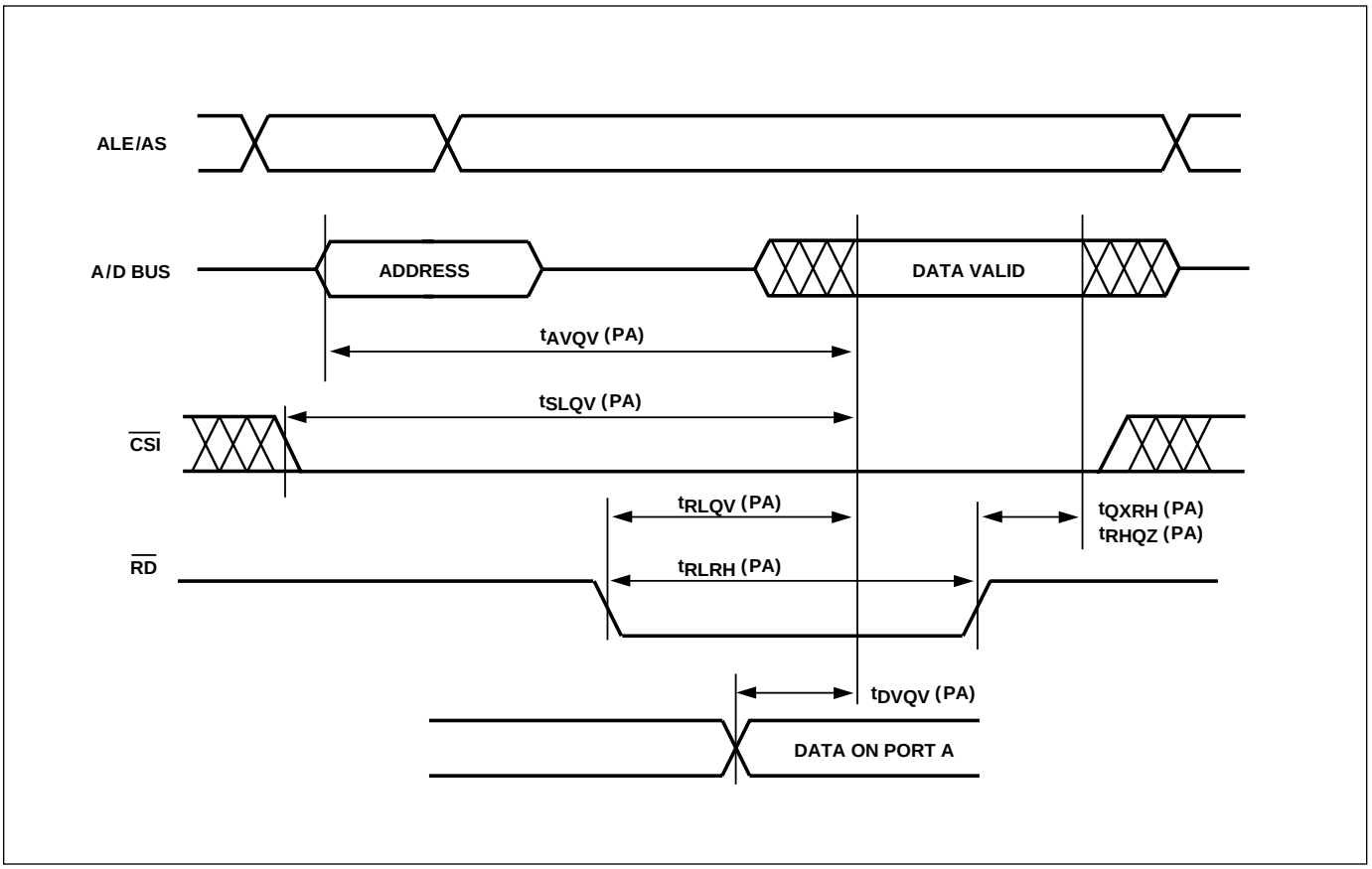


Figure 35. Peripheral I/O Write Timing

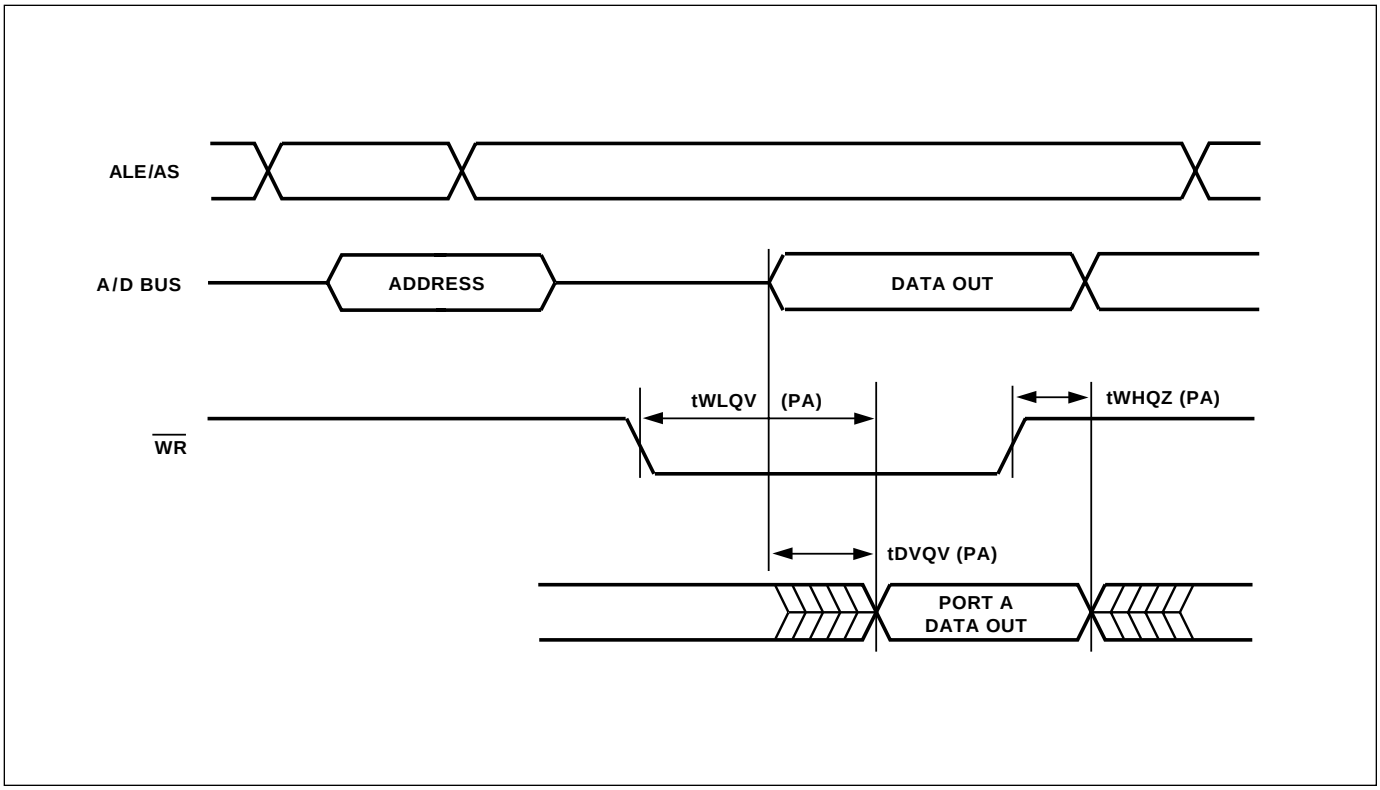


Figure 36. Combinatorial Timing – PLD

