



MA28155

T-52-33-51

Radiation Hard Programmable Peripheral Interface

FEATURES

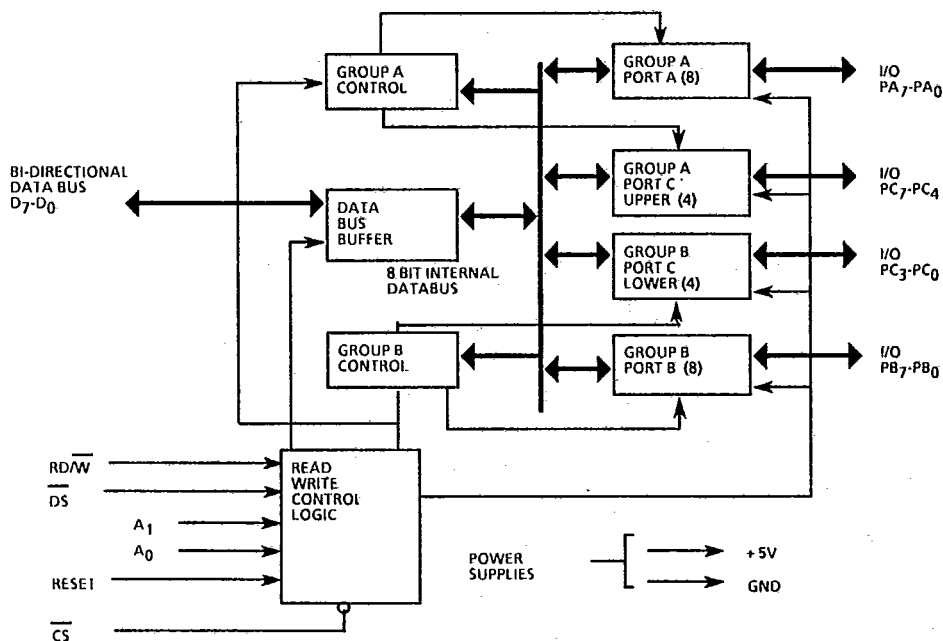
- Radiation Hard to 1 MRad (Si)
- High SEU immunity, latch up free
- Silicon-on-Sapphire technology
- 24 Programmable I/O Pins
- All inputs & outputs are TTL Compatible
- Direct Bit Set/Reset Capability Easing Control application Interface
- Reduces System Package Count
- Compatible with (Mil Std 1750A) MAS281 microprocessor

GENERAL DESCRIPTION

The MA28155 is a general purpose programmable Input/Output device designed for use with the MAS281 microprocessor. It has 24 I/O pins which may be individually programmed in 2 groups of 12 and used in 3 major modes of operation.

In the first mode (MODE 0), each group of 12 I/O pins may be programmed in sets of 4 to be inputs or outputs. In the second mode (MODE 1), each group may be programmed to have 8 lines of input or output. Of the remaining 4 pins, 3 are used for hand-shaking and interrupt control signals. The third mode of operation (MODE 2) is the bidirectional bus mode, which uses 8 lines for a bidirectional bus and 5 lines, borrowing one from the other group, for hand-shaking.

BLOCK DIAGRAM



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C458D Issue 1 Nov. 1988

MA28155



Radiation Hard Programmable Peripheral Interface

FUNCTIONAL DESCRIPTION

The MA28155 is a programmable peripheral interface (PPI) device designed for use with MAS281. Its function is that of a general purpose I/O component to interface peripheral equipment to the microcomputer system bus. The functional configuration of the MA28155 is programmed by the system software so that, normally, no external logic is necessary to interface peripheral devices or structures.

Data Bus Buffer

This 3-state, bidirectional, 8-bit buffer is used to interface the MA28155 to the system data bus. Data is transmitted or received by the buffer upon execution of input or output instructions by the CPU. Control words and status information are also transferred through the data bus buffer.

Read/Write and Control Logic

The function of this block is to manage all of the internal and external transfers of both Data and Control Status words. It accepts inputs from the CPU Address and Control busses and in turn, issues commands to both of the Control Groups.

(RESET)

A high on this input clears the control register and all ports (A,B,C) are set to the input mode.

(CS) Chip Select

A low on this input pin enables the communication between the MA28155 and the CPU.

RD/W

A high on RD/W indicates a CPU read from the MA28155 and a low indicates a CPU data or control word write to the MA28155. The RD/W line is active only when DS is low.

DS (Data Strobe)

This input indicates that a data transfer is taking place. During a CPU write operation the MA28155 reads data from the bus on the rising edge of DS. During a read operation the MA28155 outputs data to the bus while DS is low. Data is valid on the rising edge of DS.

(A0 and A1)

Port Select 0 and Port Select 1.

These input signals, in conjunction with the DS and RD/W inputs, control the selection of one of the three ports of the control word registers. They are normally connected to the least significant bits of the address bus.

MA28155 BASIC OPERATION

A ₁	A ₀	DS	R/W	CS	READ
0	0	0	1	0	PORT A → DATA BUS
0	1	0	1	0	PORT B → DATA BUS
1	0	0	1	0	PORT C → DATA BUS
					WRITE
0	0	0	0	0	DATA BUS → PORT A
0	1	0	0	0	DATA BUS → PORT B
1	0	0	0	0	DATA BUS → PORT C
1	1	0	0	0	DATA BUS → CONTROL
					DISABLE
x	x	x	x	1	DATA BUS → TRI-STATE
1	1	0	1	0	ILLEGAL CONDITION
x	x	1	x	0	DATA BUS → TRI-STATE

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OPERATIONAL DESCRIPTION

Mode Selection.

There are three basic modes of operation that can be selected by the system software:

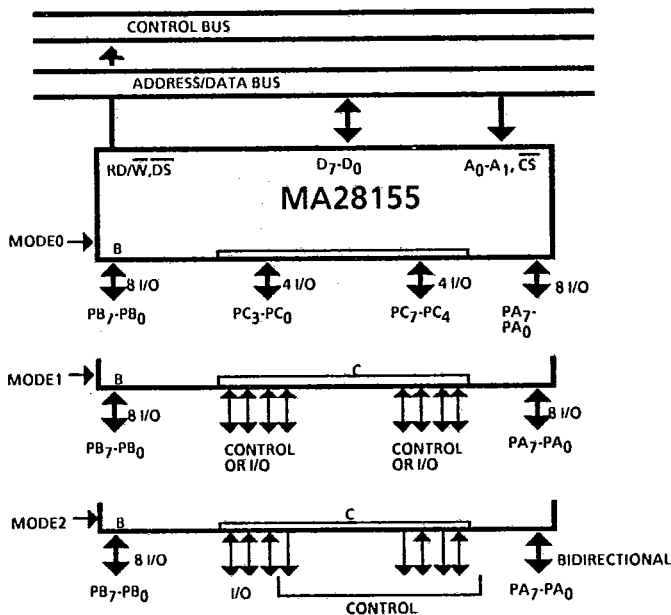
- Mode 0. Basic Input/Output
- Mode 1. Strobed Input/Output
- Mode 2. Bi-directional Bus

When the reset input goes high all ports will be set to the input mode (i.e. all 24 lines will be in the high impedance state). After the reset is removed the MA28155 can remain in the input mode with no additional initialization required.

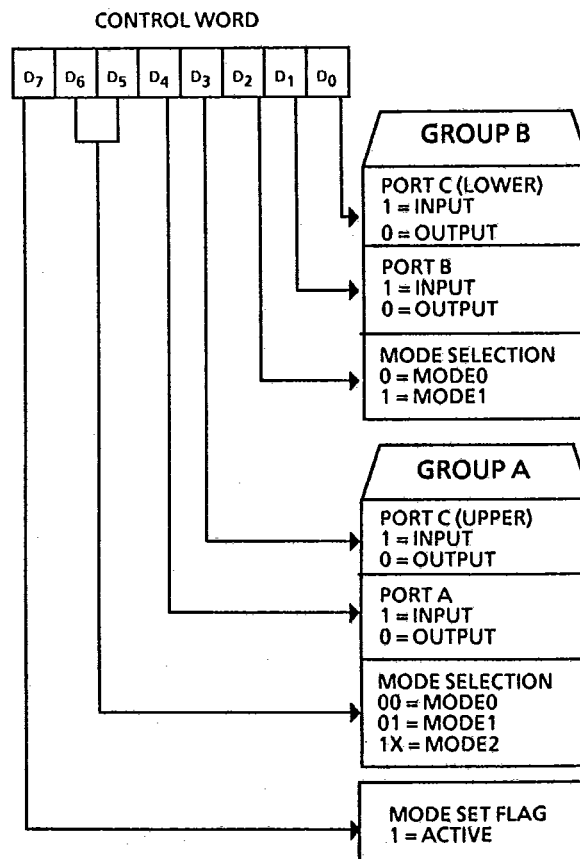
During the execution of the system program any of the other modes may be selected using a single output instruction. This allows a single MA28155 to service a variety of peripheral devices with a single software maintenance routine.

