GENERAL DESCRIPTION

The XR16L2552 (L2552) is a dual universal asynchronous receiver and transmitter (UART) with 5 volt tolerant inputs. The XR16L2552 is an improved version of the ST16C2552 UART with lower operating voltages and 5 volt tolerant inputs. The L2552 provides enhanced UART functions with 16 byte TX and RX FIFOs, automatic hardware (RTS/CTS) and software (Xon/Xoff) flow control, and a complete modem control interface. Onboard status registers provide the user with error indications and operational status. Indepedendent programmable baud rate generators are provided to select transmit and receive clock rates up to 3.125Mbps. An internal loop-back capability allows onboard diagnostics. The L2552 provides block mode data transfers (DMA) through FIFO controls. DMA transfer monitoring is provided through the signals TXRDY# and RXRDY#. An Alternate Function Register provides the user with the ability to write the control registers for both UARTs concurrently and selection of the Multi-Function output (Baudout#, OP2#, or RXRDY#).

NOTE: *1 Covered by U.S. Patent #5,649,122.*

APPLICATIONS

- Portable Appliances
- Telecommunication Network Routers
- Ethernet Network Routers
- Cellular Data Devices
- Factory Automation and Process Controls

FEATURES

- **2.25 to 5.5 Volt Operation**
- **5 Volt Tolerant Inputs**
- Pin-to-pin and functionally compatible to National PC16552
- Pin-to-pin Compatible to Exar's ST16C2552, XR16L2752 and XR16C2852 in the 44-PLCC
- 2 Independent UART Channels
  - Up to 3.125Mbps with external clock of 50 MHz
  - Register Set Compatible to 16C550
  - 16 byte Transmit FIFO to reduce the bandwidth requirement of the external CPU
  - 16 byte Receive FIFO with error tags to reduce the bandwidth requirement of the external CPU
  - 4 selectable RX FIFO Trigger Levels
  - **Automatic RTS/CTS hardware flow control**
  - **Automatic XonXoff software flow control**
  - **Wireless infrared encoder/decoder**
  - Full Modem Interface (CTS#, RTS#, DSR#, DTR#, RI#, CD#)
  - Programmable character lengths (5, 6, 7, 8) with even, odd, or no parity
  - Multi-Function output allows more package functions with fewer I/O pins
- Concurrent write to Channels A and B
- Crystal oscillator or external clock input
- **48-TQFP (7x7x1.0 mm)** and 44-PLCC packages

FIGURE 1. XR16L2552 BLOCK DIAGRAM

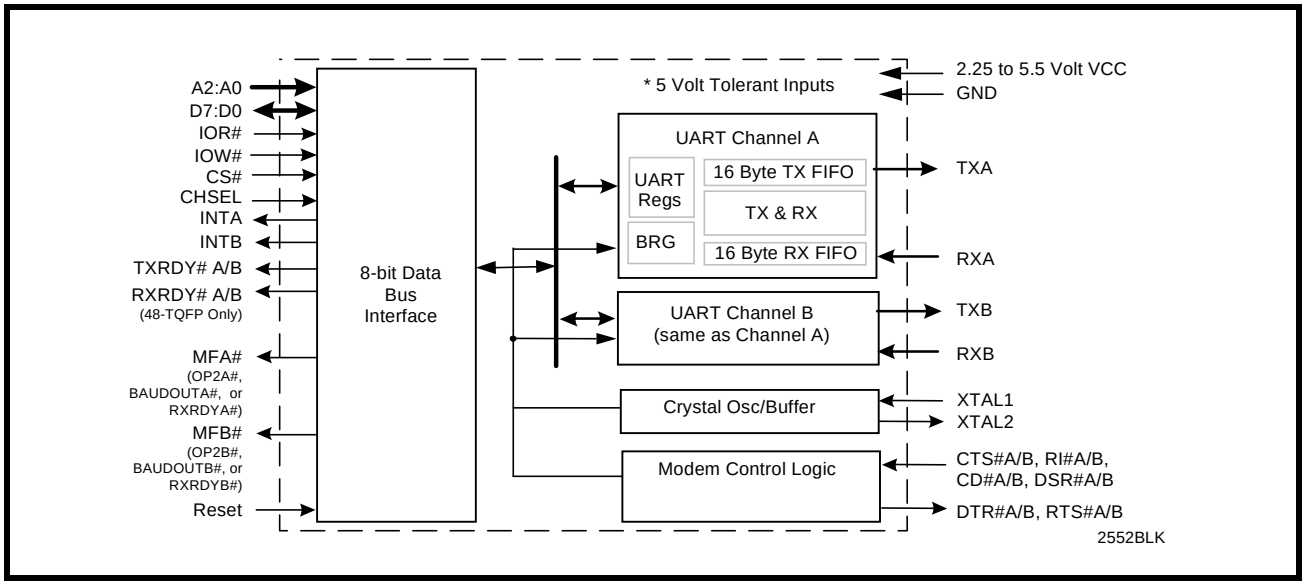
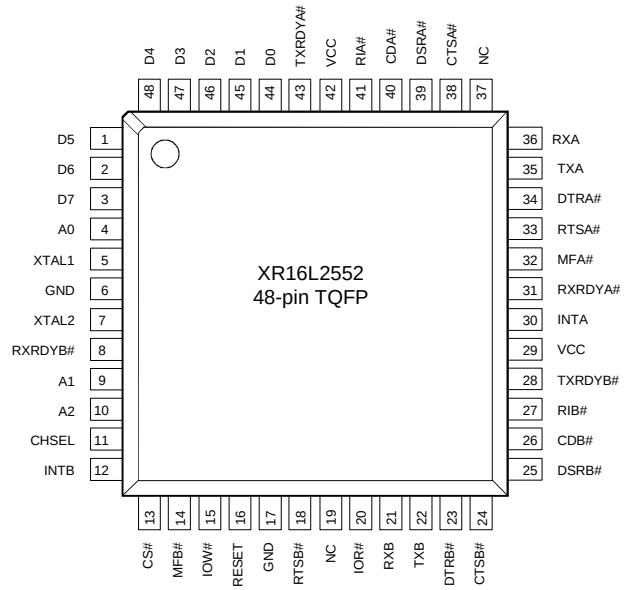
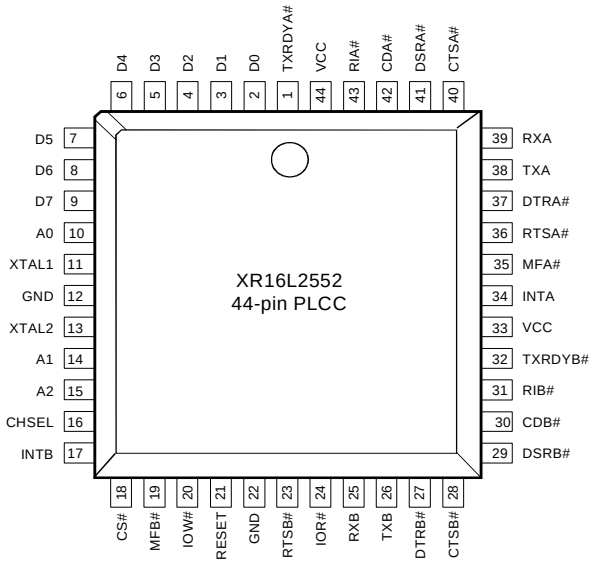


FIGURE 2. PIN OUT ASSIGNMENTS

48-TQFP PACKAGE



44-PLCC PACKAGE



ORDERING INFORMATION

PART NUMBER	PACKAGE	OPERATING TEMPERATURE RANGE	DEVICE STATUS
XR16L2552IM	48-Lead TQFP	-40°C to +85°C	Active
XR16L2552IJ	44-Lead PLCC	-40°C to +85°C	Active

PIN DESCRIPTIONS

Pin Description

NAME	48-TQFP PIN#	44-PLCC PIN #	TYPE	DESCRIPTION
DATA BUS INTERFACE				
A2 A1 A0	10 9 4	10 14 15	I	Address data lines [2:0]. These 3 address lines select one of the internal registers in UART channel A/B during a data bus transaction.
D7 D6 D5 D4 D3 D2 D1 D0	3 2 1 48 47 46 45 44	9 8 7 6 5 4 3 2	I/O	Data bus lines [7:0] (bidirectional).
IOR#	20	24	I	Input/Output Read Strobe (active low). The falling edge instigates an internal read cycle and retrieves the data byte from an internal register pointed to by the address lines [A2:A0]. The data byte is placed on the data bus to allow the host processor to read it on the rising edge.
IOW#	15	20	I	Input/Output Write Strobe (active low). The falling edge instigates an internal write cycle and the rising edge transfers the data byte on the data bus to an internal register pointed by the address lines.
CS#	13	18	I	UART chip select (active low). This function selects channel A or B in accordance with the logical state of the CHSEL pin. This allows data to be transferred between the user CPU and the L2552.
CHSEL	11	16	I	Channel Select - UART channel A or B is selected by the logical state of this pin when the CS# pin is a logic 0. A logic 0 on the CHSEL selects the UART channel B while a logic 1 selects UART channel A. Normally, CHSEL could just be an address line from the user CPU such as A3. Bit-0 of the Alternate Function Register (AFR) can temporarily override CHSEL function, allowing the user to write to both channel register simultaneously with one write cycle when CS# is low. It is especially useful during the initialization routine.
INTA	30	34	O	UART channel A Interrupt output (active high). A logic high indicates channel A is requesting for service.
INTB	12	17	O	UART channel B Interrupt output (active high). A logic high indicates channel B is requesting for service.
TXRDYA#	43	1	O	UART channel A Transmitter Ready (active low). The output provides the TX FIFO/THR status for transmit channel A. If it is not used, leave it unconnected.
RXRDYA#	31	-	O	UART channel A Receiver Ready (active low). This output provides the RX FIFO/RHR status for receive channel A. This pin is only available on the 48-pin TQFP package. If it is not used, leave it unconnected.
TXRDYB#	28	32	O	UART channel B Transmitter Ready (active low). The output provides the TX FIFO/THR status for transmit channel B. If it is not used, leave it unconnected.
RXRDYB#	8	-	O	UART channel B Receiver Ready (active low). This output provides the RX FIFO/RHR status for receive channel B. This pin is only available on the 48-pin TQFP package. If it is not used, leave it unconnected.

Pin Description

NAME	48-TQFP PIN#	44-PLCC PIN #	TYPE	DESCRIPTION
MODEM OR SERIAL I/O INTERFACE				
TXA	35	38	O	UART channel A Transmit Data. If it is not used, leave it unconnected.
RXA	36	39	I	UART channel A Receive Data. Normal receive data input must idle at logic 1 condition. If it is not used, tie it to VCC or pull it high via a 100k ohm resistor.
RTSA#	33	36	O	UART channel A Request-to-Send (active low) or general purpose output. This output must be asserted prior to using auto RTS flow control, see EFR[6], MCR[1] and IER[6]. If it is not used, leave it unconnected.
CTSA#	38	40	I	UART channel A Clear-to-Send (active low) or general purpose input. It can be used for auto CTS flow control, see EFR[7] and IER[7]. This input should be connected to VCC when not used.
DTRA#	34	37	O	UART channel A Data-Terminal-Ready (active low) or general purpose output. If it is not used, leave it unconnected.
DSRA#	39	41	I	UART channel A Data-Set-Ready (active low) or general purpose input. This input should be connected to VCC when not used. This input has no effect on the UART.
CDA#	40	42	I	UART channel A Carrier-Detect (active low) or general purpose input. This input should be connected to VCC when not used. This input has no effect on the UART.
RIA#	41	43	I	UART channel A Ring-Indicator (active low) or general purpose input. This input should be connected to VCC when not used. This input has no effect on the UART.
TXB	22	26	O	UART channel B Transmit Data. If it is not used, leave it unconnected.
RXB	21	25	I	UART channel B Receive Data. Normal receive data input must idle at logic 1 condition. If it is not used, tie it to VCC or pull it high via a 100k ohm resistor.
RTSB#	18	23	O	UART channel B Request-to-Send (active low) or general purpose output. This output must be asserted prior to using auto RTS flow control, see EFR[6], MCR[1] and IER[6]. If it is not used, leave it unconnected.
CTSB#	24	28	I	UART channel B Clear-to-Send (active low) or general purpose input. It can be used for auto CTS flow control, see EFR[7] and IER[7]. This input should be connected to VCC when not used.
DTRB#	23	27	O	UART channel B Data-Terminal-Ready (active low) or general purpose output. If it is not used, leave it unconnected.
DSRB#	25	29	I	UART channel B Data-Set-Ready (active low) or general purpose input. This input should be connected to VCC when not used. This input has no effect on the UART.
CDB#	26	30	I	UART channel B Carrier-Detect (active low) or general purpose input. This input should be connected to VCC when not used. This input has no effect on the UART.
RIB#	27	31	I	UART channel B Ring-Indicator (active low) or general purpose input. This input should be connected to VCC when not used. This input has no effect on the UART.

Pin Description

NAME	48-TQFP PIN#	44-PLCC PIN #	TYPE	DESCRIPTION
MFA#	32	35	O	Multi-Function Output Channel A. This output pin can function as the OP2A#, BAUDOUTA#, or RXRDYA# pin. One of these output signal functions can be selected by the user programmable bits 1-2 of the Alternate Function Register (AFR). These signal functions are described as follows: 1) OP2A# - When OP2A# (active low) is selected, the MF# pin is a logic 0 when MCR bit-3 is set to a logic 1 (see MCR bit-3). MCR bit-3 defaults to a logic 1 condition after a reset or power-up. 2) BAUDOUTA# - When BAUDOUTA# function is selected, the 16X Baud rate clock output is available at this pin. 3) RXRDYA# - RXRDYA# (active low) is intended for monitoring DMA data transfers. If using the 48-TQFP package, this output is already available at pin 31. If it is not used, leave it unconnected.
MFB#	14	19	O	Multi-Function Output ChannelB. This output pin can function as the OP2B#, BAUDOUTB#, or RXRDYB# pin. One of these output signal functions can be selected by the user programmable bits 1-2 of the Alternate Function Register (AFR). These signal functions are described as follows: 1) OP2B# - When OP2B# (active low) is selected, the MF# pin is a logic 0 when MCR bit-3 is set to a logic 1 (see MCR bit-3). MCR bit-3 defaults to a logic 1 condition after a reset or power-up. 2) BAUDOUTB# - When BAUDOUTB# function is selected, the 16X Baud rate clock output is available at this pin. 3) RXRDYB# - RXRDYB# (active low) is intended for monitoring DMA data transfers. If using the 48-TQFP package, this output is already available at pin 8. If it is not used, leave it unconnected.
ANCILLARY SIGNALS				
XTAL1	5	11	I	Crystal or external clock input.
XTAL2	7	13	O	Crystal or buffered clock output.
RESET	16	21	I	Reset (active high) - A longer than 40 ns logic 1 pulse on this pin will reset the internal registers and all outputs. The UART transmitter output will be held at logic 1, the receiver input will be ignored and outputs are reset during reset period (see External Reset Conditions).
VCC	29, 42	44, 33	Pwr	2.25V to 5.5V power supply. All input pins are 5V tolerant.
GND	6, 17	22, 12	Pwr	Power supply common, ground.
NC	19, 37	-	-	Not Connected Internally.

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

1.0 PRODUCT DESCRIPTION

The XR16L2552 (L2552) provides serial asynchronous receive data synchronization, parallel-to-serial and serial-to-parallel data conversions for both the transmitter and receiver sections. These functions are necessary for converting the serial data stream into parallel data that is required with digital data systems. Synchronization for the serial data stream is accomplished by adding start and stop bits to the transmit data to form a data character (character orientated protocol). Data integrity is ensured by attaching a parity bit to the data character. The parity bit is checked by the receiver for any transmission bit errors. The electronic circuitry to provide all these functions is fairly complex especially when manufactured on a single integrated silicon chip. The L2552 represents such an integration with greatly enhanced features. The L2552 is fabricated with an advanced CMOS process.

Transmit and Receive FIFOs (16 Bytes each)

The L2552 is an upward solution that provides a dual UART capability with 16 bytes of transmit and receive FIFO memory, instead of none in the 16C2450. The L2552 is designed to work with low voltage supplies and high performance data communication systems, that require fast data processing time. Increased performance is realized in the L2552 by the transmit and receive FIFO's. This allows the external processor to handle more networking tasks within a given time. For example, the ST16C2450 without a receive FIFO, will require unloading of the RHR in 93 microseconds (This example uses a character length of 11 bits, including start/stop bits at 115.2 Kbps). This means the external CPU will have to service the receive FIFO less than every 100 microseconds. However with the 16 byte FIFO in the L2552, the data buffer will not require unloading/loading for 1.53 ms. This increases the service interval giving the external CPU additional time for other applications and reducing the overall UART interrupt servicing time. In addition, the 4 selectable receive FIFO trigger interrupt levels is uniquely provided for maximum data throughput performance especially when operating in a multi-channel environment. The FIFO memory greatly reduces the bandwidth requirement of the external controlling CPU, increases performance, and reduces power consumption.

Enhanced Features

The XR16L2552 integrates the functions of 2 enhanced 16C550 Universal Asynchronous Receiver and Transmitter (UART). Each UART is independently controlled having its own set of device configuration registers. The configuration registers set is 16550 UART compatible for control, status and data transfer. Additionally, each UART channel has automatic RTS/CTS hardware flow control, automatic Xon/Xoff and special character software flow control, infrared encoder and decoder (IrDA ver 1.0), programmable baud rate generator with a prescaler of divide by 1 or 4, and data rate up to 4 Mbps at 5V.

