

Sequence of Events Recording for the Modicon 984 PLC

Users Guide

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1.0 SER SYSTEM OVERVIEW

The Sequence of Events Recorder (SER) provides a permanent record of events which occur within milliseconds of each other, such as operation of circuit breakers, etc. The SER will provide the time of the event, the new state of the point, and a description of the point.

Multiple SER cards may be synchronized together to provide a distributed event recording system. Interface cards are available to synchronize the SER cards with an external time standard such as a Global Positioning Satellite (GPS) receiver.

Software is available for:

- the 984 Controller to gather the events from multiple cards and transmit them over a Modbus Plus network
- the BM85E Bridgemux to gather the events from multiple 984 controllers over a Modbus Plus network and print a record of the events
- the SA85 PC interface card to gather events from multiple 984 controllers over a Modbus Plus network
- the M80 External Time Reference Interface to configure the SER cards and gather events from multiple cards over the RS-485 interface.

1.1 SER CARD

The SER inputs cards, which are designed as standard Modicon input cards, contain additional logic to generate a time stamp for each transition of the input points. The card is synchronized to an external time source through an isolated RS-485 port. The card can also be operated without an external time source. In this case, the card's clock can be set to the PLC's time of day clock after startup. The input point parameters can be configured through a custom loadable running in the ladder logic of the PLC or through the RS-485 port. This loadable also retrieves the events from the SER card's event buffer and stores it in a 30-event-buffer in the PLC's 4x registers.

1.2 EXTERNAL TIME REFERENCE INTERFACE

There are two versions of the External Time Reference Interface, one that plugs into an ISA slot of a personal computer, and another that plugs into the I/O slot of an 800 Series chassis. Both cards contain an isolated RS-485 interface for communicating with the SER cards and interfaces for communicating with both an IRIG-B time code source and a Trimble Acutime GPS receiver. The ISA version of the interface contains dual ported memory for communicating with the PC and the 800 Series version contains an RS-232 interface for communicating a PC.

1.3 SER LOADABLE

The SER loadable provides an easy means of both configuring and gathering data from the SER cards. When using the custom loadable, all programming of the SER card is done using Modsoft software.

1.4 SER DATA TRANSMISSION

In order to provide a flexible system configuration there are two ways to communicate with the SER cards. If a Modbus Plus communication network is available, then data may be transmitted through the network. If a Modbus Plus network is not available, the data may be transmitted through the RS-485 port on the SER card.

1.4.1 MODBUS PLUS SYSTEM CONFIGURATION

In order to transmit event data over Modbus Plus, you must use the custom loadable. When the 984 controller is reset, the loadable will configure the SER cards and start to scan them for event data. When an event is detected, the loadable will build a buffer containing the event data and send it over Modbus Plus to a receiving drop. In this configuration the SER cards are I/O mapped as B884 modules.

1.4.2 RS-485 SYSTEM CONFIGURATION

If the RS-485 port is to be used for gathering event data, then the custom loadable is not used. The RS-485 bus master contains all of the configuration data for the SER cards. The master continuously scans all of the SER cards for event data. If the master detects a Reset Event from any of the SER cards it will log the event and download the configuration data to that card. The master also maintains communications statistics for each card and will generate an event for each card failure. In this configuration the SER cards are I/O mapped as B807 modules.

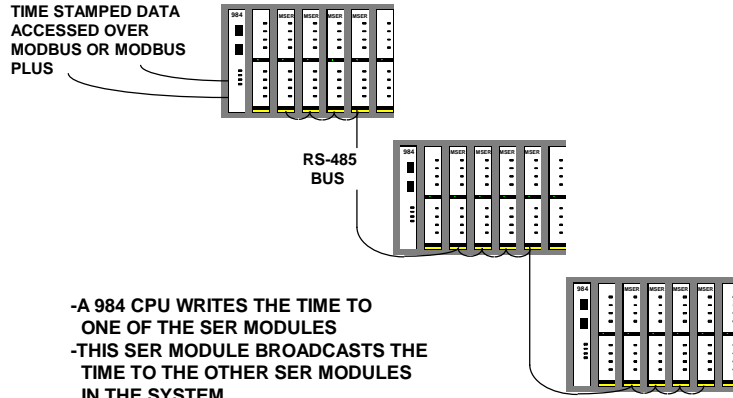
1.5 TIME SYNCHRONIZATION

If more than 32 points of SER data are required, then more than one SER card will be required. In order to maintain the accuracy of the time information from multiple SER cards, all of the cards receive a time synchronization signal over the RS-485 port. This synchronization signal can originate in either another SER card or an External Time Reference Interface card.

1.5.1 SELF SYNCHRONIZATION

If an SER card is used for time synchronization, then the system is said to be Self Synchronized. An example would be an application where it is necessary to resolve the sequence of events to a 1mS resolution at a single location, but it is not necessary to achieve 1mS resolution with data from other locations. In this mode, the configuration switch on one of the SER cards is set for Time Sync Master. The custom loadable is used to set the master SER card's clock from the 984 Controller clock. The master SER card then sends the time to all of the other SER cards over the RS-485 bus. All of the SER cards connected over the RS-485 bus will be synchronized to within 1mS.

**TIME SYNCHRONIZATION OPTION #1
-SELF SYNCHRONIZATION**

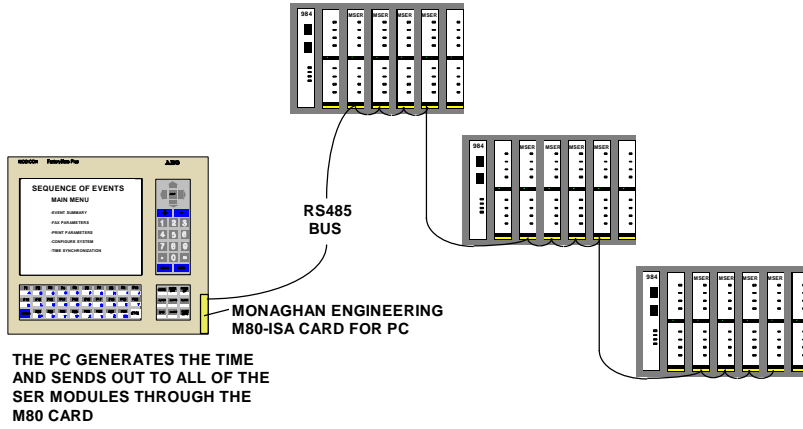


THIS APPROACH REQUIRES THE SER FUNCTION BLOCK IN THE 984 CPU

1.5.2 EXTERNAL TIME REFERENCE INTERFACE - STANDALONE

If an External Time Reference Interface is used for time synchronization and the interface is not connected to an external time reference, then the system is said to be in standalone mode. An example would be an application where it is necessary to resolve the sequence of events to a 1mS resolution at a single location, and it is necessary to synchronize the event time with a computer, but it is not necessary to achieve 1mS resolution with data from other locations. The interface will initially set the system time from the battery backed-up real time clock contained on the interface and optionally the time can be set through the PC interface in the card. The master ETR card then sends the time to all of the other SER cards over the RS-485 bus. All of the SER cards connected over the RS-485 bus will be synchronized to within 1mS.

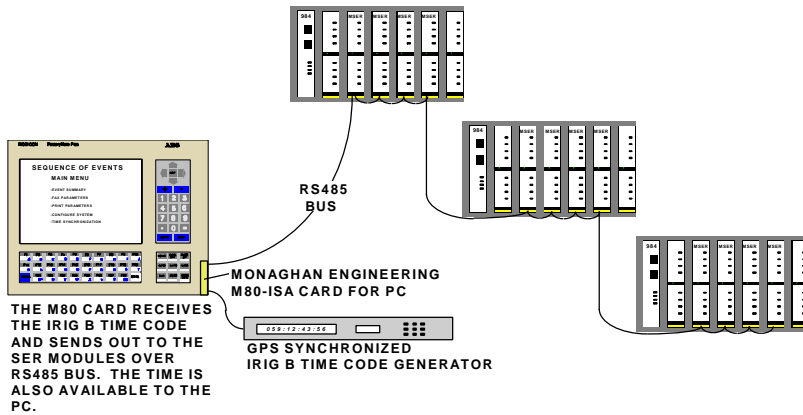
**TIME SYNCHRONIZATION OPTION #2
-BROADCAST FROM PC (without IRIG B)**



1.5.3 EXTERNAL TIME REFERENCE INTERFACE - SYNCHRONIZED

If an External Time Reference Interface is used for time synchronization and the interface is connected to an external time reference, then the system is said to be in synchronized mode. The interface will maintain SER system time synchronized to the time received from the external time reference.

**TIME SYNCHRONIZATION OPTION #3
-BROADCAST FROM PC (with IRIG B)**



2.0 SER HARDWARE

The SER hardware is comprised of two types of cards. The SER card, which is located in an 800 Series I/O chassis and the External Time Standard Interface card, which can reside in an ISA I/O slot of a Personal Computer or an I/O slot of an 800 Series chassis. The SER card provides the interface to the field devices and does the time stamping of events as they occur.. The External Time Standard Interface card provides the interface to an external time source and it also provides a way for a Personal Computer to gather event data.

2.1 MONAGHAN ENGINEERING SER INPUT MODULE

The SER card can be mounted and configured in the PLC's I/O map like any other Modicon I/O module. Up to 32 SER modules with 32 status inputs each, may be mounted with a single PLC. Limitations in the 984 controllers addressable I/O space may limit the number of SER cards per controller to less than 32.

The SER card will sample the input points every millisecond, digitally filter the data to remove contact bounce and noise, and build a buffer containing a time stamp and the point identification of any points that have changed. The card will buffer this information for later transmission to the 984 controller. The card is capable of holding 2000 events before overflowing the buffer. All of the inputs are available as 1X Status points for ladder logic programming.

The following parameters may be set individually for each point:

- Contact filter time (0-65,535 mS)
- Contact debounce time (0-65,535 mS)
- Chatter count (0-255)
- Scan status (On/Off scan)

2.1.1 SER CARD CONFIGURATION SWITCH SETTINGS

The SER card has an eight position dip switch which is accessible from the rear edge of the card. The function of each switch is as follows:

Switch	Function
1	Filter Select DOWN - 1X Inputs are passed directly from hardware UP - 1X Inputs are filtered by the SER card before passing to the PLC
2-6	Five bit address of the card. (DOWN = 0, UP = 1)
7	I/O Map select DOWN - Card is I/O mapped as a B884 UP - Card is I/O mapped as a B807
8	Time sync select DOWN - Card is set as a time sync slave UP - Card is set as a time sync master (Only one card in each system can be set as a master)

The Filter Select, switch 1, is used to determine whether the inputs are passed directly to the PLC or filtered by the SER card. When the switch is down, the 1X inputs will be passed directly to the PLC without any filtering. When the switch is up, the SER card will filter the input using the Contact Filter Time associated with that point before passing the input to the PLC.

