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GENERAL DESCRIPTION

The XR17D158¹ (D158) is an octal PCI Bus Universal Asynchronous Receiver and Transmitter (UART) with support for PCI Bus universal VIO buffers in the same package and pin-out as the XR17C158, XR17C154 and XR17D154. The device is designed to meet the 32-bit PCI Bus and high bandwidth requirement in communication systems. A global interrupt source register provides a complete interrupt status indication for all 8 channels to speed up interrupt parsing. Each UART has its own 16C550 compatible set of configuration registers, transmit and receive FIFOs of 64 bytes, fully programmable transmit and receive FIFO level trigger levels, transmit and receive FIFO level counters, automatic RTS/CTS or DTR/DSR hardware flow control with programmable hysteresis levels, automatic software (Xon/Xoff) flow control, IrDA (Infrared Data Association) encoder/decoder, 8 multi-purpose inputs/outputs and a 16-bit general purpose timer/counter.

NOTE: 1 Covered by U.S. Patents #5,649,122 and #5,949,787

APPLICATIONS

- Universal Form Factor PCI Bus Add-in Card
- Remote Access Servers
- Network Management
- Factory Automation and Process Control
- Point-of-Sale Systems
- Multi-port RS-232/RS-422/RS-485 Cards

FEATURES

- High Performance Octal PCI UART
- Universal PCI Bus Buffers - Auto-sense 3.3V or 5V Operation
- 32-bit PCI Bus 2.3 Target Signalling Compliance
- A Global Interrupt Source Register for all 8 UARTs
- Data Transfer in Byte, Word and Double-word
- Data Read/Write Burst Operation
- Each UART is independently controlled with:
 - 16C550 Compatible 5G Register Set
 - 64-byte Transmit and Receive FIFOs
 - Transmit and Receive FIFO Level Counters
 - Programmable TX and RX FIFO Trigger Level
 - Automatic RTS/CTS or DTR/DSR Flow Control
 - Automatic Xon/Xoff Software Flow Control
 - RS485 HDX Control Output with Selectable Turn-around Delay
 - Infrared (IrDA 1.0) Data Encoder/Decoder
 - Programmable Data Rate with Prescaler
 - Up to 6.25 Mbps Serial Data Rate
- Eight Multi-Purpose Inputs/outputs
- A General Purpose 16-bit Timer/counter
- Sleep Mode with Automatic Wake-up
- EEPROM Interface for PCI Configuration
- Same Package and Pin-out as the XR17C158, XR17C154 and XR17D154

FIGURE 1. BLOCK DIAGRAM

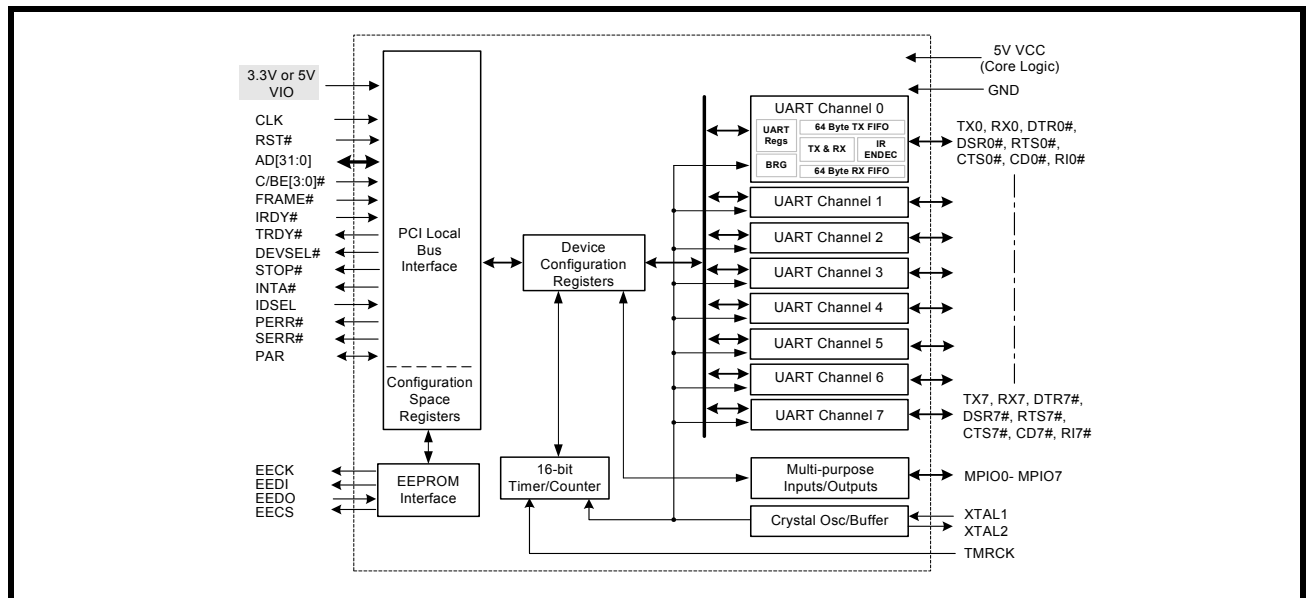
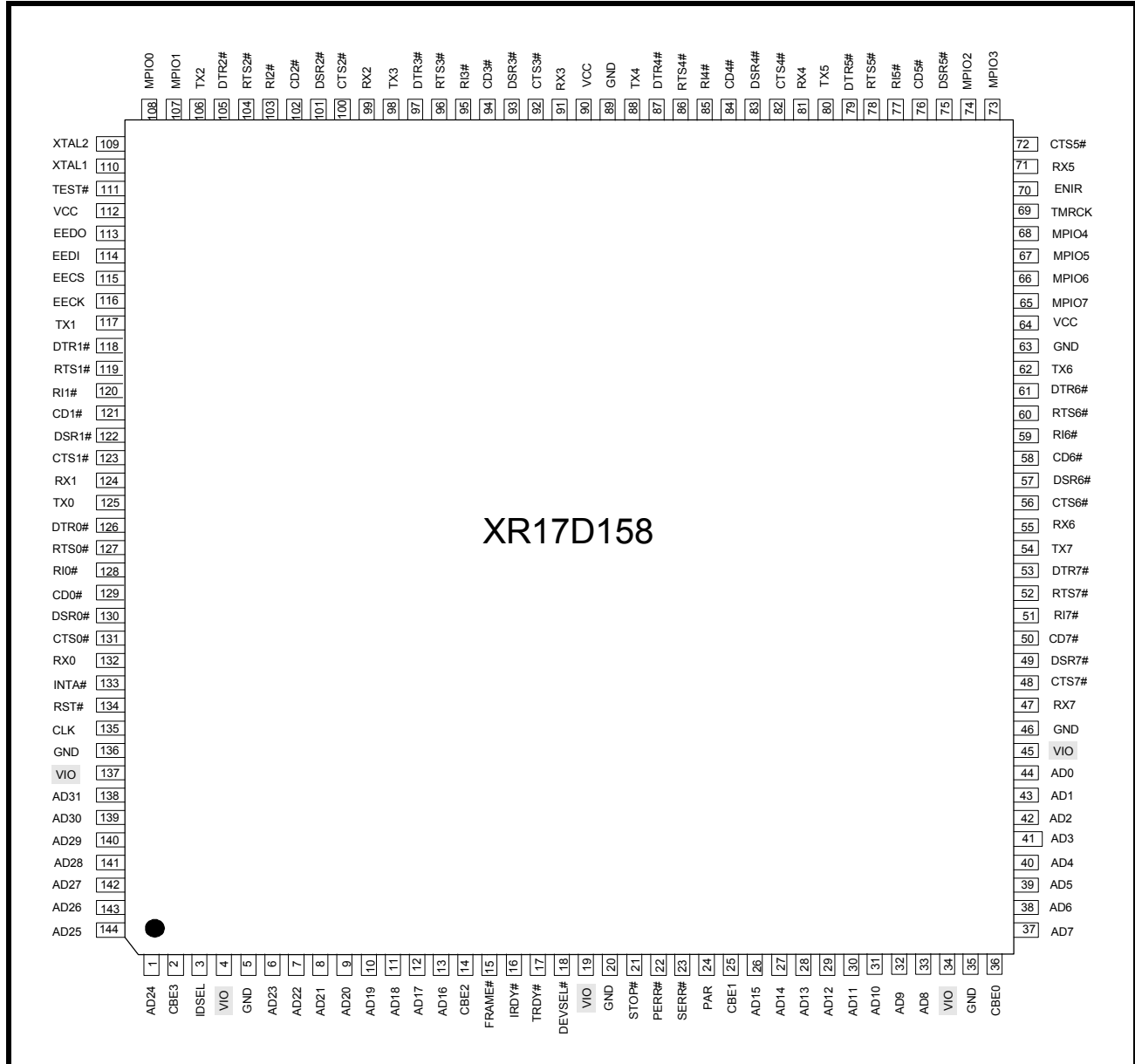