The modes for Port A and Port B can be separately defined, while Port C is divided into two portions as required by the Port A and Port B definitions. All of the output registers, including the status flip-flops, will be reset whenever the mode is changed. Modes may be combined so that their functional definition can be tailored to almost any I/O structure. For instance; Group B can be programmed in Mode 0 to monitor simple switch closings or display computational results, Group A could be programmed in Mode 1 to monitor a keyboard or tape reader on an interrupt-driven basis.

The design of the MA28155 has taken into account things such as efficient PC board layout, control signal definition versus PC layout and complete functional flexibility to support almost any peripheral device with no external logic. Such design represents the optimum use of available pins.



Basic Mode Definitions and Bus Interface



Mode Definition Format

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Single Bit Set/Reset Feature

Any of the eight bits of Port C can be Set or Reset using a single OUTput instruction. This feature reduces software requirements in Control-based applications.

When Port C is being used as Status/Control for Port A or B, these bits can be set or reset by using the Bit Set/Reset operation just as if they were data output ports.

Interrupt Control Functions (Figure 1. below)

When the MA28155 is programmed to operate in Mode 1 or 2, control signals are provided that can be used as interrupt request inputs to the CPU. The interrupt request signals, generated from Port C, can be inhibited or enabled by setting or resetting the associated INTE flip-flop, using the Bit Set/Reset function of Port C.

This function allows the programmer to disallow or allow a specific I/O device to interrupt the CPU, without affecting any other device in the interrupt structure.

INTE flip-flop definitions:

(BIT-SET): INTE is SET -Interrupt enable

(BIT-RESET): INTE is RESET -Interrupt disable

Note: All Mask flip-flops are automatically reset during mode selection and device reset.

Group A and Group B Controls

The functional configuration of each port is programmed by the system software. In essence, the CPU outputs a control word to the MA28155. The control word contains information such as mode, bit set, bit reset, etc., this initializes the functional configuration of the MA28155.

Each of the Control blocks (Group A and Group B) accept commands from the Read/Write Control Logic, receive control words from the internal data bus and issue the proper commands to its associated ports:

Control Group A - Port A and Port C upper (C₇-C₄)

Control Group B - Port B and Port C lower (C₃-C₀)

The Control Word Register can only be written into. Therefore reading of the Control Word Register is not allowed.

Ports A, B and C

The MA28155 contains three 8-bit ports (A, B, and C). All can be configured in a wide variety of functional characteristics by the system software but each has its own special features or personality to further enhance the power and flexibility of the MA28155.

Port A.

One 8-bit data output latch/buffer and one 8-bit data input latch.

Port B.

One 8-bit data input/output latch/buffer and one 8-bit input buffer.

Port C.

One 8-bit data output latch/buffer and one 8-bit data input buffer (no latch for input). This port can be divided into two 4-bit ports under the mode control. Each 4-bit port contains a 4-bit latch and it can be used for the control signal outputs and status signal inputs in conjunction with ports A and B.

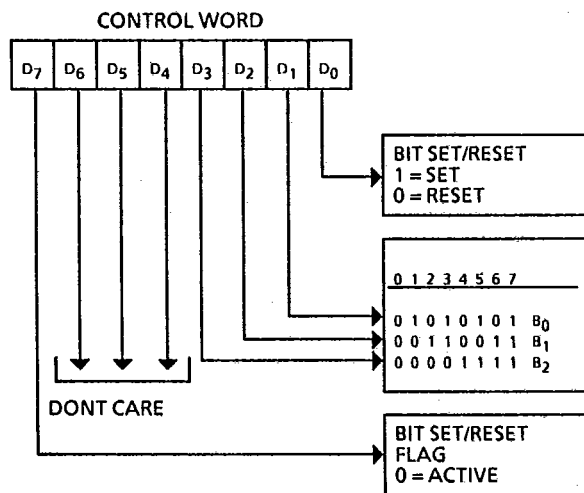


Figure 1: Bit Set/Reset Format



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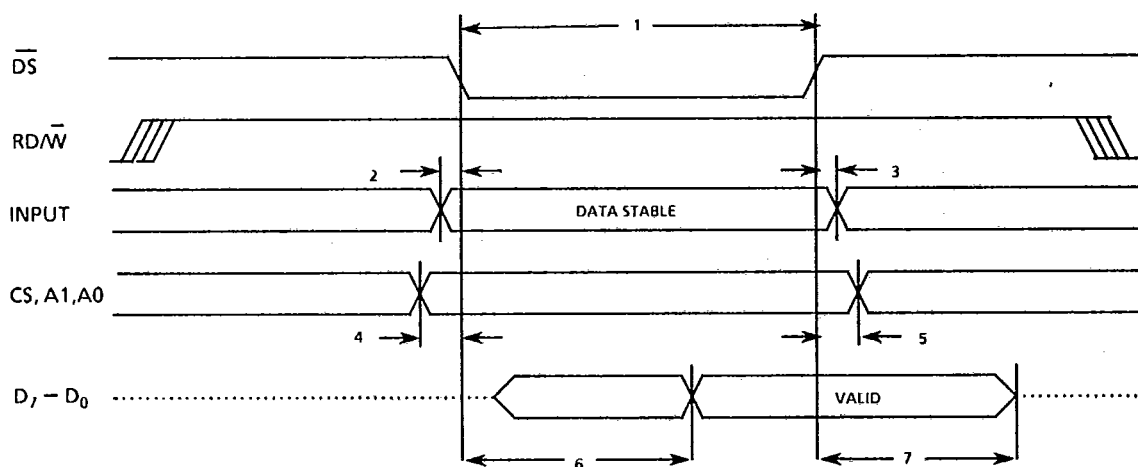
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OPERATING MODE 0 (BASIC INPUT/OUTPUT)

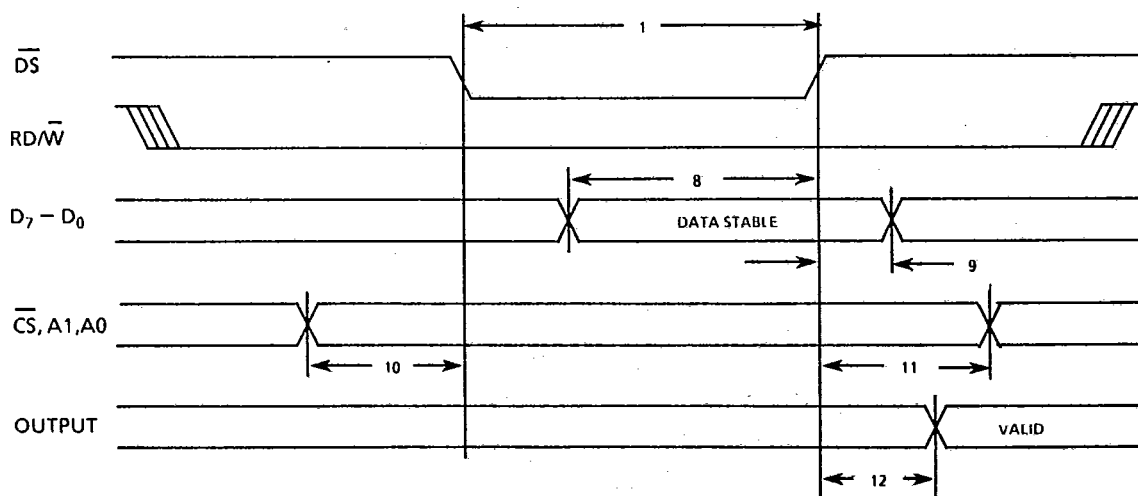
This functional configuration provides simple input and output operation for each of the three ports. No handshaking is required; data is simply written to or read from a specified port.

- Two 8-bit ports and 4-bit ports.
- Any port can be input or output.
- Outputs are latched.
- Inputs are not latched.
- 16 different Input/Output configurations are possible in this Mode.