The five bit address selected by switches 2-6 is used to address the card through the RS-485 port. It is only used when the card is operating in B807 mode. The address is used to define the card number which

is included in the SER event data record. In order to maintain the Modicon convention of starting all numbering with 1, the card number is defined as the card address plus 1.

The I/O Map Select, switch 7, is used to define the card type. If the B807 option is selected, the card will occupy two input registers (32 Digital In Points) and all card configuration and SER data gathering is performed through the RS-485 port. If the B884 option is selected, the card will occupy four input registers (64 Digital Input Points) and four output registers (64 Digital Output Points) and all card configuration and SER data gathering will be done using the custom loadables.

The Time Sync Select switch is used to determine whether the card acts as a time sync master or time sync slave. When configured as a time sync slave the card will receive time synchronization messages over the RS-485 port every second. The SER card will synchronize its internal crystal controlled clock with the synchronization messages. When configured as a time sync master the SER card will send time sync messages to all of the other SER cards every second. In this mode the CLOCK custom loadable is used to set the time of the time sync masters clock. In systems that use an External Time Reference interface, all of the SER cards must be set to the time sync slave mode.

2.1.2 SER POINT CONFIGURATION

Each of the thirty two points on the SER card is individually configurable. The inputs may be enabled or disabled for event processing and values may be assigned for input filtering, debounce and chatter count. Enabling or disabling a point for event processing does not affect the availability of the point for ladder logic use. All input points are always available for ladder logic programming.

2.1.2.1 CONTACT FILTER TIME

The contact filter time can be set to any value from 0 to 65,535 milliseconds. The purpose of the contact filter time is to eliminate false event messages caused by noise. The filter time is the amount of time that a point must stay in a new state in order to be recognized as an event. As an example, if the filter time for a point is set to 25 milliseconds, when the input changes state it must remain in the new state for 25 milliseconds before an event message is generated. If the input returns to the previous state in less than 25 milliseconds, the filter is reset and the next time the state changes it will again have to remain in that state for 25 milliseconds before an event message is generated. The time that is associated with the event is the time at which the point first changed, not the time when the filter recognized the event. If two input points with different input filter values were to change at the same time, the event messages would be generated at different times, but the time that was contained in the event message would be identical.

2.1.2.2 CONTACT DEBOUNCE TIME

The contact debounce time can be set to any value from 0 to 65,535 milliseconds. The purpose of the contact debounce time is to prevent multiple events from being generated from a single contact closure. The debounce time is the amount of time that input processing is disabled for a point after an event has been recorded

2.1.2.3 CHATTER COUNT

The chatter count can be set to any value from 0 to 255. The purpose of the chatter count is to prevent erroneous event messages from being generated by a faulty input point. The SER card maintains a count of the number of events generated by each point. If the number of events per minute exceeds the value entered for the chatter count, the point will be disabled for event processing. An event message will be generated indicating the exact time at which the point was disabled. When the number of events per minute drops below the chatter count value, the point will be enabled for processing and another event message will be generated indicating the time at which event processing was enabled. Setting the chatter count to 0 will disable the chatter count feature.

2.1.3 RS-485 INTERFACE

The RS-485 interface is used for time synchronization and communicating with the SER card. The interface is electrically isolated from the SER card and the 984 controller card. The connections to the RS-485 interface are located on pins 37 - 40 of the wiring connector. Pin 37 is an open collector driver that is pulled low when the RS-485 interface output drivers are active. This pin is used to control the output drivers of a fiber-optic interface module and is not used when connections are made using twisted pair wires for communication. Pins 38 - 40 are the A, B and Ground connections of the RS-485 interface. In a typical installation all of the A connections and all of the B connections of multiple modules would be wired together using a twisted pair shielded cable. All of the Ground connections would be connected to the shield. Since all of the RS-485 interface connections are electrically isolated from the 984 controllers, the cable shield should be grounded at one point to earth ground.

2.1.4 SER EVENT TYPES

The SER card communicates by generating event messages. The data that is associated with each event will vary depending on the event type. A list of event types and the data associated with each can be found in Appendix C.

2.1.4.1 NULL EVENT

When the SER card is scanned for messages, a Null Event is returned to indicate that no events are currently in the buffer.

2.1.4.2 STATUS CHANGE

A Status Change event message will be generated whenever the SER card detects that an input point has changed state. The message will contain the current state of the point, the point number, and the time of the event. It should be noted that while the numbering convention for status points is usually 1 - 32, the point number is contained in a 5 bit field which yields a number in the range of 0 - 31.

2.1.4.3 ON SCAN

An On Scan event message is generated whenever the SER card receives a command to start SER processing for an individual point. The message will contain the current state of the point, the point number, and the time of the event.

2.1.4.4 OFF SCAN

An On Scan event message is generated whenever the SER card receives a command to stop SER processing for an individual point. The message will contain the current state of the point, the point number, and the time of the event.

2.1.4.5 CHATTER ON SCAN

A Chatter On Scan event message is generated whenever the SER card determines that it is time to start SER processing for a point that has been disabled due to a chattering input. This event will always occur on a one second boundary because the SER card is looking for a one second period in which the number of input transitions is less than the chatter count. The message will contain the current state of the point, the point number, and the time of the event.

2.1.4.6 CHATTER OFF SCAN

A Chatter Off Scan event message is generated whenever the SER card removes a point from scan due to a chattering input. The message will contain the current state of the point, the point number, and the time of the event.

2.1.4.7 POWER ON RESET

A Power On Reset event message is generated when the SER card is powered up, or has gone through a reset sequence. The only time this event should be generated is when power is applied to the 984 controller or the SER card is plugged into a “hot” I/O slot. If this event message is generated at any other time, it indicates that the watch-dog timer in the SER card has detected an internal failure of the card and the card should be removed for repair. The message will contain the a point number of zero, and the time of the event.

2.1.4.8 TIME SYNC SIGNAL LOCK

A Time Sync Signal Lock event message is generated when the SER card has received a time sync signal over the RS-485 port and is currently locked to that signal. The message will contain the a point number of zero, and the time of the event.

2.1.4.9 TIME SYNC SIGNAL LOST

A Time Sync Signal Lost event message is generated when the SER card has not received a time sync signal for a period of one minute. The message will contain the a point number of zero, and the time of the event.

2.1.4.10 SOE BUFFER OVERFLOW

An SOE Buffer Overflow event message is generated whenever the event buffer is full and a new event is generated. The SER card will overwrite the oldest event with the new event and then overwrite the next oldest event with the SOE Buffer Overflow event message. The buffer output pointer is then adjusted so that the next event read will be the SOE Buffer Overflow event. The message will contain the a point number of zero, and the time of the event.

2.1.4.11 SCAN BUFFER OVERFLOW

The Scan Buffer Overflow event message indicates an internal error in the SER card. If this event message is received please contact the factory for help. The message will contain the a point number of zero, and the time of the event.

2.1.4.12 TIME RESYNC OLD TIME

The Time Resync Old Time event message is generated whenever a time sync message is received that contains a time that differs from the SER cards time by more than 1 millisecond. This message contains the current time of the SER clock. This message will be followed by a Time Resync New Time event message, which will contain the new time that the SER clock has been set to, and a Time Resync New Date message.

2.1.4.13 TIME SYNC NEW TIME

The Time Resync New Time message is generated whenever a time sync message is received that contains a time that differs from the SER cards time by more than 1 millisecond. This message contains the new time of the SER clock. This message will be preceded by a Time Resync Old Time event message, which

will contain the old time that the SER clock was set to, and will be followed by a Time Resync New Date message..

2.1.4.14 HOURLY TIME UPDATE

An Hourly Time Update event message will be generated at the beginning of each hour. Only one message is generated per card. The purpose of this message is to provide a way to determine that all of the cards in the system are functioning properly and to provide hour, day, month and year information. The time data contained in all of the previous messages contains hour, minute, second and millisecond time data. By inserting an hourly entry into the event buffer which contains hour, day, month and year information, a complete time stamp can be generated for all events.

2.1.4.15 TIME SYNC NEW DATE

The Time Resync New Date message is generated whenever a time sync message is received that contains a time that differs from the SER cards time by more than 1 millisecond. This message contains the new date of the SER clock. This message will be preceded by a Time Resync Old Time event message, which will contain the old time that the SER clock was set to, and a Time Sync New Time Message.

2.1.4.16 RECONFIGURE

The Reconfigure message is generated whenever any of the SER card configuration registers have been changed. This message contains the date of the SER clock.

2.2 MONAGHAN ENGINEERING EXTERNAL TIME REFERENCE INTERFACE

The External Time Reference Interface (ETR) card provides a way to synchronize multiple SER cards to an external time reference. The card also provides an interface between a PC and the RS-485 bus that is used to communicate with the SER cards. This interface can be used in systems that do not use the custom loadable to gather the SER data. The PC input also allows the PC to both read and set the current time. A time offset register is also provided which allows the ETR to adjust the time for local time zones.

The ETR has three synchronizing inputs, a Global Position Satellite (GPS) receiver interface, a modulated IRIG-B interface and a 50/60 HZ line frequency interface. The M80-800 series ETR, which plugs into a Modicon 800 series I/O chassis, also contains a battery backed up Real Time Clock/Calendar. The M80-800 will initially set the current time and date based on the value contained in the clock/calendar chip. The M80-ISA series ETR, which plugs into one of the ISA slots of a personal computer, comes with a program which can be used to set the time from the computers clock. After the ETRs initial time has been set it will then try to synchronize with a GPS receiver, IRIG-B signal or 50/60 HZ line input in that order.

When the ETR has synchronized with a GPS receiver, the clock/calendar chip will be updated with the current time and date. Since an IRIG-B time code signal does not contain year information, when the ETR has synchronized with an IRIG-B signal the time, day and month will be updated but the year will be obtained from the clock/calendar chip.

