Sequence of Events Recorder

SER x53 00

User's 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 the operation of circuit breakers or the shutdown sequences of compressors and other high speed devices. The SER will provide the time of the event, the state of the point, and the point identification.

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.

1.1 SER CARD

The SER inputs cards, which are designed to operate as standard 32 point Modicon input cards, contain additional logic to generate a time stamp for each transition of the input points. Each card is synchronized to an external time source through an isolated RS-485 port. If no external time source is available, the cards can be synchronized to the time of day clock in the PLC. Each of the 32 input points has an individually configurable digital noise filter, digital bounce filter and chattering contact filter. Each input can also be individually enabled or disabled for event processing. All of the configuration data for the card is stored in the PLC controllers register space. The configuration data is downloaded to the SER card on command.

In addition to the 32 inputs, the card also has 32 output points configured in the I/O address map. These output points do not connect to any physical outputs, but they can be used in ladder logic to generate time tagged events. An example would be to place one of these coils in parallel with a physical output coil to generate a time stamp when the coil is energized.

1.2 SER FUNCTION BLOCKS

Function blocks are provided with the SER card for Modsoft, ProWorX, Concept and Unity programming packages. The SER function blocks provide an easy means of both configuring and gathering data from the SER cards. When the controller is reset, the function block will configure the SER cards and scan for event data. When an event is detected, the function block will build a buffer containing the event data and either send it over Modbus Plus to a receiving drop, or hold the buffer until a host computer polls the PLC for the data. Information on these function blocks can be found in the following manuals:

Users Guide for SER 984 Ladder Logic Function Blocks	Publication #10011
Users Guide for SER IEC Function Blocks	Publication #10012
Users Guide for Unity Function Blocks	Publication #10020

1.3 TIME SYNCHRONIZATION

If more that 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. Time synchronization is indicated by a red “F” light in the upper right hand side of the display. If the “F” light is off, the card is receiving a synchronization signal. If the “F” light is on, the card is not receiving a synchronization signal.

2.0 SER INSTALLATION

The SER card is mounted in the I/O rack of a Quantum controller. The card can be used in a Local, Remote or Distributed I/O configuration. In order for the controller to address the card it must first be placed in the controller I/O map. I/O mapping is supported for both Modsoft and Concept programming languages.

2.1 MODSOFT

The SER x53 00 card is supported under Modsoft version 2.6 and later, with no modifications. For earlier versions of Modsoft, a disk is provided with each card that contains the files:

QUANTUM.SYS
GCNFTCOP.SYS

If this disk is not available, it can be downloaded from the Monaghan Engineering web site at www.monaghan-engineering.com.

The QUANTUM.SYS file contains the help screens for all of the Quantum modules. The version that is provided with the SER card is the standard Modsoft version 2.51 QUANTUM.SYS, with support for the SER x53 00 card added. This file should be copied to the C:\MODSOFT\RUNTIME subdirectory.

The GCNFTCOP.SYS file contains the I/O addressing information for all of the Modicon I/O modules. The version that is provided with the SER card is the standard Modsoft version 2.51 GCNFTCOP.SYS, with support for the SER x53 00 card added. This file should be copied to the C:\MODSOFT\RUNTIME subdirectory.

Under some circumstances it may be necessary to add support for the SER x53 00 card to an existing GCNFTCOP.SYS file. This can be done by adding the following lines to the existing file, following the directions in the file header.

SER x53 00,yyy,0,08,08,Help Alt-h,0,L012E,0,0000,0
GPS 100 00,yyy,0,12,06,GPS/IRIG TIME SYNC,1,L0133,1,0000,0

where yyy is the module order number.