Basic Input (read)



Basic Output (write)



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**OPERATING MODE 0
(BASIC INPUT/OUTPUT) cont.**

Port Definition

D ₄	D ₃	D ₁	D ₀	PORT A	PORT C (UPPER)		PORT B	PORT C (LOWER)
0	0	0	0	OUTPUT	OUTPUT	0	OUTPUT	OUTPUT
0	0	0	1	OUTPUT	OUTPUT	1	OUTPUT	INPUT
0	0	1	0	OUTPUT	OUTPUT	2	INPUT	OUTPUT
0	0	1	1	OUTPUT	OUTPUT	3	INPUT	INPUT
0	1	0	0	OUTPUT	INPUT	4	OUTPUT	OUTPUT
0	1	0	1	OUTPUT	INPUT	5	OUTPUT	INPUT
0	1	1	0	OUTPUT	INPUT	6	INPUT	OUTPUT
0	1	1	1	OUTPUT	INPUT	7	INPUT	INPUT
1	0	0	0	INPUT	OUTPUT	8	OUTPUT	OUTPUT
1	0	0	1	INPUT	OUTPUT	9	OUTPUT	INPUT
1	0	1	0	INPUT	OUTPUT	10	INPUT	OUTPUT
1	0	1	1	INPUT	OUTPUT	11	INPUT	INPUT
1	1	0	0	INPUT	INPUT	12	OUTPUT	OUTPUT
1	1	0	1	INPUT	INPUT	13	OUTPUT	INPUT
1	1	1	0	INPUT	INPUT	14	INPUT	OUTPUT
1	1	1	1	INPUT	INPUT	15	INPUT	INPUT



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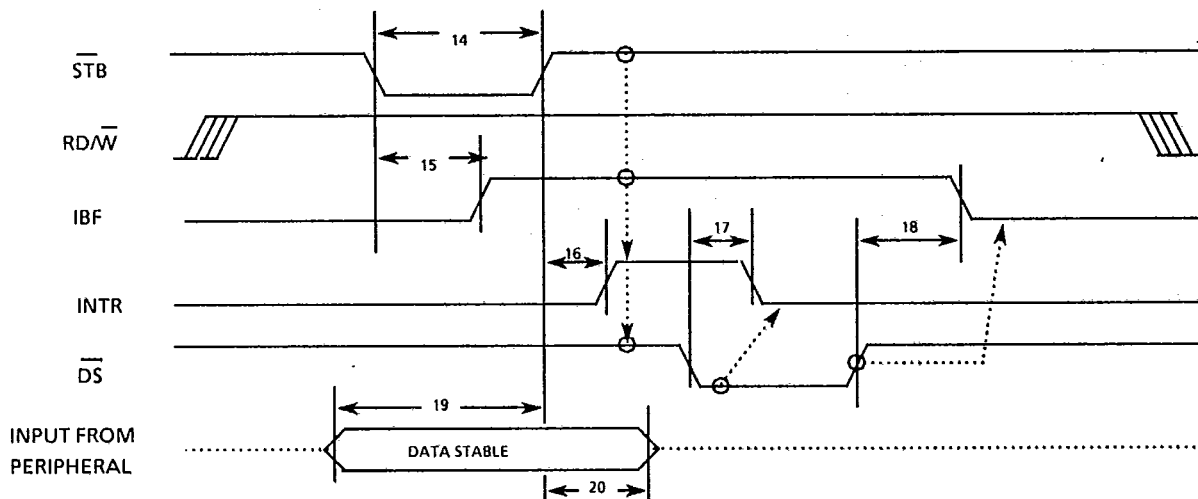
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OPERATING MODE 1 (STROBED INPUT/OUTPUT).

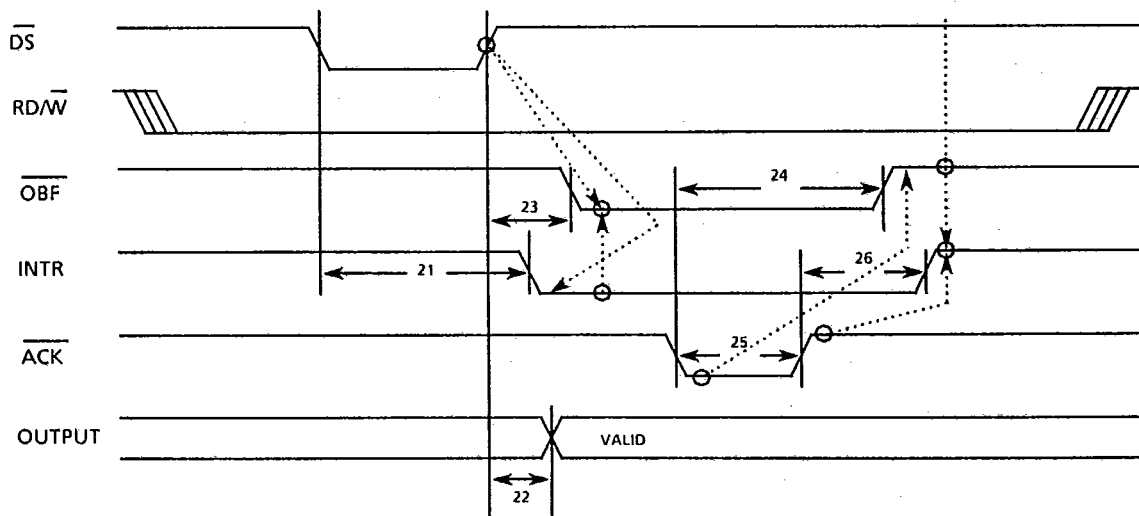
This functional configuration provides a means for transferring I/O data to or from a specified port in conjunction with strobes or handshaking signals. In mode 1, port A and port B use the lines on port C to generate or accept these handshaking signals.

- Two Groups (Group A and Group B) .
- Each Group contains one 8-bit data port and one 4-Bit control/data port.
- The 8-bit data port can be either input or output. Both inputs and outputs are latched.
- The 4-bit port is used for control and status of the 8-bit data port.

Strobed Input



Strobed Output



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**OPERATING MODE 1
(STROBED INPUT/OUTPUT) cont.**

Input Control Signal Definition

STB (Strobe Input).

A low on this input loads data into the input latch.

IBF (Input Buffer Full F/F).

A high on this output indicates that the data has been loaded into the input latch; in essence, an acknowledgement.

IBF is set by the STB input being low and is reset by the rising edge of DS input.

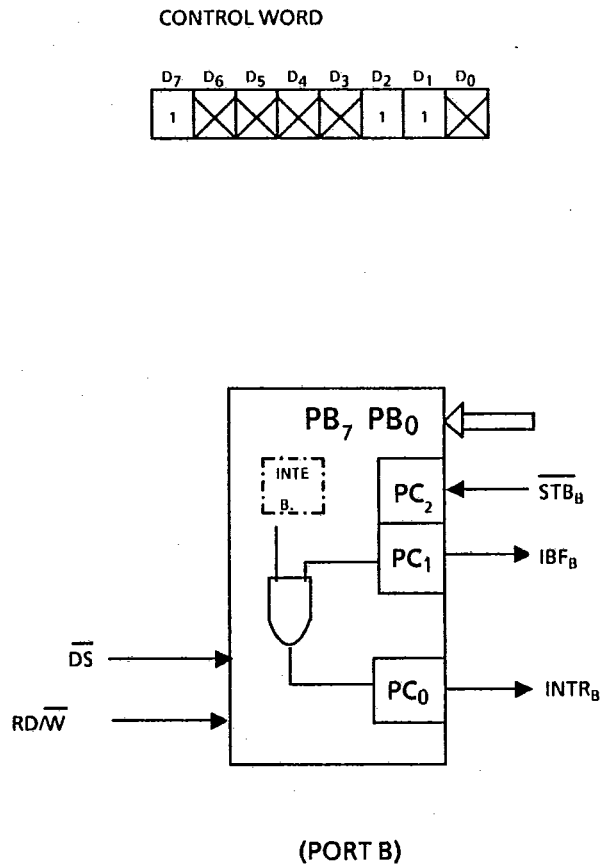
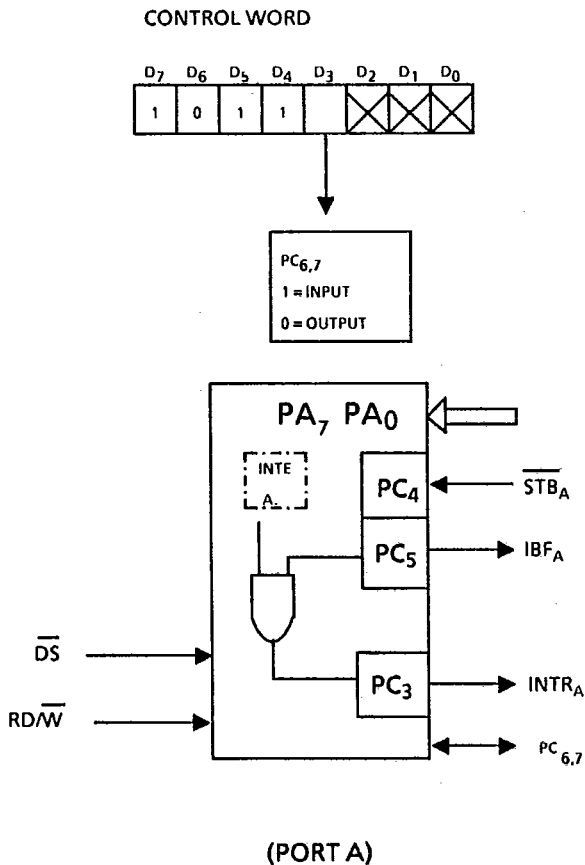
INTR (Interrupt Request).