Included in the time synchronization signal that is sent to the SER cards is a time quality indication. The time quality is calculated based on the synchronization mode of the ETR. When the ETR is first turned on, the time will be based on the clock/calendar chip or the time downloaded from the computer. If the ETR is unable to read a valid time from the clock/calendar or if the computer does not download a time, the time quality will be "BAD" indicating that no time reference is available. If a valid time is read, then the time quality will be set to "POOR" indicating an error of greater than 50 mS. If the ETR is synchronized with either a GPS receiver or an IRIG-B signal then the time quality will be "GOOD" indicating synchronization within 1 mS. If both of these signals are lost then the ETR will continue to maintain time based on the internal crystal oscillator. When a time period has elapsed sufficient for the

crystal oscillator to have drifted more than 1 mS, the time quality will change to “FAIR” indicating an error of greater than 1 mS but less than 50 mS. At this time the ETR will try to synchronize with the 50/60 HZ input. If it can synchronize with the 50/60 HZ line input then the time quality will remain “FAIR” and the error will remain less than 50 mS. If no 50/60 HZ input is available, the ETR will continue to keep time based on the crystal oscillator. When a time period has elapsed sufficient for the crystal oscillator to have drifted more than 50 mS, the time quality will change to “POOR” indicating an error of greater than 50 mS

2.2.1 ETR PROGRAMMING

The ETR is programmed by using the MODBUS Read Register and Preset Multiple Register commands. The ETR contains a block of registers starting at location 40001. If the custom loadable is used to gather the SER data, the only registers used are registers 40001 through 40010 which are defined as follows:

40001 - Month
40002 - Day
40003 - Year
40004 - Hour
40005 - Minute
40006 - Second
40007 - Millisecond
40008 - Time quality. 0 = Good, 1 = Fair, 2 = Poor, 3 = Bad
40009 - Time bias (+/- 23). Time which is added or subtracted from the GPS or IRIG-B time.
40010 - Signal Source Bit 0 - GPS, Bit 1 - IRIG-B, Bit 2 - 50/60 Hz

If the custom loadable is not used to gather the SER data, the ETR can be programmed to perform this function. When operating in this mode, the SER cards are configured as B807 modules and all time synchronization, configuration and SER data gathering is done using the RS-485 port on each card. Appendix D contains a complete definition of all of the registers that are used to control the SER cards.

The registers are divided into groups according to their function. The first group of registers, 40021 - 40085, contain the current state of each SER point.

The second group of registers, 40101 - 40191, contain the Event Buffer. The first register, 40101, contains the number of events in the buffer. The following registers contain up to 30 event records, with each record occupying three registers.

The third group of registers, 40201 - 40291, contain the Event Resend Buffer. When a Modbus command to read the event buffer is received, the ETR will transmit the contents of the buffer to the Modbus master device, copy the Event Buffer to the Event Resend Buffer and then clear the Event Buffer. By reading the Event Resend Buffer the Modbus master can always retrieve the last Event Buffer that was read.

The fourth group of registers, 40301 - 40332, contain the card configuration data. Bit 0 of each register is used to define the scan status of each card. If the bit is set to 0, the card will not be configured or scanned by the ETR. If the bit is set to 1, the card will be configured and scanned by the ETR.

The fifth group of registers, 40351 - 40382, contain the card status data. Bits 0 and 1 are used to define the communications status of the card. If both bits are set to 0, the card is communicating normally. If bit 0 is set to 1 and bit 1 is set to 0, communications with the card are marginal. If bit 0 is set to 0 and bit 1 is set to 1, the card is not responding to communications requests.

The sixth group of registers, 40401 - 43596, contain point configuration data for each card. When any of the configuration registers for a card are changed, the ETR will download all 96 configuration registers to the card.

2.2.2 ISA EXTERNAL TIME REFERENCE INTERFACE

The ISA External Time Reference Interface card plugs into an ISA slot of a PC. The card communicates with the PC through a 1K block of shared memory. The shared memory can be assigned a starting address on any 1K boundary in the range of C0000 to FFC00. The card supports interrupt driven communications on IRQ lines 2,3,4,5 and 7. Commands are sent to the ETR by writing to a buffer and then setting a semaphore register. This generates an interrupt in the ETR which will process the command. The ETR responds by writing to the proper buffer and then setting a semaphore register. If an interrupt has been selected for the card, this will generate an interrupt to the PC. If interrupts have not been selected then the PC will have to poll the semaphore register to determine when it has been set.

The memory block is divided into three data buffer areas. The first buffer area, the transmit buffer, is contained in memory locations 0 - 255. The PC communicates with the ETR by placing a Modbus command in the transmit buffer and then setting memory location 1022 equal to 1. The ETR will then set memory location equal to 0 when the command is read.

The second buffer area, the receive buffer, is contained in memory locations 256 - 511. The ETR communicates with the PC by placing a Modbus response in the receive buffer and setting memory location 1023 equal to 1. The PC should then set memory location equal to 0 after the response is read.

The third buffer area, the time buffer, is contained in memory locations 512 - 520. This buffer is a read only buffer which contains the contains of registers 40001 - 40009.

2.2.2.1 ISA SWITCH SETTINGS

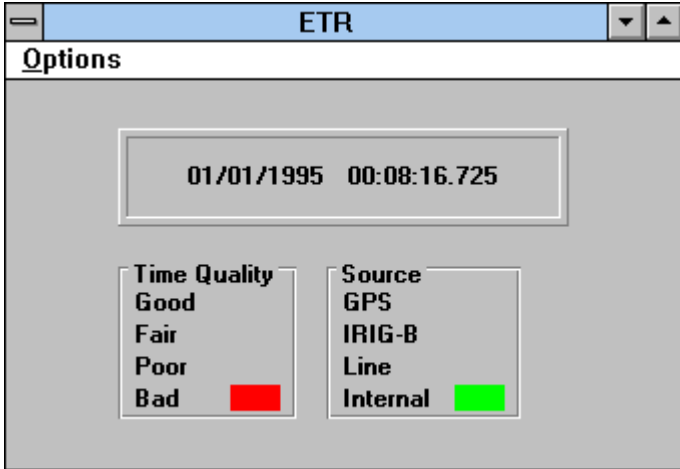
The shared memory address for the ETR-ISA card is determined by the setting of switch S1.

A17	A16	A15	A14	A13	A12	A11	A10	Address
0	0	0	0	0	0	0	0	C0000
0	0	0	0	0	0	0	1	C0400
0	0	0	0	0	0	1	0	C0800
0	0	0	0	0	0	1	1	C0C00
0	0	0	0	0	1	0	0	C1000
				.				
				.				
				.				
1	1	1	1	1	1	1	0	FF800
1	1	1	1	1	1	1	1	FFC00

Switch Up - 1
 Switch Down - 0

2.2.2.2 ISA SOFTWARE

The ETR-ISA card is shipped with a windows based program which allows the personal computer to communicate with the card. The program displays the following main screen when it is running.

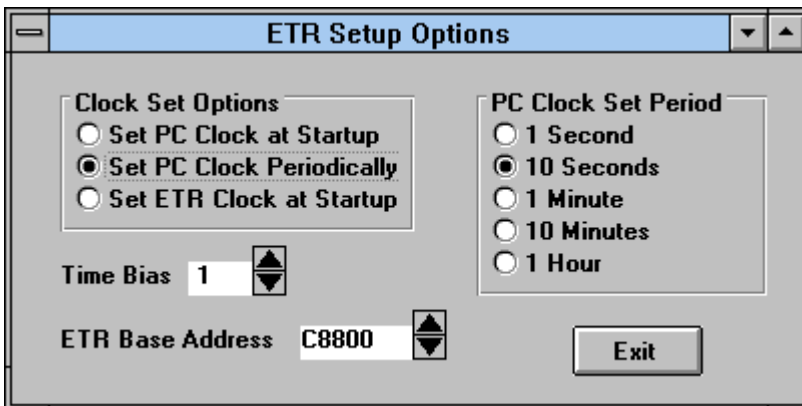


The current time, time quality and time code signal source is shown on the screen.

A good time quality is indicated by a green bar, a fair or poor time quality is indicated by a yellow bar, and a bad time quality is indicated by a red bar beside the appropriate label.

The signal source indicators are color coded to indicate the current condition of the signal. A green bar indicates that the signal is currently being used as the time source. A yellow bar indicates that the signal is good but it is not being used as the timing source. A red bar indicates that the signal is present but no time code information is available, such as a GPS receiver connected and operating but not receiving a satellite signal.

The program setup may be changed by clicking on the Options selection and then clicking on the Setup selection.



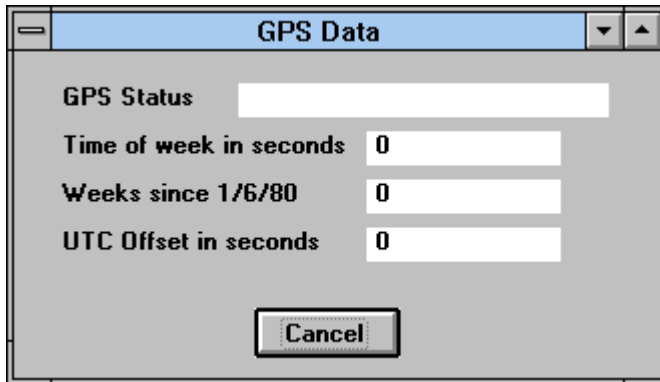
Three clock options are provided. The program will set the PC clock when it is started, or the PC clock can be set periodically, or the ETR clock can be set by the PC at startup.

If the option is selected which sets the PC clock periodically, the interval at which the clock is reset can be selected.

The time bias is the number of hours that are added or subtracted from the time code signal to generate the correct time. This can be used to offset the time for Daylight Savings Time or to offset the time to the proper time zone.

The ETR Base Address setting is used to define the selected base address of the ETR card.

When a Trimble Navigation Acutime receiver is connected to the ETR, the GPS receiver status information is available click on the Options selection and then clicking on the GPS Data selection.



The current status of the GPS receiver is displayed at the top. The normal status is “Doing position fixes”. All other status conditions indicate an error, and the time displayed may be in error.

