

# **Event Collector**

Part of the Brigger & Associates Event Recorder System

**User Manual**

for

**Allen-Bradley ControlLogix™ PLC's**



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## **ACRONYMS**

PLC – programmable logic controller.

PC – Microsoft Windows based personal computer.

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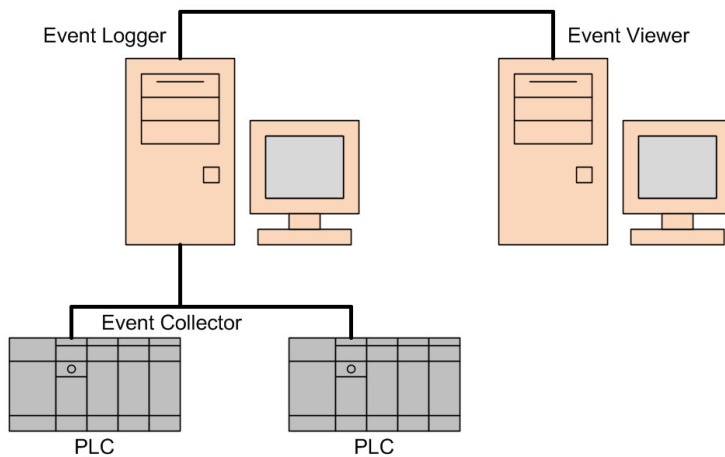
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## INTRODUCTION

The Event Recorder System is a tool for logging and displaying changes in digital conditions within a PLC program. It consists of 3 software applications:

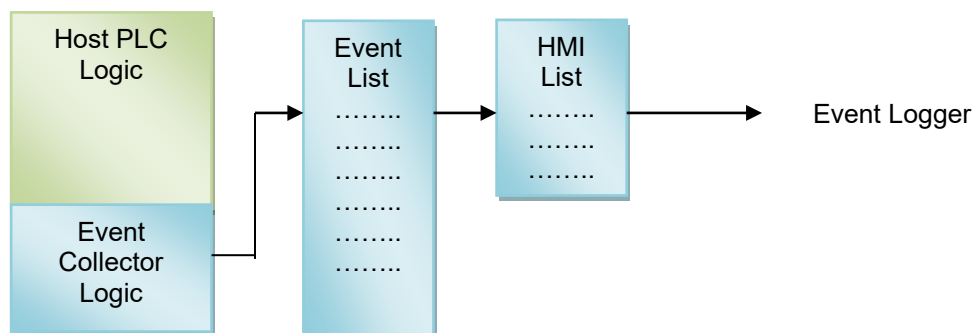
- Event Collector – Captures events.
- Event Logger – Logs events to a PC database.
- Event Viewer – Displays logged events.

A typical Event Recorder System is shown in the following figure:



The *Event Collector* is PLC logic that is part of the Brigger & Associates Event Recorder System. It collects events in the PLC and stores them until read by the *Event Logger*. It does this by monitoring the value of specified digital addresses during each PLC scan. When the value changes, an event occurs and the date and time of the event, as well as data identifying the event, are captured. Thus, unlike other data logging software, events that occur only during a single PLC scan are captured.

The *Event Collector* consists of PLC logic and 2 data files - the Event List and the HMI List. The PLC logic is added to the logic of an existing PLC program, referred to as the Host PLC logic.



When an event is captured, the date and time of the event, as well as data identifying the event, are written to the Event List. The data from this file is written to the HMI List. The event data in the HMI List is the data that is read by *Event Logger*.

The Event List stores event data until the event data in the HMI List is read by *Event Logger*. After the HMI List is read by *Event Logger*, data from the Event List is written to the HMI List.

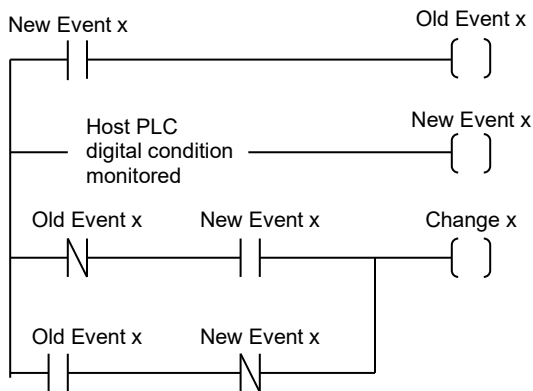
*Event Collector* PLC logic is supplied with the “Event Recorder System”.