A high on this output can be used to interrupt the CPU when an input device is requesting service. INTR is set by the STB being high and IBF being high and INTE being enabled. It is reset by the falling edge of DS. This procedure allows an input device to request service from the CPU by simply strobing its data into the port.

INTE A: Controlled by bit set/reset of PC₄

INTE B: Controlled by bit set/reset of PC₂

Strobed Input



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**OPERATING MODE 1
(STROBED INPUT/OUTPUT) cont.**

Output Control Signal Definition

OBF (Output Buffer Full F/F).

The OBF output will go low to indicate that the CPU has written data out to the specified port. The OBF F/F will be set by the rising edge of the DS input and reset by ACK input being low.

ACK (Acknowledge Input).

A low on this input informs the 28155 that the data from port A or port B has been accepted; in essence, a response from the peripheral device indicating that it has received the data output by the CPU.

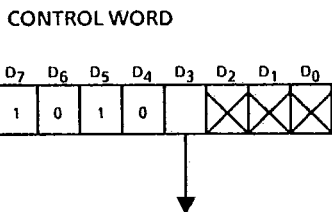
INTR (Interrupt Request).

A high on this output can be used to interrupt the CPU when an output device has accepted data transmitted by the CPU. INTR is set when ACK is high, OBF is high and INTE is high. It is reset by the falling edge of DS.

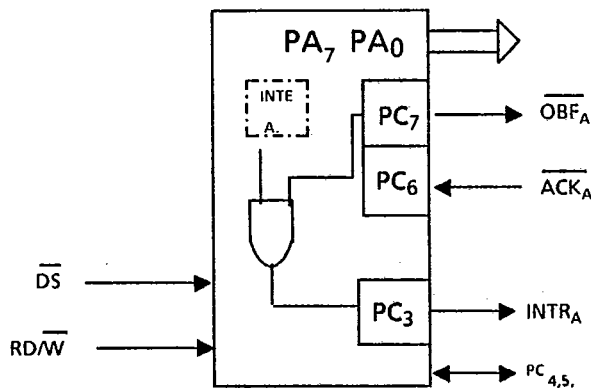
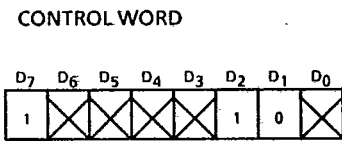
INTE A: Controlled by bit set/reset of PC₆

INTE B: Controlled by bit set/reset of PC₂

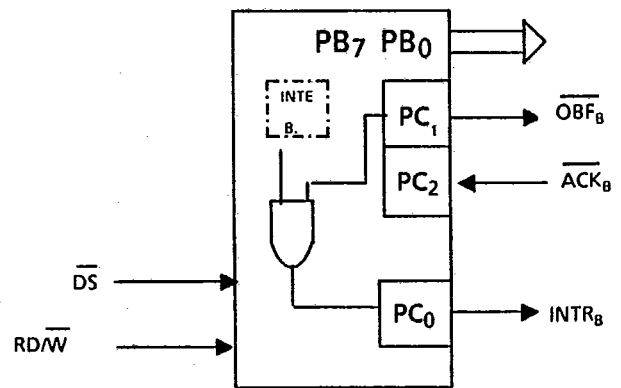
Strobed Output



PC_{4,5}
1 = INPUT
0 = OUTPUT



(PORT A)



(PORT B)

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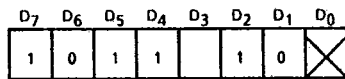


OPERATING MODE 1 (STROBED INPUT/OUTPUT) cont.

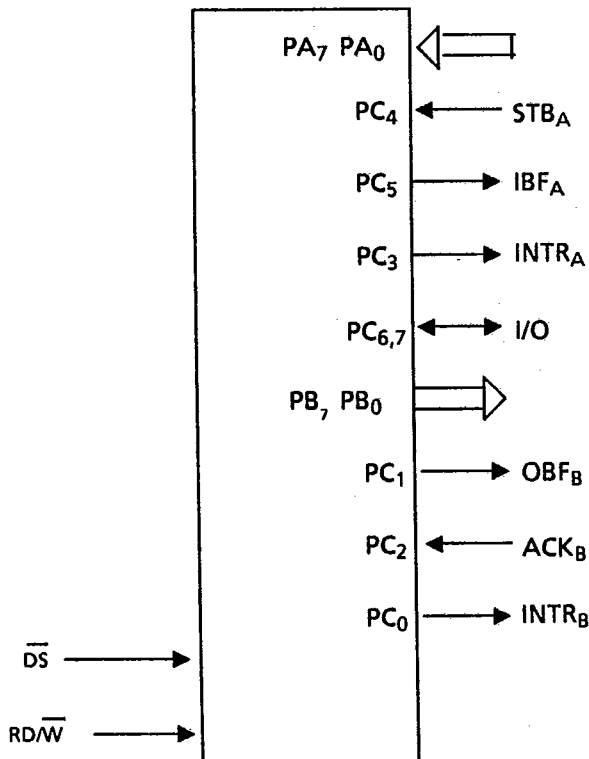
Combinations of Mode 1

Port A and Port B can be individually defined as input or output in Mode 1 to support a wide variety of strobed I/O applications.

CONTROL WORD

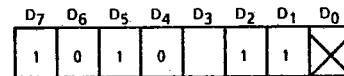


PC_{6,7}
1=INPUT
0=OUTPUT

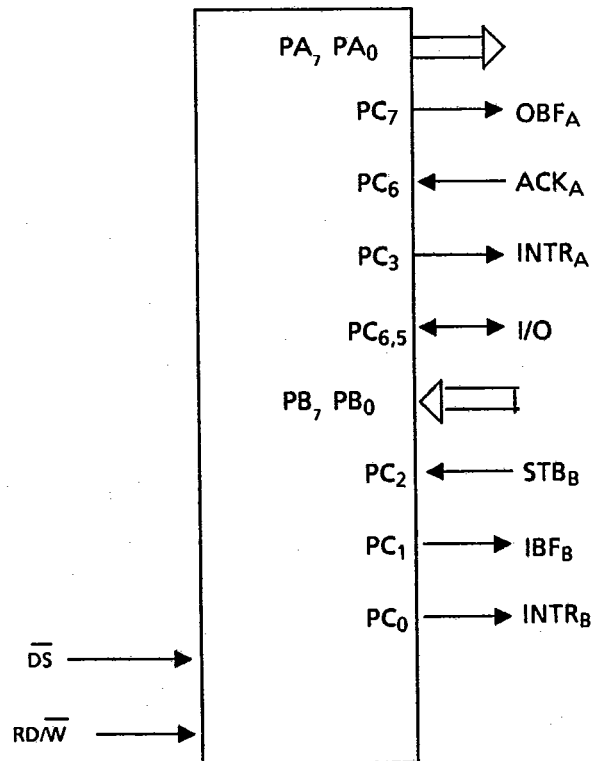


PORT A-(STROBED INPUT)
PORT B-(STROBED OUTPUT)