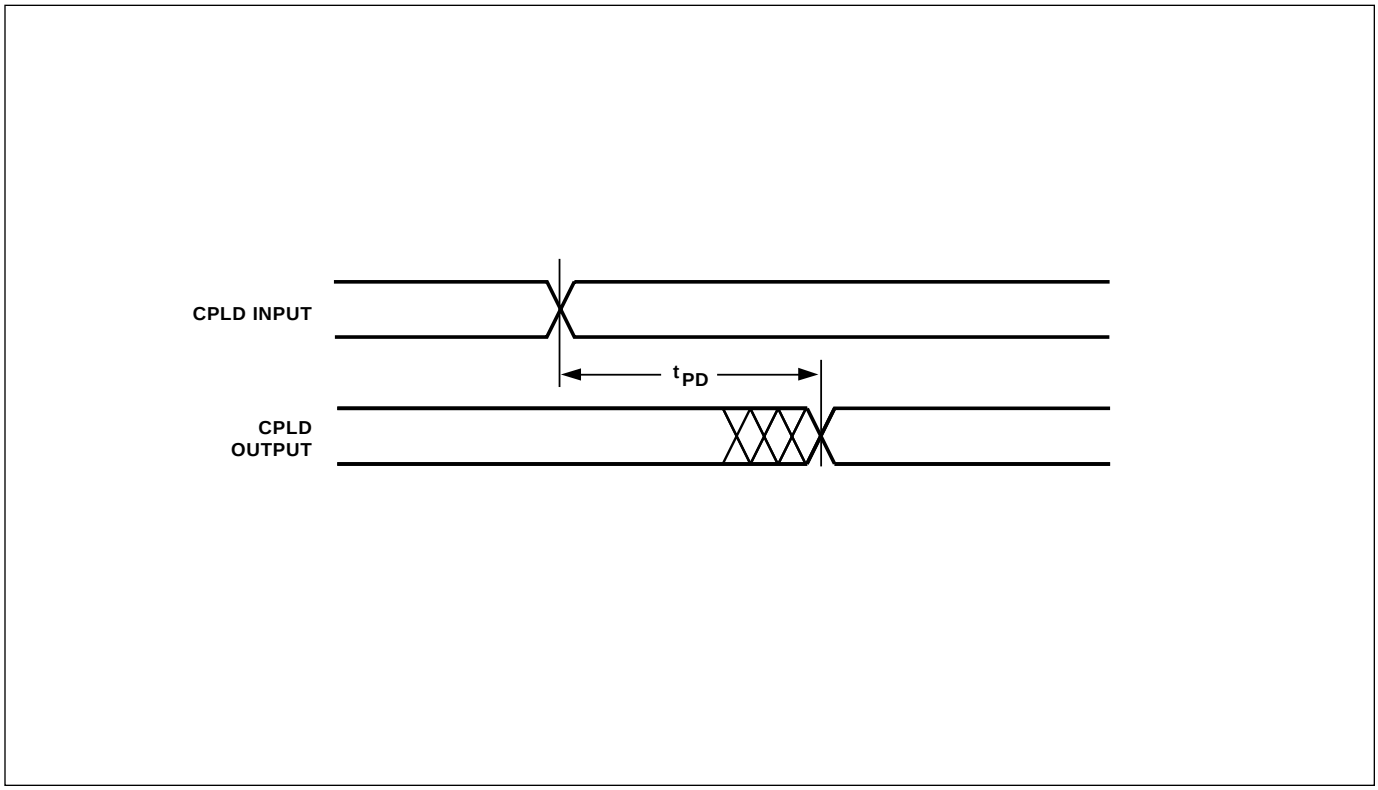


Figure 37. Synchronous Clock Mode Timing – PLD

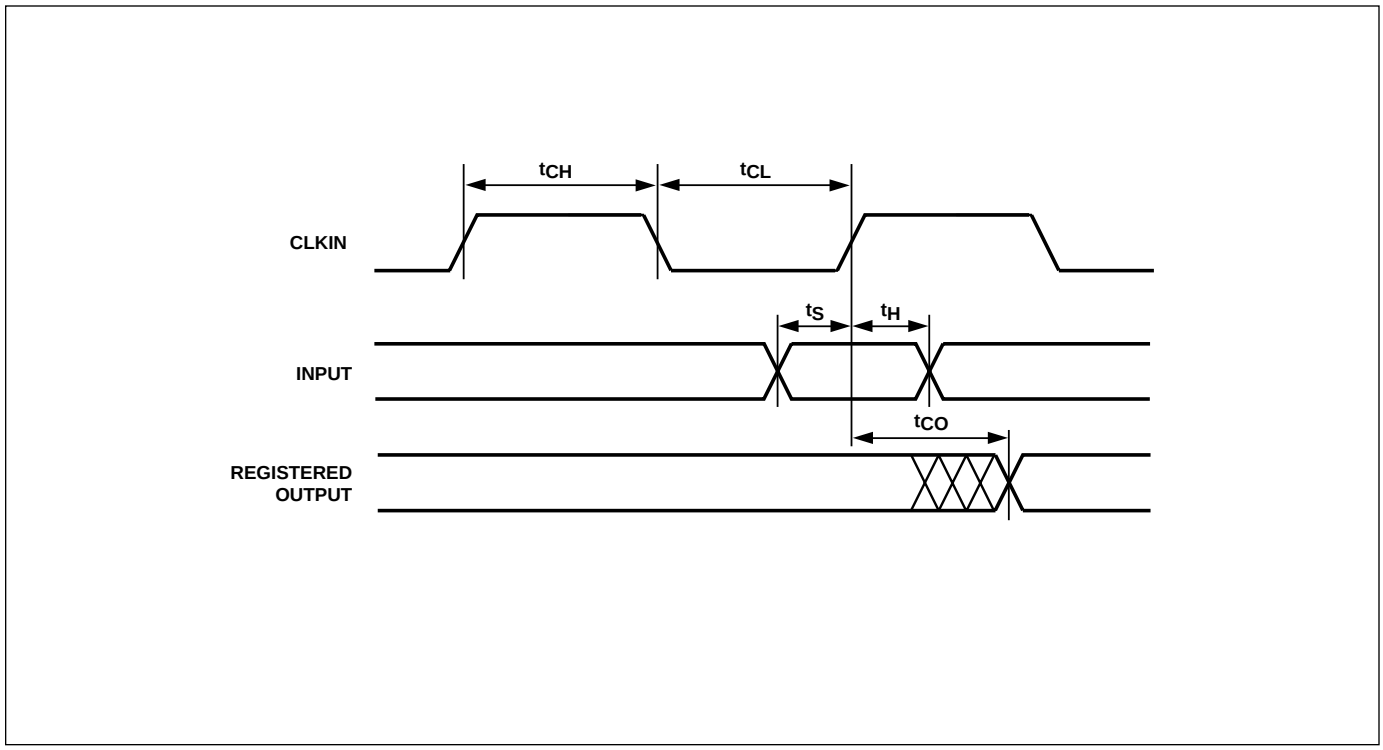


Figure38. Asynchronous Clock Mode Timing (Product-Term Clock)