The time of week is the number of seconds since midnight the previous Sunday. The UTC offset is the difference between GPS time, the time provided by the satellite, and UTC, Universal Coordinated Time.
 $UTC = (GPS\ time) - (UTC\ offset)$

2.2.3 800 SERIES EXTERNAL TIME REFERENCE INTERFACE

The 800 Series External Time Reference Interface card plugs into the I/O slot of an 800 Series I/O chassis. The card communicates with a PC through an RS-232 interface on the card. All communications with the card are through Modbus messages.

2.2.4 IRIG-B INTERFACE

The IRIG-B interface provides an industry standard time code interface. The connection is through a BNC connector on the interface card. The IRIG-B decoder is designed for a modulated IRIG-B signal.

2.2.5 TRIMBLE ACUTIME INTERFACE

The Acutime receiver, manufactured by Trimble Navigation, is a low cost GPS satellite receiver. The interface consists of an RS-422 interface which is used to interrogate the Acutime receiver for the current time and an interface for the one pulse per second output from the Acutime receiver which is used to determine the start of each second.

2.3 NOVATECH BM85E/PC

A BM85E or a PC may be used as a data concentrator in the field to receive and process SOE events from different PLCs via Modbus Plus. Depending on the application, the BM85E or PC may perform a variety of tasks:

- sort events according to time stamps, type of event, or originating PLC
- print events on on-site printer and/or terminal
- forward events via leased line, dialup modem and telephone line, or radio to a remote engineering PC for data processing and storage

- provide protocol conversion for bit oriented protocol or byte oriented protocol in order to allow an on-line connection to a SCADA master (BM85E only)
- store SOE data on hard drive (PC only)
- notification of technical personnel via pagers and alphanumeric event codes in case of emergencies by using a modem

3.0 SER SOFTWARE

3.1 SER LOADABLE

The SER software performs three separate functions. Each of these functions is implemented in a separate loadable.

For every SER module mounted with a PLC, one instance of the SER Card function block in ladder logic is required. The purpose of this kind of function block is to upload SOE events from the SER module to which it is assigned, and store the events in a SOE event buffer in the PLC.

The SER Modbus Plus loadable sends the events uploaded by all SER Card function blocks in the PLC, to a BM85E or a PC with a SA85 card. It is used only once throughout the entire ladder logic.

The SER Clock (CLCK) loadable is optional. It is also used only once in the entire ladder logic. Its purpose is to set the PLC's time of day clock (if configured) to the IRIG-B time received from a SER card. However, should the SER card be unable to receive the IRIG-B time, or operated without IRIG-B input, the loadable allows the ladder logic program to set the SER card's clock with the PLC's time of day clock.

3.1.1 PLC CONFIGURATION

The SER Input Module M884 is configured as a B884 in the PLC's I/O map. For every SER input module, there must be one entry in the I/O map. Other I/O modules may be configured as needed.

The following example shows the I/O map for three SER input modules.

```

Utility          DelDrop HoldTme ASCPort GetDrop          Quit
F1-----F2-----F3-----F4-----F5-----F6-----F7-Lev 8-F8-OFF---F9-----+
|
|              I/O MAP
|              800 SERIES I/O
| Drop          : 1 of 1      Rack          :          1
| Drop Hold Up Time : 3      (x100ms) ASCII Port :          0
| Number Inputs  : 192      Number Outputs :          192
|-----|
| Slot  Module  Reference Numbers      Data  Module
|      Type    Input      Output      type  Description
|-----|
| 101   984
| 102   984          PLC-685
| 103  B884  10001 -10064  00001 -00064  BIN  BIDIR 4 REG  B884
| 104  B884  10065 -10128  00065 -00128  BIN  BIDIR 4 REG  B884
| 105  B884  10129 -10192  00129 -00192  BIN  BIDIR 4 REG  B884
| 106   B8
| 107   B8
| 108   B8
| 109   B8
| 110   B8
| 111   B8
|-----|

```

The SER Loadable is loaded into a PLC configuration with the following sequence of key strokes:

1. Select the PLC configuration
2. Press <F7> (Loadable) in order to select the screen shown below.
3. Press <F3> (Directory)
4. Press <F1> (Load). Modsoft pops up a window in which the DOS file name must be entered. If, for example, the loadable file CARD.DAT is stored in the directory


```

Utility      Overview I/OMap  Ports   Segmnts  Loadable Cfg Ext  Quit
F1-----F2-----F3-----F4-----F5-----F6-----F7-Lev 8-F8-OFF---F9-----+
|
|              CONFIGURATION OVERVIEW
|
|   PLC      :      |      Size of Full Logic Area  13867
|   PLC Type  984 - 685 |      No. of I/O Map Words      00015
|   Exec Pack          |      +-----+
|   Memory      16.0K |      I/O :      I/O Type      800
|   Extended Memory   K |      Number of Segments      32
|   Redundant      N |      IO Drops / Channel Pairs  1
|   DCP Drop ID      |      I/O Modules              1
|-----+-----+
|              Specials :
|   Ranges  :      |      Battery Coil              0-----
|   0xxxx   00001 - 01536 |      Timer Register              4-----
|   1xxxx   10001 - 10512 |      >>Time of Day Clock        41500 - 41507<<
|   3xxxx   30001 - 30048 |      +-----+
|   4xxxx   40001 - 41872 |      ASCII:
|   4xxxx for SFC      None |      Number of Messages          0
|-----+-----+      |      Message Area Size           0
|   0xxxx for SFC      None |      Number of ASCII Ports       0
|              Simple ASCII Output
|              Simple ASCII Input
+-----+-----+
+I/O Map is the traffic cop which links the I/O modules to program logic. +
    
```

3.1.2 LADDER LOGIC PROGRAM

The various function blocks are used in ladder logic as follows.

Loadable Name	Function	Description
CARD	SER Card Loadable	Uploads the SOE events from a specific SER module to a common buffer used by all SER modules, in the PLC's 4x registers.
CMBP	SER Modbus Plus Loadable	Controls an MSTR function block which sends the SOE events from the PLC's SOE event buffer to a BM85 or a PC with a SA85 card.
CLCK	SER Clock Loadable	Allows to set PLC's Time of Day clock with IRIG-B time from SER module, and vice versa if necessary. The use of this loadable is optional.

```

Utility PlcOps Elements Edit Go/Srch Network Refs Tools Quit
F1-----F2-----F3-----F4-----F5-----F6-----F7-Lev 8-F8-COMBO-F9-R4--+
|Seg. 1 #1 /1 SER MB+ Function incl. MSTR
|+-----+
||
|| 40014|
|| | +---( )--
|| 40023||01500
|| |MSTR++
|| #0100+
|+-----+
|| #0001|
|+--|P+--| +---( )--
||01500 40001| 00001
|+--| +--|CMBP+---( )--
||01501 #0122+ 00002
||
|+-----+
|----- Reference Data -----|
|01500 MSTRFeedBk 0 E | 40001 SERSendBlk 500 Dec
|01501 FlushQueue 0 E |
| | 40014 MSTR_Setup 1 Dec
|00001 FillQueue 1 E | 40023 EventBuf 2 Dec
|00002 SER_Error 0 E |
+ Format :Decimal Online Range : 1 -----+

```

```

Utility PlcOps Elements Edit Go/Srch Network Refs Tools Quit
F1-----F2-----F3-----F4-----F5-----F6-----F7-Lev 8-F8-COMBO-F9-R4--+
|Seg. 1 #2 /2 SER Cards 1 and 2
|+-----+
|| #0001|
|+--|P+--| +---( )--
||00008 40400| 00009
|+--| +--|CARD+---( )--
||00001 #0130+ 00010
||
|+-----+
|| #0002|
|+--|P+--| +---( )--
||00011 40700| 00012
|+--| +--|CARD+---( )--
||00001 #0130+ 00013
||
|+-----+
|----- Reference Data -----|
|00001 FillQueue 1 E |
|00008 CnfgCard1 0 E | 00011 CnfgCard2 0 E
|00009 Cnfg1Compl 0 E | 00012 Cnfg2Compl 0 E
|00010 SERCrld1Err 0 E | 00013 SERCrld2Err 0 E
|40400 SERCrld1Blk 10 Dec | 40700 SERCrld2Blk 0 Dec
+ Format :Decimal Online Range : 1 -----+

```

```

Utility  PlcOps  Elements Edit      Go/Srch Network Refs      Tools      Quit
F1-----F2-----F3-----F4-----F5-----F6-----F7-Lev 8-F8-COMBO-F9-R4---+
|Seg. 1  #3 /3 SER Card 3 and SER Clock
+-----+
||          #0003|
+--|P+--|      +---( )--
||00014  40950| 00015
+--| +---|CARD+---( )--
||00001  #0130+ 00016
+
||
+-----+
||          #0001|
+--|P+--|      +---( )--
||00100  40900| 00102
+--|P+--|CLK+---( )--
||00101  #0010+ 00103
+-----+
+-----+----- Reference Data -----+
|00001  FillQueue  1          E | 00100  SetPLCClck  0          E |
|00014  CnfgCard3  0          E | 00101  SetSERClks  0          E |
|00015  Cnfg3Cmpl  0          E | 00102  ClkSetCmpl  0          E |
|00016  SERCr3Err  0          E | 00103  ClkError    0          E |
|40950  SERCr3Blk      0 Dec  | 40900  SetClkBlck  0 Dec
+ Format :Hexadecimal      Online      Range : 1 -----+

```

3.1.3 SER CARD FUNCTION BLOCK

3.1.3.1 SER CARD FUNCTION BLOCK PROGRAMMING

The SER Card function block can be inserted in ladder logic by selecting CARD from the Modsoft loadable menu. The top node specifies the card number. In order to properly identify an event, every card number between 1 and 32 must be used only once. Numbers outside this range are not valid card numbers. The middle node indicates the first of 130 4x registers required to setup the function block and to configure the input points on the SER card. The length 130 is entered in the bottom node of the function block. In the example shown below, the registers 40400 through 40529 are used for the function block. Of course, the function block may be used with any 4x register.

NOTE: The registers for each function block must not overlap. With a starting address of 40400 and length of 130 registers as shown above, registers 40400 through 40529 are occupied. The next function blocks may be placed at 40530, 40660, 40790, etc.

The top input must always be set to ON in order for the function block to be active. The middle input should be used with a positive transitional contact. Whenever there is a positive transition, the SER module is configured with the parameters discussed below.