CONTROL WORD



PC_{4,5}
1=INPUT
0=OUTPUT



PORT A-(STROBED OUTPUT)
PORT B-(STROBED INPUT)



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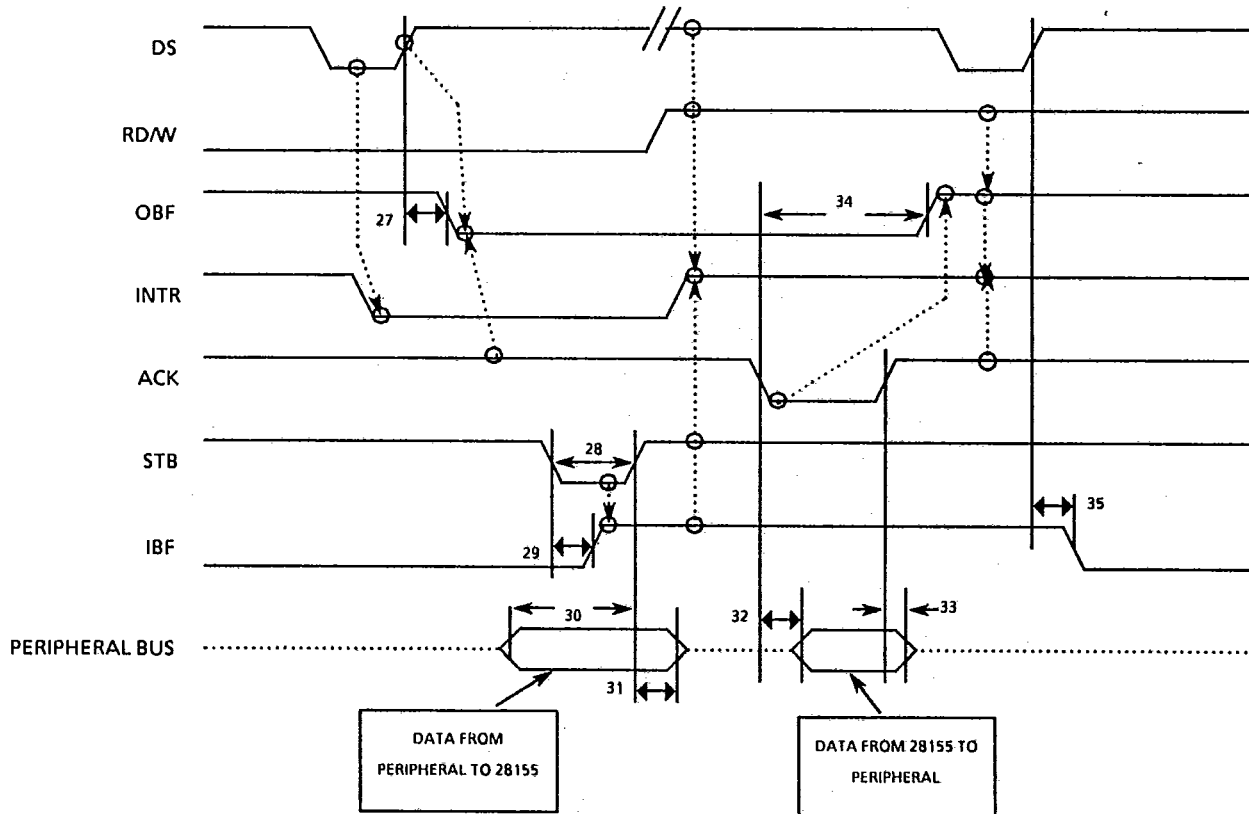
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OPERATING MODE 2 (STROBED BIDIRECTIONAL BUS)

This functional configuration provides a means for communicating with a peripheral device or structure on a single 8-bit bus for both transmitting and receiving data (bidirectional bus I/O). Handshaking signals are provided to maintain proper bus flow discipline in a similar manner to Mode 1. Interrupt generation and enable/disable functions are also available.

- Used in group A only.
- One 8-bit bidirectional bus port (port A) and 5-bit control port (port C).
- Both inputs and outputs are latched.
- The 5-bit control port (port C) is used for control and status of the 8-bit bidirectional bus port (port A).

Bidirectional



NOTE: Any sequence where RD/W = 0 coincident with DS low occurs before ACK and STB occurs before RD/W = 1 coincident with DS is permissible.

(INTR = IBF.MASK.STB.(RD/W = 1.DS = 0) + OBF.MASK.ACK.(RD/W = 0.DS = 0))

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**OPERATING MODE 2
(STROBED BIDIRECTIONAL BUS) cont.**

Bidirectional Bus I/O Control Signal Definition

INTR (Interrupt Request). A high on this output can be used to interrupt the CPU for both input or output operations.

Output Operations

OBF (output buffer full). The OBF output will go low to indicate that the CPU has written data out to port A.

ACK (Acknowledge). Allow on this input enables the tri-state output buffer of port A to send out the data. Otherwise, the output buffer will be in the high impedance state.

INTE 1 (The INTE flip-flop associated with OBF). Controlled by Bit Set/Reset of PC₆.

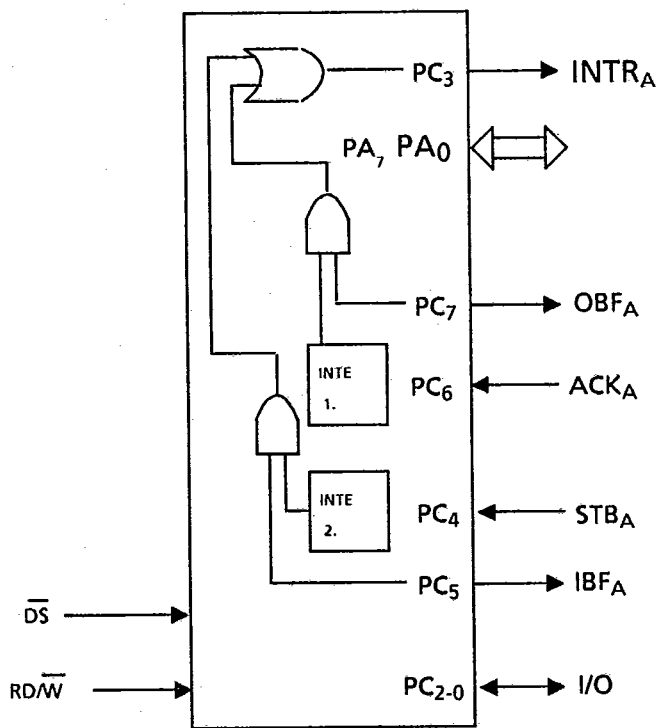
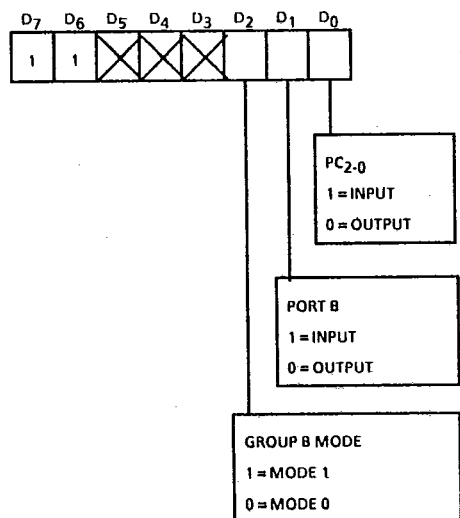
Input Operations

STB (Strobe input). A low on this input loads data in to the input latch.

IBF (Input buffer full F/F). A high on this output indicates data has been loaded in to the input latch.

INTE 2 (The INTE flip-flop associated with IBF). Controlled by Bit Set/Reset of PC₄.