FIGURE 2. PIN OUT OF THE DEVICE



ORDERING INFORMATION

PART NUMBER	PACKAGE	OPERATING TEMPERATURE RANGE	DEVICE STATUS
XR17D158CV	144-Lead LQFP	0°C to +70°C	Active
XR17D158IV	144-Lead LQFP	-40°C to +85°C	Active

PIN DESCRIPTIONS

NAME	PIN #	TYPE	DESCRIPTION
PCI LOCAL BUS INTERFACE			
RST#	134	I	PCI bus reset input (active low). It resets the PCI local bus configuration space registers, device configuration registers and UART channel registers to the default condition.
CLK	135	I	PCI bus clock input of up to 33.34MHz.
AD31-AD25, AD24, AD23-AD16, AD15-AD8, AD7-AD0	138-144, 1, 6-13, 26-33, 37-44	IO	Address data lines [31:0] (bidirectional).
FRAME#	15	I	Bus transaction cycle frame (active low). It indicates the beginning and duration of an access.
C/BE0#- C/BE3#	36,25,14,2	I	Bus Command/Byte Enable [3:0] (active low). This line is multiplexed for bus Command during the address phase and Byte Enables during the data phase.
IRDY#	16	I	Initiator Ready (active low). During a write, it indicates that valid data is present on data bus. During a read, it indicates the master is ready to accept data.
TRDY#	17	O	Target Ready (active low).
STOP#	21	O	Target request to stop current transaction (active low).
IDSEL	3	I	Initialization device select (active high).
DEVSEL#	18	O	Device select to the XR17D158 (active low).
INTA#	133	OD	Device interrupt from XR17D158 (open drain, active low).
PAR	24	IO	Parity is even across AD[31:0] and C/BE[3:0]# (bidirectional, active high).
PERR#	22	O	Data Parity error indicator, except for Special Cycle transactions (active low). Optional in bus target application.
SERR#	23	OD	System error indicator, Address parity or Data parity during Special Cycle transactions (open drain, active low). Optional in bus target application.
MODEM OR SERIAL I/O INTERFACE			
TX0	125	O	UART channel 0 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX0	132	I	UART channel 0 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS0#	127	O	UART channel 0 Request to Send or general purpose output (active low).
CTS0#	131	I	UART channel 0 Clear to Send or general purpose input (active low).
DTR0#	126	O	UART channel 0 Data Terminal Ready or general purpose output (active low).
DSR0#	130	I	UART channel 0 Data Set Ready or general purpose input (active low).
CD0#	129	I	UART channel 0 Carrier Detect or general purpose input (active low).

PIN DESCRIPTIONS

NAME	PIN #	TYPE	DESCRIPTION
RI0#	128	I	UART channel 0 Ring Indicator or general purpose input (active low).
TX1	117	O	UART channel 1 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX1	124	I	UART channel 1 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS1#	119	O	UART channel 1 Request to Send or general purpose output (active low).
CTS1#	123	I	UART channel 1 Clear to Send or general purpose input (active low).
DTR1#	118	O	UART channel 1 Data Terminal Ready or general purpose output (active low).
DSR1#	122	I	UART channel 1 Data Set Ready or general purpose input (active low).
CD1#	121	I	UART channel 1 Carrier Detect or general purpose input (active low).
RI1#	120	I	UART channel 1 Ring Indicator or general purpose input (active low).
TX2	106	O	UART channel 2 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX2	99	I	UART channel 2 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS2#	104	O	UART channel 2 Request to Send or general purpose output (active low).
CTS2#	100	I	UART channel 2 Clear to Send or general purpose input (active low).
DTR2#	105	O	UART channel 2 Data Terminal Ready or general purpose output (active low).
DSR2#	101	I	UART channel 2 Data Set Ready or general purpose input (active low).
CD2#	102	I	UART channel 2 Carrier Detect or general purpose input (active low).
RI2#	103	I	UART channel 2 Ring Indicator or general purpose input (active low).
TX3	98	O	UART channel 3 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX3	91	I	UART channel 3 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS3#	96	O	UART channel 3 Request to Send or general purpose output (active low).
CTS3#	92	I	UART channel 3 Clear to Send or general purpose input (active low).d.
DTR3#	97	O	UART channel 3 Data Terminal Ready or general purpose output (active low).
DSR3#	93	I	UART channel 3 Data Set Ready or general purpose input (active low).
CD3#	94	I	UART channel 3 Carrier Detect or general purpose input (active low).
RI3#	95	I	UART channel 3 Ring Indicator or general purpose input (active low).
TX4	88	O	UART channel 4 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX4	81	I	UART channel 4 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].

PIN DESCRIPTIONS

NAME	PIN #	TYPE	DESCRIPTION
RTS4#	86	O	UART channel 4 Request to Send or general purpose output (active low).
CTS4#	82	I	UART channel 4 Clear to Send or general purpose input (active low).
DTR4#	87	O	UART channel 4 Data Terminal Ready or general purpose output (active low).
DSR4#	83	I	UART channel 4 Data Set Ready or general purpose input (active low).
CD4#	84	I	UART channel 4 Carrier Detect or general purpose input (active low).
RI4#	85	I	UART channel 4 Ring Indicator or general purpose input (active low).
TX5	80	O	UART channel 5 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX5	71	I	UART channel 5 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS5#	78	O	UART channel 5 Request to Send or general purpose output (active low).
CTS5#	72	I	UART channel 5 Clear to Send or general purpose input (active low).
DTR5#	79	O	UART channel 5 Data Terminal Ready or general purpose output (active low).
DSR5#	75	I	UART channel 5 Data Set Ready or general purpose input (active low).
CD5#	76	I	UART channel 5 Carrier Detect or general purpose input (active low).
RI5#	77	I	UART channel 5 Ring Indicator or general purpose input (active low).
TX6	62	O	UART channel 6 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX6	55	I	UART channel 6 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS6#	60	O	UART channel 6 Request to Send or general purpose output (active low).
CTS6#	56	I	UART channel 6 Clear to Send or general purpose input (active low).
DTR6#	61	O	UART channel 6 Data Terminal Ready or general purpose output (active low).
DSR6#	57	I	UART channel 6 Data Set Ready or general purpose input (active low).
CD6#	58	I	UART channel 6 Carrier Detect or general purpose input (active low).
RI6#	59	I	UART channel 6 Ring Indicator or general purpose input (active low).
TX7	54	O	UART channel 7 Transmit Data or infrared transmit data. Normal TXD output idles HIGH while infrared TXD output idles LOW.
RX7	47	I	UART channel 7 Receive Data or infrared receive data. Normal RXD input idles HIGH. The infrared pulses typically idle LOW but can be inverted internally prior the decoder by FCTR[4].
RTS7#	52	O	UART channel 7 Request to Send or general purpose output (active low).
CTS7#	48	I	UART channel 7 Clear to Send or general purpose input (active low).
DTR7#	53	O	UART channel 7 Data Terminal Ready or general purpose output (active low).
DSR7#	49	I	UART channel 7 Data Set Ready or general purpose input (active low).

PIN DESCRIPTIONS

NAME	PIN #	TYPE	DESCRIPTION
CD7#	50	I	UART channel 7 Carrier Detect or general purpose input (active low).
RI7#	51	I	UART channel 7 Ring Indicator or general purpose input (active low).
ANCILLARY SIGNALS			
MPIO0	108	I/O	Multi-purpose input/output 0. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT
MPIO1	107	I/O	Multi-purpose input/output 1. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
MPIO2	74	I/O	Multi-purpose input/output 2. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
MPIO3	73	I/O	Multi-purpose input/output 3. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
MPIO4	68	I/O	Multi-purpose input/output 4. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
MPIO5	67	I/O	Multi-purpose input/output 5. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
MPIO6	66	I/O	Multi-purpose input/output 6. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
MPIO7	65	I/O	Multi-purpose input/output 7. The function of this pin is defined thru the Configuration Register MPIOSEL, MPIOLVL, MPIOINV, MPIO3T and MPIOINT.
EECK	116	O	Serial clock to EEPROM. An internal clock of CLK divide by 256 is used for reading the vendor and sub-vendor ID during power up or reset. However, it can be manually clocked thru the Configuration Register REGB.
EECS	115	O	Chip select to a EEPROM device like 93C46. It is manually selectable thru the Configuration Register REGB. Requires a pull-up 4.7K ohm resistor for external sensing of EEPROM during power up. See DAN112 for further details.
EEDI	114	O	Write data to EEPROM device. It is manually accessible thru the Configuration Register REGB.
EEDO	113	I	Read data from EEPROM device. It is manually accessible thru the Configuration Register REGB.
XTAL1	110	I	Crystal or external clock input.
XTAL2	109	O	Crystal or buffered clock output.
TMRCK	69	I	16-bit timer/counter external clock input.
ENIR	70	I	Infrared mode enable (active high). This pin is sampled during power up, following a hardware reset (RST#) or soft-reset (register RESET). It can be used to start up all 8 UARTs in the infrared mode. The sampled logic state is transferred to MCR bit-6 in the UART.
TEST#	111	I	Factory Test. Connect to VCC for normal operation.
VCC	64, 90, 112		Power supply for the UART core logic - 5V ONLY. This power supply determines the VOH level of the non-PCI bus interface outputs. See Table 1 for valid combinations of VCC and VIO that can be used for the XR17D158.