The bottom input must be connected to a contact controlled by the middle output of the SER Modbus Plus (CMBP) function block. This contact ensures that the SER Card function blocks cannot add SOE events from the SER module to the common SOE event buffer while that buffer is being sent to a BM85E or a PC by the SER Modbus Plus function block. As soon as the MSTR function block associated with the SER Modbus Plus function block completes the transmission, the middle output of the SER Modbus Plus function block, and subsequently the bottom input of the SER Card function blocks, are turned ON again, enabling the SER Card function blocks to upload new SOE events from the SER modules.

```

ON = Activate ----- Echoes Top Input
Function Block      |#1      |
                    |      |
--|P+-----      +--- ON (One Scan) =
0->1 = Configure   |40400   | Configuration
SER Module         |      | Completed
ON = Fill --|CARD +--- ON = Setup Error
Event Queue        |#130   |
                    +-----+
    
```

The top output echoes the top input of the function block.

The middle output is set to ON for one scan after the middle input has been triggered for configuration of the SER module, and the configuration has completed.

The bottom output is turned ON for illegal function block setup parameters.

3.1.3.2 SER CARD FUNCTION BLOCK PARAMETERS

The SER Card parameters can be entered using the Modsoft reference editor or Novatech's template. These parameters can also be changed as needed by the ladder logic program during its execution. Please note that the addresses for the parameters are relative to the register address in the middle node of the function block as shown above.

The following template pages can be invoked in Modsoft using the key combination <Alt>-Z when the ladder logic cursor is placed on the SER Card function block.

```

Utility          Hex      Dec      Bin      Goto          Quit
F1-----F2-----F3-----F4-- DX Zoom Editor -----F7-Lev 8-F8-OFF---F9-----+
                                                    Page 1 / 14
SER Module Setup V1.01 by NovaTech, Inc. (C) 1995
-----
CARD FUNCTION BLOCK-I/O MAP LINK
SER Card's First 1x Addr. in I/O Map [xxxx] 40497 INT = 1400 DEC
SER Card's First 0x Addr. in I/O Map [xxxx] 40498 INT = 209 DEC

CARD FUNCTION BLOCK-CMBP FUNCTION BLOCK LINK
Register in Middle Node of CMBP Loadable      40499 INT = 1 DEC

INPUT POINT PARAMETERIZATION
First Point to be Parameterized (1-32)      40501 INT = 7 DEC
Last Point to be Parameterized (1-32)      40502 INT = 7 DEC
Parameterize 0=All Points Individually      40503 INT = 1
1=Copy Point #1 Parameters
Re-parameterize Points on Power Reset 0=No 40504 INT = 1
1=Yes
    
```

Address of First 1x Input in I/O Map

Range: depends on number of 1x inputs in PLC configuration

Offset: +97

Usage: The SER Card function block must read the values from the SER module through 1x inputs. In this case, the 1x inputs used by the SER module are 10001 through 10064. Please note that the address entered here must match a 1x address as entered in the PLC's I/O map for the SER module. The first 32 inputs, in this case 10001 through 10032, are used to report the status of each of the 32 status inputs. 10033 through 10064 are used for internal purposes.

Note: This value must vary for all SER Card function blocks, and must not be changed by ladder logic.

Address of First 0x Output in I/O Map

Range: Depends on number of 0x outputs in PLC configuration

Offset: +98

Usage: The SER Card function block must write commands to the SER module. For this purpose, the function block needs to know the 0x outputs reserved in the PLC's I/O map for communication with the SER module. The registers are reserved for internal use. In this case, the 0x outputs used are 00001 through 00064.

Note: This value must vary for all SER Card function blocks, and must not be changed by ladder logic.

Base Register of SER Modbus Plus Function Block

Range: Depends on number of 4x registers in PLC configuration

Offset: +99

Usage: Every SER Card function block must store the events uploaded from the associated SER modules in the same event buffer. The address entered in this field is the register address in the middle node of the SER Modbus Plus function block. In this case, this address is 40001, as can also be seen in the above ladder logic.

Note: This value must be identical for all SER Card function blocks, and must not be changed by ladder logic.

First Point to be Parameterized

Range: 1..32, must be less or equal to 'Last Point to be Parameterized'

Offset: +101

Usage: see 'Last Point to be Parameterized'

Note: This value can be set in ladder logic, or through Modbus Plus as needed prior to triggering the middle input of the function block in order to parameterize the SER module.

Last Point to be Parameterized

Range: 1..32, must be greater or equal to 'First Point to be Parameterized'

Offset: +102

Usage: These two parameters allow to specify the status inputs which should be parameterized. The combination 3 (for first point) and 5 (for last point) would parameterize the inputs points 3, 4, and 5 with the current setup values shown below, upon triggering the middle input of the function block. If for example only point 16 was to be parameterized, both values would be set to 16.

Note: This value can be set in ladder logic, or through Modbus Plus as needed prior to triggering the middle input of the function block in order to parameterize the SER module.

Parameterize All Points Individually/Copy Point #1 Parameters

Range: 0, 1

Offset: +103

Usage: For a value of 0, all 32 points are parameterized with the parameters entered individually for every point. However, if all 32 points operate with the same parameters, these parameters need to be entered only once for point 1. For a value of 1, the parameters for point 1 are used to parameterize all 32 points.

Note: This value can be set in ladder logic, or through Modbus Plus as needed prior to triggering the middle input of the function block in order to configure the SER module.

Re-parameterize Points on Power Reset

Range: 0, 1

Offset: +104

Usage: Whenever an SER input point is parameterized by the CARD function block, the function block sets an internal flag to mark the parameterization of that point. Since the SER module cannot preserve any parameterizations through a power cycle, all point parameters are reset to their default values after a power cycle. Therefore, the function block re-parameterizes all points of

Range: 0..65535

Offset: +1, +4, +7, +10, +13, ...

Default: 10 ms

Usage: The purpose of the contact debounce time is to prevent multiple events from being generated from a single contact closure. The debounce time is the amount of time that input processing is disabled for a point after an event has been recorded

Note: This value can be set in ladder logic, or through Modbus Plus as needed prior to triggering the middle input of the function block in order to configure the SER module.

Chatter Count

Range: 0..255

Offset: 8 MSB bits of +2, +5, +8, +11, +14, ...

Default: 10

Usage: This parameter determines the maximum number of status changes allowed per minute before the point is taken off scan. Once a point is taken off scan, it will be put on scan again after being at least one minute below the chatter count.

Examples: Point A is taken off scan at 07:14:52.253
 --> Point A goes back on scan at 07:16:00.000
 Point B is taken off scan at 07:14:05.745
 --> Point B goes back on scan at 07:16:00.000

Note: This value can be set in ladder logic, or through Modbus Plus as needed prior to triggering the middle input of the function block in order to configure the SER module.

Scan Status

Range: 0, 1

Offset: LSB bit of +2, +5, +8, +11, +14, ...

Default: 0 (on scan)

Usage: A point can be taken off scan manually for maintenance and testing by setting the scan status to 1 (off scan), and then reconfiguring that point or set of points.

Note: This value can be set in ladder logic, or through Modbus Plus as needed prior to triggering the middle input of the function block in order to configure the SER module.

The following template page shows the function block status. It is to be used for read-only.

```

Utility          Hex      Dec      Bin      Goto          Quit
F1-----F2-----F3-----F4-- DX Zoom Editor -----F7-Lev 8-F8-OFF---F9-----+
                                                    Page 13 / 14
SER Module Setup V1.01 by NovaTech, Inc. (C) 1995
-----
SER STATUS (Read Only)
SER Module Status          40529 INT = 1000000000000000
Bit          ON          OFF
 1  IRIG B Absent          IRIG B Present
 2  SER Buffer Full (Unknown number of events lost)
 3  Power On Reset (Event buffer is completely empty)

SER Loadable Status (Bit ON = Error)          40528 INT = 0000000000000000
 7  Top Node Must Be Constant 1-32  12  Illegal Low Point Number
 8  TOD Clock Not Configured          13  Illegal SER MB+ Block Addr
 9  Illegal Configuration Op          14  Illegal 0x I/O Map Address
10  High Point < Low Point          15  Illegal 1x I/O Map Address
11  Illegal High Point Number          16  Illegal Table Length

SER Time Quality  00: Good  01: Fair          40526  01:02 = 00
                  10: Poor  11: Bad

SER Loadable Version          40527 INT = 101          DEC
    
```

SER Module Status

Range: ---

Offset: +129

Usage: This registers contains the SER module status

- Bit 1 (MSB) This bit is set ON when synchronization with an external time standard is lost.
- Bit 2 Every time the SER module event buffer overflows, this bit is set to ON for one scan.
- Bit 3 Every time the SER module goes through a power reset, this bit is set to ON for one scan.

Note: This value is read-only.

SER Module Status

Range: ---

Offset: +128

Usage: This register contains the SER Card function block status. Its primary purpose is to aid debugging during the programming and testing of the ladder logic program. Whenever a bit is turned on, a certain error condition is present.

Bit	Error Condition
16 (LSB)	Table length in bottom node of function block must be set to 130.
15	The 0x address entered in the function block is outside the valid 0x addresses as configured in the PLC's configuration. For example, if the inputs 10001 through 10512 are configured, the highest valid 1x address would be 10449, since the SER module requires 64 1x inputs.
14	The 0x address entered in the function block is outside the valid 0x addresses as configured in the PLC's configuration. For example, if the outputs 00001 through 01536 are configured, the highest valid 0x address would be 01473, since the SER module requires 64 0x outputs.
13	The 4x address entered is not the base address in the middle node of the SER Modbus Plus function block.
12	The number of the first point to be configured is out of range, i.e. less than 1 or greater than 32.
11	The number of the last point to be configured is out of range, i.e. less than 1 or greater than 32.
10	The number of the first point to be configured is greater than the number of the last point to be configured.
9	The selected configuration operation must be 0 (configure all points individually) or 1 (configure all points with parameters from point 1). Other values are not allowed.
8	The Time of Day Clock must be configured. This error is set only when the CLCK loadable is used.
7	The top node of the function block must be a value between 1 and 32 in order to identify the associated SER card. It must not be a 4x register.

Note: This value is read-only.

SER Time Quality

Range: 00-11 in the two MSB bits

Offset: +126

Usage: This register contains the current quality of the SER time stamps, in the two MSB bits. The values are as follows:

Bit	Quality
1 2 3-16	
0 0 x..x	Good, accuracy is GMT +/- 1ms
0 1 x..x	Fair, accuracy is GMT +/- 50ms
1 0 x..x	Poor, accuracy is GMT +/- 50ms or worse
1 1 x..x	Bad, no time reference available

Note: This value is read-only.