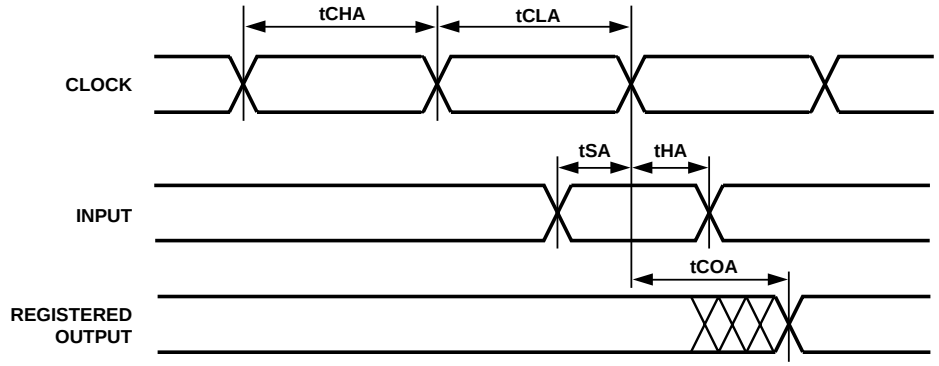


Figure 39. Input Micro⇔Cell Timing (Product-Term Clock)

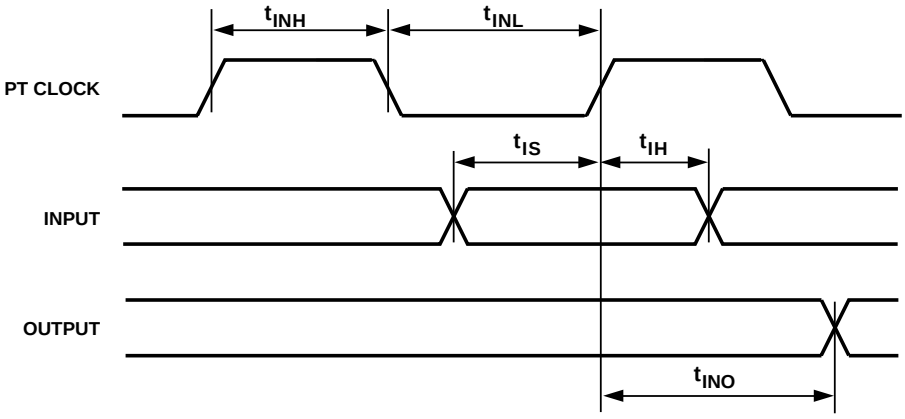


Figure 40. Input to Output Disable/Enable

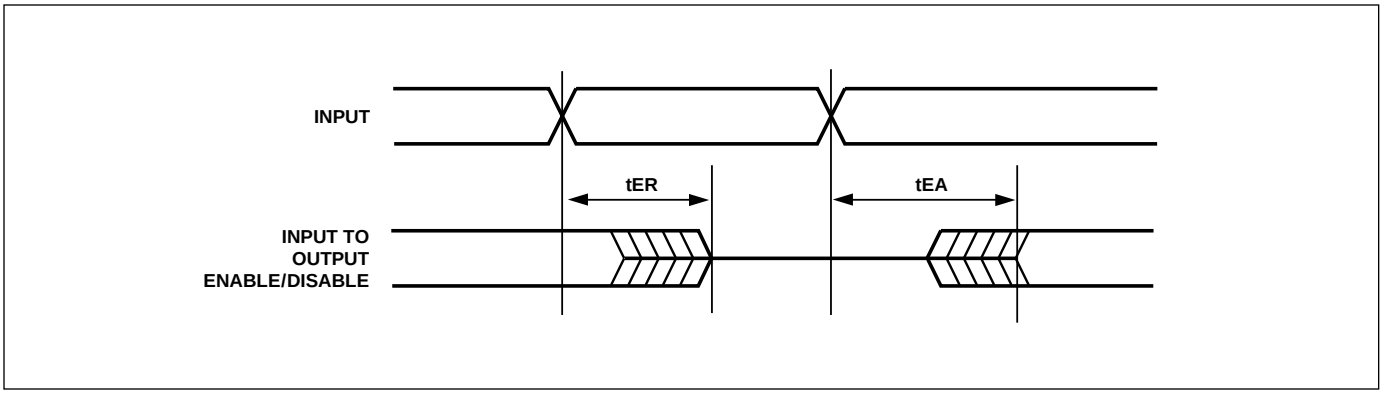


