

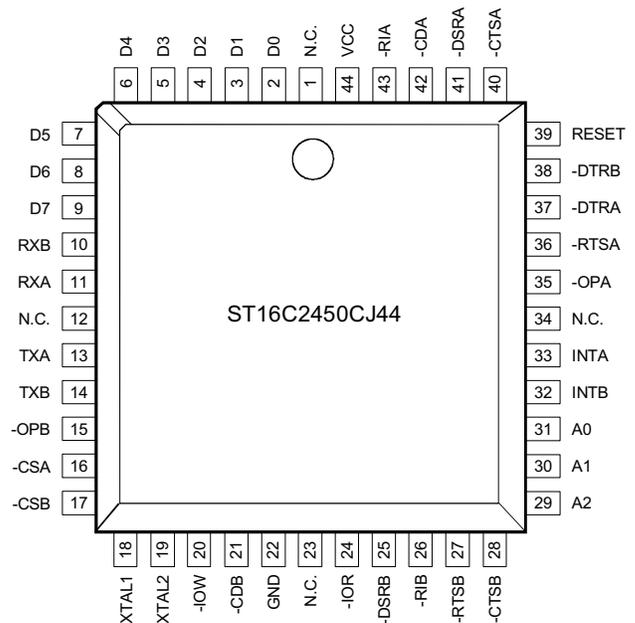
### DESCRIPTION

The ST16C2450 (2450) is a dual universal asynchronous receiver and transmitter (UART). The ST16C2450 is an improved version of the NS16450 UART with higher operating speed and lower access time. The 2450 provides enhanced UART functions with a modem control interface, and data rates up to 1.5Mbps. Onboard status registers provide the user with error indications and operational status. System interrupts and modem control features may be tailored by external software to meet specific user requirements. An internal loop-back capability allows onboard diagnostics. Independent programmable baud rate generators are provided to select transmit and receive clock rates from 50 Bps to 1.5 Mbps. The Baud rate generator can be configured for either crystal or external clock input. The 2450 is available in a 40-pin plastic-DIP, 44-pin PLCC, and 48-pin TQFP packages. The 2450 is fabricated in an advanced CMOS process to achieve low drain power and high speed requirements.

### FEATURES

- Pin and functionally compatible to ST16C2550/ Software compatible with INS8250
- 1.5 Mbps transmit/receive operation (24MHz Max.)
- Independent transmit and receive UART control
- Four selectable Receive FIFO interrupt trigger levels
- Modem control signals (-CTS, -RTS, -DSR, -DTR, -RI, -CD)
- Programmable character lengths (5, 6, 7, 8) with Even, odd, or no parity
- Status report register
- Crystal or external clock input
- 460.8 Kbps transmit/receive operation with 7.3728 MHz crystal or external clock source
- TTL compatible inputs, outputs

### PLCC Package



### ORDERING INFORMATION

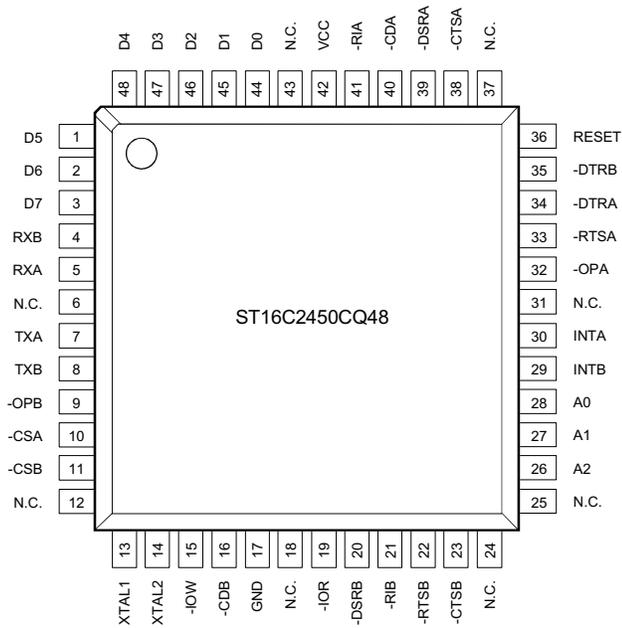
Part number	Pins	Package	Operating temperature
ST16C2450CP40	40	PDIP	0° C to + 70° C
ST16C2450CJ44	44	PLCC	0° C to + 70° C
ST16C2450CQ48	48	TQFP	0° C to + 70° C
ST16C2450IP40	40	PDIP	-40° C to + 85° C
ST16C2450IJ44	44	PLCC	-40° C to + 85° C
ST16C2450IQ48	48	TQFP	-40° C to + 85° C

# ST16C2450



Figure 1, Package Descriptions, 40 pin, 48 pin ST16C2450

## 48 Pin TQFP Package



## 40 Pin DIP Package

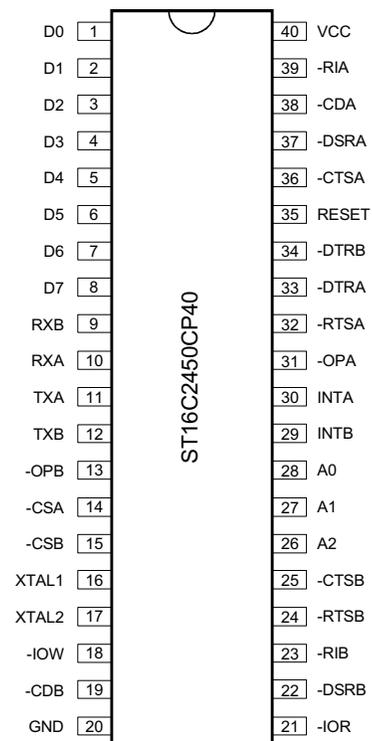
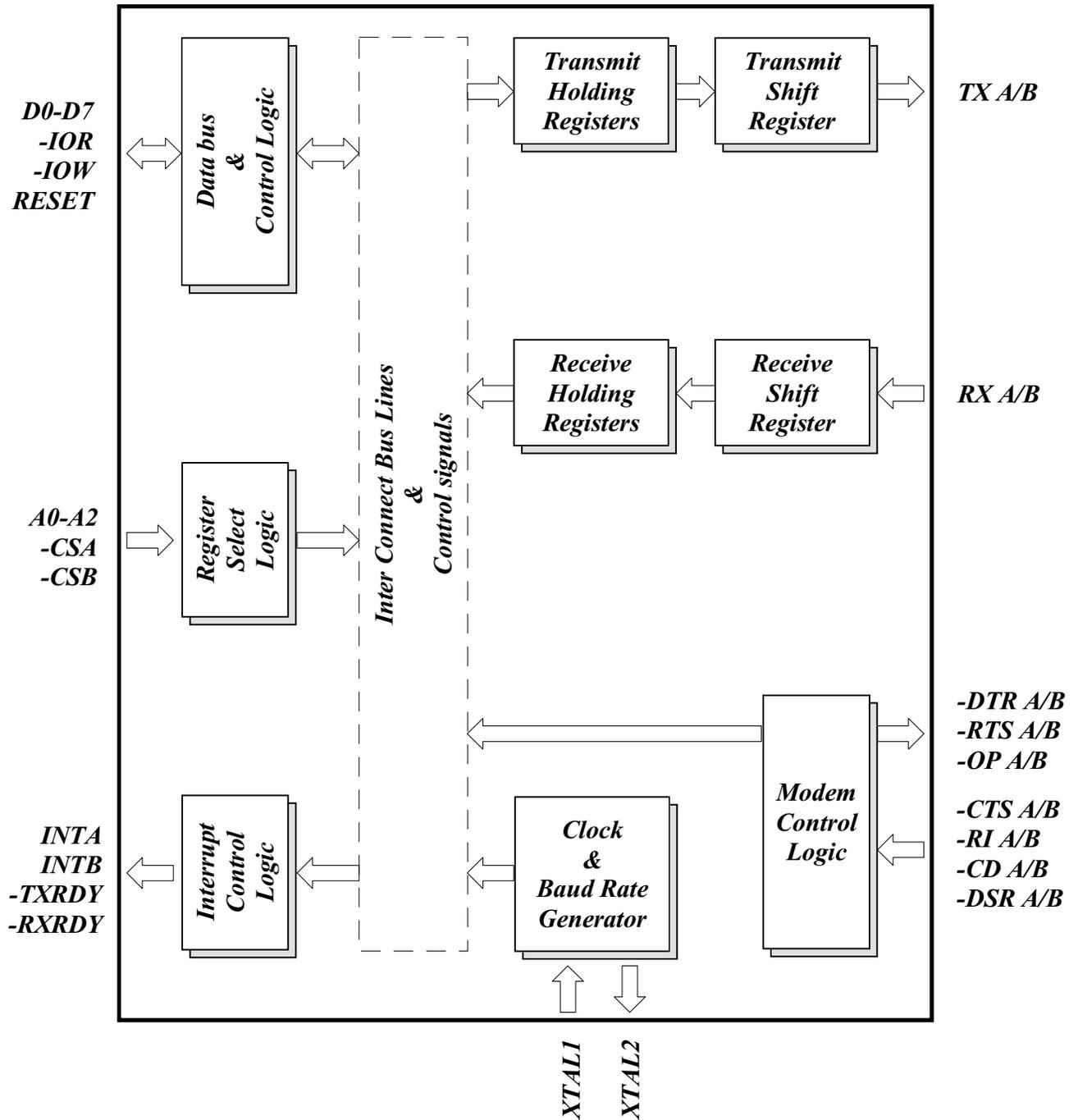