2.2 CONCEPT

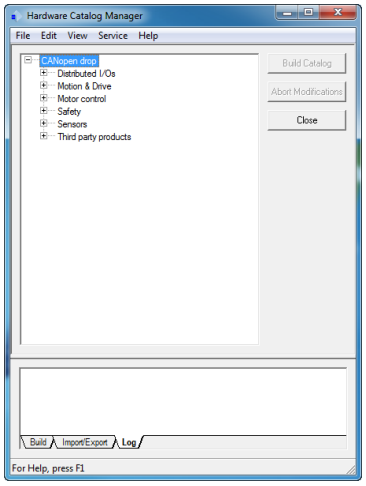
The SER x53 00 card is supported under Concept version 2.1 and later. The SER card configuration data must be added to the Concept database. This is done by running the MODCONN.EXE utility provided with Concept. Select the FILE command, then the Open Installation File command and then load the MNENG.MDC file that is provided on the disk supplied with the SER card. Then exit the program, start Concept and the SER card will be available in the module selection list.

2.3 UNITY

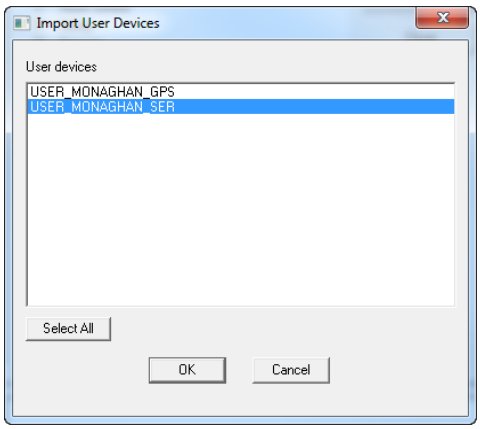
The SER x53 00 card is supported under Unity version 2.1 and later. In Unity versions 4.0 and earlier the SERx53 00 card is entered in the project configuration as a Generic Digital card. The following parameters should be entered into the card configuration screen.

Module Personality	302
Mapping	Bit(%I-1X %M-0X)
Setting the Module	
Number of Inputs	8
984 Quantum Input Format (Simple Module)	0
984 Quantum Input Format (DPM Module)	0
Number of Outputs	8
984 Quantum Output Format (Simple Module)	0
984 Quantum Output Format (DPM Module)	0
Input Type	Binary
Input Starting Address	Enter the starting 1X address of the card. Example: 1X0001 = 1
Output Type	Binary
Output Starting Address	Enter the starting 0X address of the card. Example: 0X0001 = 1

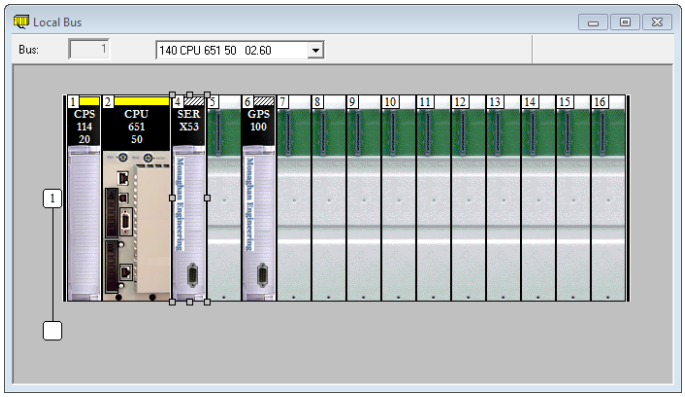
Starting with Unity 4.1, the SERx53 00 card can be added to the Hardware Catalog. This is done by running the Hardware Catalog Manager.



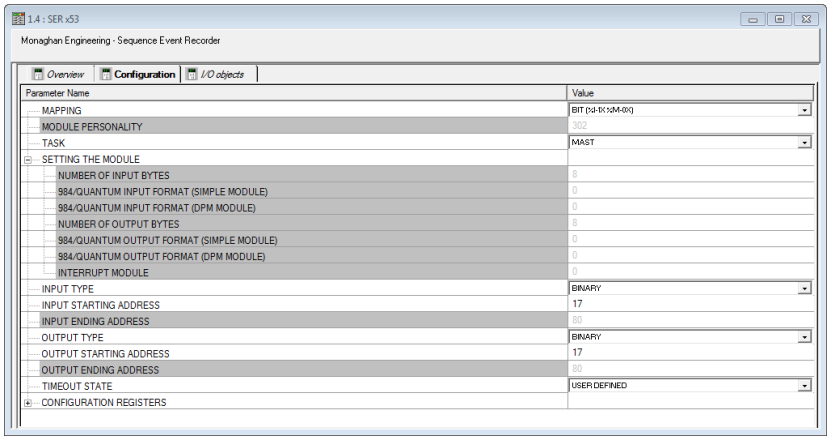
Select File and then Import User Devices. Open the USER_MONAGHAN.cpx file.