Figure 41. Asynchronous Reset/Preset

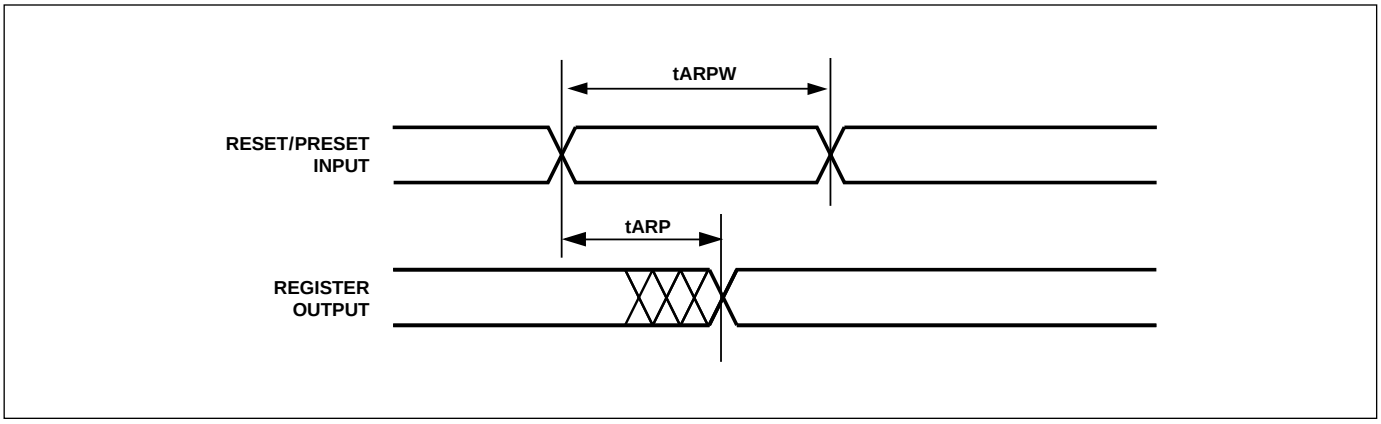


Figure 42. ISC Timing

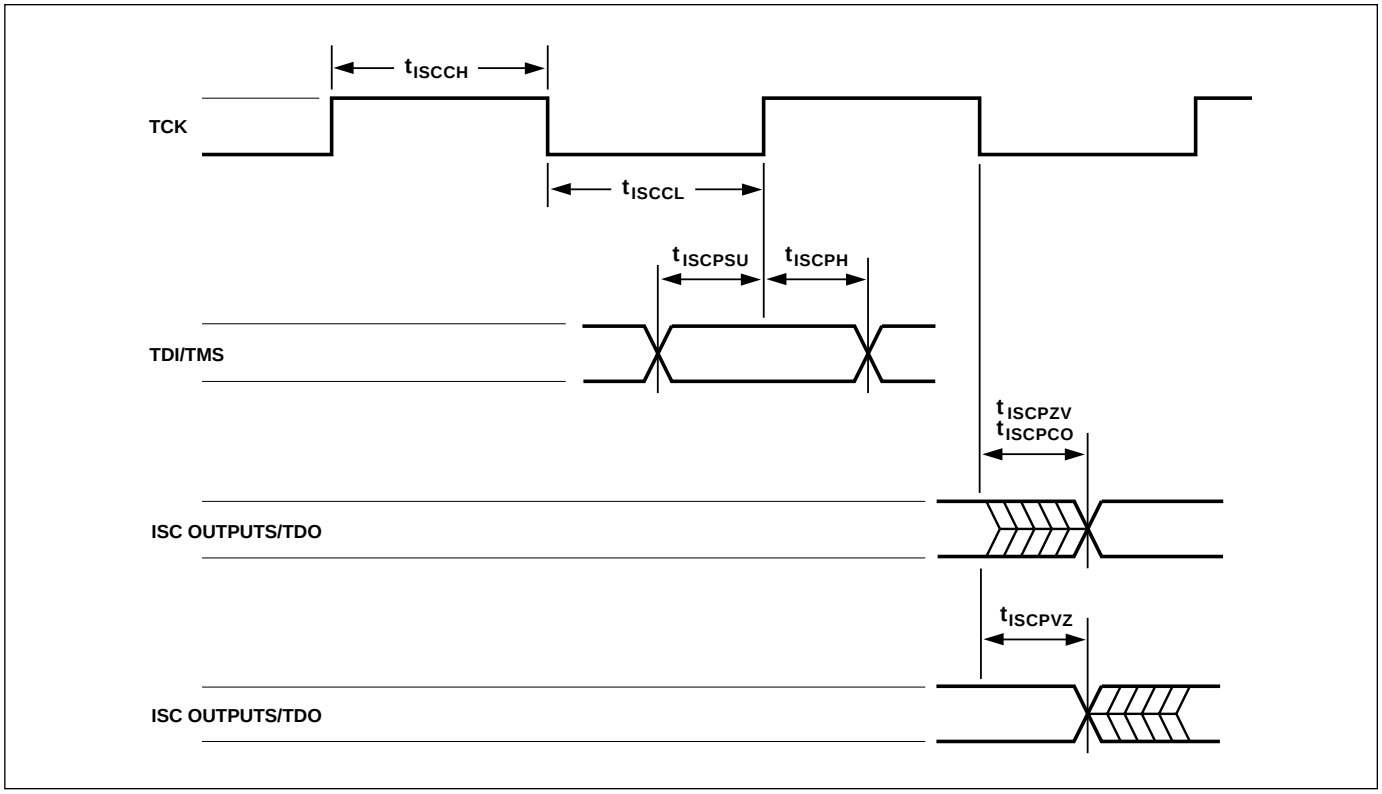


Figure 43. Reset Timing

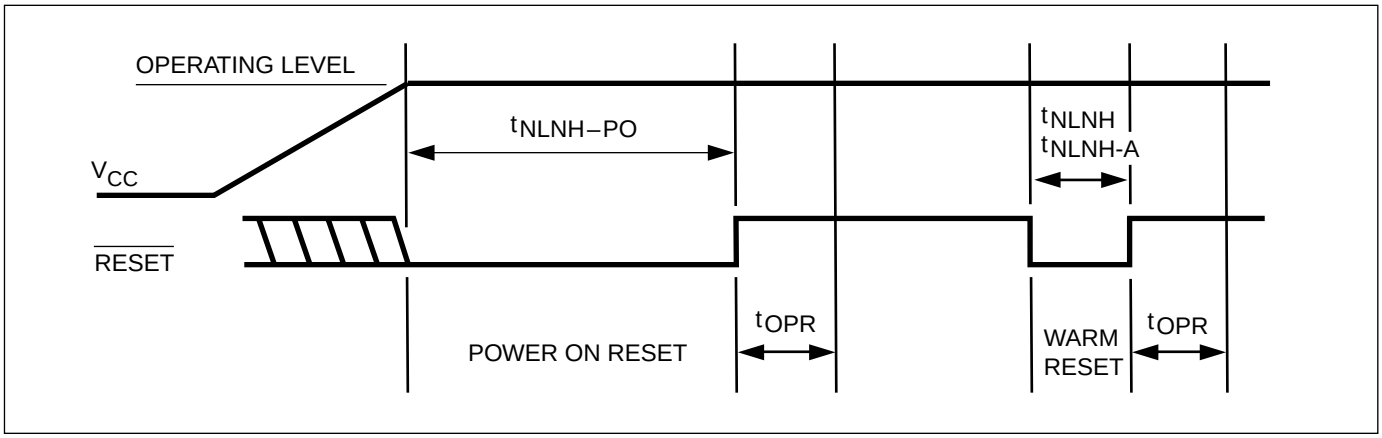
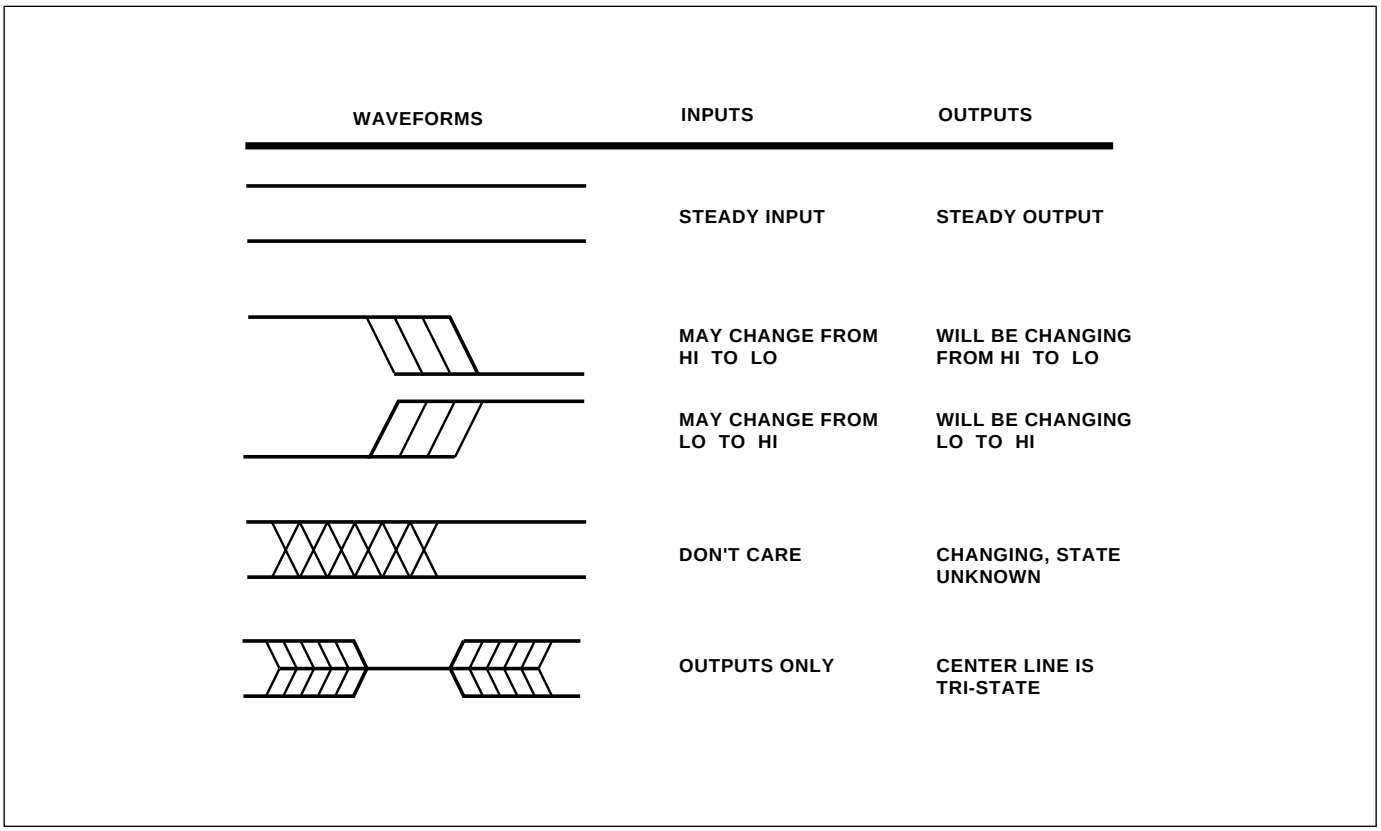