PIN DESCRIPTIONS

NAME	PIN #	TYPE	DESCRIPTION
VIO	4, 19, 34, 45, 137		PCI Bus I/O Power supply - 3.3V or 5V, detected by the auto-sense circuitry of the XR17D158. This power supply determines the VOH level of the PCI bus interface outputs. (PCI 2.3 signalling compliant at both 3.3V and 5V operation, suitable for universal form factor add-in card application)
GND	5,20,35,46,63, 89,136		Power supply common, ground.

NOTE: Pin type: I=Input, O=Output, IO= Input/output, OD=Output Open Drain.

FUNCTIONAL DESCRIPTION

The XR17D158 (D158) integrates the functions of 8 enhanced 16550 UARTs with the PCI Local Bus interface and a non-volatile memory interface for PCI bus's plug-and-play auto-configuration, a 16-bit timer/counter, 8 multi-purpose inputs/outputs, and an on-chip oscillator. The PCI local bus is a synchronous timing bus where all bus transactions are associated to the bus clock of up to 33MHz. The D158 supports 32-bit wide read and write data transfer operations including data burst mode through the PCI Local Bus interface. Read and write data operations may be in byte, word or double-word (DWORD) format. A single 32-bit interrupt status register provides interrupts status for all 8 UARTs, timer/counter, multipurpose inputs/outputs, and a special sleep wake up indicator. There are three sets of register in the device. First, the PCI local bus configuration registers for PCI auto configuration. A set of device configuration registers for overall control, 32-bit wide transmit and receive data transfer, and monitoring of the 8 UART channels. Lastly, each UART channel has its own 16550 UART compatible configuration register set for individual channel control, status, and byte wide data transfer.

Each UART has 64-byte FIFOs, automatic RTS/CTS or DTR/DSR hardware flow control with hysteresis control, automatic Xon/Xoff and special character software flow control, programmable transmit and receive FIFO trigger level, FIFO level counters, infrared encoder and decoder (IrDA ver. 1.0), programmable baud rate generator with a prescaler of 1X or 4X, and data rate up to 6.25 Mbps at 8X sampling clock. The XR17D158 is available in a thin 144-pin LQFP (20x20x1.4mm) package in commercial and industrial temperature ranges.

PCI LOCAL BUS INTERFACE

This is the host interface and it meets the PCI Local Bus Specification revision 2.3. The PCI local bus operations are synchronous meaning each transaction is associated to the bus clock. The XR17D158 can operate with the bus clock of up to a 33.34MHz. Data transfers operation can be formatted in 8-bit, 16-bit, 24-bit or 32-bit wide. With 32-bit data operations, it pushes the data transfer rate on the bus up to 132 MByte/sec. This increases the overall system's communication performance up to 16 times better than the 8-bit ISA bus. See PCI local bus specification revision 2.3 for bus operation details.

PCI LOCAL BUS CONFIGURATION SPACE REGISTERS

A set of PCI local bus configuration space register is provided. These registers provide the PCI local bus operating system with the card's vendor ID, device ID, sub-vendor ID, product model number, and resources and capabilities. The PCI local bus operating system collects this data from all the cards on the bus during the auto configuration phase that follows immediately after a power up or system reset/reboot. After it has sorted out all devices on the bus, it defines and download the operating conditions to the cards. One of the definitions is the base address loaded into the Base Address Register (BAR) where the card will be operating in the PCI local bus memory space.

EEPROM INTERFACE

An external 93C46 EEPROM is only used to store the vendor's ID and model number, and the sub-vendor's ID and product model number. This information is only used with the plug-and-play auto configuration of the PCI local bus. These data provide automatic hardware installation onto the PCI bus. The EEPROM interface consists of 4 signals, EEDI, EEDO, EECS, and EECK. The EEPROM is not needed when auto configuration is not required in the application. However, If your design requires non-volatile memory for other purpose. It is possible to store and retrieve data on the EEPROM through a special PCI device configuration register. See application note DAN112 for its programming details.

1.0 APPLICATION EXAMPLES

The XR17D158 is designed to operate with VCC (voltage to the UART Core Logic) at 5V only, irrespective of whether the PCI bus is at 3.3V or 5V. **Table 1** below shows the valid combinations of VCC and the PCI Bus Voltage, VIO that can be used for the device..

TABLE 1: VALID COMBINATIONS OF VCC AND VIO SUPPLY VOLTAGES

VCC	VIO	
5.0V	5.0V	Valid
5.0V	3.3V	Valid
3.3V	5.0V	<i>Invalid</i>
3.3V	3.3V	<i>Invalid</i>

A typical application for a universal add-in card (VCC must be 5V) is shown in **Figure 3**. In an embedded system, the designer must still choose 5V power supply for the VCC regardless of VIO (3.3 or 5V). In **Figure 4**, examples 1 and 2 show valid applications of the XR17D158 in an embedded system.

FIGURE 3. TYPICAL APPLICATION FOR A UNIVERSAL ADD-IN CARD

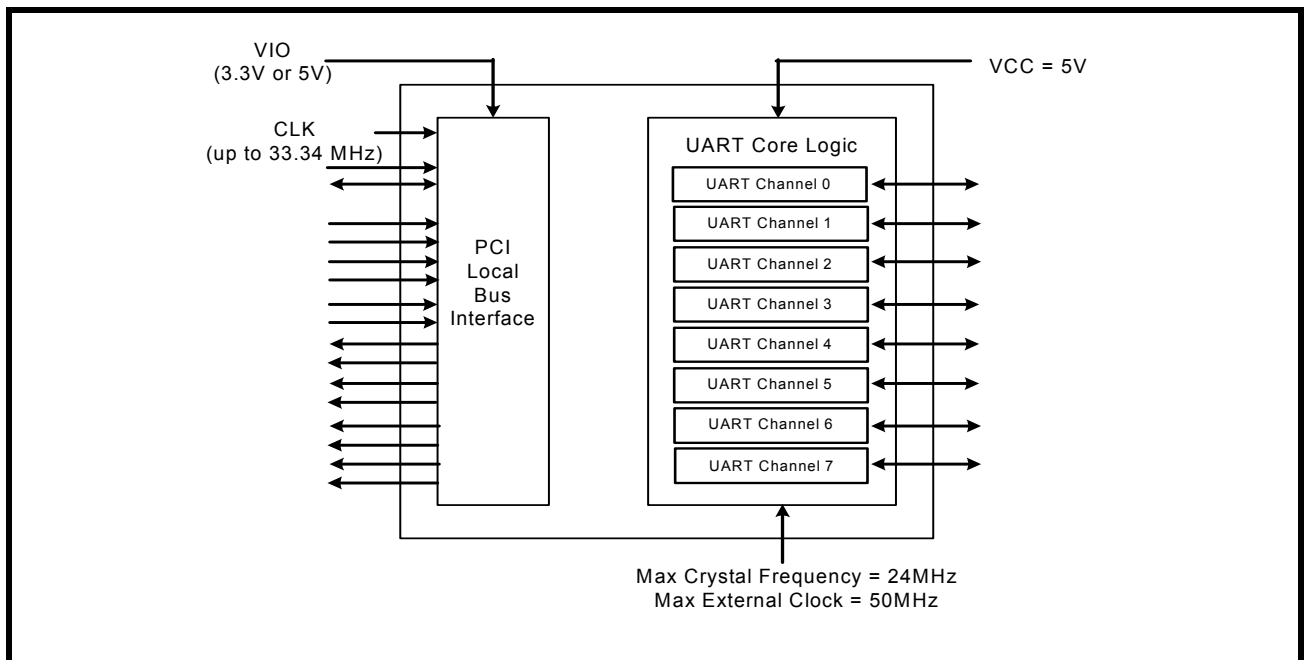
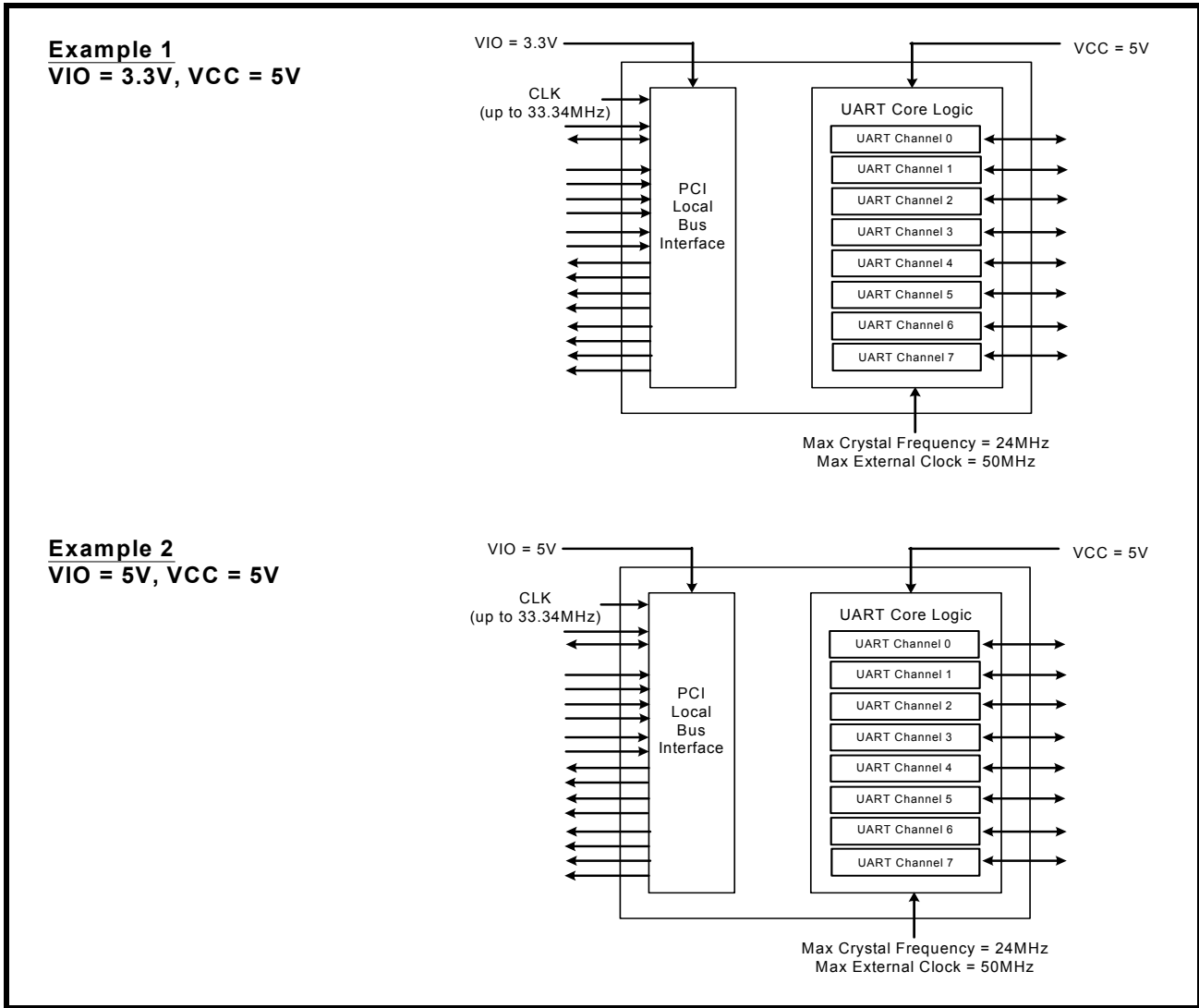