3.1.4 SER MODBUS PLUS FUNCTION BLOCK

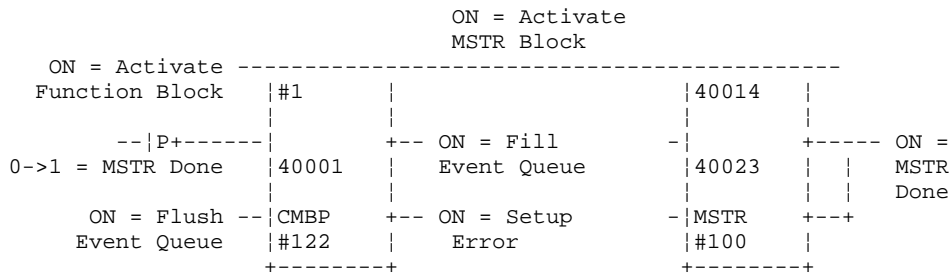
3.1.4.1 SER MODBUS PLUS FUNCTION BLOCK PROGRAMMING

The SER Modbus Plus function block can be inserted in ladder logic by selecting CMBP from the Modsoft loadable menu. The top node must always be set to #1. The middle node indicates the first of 122 4x registers required to manage the common event buffer and to control the associated MSTR function block. The length 122 is entered in the bottom node of the function block. In the example shown below, the registers 40001 through 40122 are used for the function block. Of course, the function block may be used with any 4x register.

The top input must always be set to ON in order for the function block to be active.

The middle input should be used with a positive transitional contact (---|P+---). After the associated MSTR function block is activated for transmission, the completion of the transmission is fed back to the SER Modbus Plus function block through its middle input. Subsequently, the function block turns ON the middle output in order to enable the SER Card function blocks to upload new events from the SER modules.

If the bottom input is turned ON, the current event buffer content is flushed. However, if the MSTR function block is currently active, it is allowed to complete. While the input is ON, events are still uploaded from the SER modules and stored in the event buffer. However, the buffer is continuously flushed, and no events are sent out.



Once the event buffer is full, or the time delay after putting an event in the buffer is up, the top output is turned ON in order to activate the MSTR function block. The top output remains ON until the MSTR function block feeds back a transmission completion through the middle input.

The middle output is set to ON when no Modbus Plus transmission is active. This enables the SER Card function blocks to upload events from the SER modules, and to store them in the event buffer. Once the event buffer is full, or the time delay after putting an event into the event buffer is up, the middle output is turned OFF in order to ensure the integrity of the event buffer.

The bottom output is turned on for illegal function block setup parameters.

There is always a MSTR function block associated with the SER Modbus Plus function block. The register address in the top node of the MSTR function block must be equal to the address in the middle node of the SER Modbus Plus function block, plus 13. The address in the middle node of the MSTR function block must be equal to the address in the middle node of the SER Modbus Plus function block, plus 22. For example, if the address in the middle node of the SER Modbus Plus function block was 40001, the address in the top node of the MSTR function block must be 40014, and the address in its middle node must be 40023. The table length in the bottom node of the MSTR function block must be set to 100.

All parameters in the MSTR template are set either in the SER Modbus Plus template, or directly by the SER Modbus Plus loadable. Thus, the MSTR template is generally not needed.

3.1.4.2 SER MODBUS PLUS FUNCTION BLOCK PARAMETERS

The SER Modbus Plus parameters can be entered using the Modsoft reference editor or Novatech's template. These parameters can also be changed as needed by the ladder logic program during its execution. Please note that the addresses for the parameters are relative to the register address in the middle node of the function block as shown above.

The following template pages can be invoked in Modsoft using the key combination <Alt>-Z when the ladder logic cursor is placed on the SER Modbus Plus function block.

```

Utility          Hex          Dec          Bin          Goto          Quit
F1-----F2-----F3-----F4-- DX Zoom Editor -----F7-Lev 8-F8-OFF---F9-----+
|
|                               SER Modbus Plus V1.01 by NovaTech, Inc. (C) 1994
|                               -----
|
|                               SER MODBUS PLUS SETUP
|
|   PLC Identifier                40023 INT = 2          DEC
|   Send Delay for First Event (0-6000) [10ms] 40001 INT = 500     DEC
|   MSTR Retry Delay (0-6000) [10ms]         40002 INT = 500     DEC
|   MSTR Routing Byte 1 (1-64)              40018 INT = 2       DEC
|   MSTR Routing Byte 2 (1-64)              40019 INT = 1       DEC
|   MSTR Routing Byte 3 (1-64)              40020 INT = 0       DEC
|   MSTR Routing Byte 4 (1-64)              40021 INT = 0       DEC
|   MSTR Routing Byte 5 (1-64)              40022 INT = 0       DEC
|
|                               SER MODBUS PLUS RESULTS (Read Only)
|   Number of Events in Queue                40025 INT = 0        DEC
|   SER Event Forwarder Status                40010 INT = 0000000000000000
|   MSTR Status                               40015 INT = 0000     HEX
|
|
|   SER Loadable Version                    40032 INT = 100     DEC
|
+-----+
    
```

PLC Identifier

Range: 0..32767

Offset: +22

Usage: Any input point must be identified by PLC in addition to SER module number and the actual point number in order to ensure proper system-wide identification. In case, all events are tagged as events from PLC 2, regardless of the SER module within PLC 2.

Note: This value must be unique for all PLCs in the SER system in order to properly identify SOE events, and should not be changed by ladder logic.

Send Delay for First Event [10ms]

Range: 0..6000 (0..60 seconds)

Offset: +0

Usage: When an event is placed in the event buffer, its forwarding to the BM85E or PC is delayed by this delay factor, whose unit is 10ms. For example a value of 500 indicates a delay of 5 seconds. If within 5 seconds another event is placed in the event buffer, the delay timer is reset. However, the current event buffer is sent when (a) the delay time is up, and no additional event has been placed in the event buffer, or (b) the delay time is not up yet, but the event buffer has been filled entirely, i.e. there are 30 events in the event buffer. In this case, the event buffer is sent as soon as the 30th event is stored in the event buffer. If the delay time is set to 0, every event is sent out immediately. The purpose of this factor is to enable the ladder logic program to control the number of Modbus Plus messages carrying events when the traffic load in Modbus Plus increases. For example, if the completion time for Modbus Plus messages increases, the send delay factor may also be increased. As a result, events that would be sent in separate Modbus Plus messages since they are a few seconds apart, would now be sent in a single Modbus Plus message.

Note: This value may be changed by ladder logic, depending on the specific application.

MSTR Retry Delay

Range: 0..6000 (0..60 seconds)

Offset: +1

Usage: In case an event buffer transmission via Modbus Plus fails, this parameter determines the delay before a retransmission of the same set of event is attempted. The unit of this parameter is also 10 ms. The purpose of this factor is to enable the ladder logic program to control the retry delay in case the Modbus Plus network is overloaded. Also, different PLCs can be programmed to use different retry factors in order to prevent simultaneous retries by several PLCs. If the Modbus Plus error cannot be resolved after several retries, the ladder logic program may decide to flush the event buffer, thereby losing events, or keep trying to send the present event buffer. In the latter case, the event buffers in the SER modules may overflow if more than 2000 events are present in a SER module.

Note: This value may be changed by ladder logic, depending on the specific application.

MSTR Routing Byte 1

MSTR Routing Byte 2

MSTR Routing Byte 3

MSTR Routing Byte 4

MSTR Routing Byte 5

Range: 1..64

Offset: +17, +18, +19, +20, +21

Usage: These bytes determine the route to the BM85E or the PC via Modbus Plus.

Note: If the PLC sends events to a BM85E, it must specify the data path of the BM85E to be used for the present Modbus Plus message, in addition to the BM85E's Modbus Plus node address. In the above example, the PLC and the BM85E are on the same Modbus Plus network. The BM85E's Modbus Plus address is 2, and the BM85E receives the Modbus Plus transmission through the data slave path 1. The valid range for BM85E data slave paths is 1 through 8.

The following parameters show the results of the SER Modbus Plus and the MSTR function blocks, and must be used as read-only.

Number of Events in Queue

Range: 0..30

Offset: +24

Usage: This register contains the current number of events in the event buffer. For every new event in the event buffer, the register is incremented by 1. When the event buffer has been sent via Modbus Plus, the register is set to 0. Since the event buffer may hold a maximum of 30 events, the values range between 0 and 30.

Note: This value is read-only.

SER Modbus Plus Status

Range: ---

Offset: +9

Usage: This register contains the SER Modbus Plus function block status. Its primary purpose is to aid debugging during the programming and testing of the ladder logic program. Whenever a bit is turned on, a certain error condition is present.

Bit	Error Condition
16 (LSB)	Table length in bottom node of function block must be set to 122.
15	The send delay is outside its valid range from 0 to 6000.
14	The MSTR retry delay is outside its valid range from 0 to 6000.

Note: This value is read-only.

MSTR Status

Range: ---

Offset: +14

Usage: This register contains the MSTR result code. For a complete listing and explanation of these codes, please refer to the description of the MSTR function block in the Modsoft Programmer User Manual.

Note: This value is read-only.

3.1.4.3 EVENT BUFFER STRUCTURE

The event buffer consists of two parts, the header and the buffer proper. The header is located in the first 10 registers of the Modbus Plus message. The first register contains the PLC identification, and the third register contains the number of events following. The tenth register contains the SER Loadable version number. The other seven registers are presently unused.