Figure 44. Key to Switching Waveforms



Pin Capacitance

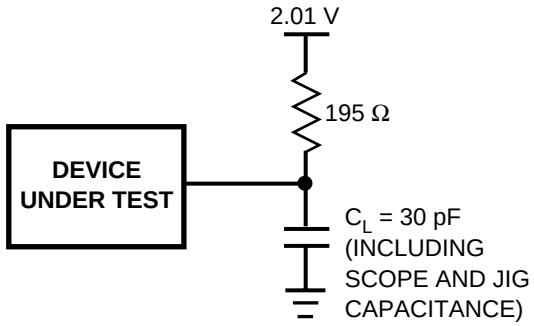
T_A = 25 °C, f = 1 MHz

Symbol	Parameter[1]	Conditions	Typical[2]	Max	Unit
C_{IN}	Capacitance (for input pins only)	V_{IN} = 0 V	4	6	pF
C_{OUT}	Capacitance (for input/output pins)	V_{OUT} = 0 V	8	12	pF
C_{VPP}	Capacitance (for CNTL2/V_{PP})	V_{PP} = 0 V	18	25	pF

NOTES: 1. These parameters are only sampled and are not 100% tested.
2. Typical values are for T_A = 25°C and nominal supply voltages.

Figure 45. AC Testing Input/Output Waveform

Figure 46. AC Testing Load Circuit



Programming

Upon delivery from ST, the PSD8XXF device has all bits in the PLDs and memories in the “1” or high state. The configuration bits are in the “0” or low state. The code, configuration, and PLDs logic are loaded through the procedure of programming.

Information for programming the device is available directly from ST. Please contact your local sales representative. (See the last page.)

PSD8XXF Pin Assignments

52-Pin Plastic Leaded Chip Carrier (PLCC) (Package Type J)

Pin No.	Pin Assignments	Pin No.	Pin Assignments
1	GND	27	PA2
2	PB5	28	PA1
3	PB4	29	PA0
4	PB3	30	AD0
5	PB2	31	AD1
6	PB1	32	AD2
7	PB0	33	AD3
8	PD2	34	AD4
9	PD1	35	AD5
10	PD0	36	AD6
11	PC7	37	AD7
12	PC6	38	V_{CC}
13	PC5	39	AD8
14	PC4	40	AD9
15	V_{CC}	41	AD10
16	GND	42	AD11
17	PC3	43	AD12
18	PC2 (VSTBY)	44	AD13
19	PC1	45	AD14
20	PC0	46	AD15
21	PA7	47	CNTL0
22	PA6	48	$\overline{\text{RESET}}$
23	PA5	49	CNTL2
24	PA4	50	CNTL1
25	PA3	51	PB7
26	GND	52	PB6

PSD8XXF Pin Assignments (cont.)

52-Pin Plastic Quad Flatpack (PQFP) (Package Type M)

Pin No.	Pin Assignments	Pin No.	Pin Assignments
1	PD2	27	AD4
2	PD1	28	AD5
3	PD0	29	AD6
4	PC7	30	AD7
5	PC6	31	VCC
6	PC5	32	AD8
7	PC4	33	AD9
8	VCC	34	AD10
9	GND	35	AD11
10	PC3	36	AD12
11	PC2	37	AD13
12	PC1	38	AD14
13	PC0	39	AD15
14	PA7	40	CNTL0
15	PA6	41	RESET
16	PA5	42	CNTL2
17	PA4	43	CNTL1
18	PA3	44	PB7
19	GND	45	PB6
20	PA2	46	GND
21	PA1	47	PB5
22	PA0	48	PB4
23	AD0	49	PB3
24	AD1	50	PB2
25	AD2	51	PB1
26	AD3	52	PB0

PSD8XXF Package Information

Figure 47. Drawing J7 – 52-Pin Plastic Leaded Chip Carrier (PLCC) (Package Type J)

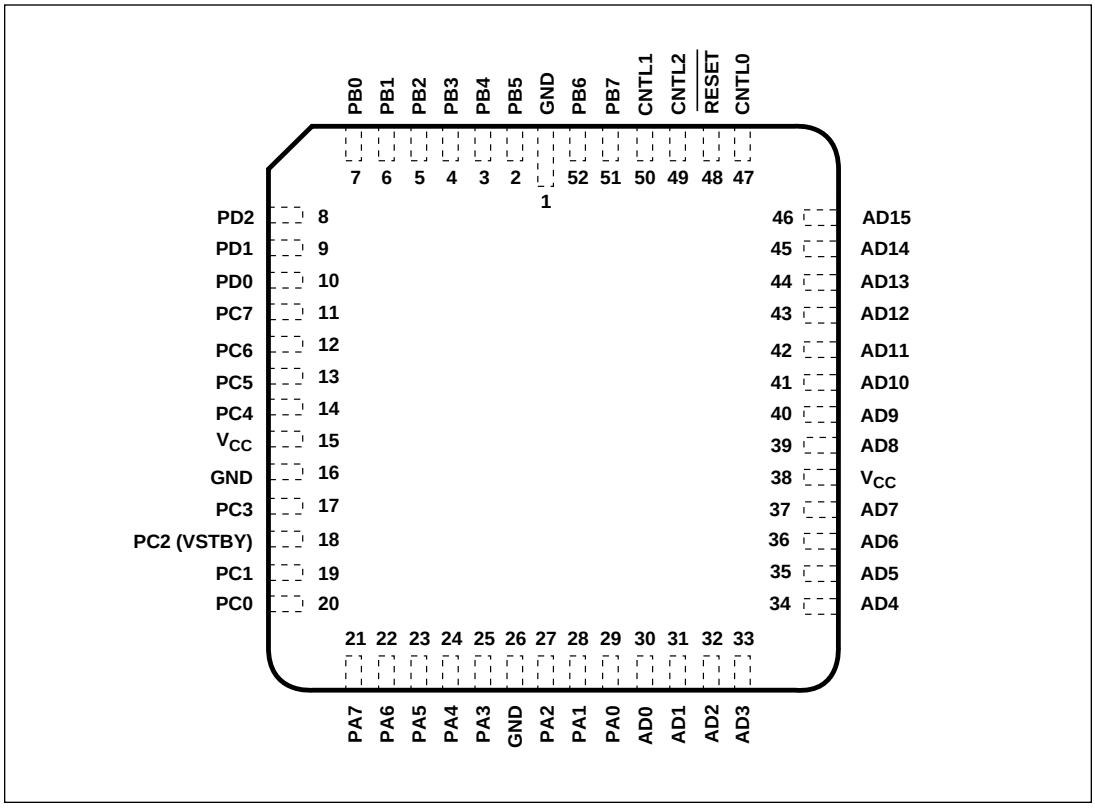


Figure 48. Drawing M3 – 52-Pin Plastic Quad Flatpack (PQFP) (Package Type M)