Figure 2, Block Diagram



## SYMBOL DESCRIPTION

Symbol	Pin			Signal type	Pin Description
	40	44	48		
A0	28	31	28	I	Address-0 Select Bit. - Internal register address selection.
A1	27	30	27	I	Address-1 Select Bit. - Internal register address selection.
A2	26	29	26	I	Address-2 Select Bit. - Internal register address selection.
-CS A-B	14,15	16,17	10,11	I	Chip Select A, B (active low) - This function is associated with individual channels, A through B. These pins enable data transfers between the user CPU and the 2450 for the channel(s) addressed. Individual UART sections (A, B) are addressed by providing a logic 0 on the respective -CS A-B pin.
D0-D7	1-8	2-9	44-48 1-3	I/O	Data Bus (Bi-directional) - These pins are the eight bit, three state data bus for transferring information to or from the controlling CPU. D0 is the least significant bit and the first data bit in a transmit or receive serial data stream.
GND	20	22	17	Pwr	Signal and power ground.
INT A-B	30,29	33,32	30,29	O	Interrupt A, B (three state) - This function is associated with individual channel interrupts, INT A-B. INT A-B are enabled when MCR bit-3 is set to a logic 1, interrupts are enabled in the interrupt enable register (IER), and when an interrupt condition exists. Interrupt conditions include: receiver errors, available receiver buffer data, transmit buffer empty, or when a modem status flag is detected.
-IOR	21	24	19	I	Read strobe. (active low Strobe) - A logic 0 transition on this pin will load the contents of an Internal register defined by address bits A0-A2 onto the 2450 data bus (D0-D7) for access by an external CPU.
-IOW	18	20	15	I	Write strobe. (active low strobe) - A logic 0 transition on this pin will transfer the contents of the data bus (D0-D7) from the external CPU to an internal register that is defined by address bits A0-A2.
-OP2 A-B	31,13	35,15	32,9	O	Output -2 (User Defined). - This function is associated with individual channels, A through B. The state at these pin(s) are defined by the user and through the software setting of

## SYMBOL DESCRIPTION

Symbol	Pin			Signal type	Pin Description
	40	44	48		
RESET	35	39	36	I	MCR register bit-3. INT A-B are set to the active mode and OP2 to a logic 0 when MCR-3 is set to a logic 1. INT A-B are set to the three state mode and OP2 to a logic 1 when MCR-3 is set to a logic 0. See bit-3, Modem Control Register (MCR bit-3).  Reset. (active high) - A logic 1 on this pin will reset the internal registers and all the outputs. The UART transmitter output and the receiver input will be disabled during reset time. (See ST16C2450 External Reset Conditions for initialization details.)
VCC	40	44	42	Pwr	Power supply input.
XTAL1	16	18	13	I	Crystal or External Clock Input - Functions as a crystal input or as an external clock input. A crystal can be connected between this pin and XTAL2 to form an internal oscillator circuit. This configuration requires an external 1 MW resistor between the XTAL1 and XTAL2 pins. Alternatively, an external clock can be connected to this pin to provide custom data rates (see Baud Rate Generator Programming).
XTAL2	17	19	14	O	Output of the Crystal Oscillator or Buffered Clock - (See also XTAL1). Crystal oscillator output or buffered clock output. Should be left open if an external clock is connected to XTAL1.
-CD A-B	38,19	42,21	40,16	I	Carrier Detect (active low) - These inputs are associated with individual UART channels A through B. A logic 0 on this pin indicates that a carrier has been detected by the modem for that channel.
-CTS A-B	36,25	40,28	38,23	I	Clear to Send (active low) - These inputs are associated with individual UART channels, A through B. A logic 0 on the -CTS pin indicates the modem or data set is ready to accept transmit data from the 2450. Status can be tested by reading MSR bit-4. This pin has no effect on the UART's transmit or receive operation.
-DSR A-B	37,22	41,25	39,20	I	Data Set Ready (active low) - These inputs are associated with individual UART channels, A through B. A logic 0 on

## SYMBOL DESCRIPTION

Symbol	Pin			Signal type	Pin Description
	40	44	48		
-DTR A-B	33,34	37,38	34,35	O	<p>this pin indicates the modem or data set is powered-on and is ready for data exchange with the UART. This pin has no effect on the UART's transmit or receive operation.</p> <p>Data Terminal Ready (active low) - These outputs are associated with individual UART channels, A through B. A logic 0 on this pin indicates that the 2450 is powered-on and ready. This pin can be controlled via the modem control register. Writing a logic 1 to MCR bit-0 will set the -DTR output to logic 0, enabling the modem. This pin will be a logic 1 after writing a logic 0 to MCR bit-0, or after a reset. This pin has no effect on the UART's transmit or receive operation.</p>
-RI A-B	39,23	43,26	41,21	I	<p>Ring Indicator (active low) - These inputs are associated with individual UART channels, A through B. A logic 0 on this pin indicates the modem has received a ringing signal from the telephone line. A logic 1 transition on this input pin will generate an interrupt.</p>
-RTS A-B	32,24	36,27	33,22	O	<p>Request to Send (active low)- These outputs are associated with individual UART channels, A through B. A logic 0 on the -RTS pin indicates the transmitter has data ready and waiting to send. Writing a logic 1 in the modem control register (MCR bit-1) will set this pin to a logic 0 indicating data is available. After a reset this pin will be set to a logic 1. This pin has no effect on the UART's transmit or receive operation.</p>
RX A-B	10,9	11,10	5,4	I	<p>Receive Data (A-B) - These inputs are associated with individual serial channel data to the 2450 receive input circuits, A-B. The RX signal will be a logic 1 during reset, idle (no data), or when the transmitter is disabled. During the local loop-back mode, the RX input pin is disabled and TX data is connected to the UART RX Input, internally.</p>
TX A-B	11,12	13,14	7,8	O	<p>Transmit Data (A-B) - These outputs are associated with individual serial transmit channel data from the 2450. The TX signal will be a logic 1 during reset, idle (no data), or when the transmitter is disabled. During the local loop-back mode, the TX output pin is disabled and TX data is internally connected to the UART RX Input.</p>

## GENERAL DESCRIPTION

The 2450 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 stops bits to the transmit data to form a data character (character orientated protocol). Data integrity is insured 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 2450 represents such an integration with greatly enhanced features. The 2450 is fabricated with an advanced CMOS process.

The 2450 is designed to work with high speed modems and shared network environments, that require fast data processing time. Increased performance is realized in the 2450 by the transmit and receive FIFO's. This allows the external processor to handle more networking tasks within a given time. The 2450 is capable of operation to 1.5Mbps with a 24 MHz. With a crystal or external clock input of 7.3728 MHz the user can select data rates up to 460.8 Kbps.

## FUNCTIONAL DESCRIPTIONS

### UART A-B Functions

The UART provides the user with the capability to Bi-directionally transfer information between an external CPU, the 2450 package, and an external serial device. A logic 0 on chip select pins -CSA and/or -CSB allows the user to configure, send data, and/or receive data via UART channels A-B. Individual channel select functions are shown in Table 2 below.

Table 2, SERIAL PORT SELECTION GUIDE

CHIP SELECT	Function
-CS A-B = 1s	None
-CS A = 0	UART CHANNEL A
-CS B = 0	UART CHANNEL B

### Internal Registers

The 2450 provides two sets of internal registers (A and B) consisting of 11 registers each for monitoring and controlling the functions of each channel of the UART. These registers are shown in Table 3 below. The UART registers function as data holding registers (THR/RHR), interrupt status and control registers (IER/ISR), line status and control registers (LCR/LSR), modem status and control registers (MCR/MSR), programmable data rate (clock) control registers (DLL/DLM), and a user assessable scratchpad register (SPR).