Data Rate

The L2552 is capable of operation up to 3.125 Mbps with a 50 MHz external clock. With a crystal or external clock input of 14.7456 MHz the user can select data rates up to 921.6 Kbps.

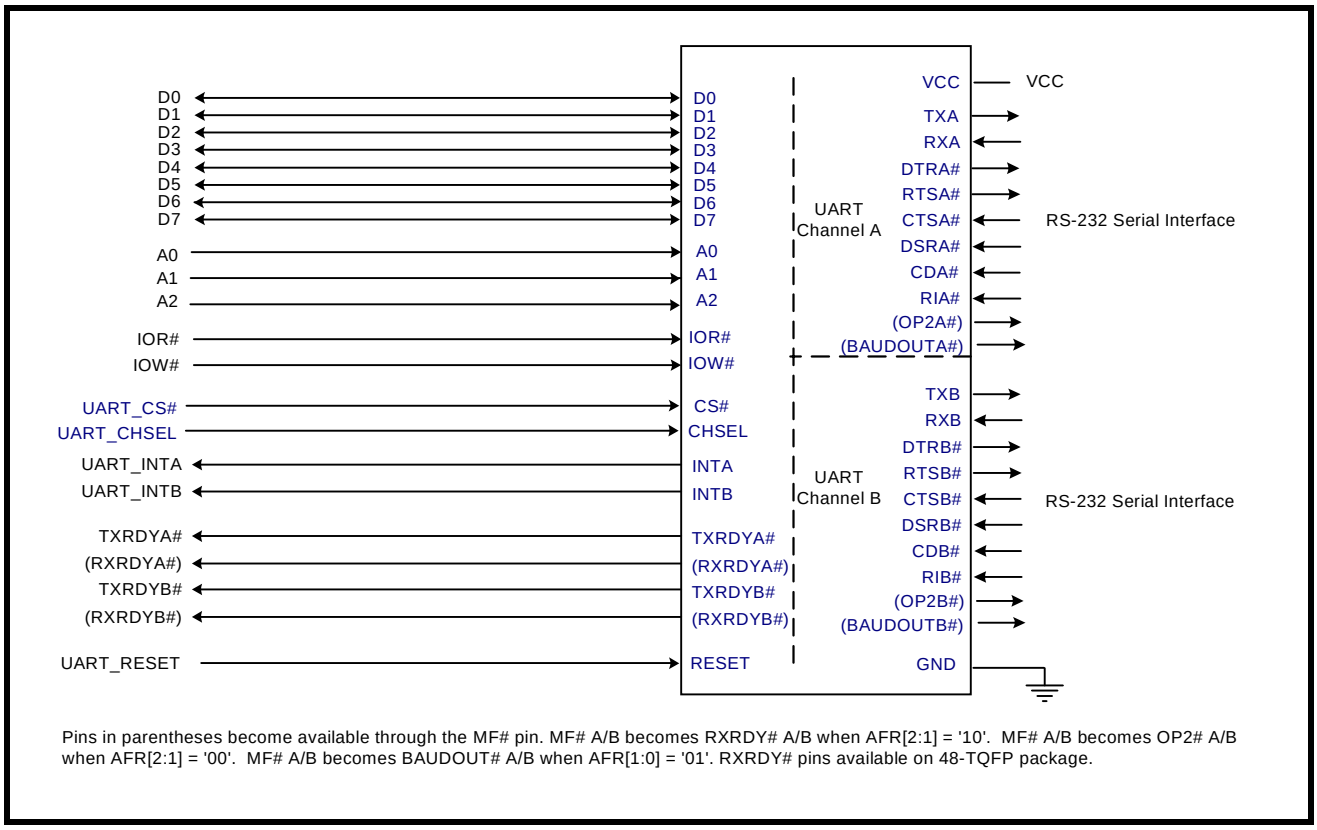
The rich feature set of the L2552 is available through internal registers. Selectable receive FIFO trigger levels, selectable TX and RX baud rates, and modem interface controls are all standard features. Following a power on reset or an external reset, the L2552 is software compatible with the 16L2752 and 16C2852.

2.0 FUNCTIONAL DESCRIPTIONS

2.1 CPU Interface

The CPU interface is 8 data bits wide with 3 address lines and control signals to execute data bus read and write transactions. The L2552 data interface supports the Intel compatible types of CPUs and it is compatible to the industry standard 16C550 UART. No clock (oscillator nor external clock) is required to operate a data bus transaction. Each bus cycle is asynchronous using CS#, IOR# and IOW# signals. Both UART channels share the same data bus for host operations. The data bus interconnections are shown in Figure 3.

FIGURE 3. XR16L2552 DATA BUS INTERCONNECTIONS



2.2 5-Volt Tolerant Inputs

The L2552 can accept up to 5V inputs even when operating at 3.3V or 2.5V. But note that if the L2552 is operating at 2.5V, its V_{OH} may not be high enough to meet the requirements of the V_{IH} of a CPU or a serial transceiver that is operating at 5V.

2.3 Device Reset

The RESET input resets the internal registers and the serial interface outputs in both channels to their default state (see the Table 13). An active high pulse of longer than 40 ns duration will be required to activate the reset function in the device.

2.4 Channel A and B Selection

The UART provides the user with the capability to bi-directionally transfer information between an external CPU and an external serial communication device. A logic 0 on chip select pin (CS#) allows the user to select the UART and then using the channel select (CHSEL) pin, the user can select channel A or B to configure, send

transmit data and/or unload receive data to/from the UART. Individual channel select functions are shown in Table 1.

TABLE 1: CHANNEL A AND B SELECT

CS#	CHSEL	FUNCTION
1	X	UART de-selected
0	1	Channel A selected
0	0	Channel B selected

2.5 Channel A and B Internal Registers

Each UART channel in the L2552 has a set of enhanced registers for controlling, monitoring and data loading and unloading. The configuration register set is compatible to those already available in the standard single 16C550 and dual ST16C2550. These registers function as data holding registers (THR/RHR), interrupt status and control registers (ISR/IER), a FIFO control register (FCR), receive line status and control registers (LSR/LCR), modem status and control registers (MSR/MCR), programmable data rate (clock) divisor registers (DLL/DLM), and a user accessible scratchpad register (SPR).

Beyond the general 16C2550 features and capabilities, the L2552 offers enhanced feature registers (AFR, EFR, Xon/Xoff 1, Xon/Xoff 2) that provide automatic RTS and CTS hardware flow control, automatic Xon/Xoff software flow control, and simultaneous writes to both channels. All the register functions are discussed in full detail later in "Section 3.0, UART INTERNAL REGISTERS" on page 20.

2.6 Simultaneous Write to Channel A and B

During a write mode cycle, the setting of Alternate Function Register (AFR) bit-0 to a logic 1 will override the CHSEL selection and allows a simultaneous write to both UART channel sections. This functional capability allow the registers in both UART channels to be modified concurrently, saving individual channel initialization time. Caution should be exercised, however, when using this capability. Any in-process serial data transfer may be disrupted by changing an active channel's mode.

2.7 DMA Mode

The device does not support direct memory access. The DMA Mode (a legacy term) in this document doesn't mean "direct memory access" but refers to data block transfer operation. The DMA mode affects the state of the RXRDY# A/B (MF# A/B becomes RXRDY# A/B output when AFR[2:1] = '10') and TXRDY# A/B output pins. The transmit and receive FIFO trigger levels provide additional flexibility to the user for block mode operation. The LSR bits 5-6 provide an indication when the transmitter is empty or has an empty location(s) for more data. The user can optionally operate the transmit and receive FIFO in the DMA mode (FCR bit-3=1). When the transmit and receive FIFO are enabled and the DMA mode is disabled (FCR bit-3 = 0), the L2552 is placed in single-character mode for data transmit or receive operation. When DMA mode is enabled (FCR bit-3 = 1), the user takes advantage of block mode operation by loading or unloading the FIFO in a block sequence determined by the programmed trigger level. The following table show their behavior. Also see Figure 18 through Figure 23.

TABLE 2: TXRDY# AND RXRDY# OUTPUTS IN FIFO AND DMA MODE

PINS	FCR BIT-0=0 (FIFO DISABLED)	FCR BIT-0=1 (FIFO ENABLED)	
		FCR Bit-3 = 0 (DMA Mode Disabled)	FCR Bit-3 = 1 (DMA Mode Enabled)
RXRDY# A/B	0 = 1 byte. 1 = no data.	0 = at least 1 byte in FIFO 1 = FIFO empty.	1 to 0 transition when FIFO reaches the trigger level, or timeout occurs. 0 to 1 transition when FIFO empties.
TXRDY# A/B	0 = THR empty. 1 = byte in THR.	0 = FIFO empty. 1 = at least 1 byte in FIFO.	0 = FIFO has at least 1 empty location. 1 = FIFO is full.

2.8 INTA and INTB Ouputs

The INTA and INTB interrupt outputs change according to the operating mode and enahnced features setup. Table 3 and Table 4 summarize the operating behavior for the transmitter and receiver. Also see Figure 18 through Figure 23.

TABLE 3: INTA AND INTB PINS OPERATION FOR TRANSMITTER

	FCR BIT-0 = 0 (FIFO DISABLED)	FCR BIT-0 = 1 (FIFO ENABLED)
INTA/B Pin	0 = a byte in THR 1 = THR empty	0 = at least 1 byte in FIFO 1 = FIFO empty

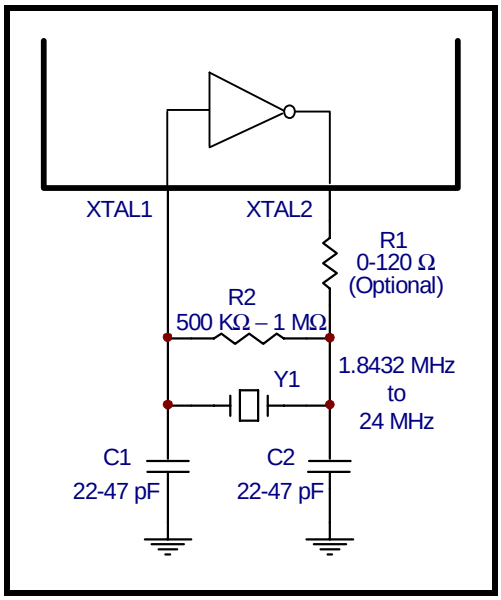
TABLE 4: INTA AND INTB PIN OPERATION FOR RECEIVER

	FCR BIT-0 = 0 (FIFO DISABLED)	FCR BIT-0 = 1 (FIFO ENABLED)
INTA/B Pin	0 = no data 1 = 1 byte	0 = FIFO below trigger level 1 = FIFO above trigger level

2.9 Crystal Oscillator or External Clock Input

The L2552 includes an on-chip oscillator (XTAL1 and XTAL2) to produce a clock for both UART sections in the device. The CPU data bus does not require this clock for bus operation. The crystal oscillator provides a system clock to the Baud Rate Generators (BRG) section found in each of the UART. XTAL1 is the input to the oscillator or external clock buffer input with XTAL2 pin being the output. For programming details, see "Programmable Baud Rate Generator."

FIGURE 4. TYPICAL OSCILLATOR CONNECTIONS

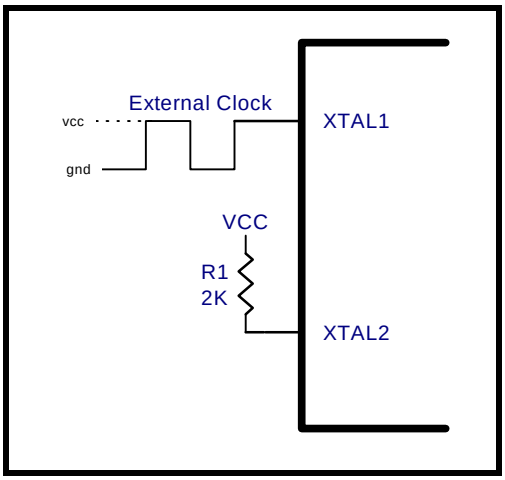


The on-chip oscillator is designed to use an industry standard microprocessor crystal (parallel resonant, fundamental frequency with 10-22 pF capacitance load, ESR of 20-120 ohms and 100ppm frequency tolerance) connected externally between the XTAL1 and XTAL2 pins (see Figure 2), with an external 500kΩ to 1 MΩ resistor across it. Alternatively, an external clock can be connected to the XTAL1 pin to clock the internal baud rate generator for standard or custom rates. Typical oscillator connections are shown in Figure 4. For further reading on oscillator circuit please see application note DAN108 on EXAR's web site.

2.10 Programmable Baud Rate Generator

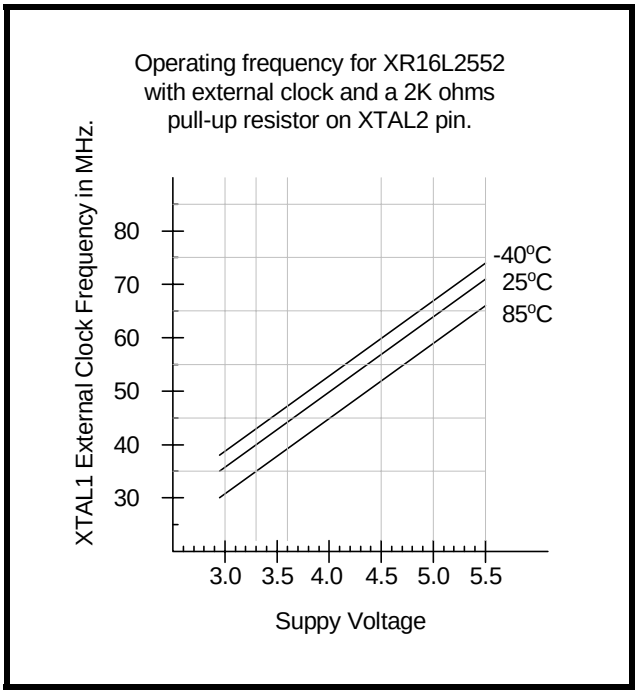
A single baud rate generator is provided for the transmitter and receiver, allowing independent TX/RX channel control. The programmable Baud Rate Generator is capable of operating with a crystal frequency of up to 24 MHz. However, with an external clock input on XTAL1 pin and a 2K ohms pull-up resistor on XTAL2 pin (as shown in Figure 5) it can extend its operation up to 64 MHz (4Mbps serial data rate) at room temperature and 5.0V.

FIGURE 5. EXTERNAL CLOCK CONNECTION FOR EXTENDED DATA RATE



To obtain maximum data rate, it is necessary to use full rail swing on the clock input. See external clock operating frequency over power supply voltage chart in Figure 6.

FIGURE 6. OPERATING FREQUENCY CHART. REQUIRES A 2K OHMS PULL-UP RESISTOR ON XTAL2 PIN TO INCREASE OPERATING SPEED



The L2552 divides the basic external clock by 16. The basic 16X clock provides table rates to support standard and custom applications using the same system design. The Baud Rate Generator divides this 16X clock by

any divisor from 1 to 2^{16} -1. The rate table is configured via the DLL and DLM internal register functions. Customized Baud Rates can be achieved by selecting the proper divisor values for the MSB and LSB sections of baud rate generator.

Table 5 shows the standard data rates available with a 14.7456 MHz crystal or external clock at 16X sampling rate. When using a non-standard frequency crystal or external clock, the divisor value can be calculated for DLL/DLM with the following equation.

divisor (decimal) = (XTAL1 or External clock frequency) / (serial data rate x 16)

TABLE 5: TYPICAL DATA RATES WITH A 14.7456 MHZ CRYSTAL OR EXTERNAL CLOCK

OUTPUT Data Rate MCR Bit-7=0	DIVISOR FOR 16X Clock (Decimal)	DIVISOR FOR 16X Clock (HEX)	DLM PROGRAM VALUE (HEX)	DLL PROGRAM VALUE (HEX)	DATA RATE ERROR (%)
400	2304	900	09	00	0
2400	384	180	01	80	0
4800	192	C0	00	C0	0
9600	96	60	00	60	0
19.2k	48	30	00	30	0
38.4k	24	18	00	18	0
76.8k	12	0C	00	0C	0
153.6k	6	06	00	06	0
230.4k	4	04	00	04	0
460.8k	2	02	00	02	0
921.6k	1	01	00	01	0

2.11 Transmitter

The transmitter section comprises of an 8-bit Transmit Shift Register (TSR) and 16 bytes of FIFO which includes a byte-wide Transmit Holding Register (THR). TSR shifts out every data bit with the 16X internal clock. A bit time is 16 clock periods. The transmitter sends the start-bit followed by the number of data bits, inserts the proper parity-bit if enabled, and adds the stop-bit(s). The status of the FIFO and TSR are reported in the Line Status Register (LSR bit-5 and bit-6).