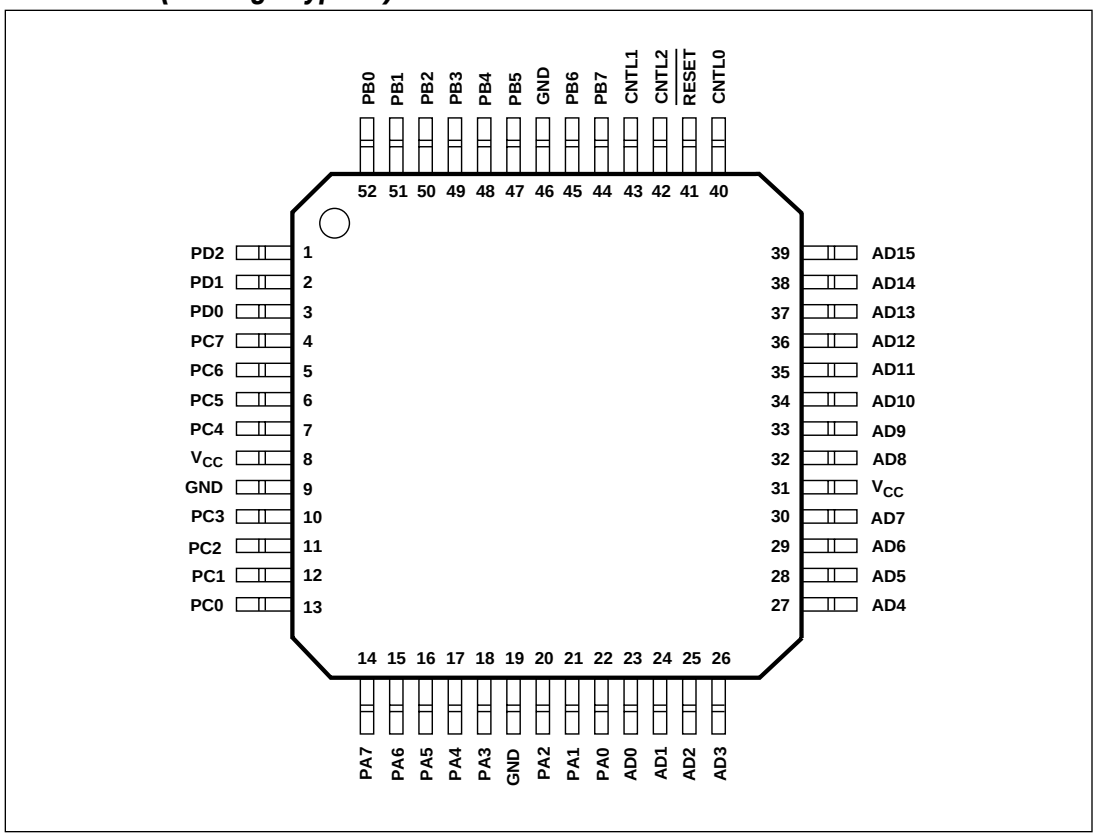
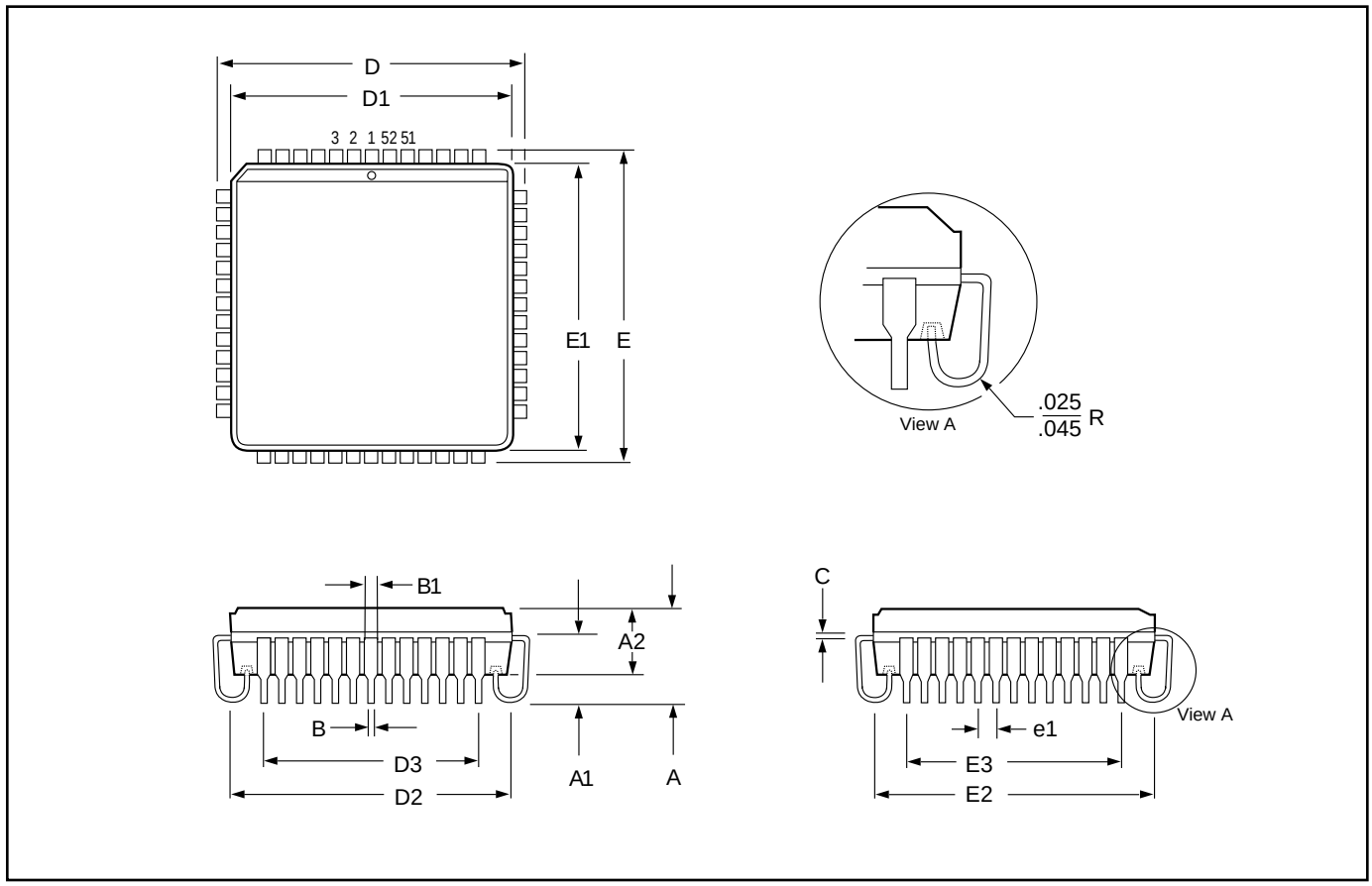


Figure 47A.
Drawing J7 – 52-Pin Plastic Leaded Chip Carrier (PLDCC) (Package Type J)