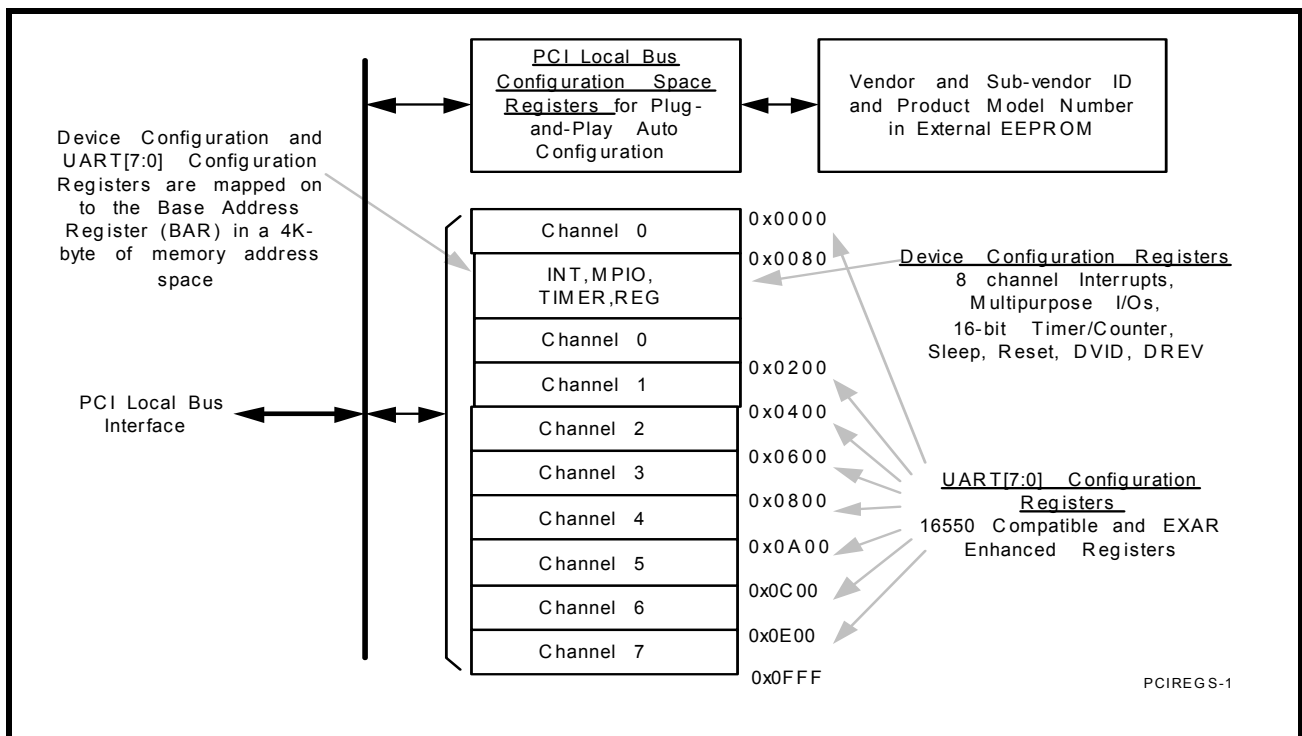
FIGURE 4. TYPICAL APPLICATIONS IN AN EMBEDDED SYSTEM



2.0 XR17D158 REGISTERS

The XR17D158 UART has three different sets of registers as shown in **Figure 5**. The PCI local bus configuration space registers are for plug-and-play auto-configuration when connecting the device to a the PCI bus. This auto-configuration feature makes installation very easy into a PCI system and it is part of the PCI local bus specification. The second register set is the device configuration registers that are accessible directly from the PCI bus for programming general operating conditions of the device and monitoring the status of various functions. These registers are mapped into 4K of the PCI bus memory address space. These functions include all 8 channel UART's interrupt control and status, 16-bit general purpose timer control and status, multipurpose inputs/outputs control and status, sleep mode, soft-reset, and device identification and revision. And lastly, each UART channel has its own set of internal UART configuration registers for its own operation control and status reporting. All 8 sets of channel registers are embedded inside the device configuration registers space, which provides faster access. The following paragraphs describe all 3 sets of registers in detail.

FIGURE 5. THE XR17D158 REGISTER SETS



2.1 PCI LOCAL BUS CONFIGURATION SPACE REGISTERS

The PCI local bus configuration space registers are responsible for setting up the device's operating environment in the PCI local bus. The pre-defined operating parameters of the device is read by the PCI bus plug-and-play auto-configuration manager in the operating system. After the PCI bus has collected all data from every device/card on the bus, it defines and downloads the memory mapping information to each device/card about their individual operation memory address location and conditions. The operating memory mapped address location is downloaded into the Base Address Register (BAR) register, 0x10. The plug-and-play auto configuration feature is only available when an external 93C46 EEPROM is used. The EEPROM contains the device vendor and sub-vendor data required by the auto-configuration setup.

