

# TrendRecorder

IEC 61131 Library for ACCELERATOR RTAC® Projects

SEL Automation Controllers

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## RTAC LIBRARY

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# TrendRecorder

## Introduction

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This library provides flexible and scalable analog trend recording capability to the RTAC. It can provide ACSELERATOR TEAM® SEL-5045 Software Load Data Profile (LDP) records, which are viewable via ACSELERATOR Meter Reports SEL-5630 Software.

By using intuitive function blocks, users can configure as many as 12 different recorders, each capable of recording 16 analog values. Two types of recorders are available: an interval recorder and a monitor recorder. The interval recorder uses a recording interval setting and records all 16 analog values each interval. The monitor recorder has a record time and a trigger input. Recording occurs when the rising edge of the trigger is observed and the time provided by the record time input is associated with the record (instead of the internal time source of the RTAC). Each recorder records the value of each analog at the time the record occurs (also known as an end-of-Interval recorder).

This document provides detailed information about the purpose and functionality of each function block (along with its inputs and outputs). It also provides a configuration example.

## Special Considerations

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### Record Storage Space

The TrendRecorder library uses files stored on the RTAC file system to record data. The amount of data that can be retained is dependent on the available hard drive space as well as the recording interval configured for each recorder.

### Recommended Library Class Usage

Copying classes from this library causes unwanted behavior. This means the following:

1. The assignment operator “:=” must not be used on any class from this library; consider assigning pointers to the objects instead.

```
// This is bad and in most cases will provide a compiler error such  
as:
```

## Supported Firmware Versions

```
// "C0328: Assignment not allowed for type
class_ProfileRecorderObject"
myProfileRecorderObject := otherProfileRecorderObject;

// This is fine
someVariable := myProfileRecorderObject.value;
// As is this
pt_myProfileRecorderObject := ADR(myProfileRecorderObject);
```

- Classes from this library must never be VAR\_INPUT or VAR\_OUTPUT members in function blocks, functions, or methods. Place them in the VAR\_IN\_OUT section or use pointers instead.

Classes in this library have memory allocated inside them. As such, they should only be created in environments of permanent scope (e.g., Programs, Global Variable Lists, or VAR\_STAT sections).

## Supported Firmware Versions

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You can use this library on any device configured using ACSELERATOR RTAC<sup>®</sup> SEL-5033 Software with firmware version R143 or higher.

To enable TrendRecorder library support, the device number of your RTAC must include the feature in its model option table (MOT). You cannot download projects including this library to RTACs that do not support the library. Use the SEL website MOT configuration (<https://www.selinc.com/onlinemot/>) to ensure that a particular part number has TrendRecorder support enabled.

Versions 3.5.0.3 and older can be used on RTAC firmware version R136-V2 and higher.

## Usage

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The purpose of this library is to provide analog trend recording capability to the RTAC in a way that requires as little configuration as possible. All settings required for recorder setup are completed with only three function blocks (see *Function Blocks on page 6* for more detail). This section provides information about the intended usage of the TrendRecorder library as well as some details about operations that occur in the background.

## Theory of Operation

The TrendRecorder library is designed to interface with TEAM. TEAM collects the recorded data in LDP format and saves it into the ACSELERATOR Database. The collected data is then available for other software solutions, such as ACSELERATOR Meter Reports SEL-5630 Software.

It is important to note that the TrendRecorder library can record analog values from any capable source—it is not limited only to typical load profile or even electrical) values. As long as the analog is of type REAL, it can be recorded.

The core of the TrendRecorder library user interface consists of two profile recorder function blocks: ProfileIntervalRecorder and ProfileTriggerRecorder. Contained within these two function blocks is everything the RTAC needs to collect and record analog data. Simply instantiate one or more of them in a Continuous Function Chart (CFC) program, connect each recorder to the ProfileManager function block, create a Telnet Access Point, and start collecting recorded data. Each recorder records 16 analogs, and as many as 12 recorder function blocks can be instantiated (192 total analogs can be recorded in a single RTAC).