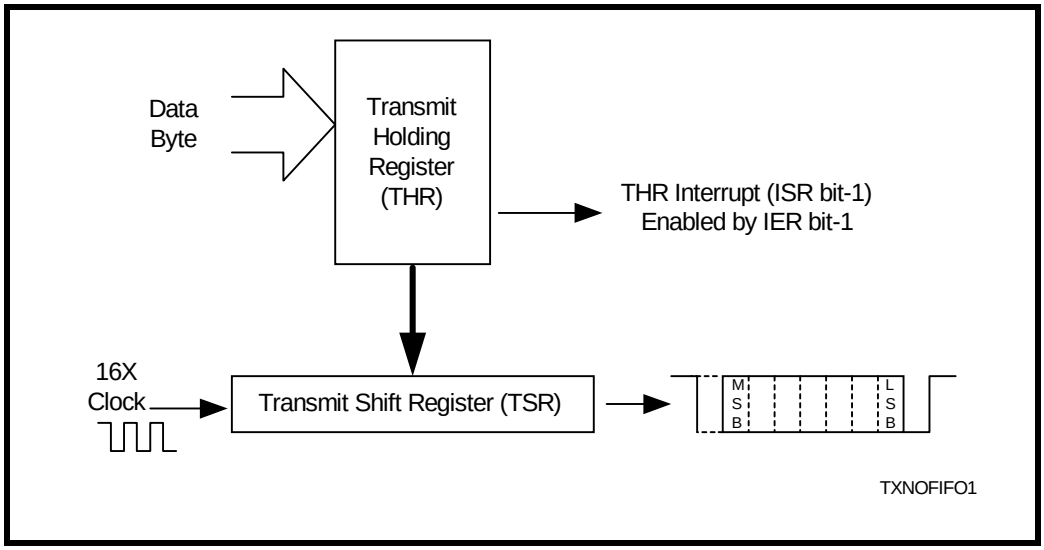
2.11.1 Transmit Holding Register (THR) - Write Only

The transmit holding register is an 8-bit register providing a data interface to the host processor. The host writes transmit data byte to the THR to be converted into a serial data stream including start-bit, data bits, parity-bit and stop-bit(s). The least-significant-bit (Bit-0) becomes first data bit to go out. The THR is the input register to the transmit FIFO of 16 bytes when FIFO operation is enabled by FCR bit-0. Every time a write operation is made to the THR, the FIFO data pointer is automatically bumped to the next sequential data location.

2.11.2 Transmitter Operation in non-FIFO Mode

The host loads transmit data to THR one character at a time. The THR empty flag (LSR bit-5) is set when the data byte is transferred to TSR. THR flag can generate a transmit empty interrupt (ISR bit-1) when it is enabled by IER bit-1. The TSR flag (LSR bit-6) is set when TSR becomes completely empty.

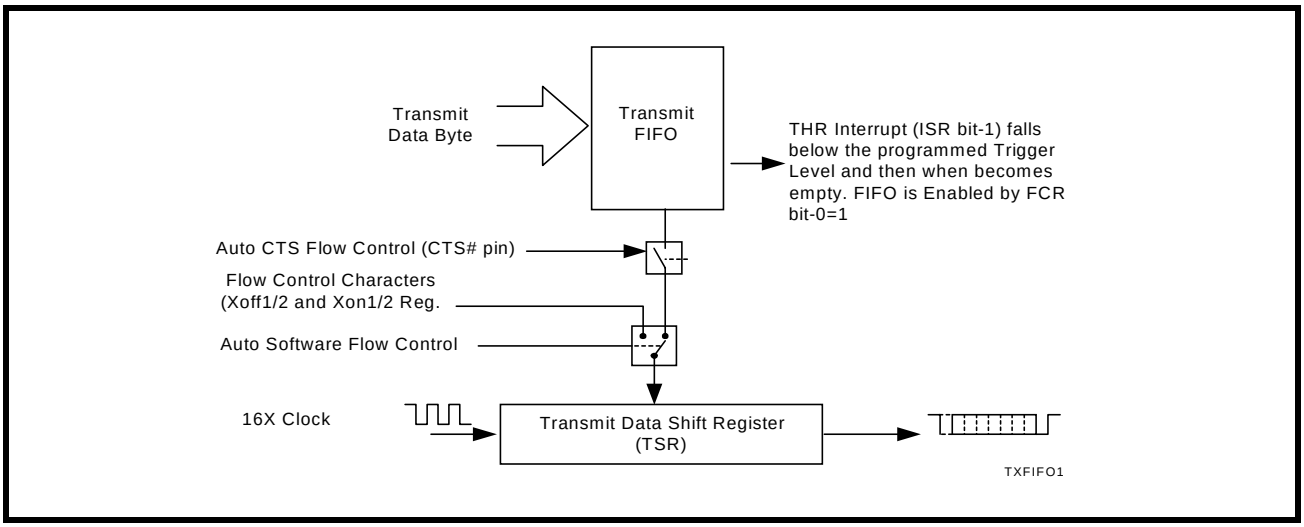
FIGURE 7. TRANSMITTER OPERATION IN NON-FIFO MODE



2.11.3 Transmitter Operation in FIFO Mode

The host may fill the transmit FIFO with up to 16 bytes of transmit data. The THR empty flag (LSR bit-5) is set whenever the FIFO is empty. The THR empty flag can generate a transmit empty interrupt (ISR bit-1) when the transmit empty interrupt is enabled by IER bit-1. The TSR flag (LSR bit-6) is set when the FIFO and the TSR become empty.

FIGURE 8. TRANSMITTER OPERATION IN FIFO AND FLOW CONTROL MODE



2.12 Receiver

The receiver section contains an 8-bit Receive Shift Register (RSR) and 16 bytes of FIFO which includes a byte-wide Receive Holding Register (RHR). The RSR uses the 16X for timing. It verifies and validates every bit on the incoming character in the middle of each data bit. On the falling edge of a start or false start bit, an internal receiver counter starts counting at the 16X. After 8 clocks the start bit period should be at the center of the start bit. At this time the start bit is sampled and if it is still a logic 0 it is validated. Evaluating the start bit in

this manner prevents the receiver from assembling a false character. The rest of the data bits and stop bits are sampled and validated in this same manner to prevent false framing. If there were any error(s), they are reported in the LSR register bits 2-4. Upon unloading the receive data byte from RHR, the receive FIFO pointer is bumped and the error tags are immediately updated to reflect the status of the data byte in RHR register. RHR can generate a receive data ready interrupt upon receiving a character or delay until it reaches the FIFO trigger level. Furthermore, data delivery to the host is guaranteed by a receive data ready time-out interrupt when data is not received for 4 word lengths as defined by LCR[1:0] plus 12 bits time. This is equivalent to 3.7-4.6 character times. The RHR interrupt is enabled by IER bit-0.

2.12.1 Receive Holding Register (RHR) - Read-Only

The Receive Holding Register is an 8-bit register that holds a receive data byte from the Receive Shift Register. It provides the receive data interface to the host processor. The RHR register is part of the receive FIFO of 16 bytes by 11-bits wide, the 3 extra bits are for the 3 error tags to be reported in LSR register. When the FIFO is enabled by FCR bit-0, the RHR contains the first data character received by the FIFO. After the RHR is read, the next character byte is loaded into the RHR and the errors associated with the current data byte are immediately updated in the LSR bits 2-4.

FIGURE 9. RECEIVER OPERATION IN NON-FIFO MODE

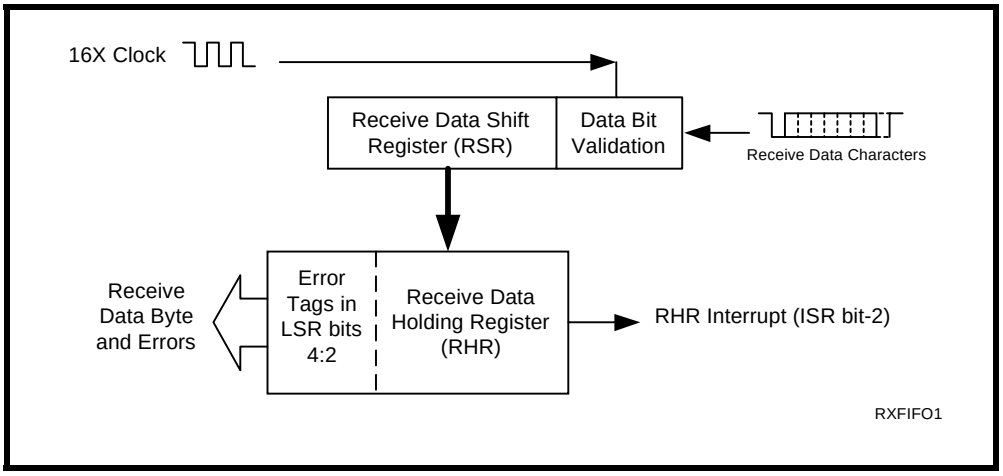
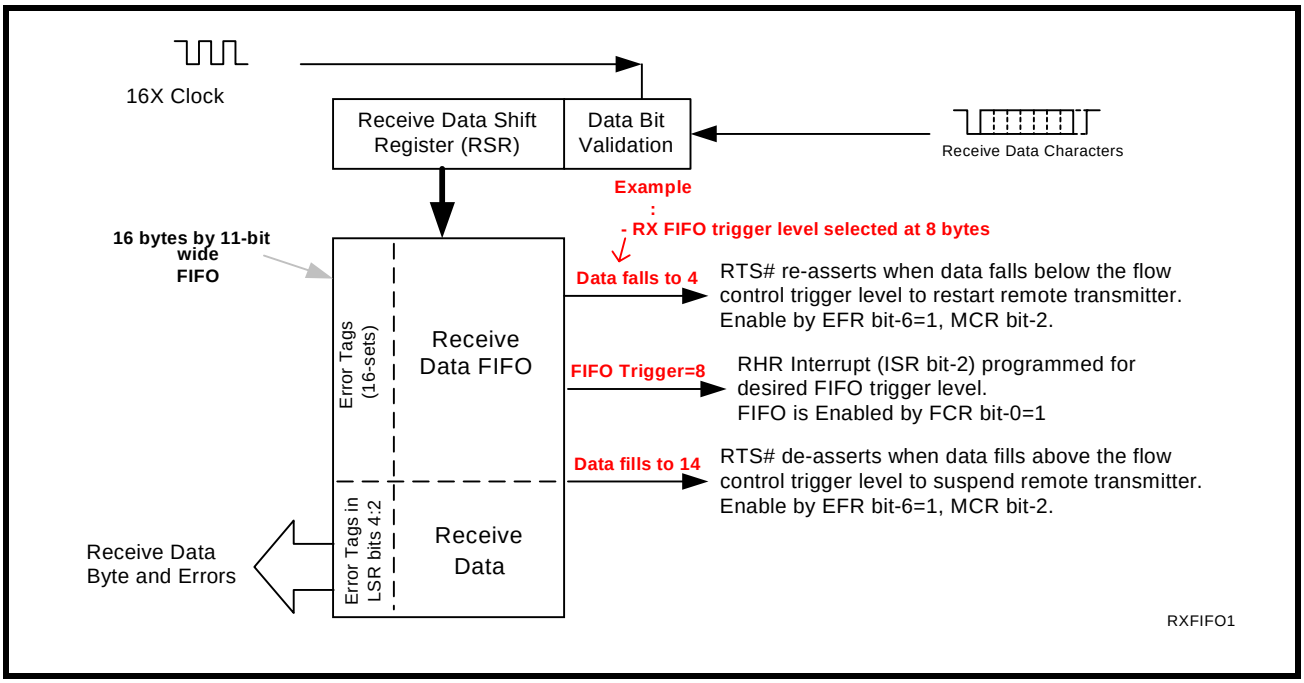


FIGURE 10. RECEIVER OPERATION IN FIFO AND AUTO RTS FLOW CONTROL MODE



2.13 Auto RTS (Hardware) Flow Control

Automatic RTS hardware flow control is used to prevent data overrun to the local receiver FIFO. The RTS# output is used to request remote unit to suspend/resume data transmission. The auto RTS flow control features is enabled to fit specific application requirement (see Figure 11):

- Enable auto RTS flow control using EFR bit-6.

- The auto RTS function must be started by asserting RTS# output pin (MCR bit-1 to logic 1 after it is enabled).

- Enable RTS interrupt through IER bit-6 (after setting EFR bit-4). The UART issues an interrupt when the RTS# pin makes a transition from low to high: ISR bit-5 will be set to logic 1.

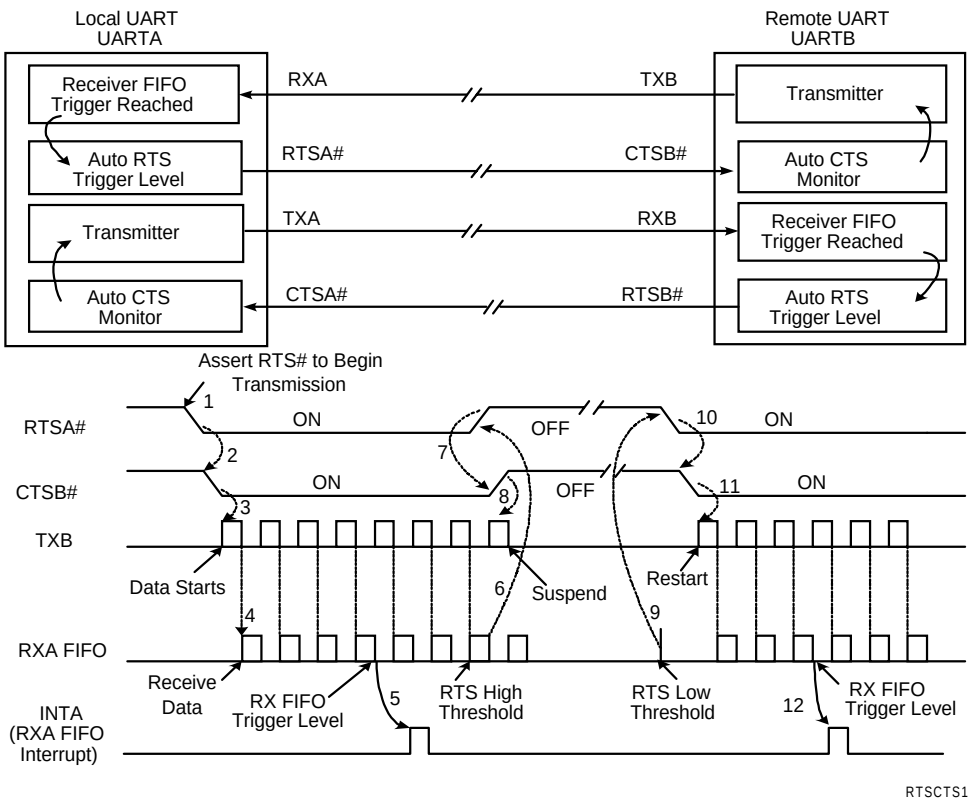
2.14 Auto CTS Flow Control

Automatic CTS flow control is used to prevent data overrun to the remote receiver FIFO. The CTS# input is monitored to suspend/restart the local transmitter. The auto CTS flow control feature is selected to fit specific application requirement (see Figure 11):

- Enable auto CTS flow control using EFR bit-7.

- Enable CTS interrupt through IER bit-7 (after setting EFR bit-4). The UART issues an interrupt when the CTS# pin is de-asserted (logic 1): ISR bit-5 will be set to 1, and UART will suspend transmission as soon as the stop bit of the character in process is shifted out. Transmission is resumed after the CTS# input is re-asserted (logic 0), indicating more data may be sent.

FIGURE 11. AUTO RTS AND CTS FLOW CONTROL OPERATION



The local UART (UARTA) starts data transfer by asserting RTSA# (1). RTSA# is normally connected to CTSB# (2) of remote UART (UARTB). CTSB# allows its transmitter to send data (3). TXB data arrives and fills UARTA receive FIFO (4). When RXA data fills up to its receive FIFO trigger level, UARTA activates its RXA data ready interrupt (5) and continues to receive and put data into its FIFO. If interrupt service latency is long and data is not being unloaded, UARTA monitors its receive data fill level to match the upper threshold of RTS delay and de-assert RTSA# (6). CTSB# follows (7) and request UARTB transmitter to suspend data transfer. UARTB stops or finishes sending the data bits in its transmit shift register (8). When receive FIFO data in UARTA is unloaded to match the lower threshold of RTS delay (9), UARTA re-asserts RTSA# (10), CTSB# recognizes the change (11) and restarts its transmitter and data flow again until next receive FIFO trigger (12). This same event applies to the reverse direction when UARTA sends data to UARTB with RTSB# and CTSA# controlling the data flow.

2.15 Auto Xon/Xoff (Software) Flow Control

When software flow control is enabled (See Table 12), the L2552 compares one or two sequential receive data characters with the programmed Xon or Xoff-1,2 character value(s). If receive character(s) (RX) match the programmed values, the L2552 will halt transmission (TX) as soon as the current character has completed transmission. When a match occurs, the Xoff (if enabled via IER bit-5) flag will be set and the interrupt output pin will be activated. Following a suspension due to a match of the Xoff character, the L2552 will monitor the receive data stream for a match to the Xon-1,2 character. If a match is found, the L2552 will resume operation and clear the flags (ISR bit-4).

Reset initially sets the contents of the Xon/Xoff 8-bit flow control registers to a logic 0. Following reset the user can write any Xon/Xoff value desired for software flow control. Different conditions can be set to detect Xon/Xoff characters (See Table 12) and suspend/resume transmissions. When double 8-bit Xon/Xoff characters are selected, the L2552 compares two consecutive receive characters with two software flow control 8-bit values (Xon1, Xon2, Xoff1, Xoff2) and controls TX transmissions accordingly. Under the above described flow control mechanisms, flow control characters are not placed (stacked) in the user accessible RX data buffer or FIFO.

In the event that the receive buffer is overfilling and flow control needs to be executed, the L2552 automatically sends an Xoff message (when enabled) via the serial TX output to the remote modem. The L2552 sends the Xoff-1,2 characters two-character-times (= time taken to send two characters at the programmed baud rate) after the receive FIFO crosses the programmed trigger level. To clear this condition, the L2552 will transmit the programmed Xon-1,2 characters as soon as receive FIFO is less than one trigger level below the programmed trigger level. See Table 6 below.