**Table 3, INTERNAL REGISTER DECODE**

A2	A1	A0	READ MODE	WRITE MODE
<b>General Register Set (THR/RHR, IER/ISR, MCR/MSR, LCR/LSR, SPR): Note 1*</b>				
0	0	0	Receive Holding Register	Transmit Holding Register
0	0	1		Interrupt Enable Register
0	1	0	Interrupt Status Register	
0	1	1		Line Control Register
1	0	0		Modem Control Register
1	0	1	Line Status Register	
1	1	0	Modem Status Register	
1	1	1	Scratchpad Register	Scratchpad Register
<b>Baud Rate Register Set (DLL/DLM): Note *2</b>				
0	0	0	LSB of Divisor Latch	LSB of Divisor Latch
0	0	1	MSB of Divisor Latch	MSB of Divisor Latch

Note 1\* The General Register set is accessible only when CS A/B is a logic 0.

Note 2\* The Baud Rate register set is accessible only when CS A/B is a logic 0 and LCR bit-7 is a logic 1.

### Programmable Baud Rate Generator

The 2450 supports high speed modem technologies that have increased input data rates by employing data compression schemes. For example a 33.6Kbps modem that employs data compression may require a 115.2Kbps input data rate. A 128.0Kbps ISDN modem that supports data compression may need an input data rate of 460.8Kbps. The 2450 can support a standard data rate of 921.6Kbps.

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 accepting an input clock up to 24 MHz, as required for supporting a 1.5Mbps data rate. The 2450 can be configured for internal or external clock operation. For internal clock oscillator operation, an industry standard microprocessor crystal (parallel resonant/ 22-33 pF load) is connected externally between the XTAL1 and XTAL2 pins, with an external

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. (see Baud Rate Generator Programming).

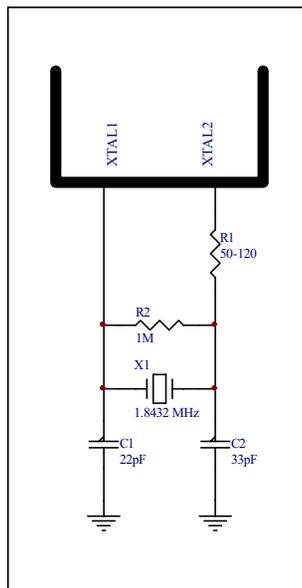
The generator divides the input 16X clock by any divisor from 1 to  $2^{16} - 1$ . The 2450 divides the basic external clock by 16. The basic 16X clock provides table rates to support standard and custom applications using the same system design. The rate table is configured via the DLL and DLM internal register functions. Customized Baud Rates can be achieved by selecting the proper divisor values for the MSB and LSB sections of baud rate generator.

Programming the Baud Rate Generator Registers DLM (MSB) and DLL (LSB) provides a user capability for selecting the desired final baud rate. The example in Table 4 below, shows the selectable baud rate table available when using a 1.8432 MHz external clock input.

Table 4, BAUD RATE GENERATOR PROGRAMMING TABLE (1.8432 MHz CLOCK):

Output Baud Rate	Output 16 x Clock Divisor (Decimal)	User 16 x Clock Divisor (HEX)	DLM Program Value (HEX)	DLL Program Value (HEX)
50	2304	900	09	00
150	768	300	03	00
300	384	180	01	80
600	192	C0	00	C0
1200	96	60	00	60
2400	48	30	00	30
3600	32	20	00	20
4800	24	18	00	18
7200	16	10	00	10
9600	12	0C	00	0C
19.2k	6	06	00	06
38.4k	3	03	00	03
57.6k	2	02	00	02
115.2k	1	01	00	01

### Crystal oscillator Connection



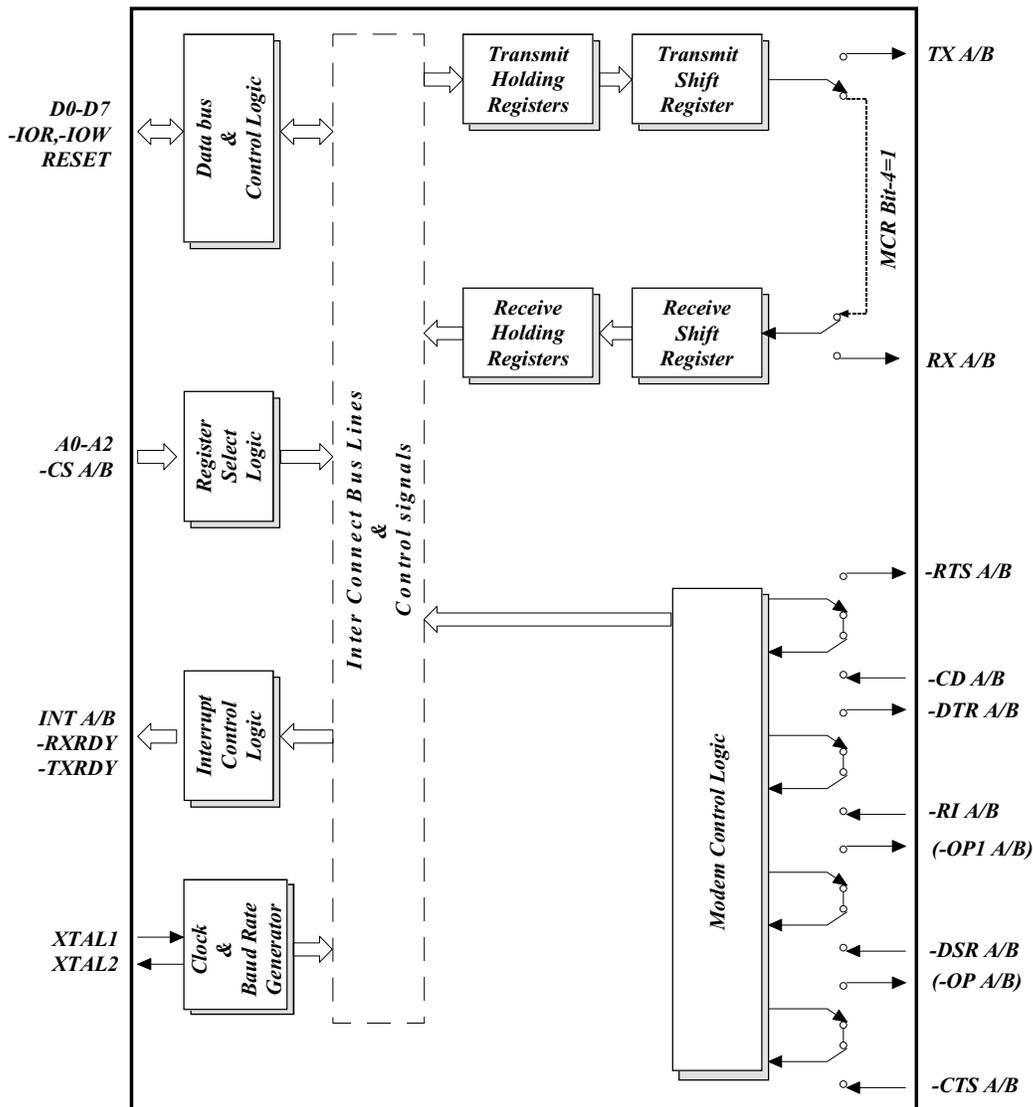
### Loop-back Mode

The internal loop-back capability allows onboard diagnostics. In the loop-back mode the normal modem interface pins are disconnected and reconfigured for loop-back internally. MCR register bits 0-3 are used for controlling loop-back diagnostic testing. In the loop-back mode INT enable and MCR bit-2 in the MCR register (bits 3/2) control the modem -RI and -CD inputs respectively. MCR signals -DTR and -RTS (bits 0-1) are used to control the modem -CTS and -DSR inputs respectively. The transmitter output (TX) and the receiver input (RX) are disconnected from their associated interface pins, and instead are connected together internally (See Figure 4). The -CTS, -DSR, -CD, and -RI are disconnected from their normal modem control inputs pins, and instead are connected internally to -DTR, -RTS, INT enable and MCR bit-2. Loop-back test data is entered into the transmit holding register via the user data bus interface, D0-D7. The transmit UART serializes the data and passes the

serial data to the receive UART via the internal loop-back connection. The receive UART converts the serial data back into parallel data that is then made available at the user data interface, D0-D7. The user optionally compares the received data to the initial transmitted data for verifying error free operation of the UART TX/RX circuits.

In this mode, the receiver and transmitter interrupts are fully operational. The Modem Control Interrupts are also operational. However, the interrupts can only be read using lower four bits of the Modem Control Register (MCR bits 0-3) instead of the four Modem Status Register bits 4-7. The interrupts are still controlled by the IER.

