Foxboro™ SCADA

SCD6000 State And Logic Language (SALL)

PSS 41S-2S6KSAL

Product Specification

April 2024

https://www.se.com

Legal Information

The information provided in this document contains general descriptions, technical characteristics and/or recommendations related to products/solutions.

This document is not intended as a substitute for a detailed study or operational and site-specific development or schematic plan. It is not to be used for determining suitability or reliability of the products/solutions for specific user applications. It is the duty of any such user to perform or have any professional expert of its choice (integrator, specifier or the like) perform the appropriate and comprehensive risk analysis, evaluation and testing of the products/solutions with respect to the relevant specific application or use thereof.

The Schneider Electric brand and any trademarks of Schneider Electric SE and its subsidiaries referred to in this document are the property of Schneider Electric SE or its subsidiaries. All other brands may be trademarks of their respective owner.

Schneider Electric does not grant any right or license for commercial use of the document or its content, except for a non-exclusive and personal license to consult it on an "as is" basis.

Schneider Electric reserves the right to make changes or updates with respect to or in the content of this document or the format thereof, at any time without notice.

To the extent permitted by applicable law, no responsibility or liability is assumed by Schneider Electric and its subsidiaries for any errors or omissions in the informational content of this document, as well as any non-intended use or misuse of the content thereof.

Overview

State And Logic Language (SALL) is a proprietary logic programming language that provides boolean, sequential, and arithmetic calculations to help you execute control and data processing logic on EcoStruxure™ Foxboro™ SCADA remote devices and RTU50 and EcoStruxure™ Electrodynamic Controller. SALL also provides High Level Serial Interface (HLSI) to Intelligent Electronic Devices (IEDs) and “State Machine” logic control. SALL can access all inputs and control all outputs. Therefore, it allows you to customize the Remote Terminal Unit (RTU).

NOTE: Electrodynamic Controllers do not support HLSI.

You can write SALL files using a text editing software. The source code passes through the SALL pre-processor to produce a C-language source. This source is compiled to produce an Executable and Linkable format (ELF) file that is downloaded to the device.

The C files created by SALL pre-processor are compiled using:

- GCC compiler version 9.3.1 for ARM Processors for Electrodynamic Controllers in simplex configurations (SY-1101207_Q or later) and High Availability (HA) configurations (SY-1101207_S or later). For more information, see *EcoStruxure™ Foxboro™ DCS Electrodynamic Controller Product Specification* (PSS 41S-2EDC).
- Wind River® DIAB Compiler version 5.9.4.0 and GCC compiler version 9.3.1 for ARM Processors for EcoStruxure™ Foxboro™ SCADA SCD6000 (SY-1101207_N or later) and EcoStruxure™ Foxboro™ SCADA SCD6000-SVX (SY-1101207_P or later).
- Wind River® DIAB Compiler version 5.9.4.0 for ARM Processors for SCD6000 with version SY-1101207_M2 and earlier.
- Wind River® DIAB Compiler version 5.9.4.0 for ARM Processors for RTU50 SVX.
- Open Watcom Compiler 1.0 or 1.1 for X86 processors which is an open source for SCD5200/RTU50.

In SCD5200, RTU50, and RTU50 SVX, the compiler is selected automatically based on the RTU type.

In Electrodynamic Controller, SCD6000, and SCD6000-SVX, the default is GCC Compiler. You can manually select the DIAB Compiler for SCD6000 and SCD6000-SVX.

SALL supports floating point arithmetic and is ideal for running gas flow correction software (AGA) before transmitting data to the Primary Station. You can also implement PIDs that allow closed loop control from SCD6000/SCD6000-SVX/SCD5200.

SALL supports Automatic Transfer Switch (ATS) functionality when SCD6000/SCD6000-SVX is used with CTVT modules. This ATS function monitors voltage, frequency, and phase of the electrical networks and sends signals to the circuit breaker switching control application.

SALL provides a unique method of defining and utilizing serial data protocols in SCD6000/SCD6000-SVX/SCD5200 without making changes to the embedded firmware.

We have replaced these terms in this document. However, the product’s user interface and ordering information might still use old terms.