TABLE 6: AUTO XON/XOFF (SOFTWARE) FLOW CONTROL

RX TRIGGER LEVEL	INT PIN ACTIVATION	XOFF CHARACTER(S) SENT (CHARACTERS IN RX FIFO)	XON CHARACTER(S) SENT (CHARACTERS IN RX FIFO)
1	1	1*	0
4	4	4*	1
8	8	8*	4
14	14	14*	8

** After the trigger level is reached, an xoff character is sent after a short span of time (= time required to send 2 characters); for example, after 2.083ms has elapsed for 9600 baud and 8-bit word length, no parity and 1 stop bit setting.*

2.16 Special Character Detect

A special character detect feature is provided to detect an 8-bit character when bit-5 is set in the Enhanced Feature Register (EFR). When this character (Xoff2) is detected, it will be placed in the FIFO along with normal incoming RX data.

The L2552 compares each incoming receive character with Xoff-2 data. If a match exists, the received data will be transferred to FIFO and ISR bit-4 will be set to indicate detection of special character. Although the Internal Register Table shows Xon, Xoff Registers with eight bits of character information, the actual number of bits is dependent on the programmed word length. Line Control Register (LCR) bits 0-1 defines the number of character bits, i.e., either 5 bits, 6 bits, 7 bits, or 8 bits. The word length selected by LCR bits 0-1 also determines the number of bits that will be used for the special character comparison. Bit-0 in the Xon, Xoff Registers corresponds with the LSB bit for the receive character.

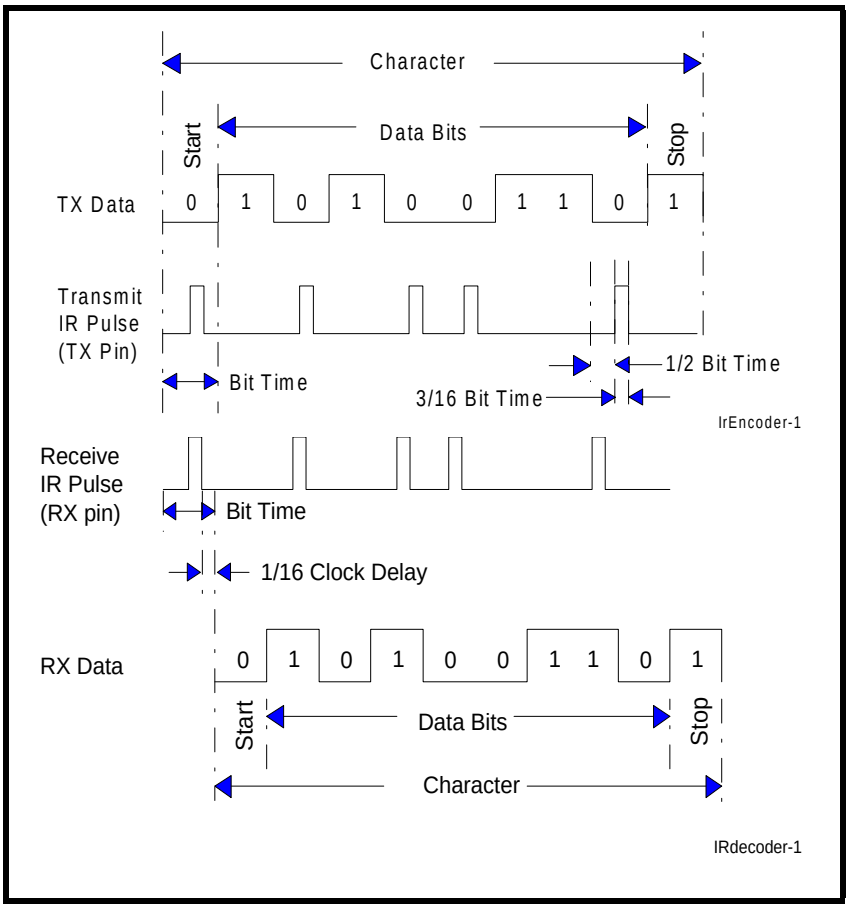
2.17 Infrared Mode

The L2552 UART includes the infrared encoder and decoder compatible to the IrDA (Infrared Data Association) version 1.0. The IrDA 1.0 standard that stipulates the infrared encoder sends out a 3/16 of a bit wide HIGH-pulse for each “0” bit in the transmit data stream. This signal encoding reduces the on-time of the infrared LED, hence reduces the power consumption. See Figure 12 below.

The infrared encoder and decoder are enabled by setting MCR register bit-6 to a ‘1’. When the infrared feature is enabled, the transmit data output, TX, idles at logic zero level. Likewise, the RX input assumes an idle level of logic zero from a reset and power up, see Figure 12.

Typically, the wireless infrared decoder receives the input pulse from the infrared sensing diode on the RX pin. Each time it senses a light pulse, it returns a logic 1 to the data bit stream.

FIGURE 12. INFRARED TRANSMIT DATA ENCODING AND RECEIVE DATA DECODING



2.18 Sleep Mode with Auto Wake-Up

The L2552 supports low voltage system designs, hence, a sleep mode is included to reduce its power consumption when the chip is not actively used.

All of these conditions must be satisfied for the L2552 to enter sleep mode:

- no interrupts pending for both channels of the L2552 (ISR bit-0 = 1)
- divisor is a non-zero value (ie. DLL = 0x1)
- sleep mode of both channels are enabled (IER bit-4 = 1)
- modem inputs are not toggling (MSR bits 0-3 = 0)
- RX input pins are idling at a logic 1

The L2552 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 L2552 resumes normal operation by any of the following:

- a receive data start bit transition (logic 1 to 0)
- 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 L2552 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 L2552 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 channel A or B. The L2552 will stay in the sleep mode of operation until it is disabled by setting IER bit-4 to a logic 0.

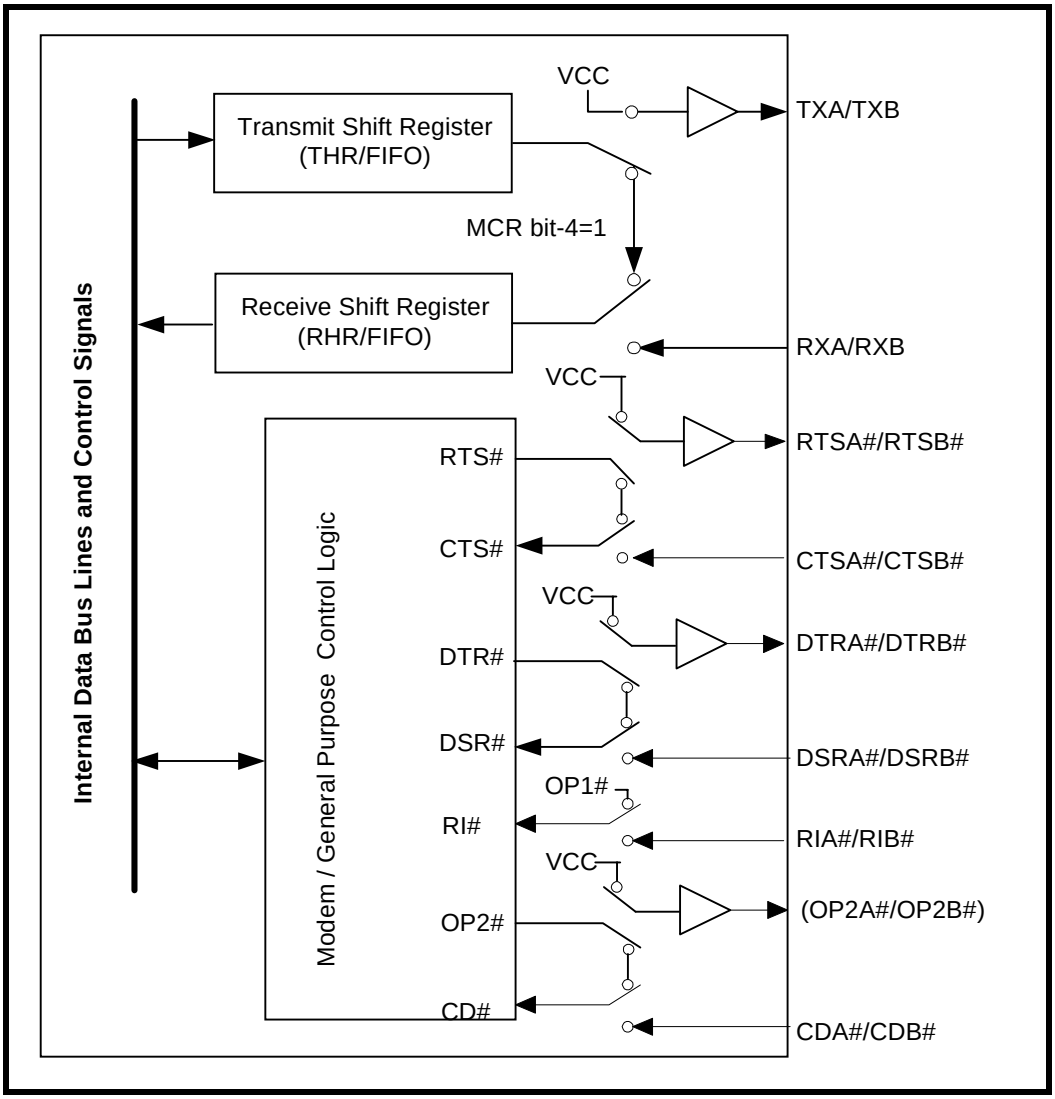
If the address lines, data bus lines, IOW#, IOR#, CSA#, CSB#, and modem input lines remain steady when the L2552 is in sleep mode, the maximum current will be in the microamp range as specified in the DC Electrical Characteristics on page 36. If the input lines are floating or are toggling while the L2552 is in sleep mode, the current can be up to 100 times more. If any of those signals are toggling or floating, then an external buffer would be required to keep the address, data and control lines steady to achieve the low current. As an alternative, please refer to the XR16L2551 with the PowerSave feature that eliminates any unnecessary external buffer.

A word of caution: owing to the starting up delay of the crystal oscillator after waking up from sleep mode, the first few receive characters may be lost. The number of characters lost during the restart also depends on your operating data rate. More characters are lost when operating at higher data rate. Also, it is important to keep RX A/B inputs idling at logic 1 or “marking” condition during sleep mode to avoid receiving a “break” condition upon the restart. This may occur when the external interface transceivers (RS-232, RS-485 or another type) are also put to sleep mode and cannot maintain the “marking” condition. To avoid this, the designer can use a 47k-100k ohm pull-up resistor on the RXA and RXB pins.

2.19 Internal Loopback

The L2552 UART provides an internal loopback capability for system diagnostic purposes. The internal loopback mode is enabled by setting MCR register bit-4 to logic 1. All regular UART functions operate normally. Figure 13 shows how the modem port signals are re-configured. Transmit data from the transmit shift register output is internally routed to the receive shift register input allowing the system to receive the same data that it was sending. The TX pin is held at logic 1 or mark condition while RTS# and DTR# are de-asserted, and CTS#, DSR# CD# and RI# inputs are ignored. Caution: the RX input must be held to a logic 1 during loopback test else upon exiting the loopback test the UART may detect and report a false “break” signal. Also, Auto RTS/ CTS is not supported during internal loopback.

FIGURE 13. INTERNAL LOOP BACK IN CHANNEL A AND B



3.0 UART INTERNAL REGISTERS

Each of the UART channel in the L2552 has its own set of configuration registers selected by address lines A0, A1 and A2 with CS# and CHSEL selecting the channel. The registers are 16C550 compatible. The complete register set is shown in Table 7 and Table 8.

TABLE 7: UART CHANNEL A AND B UART INTERNAL REGISTERS

A2,A1,A0 ADDRESSES	REGISTER	READ/WRITE	COMMENTS
16C550 COMPATIBLE REGISTERS			
0 0 0	RHR - Receive Holding Register THR - Transmit Holding Register	Read-only Write-only	LCR[7] = 0
0 0 0	DLL - Div Latch Low Byte	Read/Write	LCR[7] = 1, LCR ≠ 0xBF
0 0 1	DLM - Div Latch High Byte	Read/Write	LCR[7] = 1, LCR ≠ 0xBF
0 1 0	AFR - Alternate Function Register	Read/Write	LCR[7] = 1, LCR ≠ 0xBF
0 0 1	IER - Interrupt Enable Register	Read/Write	LCR[7] = 0
0 1 0	ISR - Interrupt Status Register FCR - FIFO Control Register	Read-only Write-only	LCR[7] = 0
0 1 1	LCR - Line Control Register	Read/Write	
1 0 0	MCR - Modem Control Register	Read/Write	LCR ≠ 0xBF
1 0 1	LSR - Line Status Register Reserved	Read-only Write-only	LCR ≠ 0xBF
1 1 0	MSR - Modem Status Register Reserved	Read-only Write-only	LCR ≠ 0xBF
1 1 1	SPR - Scratch Pad Register	Read/Write	LCR ≠ 0xBF
ENHANCED REGISTERS			
0 1 0	EFR - Enhanced Function Register	Read/Write	LCR = 0xBF
1 0 0	Xon-1 - Xon Character 1	Read/Write	LCR = 0xBF
1 0 1	Xon-2 - Xon Character 2	Read/Write	LCR = 0xBF
1 1 0	Xoff-1 - Xoff Character 1	Read/Write	LCR = 0xBF
1 1 1	Xoff-2 - Xoff Character 2	Read/Write	LCR = 0xBF

.

TABLE 8: INTERNAL REGISTERS DESCRIPTION. SHADED BITS ARE ENABLED WHEN EFR BIT-4=1

ADDRESS A2-A0	REG NAME	READ/ WRITE	BIT-7	BIT-6	BIT-5	BIT-4	BIT-3	BIT-2	BIT-1	BIT-0	COMMENT
16C550 Compatible Registers											
0 0 0	RHR	RD	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	LCR[7] = 0
0 0 0	THR	WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	
0 0 1	IER	RD/WR	0/ CTS Int. Enable	0/ RTS Int. Enable	0/ Xoff Int. Enable	0/ Sleep Mode Enable	Modem Stat. Int. Enable	RX Line Stat. Int. Enable	TX Empty Int Enable	RX Data Int. Enable	
0 1 0	ISR	RD	FIFOs Enabled	FIFOs Enabled	0/ INT Source Bit-5	0/ INT Source Bit-4	INT Source Bit-3	INT Source Bit-2	INT Source Bit-1	INT Source Bit-0	
0 1 0	FCR	WR	RX FIFO Trigger	RX FIFO Trigger	0	0	DMA Mode Enable	TX FIFO Reset	RX FIFO Reset	FIFOs Enable	
0 1 1	LCR	RD/WR	Divisor Enable	Set TX Break	Set Par-ity	Even Parity	Parity Enable	Stop Bits	Word Length Bit-1	Word Length Bit-0	
1 0 0	MCR	RD/WR	0/ BRG Pres-caler	0/ IR Mode ENable	0/ XonAny	Internal Lopback Enable	OP2# Output Control	Rsvd (OP1#)	RTS# Output Control	DTR# Output Control	LCR ≠ 0xBF
1 0 1	LSR	RD	RX FIFO Global Error	THR & TSR Empty	THR Empty	RX Break	RX Fram-ing Error	RX Parity Error	RX Over-run Error	RX Data Ready	
1 1 0	MSR	RD	CD# Input	RI# Input	DSR# Input	CTS# Input	Delta CD#	Delta RI#	Delta DSR#	Delta CTS#	
1 1 1	SPR	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	
Baud Rate Generator Divisor											
0 0 0	DLL	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	LCR[7] = 1 LCR ≠ 0xBF
0 0 1	DLM	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	
0 1 0	AFR	RD/WR	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	RXRDY# Select	Baudout# Select	Concur-rent Write	

TABLE 8: INTERNAL REGISTERS DESCRIPTION. SHADED BITS ARE ENABLED WHEN EFR BIT-4=1

ADDRESS A2-A0	REG NAME	READ/ WRITE	BIT-7	BIT-6	BIT-5	BIT-4	BIT-3	BIT-2	BIT-1	BIT-0	COMMENT
Enhanced Registers											
0 1 0	EFR	RD/WR	Auto CTS Enable	Auto RTS Enable	Special Char Select	Enable IER [7:4], ISR [5:4], FCR[5:4], MCR[7:5]	Soft-ware Flow Cntl Bit-3	Soft-ware Flow Cntl Bit-2	Soft-ware Flow Cntl Bit-1	Soft-ware Flow Cntl Bit-0	
1 0 0	XON1	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	LCR=0xBF
1 0 1	XON2	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	
1 1 0	XOFF1	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	
1 1 1	XOFF2	RD/WR	Bit-7	Bit-6	Bit-5	Bit-4	Bit-3	Bit-2	Bit-1	Bit-0	

4.0 INTERNAL REGISTER DESCRIPTIONS

4.1 Receive Holding Register (RHR) - Read- Only

See “Receiver” on page 12.

4.2 Transmit Holding Register (THR) - Write-Only

See “Transmitter” on page 11.

4.3 Baud Rate Generator Divisors (DLL and DLM) - Read/Write

The Baud Rate Generator (BRG) is a 16-bit counter that generates the data rate for the transmitter. The rate is programmed through registers DLL and DLM which are only accessible when LCR bit-7 is set to ‘1’. See “Programmable Baud Rate Generator” on page 10. for more details.

4.4 Interrupt Enable Register (IER) - Read/Write

The Interrupt Enable Register (IER) masks the interrupts from receive data ready, transmit empty, line status and modem status registers. These interrupts are reported in the Interrupt Status Register (ISR).