## THEORY OF OPERATION

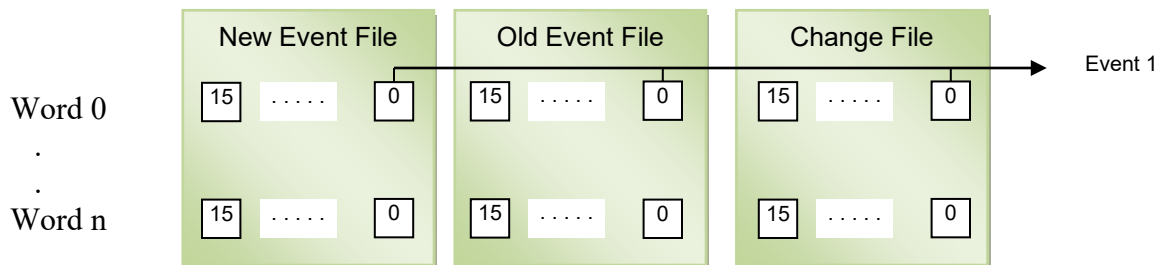
An event is defined as the change in value of any digital condition. The digital condition is usually a digital address. However, it can also be any condition with a digital result. An example of this would be a measured temperature exceeding a specific value.

### CAPTURING EVENTS

There are 3 Event Recorder bit addresses associated with each host PLC digital condition that is to be monitored by *Event Collector*. These bits are the New Event bit, the Old Event bit, and the Change bit. The New Event bit is the value of the digital condition for the current PLC scan. The Old Event bit is the value of the digital condition for the last PLC scan. And the Change bit indicates if the value has changed between the two PLC scans. The values of these bits are determined during each PLC scan by the following ladder logic:



For the *Event Collector* logic, the determination of the values of the Old Event and Change bits are determined on a word basis. In order to do this, the Old Event, New Event, and Change bits are bits in words of 3 separate integer data files, respectively.



Each possible event, referred hereafter just as an event, is represented by the same word/bit combination in each data file. Thus, the values of the Old Event and Change bits can be determined by the following Boolean equations (where XOR is the exclusive OR function):

Old Event Word = New Event Word  
Change Word = Old Event Word XOR New Event Word

### **EVENT NUMBER**

Since each bit in the data files represents a possible event, there are 16 events per word and  $n \times 16$  total possible events where  $n$  is the number of words in each file.

Each event is assigned an event number, starting from 1. If the first word in each file is word 0 and the first bit of any word is bit 0 then the event number for any word and bit combination is given by,

Event Number = (word number x 16) + (bit number + 1)

### **EVENT PACKETS**

For each PLC scan the values of the New Event, Old Event, and Change words are calculated. For each Change word whose value is not 0, one or more events represented by that word have occurred and an “event packet” is created. An event packet consists of the following 7 integer words:

1. (List Position and date (LPMMDDYY))
2. Time (HHMMSS)
3. Value of Change word
4. Value of New Event word

The List Position identifies the word in the Change word data file, with the first word having a List Position of 1. The Change word and New Event word represent 16 events. Knowing the List Position and the bits in the Change word that have a value of 1, the *Event Logger* determines Event Numbers and the New Event word determines the new value for the bits that changed.

The time and date are current time and date from the PLC’s calendar/clock.

### **STORING AND TRANSFERRING EVENTS**

As Event Packets are created, they are stored in the Event List until they can be sent to the HMI

List. The Event List is 192 words in length which means it can hold a total of 48 event packets.

The *Event Logger* reads the data in the HMI List. The HMI List is 194 words in length, consisting of 48 event packets and two communication words. The PLC driver used by the *Event Logger* can only read 100 words at a time. Therefore, in order to read the entire HMI List, the *Event Logger* reads words 0 to 95 first followed by words 96 to 191.

### **SYSTEM EVENTS**

There are 3 system events – PLC first scan, heartbeat, and event queue full. The PLC first scan event indicates that the PLC was started. The heartbeat event is a 30 minute pulse that indicates that the Event Recorder is working in case no other events occur during that time. And the queue full event indicates that the Event List was full so events after this were not logged. This would occur if the *Event Logger* was not reading the HMI List or events were being logged faster than could be read by the *Event Logger*.