**Figure 4, INTERNAL LOOP-BACK MODE DIAGRAM**



## REGISTER FUNCTIONAL DESCRIPTIONS

The following table delineates the assigned bit functions for the twelve 2450 internal registers. The assigned bit functions are more fully defined in the following paragraphs.

**Table 5, ST16C2450 INTERNAL REGISTERS**

A2	A1	A0	Register [Default] Note 3*	BIT-7	BIT-6	BIT-5	BIT-4	BIT-3	BIT-2	BIT-1	BIT-0
<b>General Register Set: Note 1*</b>											
0	0	0	RHR [XX]	bit-7	bit-6	bit-5	bit-4	bit-3	bit-2	bit-1	bit-0
0	0	0	THR [XX]	bit-7	bit-6	bit-5	bit-4	bit-3	bit-2	bit-1	bit-0
0	0	1	IER [00]	0	0	0	0	Modem Status Interrupt	Receive Line Status interrupt	Transmit Holding Register interrupt	Receive Holding Register
0	1	0	ISR [01]	0	0	0	0	INT priority bit-2	INT priority bit-1	INT priority bit-0	INT status
0	1	1	LCR [00]	divisor latch enable	set break	set parity	even parity	parity enable	stop bits	word length bit-1	word length bit-0
1	0	0	MCR [00]	0	0	0	loop back	-OP2/ INT enable	-OP1	-RTS	-DTR
1	0	1	LSR [60]	0	THR & TSR empty	THR. empty	break interrupt	framing error	parity error	overrun error	receive data ready
1	1	0	MSR [X0]	CD	RI	DSR	CTS	delta -CD	delta -RI	delta -DSR	delta -CTS
1	1	1	SPR [FF]	bit-7	bit-6	bit-5	bit-4	bit-3	bit-2	bit-1	bit-0
<b>Special Register Set: Note *2</b>											
0	0	0	DLL [XX]	bit-7	bit-6	bit-5	bit-4	bit-3	bit-2	bit-1	bit-0
0	0	1	DLM [XX]	bit-15	bit-14	bit-13	bit-12	bit-11	bit-10	bit-9	bit-8

Note 1\* The General Register set is accessible only when CS A/B is a logic 0.

Note 2\* The Baud Rate register set is accessible only when CS A/B is a logic 0 and LCR bit-7 is a logic 1.

Note 3\* The value between the square brackets represents the register's initialized HEX value, X = N/A.

## Transmit (THR) and Receive (RHR) Holding Registers

The serial transmitter section consists of an 8-bit Transmit Hold Register (THR) and Transmit Shift Register (TSR). The status of the THR is provided in the Line Status Register (LSR). Writing to the THR transfers the contents of the data bus (D7-D0) to the TSR and UART via the THR, providing that the THR is empty. The THR empty flag in the LSR register will be set to a logic 1 when the transmitter is empty or when data is transferred to the TSR. Note that a write operation can be performed when the transmit holding register empty flag is set.

The serial receive section also contains an 8-bit Receive Holding Register, RHR and a Receive Serial Shift Register (RSR). Receive data is removed from the 2450 by reading the RHR register. The receive section provides a mechanism to prevent false starts. On the falling edge of a start or false start bit, an internal receiver counter starts counting clocks at the 16x clock rate. After 7 1/2 clocks the start bit time should be shifted to 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. Receiver status codes will be posted in the LSR.

## Interrupt Enable Register (IER)

The Interrupt Enable Register (IER) masks the interrupts from receiver ready, transmitter empty, line status and modem status registers. These interrupts would normally be seen on the INT A-B output pins.

### IER BIT-0:

This interrupt will be issued when the RHR has data or is cleared when the RHR is empty.

Logic 0 = Disable the receiver ready (ISR level 2, RXRDY) interrupt. (normal default condition)

Logic 1 = Enable the RXRDY (ISR level 2) interrupt.

### IER BIT-1:

This interrupt will be issued whenever the THR is empty and is associated with bit-5 in the LSR register.

Logic 0 = Disable the Transmit Holding Register Empty (TXRDY) interrupt. (normal default condition)

Logic 1 = Enable the TXRDY interrupt.

### IER BIT-2:

This interrupt will be issued whenever an receive data error condition exists as reflected in LSR bits 1-4.

Logic 0 = Disable the receiver line status interrupt. (normal default condition)

Logic 1 = Enable the receiver line status interrupt.

### IER BIT-3:

This interrupt will be issued whenever there is a modem status change as reflected in MSR bits 0-3.

Logic 0 = Disable the modem status register interrupt. (normal default condition)

Logic 1 = Enable the modem status register interrupt.

### IER BIT 4-7:

Not Used - initialized to a logic 0.

## Interrupt Status Register (ISR)

The 2450 provides four levels of prioritized interrupts to minimize external software interaction. The Interrupt Status Register (ISR) provides the user with four interrupt status bits. Performing a read cycle on the ISR will provide the user with the highest pending interrupt level to be serviced. No other interrupts are acknowledged until the pending interrupt is serviced. Whenever the interrupt status register is read, the interrupt status is cleared. However it should be noted that only the current pending interrupt is cleared by the read. A lower level interrupt may be seen after rereading the interrupt status bits. The Interrupt Source Table 6 (below) shows the data values (bits 0-3) for the four prioritized interrupt levels and the interrupt sources associated with each of these interrupt levels:

**Table 6, INTERRUPT SOURCE TABLE**

Priority Level	[ ISR BITS ]				Source of the interrupt
	Bit-3	Bit-2	Bit-1	Bit-0	
1	0	1	1	0	LSR (Receiver Line Status Register)
2	0	1	0	0	RXRDY (Received Data Ready)
3	0	0	1	0	TXRDY (Transmitter Holding Register Empty)
4	0	0	0	0	MSR (Modem Status Register)

**ISR BIT-0:**

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. (normal default condition)

**ISR BIT 1-3: (logic 0 or cleared is the default condition)**

These bits indicate the source for a pending interrupt at interrupt priority levels 1, 2, and 3 (See Interrupt Source Table).

**ISR BIT 4-7: (logic 0 or cleared is the default condition)**

Not Used - initialized to a logic 0.

**Line Control Register (LCR)**

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

**LCR BIT 0-1: (logic 0 or cleared is the default condition)**

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

BIT-1	BIT-0	Word length
0	0	5
0	1	6
1	0	7
1	1	8

**LCR BIT-2: (logic 0 or cleared is the default condition)**

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
1	5	1-1/2
1	6,7,8	2

**LCR BIT-3:**

Parity or no parity can be selected via this bit.

Logic 0 = No parity. (normal default condition)

Logic 1 = A parity bit is generated during the transmission, receiver checks the data and parity for transmission errors.

**LCR BIT-4:**

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 data. The receiver must be programmed to check the same format. (normal default condition)

Logic 1 = EVEN Parity is generated by forcing an even the number of logic 1's in the transmitted. The receiver must be programmed to check the same format.

**LCR BIT-5:**

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

LCR BIT-5 = logic 0, parity is not forced. (normal default condition)

LCR BIT-5 = logic 1 and LCR BIT-4 = logic 0, parity bit is forced to a logical 1 for the transmit and receive data.

LCR BIT-5 = logic 1 and LCR BIT-4 = logic 1, parity bit is forced to a logical 0 for the transmit and receive data.

LCR Bit-3	LCR Bit-4	LCR Bit-5	Parity selection
0	X	X	No parity
1	0	0	Odd parity
1	1	0	Even parity
1	0	1	Force parity "1"
1	1	1	Forced parity "0"

#### LCR BIT-6:

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

Logic 0 = No TX break condition. (normal default condition)

Logic 1 = Forces the transmitter output (TX) to a logic 0 for alerting the remote receiver to a line break condition.

#### LCR BIT-7:

The internal baud rate counter latch and Enhance Feature mode enable.

Logic 0 = Divisor latch disabled. (normal default condition)

Logic 1 = Divisor latch and enhanced feature register enabled.

### Modem Control Register (MCR)

This register controls the interface with the modem or a peripheral device.

#### MCR BIT-0:

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

Logic 1 = Force -DTR output to a logic 0.

#### MCR BIT-1:

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

Logic 1 = Force -RTS output to a logic 0.

#### MCR BIT-2:

This bit is used in the Loop-back mode only. In the loop-back mode this bit is use to write the state of the modem -RI interface signal.

MCR BIT-3: (Used to control the modem -CD signal in the loop-back mode.)

Logic 0 = Forces INT (A-B) outputs to the three state mode and sets -OP2 to a logic 1. (normal default condition)

In the Loop-back mode, sets -CD internally to a logic 1.

Logic 1 = Forces the INT (A-B) outputs to the active mode and sets -OP2 to a logic 0.

In the Loop-back mode, sets -CD internally to a logic 0.