TABLE 2: PCI LOCAL BUS CONFIGURATION SPACE REGISTERS

ADDRESS	BITS	TYPE	DESCRIPTION	RESET VALUE (HEX)
0x00	31:16	RWR ¹	Device ID (Exar device ID number)	0x0158
	15:0	RWR ¹	Vendor ID (Exar) specified by PCISIG	0x13A8
0x04	31 30 29:28	RWC RWC RO	Parity error detected. Cleared by writing a logic 1. System error detected. Cleared by writing a logic 1. Unused	0000
	27	R-Reset	Target Abort. Set whenever D158 terminates with a target abort.	0
	26:25	RO	DEVSEL# timing.	00
	24	RO	Unemployments bus master error reporting bit	0
	23	RO	Fast back to back transactions are supported	1
	22:16	RO	Reserved Status bits	000 0000
	15:9,7, 5,4,3,2	RO	Command bits (reserved)	0x0000
	8	RWR	SERR# driver enable. Logic 1=enable driver and 0=disable driver	0
	6	RWR	Parity error enable. Logic 1=respond to parity error and 0=ignore	0
	1	RWR	Command controls a device's response to mem space accesses: 0=disable mem space accesses, 1=enable mem space accesses	0
	0	RO	Device's response to I/O space accesses is disabled. (0 = disable I/O space accesses)	0
0x08	31:8	RO	Class Code (Simple 550 Communication Controller).	0x070002
	7:0	RO	Revision ID (Exar device revision number)	Current Rev. value
0x0C	31:24	RO	BIST (Built-in Self Test)	0x00
	23:16	RO	Header Type (a single function device with one BAR)	0x00
	15:8	RO	Unimplemented Latency Timer (needed only for bus master)	0x00
	7:0	RO	Unimplemented Cache Line Size	0x00
0x10	31:12	RWR	Memory Base Address Register (BAR)	0x00
	11:0	RO	Claims a 4K address space for the memory mapped UARTs	0x000
0x14	31:0	RO	Unimplemented Base Address Register (returns zeros)	0x00000000
0x18h	31:0	RO	Unimplemented Base Address Register (returns zeros)	0x00000000
0x1C	31:0	RO	Unimplemented Base Address Register (returns zeros)	0x00000000
0x20	31:0	RO	Unimplemented Base Address Register (returns zeros)	0x00000000
0x24	31:0	RO	Unimplemented Base Address Register (returns zeros)	0x00000000
0x28	31:0	RO	Reserved	0x00000000

TABLE 2: PCI LOCAL BUS CONFIGURATION SPACE REGISTERS

ADDRESS	BITS	TYPE	DESCRIPTION	RESET VALUE (HEX)
0x2C	31:16	RWR ¹	Subsystem ID (write from external EEPROM by customer)	0x0000
	15:0	RWR ¹	Subsystem Vendor ID (write from external EEPROM by customer)	0x0000
0x30	31:0	RO	Expansion ROM Base Address (Unimplemented)	0x00000000
0x34	31:0	RO	Reserved (returns zeros)	0x00000000
0x38	31:0	RO	Reserved (returns zeros)	0x00000000
0x3C	31:24	RO	Unimplemented MAXLAT	0x00
	23:16	RO	Unimplemented MINGNT	0x00
	15:8	RO	Interrupt Pin, use INTA#.	0x01
	7:0	RWR	Interrupt Line.	0xXX

NOTE: RWR¹=Read/Write from external EEPROM. RWR=Read/Write from AD[31:0]. RO= Read Only. RWC=Read/Write-Clear.

2.2 Device Configuration Register Set

The device configuration registers and a special way to access each of the UART's transmit and receive data FIFOs are accessible directly from the PCI data bus. This provides easy programming of general operating parameters to the D158 UART and for monitoring the status of various functions. The registers occupy 4K of PCI bus memory address space. These addresses are offset onto the basic memory address, a value loaded into the Memory Base Address Register (BAR) in the PCI local bus configuration register set. These registers control or report on all 8 channel UARTs functions that include interrupt control and status, 16-bit general purpose timer control and status, multipurpose inputs/outputs control and status, sleep mode control, soft-reset control, and device identification and revision, and others.

The registers set is mapped into 8 address blocks where each UART channel occupies 512 bytes memory space for its own 16550 compatible configuration registers. The device configuration and control registers are embedded inside the UART channel zero's address space between 0x0080 to 0x0093. All these registers can be accessed in 8, 16, 24 or 32 bit width depending on the starting address given by the host at beginning of the bus cycle. Transmit and receive data may be loaded or unloaded in 8, 16, 24 or 32 bit format to the register's address. Every time a read or write operation is made to the transmit or receive register, its FIFO data pointer is automatically bumped to the next sequential data location either in byte, word or dword. One special case applies to the receive data unloading when reading the receive data together with its LSR register content. The host must read them in 16 or 32 bits format in order to maintain integrity of the data byte with its associated error flags.

TABLE 3: XR17D158 DEVICE CONFIGURATION REGISTERS

OFFSET ADDRESS	MEMORY SPACE	READ/WRITE	DATA WIDTH	COMMENT
0x000 - 0x00F	UART channel 0 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0x010 - 0x07F	Reserved			
0x080 - 0x093	DEVICE CONFIG. REGISTERS	(Table 4)	8/16/24/32	
0x094 - 0x0FF	Reserved			
0x100 - 0x13F	UART 0 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0x100 - 0x13F	UART 0 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data
0x140 - 0x17F	Reserved			
0x180 - 0x1FF	UART 0 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0x200 - 0x20F	UART channel 1 Regs	(Table 12 & Table 13)	8/16//24/32	First 8 regs are 16550 compatible
0x210 - 0x2FF	Reserved			
0x300 - 0x33F	UART 1 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0x300 - 0x33F	UART 1 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data
0x340 - 0x37F	Reserved			
0x380 - 0x3FF	UART 1 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0x400 - 0x40F	UART channel 2 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0x410 - 0x4FF	Reserved			
0x500 - 0x53F	UART 2 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0x500 - 0x53F	UART 2 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data
0x540 - 0x57F	Reserved			
0x580 - 0x5FF	UART 2 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0x600 - 0x60F	UART channel 3 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0x610 - 0x6FF	Reserved			
0x700 - 0x73F	UART 3 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0x700 - 0x73F	UART 3 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data

TABLE 3: XR17D158 DEVICE CONFIGURATION REGISTERS

OFFSET ADDRESS	MEMORY SPACE	READ/WRITE	DATA WIDTH	COMMENT
0x740 - 0x77F	Reserved			
0x780 - 0x7FF	UART 3 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0x800 - 0x80F	UART channel 4 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0x810 - 0x8FF	Reserved			
0x900 - 0x93F	UART 4 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0x900 - 0x93F	UART 4 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data
0x940 - 0x97F	Reserved			
0x980 - 0x9FF	UART 4 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0xA00 - 0xA0F	UART channel 5 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0xA10 - 0xAFF	Reserved	ite		
0xB00 - 0xB3F	UART 5 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0xB00 - 0xB3F	UART 5 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data
0xB40 - 0xB7F	Reserved			
0xB80 - 0xBFF	UART 5 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0xC00 - 0xC0F	UART channel 6 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0xC10 - 0xCFF	Reserved			
0xD00 - 0xD3F	UART 6 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0xD00 - 0xD3F	UART 6 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data
0xD40 - 0xD7F	Reserved			
0xD80 - 0xDFF	UART 6 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR
0xE00 - 0xE0F	UART channel 7 Regs	(Table 12 & Table 13)	8/16/24/32	First 8 regs are 16550 compatible
0xE10 - 0xEFF	Reserved			
0xF00 - 0xF3F	UART 7 – Read FIFO	Read-Only	8/16/24/32	64 bytes of RX FIFO data
0xF00 - 0xF3F	UART 7 – Write FIFO	Write-Only	8/16/24/32	64 bytes of TX FIFO data

TABLE 3: XR17D158 DEVICE CONFIGURATION REGISTERS

OFFSET ADDRESS	MEMORY SPACE	READ/WRITE	DATA WIDTH	COMMENT
0xF40 - 0xF7F	Reserved			
0xF80 - 0xFFFF	UART 7 – Read FIFO with errors	Read-Only	16/32	64 bytes of RX FIFO data + LSR

TABLE 4: DEVICE CONFIGURATION REGISTERS SHOWN IN BYTE ALIGNMENT

ADDRESS [A7:A0]	REGISTER	READ/WRITE COMMENT	RESET STATE
0x080	INT0 [7:0]	Read-only Interrupt [7:0]	Bits 7-0 = 0x00
0x081	INT1 [15:8]	Read-only	Bits 7-0 = 0x00
0x082	INT2 [23:16]	Read-only	Bits 7-0 = 0x00
0x083	INT3 [31:24]	Read-only	Bits 7-0 = 0x00
0x084	TIMERCNTL	Read/Write Timer Control	Bits 7-0 = 0x00
0x085	TIMER	Reserved	Bits 7-0 = 0x00
0x086	TIMERLSB	Read/Write Timer LSB	Bits 7-0 = 0x00
0x087	TIMERMSB	Read/Write Timer MSB	Bits 7-0 = 0x00
0x088	8XMODE	Read/Write	Bits 7-0 = 0x00
0x089	REGA	Reserved	Bits 7-0 = 0x00
0x08A	RESET	Write-only Self clear bits after executing Reset	Bits 7-0 = 0x00
0x08B	SLEEP	Read/Write Sleep mode	Bits 7-0 = 0x00
0x08C	DREV	Read-only Device revision	Bits 7-0 = 0x09
0x08D	DVID	Read-only Device identification	Bits 7-0 = 0x28
0x08E	REGB	Write-only	Bits 7-0 = 0x00
0x08F	MPOINT	Read/Write MPIO interrupt mask	Bits 7-0 = 0x00
0x090	MPIOLVL	Read/Write MPIO level control	Bits 7-0 = 0x00
0x091	MPIO3T	Read/Write MPIO output control	Bits 7-0 = 0x00
0x092	MPIOINV	Read/Write MPIO input polarity select	Bits 7-0 = 0x00
0x093	MPIOSEL	Read/Write MPIO select	Bits 7-0 = 0xFF