### **COMMUNICATION FAULT**

The communication between the PLC and the *Event Logger* PC is continuously monitored. If data is in the HMI list but hasn't been read by the *Event Logger* PC, the following PLC bit is set to indicate the loss of communication:

Communication Fault Bit ER.Misc\_Bits[11]

This bit should be monitored by the Host PLC program to alert the operator.



## INSTALLATION OF PLC LOGIC

### INTRODUCTION

The PLC logic for the *Event Collector* is provided in the “Event Collector” folder of the “Event Recorder System” USB flash drive. The logic is provided as an Allen-Bradley ControlLogix project file, “Event Collector.ACD”. A “pdf” copy of this program is also provided.

The PLC logic consists of a “Main” routine and the following four routines:

ER0\_Clock\_1 This is logic for mapping the PLC dates and times of the host program to variables used by *Event Collector*.

ER0\_Clock\_2 This is logic to read the date and time from the PLC clock and mapping them to variables used by *Event Collector*.

ER1\_Logic This is the logic that captures and store events.

ER2\_List This is the logic that defines the digital conditions to be monitored.

The PLC addresses used by the Event Collector logic are those of the User-Defined Data Type “ER”. The elements of this data type are listed in Table 1.

In addition, there are 6 temporary integers, as listed below. These are only required if the ER0\_Clock\_1 is used.

USER-Year  
USER-Month  
USER-Day  
USER-Hour  
USER-Minute  
USER-Seconds

The *Event Collector* assigns a date and time to each event. The date and time are read from the PLC clock/calendar. As shown above, there are two clock routines, ER0\_Clock\_1 and ER0\_Clock\_2. Only one of these is used. ER0\_Clock\_1 is used if the host PLC already reads the PLC clock/calendar. Otherwise, ER0\_Clock\_2 is used.

To install the *Event Collector* logic into a host program the routines and USER-Defined Data Type “ER” are exported from “Event Collector.ACD” and imported into the host PLC.

## EXPORTING EVENT COLLECTOR ROUTINES

The following steps describe how to export the *Event Collector* ER data type and routines.

1. Load the “Event Collector.ACD” program with RSLogix5000 or Studio 5000 software.
2. In the “Controller Organizer”, open the “Data Types” folder and then the “User-Defined” folder. Right-click on “ER” and select “Export Data Type”. Specify where it is to be saved and click “Export”. The data type will be saved as an XML file with an extension of “.L5X”.
3. For each routine, select the routine name. Right-click on “Export Routine” and then specify where the routine is to be saved and click “Export”. Each routine will be saved as an XML file with an extension of “.L5X”. Note that only one clock routine needs to be exported.

## IMPORTING EVENT COLLECTOR ROUTINES

Once the *Event Collector* routines have been exported, they are then imported into the Host PLC per the following steps. Note that the routines are imported one at a time.

1. Load the Host program with RSLogix5000 or Studio 5000 software.
2. Select from the menu “File / Import Component / Data Type”. In the subsequently displayed window, select “ER.L5X” and click “Import”.
3. Select from the menu “File / Import Component / Routine”. In the subsequently displayed window, select an exported routine (“.L5X”) to be imported. Select where it is to be imported with the “Into” dropdown menu and click “Import”. Repeat for each exported routine.
4. In the Host Main routine, add an unconditional subroutine call to the “ER1\_Logic” routine and the imported clock routine.

## CONFIGURING ER0\_Clock\_1 ROUTINE

This is logic for mapping the PLC dates and times of the Host program to variables used by the *Event Collector*. This is only to be installed if the Host PLC reads the PLC clock/calendar and there are already time and date tags in the Host logic.

This routine is configured by replacing the “USER\_ xxx” tags in the MOV statements with the tags from the Host logic and removing the “AFI” contact. Note the date and time values are subject to the following value ranges:

USER\_Year    20xx

USER\_Month 1-12  
USER\_Day 1-3`  
USER\_Hour 0-23  
USER\_Minute 0-59  
USER\_Second 0-59

If this routine is installed, an unconditional call to this routine must be added to the Host Main routine.

Note, this mapping can be done anywhere in the Host PLC, if desired. In that case this file is not required.

### **CONFIGURING ER0\_Clock\_2 ROUTINE**

This routine must be used if the Host PLC does not read the PLC clock/calendar. It reads the PLC clock/calendar and maps the values to *Event Collector* tags.