#### MCR BIT-4:

Enable the local loop-back mode (diagnostics). In this mode the transmitter output TX and the receiver input RX, -CTS, -DSR, -CD, and -RI are disconnected from the 2450 I/O pins. Internally the modem data and control pins are connected into a loop-back data configuration. In this mode, the receiver and transmitter interrupts remain fully operational. The Modem Control Interrupts are also operational, but the interrupts sources are switched to the lower four bits of the Modem Control. Interrupts continue to be controlled by the IER register.

Logic 0 = Disable loop-back mode. (normal default condition)

Logic 1 = Enable local loop-back mode (diagnostics).

#### MCR BIT 5-7:

Not Used - initialized to a logic 0.

### Line Status Register (LSR)

This register provides the status of data transfers between. the 2450 and the CPU.

#### LSR BIT-0:

Logic 0 = No data in receive holding register or FIFO. (normal default condition)

Logic 1 = Data has been received and is saved in the receive holding register or FIFO.

**LSR BIT-1:**

Logic 0 = No overrun error. (normal default condition)  
Logic 1 = Overrun error. A data overrun error 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 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 BIT-2:**

Logic 0 = No parity error. (normal default condition)  
Logic 1 = Parity error. The receive character does not have correct parity information and is suspect. In the FIFO mode, this error is associated with the character at the top of the FIFO.

**LSR BIT-3:**

Logic 0 = No framing error. (normal default condition)  
Logic 1 = Framing error. The receive character did not have a valid stop bit(s). In the FIFO mode this error is associated with the character at the top of the FIFO.

**LSR BIT-4:**

Logic 0 = No break condition. (normal default condition)  
Logic 1 = The receiver received a break signal (RX was a logic 0 for one character frame time). In the FIFO mode, only one break character is loaded into the FIFO.

**LSR BIT-5:**

This bit indicates that the 2450 is ready to accept new characters for transmission. This bit causes the 2450 to issue an interrupt to the CPU when the transmit holding register is empty and the interrupt enable is set.

Logic 0 = Transmit holding register is not empty. (normal default condition)

Logic 1 = Transmit holding register (or FIFO) is empty. When this bit is a logic 1, the CPU can load a maximum of 16 (FIFO's enabled) new characters into the Transmit Holding Register for transmission.

**LSR BIT-6:**

Logic 0 = Transmitter holding and shift registers are full.

Logic 1 = Transmitter holding and shift registers are empty. In FIFO mode this bit is set to a logic 1 whenever the transmit FIFO and transmit shift register are empty. (normal default condition)

**LSR BIT-7:**

Not Used - initialized to a logic 0.

**Modem Status Register (MSR)**

This register provides the current state of the control interface signals from the modem, or other peripheral device that the 2450 is connected to. Four bits of this register are used to indicate the changed information. These bits are set to a logic 1 whenever a control input from the modem changes state. These bits are set to a logic 0 whenever the CPU reads this register.

**MSR BIT-0:**

Logic 0 = No -CTS Change (normal default condition)  
Logic 1 = The -CTS input to the 2450 has changed state since the last time it was read. A modem Status Interrupt will be generated.

**MSR BIT-1:**

Logic 0 = No -DSR Change. (normal default condition)  
Logic 1 = The -DSR input to the 2450 has changed state since the last time it was read. A modem Status Interrupt will be generated.

**MSR BIT-2:**

Logic 0 = No -RI Change. (normal default condition)  
Logic 1 = The -RI input to the 2450 has changed from a logic 0 to a logic 1. A modem Status Interrupt will be generated.

**MSR BIT-3:**

Logic 0 = No -CD Change. (normal default condition)  
Logic 1 = Indicates that the -CD input to the has changed state since the last time it was read. A modem Status Interrupt will be generated.

**MSR BIT-4:**

During normal operation, this bit is the compliment of the -CTS input. During the loop-back mode this bit is equivalent to MCR bit-1 (-RTS).

### MSR BIT-5:

During normal operation, this bit is the compliment of the -DSR input. During the loop-back mode, this bit is equivalent to MCR bit-0 (-DTR).

### MSR BIT-6:

During normal operation, this bit is the compliment of the -RI input. Reading this bit in the loop-back mode produces the state of MCR bit-2 (-OP1)

### MSR BIT-7:

During normal operation, this bit is the compliment of the -CD input. Reading this bit in the loop-back mode produces the state of MCR bit-3 (-OP2).

Note: Whenever any MSR bit 0-3: is set to logic "1", a MODEM Status Interrupt will be generated.

### Scratchpad Register (SPR)

The ST16C2450 provides a temporary data register to store 8 bits of user information.

### ST16C2450 EXTERNAL RESET CONDITION

REGISTERS	RESET STATE
IER	IER BITS 0-7=0
ISR	ISR BIT-0=1, ISR BITS 1-7=0
LCR	LCR BITS 0-7=0
MCR	MCR BITS 0-7=0
LSR	LSR BITS 0-4=0, LSR BITS 5-6=1 LSR, BIT 7=0
MSR	MSR BITS 0-3=0, MSR BITS 4-7=input signals

SIGNALS	RESET STATE
TX	High
-OP2	High
-RTS	High
-DTR	High
INT	Three state mode

## AC ELECTRICAL CHARACTERISTICS

$T_A=0^\circ - 70^\circ\text{C}$  ( $-40^\circ - +85^\circ\text{C}$  for Industrial grade packages),  $V_{CC}=3.3 - 5.0\text{ V} \pm 10\%$  unless otherwise specified.

Symbol	Parameter	Limits 3.3		Limits 5.0		Units	Conditions
		Min	Max	Min	Max		
$T_{1w}, T_{2w}$	Clock pulse duration	17		17		ns	
$T_{3w}$	Oscillator/Clock frequency		8		24	MHz	
$T_{6s}$	Address setup time	5		0		ns	
$T_{7d}$	-IOR delay from chip select	10		10		ns	
$T_{7w}$	-IOR strobe width	35		25		ns	
$T_{7h}$	Chip select hold time from -IOR	0		0		ns	
$T_{9d}$	Read cycle delay	40		30		ns	
$T_{12d}$	Delay from -IOR to data		35		25	ns	
$T_{12h}$	Data disable time		25		15	ns	
$T_{13d}$	-IOW delay from chip select	10		10		ns	
$T_{13w}$	-IOW strobe width	40		25		ns	
$T_{13h}$	Chip select hold time from -IOW	0		0		ns	
$T_{15d}$	Write cycle delay	40		30		ns	
$T_{16s}$	Data setup time	20		15		ns	
$T_{16h}$	Data hold time	5		5		ns	
$T_{17d}$	Delay from -IOW to output		50		40	ns	100 pF load
$T_{18d}$	Delay to set interrupt from MODEM input		40		35	ns	100 pF load
$T_{19d}$	Delay to reset interrupt from -IOR		40		35	ns	100 pF load
$T_{20d}$	Delay from stop to set interrupt		1		1	Rclk	
$T_{21d}$	Delay from -IOR to reset interrupt		45		40	ns	100 pF load
$T_{22d}$	Delay from stop to interrupt		45		40	ns	
$T_{23d}$	Delay from initial INT reset to transmit start	8	24	8	24	Rclk	
$T_{24d}$	Delay from -IOW to reset interrupt		45		40	ns	
$T_R$	Reset pulse width	40		40		ns	
N	Baud rate divisor	1	$2^{16}-1$	1	$2^{16}-1$	Rclk	

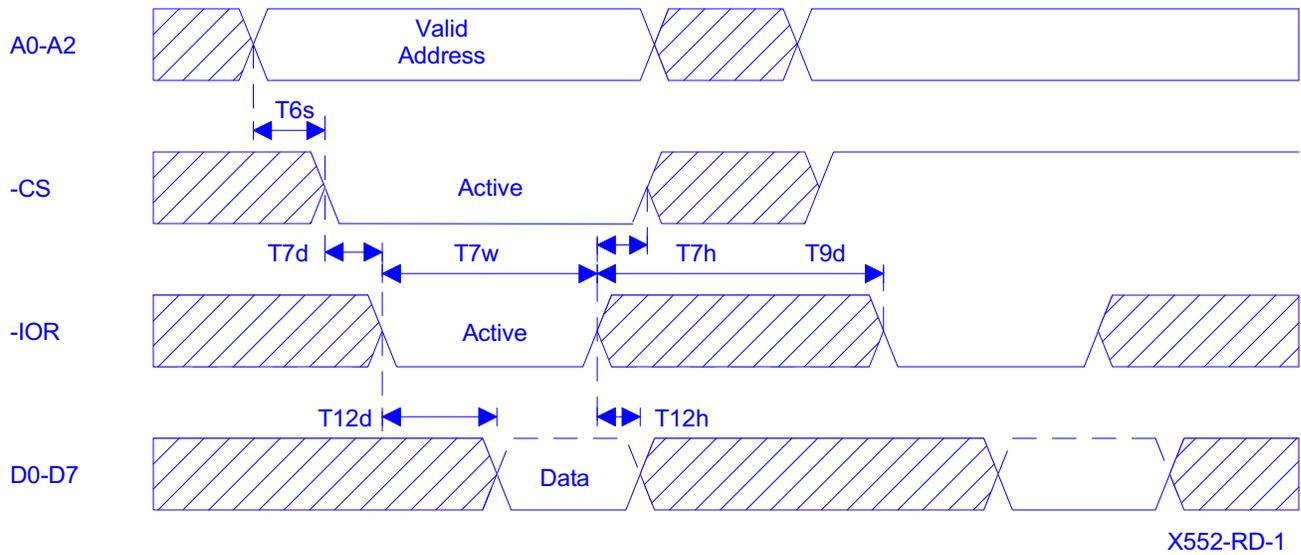
## ABSOLUTE MAXIMUM RATINGS

Supply range	7 Volts
Voltage at any pin	GND - 0.3 V to VCC +0.3 V
Operating temperature	-40° C to +85° C
Storage temperature	-65° C to 150° C
Package dissipation	500 mW