Each ProfileIntervalRecorder records data at an interval specified by its *RecordingInterval* setting. If possible, the recorder will align the recording interval with the current time. For example, if an interval of 5 seconds is specified, the recorder will record data at 0, 5, 10, 15, 20 seconds, and so on. If 900 seconds is specified (equal to 30 minutes), the recorder will record data at the top of the hour and the bottom of the hour (at 0 and 30 minutes of the hour). A full list of auto-aligned intervals is available in *Table 1*.

Each ProfileTriggerRecorder records data when the rising edge of an external trigger is observed, at a frequency as high as once per second. It is capable of accepting an external time stamp to associate with the data record. This allows the RTAC to save data with the same time stamp provided by a remote IED with the data over a protocol that supports time-stamped data (such as Distributed Network Protocol (DNP)).

The ProfileManager function block is responsible for providing the Telnet command line interface that TEAM uses to collect recorded data. It is also responsible for compiling and transmitting records via a binary data format to TEAM via YMODEM.

**Note:** TEAM collects trend record data from the RTAC via Telnet. An Access Point configured for Telnet Port 23 must exist within the RTAC project to facilitate this communication.

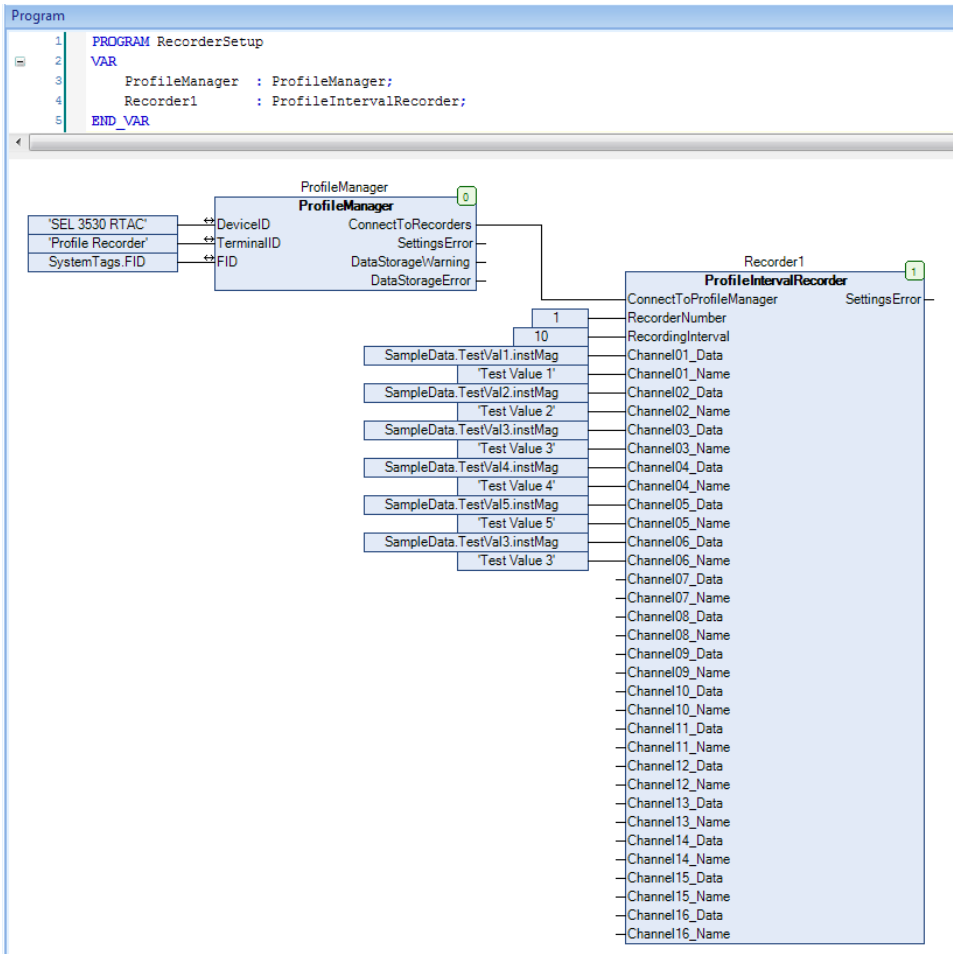


Figure 1 Example Recorder Usage

## Function Blocks

This library provides three function blocks for use in setting up trend recorders: ProfileIntervalRecorder, ProfileTriggerRecorder, and ProfileManager. You only need these function blocks to configure fully functional profile recording in the RTAC.