The actual events are stored immediately following the header. The first event will be stored in registers 11 through 13, the second event in registers 14-16, and the nth event in registers (n-1)*3+10 through (n-1)*3+12. These three registers per event are used as follows:

Register	Bits	Usage
1	11-15	SER Card Identification (0..31) (from SER Card Function Block)
1	10	Current Status Value (0 or 1, from SER module)
1	5-9	Status Identifier (0..31, from SER module)
1	0-4	Event Type
		1: Status Change
		2: Point On Scan
		3: Point Off Scan
		4: Chatter On Scan
		5: Chatter Off Scan
		6: Power On Reset
		7: External Time Sync Lock
		8: External Time Sync Lost
		9: SER Card Event Buffer Overflow (from SER module)
		10: Scan Buffer Overflow
		11: Time Resync Old Time
		12: Time Resync New Time
		13: Hourly Time Update
		14:Time Resync New Date
		15:Reconfigure
		Events 1 - 12
2	10-15	Seconds (0..59, from SER module)
2	0-9	Milliseconds (0..999, from SER module)
		Events 13 - 15
2	9-13	Hour (0..23)
2	4-8	Day (1..31)
2	0-3	Month (1..12)
		Events 1 - 12
	14-15	Time Quality
3	8-12	Hours (0..23, from SER module)
3	0-5	Minutes (0..59, from SER module)
		Events 13 - 15
3	14-15	Time Quality
3	0-12	Year (0..4095)

Example:

Offset	Value	Description
0	23	Message originated in PLC 23
1	x	unused
2	2	Message contains two events
3	x	unused
4	x	unused
5	x	unused
6	x	unused
7	x	unused
8	x	unused
9	100	Loadable version 1.00
10	15873 = 00111 1 10000 00001	Identifier of first event SER card 7 Current status 1 Status point 16 Event type 1 (status change)
11	39228 = 100110 0100111100	Second/milliseconds of event 38 seconds/316 milliseconds
12	4399 = 000 10001 00 101111	Hours/minutes of event 17 hours/47 minutes => Status point 16 on SER card 7 of PLC 23 changed to value 1 at 17:47:38.316
13	15873 = 00101 0 00000 01001	Identifier of second event SER card 5 Current status not used Status point not used Event type 9 (SER buffer overflow)
14	39228 = 100110 0101110010	Second/milliseconds of event 38 seconds/370 milliseconds
15	4399 = 000 10001 00 101111	Hours/minutes of event 17 hours/47 minutes => Buffer overflow on SER card 5 of PLC 23 at 17:47:38.370

3.1.5 SER CLOCK FUNCTION BLOCK

The use of SER Clock loadable is only necessary if:

- the application requires the PLC's time of day clock to be set from an external time standard
- the SER modules are operated without an external time standard, and therefore require the SER clocks to be set with the PLC's time of day clock

Absence of the SER Clock loadable does not affect the operation of the SER Card function blocks or the SER Modbus Plus function block.

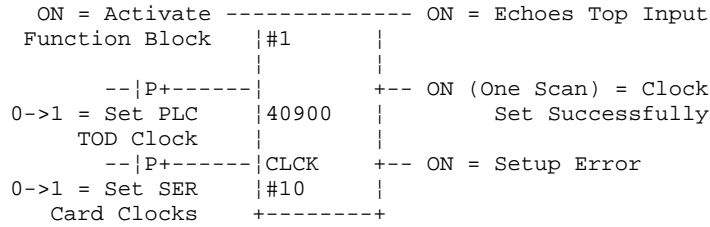
3.1.5.1 SER CLOCK FUNCTION BLOCK PROGRAMMING

The SER Clock function block can be inserted in ladder logic by selecting CLCK from the Modsoft loadable menu. The top node must always be set to #1. The middle node indicates the first of 10 4x registers required for this function block. The length 10 is entered in the bottom node of the function block. In the example shown below, the registers 40900 through 40944 are used for the function block. Of course, the function block may be used with any 4x register.

The top input must always be set to ON in order for the function block to be active.

The middle input should be used with a positive transitional contact. When the contact is triggered, the PLC's time of day clock is set with the IRIG-B time from the first SER module specified in the following list.

The bottom input should be used with a positive transitional contact. When the contact is triggered, the function block writes the current time from the PLC's time of day clock to all SER modules.



The top output echoes the top input.

The middle output is turned ON for one scan when the setting of the PLC's time of day clock is completed.

The bottom output is turned ON for illegal function block setup parameters.

3.1.5.2 SER CLOCK FUNCTION BLOCK PARAMETERS

The SER Clock parameters can be entered using the Modsoft reference editor or Novatech's template. These parameters can also be changed as needed by the ladder logic program during its execution. Please note that the addresses for the parameters are relative to the register address in the middle node of the function block as shown above.

The following template pages can be invoked in Modsoft using the key combination <Alt>-Z when the ladder logic cursor is placed on the SER Clock function block.

In this example, the SER Clock Loadable uses the CARD function block at 40400-40529 to set the PLC's time of day clock, or the SER card's internal clock. Once the SER card's clock is set, the SER card will send the new time to all other SER cards. Therefore, this SER card associated with the function block ar address 40400, must be set up to contain the master clock.

```

Utility          Hex      Dec      Bin      Goto          Quit
F1-----F2-----F3-----F4-- DX Zoom Editor -----F7-Lev 8-F8-OFF---F9-----+
|
|                SER Clock Setup V1.01 by NovaTech, Inc. (C) 1995
|                -----
|
|                SER MASTER CLOCK
| SER Card Function Block Address          40908 INT  = 400          DEC
|
|                SER CLOCK STATUS (Read Only)
| SER Clock Status (Bit Set = Error)      40900 INT  = 0000000000000000
| 12 Both Middle and Bottom Inputs Turned On
| 13 No SER Card Function Block Found at Entered Address
| 14 No SER Card Function Block Address Entered
| 15 Time of Day Clock Not Configured
| 16 Illegal Table Length
|
|
| SER Loadable Version                    40909 INT  = 101          DEC
|
+-----+
    
```

SER Card Function Block Address

Range: Depends on number of 4x registers in PLC configuration

Offset: +8

Usage: The SER Clock function block must know the base register address of the CARD function block associated with the SER card containing the master clock.

Note: This address should not be changed by ladder logic.

SER Clock Status

Range: ---

Offset: +0

Usage: This register contains the SER Clock function block status. Its primary purpose is to aid debugging during the programming and testing of the ladder logic program. Whenever a bit is turned on, a certain error condition is present.

Bit	Error Condition
16 (LSB)	Table length in bottom node of function block must be set to 10.
15	The time of day clock has not been configured in the PLC's configuration.
14	No SER Card function block address has been entered.
13	There is no CARD function block located at the entered address.
12	Both the middle and the bottom input are turned on simultaneously. It is not possible to set both clocks at the same time.

Note: This value is read-only.

APPENDIX A

SER CARD HARDWARE SPECIFICATIONS

32 Status input points per SER module
 24VDC, 48VDC and 125VDC Inputs available
 SER module 100% compatible with Modicon slot-mount PLCs and Modsoft
 Number of SER modules per PLC limited only by PLC's I/O capability
 Synchronization to external time standard
 1ms resolution time stamps
 2000 event buffer in SER module
 Each point may be configured individually with the following parameters:
 Contact Filter Time (0-65535ms)
 Contact Debounce Time (0-65535ms)
 Chatter Count (0-255) per minute
 Scan Status (0-On 1-Off)

Events reported by SER module:

Status Change
 Point Off Scan (before maintenance, testing, etc.)
 Point On Scan (after maintenance, testing, etc.)
 Chatter Off Scan (if chatter count per minute exceeded)
 Chatter On Scan (if chatter stopped)
 Power On Reset (after SER module is power-cycled)
 Time Sync Signal Lost
 Time Sync Signal Lock
 SOE Buffer Overflow (more than 2000 events present in module)
 Time Resync Old Time
 Time Resync New Time
 Hourly Time Update
 Time Resync New Date
 Reconfigure

Power Consumption 5V @ 125mA

Status Inputs	Turn On Voltage	Turn On Current	Maximum Current
125VDC	70VDC	1.5mA	5.5mA @ 140VDC
48VDC	27VDC	1.5mA	5.0mA @ 56VDC
24VDC	13VDC	1.5mA	5.3mA @ 28VDC

APPENDIX B**SER CARD I/O WIRING**

Terminal	Use
1	Positive input for point 1
2	Positive input for point 2
3	Positive input for point 3
4	Positive input for point 4
5	Positive input for point 5
6	Positive input for point 6
7	Positive input for point 7
8	Positive input for point 8
9	Common ground for points 1 through 8
10	Positive input for point 9
11	Positive input for point 10
12	Positive input for point 11
13	Positive input for point 12
14	Positive input for point 13
15	Positive input for point 14
16	Positive input for point 15
17	Positive input for point 16
18	Common ground for points 9 through 16
19	Positive input for point 17
20	Positive input for point 18
21	Positive input for point 19
22	Positive input for point 20
23	Positive input for point 21
24	Positive input for point 22
25	Positive input for point 23
26	Positive input for point 24
27	Common ground for points 17 through 24
28	Positive input for point 25
29	Positive input for point 26
30	Positive input for point 27
31	Positive input for point 28
32	Positive input for point 29
33	Positive input for point 30
34	Positive input for point 31
35	Positive input for point 32
36	Common ground for points 25 through 32
37	RS-485 Output driver enable (Open collector drive for fiber optic interface)
38	RS-485 A terminal
39	RS-485 B terminal
40	RS-485 ground

APPENDIX C

SER CARD REGISTER CONFIGURATION

Card Configuration: B807

Registers: 2 Input

Register Usage: Input register 1: Input points 1 - 16
 Input register 2: Input points 17 - 32

Card Configuration : B884

Registers: 4 Bi-directional

Register Usage: Output register 1: Not used
 Output register 2: Not used
 Output register 3: Command register
 Output register 4: Data register
 Input register 1: Input points 1 - 16
 Input register 2: Input points 17 - 32
 Input register 3: Echo of command
 Input register 4: Data

The SOE card contains 105 internal registers that are addressable through the command and data register. The organization of the command register is as follows:

Command Register: Bit 8 - 11 Command
 Bit 0 - 7 Register Address

Commands: 0 No Operation
 1 Read
 2 Write

The internal register assignments of the SOE card are as follows:

Register: 0 - 95 Point configuration registers (2 per point)
 96 - 98 Sequence of Events data buffer
 99 - 105 Time buffer

Point Configuration: Register 1 Filter constant (0 - 65,535)
 Register 2 Debounce time (0 - 65,535)
 Register 3 Bit 8 - 15 Chatter count (0 - 255)
 Bit 0 On/Off processing
 0 - On Scan
 1 - Off Scan

SOE Data: Event types 0 - 12

Register 1	Bit 0 - 4	Event type
	Bit 13	Current status
	Bit 8 - 12	Point number (0 - 31)
Register 2	Bit 10 - 15	Seconds (0 - 59)
	Bit 0 - 9	Milliseconds (0 - 999)
Register 3	Bit 14 - 15	Time Quality
		00 - Good (GMT +/- 1mS)
		01 - Fair (GMT +/- 50mS)
		10 - Poor (GMT +/- > 50mS)
		11 - Bad (No time reference)
	Bit 8 - 12	Hours (0 - 23)
	Bit 0 - 5	Minutes (0 - 59)

Event types 13 - 15

Register 1	Bit 0 - 4	Event type
	Bit 13	Current status
	Bit 8 - 12	Point number (0)
Register 2	Bit 9 - 13	Hour (0 - 23)
	Bit 4 - 8	Day (1 - 31)
	Bit 0 - 3	Month (1 - 12)
Register 3	Bit 14 - 15	Time Quality
		00 - Good (GMT +/- 1mS)
		01 - Fair (GMT +/- 50mS)
		10 - Poor (GMT +/- > 50mS)
		11 - Bad (No time reference)
	Bit 0 - 12	Year (0 - 4095)

Note: Register 1 bit fields 8 - 13, Point Number and Current Status, are only valid for event types 1 - 5. All other event types indicate card level conditions and these bit fields will contain zeros.