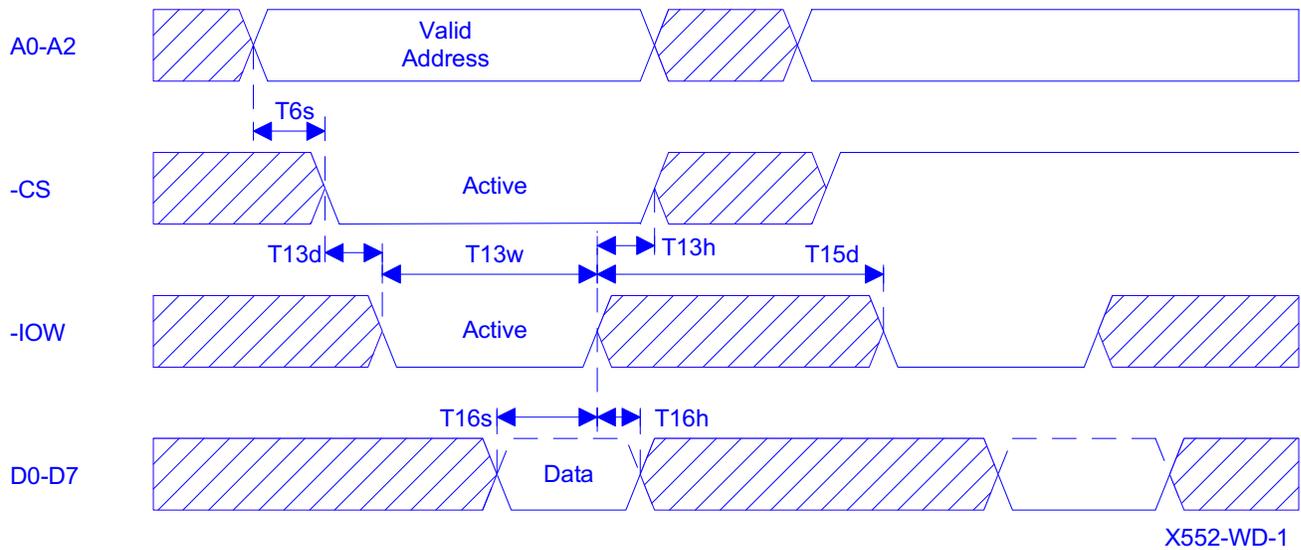
## DC ELECTRICAL CHARACTERISTICS

$T_A=0^\circ - 70^\circ\text{C}$  (-40° - +85°C for Industrial grade packages),  $V_{CC}=3.3 - 5.0\text{ V} \pm 10\%$  unless otherwise specified.

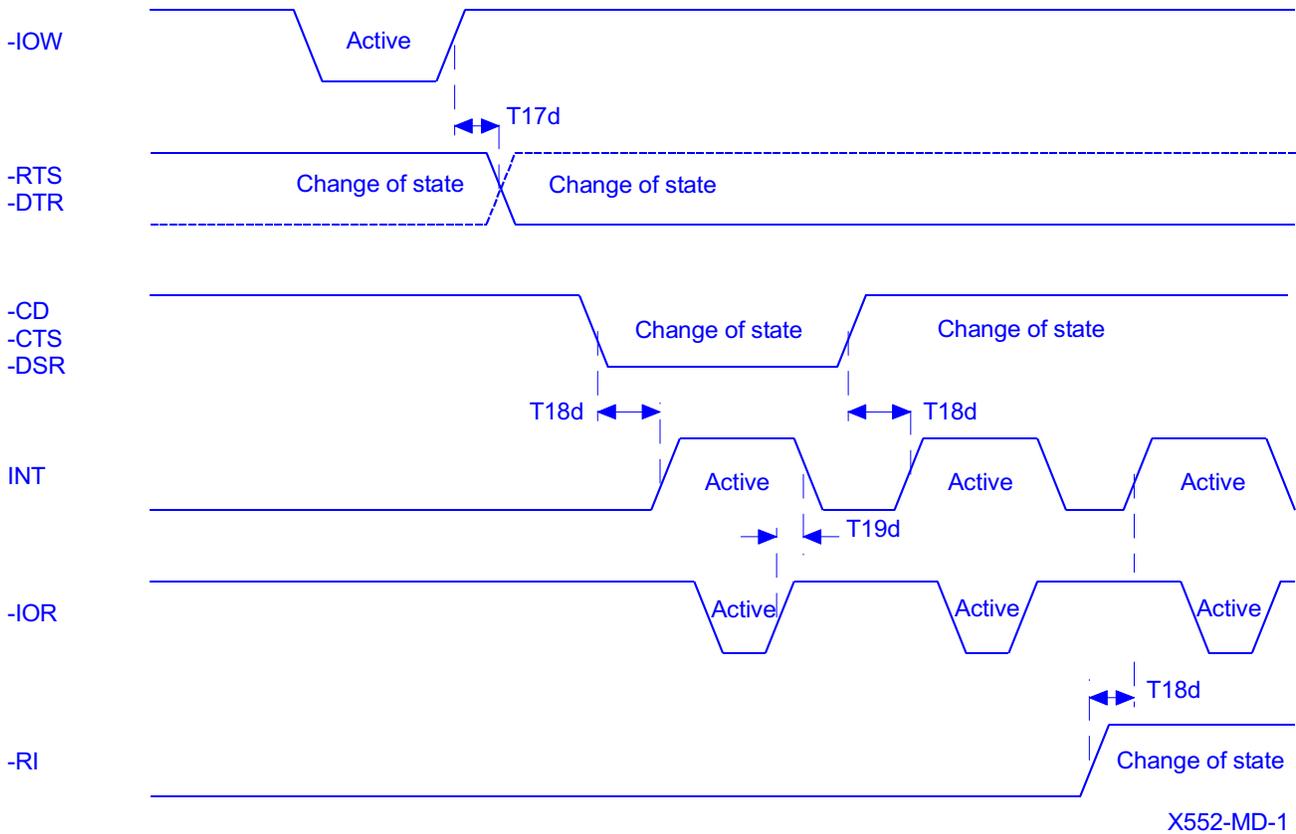
Symbol	Parameter	Limits 3.3		Limits 5.0		Units	Conditions
		Min	Max	Min	Max		
$V_{ILCK}$	Clock input low level	-0.3	0.6	-0.5	0.6	V	
$V_{IHCK}$	Clock input high level	2.4	VCC	3.0	VCC	V	
$V_{IL}$	Input low level	-0.3	0.8	-0.5	0.8	V	
$V_{IH}$	Input high level	2.0		2.2	VCC	V	
$V_{OL}$	Output low level on all outputs				0.4	V	$I_{OL} = 5\text{ mA}$
$V_{OL}$	Output low level on all outputs		0.4			V	$I_{OL} = 4\text{ mA}$
$V_{OH}$	Output high level			2.4		V	$I_{OH} = -5\text{ mA}$
$V_{OH}$	Output high level	2.0				V	$I_{OH} = -1\text{ mA}$
$I_{IL}$	Input leakage		$\pm 10$		$\pm 10$	$\mu\text{A}$	
$I_{CL}$	Clock leakage		$\pm 10$		$\pm 10$	$\mu\text{A}$	
$I_{CC}$	Avg power supply current		1.3		3	mA	
$C_P$	Input capacitance		5		5	pF	