Select USER_MONAGHAN_SER and press OK. This will add the SERx53 00 card to the Unity Hardware Catalog. When configuring the drop, the SERx53 00 card will be shown in the rack.



Double clicking the SERx53 00 card will bring up the configuration screen where you can enter the proper starting addresses for the card.



2.4 I/O WIRING

Field wiring is connected to the SER x53 00 card using the Modicon 140 XTS 002 00 high density wiring connector.

2.3.1 STATUS INPUTS

The 32 input points are divided into four groups of eight inputs. Each group shares a common return. The screw terminal assignment of each point is contained in Appendix B of this manual.

2.3.2 RS-485 INTERFACE

The RS-485 interface is used for time synchronization of the SER card. The interface is electrically isolated from the SER card and the Quantum controller card. The connections to the RS-485 interface are located on pins 1 - 4 of the wiring connector. Pin 1 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. Pins 2 - 4 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 Quantum controllers, the cable shield should be grounded at one point to earth ground.

3.0 SER CARD FEATURES

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 Quantum controller's 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 Quantum 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)

3.1 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.

3.1.1 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.

3.1.2 CONTACT DEBOUNCE TIME

The contact debounce time can be set to any value form 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

3.1.3 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.

3.2 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.

3.2.1 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.

3.2.2 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.

3.2.3 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.

3.2.4 OFF SCAN

An Off 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.

3.2.5 CHATTER ON SCAN

A Chatter On Scan event message is generated whenever the SER card determines the 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.

3.2.6 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.

3.2.7 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 Quantum 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.

3.2.8 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.

3.2.9 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.

3.2.10 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.

3.2.11 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.

3.2.12 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. A total of three events will be generated when a time re-sync occurs. 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.

3.2.13 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. A total of three events will be generated when a time re-sync occurs. 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..

3.2.14 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.

3.2.15 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. A total of three events will be generated when a time re-sync occurs. 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.

3.2.16 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.

3.2.17 OUTPUT CHANGE

An Output Change event message will be generated whenever the SER card detects that an output 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. The output points contained on the card are addressed as 0X registers, but there are no physical output drivers.

3.2.7 RESTART DATE

A Restart Date event message is generated when the battery backup is enabled and 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 Quantum 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 date when the SER card lost power.

3.2.7 RESTART TIME

A Restart Time event message is generated when the battery backup is enabled and 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 Quantum 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 when the SER card lost power.

APPENDIX A

SER CARD HARDWARE SPECIFICATIONS

32 Status input points per SER module
32 Phantom output points per SER module
24VDC, 48VDC and 125VDC Inputs available
Battery backup of event data
SER module 100% compatible with Modicon Quantum PLC, Modsoft and Concept
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
- Output Point Change
- Restart Date (after SER module is power cycled with battery backup enabled)
- Restart Time (after SER module is power cycled with battery backup enabled)

Power Consumption 5V @ 250mA

Status Inputs	Minimum On Voltage	Minimum On Current	Maximum On Current
125VDC	70VDC	0.4mA	2.0mA @ 140VDC
48VDC	27VDC	0.8mA	3.5mA @ 56VDC
24VDC	15VDC	1.2mA	5.3mA @ 28VDC

APPENDIX B

SER CARD I/O WIRING

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

APPENDIX C

SER CARD REGISTER CONFIGURATION

Registers: 4 Bi-directional

Register Usage:
- Output register 1: Phantom Output points 1 - 16
- Output register 2: Phantom Output points 17 - 32
- 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 128 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 (3 per point)
	96 - 98	Sequence of Events data buffer
	99 - 105	Time buffer
	125 – 127	Local event data 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, 16, 18

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, 17

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 & 16. 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
16	Output Change
17	Restart Date
18	Restart Time