TABLE 5: DEVICE CONFIGURATION REGISTERS SHOWN IN DWORD ALIGNMENT

ADDRESS	REGISTER	BYTE 3 [31:24]	BYTE 2 [23:16]	BYTE 1 [15:8]	BYTE 0 [7:0]
0x080-083	INTERRUPT (read-only)	INT3	INT2[INT1	INT0
0x084-087	TIMER (read/write)	TIMERMSB	TIMERLSB	TIMER (reserved)	TIMERCNTL
0x088-08B	ANCILLARY1 (read/write)	SLEEP	RESET	REGA (reserved)	8XMODE
0x08C-08F	ANCILLARY2 (read-only)	MPOINT	REGB	DVID	DREV
0x090-093	MPIO (read/write)	MPIOSEL	MPIOINV	MPIO3T	MPIOLVL

2.2.1 The Interrupt Status Register

The XR17D158 has a 32-bit wide register [INT0, INT1, INT2 and INT3] to provide interrupt information and supports two interrupt schemes. The first scheme uses an 8-bit indicator (INT0) representing each channel from 0 to 7. This permits the interrupt routine to quickly vector and serve that UART channel and determine the source(s) in each individual routines. INT0 bit-0 represents the interrupt status for UART channel 0 when its transmitter, receiver, line status, or modem port status requires service. Other bits in the INT0 register provide indication for the other channels with bit-7 representing UART channel 7 respectively.

The second scheme provides detail about the source of the interrupts for each UART channel. All the interrupts are encoded into a 3-bit code. This 3-bit code represents 7 interrupts corresponding to individual UART's transmitter, receiver, line status, modem port status. INT1, INT2 and INT3 registers provide the 24-bit interrupt status for all 8 channels. Bits 8, 9 and 10 representing channel 0 and bits 29, 30 and 31 representing channel 7 respectively. All 8 channel interrupts status are available with a single DWORD read operation. This feature allows the host quickly vectors and serves the interrupts, reducing service interval, hence, reduce host bandwidth requirement. Figure 6 shows the 4-byte interrupt register and its make up.

GLOBAL INTERRUPT REGISTER (DWORD) [default 0x00-00-00-00]

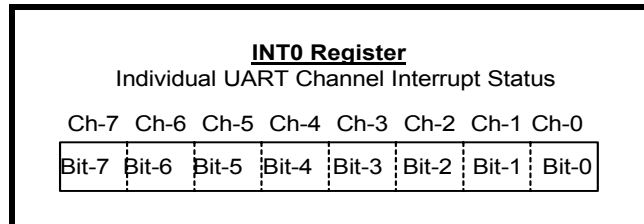


A special interrupt condition is generated by the D158 when it wakes up from sleep mode. This special interrupt is cleared by reading the INT0 register. If there are not any other interrupts pending, the value read from INT0 would be 0x00.

INT0 [7:0] Channel Interrupt Indicator

Each bit gives an indication of the channel that has requested for service. Bit-0 represents channel 0 and bit-7 indicates channel 7. Logic one indicates that a channel has called for service. The interrupt bit clears after reading the appropriate register of the interrupting channel register, see Interrupt Clearing section.

The INT0 register provides individual status for each channel



INT3, INT2 and INT1 [32:8]

Twenty four bit encoded interrupt indicator. Each channel's interrupt is encoded into 3 bits for receive, transmit, and status. Bit [10:8] represent channel 0 and go up to channel 7 with bits [31:29]. The 3 bit encoding and their priority order are shown below in Table 6. The Timer and MPIO interrupts are for the device and therefore they exist within channel 0 space (bits [10:8]) only.

FIGURE 6. THE GLOBAL INTERRUPT REGISTER, INTO, INT1, INT2 AND INT3

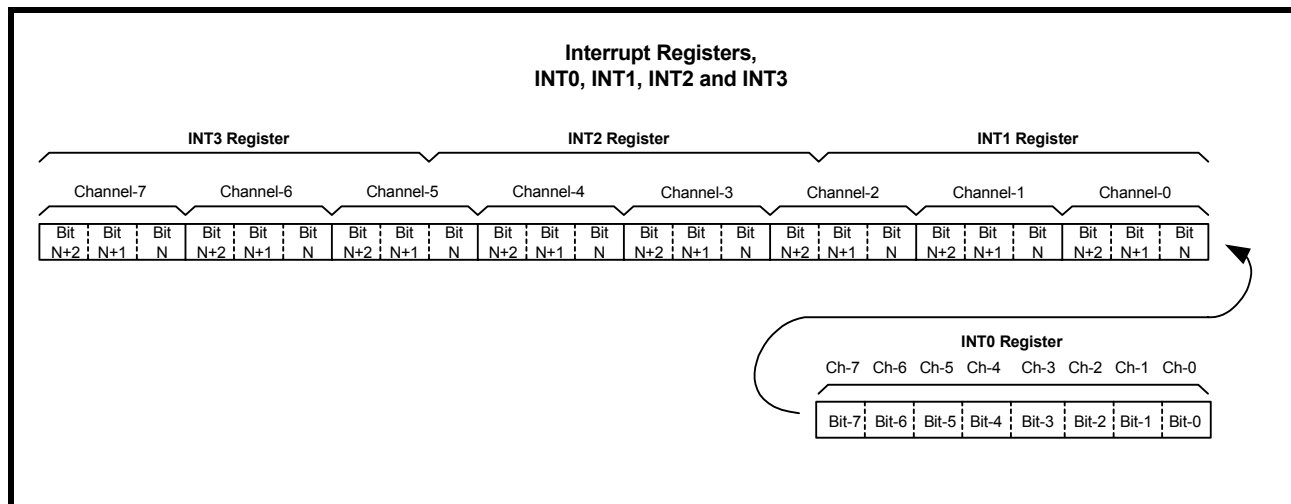


TABLE 6: UART CHANNEL [7:0] INTERRUPT SOURCE ENCODING

PRIORITY	BIT[N+2]	BIT[N+1]	BIT[N]	INTERRUPT SOURCE(S)
x	0	0	0	None
1	0	0	1	RXRDY and RX Line Status (logic OR of LSR[4:1])
2	0	1	0	RXRDY Time-out
3	0	1	1	TXRDY, THR or TSR (auto RS485 mode) empty
4	1	0	0	MSR, RTS/CTS or DTR/DSR delta or Xoff/Xon det. or special char. detected
5	1	0	1	Reserved.
6	1	1	0	MPIO pin(s). Available only within channel 0, reserved in other channels.
7	1	1	1	TIMER Time-out. Available only within channel 0, reserved in other channels.

TABLE 7: UART CHANNEL [7:0] INTERRUPT CLEARING:

RXRDY is cleared by reading data in the RX FIFO until it falls below the trigger level.
RXRDY Time-out is cleared by reading data until the RX FIFO is empty.
RX Line Status interrupt clears after reading the LSR register.
TXRDY interrupt clears after reading ISR register that is in the UART channel register set.
Modem Status Register interrupt clears after reading MSR register that is in the UART channel register set.
RTS/CTS or DTR/DSR delta interrupt clears after reading MSR register that is in the UART channel register set.
Xoff/Xon interrupt clears after reading the ISR register that is in the UART channel register set.
Special character detect interrupt is cleared by a read to ISR or after the next character is received.
TIMER Time-out interrupt clears after reading the TIMERCNTL register that is in the Device Configuration register set.
MPIO interrupt clears after reading the MPIOLVL register that is in the Device Configuration register set.

2.2.2 General Purpose 16-bit Timer/Counter [TIMERM5B, TIMEL5B, TIMER, TIMECNTL] (DEFAULT 0xXX-XX-00-00)

A 16-bit down-count timer for general purpose timer or counter. Its clock source may be selected from internal crystal oscillator or externally on pin TMRCK. The timer can be set to be a single-shot for a one-time event or re-triggerable for continue interval. An interrupt may be generated in the INT Register when the timer times out. It is controlled through 4 configuration registers [TIMERCNTL, TIMER, TIMEL5B, TIMERM5B]. These registers provide start/stop and re-triggerable or one-shot operation. The time-out output of the Timer can be set to generate an interrupt for system or event alarm.

FIGURE 7. TIMER/COUNTER CIRCUIT.