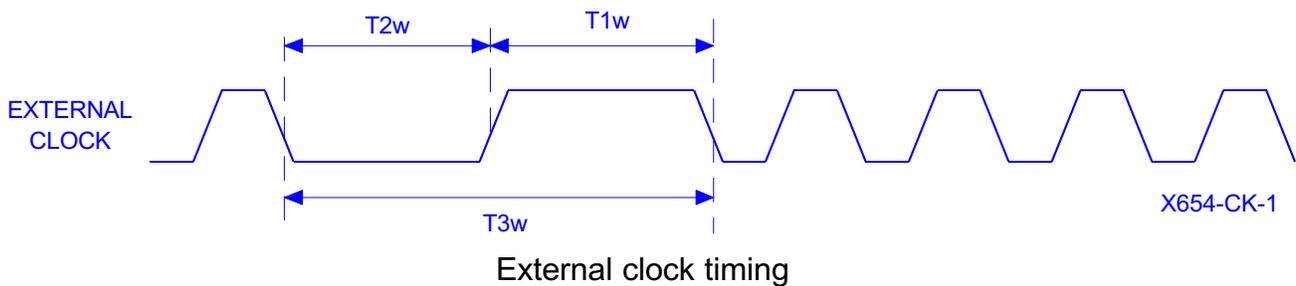
General read timing



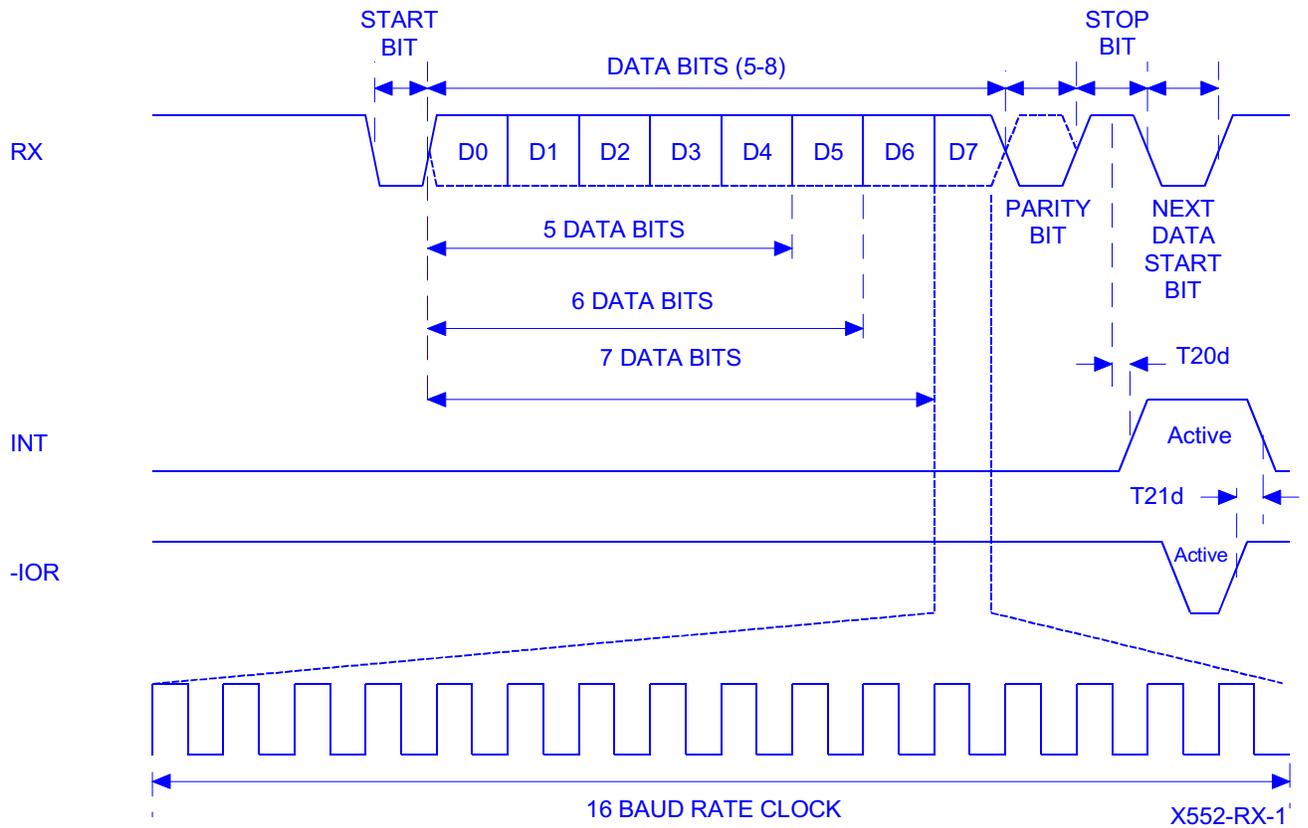
General write timing



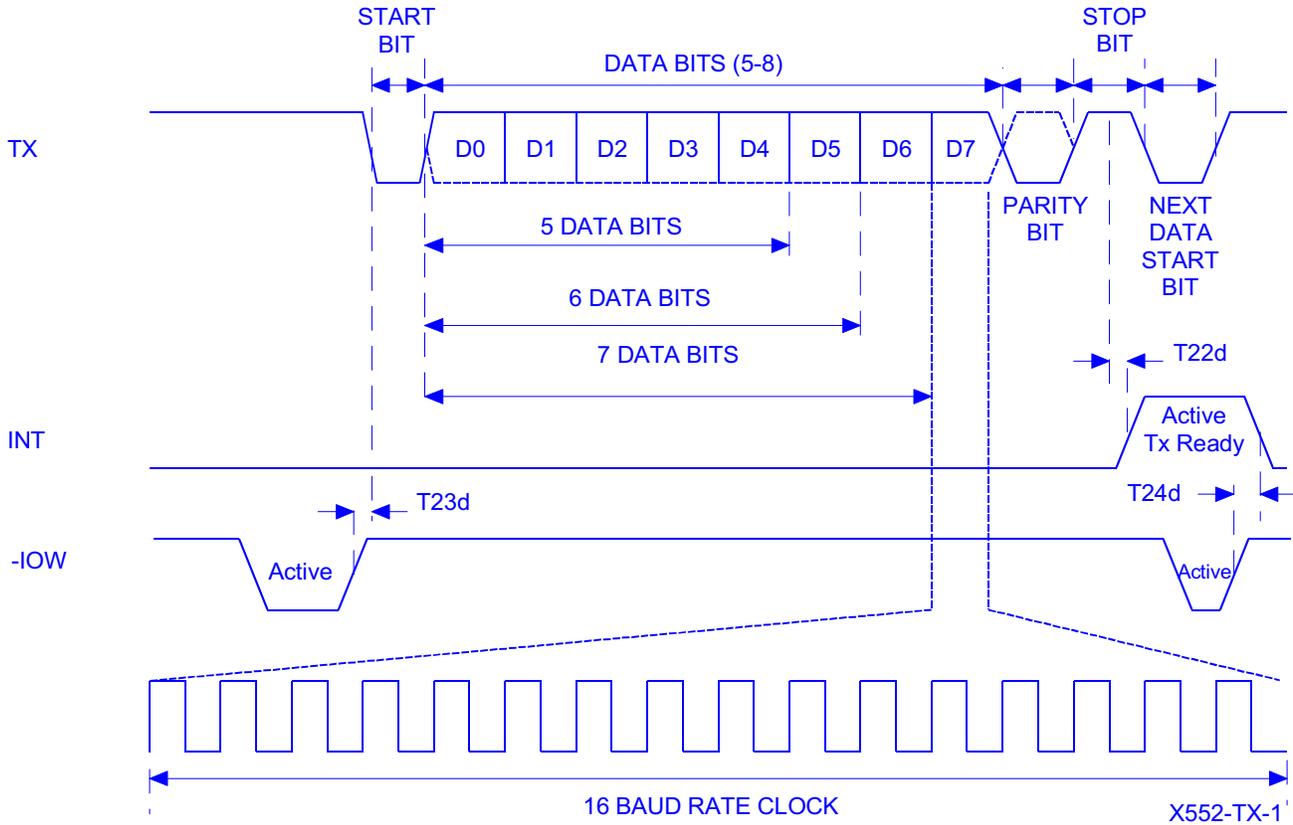
Modem input/output timing



External clock timing



Receive timing

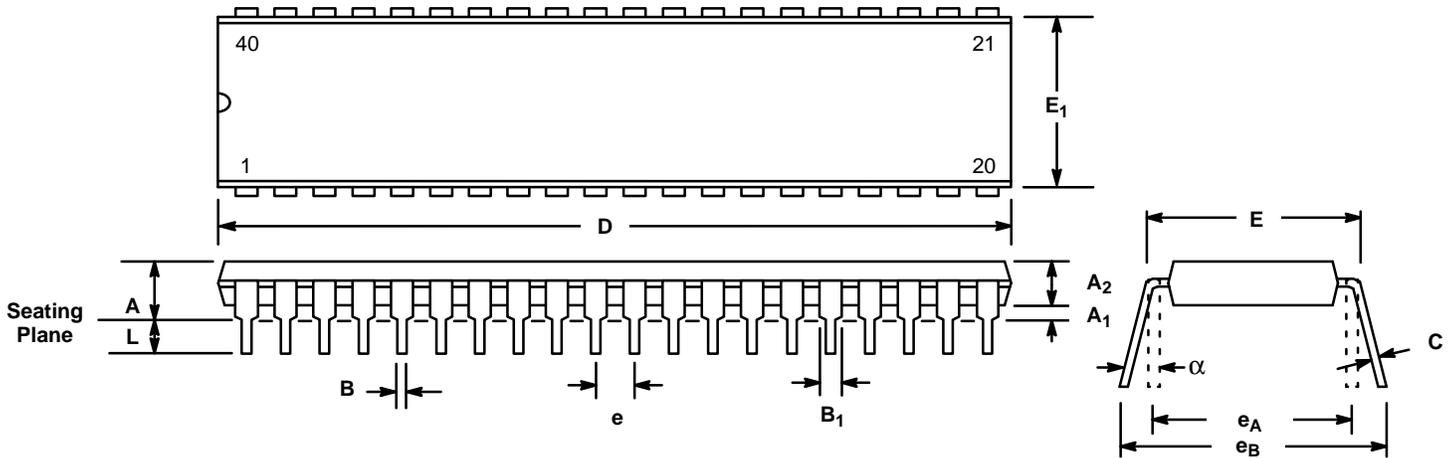


Transmit timing

# Package Dimensions

## 40 LEAD PLASTIC DUAL-IN-LINE (600 MIL PDIP)

Rev. 1.00



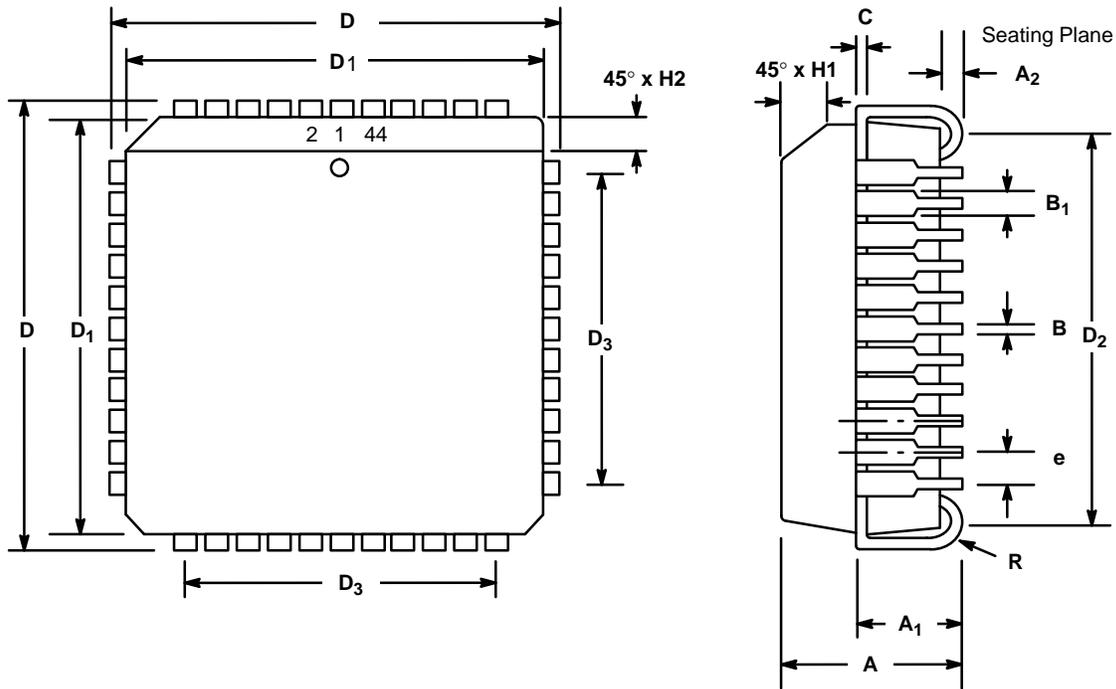
SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.160	0.250	4.06	6.35
A <sub>1</sub>	0.015	0.070	0.38	1.78
A <sub>2</sub>	0.125	0.195	3.18	4.95
B	0.014	0.024	0.36	0.56
B <sub>1</sub>	0.030	0.070	0.76	1.78
C	0.008	0.014	0.20	0.38
D	1.980	2.095	50.29	53.21
E	0.600	0.625	15.24	15.88
E <sub>1</sub>	0.485	0.580	12.32	14.73
e	0.100 BSC		2.54 BSC	
e <sub>A</sub>	0.600 BSC		15.24 BSC	
e <sub>B</sub>	0.600	0.700	15.24	17.78
L	0.115	0.200	2.92	5.08
α	0°	15°	0°	15°

Note: The control dimension is the inch column

# Package Dimensions

## 44 LEAD PLASTIC LEADED CHIP CARRIER (PLCC)

Rev. 1.00