### ProfileIntervalRecorder (Function Block)

This function block records 16 analogs of type REAL at a specified interval from 1 to 7200 seconds. Any unused channels record a zero at each recording interval.

## Inputs

Name	IEC 61131 Type	Description
ConnectToProfileManager		This pin must be connected to the ProfileManager. This connection is required for the recorder to save data and for the manager to retrieve data when TEAM requests it.
RecorderNumber	UINT	The recorder number (1–12) to assign to the recorder. Any recorder with a recorder number outside of this range will not record data. Any recorders that duplicate a recorder number will not record data.
RecordingInterval	UINT	The interval (1–7200, in seconds) at which to record data. If no <i>RecordingInterval</i> is provided, the recorder will default to a setting of 60 seconds. Any interval value less than one will be forced to a setting of one. Any interval value greater than 7200 will be forced to a setting of 7200.
Channel[n]_Data	REAL	The analog inputs to be recorded, where <i>n</i> is the channel number from 1–16. Zeros are recorded for all disconnected channel data inputs.
Channel[n]_Name	STRING(15)	The names of analogs to be recorded, where <i>n</i> is the channel number from 1–16. Channel names longer than 15 characters will be truncated to the first 15 characters. If no value is assigned, the channel name will be set to <b>Chan [n] Rec [x]</b> , where <i>n</i> is the channel number and <i>x</i> is the recorder number.

## Outputs

Name	IEC 61131 Type	Description
SettingsError	BOOL	This output asserts if the recorder has a settings error. If this output is asserted, the recorder will not function.

## ProfileTriggerRecorder (Function Block)

This function block records 16 analogs of type REAL any time the rising edge of the record trigger input is observed, at a frequency as high as once per second. Any unused channels will record a zero at each recording interval.

## Inputs

Name	IEC 61131 Type	Description
ConnectToProfileManager		This pin must be connected to the ProfileManager. This connection is required for the recorder to save data and for the manager to retrieve data when TEAM requests it.
RecorderNumber	UINT	The recorder number (1–12) to assign to the recorder. Any recorder with a recorder number outside of this range will not record data. Any recorders that duplicate a recorder number will not record data.
RecordTrigger	UINT	The recording trigger. Asserting this trigger at a rate as high as once per second will result in data being recorded.
RecordTime	DT	The record time that will be used when recording data. If this input is not providing a valid time or is left disconnected, the internal time of the RTAC will be used instead.
Channel[n]_Data	REAL	The analog inputs to be recorded, where <i>n</i> is the channel number from 1–16. Zeros are recorded for all disconnected channel data inputs.
Channel[n]_Name	STRING(15)	The names of analogs to be recorded, where <i>n</i> is the channel number from 01–16. Channel names longer than 15 characters will be truncated to the first 15 characters. If no value is assigned, the channel name will be set to <b>Chan [n] Rec [x]</b> , where <i>n</i> is the channel number and <i>x</i> is the recorder number.

## Outputs

Name	IEC 61131 Type	Description
SettingsError	BOOL	This output asserts if the recorder has a settings error. If this output is asserted, the recorder will not function.
RecordingBlocked	BOOL	This output asserts immediately following an assertion of the RecordTrigger input and remains asserted for one second. When asserted, no recording occurs, and any assertion of the RecordTrigger input is ignored.

## ProfileManager (Function Block)

This function block is used to provide files to TEAM. It also helps manage RTAC storage space for all configured recorders. It has three inputs—*DeviceID*, *TerminalID*, and *FID*—which are used by Meter Reports software to label reports generated using data collected from the RTAC. Do not create more than one instance of ProfileManager, as doing so results in undesired behavior. All configured recorders must be connected to it via their *ConnectToProfileManager* pins.