CONTROL WORD



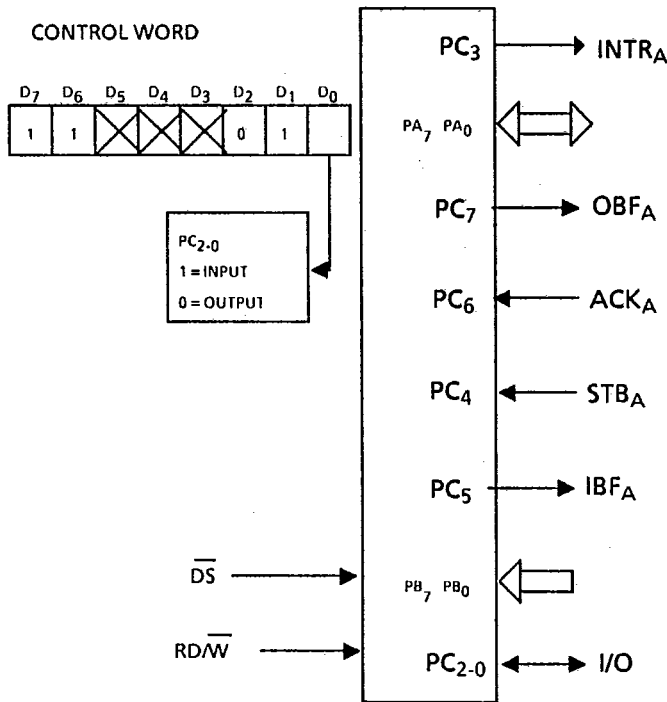
MODE 2 BIDIRECTIONAL



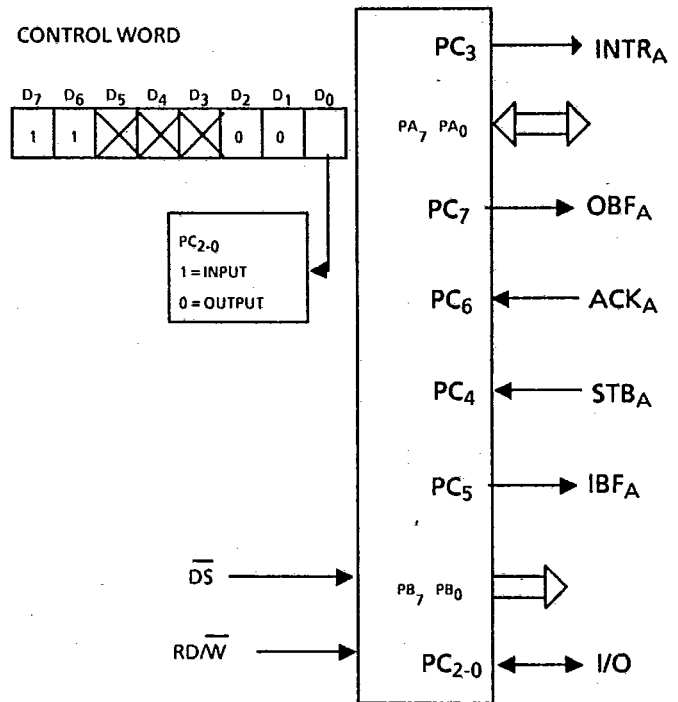
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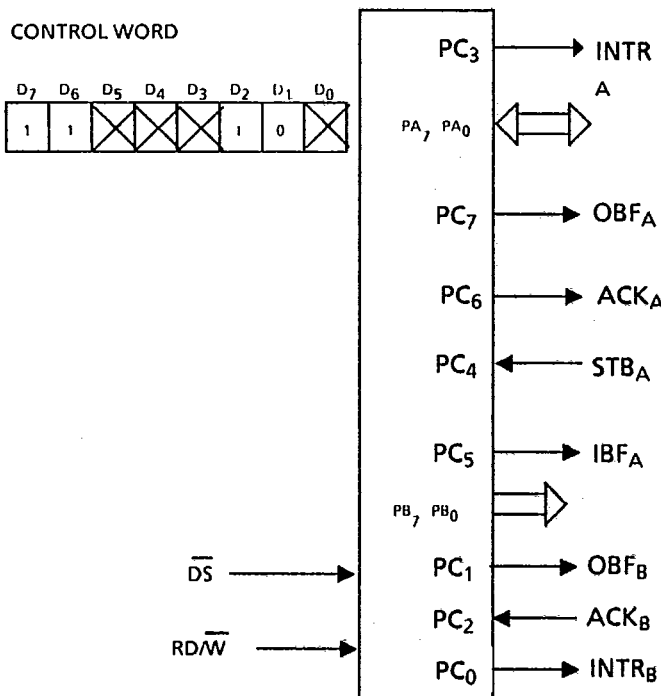
MODE 2 AND MODE 0 (INPUT)



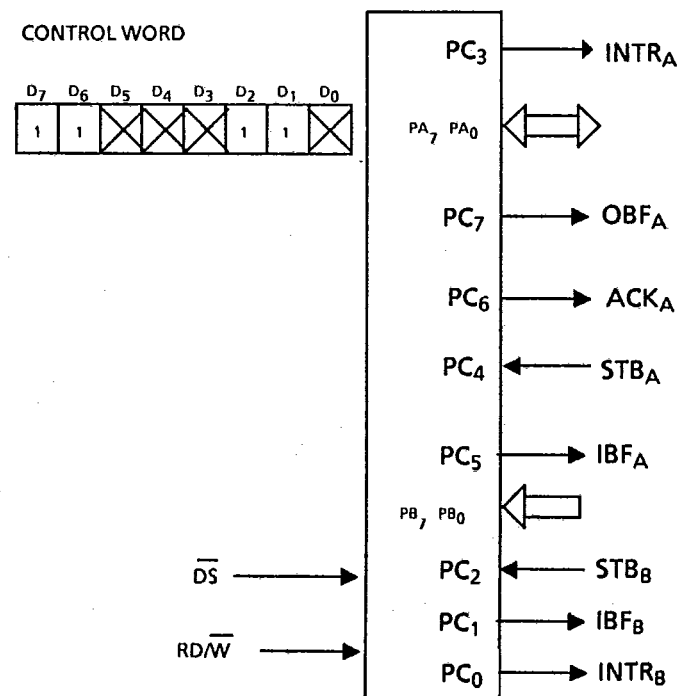
MODE 2 AND MODE 0 (OUTPUT)



MODE 2 AND MODE 1 (OUTPUT)



MODE 2 AND MODE 1 (INPUT)



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MODE DEFINITION SUMMARY

	MODE 0		MODE 1		MODE 2
	IN	OUT	IN	OUT	
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PA ₀	IN	OUT	IN	OUT	⇔
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PB ₀	IN	OUT	IN	OUT	-
PC ₀	IN	OUT	INTR _B	INTR _B	I/O
PC ₀	IN	OUT	IBF _B	OBF	I/O
PC ₀	IN	OUT	STB _B	ACK	I/O
PC ₀	IN	OUT	INTR _A	INTR _A	INTR _A
PC ₀	IN	OUT	STB _A	I/O	STB _A
PC ₀	IN	OUT	IBF _A	I/O	IBF _A
PC ₀	IN	OUT	I/O	ACK _A	ACK _A
PC ₀	IN	OUT	I/O	OBF _A	OBF _A



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Special Mode Combination Considerations.

There are several combinations of modes when not all of the bits in port C are used for control or status. The remaining bits can be used as follows:

if programmed as inputs -

All input lines can be accessed during normal port C read

if programmed as outputs-

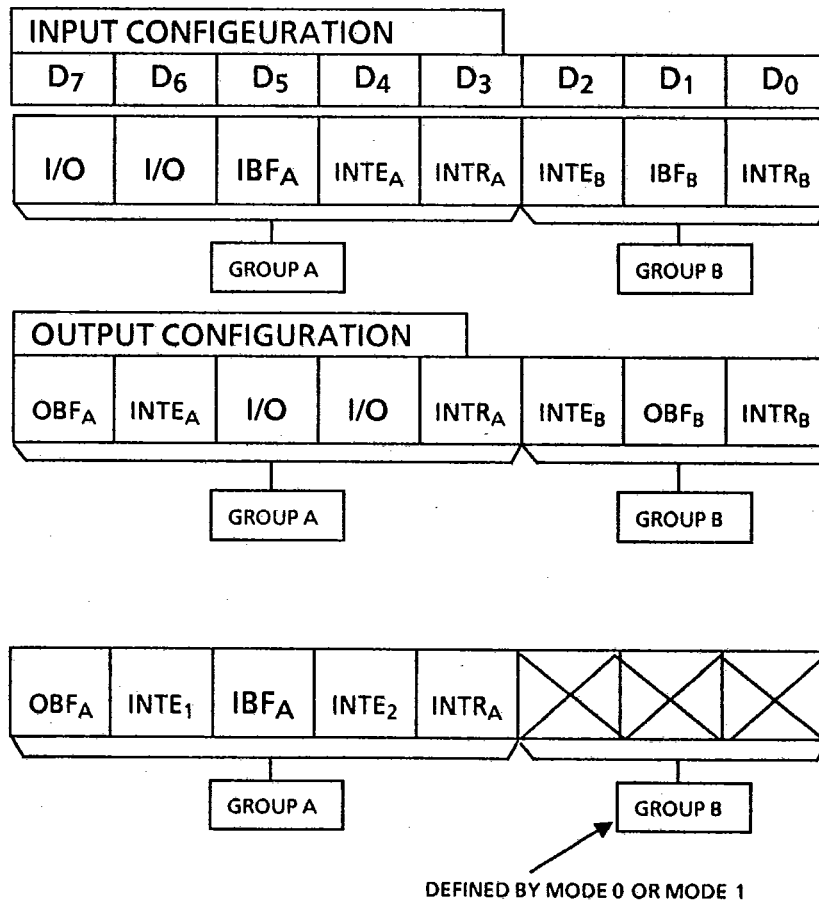
Bits in C upper (PC₇-PC₄) must be individually accessed using a bit set/reset function.