4.4.1 IER versus Receive FIFO Interrupt Mode Operation

When the receive FIFO (FCR BIT-0 = 1) and receive interrupts (IER BIT-0 = 1) are enabled, the RHR interrupts (see ISR bits 2 and 3) status will reflect the following:

A. The receive data available interrupts are issued to the host when the FIFO has reached the programmed trigger level. It will be cleared when the FIFO drops below the programmed trigger level.

B. FIFO level will be reflected in the ISR register when the FIFO trigger level is reached. Both the ISR register status bit and the interrupt will be cleared when the FIFO drops below the trigger level.

C. The receive data ready bit (LSR BIT-0) is set as soon as a character is transferred from the shift register to the receive FIFO. It is reset when the FIFO is empty.

4.4.2 IER versus Receive/Transmit FIFO Polled Mode Operation

When FCR BIT-0 equals a logic 1 for FIFO enable; resetting IER bits 0-3 enables the XR16L2552 in the FIFO polled mode of operation. Since the receiver and transmitter have separate bits in the LSR either or both can be used in the polled mode by selecting respective transmit or receive control bit(s).

A. LSR BIT-0 indicates there is data in RHR or RX FIFO.

B. LSR BIT-1 indicates an overrun error has occurred and that data in the FIFO may not be valid.

C. LSR BIT 2-4 provides the type of receive data errors encountered for the data byte in RHR, if any.

D. LSR BIT-5 indicates transmit FIFO is empty.

E. LSR BIT-6 indicates when both the transmit FIFO and TSR are empty.

F. LSR BIT-7 indicates a data error in at least one character in the RX FIFO.

IER[0]: RHR Interrupt Enable

The receive data ready interrupt will be issued when RHR has a data character in the non-FIFO mode or when the receive FIFO has reached the programmed trigger level in the FIFO mode.

- Logic 0 = Disable the receive data ready interrupt (default).
- Logic 1 = Enable the receiver data ready interrupt.

IER[1]: THR Interrupt Enable

This bit enables the Transmit Ready interrupt which is issued whenever the TX FIFO becomes empty.

- Logic 0 = Disable Transmit Ready interrupt (default).
- Logic 1 = Enable Transmit Ready interrupt.

IER[2]: Receive Line Status Interrupt Enable

If any of the LSR register bits 1, 2, 3 or 4 is a logic 1, it will generate an interrupt to inform the host controller about the error status of the current data byte in FIFO. LSR bit-1 generates an interrupt immediately when the character has been received. LSR bits 2-4 generate an interrupt when the character with errors is read out of the FIFO.

- Logic 0 = Disable the receiver line status interrupt (default).
- Logic 1 = Enable the receiver line status interrupt.

IER[3]: Modem Status Interrupt Enable

- Logic 0 = Disable the modem status register interrupt (default).
- Logic 1 = Enable the modem status register interrupt.

IER[4]: Sleep Mode Enable (requires EFR bit-4 = 1)

- Logic 0 = Disable Sleep Mode (default).
- Logic 1 = Enable Sleep Mode. See Sleep Mode section for further details.

IER[5]: Xoff Interrupt Enable (requires EFR bit-4=1)

- Logic 0 = Disable the software flow control, receive Xoff interrupt. (default)
- Logic 1 = Enable the software flow control, receive Xoff interrupt. See Software Flow Control section for details.

IER[6]: RTS# Output Interrupt Enable (requires EFR bit-4=1)

- Logic 0 = Disable the RTS# interrupt (default).
- Logic 1 = Enable the RTS# interrupt. The UART issues an interrupt when the RTS# pin makes a transition from low to high.

IER[7]: CTS# Input Interrupt Enable (requires EFR bit-4=1)

- Logic 0 = Disable the CTS# interrupt (default).
- Logic 1 = Enable the CTS# interrupt. The UART issues an interrupt when CTS# pin makes a transition from low to high.

4.5 Interrupt Status Register (ISR) - Read-Only

The UART provides multiple levels of prioritized interrupts to minimize external software interaction. The Interrupt Status Register (ISR) provides the user with six interrupt status bits. Performing a read cycle on the ISR will give the user the current highest pending interrupt level to be serviced, others are queued up to be serviced next. No other interrupts are acknowledged until the pending interrupt is serviced. The Interrupt Source Table, Table 9, shows the data values (bit 0-5) for the interrupt priority levels and the interrupt sources associated with each of these interrupt levels.

4.5.1 Interrupt Generation:

- LSR is by any of the LSR bits 1, 2, 3 and 4.
- RXRDY is by RX trigger level.
- RXRDY Time-out is by a 4-char plus 12 bits delay timer.
- TXRDY is by TX FIFO empty.
- MSR is by any of the MSR bits 0, 1, 2 and 3.
- Receive Xoff/Special character is by detection of a Xoff or Special character.
- CTS# is when its transmitter toggles the input pin (from low to high) during auto CTS flow control enabled by EFR bit-7.
- RTS# is when its receiver toggles the output pin (from low to high) during auto RTS flow control enabled by EFR bit-6.

4.5.2 Interrupt Clearing:

- LSR interrupt is cleared by a read to the LSR register (but flags and tags not cleared until character(s) that generated the interrupt(s) has been emptied or cleared from FIFO).
- RXRDY interrupt is cleared by reading data until FIFO falls below the trigger level.
- RXRDY Time-out interrupt is cleared by reading RHR.
- TXRDY interrupt is cleared by a read to the ISR register or writing to THR.
- MSR interrupt is cleared by a read to the MSR register.
- Xoff interrupt is cleared by a read to ISR or when Xon character(s) is received.
- Special character interrupt is cleared by a read to ISR or after the next character is received.
- RTS# and CTS# flow control interrupts are cleared by a read to the MSR register.

TABLE 9: INTERRUPT SOURCE AND PRIORITY LEVEL

PRIORITY LEVEL	ISR REGISTER STATUS BITS						SOURCE OF INTERRUPT
	BIT-5	BIT-4	BIT-3	BIT-2	BIT-1	BIT-0	
1	0	0	0	1	1	0	LSR (Receiver Line Status Register)
2	0	0	1	1	0	0	RXRDY (Receive Data Time-out)
3	0	0	0	1	0	0	RXRDY (Received Data Ready)
4	0	0	0	0	1	0	TXRDY (Transmit Ready)
5	0	0	0	0	0	0	MSR (Modem Status Register)
6	0	1	0	0	0	0	RXRDY (Received Xoff or Special character)
7	1	0	0	0	0	0	CTS#, RTS# change of state
-	0	0	0	0	0	1	None (default)

ISR[0]: Interrupt Status

- Logic 0 = An interrupt is pending and the ISR contents may be used as a pointer to the appropriate interrupt service routine.
- Logic 1 = No interrupt pending (default condition).

ISR[3:1]: Interrupt Status

These bits indicate the source for a pending interrupt at interrupt priority levels (See Interrupt Source Table 9).

ISR[4]: Xoff or Special Character Interrupt Status

This bit is enabled when EFR bit-4 is set to a logic 1. ISR bit-4 indicates that the receiver detected a data match of the Xoff character(s). If this is an Xoff interrupt, it can be cleared by a read to the ISR or when an Xon character is received. If it is a special character interrupt, it will automatically clear after the next character is received.

ISR[5]: RTS#/CTS# Interrupt Status

This bit is enabled when EFR bit-4 is set to a logic 1. ISR bit-5 indicates that the CTS# or RTS# has changed state from low to high.

ISR[7:6]: FIFO Enable Status

These bits are set to a logic 0 when the FIFOs are disabled. They are set to a logic 1 when the FIFOs are enabled.

4.6 FIFO Control Register (FCR) - Write-Only

This register is used to enable the FIFOs, clear the FIFOs, set the transmit/receive FIFO trigger levels, and select the DMA mode. The DMA, and FIFO modes are defined as follows:

FCR[0]: TX and RX FIFO Enable

- Logic 0 = Disable the transmit and receive FIFO (default).
- Logic 1 = Enable the transmit and receive FIFOs. This bit must be set to logic 1 when other FCR bits are written or they will not be programmed.

FCR[1]: RX FIFO Reset

This bit is only active when FCR bit-0 is a ‘1’.

- Logic 0 = No receive FIFO reset (default)
- Logic 1 = Reset the receive FIFO pointers and FIFO level counter logic (the receive shift register is not cleared or altered). This bit will return to a logic 0 after resetting the FIFO.

FCR[2]: TX FIFO Reset

This bit is only active when FCR bit-0 is a ‘1’.

- Logic 0 = No transmit FIFO reset (default).
- Logic 1 = Reset the transmit FIFO pointers and FIFO level counter logic (the transmit shift register is not cleared or altered). This bit will return to a logic 0 after resetting the FIFO.

FCR[3]: DMA Mode Select

Controls the behavior of the TXRDY# and RXRDY# pins. See DMA operation section for details.

- Logic 0 = Normal Operation (default).
- Logic 1 = DMA Mode.

FCR[5:4]: Reserved

FCR[7:6]: Receive FIFO Trigger Select

(logic 0 = default, RX trigger level =1)

These 2 bits are used to set the trigger level for the receive FIFO. The UART will issue a receive interrupt when the number of the characters in the FIFO crosses the trigger level. Table 10 shows the complete selections.

TABLE 10: RECEIVE FIFO TRIGGER LEVEL SELECTION

FCR BIT-7	FCR BIT-6	RECEIVE TRIGGER LEVEL	COMPATIBILITY
0	0	1 (default)	Table-A. 16C550, 16C2550, 16C2552, 16C554, 16C580 compatible.
0	1	4	
1	0	8	
1	1	14	

4.7 Line Control Register (LCR) - Read/Write

The Line Control Register is used to specify the asynchronous data communication format. The word or character length, the number of stop bits, and the parity are selected by writing the appropriate bits in this register.

LCR[1:0]: TX and RX Word Length Select

These two bits specify the word length to be transmitted or received.

BIT-1	BIT-0	WORD LENGTH
0	0	5 (default)
0	1	6
1	0	7
1	1	8

LCR[2]: TX and RX Stop-bit Length Select

The length of stop bit is specified by this bit in conjunction with the programmed word length.

BIT-2	WORD LENGTH	STOP BIT LENGTH (BIT TIME(S))
0	5,6,7,8	1 (default)
1	5	1-1/2
1	6,7,8	2

LCR[3]: TX and RX Parity Select

Parity or no parity can be selected via this bit. The parity bit is a simple way used in communications for data integrity check. See Table 11 for parity selection summary below.

- Logic 0 = No parity.
- Logic 1 = A parity bit is generated during the transmission while the receiver checks for parity error of the data character received.

LCR[4]: TX and RX Parity Select

If the parity bit is enabled with LCR bit-3 set to a logic 1, LCR BIT-4 selects the even or odd parity format.

- Logic 0 = ODD Parity is generated by forcing an odd number of logic 1's in the transmitted character. The receiver must be programmed to check the same format (default).
- Logic 1 = EVEN Parity is generated by forcing an even number of logic 1's in the transmitted character. The receiver must be programmed to check the same format.

LCR[5]: TX and RX Parity Select

If the parity bit is enabled, LCR BIT-5 selects the forced parity format.

- LCR[5] = logic 0, parity is not forced (default).
- LCR[5] = logic 1 and LCR[4] = logic 0, parity bit is forced to a logical 1 for the transmit and receive data.
- LCR[5] = logic 1 and LCR[4] = logic 1, parity bit is forced to a logical 0 for the transmit and receive data.

TABLE 11: PARITY SELECTION

LCR BIT-5	LCR BIT-4	LCR BIT-3	PARITY SELECTION
X	X	0	No parity
0	0	1	Odd parity
0	1	1	Even parity
1	0	1	Force parity to mark, “1”
1	1	1	Forced parity to space, “0”

LCR[6]: Transmit Break Enable

When enabled, the Break control bit causes a break condition to be transmitted (the TX output is forced to a “space’, logic 0, state). This condition remains, until disabled by setting LCR bit-6 to a logic 0.

- Logic 0 = No TX break condition (default).
- Logic 1 = Forces the transmitter output (TX) to a “space”, logic 0, for alerting the remote receiver of a line break condition.

LCR[7]: Baud Rate Divisors Enable

Baud rate generator divisor (DLL/DLM) enable.

- Logic 0 = Data registers are selected (default).
- Logic 1 = Divisor latch registers are selected.

4.8 Modem Control Register (MCR) or General Purpose Outputs Control - Read/Write

The MCR register is used for controlling the serial/modem interface signals or general purpose inputs/outputs.

MCR[0]: DTR# Output

The DTR# pin is a modem control output. If the modem interface is not used, this output may be used as a general purpose output.

- Logic 0 = Force DTR# output to a logic 1 (default).
- Logic 1 = Force DTR# output to a logic 0.

MCR[1]: RTS# Output

The RTS# pin is a modem control output. If the modem interface is not used, this output may be used as a general purpose output.

- Logic 0 = Force RTS# output to a logic 1 (default).
- Logic 1 = Force RTS# output to a logic 0.

MCR[2]: OP1# Output

OP1# is not available as an output pin on the L2552. But it is available for use during Internal Loopback Mode. In the Loopback Mode, this bit is used to write the state of the modem RI# interface signal.

MCR[3]: OP2# Output

OP2# is available as an output pin on the L2552 when AFR[2:1] = '00'. In the Loopback Mode, MCR[3] is used to write the state of the modem CD# interface signal. Also see pin descriptions for MF# pins.

- Logic 0 = Forces OP2# output to a logic 1 (default).
- Logic 1 = Forces OP2# output to a logic 0.

MCR[4]: Internal Loopback Enable

- Logic 0 = Disable loopback mode (default).
- Logic 1 = Enable local loopback mode, see loopback section and Figure 13.

MCR[5]: Xon-Any Enable

- Logic 0 = Disable Xon-Any function (for 16C550 compatibility, default).
- Logic 1 = Enable Xon-Any function. In this mode, any RX character received will resume transmit operation. The RX character will be loaded into the RX FIFO , unless the RX character is an Xon or Xoff character and the L2552 is programmed to use the Xon/Xoff flow control.

MCR[6]: Infrared Encoder/Decoder Enable

- Logic 0 = Enable the standard modem receive and transmit input/output interface. (Default)
- Logic 1 = Enable infrared IrDA receive and transmit inputs/outputs. The TX/RX output/input are routed to the infrared encoder/decoder. The data input and output levels conform to the IrDA infrared interface requirement. While in this mode, the infrared TX output will be a logic 0 during idle data conditions.

MCR[7]: Clock Prescaler Select

- Logic 0 = Divide by one. The input clock from the crystal or external clock is fed directly to the Programmable Baud Rate Generator without further modification, i.e., divide by one (default).
- Logic 1 = Divide by four. The prescaler divides the input clock from the crystal or external clock by four and feeds it to the Programmable Baud Rate Generator, hence, data rates become one forth.

4.9 Line Status Register (LSR) - Read Only

This register provides the status of data transfers between the UART and the host.

LSR[0]: Receive Data Ready Indicator

- Logic 0 = No data in receive holding register or FIFO (default).
- Logic 1 = Data has been received and is saved in the receive holding register or FIFO.

LSR[1]: Receiver Overrun Flag

- Logic 0 = No overrun error (default).
- Logic 1 = Overrun error. A data overrun error condition occurred in the receive shift register. This happens when additional data arrives while the FIFO is full. In this case the previous data in the receive shift register is overwritten. Note that under this condition the data byte in the receive shift register is not transferred into the FIFO, therefore the data in the FIFO is not corrupted by the error.

LSR[2]: Receive Data Parity Error Tag

- Logic 0 = No parity error (default).
- Logic 1 = Parity error. The receive character in RHR does not have correct parity information and is suspect. This error is associated with the character available for reading in RHR.

LSR[3]: Receive Data Framing Error Tag

- Logic 0 = No framing error (default).
- Logic 1 = Framing error. The receive character did not have a valid stop bit(s). This error is associated with the character available for reading in RHR.

LSR[4]: Receive Break Tag

- Logic 0 = No break condition (default).
- Logic 1 = The receiver received a break signal (RX was a logic 0 for at least one character frame time). In the FIFO mode, only one break character is loaded into the FIFO. The break indication remains until the RX input returns to the idle condition, “mark” or logic 1.

LSR[5]: Transmit Holding Register Empty Flag

This bit is the Transmit Holding Register Empty indicator. This bit indicates that the transmitter is ready to accept a new character for transmission. In addition, this bit causes the UART to issue an interrupt to the host when the THR interrupt enable is set. The THR bit is set to a logic 1 when the last data byte is transferred from the transmit holding register to the transmit shift register. The bit is reset to logic 0 concurrently with the data loading to the transmit holding register by the host. In the FIFO mode this bit is set when the transmit FIFO is empty, it is cleared when the transmit FIFO contains at least 1 byte.

LSR[6]: THR and TSR Empty Flag

This bit is set to a logic 1 whenever the transmitter goes idle. It is set to logic 0 whenever either the THR or TSR contains a data character. In the FIFO mode this bit is set to a logic 1 whenever the transmit FIFO and transmit shift register are both empty.

LSR[7]: Receive FIFO Data Error Flag

- Logic 0 = No FIFO error (default).
- Logic 1 = A global indicator for the sum of all error bits in the RX FIFO. At least one parity error, framing error or break indication is in the FIFO data. This bit clears when there is no more error(s) in the FIFO.

4.10 Modem Status Register (MSR) - Read Only

This register provides the current state of the modem interface signals, or other peripheral device that the UART is connected. Lower four bits of this register are used to indicate the changed information. These bits are set to a logic 1 whenever a signal from the modem changes state. These bits may be used as general purpose inputs/outputs when they are not used with modem signals.