## Inputs/Outputs

Name	IEC 61131 Type	Description
DeviceID	STRING(22)	The RTAC device description. Inputs greater than 22 characters are truncated to 22 characters.
TerminalID	STRING(22)	A description of the function or location of the RTAC. Inputs greater than 22 characters are truncated to 22 characters.
FID	STRING	The Firmware ID of the RTAC. SystemTags.FID must be connected to this input. If this input is not connected, no recording occurs.

## Outputs

Name	IEC 61131 Type	Description
ConnectToRecorders		The connection point for the <i>ConnectToProfileManager</i> pins on each configured recorder. Each recorder must be connected to this pin in order to function.
DataStorageWarning	BOOL	This output asserts when not enough storage space is available to meet the requirements of the current recorder configurations. When this output asserts recorders will run out of storage space within 30 days. To resolve this issue either free up hard drive space on the RTAC or reduce the number of configured recorders.
DataStorageError	BOOL	This output asserts when no storage space is available, indicating no new data are being saved.
SettingsError	BOOL	This output asserts if the manager has a settings error. If asserted, none of the recorders will function.

## Telnet Communications

The ProfileManager function block uses Telnet to provide trend data to external clients such as TEAM. To be able to communicate via Telnet on the RTAC, an Access Point with Network Connection Type of Telnet and Local Port Number of 23 must be added to the RTAC project.

# Recorder Operation

## Recording Interval Functionality

The ProfileIntervalRecorder attempts to time-align the recording interval with the top of minute, top of hour, or top of day. This makes for cleaner chart generation and data visualization. The following table describes how each interval setting is adjusted.

Interval Setting (seconds)	Time Alignment Behavior
1	Top of second
2	Top of second AND current second MOD 2 = 0

Interval Setting (seconds)	Time Alignment Behavior
3	Top of second AND current second MOD 3 = 0
4	Top of second AND current second MOD 4 = 0
5	Top of second AND current second MOD 5 = 0
6	Top of second AND current second MOD 6 = 0
10	Top of second AND current second MOD 10 = 0
15	Top of second AND current second MOD 15 = 0
20	Top of second AND current second MOD 20 = 0
30	Top of second AND current second MOD 30 = 0
60	Top of minute
120	Top of minute AND current minute MOD 2 = 0
180	Top of minute AND current minute MOD 3 = 0
240	Top of minute AND current minute MOD 4 = 0
300	Top of minute AND current minute MOD 5 = 0
360	Top of minute AND current minute MOD 6 = 0
600	Top of minute AND current minute MOD 10 = 0
900	Top of minute AND current minute MOD 15 = 0
1800	Top of minute AND current minute MOD 30 = 0
3600	Top of hour
7200	Top of hour AND current hour MOD 2 = 0
All others	Start recording immediately (no time alignment)

## Effect of Task Cycle Time on TrendRecorder Functionality

Like all user logic executing on an RTAC, the Trend Recorder library executes at a speed defined by the Cycle Time setting of the task it is running on. It is highly recommended that configured recorders be run on a task with a cycle time as fast as possible (i.e., 100 milliseconds or less).

**NOTE:** The slower the Task Cycle setting, the longer it will take for the RTAC to communicate with TEAM. The collection interval configured in TEAM should be adjusted to account for this.

## ProfileTriggerRecorder RecordTime Input Requirements

The ProfileTriggerRecorder function block can associate record data with an external time stamp provided via the RecordTime input. This input is of type DT and in order to be valid must be greater than midnight on January 1, 2000.

## Settings Changes

When the settings of a recorder are changed, all of the saved data for that recorder is removed from the RTAC. A loss of data in other recorders could also occur because of storage reallocation caused by the addition of a new recorder.

Changes to settings elsewhere in the RTAC (i.e., not recorder settings) will not result in deleted data. The only data loss that may occur would be caused by a missed recording interval during the sending of the new settings to the RTAC.

Do not remove or modify the files stored in the LDP folder on the RTAC. These files contain settings and record data. Tampering with or removing these files may result in recorder data loss or deletion.