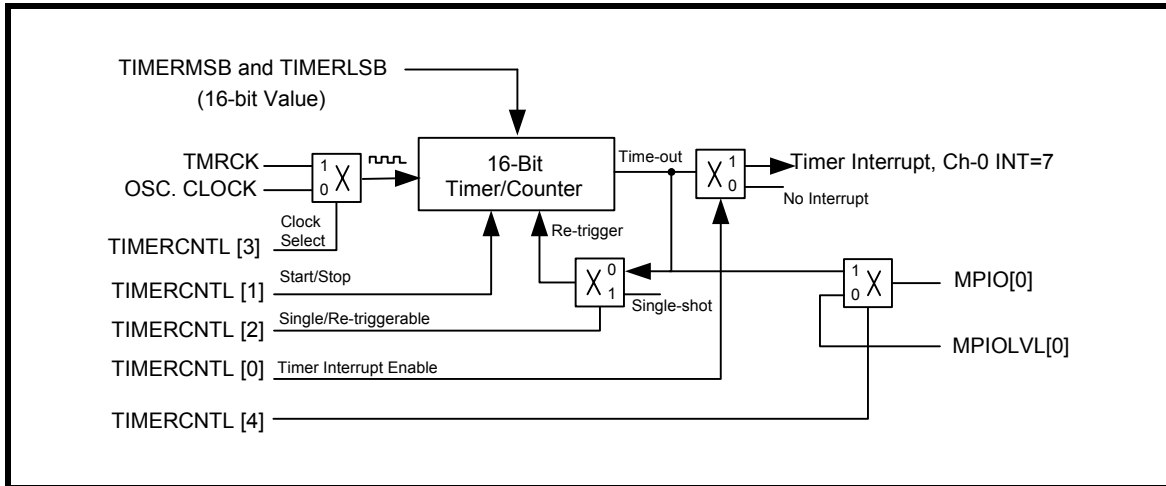
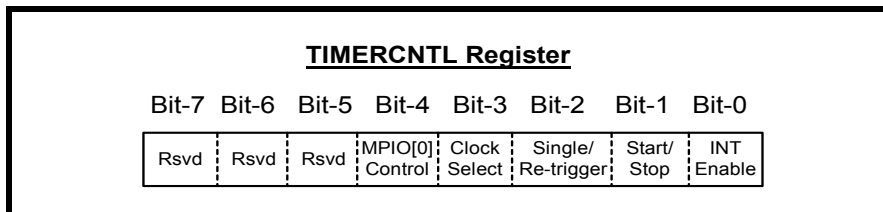


TABLE 8: TIMER CONTROL REGISTERS

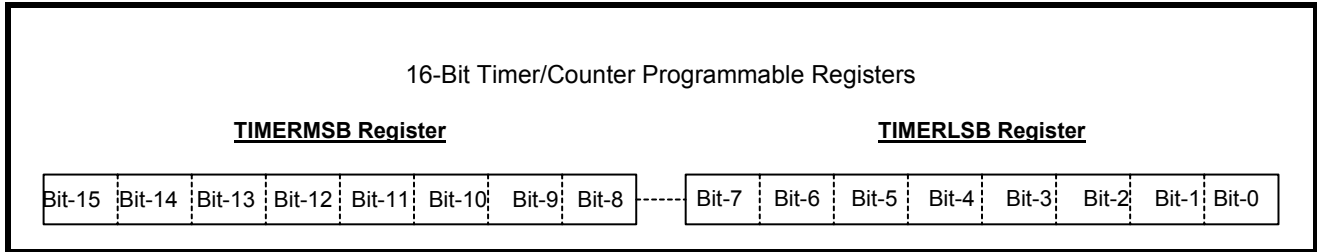
TIMERCNTL [0]	Logic zero (default) disables Timer-Counter interrupt and logic one enables the interrupt, reading the TIMERCNTL clears the interrupt.
TIMERCNTL [1]	Logic zero (default) stops/pauses the timer and logic one starts/re-starts the timer/counter.
TIMERCNTL [2]	Logic zero (default) selects re-trigger timer function and logic one selects one-shot (timer function).
TIMERCNTL [3]	Logic zero (default) selects internal and logic one selects external clock to the timer/counter.
TIMERCNTL [4]	Routes the Timer-Counter interrupt to MPIO[0] if MPIOSEL[0]=0 for external event control.
TIMERCNTL [7:5]	Reserved (defaults to zero)



TIMER [15:8] Reserved

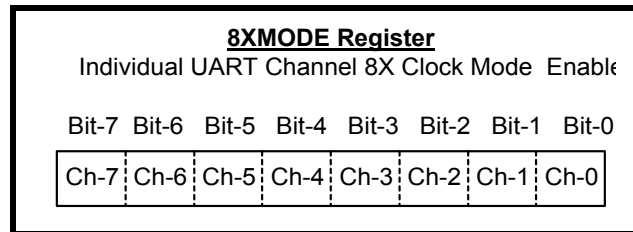
TIMERMSB [31:24] and TIMERLSB [23:16]

TIMERMSB and TIMERLSB form a 16-bit value. The least-significant bit of the timer is being bit [0] of the TIMERLSB with most-significant-bit being bit [7] in TIMERMSB. Notice that these registers do not hold the current counter value when read. Reading the TIMERCNTL register will clear its interrupt. Default value is zero (timer disabled) upon powerup and reset.



2.2.3 8XMODE [7:0] (default 0x00)

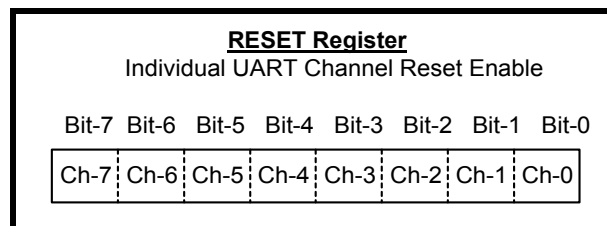
Each bit selects 8X or 16X sampling rate for that UART channel, bit-0 is channel 0. Logic 0 (default) selects normal 16X sampling with logic one selects 8X sampling rate. Transmit and receive data rates will double by selecting 8X.



2.2.4 REGA [15:8] Reserved

2.2.5 RESET [23:16] (default 0x00)

The 8-bit Reset register [RESET] provides the software with the ability to reset the UART(s) when there is a need. Each bit is self-resetting after it is written a logic 1 to perform a reset to that channel. All registers in that channel will be reset to the default condition, see [Table 20](#) for details. Bit-0 =1 resets UART channel 0 with bit-7=1 resets channel 7.



2.2.6 SLEEP [31:24] (default 0x00)

Each UART can be separately enabled to enter Sleep mode through the Sleep register. Sleep mode reduces power consumption when the system needs to put the UART(s) to idle. All of these conditions must be satisfied for the D158 to enter sleep mode:

- no interrupts pending (INT0 = 0x00)
- divisor is a non-zero value for all channels (ie. DLL = 0x1)
- sleep mode is enabled (SLEEP = 0xFF)
- modem inputs for all channels are not toggling (MSR bits 0-3 = 0)
- RX input pins for all channels are idling HIGH

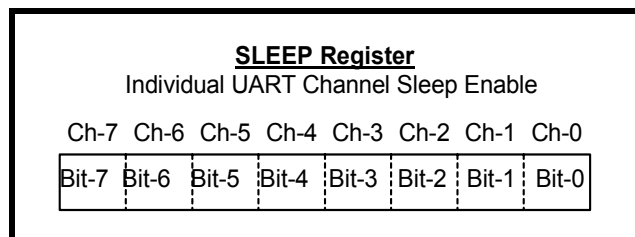
The D158 stops its crystal oscillator to conserve power in the sleep mode. User can check the XTAL2 pin for no clock output as an indication that the device has entered the sleep mode.

The D158 resumes normal operation by any of the following:

- a receive data start bit transition (HIGH to LOW)
- a data byte is loaded to the transmitter, THR or FIFO
- a change of logic state on any of the modem or general purpose serial inputs: CTS#, DSR#, CD#, RI#

If the D158 is awakened by any one of the above conditions, it will return to the sleep mode automatically after all interrupting conditions have been serviced and cleared. If the D158 is awakened by the modem inputs, a read to the MSR is required to reset the modem inputs. In any case, the sleep mode will not be entered while an interrupt is pending from any channel. The D158 will stay in the sleep mode of operation until it is disabled by setting Sleep = 0x00. In this case, the octal UART is awakened by any of the UART channel from a receive data byte or a change on the serial port. The UART is ready after 32 crystal clocks to ensure full functionality. Also, a special interrupt is generated with an indication of no pending interrupt. Reading INT0 will clear this special interrupt. Logic 0 (default) is disable and logic 1 is enable to sleep mode.