MSR[0]: Delta CTS# Input Flag

- Logic 0 = No change on CTS# input (default).
- Logic 1 = The CTS# input has changed state since the last time it was monitored. A modem status interrupt will be generated if MSR interrupt is enabled (IER bit-3).

MSR[1]: Delta DSR# Input Flag

- Logic 0 = No change on DSR# input (default).
- Logic 1 = The DSR# input has changed state since the last time it was monitored. A modem status interrupt will be generated if MSR interrupt is enabled (IER bit-3).

MSR[2]: Delta RI# Input Flag

- Logic 0 = No change on RI# input (default).
- Logic 1 = The RI# input has changed from a logic 0 to a logic 1, ending of the ringing signal. A modem status interrupt will be generated if MSR interrupt is enabled (IER bit-3).

MSR[3]: Delta CD# Input Flag

- Logic 0 = No change on CD# input (default).
- Logic 1 = Indicates that the CD# input has changed state since the last time it was monitored. A modem status interrupt will be generated if MSR interrupt is enabled (IER bit-3).

MSR[4]: CTS Input Status

Normally this bit is the compliment of the CTS# input. However in the loopback mode, this bit is equivalent to the RTS# bit in the MCR register. The CTS# input may be used as a general purpose input when the modem interface is not used.

MSR[5]: DSR Input Status

Normally this bit is the compliment of the DSR# input. In the loopback mode, this bit is equivalent to the DTR# bit in the MCR register. The DSR# input may be used as a general purpose input when the modem interface is not used.

MSR[6]: RI Input Status

Normally this bit is the compliment of the RI# input. In the loopback mode this bit is equivalent to bit-2 in the MCR register. The RI# input may be used as a general purpose input when the modem interface is not used.

MSR[7]: CD Input Status

Normally this bit is the compliment of the CD# input. In the loopback mode this bit is equivalent to bit-3 in the MCR register. The CD# input may be used as a general purpose input when the modem interface is not used.

4.11 Scratch Pad Register (SPR) - Read/Write

This is a 8-bit general purpose register for the user to store temporary data. The content of this register is preserved during sleep mode but becomes 0xFF (default) after a reset or a power off-on cycle.

4.12 Baud Rate Generator Registers (DLL and DLM) - Read/Write

The concatenation of the contents of DLM and DLL gives the 16-bit divisor value which is used to calculate the baud rate:

- Baud Rate = (Clock Frequency / 16) / Divisor

See MCR bit-7 and the baud rate table also.

4.13 Alternate Function Register (AFR) - Read/Write

This register is used to select specific modes of MF# operation and to allow both UART register sets to be written concurrently.

AFR[0]: Concurrent Write Mode

When this bit is set, the CPU can write concurrently to the same register in both UARTs. This function is intended to reduce the dual UART initialization time. It can be used by the CPU when both channels are initialized to the same state. The external CPU can set or clear this bit by accessing either register set. When this bit is set, the channel select pin still selects the channel to be accessed during read operations. The user should ensure that LCR Bit-7 of both channels are in the same state before executing a concurrent write to the registers at address 0, 1, or 2.

- Logic 0 = No concurrent write (default).
- Logic 1 = Register set A and B are written concurrently with a single external CPU I/O write operation.

AFR[2:1]: MF# Output Select

These bits select a signal function for output on the MF# A/B pins. These signal function are described as: OP2#, BAUDOUT#, or RXRDY#. Only one signal function can be selected at a time.

BIT-2	BIT-1	MF# FUNCTION
0	0	OP2# (default)
0	1	BAUDOUT#
1	0	RXRDY#
1	1	Reserved

AFR[7:3]: Reserved

All are initialized to logic 0.

4.14 Enhanced Feature Register (EFR)

Enhanced features are enabled or disabled using this register. Bit 0-3 provide single or dual consecutive character software flow control selection (see Table 12). When the Xon1 and Xon2 and Xoff1 and Xoff2 modes are selected, the double 8-bit words are concatenated into two sequential characters. Caution: note that whenever changing the TX or RX flow control bits, always reset all bits back to logic 0 (disable) before programming a new setting.

EFR[3:0]: Software Flow Control Select

Single character and dual sequential characters software flow control is supported. Combinations of software flow control can be selected by programming these bits.

TABLE 12: SOFTWARE FLOW CONTROL FUNCTIONS

EFR BIT-3 CONT-3	EFR BIT-2 CONT-2	EFR BIT-1 CONT-1	EFR BIT-0 CONT-0	TRANSMIT AND RECEIVE SOFTWARE FLOW CONTROL
0	0	0	0	No TX and RX flow control (default and reset)
0	0	X	X	No transmit flow control
1	0	X	X	Transmit Xon1, Xoff1
0	1	X	X	Transmit Xon2, Xoff2
1	1	X	X	Transmit Xon1 and Xon2, Xoff1 and Xoff2
X	X	0	0	No receive flow control
X	X	1	0	Receiver compares Xon1, Xoff1
X	X	0	1	Receiver compares Xon2, Xoff2
1	0	1	1	Transmit Xon1, Xoff1 Receiver compares Xon1 or Xon2, Xoff1 or Xoff2
0	1	1	1	Transmit Xon2, Xoff2 Receiver compares Xon1 or Xon2, Xoff1 or Xoff2
1	1	1	1	Transmit Xon1 and Xon2, Xoff1 and Xoff2, Receiver compares Xon1 and Xon2, Xoff1 and Xoff2
0	0	1	1	No transmit flow control, Receiver compares Xon1 and Xon2, Xoff1 and Xoff2

EFR[4]: Enhanced Function Bits Enable

Enhanced function control bit. This bit enables IER bits 4-7, ISR bits 4-5, and MCR bits 5-7 to be modified. After modifying any enhanced bits, EFR bit-4 can be set to a logic 0 to latch the new values. This feature prevents legacy software from altering or overwriting the enhanced functions once set. Normally, it is recommended to leave it enabled, logic 1.

- Logic 0 = modification disable/latch enhanced features. IER bits 4-7, ISR bits 4-5, and MCR bits 5-7 are saved to retain the user settings. After a reset, the IER bits 4-7, ISR bits 4-5, and MCR bits 5-7are set to a logic 0 to be compatible with ST16C550 mode (default).
- Logic 1 = Enables the above-mentioned register bits to be modified by the user.

EFR[5]: Special Character Detect Enable

- Logic 0 = Special Character Detect Disabled (default).
- Logic 1 = Special Character Detect Enabled. The UART compares each incoming receive character with data in Xoff-2 register. If a match exists, the receive data will be transferred to FIFO and ISR bit-4 will be set to indicate detection of the special character. Bit-0 corresponds with the LSB bit of the receive character. If flow control is set for comparing Xon1, Xoff1 (EFR [1:0]= ‘10’) then flow control and special character work normally. However, if flow control is set for comparing Xon2, Xoff2 (EFR[1:0]= ‘01’) then flow control works normally, but Xoff2 will not go to the FIFO, and will generate an Xoff interrupt and a special character interrupt, if enabled via IER bit-5. Special character interrupts are cleared automatically after the next received character.

EFR[6]: Auto RTS Flow Control Enable

RTS# output may be used for hardware flow control by setting EFR bit-6 to logic 1. When Auto RTS is selected, an interrupt will be generated when the receive FIFO is filled to the programmed trigger level and RTS de-asserts to a logic 1 at the next upper trigger level. RTS# will return to a logic 0 when FIFO data falls below the next lower trigger level. The RTS# output must be asserted (logic 0) before the auto RTS can take effect. RTS# pin will function as a general purpose output when hardware flow control is disabled.

- Logic 0 = Automatic RTS flow control is disabled (default).
- Logic 1 = Enable Automatic RTS flow control.

EFR[7]: Auto CTS Flow Control Enable

Automatic CTS Flow Control.

- Logic 0 = Automatic CTS flow control is disabled (default).
- Logic 1 = Enable Automatic CTS flow control. Data transmission stops when CTS# input de-asserts to logic 1. Data transmission resumes when CTS# returns to a logic 0.

4.15 Software Flow Control Registers (XOFF1, XOFF2, XON1, XON2) - Read/Write

These registers are used as the programmable software flow control characters XOFF1, XOFF2, XON1, and XON2. For more details, see Table 6.

TABLE 13: UART RESET CONDITIONS FOR CHANNELS A AND B

REGISTERS	RESET STATE
DLL	Bits 7-0 = 0xXX
DLM	Bits 7-0 = 0xXX
AFR	Bits 7-0 = 0x00
RHR	Bits 7-0 = 0xXX
THR	Bits 7-0 = 0xXX
IER	Bits 7-0 = 0x00
FCR	Bits 7-0 = 0x00
ISR	Bits 7-0 = 0x01
LCR	Bits 7-0 = 0x00
MCR	Bits 7-0 = 0x00
LSR	Bits 7-0 = 0x60
MSR	Bits 3-0 = Logic 0 Bits 7-4 = Logic levels of the inputs inverted
SPR	Bits 7-0 = 0xFF
EFR	Bits 7-0 = 0x00
XON1	Bits 7-0 = 0x00
XON2	Bits 7-0 = 0x00
XOFF1	Bits 7-0 = 0x00
XOFF2	Bits 7-0 = 0x00
I/O SIGNALS	**RESET STATE**
TX	Logic 1
MF#	Logic 1
RTS#	Logic 1
DTR#	Logic 1
TXRDY#	Logic 0
INT	Logic 0

ABSOLUTE MAXIMUM RATINGS

Power Supply Range	7 Volts
Voltage at Any Pin	GND-0.3 V to VCC+0.3 V
Operating Temperature	-40^{o} to +85^{o}C
Storage Temperature	-65^{o} to +150^{o}C
Package Dissipation	500 mW

TYPICAL PACKAGE THERMAL RESISTANCE DATA (MARGIN OF ERROR: ± 15%)

Thermal Resistance (48-TQFP)	theta-ja =59^{o}C/W, theta-jc = 16^{o}C/W
Thermal Resistance (44-PLCC)	theta-ja = 50^{o}C/W, theta-jc = 21^{o}C/W

ELECTRICAL CHARACTERISTICS

DC ELECTRICAL CHARACTERISTICS

UNLESS OTHERWISE NOTED: TA=-40^{O} TO +85^{O}C FOR INDUSTRIAL GRADE PACKAGE, VCC IS 2.25 TO 5.5V

SYMBOL	PARAMETER	LIMITS 2.5V MIN	LIMITS 2.5V MAX	LIMITS 3.3V MIN	LIMITS 3.3V MAX	LIMITS 5.0V MIN	LIMITS 5.0V MAX	UNITS	CONDITIONS
V_{ILCK}	Clock Input Low Level	-0.3	0.2	-0.3	0.6	-0.5	0.6	V	
V_{IHCK}	Clock Input High Level	2.0	5.5	2.4	5.5	3.0	5.5	V	
V_{IL}	Input Low Voltage	-0.3	0.6	-0.3	0.8	-0.5	0.8	V	
V_{IH}	Input High Voltage	2.0	5.5	2.0	5.5	2.2	5.5	V	
V_{OL}	Output Low Voltage		0.4		0.4		0.4	V V V	I_{OL} = 6 mA I_{OL} = 4 mA I_{OL} = 2 mA
V_{OH}	Output High Voltage	1.8		2.0		2.4		V V V	I_{OH} = -6 mA I_{OH} = -1 mA I_{OH} = -400 uA
I_{IL}	Input Low Leakage Current		±10		±10		±10	uA	
I_{IH}	Input High Leakage Current		±10		±10		±10	uA	
C_{IN}	Input Pin Capacitance		5		5		5	pF	
I_{CC}	Power Supply Current		1		1.3		3	mA	
I_{SLEEP}	Sleep Current		6		15		30	uA	See Test 1

Test 1: The following inputs must remain steady at VCC or GND state to minimize Sleep current: A0-A2, D0-D7, IOR#, IOW#, CS#, CHSEL, and all modem inputs. Also, RXA and RXB inputs must idle at logic 1 state while asleep. Floating inputs will result in sleep currents in the mA range. For PowerSave feature that isolates address, data and control signals, please see the XR16L2551 datasheet.

AC ELECTRICAL CHARACTERISTICS

UNLESS OTHERWISE NOTED: TA=-40^{O} TO +85^{O}C, VCC IS 2.25V TO 5.5V,

70 PF LOAD WHERE APPLICABLE

SYMBOL	PARAMETER	LIMITS 2.5 MIN	LIMITS 2.5 MAX	LIMITS 3.3 MIN	LIMITS 3.3 MAX	LIMITS 5.0 MIN	LIMITS 5.0 MAX	UNIT
-	Crystal Frequency		16		20		24	MHz

AC ELECTRICAL CHARACTERISTICS

UNLESS OTHERWISE NOTED: TA=-40^{O} TO +85^{O}C, VCC IS 2.25V TO 5.5V, 70 PF LOAD WHERE APPLICABLE

SYMBOL	PARAMETER	LIMITS 2.5		LIMITS 3.3		LIMITS 5.0		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
CLK	External Clock Low/High Time	31		17		10		ns
OSC	External Clock Frequency		16		30		50	MHz
T_{AS}	Address Setup Time	10		10		10		ns
T_{AH}	Address Hold Time	10		10		10		ns
T_{CS}	Chip Select Width	150		75		50		ns
T_{RD}	IOR# Strobe Width	150		75		50		ns
T_{DY}	Read Cycle Delay	150		75		50		ns
T_{RDV}	Data Access Time		125		80		50	ns
T_{DD}	Data Disable Time	0	45	0	30	0	30	ns
T_{WR}	IOW# Strobe Width	150		75		50		ns
T_{DY}	Write Cycle Delay	150		75		50		ns
T_{DS}	Data Setup Time	25		20		15		ns
T_{DH}	Data Hold Time	15		10		10		ns
T_{WDO}	Delay From IOW# To Output		150		75		50	ns
T_{MOD}	Delay To Set Interrupt From MODEM Input		150		75		50	ns
T_{RSI}	Delay To Reset Interrupt From IOR#		150		75		50	ns
T_{SSI}	Delay From Stop To Set Interrupt		1		1		1	Bclk
T_{RRI}	Delay From IOR# To Reset Interrupt		150		75		50	ns
T_{SI}	Delay From Stop To Interrupt		150		75		50	ns
T_{INT}	Delay From Initial INT Reset To Transmit Start	8	24	8	24	8	24	Bclk
T_{WRI}	Delay From IOW# To Reset Interrupt		150		75		50	ns
T_{SSR}	Delay From Stop To Set RXRDY#		1		1		1	Bclk
T_{RR}	Delay From IOR# To Reset RXRDY#		150		75		50	ns
T_{WT}	Delay From IOW# To Set TXRDY#		150		75		50	ns
T_{SRT}	Delay From Center of Start To Reset TXRDY#		8		8		8	Bclk
T_{RST}	Reset Pulse Width	40		40		40		ns
N	Baud Rate Divisor	1	2^{16}-1	1	2^{16}-1	1	2^{16}-1	-

AC ELECTRICAL CHARACTERISTICS

UNLESS OTHERWISE NOTED: TA=-40° TO +85°C, VCC IS 2.25V TO 5.5V,

70 PF LOAD WHERE APPLICABLE

SYMBOL	PARAMETER	LIMITS 2.5 MIN	LIMITS 2.5 MAX	LIMITS 3.3 MIN	LIMITS 3.3 MAX	LIMITS 5.0 MIN	LIMITS 5.0 MAX	UNIT
Bclk	Baud Clock	16X of data rate						Hz