Old Term	New Term
Master	Primary

Features

- Structure and syntax similar to C language
- Access to all input and output points
- Optional PID and AGA gas flow calculations (in standard SCADA configurations only)
- User-defined or event driven execution frequency
- Debugging options available in EcoStruxure™ Foxboro™ SCADA Remote Terminal Viewer (RTV)
- SALL HLSI supports serial interface to IEDs (in standard SCADA configurations only)
- Integral to the operation of the EcoStruxure™ Foxboro™ SCADA Remote Terminal Unit (RTU) Station

State And Logic Language

Using SALL, you can generate program modules designed from a sequential or state diagram. These modules are stored in the FLASH™ memory.

SALL supports and constructs these types of expressions:

- Boolean, Integer, Timer, and Floating Point
- Arithmetic expressions (+, -, *, /, <<, >>)
- Logic operations (AND, OR, NOT, XOR, INV)
- Bit wise Shift and Logic operators
- Conditional flow statements such as if and if-else
- Incremental and decremental loops
- Predefined functions such as Timer, Control, and Accumulators
- Arrays

SALL also supports Function statements, Timer elements, and Logic elements.

In RTU firmware SY-1101207_M or earlier versions, the SALL subsystem can run up to three independent logic modules that can be executed at user selectable periods and priorities, or according to the occurrence of the nominated events.

In RTU firmware SY-1101207_N or later versions, it can run multiple logic modules. For example, a program involving PID calculations can run every 150 milliseconds, while another can run each time one of the five inputs changes state. You can optionally provide Electric Power algorithms for Circuit Breaker Auto Reclose, Transformer Tap Control, Capacitor Bank Control, and Load Shed Coordination.

In RTU firmware SY-1101207_R1 or later versions, SALL supports ATS functionality. In this application, SCD6000 uses AC Transducer – Type 2 (CTVT) modules with synch check functionality to function as an ATS intelligent electronic device (IED). The Electrodynamic Controller receives data from and sends control requests to the ATS IED. For information on how to use SALL to configure the ATS IED, see *EcoStruxure™ Foxboro™ SCADA RTU AC Transducer Module - Type 2 User's Guide*.

You can provide standard AGA flow calculations (AGA-3, AGA-7, and NX-19) for gas applications. A PID software control algorithm is also available for process control applications.

In Electrodynamic Controllers using firmware SY-1101207_S or later versions, the SALL subsystem can run one logic module that can be executed at user selectable periods and priorities, or according to the occurrence of the nominated events.

For more information, see *EcoStruxure™ Foxboro™ SCADA RTU Programming: State and Logic Language (SALL) Reference User's Guide* (B0780DK).

High Level Serial Interface for SCADA Configurations

SALL provides a unique method of defining and implementing Async serial data protocols in Foxboro SCADA remote devices without changing the embedded firmware. This facility allows you to program the serial interface to a variety of IEDs.

RTU Station is used to define the serial protocol. This definition includes serial point setup, protocol framing information, and check value information. Check value information consists of CRC, checksum or user-defined check algorithm, and data position within frame.

When defined, this information is available to the SALL programmer, who uses the embedded functions to formulate messages to external devices and decode incoming messages. Information can be passed between serial port messages and to the internal database of the RTU.

For more information, see *EcoStruxure™ Foxboro™ SCADA SALL High Level Serial Interface (Foxboro SCADA Remote Devices and RTU50) User's Guide*.