Bits in C lower (PC₃-PC₀) can be accessed using the bit set/reset function or bits PC₂-PC₀ may also be accessed as a trio by writing into port C.

Reading Port C Status.

In Mode 0 Port C transfers data from or to the peripheral device. When the MA28155 is programmed to function in Modes 1 or 2 Port C generates or accepts handshaking signals with the peripheral device. Reading the contents of Port C allows the programmer to test or verify the status of each peripheral device and change the program flow accordingly.

There is no special instruction to read the Status Information from Port C. A normal read operation of Port C is executed to perform this function.



MA28155**Radiation Hard
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Electronic Devices**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	MIN	MAX	UNITS
SUPPLY VOLTAGE	-0.5	10	V
INPUT VOLTAGE	-0.3	$V_{DD} + 0.3$	V
CURRENT THROUGH ANY PIN	-20	20	mA
OPERATING TEMP	-55	125	°C
STORAGE TEMP	-65	150	°C

Stresses above those listed may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions, or at any other condition above those indicated in the operations section of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**OPERATING DC
ELECTRICAL CHARACTERISTICS**

$V_{DD} = 5V \pm 10\%$. Over full operating temperature range.

SYMBOL	PARAMETER	TOTAL DOSE RADIATION NOT EXCEEDING 3×10^5 RAD (Si)			TOTAL DOSE ≤ 1 MRAD (Si)		UNITS	CONDITION
		MIN	TYP	MAX	MIN	MAX		
V_{DD}	SUPPLY VOLTAGE	4.5	5.0	5.5	4.5	5.5	V	
V_{IH}	TTL Input High Voltage	2.0			2.0		V	
V_{IL}	TTL Input Low Voltage			0.8		0.3	V	
V_{OH}	TTL Output High Voltage	2.4			2.4		V	$I_{OH} = -8mA$
V_{OL}	TTL Output low Voltage			0.4		0.4	V	$I_{OL} = 15.0mA$
I_{IL}	Input Low Current			100		100	μA	
I_{IH}	Input High Current			100		100	μA	
I_{DD}	Power Supply Current			10		10	mA	

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AC ELECTRICAL CHARACTERISTICS

$V_{DD} = 5V \pm 10\%$. $C_{CL} = 50pF$. Over full operating temperature range.

	PARAMETER	MIN	MAX	UNITS
	Minimum time between READS and/or WRITES	200	-	ns
	RD/W set-up to DS ↓	5	-	ns
1	DS width	50	-	ns
2	Peripheral Data set up to DS	0	-	ns
3	Peripheral Data hold after DS	0	-	ns
4	CS, A1,A0 setup to DS ↓	0	-	ns
5	CS, A1,A0 hold after DS ↑	0	-	ns
6	Data valid from DS ↓	-	45	ns
7	Data float from DS ↑	10	100	ns
8	Data set up to DS ↓	50	-	ns
9	Data hold after DS ↑	30	-	ns
10	CS, A1,A0 setup to DS ↓	20	-	ns
11	CS, A1,A0 hold after DS ↑	0	-	ns
12	Output valid from DS ↑	-	45	ns

1. Input Pulse V_{SS} to 3.0 Volts.
2. Times Measurement Reference Level 1.5 Volts.

MA28155**Radiation Hard
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	PARAMETER	MIN	MAX	UNITS
14	STB pulse width	100	-	ns
15	STB ↓ to IBF ↑	-	50	ns
16	STB ↑ to INTR ↑	-	50	ns
17	DS ↓ to INTR ↓	-	50	ns
18	DS ↑ to IBF ↓	-	50	ns
19	Peripheral Data set up to STB ↑	0	-	ns
20	Peripheral Data hold after STB ↑	100	-	ns
21	DS ↓ to INTR ↓	-	50	ns
22	Output valid from DS ↑	-	45	ns
23	DS ↑ to OBF ↓	-	50	ns
24	ACK ↓ to OBF ↑	-	50	ns
25	ACK pulse width	100	-	ns
26	ACK ↑ INTR ↑	-	80	ns
27	DS ↑ to OBF ↓	-	50	ns
28	STB pulse width	100	-	ns
29	STB ↓ to IBF ↑	-	50	ns
30	Peripheral Data set up to STB ↑	0	-	ns
31	Peripheral Data hold after STB ↑	100	-	ns
32	Output valid from ACK ↓	-	45	ns
33	Output float from ACK ↑	0	180	ns
34	ACK ↓ to OBF ↑	-	50	ns
35	DS ↑ to IBF ↓	-	50	ns