Note: The bit assignments shown for Register 1 describe the data as it is retrieved from the card. When the Card loadable is used to access the data, the bit assignments for Register 1 are modified to include the card number. The data will appear in the SER data buffer as follows:

Register 1	Bit 0 - 4	Event type
	Bit 5 - 9	Point number (0 - 31)
	Bit 10	Current status
	Bit 11 - 15	Card Number (0 - 31)

SOE Event Types:	0	No Event
	1	Status Change
	2	On Scan
	3	Off Scan
	4	Chatter On Scan
	5	Chatter Off Scan
	6	Power On Reset
	7	Time Sync Signal Lock
	8	Time Sync Signal Lost
	9	SOE Buffer Overflow
	10	Scan Buffer Overflow

- 11 Time Resync Old Time
- 12 Time Resync New Time
- 13 Hourly Time Update
- 14 Time Resync New Date
- 15 Reconfigure

APPENDIX D**EXTERNAL TIME REFERENCE INTERFACE SPECIFICATIONS****M80-800**

Communications	Modbus messages Baud rate - 9600 Bits - 8 Parity - Even Stop bits - 1 Address - 240
Power Consumption	5V @ 125mA Without Acutime Receiver 5V @ 900mA With Acutime Receiver -5V @ 25mA

M80-ISA

Power Consumption	5V @ 75mA +12V @ 30mA Without Acutime Receiver +12V @ 450mA with Acutime Receiver -12V @ 30mA
ISA Interface	1K Block of shared memory with the starting address selectable on a 1K boundary from C0000 to FFFFFF. Address selection switch S1 in the ON position is a Zero and in the OFF position is a ONE.
Communications	Modbus messages Modbus Address - 240 Message buffers in shared ram 0 - 255 Modbus Transmit Buffer (PC to M80) 1022 Transmit Semaphore Register 256 - 511 Modbus Receive Buffer (M80 to PC) 1023 Receive Semaphore Register 512 - 520 Current Date and Time (Read Only)
Interrupts	IRQ 2,3,4,5,7

EXTERNAL TIME REFERENCE I/O WIRING

M80 - 800

Port 1 - 9 Pin D connector - Trimble Navigation Acutime Receiver

Pin	Description
1	RS-422 A terminal RX Data from receiver
2	RS-422 B terminal RX Data from receiver
3	RS-422 B terminal TX Data to receiver
4	RS-422 A terminal TX Data to receiver
5	RS-422 A terminal 1 Pulse / Second signal from receiver
6	RS-422 B terminal 1 Pulse / Second signal from receiver
7	Ground
9	+12 Volt - Power for receiver

Port 2 - 9 Pin D connector - Computer Interface

Pin	Description
2	RX Data from computer
3	TX Data to computer
4	Tied to pin 6
5	Ground
6	Tied to pin 4
7	Request to send
8	Clear to send

Port 3 - 9 Pin D connector - Printer Interface (Option M81-800 Only)

Pin	Description
2	RX Data from printer
3	TX Data to printer
4	Tied to pin 6
5	Ground
6	Tied to pin 4
7	Request to send
8	Clear to send

Port 4 - 50/60 Hz Input

Pin	Description
1	9 - 24 VAC
2	9 - 24 VAC

Port 5 - 4 Position Phoenix connector - RS-485 Port

Pin	Description
1	Output driver enable (Open collector drive for fiber optic interface)
2	RS-485 A terminal
3	RS-485 B terminal
4	RS-486 Ground

Port 6 - BNC Connector for Modulated IRIG-B Time Code Signal

M80 - ISA

Port 1 - BNC Connector for Modulated IRIG-B Time Code Signal

Port 2 - 50/60 Hz Input - 2 Position Phoenix connector

Pin	Description
1	9 - 24 VAC
2	9 - 24 VAC

Port 3 - 4 Position Phoenix connector - RS-485 Port

Pin	Description
1	Output driver enable (Open collector drive for fiber optic interface) (Bottom Pin)
2	RS-485 A terminal
3	RS-485 B terminal
4	RS-485 Ground (Top pin)

Port 4 - 9 Pin D connector - Trimble Navigation Acutime Receiver

Pin	Description
1	RS-422 A terminal RX Data from receiver
2	RS-422 B terminal RX Data from receiver
3	RS-422 B terminal TX Data to receiver
4	RS-422 A terminal TX Data to receiver
5	RS-422 A terminal 1 Pulse / Second signal from receiver
6	RS-422 B terminal 1 Pulse / Second signal from receiver
7	Ground
9	+12 Volt - Power for receiver

RS-485 Wiring

In order to time sync multiple SER modules with an External Time Reference module, the RS-485 time synchronization bus must be connected between all of the modules. Wiring within a single I/O rack may be done with unshielded wire, but for long runs between I/O racks a twisted pair shielded cable must be used. The RS-485 bus connects to pins 38 - 40 of the front wiring connector on the SER card and to pins 2, 3 & 4 of the plug connector on the ETR card. On the M80-800 card, pin 1 of the RS-485 connector is located toward the top of the card, and on the M80-ISA card, pin 1 is located toward the bottom of the card. The wiring is as follows:

ETR	SER #1	SER #2	SER #3	SER #N	Signal Name
2 -----	38 -----	38 -----	38 -----	38 -----	A
3 -----	39 -----	39 -----	39 -----	39 -----	B
4 -----	40 -----	40 -----	40 -----	40 -----	Ground

EXTERNAL TIME REFERENCE REGISTER ASSIGNMENTS

Time Registers

40001 - Month
40002 - Day
40003 - Year
40004 - Hour
40005 - Minute
40006 - Second
40007 - Millisecond
40008 - Time quality. 0 = Good, 1 = Fair, 2 = Poor, 3 = Bad
40009 - Time bias (+/- 23). Time which is added or subtracted from the GPS or IRIG-B time.
40010 - Signal Source Bit 0 - GPS Selected
 Bit 1 - IRIG-B Selected
 Bit 2 - 50/60 Hz Selected
 Bit 3 - GPS 1PPS Signal Present
 Bit 4 - GPS Time Sync Message Present
 Bit 5 - IRIG-B Signal Present
 Bit 6 - 50/60Hz Signal Present

Current Status Registers

40021 - Card 1 Bits 1 - 16
40022 - Card 1 Bits 17 - 32
40023 - Card 2 Bits 1 - 16
|
40085 - Card 32 Bits 17 - 32

Event Buffer

40101 - Number of Events
40102 - Event #1 Register 1
40103 - Event #1 Register 2
40104 - Event #1 Register 3
40105 - Event #2 Register 1
|
40192 - Event #30 Register 3

Event Resend Buffer

40201 - Number of Events
40202 - Event #1 Register 1
40203 - Event #1 Register 2
40204 - Event #1 Register 3
40205 - Event #2 Register 1
|
40292 - Event #30 Register 3

Card Configuration Registers

40301 - Card 1 Command Register
 Bit 0 - 0 = Off Scan
 1 = On Scan
 Bit 1 - 0 = Normal
 1 = Reconfigure
40302 - Card 2 Command Register
|

40332 - Card 32 Command Register

Card Status Registers

40351 - Card 1 Status Register

 Bit 0&1 - Communications Status

 00 = Good

 01 = Marginal

 10 = Bad

40352 - Card 2 Status Register

|

40382 - Card 32 Status Register

Point Configuration Registers

40401 - Card 1 Point 1 Filter Constant

40402 - Card 1 Point 1 Debounce Constant

40403 - Card 1 Point 1 Chatter Count and Scan Status

40404 - Card 1 Point 2 Filter Constant

|

40496 - Card 1 Point 32 Chatter Count and Scan Status

40501 - Card 2 Point 1 Filter Constant

40502 - Card 2 Point 1 Debounce Constant

40503 - Card 2 Point 1 Chatter Count and Scan Status

40504 - Card 2 Point 2 Filter Constant

|

40596 - Card 2 Point 32 Chatter Count and Scan Status

|

43501 - Card 32 Point 1 Filter Constant

43502 - Card 32 Point 1 Debounce Constant

43503 - Card 32 Point 1 Chatter Count and Scan Status

43504 - Card 32 Point 2 Filter Constant

|

43596 - Card 32 Point 32 Chatter Count and Scan Status

APPENDIX E**SER LOADABLE SPECIFICATIONS**

SER Loadables run on all Modicon slot-mount PLCs
 Special templates in order to facilitate easy parameterization of loadables
 Transmission of events via Modbus Plus
 Total memory requirement: 2.3k (1.3k + 0.4k + 0.6k)

SER Card Loadable (CARD)

Loadable Size	1.3k
Average Scan Time	.5 ms
Maximum Scan Time	< 1 ms
4x Registers Required	130

This loadable is used once for every SER module in the PLC. Thus, scan time and registers requirements must be added up for every SER module used.

SER Modbus Plus Loadable (CMBP)

Loadable Size	0.4k
Average Scan Time	.5 ms
Maximum Scan Time	< 1 ms
4x Registers Required	122

This loadable is used only once in the entire ladder logic program.

SER Clock Loadable (CLCK)

Loadable Size	0.6k
Average Scan Time	.7 ms
Maximum Scan Time	< 2 ms
4x Registers Required	45

This loadable is optional, and used only once in the entire ladder logic program.

The scan times are based on a Modicon 984-385D PLC.