Important: The XR17D158 is a versatile device designed to operate with different VCC (core power supply) and VIO (PCI bus I/O power supply). However, the VCC and VIO must be equal (VCC = VIO) for the sleep mode to reduce power consumption. Any difference in these voltages will result in high currents, when placed in sleep mode. If sleep mode is used, it is recommended that both VCC and VIO be powered by the PCI bus VIO power pins. If sleep mode is not used, there is no concern about high currents whether VCC = VIO or VCC > VIO. In any case, VCC should never be less than VIO.



2.2.7 Device Identification and Revision

There are two internal registers that provide device identification and revision, DVID and DREV registers. The 8-bit content in the DVID register provides device identification. A return value of 0x28 from this register indicates the device is a XR17D158. The DREV register returns an 8-bit value of 0x01 for revision A with 0x02 equals to revision B and so forth. This information is very useful to the software driver for identifying which device it is communicating with and to keep up with revision changes.

DVID [15:8]

Device identification for the type of UART. The upper nibble indicates it is a XR17Dxxx series with lower nibble indicating the number of channels.

Examples:

XR17C158 or XR17D158 = 0x28

XR17C154 or XR17D154 = 0x24

XR17C152 or XR17D152 = 0x22

DREV [7:0]

Revision number of the XR17D158. A 0x01 represents "revision-A" with 0x02 for rev-B and so forth.

REGB [23:16] (default 0x00)

REGB register provides a control for simultaneous write to all 8 UARTs configuration register or individually. This is very useful for device initialization in the power up and reset routines. Also, the register provides a facility to interface to the non-volatile memory device such as a 93C46 EEPROM. In embedded applications, the user can use this facility to store proprietary data.

2.2.8 REGB Register

REGB[16](Read/Write)	Logic 0 (default) write to each UART configuration registers individually.
	Logic 1 enables simultaneous write to all 8 UARTs configuration register.
REGB[19:17]	Reserved
REGB[20] (Write-Only)	Control the EECK, clock, output (pin 116) on the EEPROM interface.
REGB[21] (Write-Only)	Control the EECS, chips select, output (pin 115) to the EEPROM device.
REGB[22] (Write-Only)	EEDI (pin 114) data input. Write data to the EEPROM device.
REGB[23] (Read-Only)	EEDO (pin 113) data output. Read data from the EEPROM device.

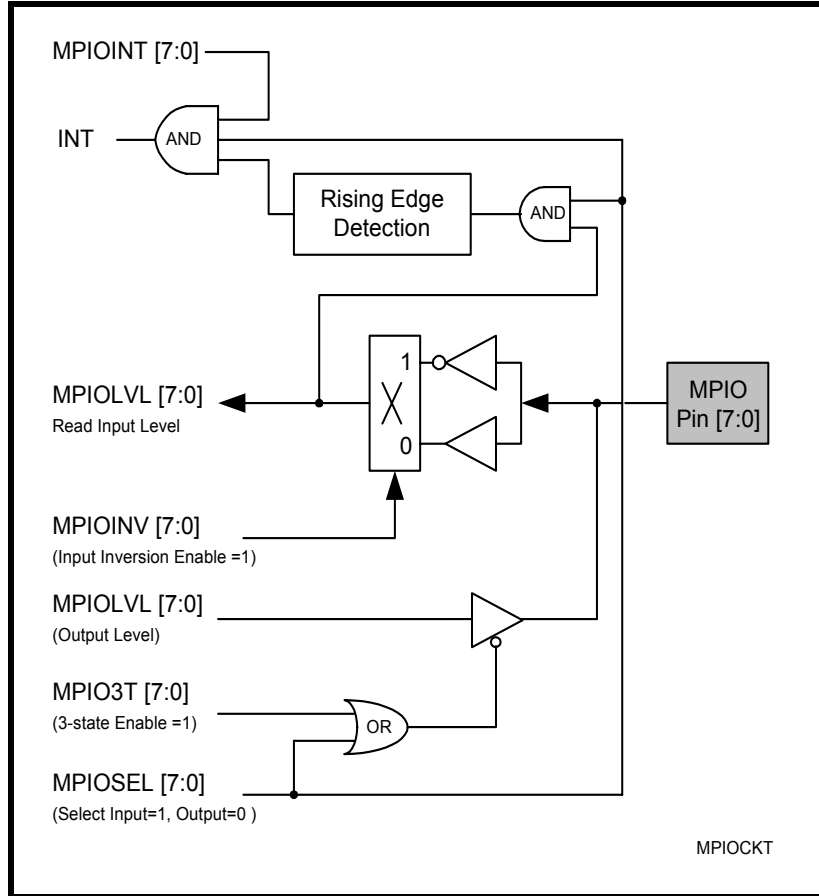
2.2.9 Multi-Purpose Inputs and Outputs

The D158 provides 8 multi-purpose inputs/outputs [MPIO7:0] for general use. Each pin can be programmed to be an input or output function. The input logic state can be set for normal or inverted level, and optionally set to generate an interrupt. The outputs can be set to be normal logic 1 or 0 state, or 3-state. Their functions and definitions are programmed through 5 registers: MPIOINT, MPIOVLV, MPIO3T, MPIOINV and MPIOSEL. If all 8 pins are set for inputs, all 8 interrupts would be OR'ed together. The OR'ed interrupt is reported in the channel 0 UART interrupt status, see Interrupt Status Register. The pins may also be programmed to be outputs and to the 3-state condition for signal sharing.

2.2.10 MPIO REGISTER

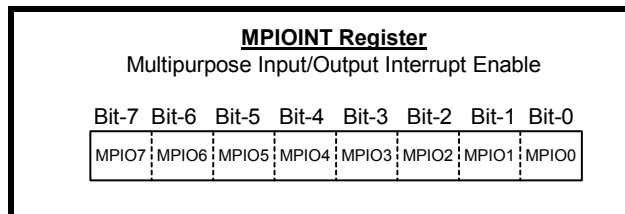
Bit 7 represents MPIO7 pin and bit 0 represents MPIO0 pin. There are 5 registers that select, control and monitor the 8 multipurpose inputs and outputs. **Figure 8** shows the internal circuitry.

FIGURE 8. MULTIPURPOSE INPUT/OUTPUT INTERNAL CIRCUIT



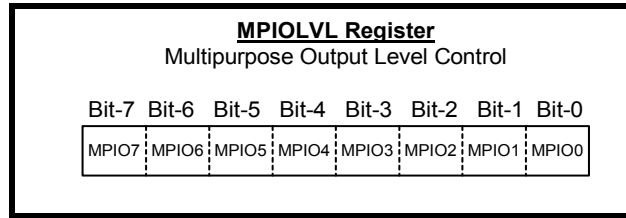
MPIOINT [7:0] (default 0x00)

Enable multipurpose input pin interrupt. If the pin is selected by MPIOSEL as input then bit-0 enables input pin 0 for interrupt, and bit-7 enables input pin 7. No interrupt is enable if the pin is selected to be an output. The interrupt is edge sensing and determined by MPIOINV and MPIOLVL registers. The MPIO interrupt clears after a read to register MPIOLVL. The combination of MPIOLVL and MPIOINV determines the interrupt being active low or active high, it's level trigger. Logic 0 (default) disables the pin's interrupt and logic 1 enables it.



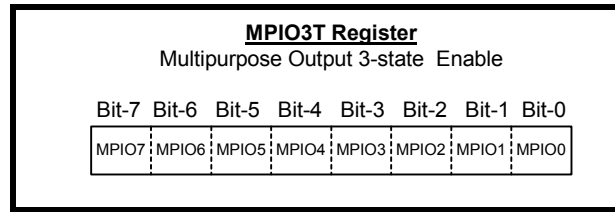
MPIOLVL [7:0] (default 0x00)

Output pin level control and input level status. The status of the input pin(s) is read on this register and output pins are controlled on this register. A logic 0 (default) sets the output to low and a logic 1 sets the output pin to high. The MPIO interrupt will clear upon reading this register.



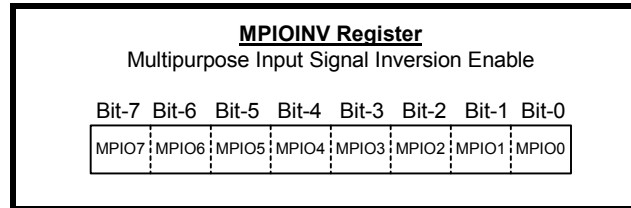
MPIO3T [7:0] (default 0x00)

Output pin tri-state control. A logic 0 (default) sets the output to active level per register MPIOBIT settling, a logic 1 sets the output pin to tri-state.



MPIOINV [7:0] (default 0x00)

Input inversion control. A logic 0 (default) does not invert the input pin logic. A logic 1 inverts the input logic level.



MPIOSEL [7:0] (default 0xFF)

Multipurpose input/output pin select. This register defines the functions of the pins. A logic 1 (default) defines the pin for input and a logic 0 for output.