If this routine is installed, an unconditional call to this routine must be added to the Host Main routine. There is no configuration required for this routine.

### **CONFIGURING ER1\_Logic ROUTINE**

This is the logic that captures the events. There is ordinarily no configuration. However, the default number of possible events can be changed and a loss of communication can be monitored.

#### Changing Default Number of Possible Events

The logic is configured for 1600 events – 100 New Event words, 100 Old Event words, and 100 Change words. The following changes are required if other than 100 event words are to be used:

1. In the “Update Old Events” section (Rung 24), change the “Length” in the COP function (rung 25) from 100 to the new number of words.
2. In the “Calculate Value of Change Words” section (Rung 30), change the “Source B” in the LES function (rung 34) from 100 to the new number of words.
3. In the “Construct Event Packets” section (Rung 35), change the “Source B” in the GEQ function (rung 38) from 100 to the new number of words.
4. Edit the ER tag. Change the array size for ER.New\_Events, ER.Old\_Events, and ER.Change\_Words to the new number of words.

Monitoring a Loss of Communication

If the Event Collector logic detects that the Event Logger is not reading events in the Event List, the bit ER.Misc\_Bits[11] is set. This bit should be monitored by the HMI or SCADA to alert the operator. It can also be mapped to a digital output to sound an alarm.

**CONFIGURING ER2\_List ROUTINE**

The New\_Events words represent the digital conditions that are monitored. Each digital condition monitored is mapped to a New Event word bit, ER.New\_Events[w].b where w is the word and b is the bit (0-15). Events 1 to 3 are system events that are preprogrammed:

- Event 1 Queue Full
- Event 2 PLC Started
- Event 3 Heartbeat

Events 4 – 96 are preprogrammed with an AFI command in each rung:



Replacing the AFI with a digital address or a digital condition will assign that address or condition associated Event address. Rungs must be added for more events to be monitored. Note that “ER.New\_Events” is a 16 bit array so that after bit 15 a new word with bit 0 is used.

This routine is called from the ER1\_Logic so it must NOT be called from the Main routine.

PLC Event Address Table

A Microsoft Excel workbook titled “PLC Event Address Table” is supplied with the “Event Recorder System” in the “Event Collector” folder. The Worksheet of this Workbook lists the event numbers and their associated New\_Event address. It is recommended that this workbook be used for setting up the digital conditions to be monitored. It can then be imported into the *Event Viewer* to provide descriptions for each event.

	A	B	C	D
1	Event	Description	Host	New Event
2	1	EVENT QUEUE FULL		ER.New_Events[0].0
3	2	PLC STARTED		ER.New_Events[0].1
4	3	30 MINUTE PULSE		ER.New_Events[0].2
5	4			ER.New_Events[0].3
6	5			ER.New_Events[0].4
7	6			ER.New_Events[0].5
8	7			ER.New_Events[0].6
9	8			ER.New_Events[0].7
10	9			ER.New_Events[0].8
11	10			ER.New_Events[0].9
12	11			ER.New_Events[0].10
13	12			ER.New_Events[0].11
14	13			ER.New_Events[0].12
15	14			ER.New_Events[0].13

Enter the digital condition in the host PLC to be monitored in the “Host” column and a description in the “Description” column. The “Event” and “New Event” columns must not be edited. There are rows for 100 event words. Excess rows can be deleted. Once this table has been filled in, ER2\_List can be programmed. New entries can be made later or existing entries edited.

Any PLC digital address can be monitored. The following are usually monitored as a minimum:

- Digital inputs
- Digital outputs
- Alarms
- Operator commands from an HMI terminal

Digital addresses that represent certain conditions may be monitored, such as a process mode, a control sequence running, etc.

Also, any condition with a digital result can be monitored.

### **Warning**

Monitoring digital conditions that change rapidly and often, such as a flow pulse, can overload the *Event Collector*, resulting in loss of events. This would be indicated by a “Queue Full” event in the *Event Viewer*.

The completed “PLC Event Address Table” is used by the *Event Viewer* in assigning descriptions to the events. The description and address for each event must match the requirements of *Event Viewer*. These are that the number of characters is limited to 50 for the “Description” and 40 for the “Host” address.

The appendix describes how to fill out the PLC Event Address Table using the Host program labels.