Functional Specifications

Maximum number of Programs	For SCD6000 SY-1101207_M2 or earlier: • Three For SCD6000 SY-1101207_N or later and SCD6000-SVX SY-1101207_P or later: • 245 For Electrodynamic Controllers SY-1101207_S or later: • One
Execution Period	• 1 to 32767 milliseconds (periodic) for RTU configurations • 50 to 32767 milliseconds (periodic) for Electrodynamic Controllers • 0 (event driven)
Supported Data Types	I/O Types: • Analog input • Digital input • Non-volatile Digital • SOE • Control (Latch, Trip/Close, Setpoint, Raise/Lower) • Floating Point Analog • PACKIn point • PACKOut point Internal Variable Types: • Boolean • Integer • Floating Point • Timer • Zone Variable • Array
Maximum size of SALL files Executable	For SY-1101207_N or later: • Total size of all 245 SALL files executable is up to 3MB. For Electrodynamic Controllers SY-1101207_S or later: • Total size of one SALL file executable is up to 3MB.
Flow Control	if, if-else, state machines
Assignment Operator	=
Shift Operators	>>, <<, (SHR, SHL)
Logical Operators	&&, ||, (AND, OR)
Relational Operator	<=, >=, <, >, = =, !=, (LE, GE, LT, GT, EQ, NE)
Bitwise Operators	&, ^, | (BIT_AND, BIT_XOR, BIT_OR)
Unary Operators	!, ~, - (NOT, COMP, NEG)
Binary Operators	-, +, *, /, MOD
Accumulator Functions	Add_to_Dicnt, Dicnt, Freeze, Freeze, and Reset
Output Functions	Output, OutputQ, OutputQueuedControls

Timing Functions	Every, TimeDelayOn, TimeDelayOff, Pulse, RetriggablePulse, TimeLeft
Transition Functions	LL, HL, Low-to-High, High-to-Low
Floating Point Function	Int_to_FP, FP_to_Int, FP_Comp, FP_Add, FP_Sub, FP_Mul, FP_Div, FP_Sin, FP_Cos, FP_Exp, FP_Ln, FP_Pow, FP_Sqrt
Industry Functions[(a)]	AGA3, AGA7, NX19
Serial Interface Functions[(a)]	Serial_Interface, Serial_Write, Serial_Read, Output_Packet, Get_Packet, and twelve data conversion functions
(a) Electrodynamic Controllers do not support these functions.	

Performance Characteristics for SCADA Configurations

No of SALLs Committed	Period (msec)	Priority	No. of Variable assignments per SALL	No. of Functions per SALL[d]	CPU Idle % before data Simulation [CPU0/ CPU1]	CPU Idle % after data simulation [CPU0/ CPU1]	Total Heap Left (MB)
245	10000	80	5	3	90/100	90/100	124.0319023
245	1000	80	5	3	87/100	85/100	124.0316963
245	1000	80	21	3	84/100	83/100	121.177269
245	50	1	21	3	49/100	30/100	148.3019676
245	50	126	21	3	50/99	26/100	148.301815
40	0[a]	80	494[b], 6[c]	3	84/99	83/99	123.6491356
60	0[a]	80	494[b], 6[c]	3	31/100	31/100	149.5800705
90	0[a]	80	494[b], 6[c]	3	20/100	19/100	147.7489166
245	82 SALL file with 1000ms 82 SALL files with 5000ms 81 SALL files with 10000ms	80	21	3	88/100	87/100	148.301815

(a) One SALL file for event trigger having period of 10msec and for all other SALLs are with Period 0.

(b) Event trigger SALL has 548 declared variables and 494 assigned variables in SALL functions.

(c) All SALL files with 0 period have an average of 5 declared variables and 6 variable assignments in SALL functions.

(d) Plus (Addition), Logical negation and FP_Add functions are used in all the SALL files.

Related Documents

Document Number	Document Name
B0780DK	*EcoStruxure™ Foxboro™ SCADA RTU Programming: State and Logic Language (SALL) Reference User's Guide*
B0780DM	*EcoStruxure™ Foxboro™ SCADA SALL High Level Serial Interface (Foxboro SCADA Remote Devices and RTU50) User's Guide*
B0700JB	*EcoStruxure™ Foxboro™ DCS Electrodynamic Controller User's Guide*
PSS 41S-2EDC	*EcoStruxure™ Electrodynamic Controller*

⚠ **WARNING**: This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.p65warnings.ca.gov/.

Schneider Electric Systems USA, Inc.
70 Mechanic Street
Foxboro, Massachusetts 02035–2040
United States of America

Global Customer Support: https://pasupport.se.com

As standards, specifications, and design change from time to time, please ask for confirmation of the information given in this publication.

PSS 41S-2S6KSAL, Rev B