Family: Plastic Leaded Chip Carrier

	Millimeters			Inches		
Symbol	Min	Max	Notes	Min	Max	Notes
A	4.19	4.57		0.165	0.180	
A1	2.54	2.79		0.100	0.110	
A2	3.66	3.86		0.144	0.152	
B	0.33	0.53		0.013	0.021	
B1	0.66	0.81		0.026	0.032	
C	0.246	0.261		0.0097	0.0103	
D	19.94	20.19		0.785	0.795	
D1	19.05	19.15		0.750	0.754	
D2	17.53	18.54		0.690	0.730	
D3	15.24		Reference	0.600		Reference
E	19.94	20.19		0.785	0.795	
E1	19.05	19.15		0.750	0.754	
E2	17.53	18.54		0.690	0.730	
E3	15.24		Reference	0.600		Reference
e1	1.27		Reference	0.050		Reference
N	52			52		

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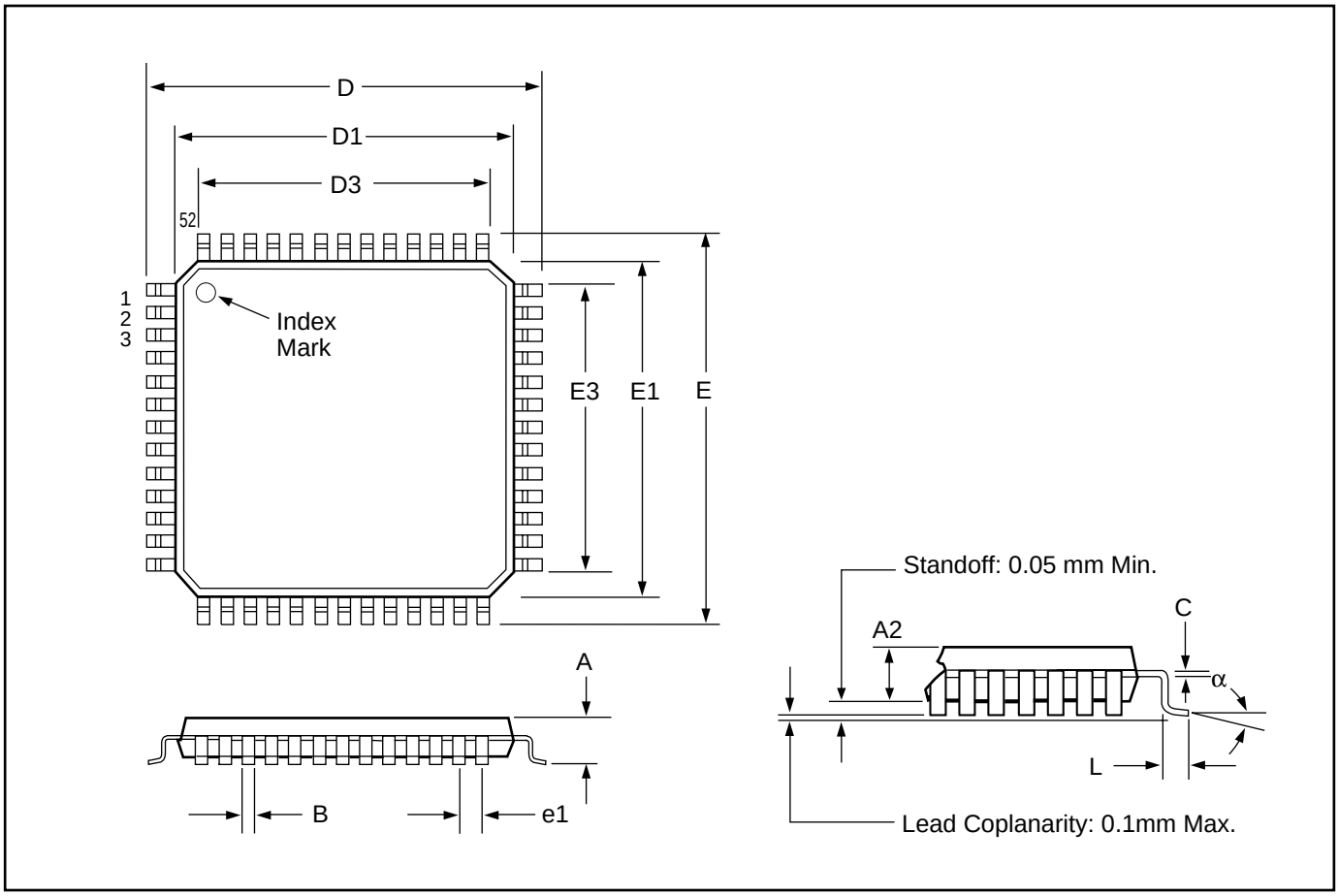
Figure 48A.
Drawing M3 – 52-Pin Plastic Quad Flatpack (PQFP) (Package Type M)



Family: Plastic Quad Flatpack (PQFP)

	Millimeters			Inches		
Symbol	**Min**	**Max**	**Notes**	**Min**	**Max**	**Notes**
α	0°	7°		0°	7°	
A	–	2.35		–	0.093	
A2	1.95	2.10		0.077	0.083	
B	0.22	0.38	Reference	0.009	0.015	
C		0.23			0.009	
D	13.15	13.25		0.518	0.522	
D1	9.95	10.05		0.392	0.396	
D3	7.80		Reference	0.307		Reference
E	13.15	13.25		0.518	0.522	
E1	9.95	10.05		0.392	0.396	
E3	7.80		Reference	0.307		Reference
e1	0.65		Reference	0.026		Reference
L	0.73	1.03		0.029	0.041	
N	52			52		