1. Input Pulse V_{SS} to 3.0 Volts.

2. Times Measurement Reference Level 1.5 Volts.

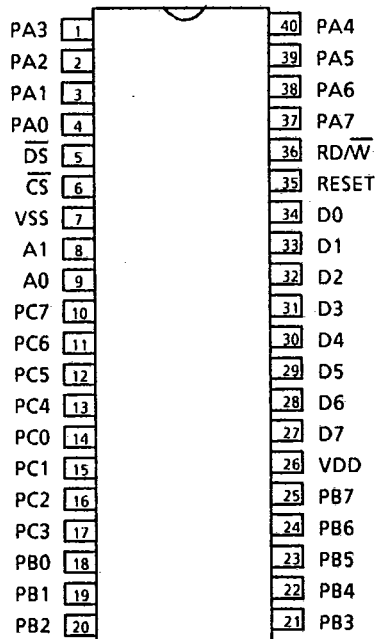
Marconi

Electronic Devices

MA28155

Radiation Hard Programmable Peripheral Interface

PIN ASSIGNMENTS

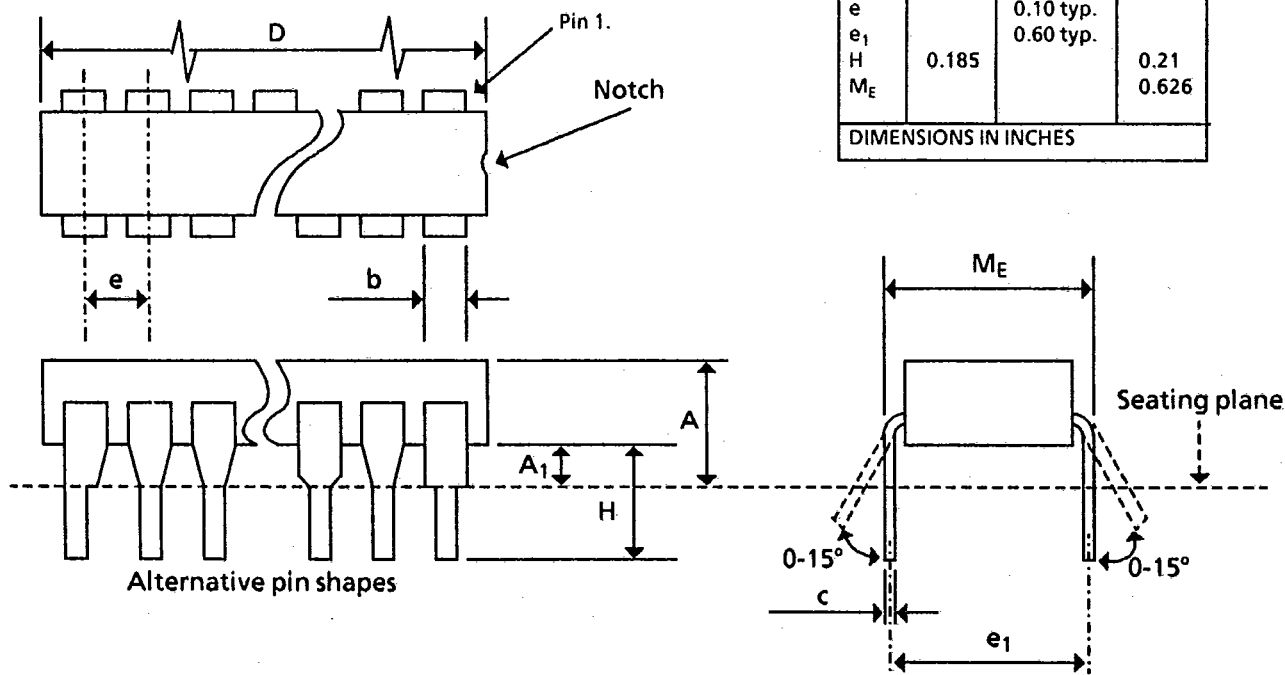


PACKAGE OUTLINES

40 Lead Ceramic DIL

Ref.	Min.	Nom.	Max.
A			0.220
A ₁	0.015		0.060
b	0.047		0.060
c	0.008		0.014
D			2.020
e		0.10 typ.	
e ₁		0.60 typ.	
H	0.185		0.21
M _E			0.626

DIMENSIONS IN INCHES



MA28155

Radiation Hard Programmable Peripheral Interface



TOTAL DOSE RADIATION TESTING

For product procured to guaranteed total dose radiation levels, each wafer lot will be approved when all sample devices from each lot pass the total dose radiation test.

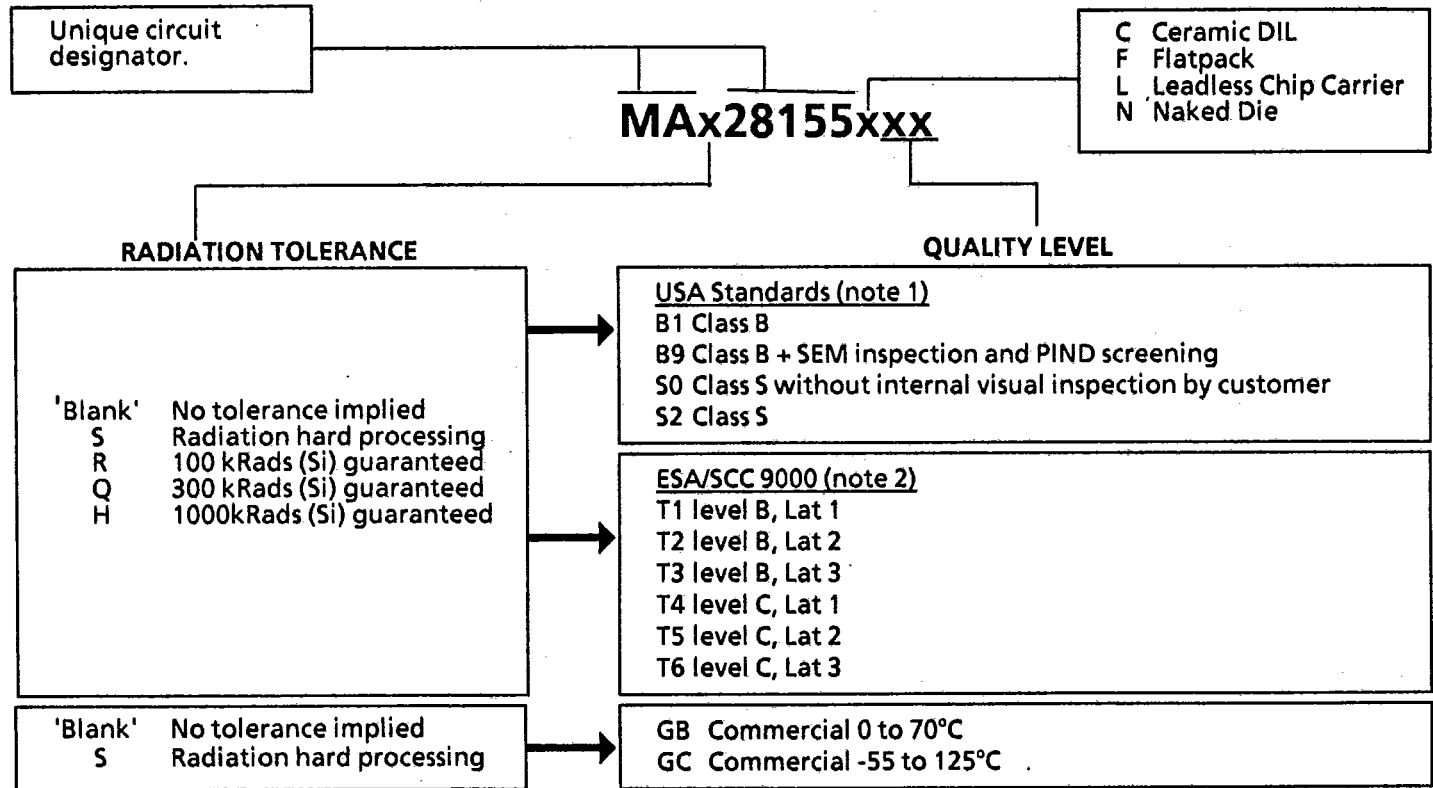
The sample devices will be subjected to the total dose radiation level (Cobalt-60 Source), defined by the ordering code, and must continue to meet the electrical parameters specified in the data sheet. Electrical tests, pre and post irradiation, will be read and recorded.

Marconi Electronic Devices can provide radiation testing compliant with MIL STD 883C remote sensing method 1019 notice 5.

RADIATION PERFORMANCE

Total Dose (Function to specification)	3x10 ⁵ Rad(Si)
Total Dose (Function to 1MRad (si) specification)	1x10 ⁶ Rad(Si)
Transient Upset (Stored data loss)	3x10 ¹⁰ Rad(Si)/s
Transient Upset (Survivability)	> 1x10 ¹² Rad(Si)/s
Neutron Hardness (Function to specification)	1x10 ¹⁵ neutrons/cm ²
Latch-up	Not possible

ORDERING INFORMATION



1 Marconi Electronic Devices quality levels conform to MIL STD 883C class B/S, screening method 5004 and Quality Conformance Inspection method 5005. This does not imply DESC certification, however MIL-M-38510 qualified product listing is being sought.

2 Marconi's specifications for European Space manufacturing flows, including their associated screening procedures, conform to ESA/SCC Generic Specification No.9000. A Process Identification Document, describing the manufacture of these devices, has been approved by the European Space Agency.

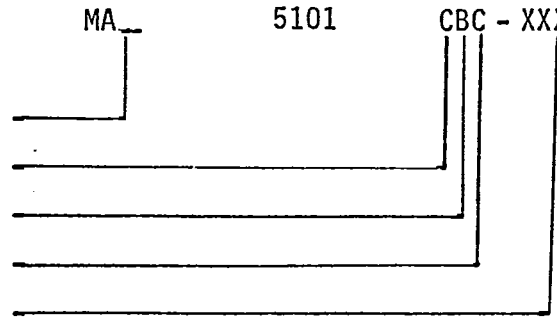
MARCONI ELECTRONIC DEVICES, INC



PREFIX DEVICE SUFFIX

MA_ 5101 CBC - XXX

Add S for Radiation Hard CMOS/SOS
 Package
 Screening & Inspection
 Temperature Range
 Special Requirements/Enhancements



PACKAGE

- A. Pin Grid Array
- C. Ceramic DIL
- E. Epic
- F. Flat Pack
- G. Cerdip
- L. Leadless Chip Carrier
- M. Module
- N. Naked Die
- P. Plastic DIL
- Q. Quad Plastic J-Lead
- R. Quad Cerpack J-Lead
- S. SO Plastic
- X. Special

TEMPERATURE RANGE

- A. Special
- B. 0 to 70°C
- C. -55 to +125°C
- D. -25 to +70°C
- E. -25 to +85°C
- F. -40 to +85°C
- G. -55 to +85°C
- H. -40 to +125°C
- J. -10 to +80°C
- K. 0 to +200°C

SCREENING & INSPECTION

- B. Mil Std-883C Class B
- G. Commercial Hermetic
- L. Commercial Plastic
- S. Mil Std-883C Class S
- T. ESA9000
- X. Special