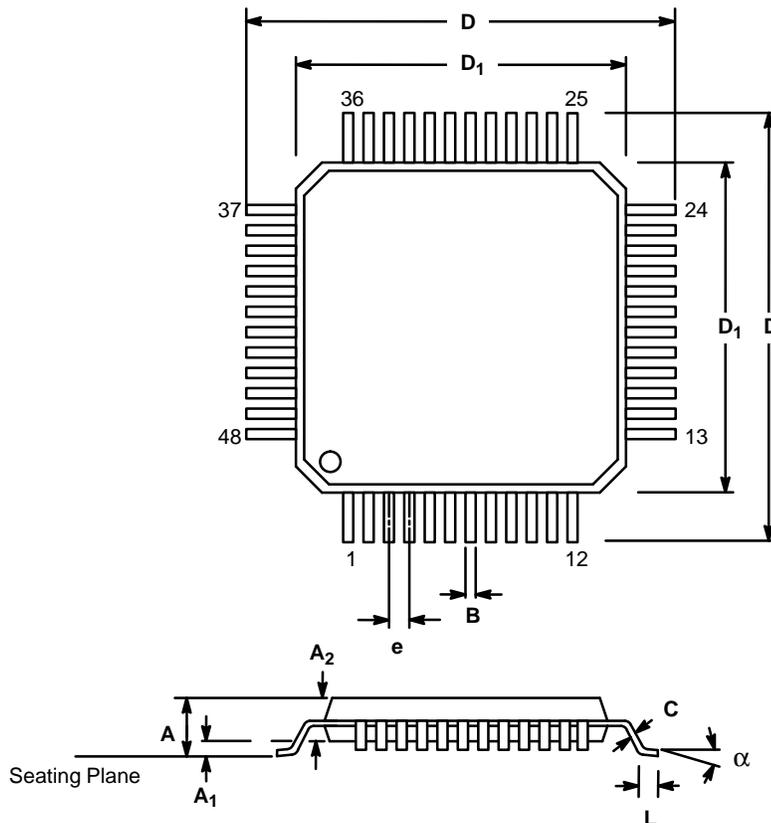
SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.165	0.180	4.19	4.57
A <sub>1</sub>	0.090	0.120	2.29	3.05
A <sub>2</sub>	0.020	—	0.51	—
B	0.013	0.021	0.33	0.53
B <sub>1</sub>	0.026	0.032	0.66	0.81
C	0.008	0.013	0.19	0.32
D	0.685	0.695	17.40	17.65
D <sub>1</sub>	0.650	0.656	16.51	16.66
D <sub>2</sub>	0.590	0.630	14.99	16.00
D <sub>3</sub>	0.500 typ.		12.70 typ.	
e	0.050 BSC		1.27 BSC	
H1	0.042	0.056	1.07	1.42
H2	0.042	0.048	1.07	1.22
R	0.025	0.045	0.64	1.14

Note: The control dimension is the inch column

# Package Dimensions

## 48 LEAD THIN QUAD FLAT PACK (7 x 7 x 1.0 mm, TQFP)

Rev. 1.00



SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.039	0.047	1.00	1.20
A <sub>1</sub>	0.002	0.006	0.05	0.15
A <sub>2</sub>	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
D <sub>1</sub>	0.272	0.280	6.90	7.10
e	0.020 BSC		0.50 BSC	
L	0.018	0.030	0.45	0.75
$\alpha$	0°	7°	0°	7°

Note: The control dimension is the millimeter column



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