**TABLE 1: USER DEFINED DATA TYPE ER**

Variable	Type	Description
ER.New Events	DINT[100]	Value of Event words for current scan
EROld Events	DINT[100]	Value of Event words for previous scan
ER.Change Words	DINT[100]	Words whose values change
ER.Event List	DINT[192]	Stored events
ER.MMI List	DINT[195]	Events to be read by <i>Event Logger</i>
ER.List Position	INT	Position in Event List for event packet
ER.Event List Pointer	INT	Position in Event List for next event
ER.Comm Counter	INT	Communication word read by Event Logger
ER.Change Word Loop Pointer	INT	Current word for checking Change words
ER.Event Words	DINT[4]	
ER.Event Words[0]	DINT	Event Word 1 - LPMMDDYY
ER.Event Words[1]	DINT	Event Word 2 - HHMMSS
ER.Event Words[2]	DINT	Event Word 3 - Change Word
ER.Event Words[3]	DINT	Event Word 4 - New Event Word
ER.Misc Bits	BOOL[32]	
ER.Misc Bits[0]		Communication Flag
ER.Misc Bits[1]		Okay to Transfer Event List to HMI List
ER.Misc Bits[2]		Transfer Event List to HMI List
ER.Misc Bits[3]		Event Queue Full
ER.Misc Bits[4]		
ER.Misc Bits[5]		Toggle ON to update clock
ER.Misc Bits[6]		System Heart Beat (30 min flip flop)
ER.Misc Bits[7]		
ER.Misc Bits[8]		Increment Counter (HMI not responding)
ER.Misc Bits[9]		
ER.Misc Bits[10]		Reset Event Collector Files
ER.Misc Bits[11]		Event Logger Communication Fault
ER.Timers	TIMER[5]	
ER.Timers[0]	TIMER	Events Pending Time
ER.Timers[1]	TIMER	HMI Not Responding Time

**TABLE 1: EVENT COLLECTOR VARIABLES**

**User Defined Data Type: ER**

<b>Variable</b>	<b>Type</b>	<b>Description</b>
ER.Timers	TIMER[5]	
ER.Timers[0]	TIMER	Events Pending Time
ER.Timers[1]	TIMER	Heartbeat – Pulse ON Time
ER.Timers[2]	TIMER	Heartbeat – Pulse OFF Time
ER.Timers[3]	TIMER	HMI Not Responding Time
ER.Timers[4]	TIMER	HMI Communication Fault Time
ER.DateTime	INT[6]	
ER.DateTime[0]	INT	Current Year
ER.DateTime[1]	INT	Current Month
ER.DateTime[2]	INT	Current Day
ER.DateTime[3]	INT	Current Hour
ER.DateTime[4]	INT	Current Minute
ER.DateTime[5]	INT	Current Seconds
ER.Clock Parameters	DINT[7]	
ER.Clock Parameters[0]	DINT	PLC Year
ER.Clock Parameters[1]	DINT	PLC Month
ER.Clock Parameters[2]	DINT	PLC Day
ER.Clock Parameters[3]	DINT	PLC Hour
ER.Clock Parameters[4]	DINT	PLC Minutes
ER.Clock Parameters[5]	DINT	PLC Seconds
ER.Clock Parameters[6]	DINT	PLC Microseconds

## APPENDIX: USING PROGRAM LABELS

The Host PLC program address labels can be used to assist in filling out the “PLC Event Address Table” for digital addresses. This can be done through the following steps:

1. Display the Host PLC program.
2. Select the menu “Tools / Export / Tags and Logic Comments”. This will create a “.csv” file.
3. Open this file into a new Excel Workbook and save as a “.xlsx” file.
4. Delete rows 1 through 7.
5. Delete columns A, B, C, E, and G. Thus, only the description is shown in column A and the address in column B. Expand the columns for readability.
6. Delete all rows for addresses not to be monitored.
7. A “\$N” is used to separate each line of a label when displayed in the PLC logic. Replace the “\$N” with a blank using the “Replace” feature of Excel.
8. Copy the two columns of the row and paste into the “PLC Event Address Table”. Start after Event 16. The copied rows do not have to be contiguous. There can be empty event data.
9. Assure that the descriptions are less than 50 characters and addresses are less than 40 characters.
10. Save the “PLC Event Address Table” workbook.
11. Use the “PLC Event Address Table” workbook to enter the logic in the ER2\_List routine. (A contact with “Host” address with a coil with the “New Event” Address.)