## Loss of Data Because of File System Use

Because of the flexibility of the RTAC, its file system usage is dependent on the specifics of the application. If the file system is used for more than just the TrendRecorder library (such as for file storage, FTP operations, or file retrieval), it is possible that not enough file space will be available to store TrendRecorder data. If this occurs, recorders will not be able to record new data.

## Trend Recorder Data Files

Each recorder saves data to the RTAC hard drive in a binary file. A new file is created at the top of each day, for as many as 30 days of record data. These files are viewable from the RTAC web interface, but are saved in a binary format and are not human-readable. Do not delete these files—doing so will cause recorder data loss. The TrendRecorder library limits itself to 1 GB of space on the RTAC file system. Each recorder is given an equal share of that space and will use as much of that space as is required based on its recording interval setting or record trigger frequency.

# Benchmarks

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## Benchmark Platforms

The benchmarking tests recorded for this library are performed on the following platforms.

- SEL-3505
  - R136-V0
- SEL-3530
  - R136-V0
- SEL-3555
  - Dual-core Intel i7-3555LE processor
  - 4 GB ECC RAM
  - R136-V0

## Benchmark Test Descriptions

All tests were run on a 100-millisecond task cycle time with ProfileRecorders running at the default interval of 60 seconds.

The posted times include the minimum, mean, maximum, and standard deviation of execution time in microseconds over 5000 samples.

## Benchmark Results

**Note:** The benchmarks were not found to be different in any statistically significant way from those for the previous release, so the numbers have not been updated.

Operation Tested		Platform (time in $\mu s$ )		
		SEL-3505	SEL-3530	SEL-3555
ProfileManager	Min	23	18	1
	Mean	571	233	27
	Max	154315	1546	627
	$\sigma$	2875	152	34
1 ProfileIntervalRecorder	Min	26	19	1
	Mean	978	556	26
	Max	2572	1120	80
	$\sigma$	285	176	8
ProfileManager	Min	25	18	1
	Mean	854	311	37
	Max	186153	1567	568
	$\sigma$	5422	214	42
4 ProfileIntervalRecorders	Min	84	60	1
	Mean	3633	2103	63
	Max	5462	3263	129
	$\sigma$	834	641	14
ProfileManager	Min	27	18	1
	Mean	359	316	38
	Max	312459	2318	578
	$\sigma$	4416	274	42
12 ProfileIntervalRecorders	Min	252	164	4
	Mean	10320	5642	179
	Max	16134	7944	328
	$\sigma$	3972	1668	51
ProfileManager	Min	24	19	1
	Mean	233	278	34
	Max	88357	9557	717
	$\sigma$	1259	259	43
1 ProfileTriggerRecorder	Min	25	19	1
	Mean	1026	565	23
	Max	2779	1100	60
	$\sigma$	263	131	6
ProfileManager	Min	25	19	1
	Mean	778	191	43
	Max	142039	13522	780
	$\sigma$	3505	259	46
4 ProfileTriggerRecorders	Min	87	60	2
	Mean	3979	2182	66
	Max	5852	3450	151
	$\sigma$	876	473	13
ProfileManager	Min	27	18	1
	Mean	216	265	11
	Max	90038	14945	92
	$\sigma$	1284	310	5

Operation Tested		Platform (time in $\mu s$ )		
		SEL-3505	SEL-3530	SEL-3555
12 ProfileTriggerRecorders	Min	236	236	4
	Mean	11434	6230	190
	Max	14799	8152	330
	$\sigma$	2496	1201	37

# Release Notes

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<b>Version</b>	<b>Summary of Revisions</b>	<b>Date Code</b>
3.5.1.0	<ul style="list-style-type: none"><li>▶ Allows new versions of ACSELERATOR RTAC to compile projects for previous firmware versions without SEL IEC types “Cannot convert” messages.</li><li>▶ Must be used with R143 firmware or later.</li></ul>	20180921
3.5.0.3	<ul style="list-style-type: none"><li>▶ Resolved an issue where, under certain conditions, recorded data were not provided to ACSELERATOR TEAM software.</li><li>▶ Removed library version 3.5.0.2 from the installer.</li></ul>	20170412
3.5.0.2	<ul style="list-style-type: none"><li>▶ Initial release.</li></ul>	20161216