FIGURE 14. CLOCK TIMING

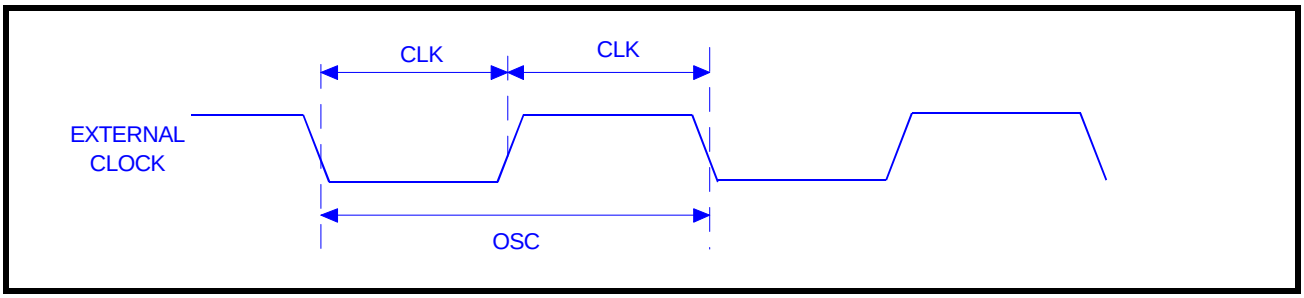


FIGURE 15. MODEM INPUT/OUTPUT TIMING FOR CHANNELS A & B

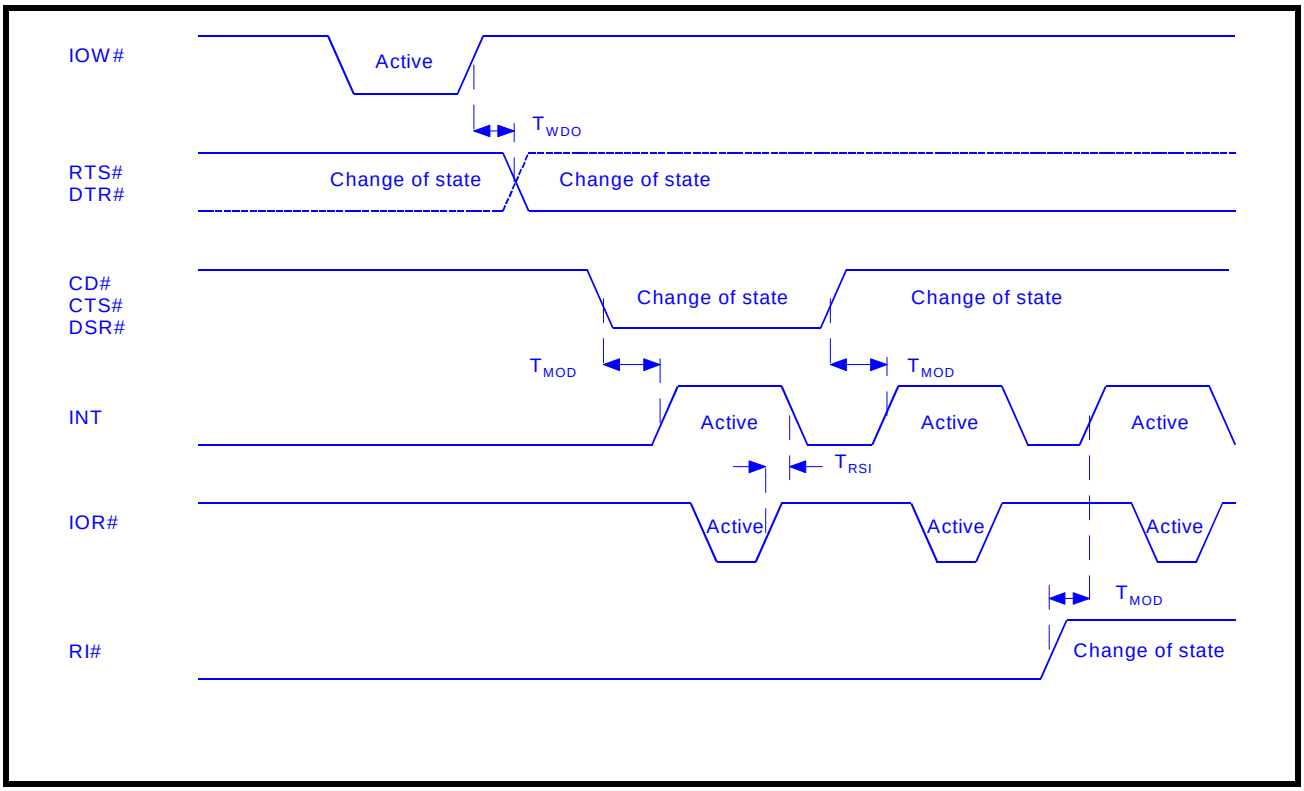


FIGURE 16. DATA BUS READ TIMING

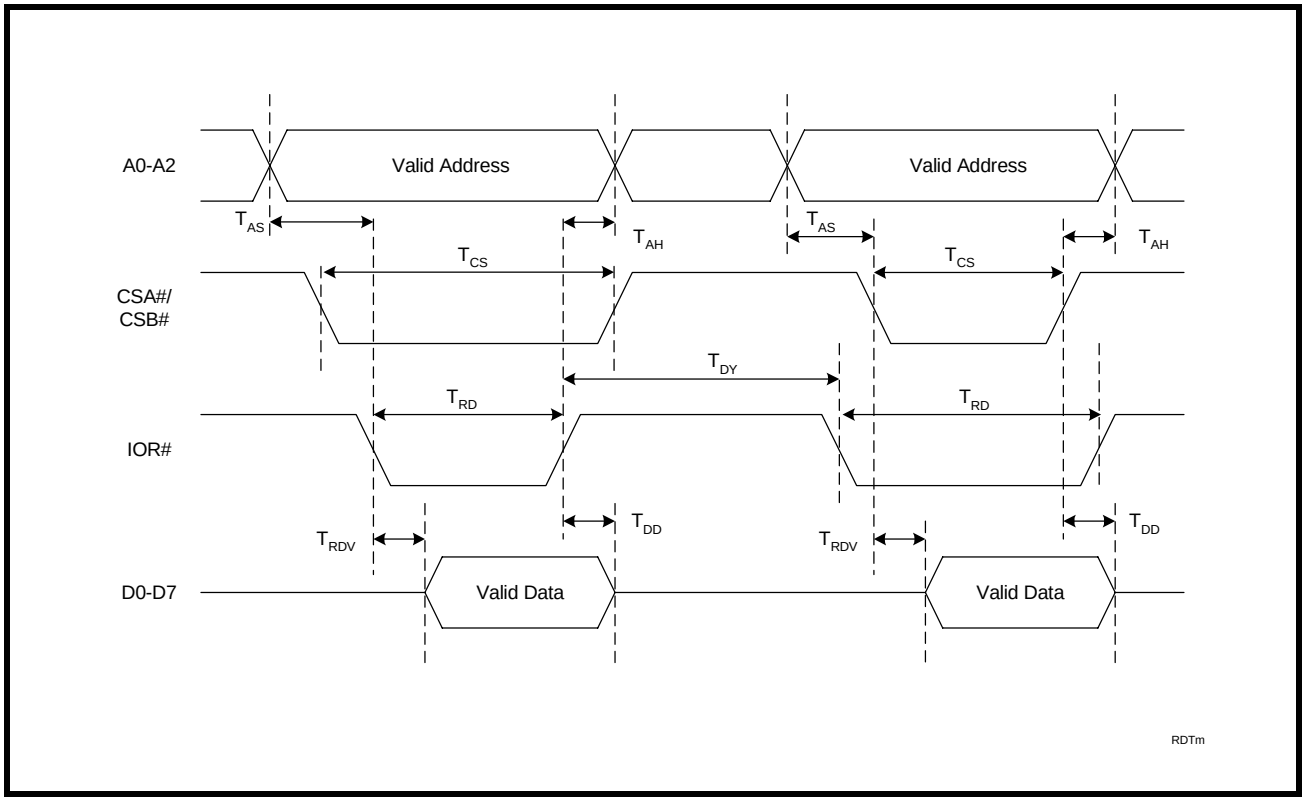


FIGURE 17. DATA BUS WRITE TIMING

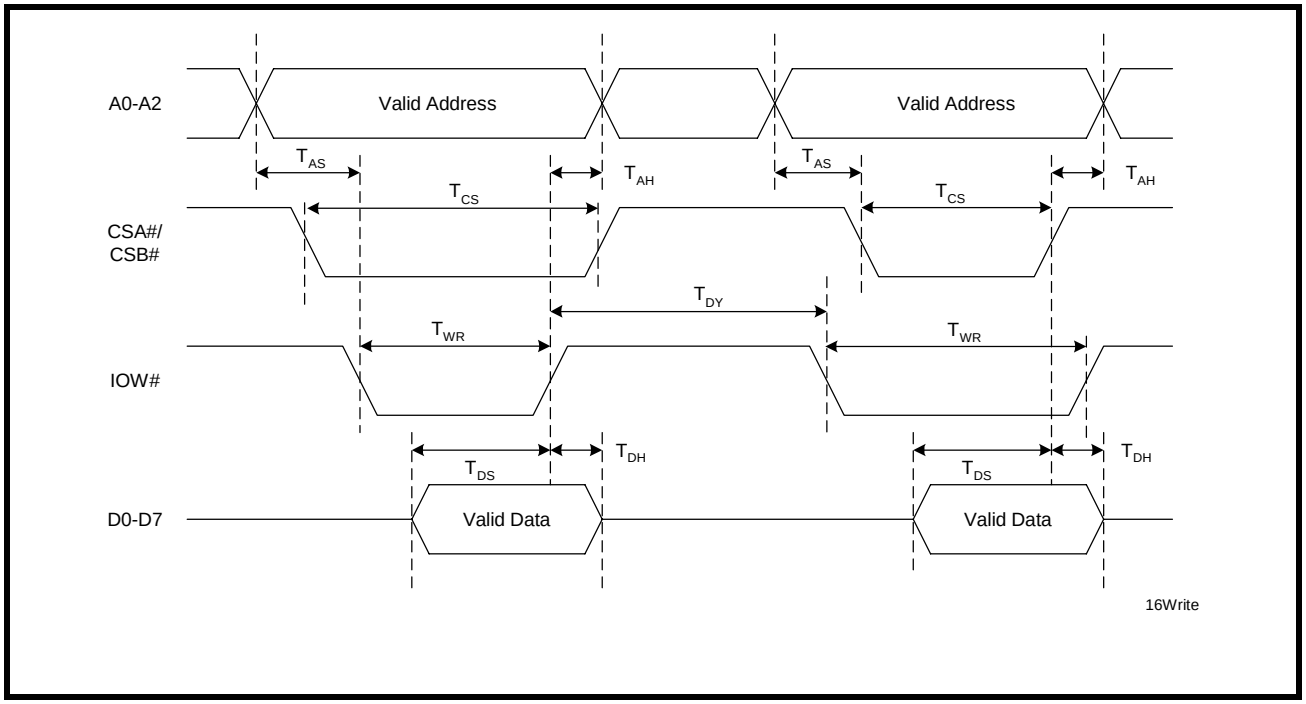


FIGURE 18. RECEIVE READY & INTERRUPT TIMING [NON-FIFO MODE] FOR CHANNELS A & B

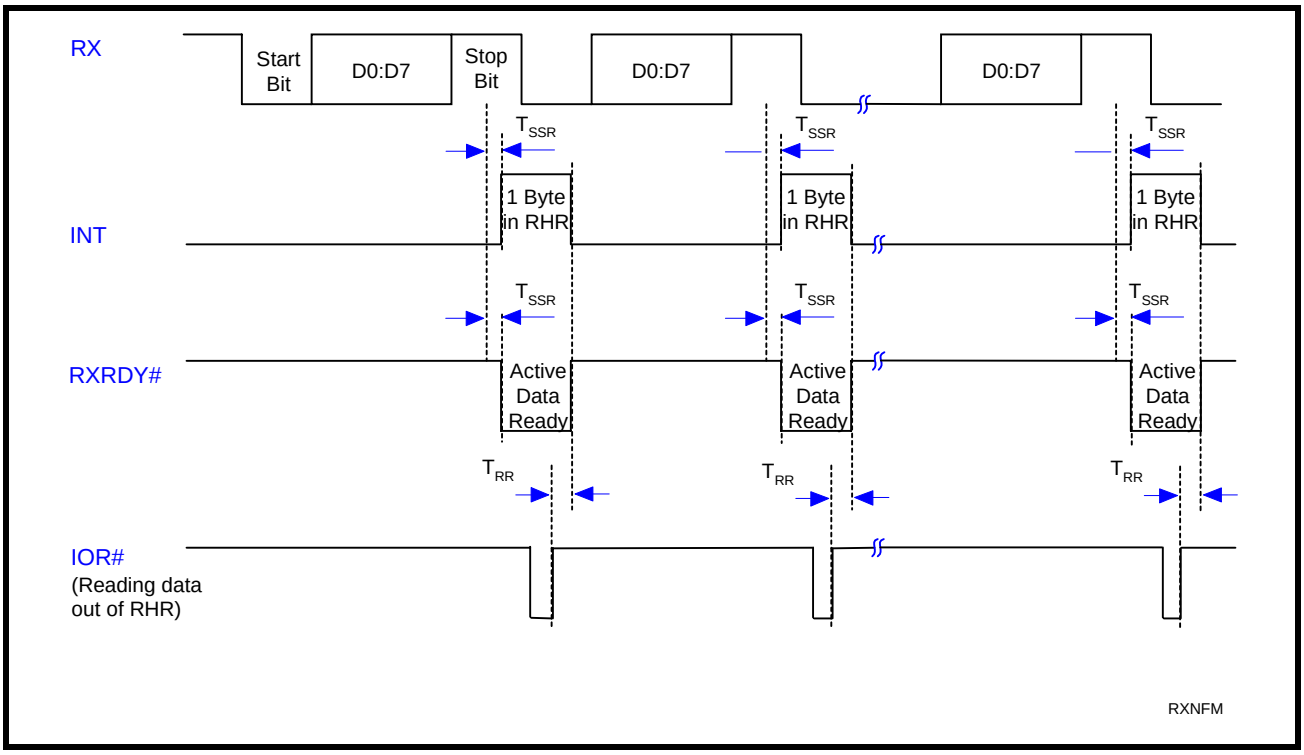


FIGURE 19. TRANSMIT READY & INTERRUPT TIMING [NON-FIFO MODE] FOR CHANNELS A & B

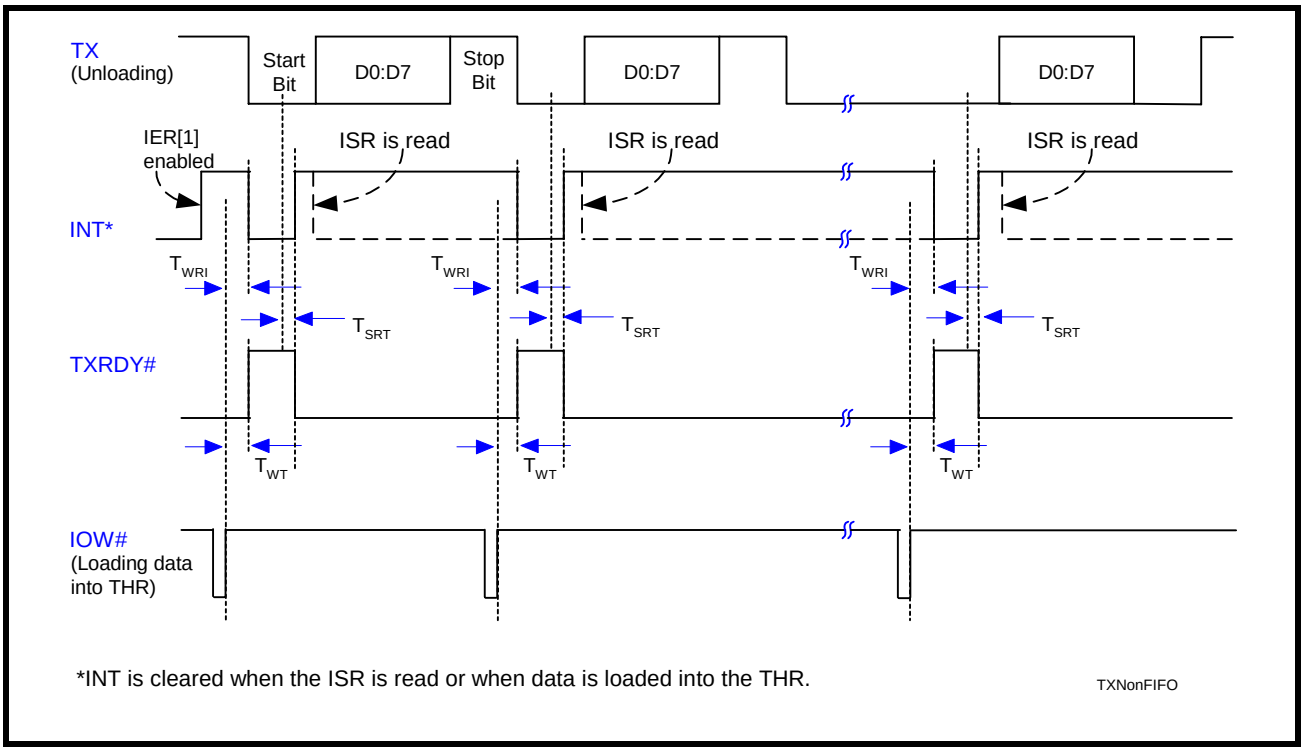


FIGURE 20. RECEIVE READY & INTERRUPT TIMING [FIFO MODE, DMA DISABLED] FOR CHANNELS A & B

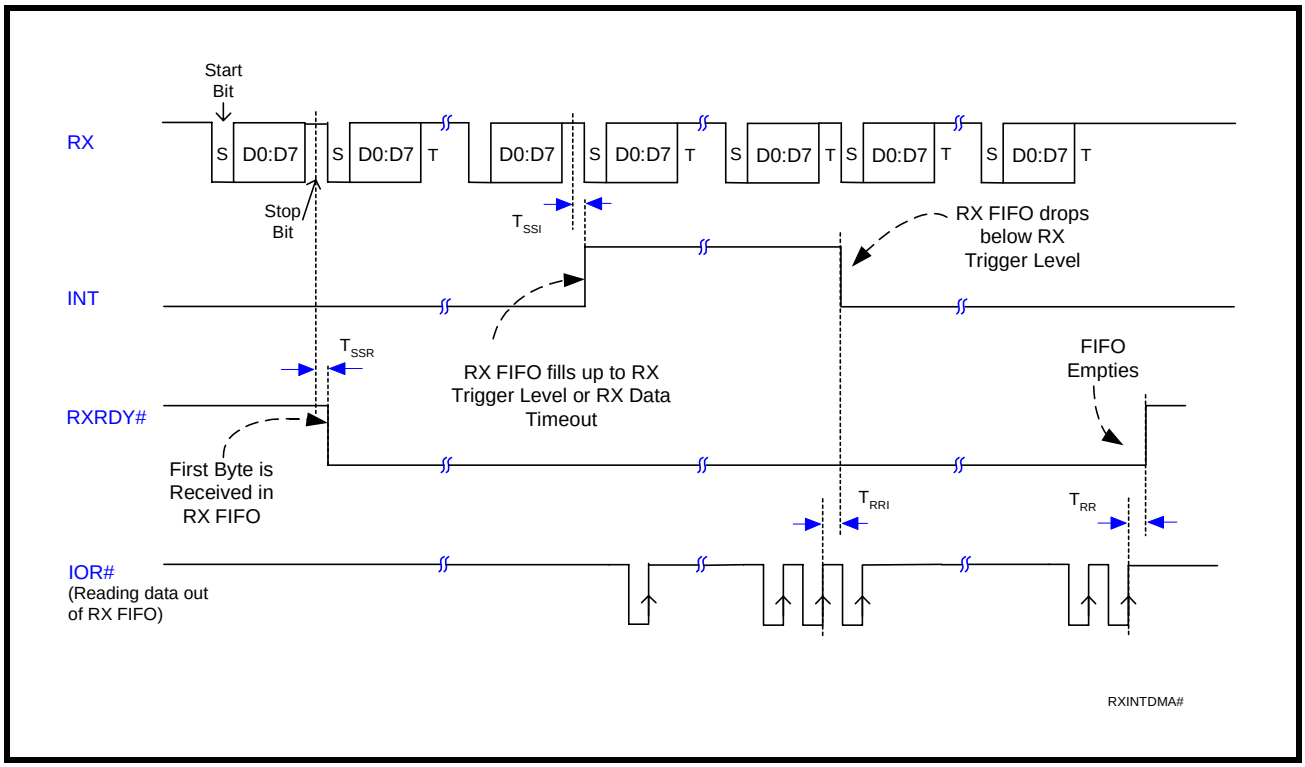


FIGURE 21. RECEIVE READY & INTERRUPT TIMING [FIFO MODE, DMA ENABLED] FOR CHANNELS A & B

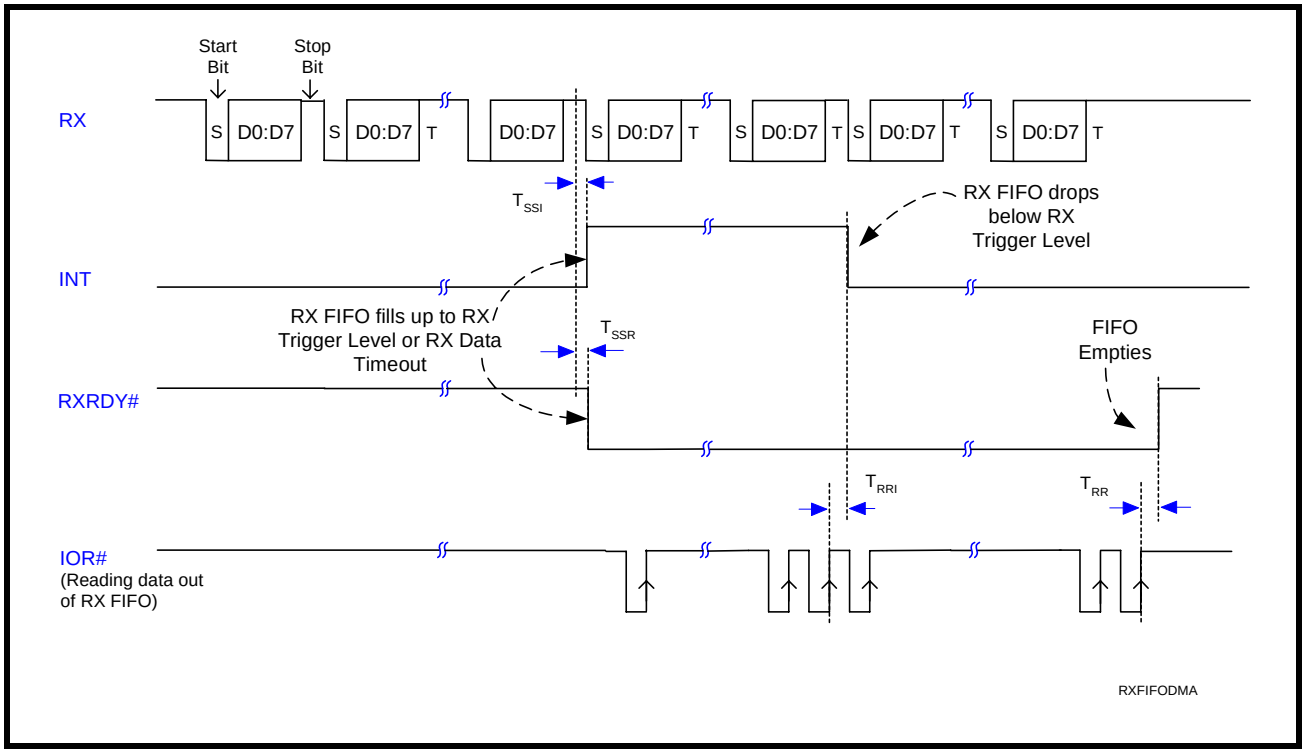


FIGURE 22. TRANSMIT READY & INTERRUPT TIMING [FIFO MODE, DMA MODE DISABLED] FOR CHANNELS A & B

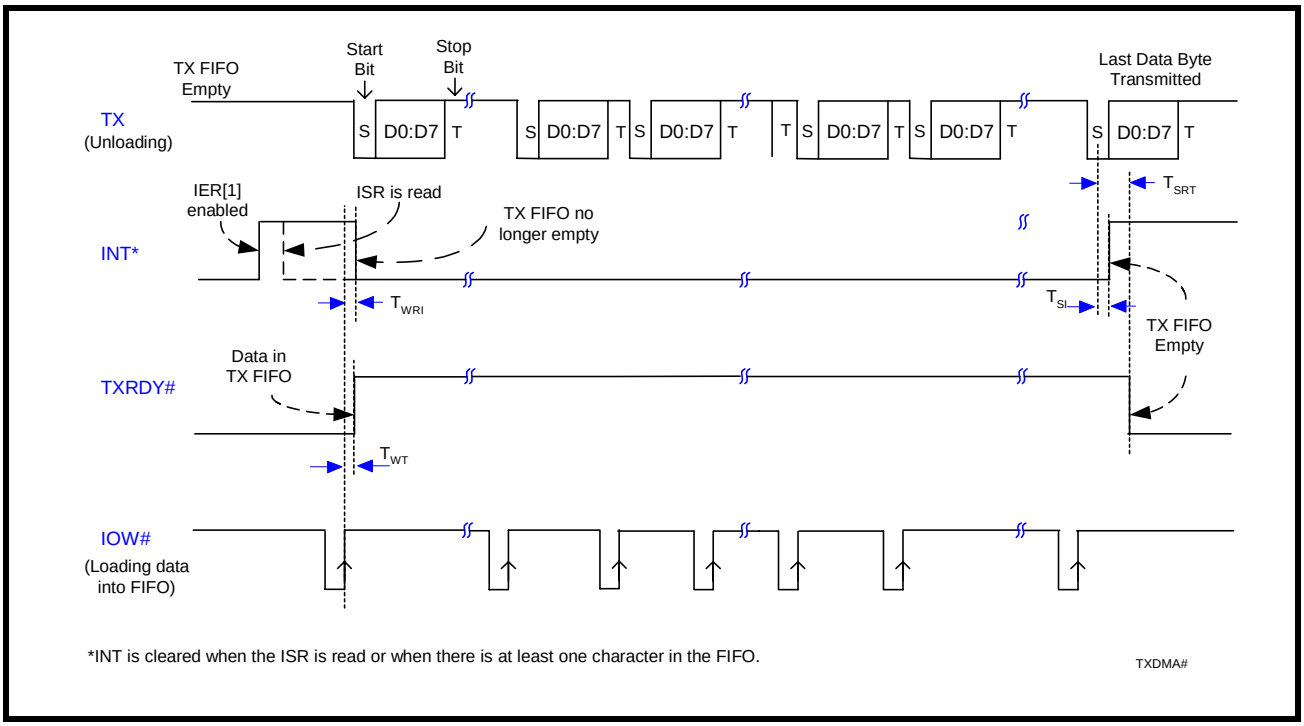
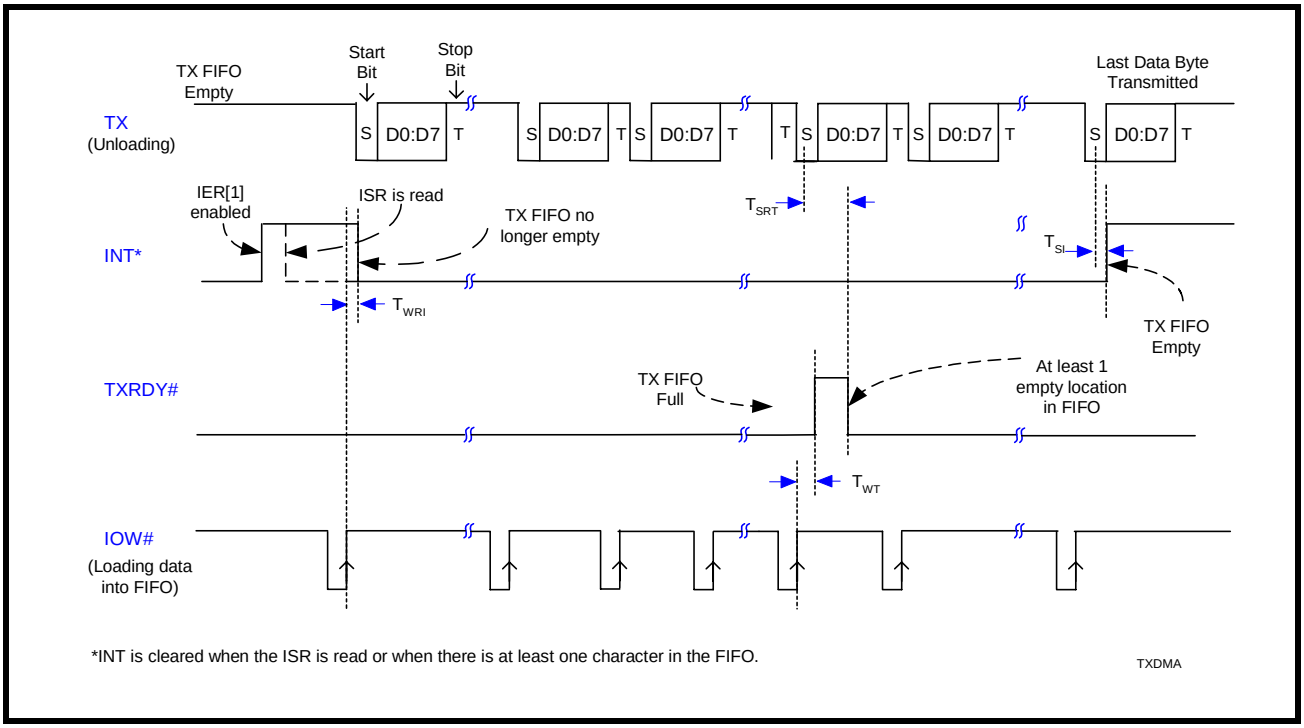
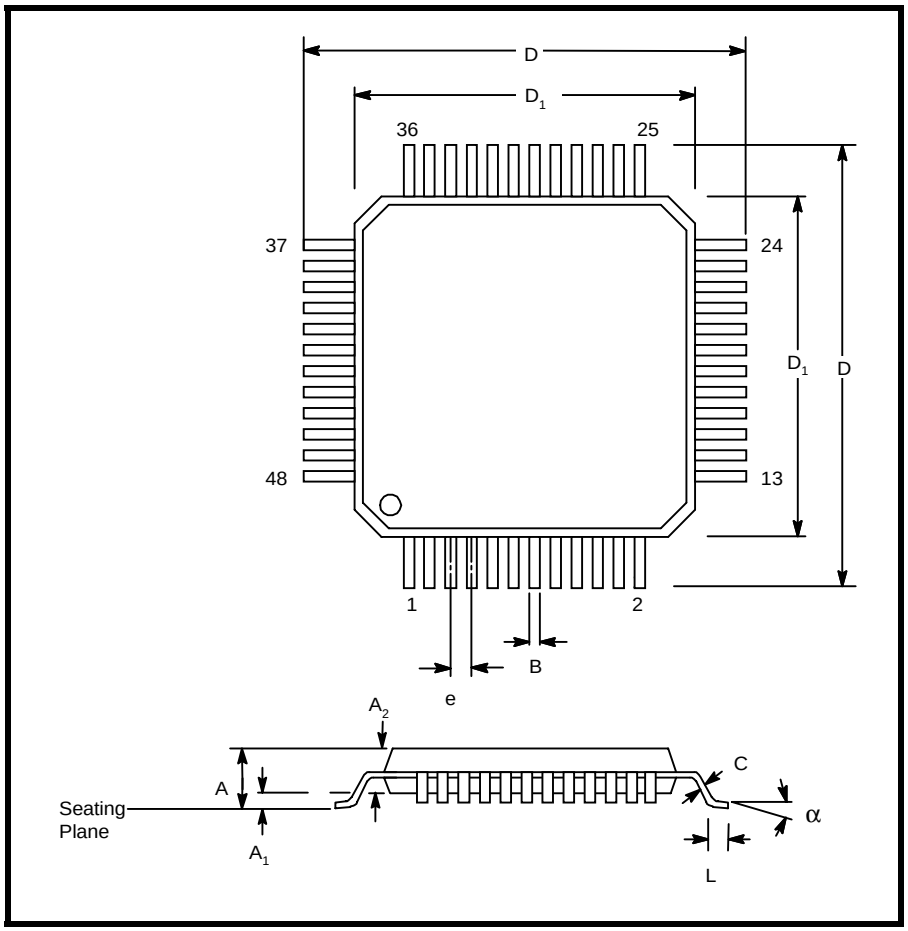


FIGURE 23. TRANSMIT READY & INTERRUPT TIMING [FIFO MODE, DMA MODE ENABLED] FOR CHANNELS A & B



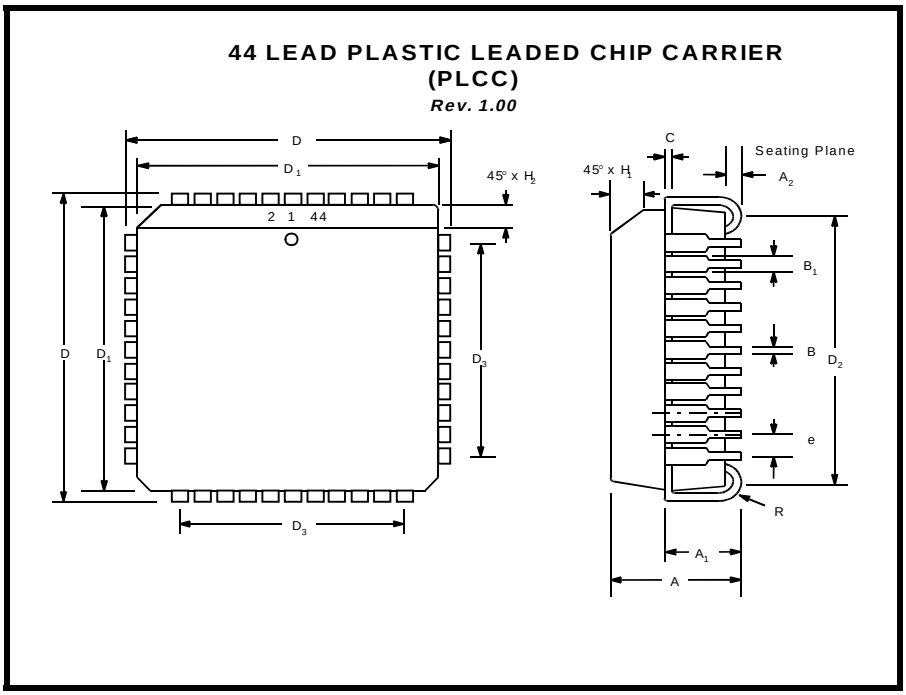
PACKAGE DIMENSIONS (48 PIN TQFP - 7 X 7 X 1 mm)



Note: The control dimension is the millimeter column

SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.039	0.047	1.00	1.20
A1	0.002	0.006	0.05	0.15
A2	0.037	0.041	0.95	1.05
B	0.007	0.011	0.17	0.27
C	0.004	0.008	0.09	0.20
D	0.346	0.362	8.80	9.20
D1	0.272	0.280	6.90	7.10
e	0.020 BSC		0.50 BSC	
L	0.018	0.030	0.45	0.75
α	0°	7°	0°	7°

PACKAGE DIMENSIONS (44 PIN PLCC)



Note: The control dimension is the millimeter column

SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.165	0.180	4.19	4.57
A1	0.090	0.120	2.29	3.05
A2	0.020	---	0.51	---
B	0.013	0.021	0.33	0.53
B_1	0.026	0.032	0.66	0.81
C	0.008	0.013	0.19	0.32
D	0.685	0.695	17.40	17.65
D1	0.650	0.656	16.51	16.66
D_2	0.590	0.630	14.99	16.00
D_3	0.500 typ.		12.70 typ.	
e	0.050 BSC		1.27 BSC	
H_1	0.042	0.056	1.07	1.42
H_2	0.042	0.048	1.07	1.22
R	0.025	0.045	0.64	1.14

REVISION HISTORY

Date	Revision	Description
November 2002	P1.0.0	Preliminary Datasheet.
March 2003	P1.0.1	Updated AC Electrical Characteristics. Updated register set with enhanced features.
May 2003	P1.0.2	Added patent number to first page.
June 2003	P1.0.3	Added Device Status to Ordering Information.
July 2003	P1.0.4	Updated AC Electrical Characteristics.
September 2003	1.0.0	Final Production Release. Updated 5V tolerance information.

Datasheet September 2003.

Send your UART technical inquiry with technical details to hotline: uarttechsupport@exar.com.