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Selector Guide

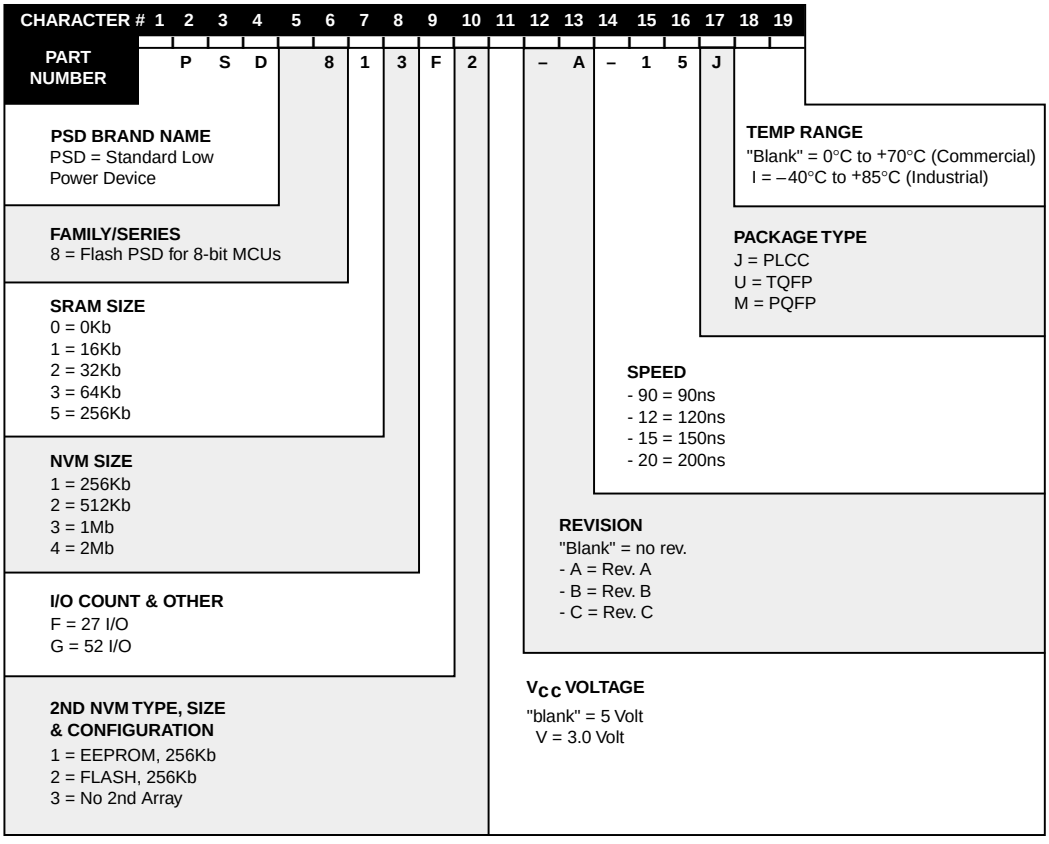
Selector Guide – PSD8XXF Family

Part #		MCU	PLDs/Decoders					I/O	Memory		
PSD @ 5 V	PSD @ 3 V	Data Path	PLD Inputs	Input Macrocells	Output Macrocells	PLD Outputs	Page Reg.	Ports	Main Flash	Boot Flash	SRAM
PSD813F2	PSD813F2V	8	73	24	16	19	8-Bit	27	1Mb	256Kb	16Kb
PSD813F3	PSD813F3V	8	73	24	16	19	8-Bit	27	1Mb	–	16Kb
PSD813F4	PSD813F4V	8	73	24	16	19	8-Bit	27	1Mb	256Kb	–
PSD813F5	PSD813F5V	8	73	24	16	19	8-Bit	27	1Mb	–	–
PSD833F2	PSD833F2V	8	73	24	16	19	8-Bit	27	1Mb	256Kb	64Kb
PSD834F2	PSD834F2V	8	73	24	16	19	8-Bit	27	2Mb	256Kb	64Kb
PSD853F2	PSD853F2V	8	73	24	16	19	8-Bit	27	1Mb	256Kb	256Kb
PSD854F2	PSD854F2V	8	73	24	16	19	8-Bit	27	2Mb	256Kb	256Kb

Legend:
PSDV = 3.0 V to 3.6 V V_{CC} on PSD8XXF family.

Part Number Construction

Flash PSD Part Number Construction



Ordering Information

Part Number	Speed (ns)	Package Type	Operating Temperature Range
PSD813F2-A-70J	70	52 Pin PLCC	Comm'l
PSD813F2-A-70M	70	52 Pin PQFP	Comm'll
PSD813F2-A-90J	90	52 Pin PLCC	Comm'l
PSD813F2-A-90JI	90	52 Pin PLCC	Industrial
PSD813F2-A-90M	90	52 Pin PQFP	Comm'l
PSD813F2-A-90MI	90	52 Pin PQFP	Industrial
PSD813F2-A-V-15J	150	52 Pin PLCC	Comm'l
PSD813F2-A-V-15M	150	52 Pin PQFP	Comm'l
PSD813F2-A-V-20JI	200	52 Pin PLCC	Industrial
PSD813F2-A-V-20MI	200	52 Pin PQFP	Industrial
PSD813F3-A-90J	90	52 Pin PLCC	Comm'l
PSD813F3-A-90JI	90	52 Pin PLCC	Industrial
PSD813F3-A-90M	90	52 Pin PQFP	Comm'l
PSD813F3-A-90MI	90	52 Pin PQFP	Industrial
PSD813F3-A-V-15J	150	52 Pin PLCC	Comm'l
PSD813F3-A-V-15M	150	52 Pin PQFP	Comm'l
PSD813F3-A-V-20JI	200	52 Pin PLCC	Industrial
PSD813F3-A-V-20MI	200	52 Pin PQFP	Industrial
PSD813F4-A-90J	90	52 Pin PLCC	Comm'l
PSD813F4-A-90JI	90	52 Pin PLCC	Industrial
PSD813F4-A-90M	90	52 Pin PQFP	Comm'l
PSD813F4-A-90MI	90	52 Pin PQFP	Industrial
PSD813F4-A-V-15J	150	52 Pin PLCC	Comm'l
PSD813F4-A-V-15M	150	52 Pin PQFP	Comm'l
PSD813F4-A-V-20JI	200	52 Pin PLCC	Industrial
PSD813F4-A-V-20MI	200	52 Pin PQFP	Industrial
PSD813F5-A-90J	90	52 Pin PLCC	Comm'l
PSD813F5-A-90JI	90	52 Pin PLCC	Industrial
PSD813F5-A-90M	90	52 Pin PQFP	Comm'l
PSD813F5-A-90MI	90	52 Pin PQFP	Industrial
PSD813F5-A-V-15J	150	52 Pin PLCC	Comm'l
PSD813F5-A-V-15M	150	52 Pin PQFP	Comm'l
PSD813F5-A-V-20JI	200	52 Pin PLCC	Industrial
PSD813F5-A-V-20MI	200	52 Pin PQFP	Industrial

Ordering Information

Part Number	Speed (ns)	Package Type	Operating Temperature Range
PSD833F2-70J	70	52 Pin PLCC	Comm'l
PSD833F2-70M	70	52 Pin PQFP	Comm'l
PSD833F2-90J	90	52 Pin PLCC	Comm'l
PSD833F2-90M	90	52 Pin PQFP	Comm'l
PSD833F2V-15J	150	52 Pin PLCC	Comm'l
PSD833F2V-15JI	150	52 Pin PLCC	Industrial
PSD833F2V-15M	150	52 Pin PQFP	Comm'l
PSD833F2V-15MI	150	52 Pin PQFP	Industrial
PSD834F2-70J	70	52 Pin PLCC	Comm'l
PSD834F2-70M	70	52 Pin PQFP	Comm'l
PSD834F2-90J	90	52 Pin PLCC	Comm'l
PSD834F2-90M	90	52 Pin PQFP	Comm'l
PSD834F2V-15J	150	52 Pin PLCC	Comm'l
PSD834F2V-15M	150	52 Pin PQFP	Comm'l
PSD834F2V-20JI	200	52 Pin PLCC	Industrial
PSD834F2V-20MI	200	52 Pin PQFP	Industrial
PSD853F2-70J	70	52 Pin PLCC	Comm'l
PSD853F2-70M	70	52 Pin PQFP	Comm'l
PSD853F2-90JI	90	52 Pin PLCC	Industrial
PSD853F2-90MI	90	52 Pin PQFP	Industrial
PSD854F2-90J	90	52 Pin PLCC	Comm'l
PSD854F2-90M	90	52 Pin PQFP	Comm'l
PSD854F2V-12JI	120	52 Pin PLCC	Industrial
PSD854F2V-12MI	120	52 Pin PQFP	Industrial

Document Revisions

Date	Revision Reason	Data Sheet Changes
15 Oct 99	PSD8XXF Initial release	–
27 Oct 00	Modification	Page 93 – Port A Peripheral Data Mode Read Timing, -15 Max. – changed 45 to 50
30 Nov 00	Add PSD85XF2	Change SRAM max. sixe to 256K bit

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