Compact Product Suite

Compact Control Builder AC 800M
Product Guide

Version 6.0

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ABB

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About This Book

Intended Use of This Book

Target Group

This Product Guide is intended for sales representatives to provide information on Compact Control Builder AC 800M and OPC Server for AC 800M.

Compact Control Builder Release Notes (*3BSE033044**) contains additional information.

Purpose, Scope and Intended Use

This book provides details on Compact Control Builder AC 800M and OPC Server for AC 800M.

Section 1, Key Benefits describes key benefits of the Compact Control Builder AC 800M and OPC Server for AC 800M.

Section 2, Product Description describes the Compact Control Builder AC 800M product and some of the components included when purchasing the Compact Control Builder AC 800M.

Section 3, Technical Data and Performance describes hardware and software requirements for operating Compact Control Builder AC 800M.

Section 4, Ordering and Licensing describes the ordering procedure, price list structure and licenses for purchasing the Compact Control Builder AC 800M and OPC Server for AC 800M.

Appendix A, Control and I/O describes the performance and technical data for Control Software, Control Builder key functions, hardware modules and I/O families supported by Compact Control Builder AC 800M.

Appendix B, Fieldbus describes the capacity limits and constraints for the application design that need to be considered when using standardized fieldbus protocols to connect field devices to AC 800M.

New in this Release

The Compact Control Builder version 6.0.0 contains new and improved functionality compared to version 5.1.1.

Engineering Environment

Support for new Operating Systems

Version 6.0.0-1 is released to be used with Windows 10.

Version 6.0 is released to be used with Windows 8.1 and Windows Server 2012 R2.

In addition, it can be used with 64-bit Windows 7 SP1 and Server 2008 R2 SP1.

Support for Microsoft Word 2016

Version 6.0 is released to be used with Microsoft Word 2010, 2013 and 2016

ABB Start Menu

The new ABB Start Menu is used in Windows 8.1 and Windows 10 to display a Windows 7 style start menu for the ABB products. The items on the start menu can be selected and started. The start menu executes only in the desktop environment.
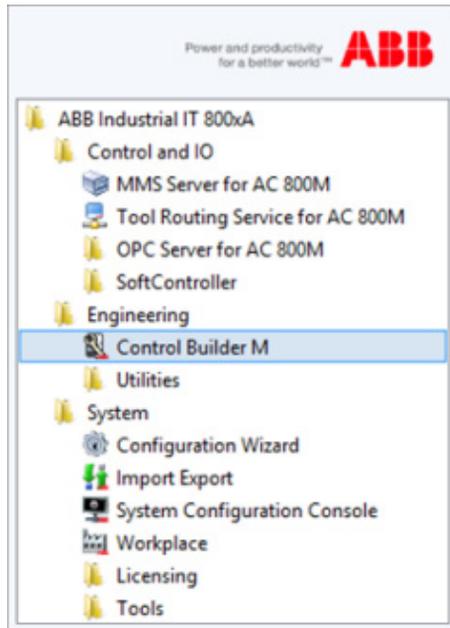
Figure 1. ABB Start Menu

Improved Security

Windows UAC (User Account Control) can now be left turned on (default), and all executables are digitally signed and carry ABB branding and copyright information.

Multiple Soft Controllers on the same PC

It is now possible to run up to 25 Soft Controllers simultaneously on the same PC. Peer-to-peer communication using IAC is automatically set up between the soft controllers. The Soft Controller panel has been changed so it can be used to administer and monitor the different instances.
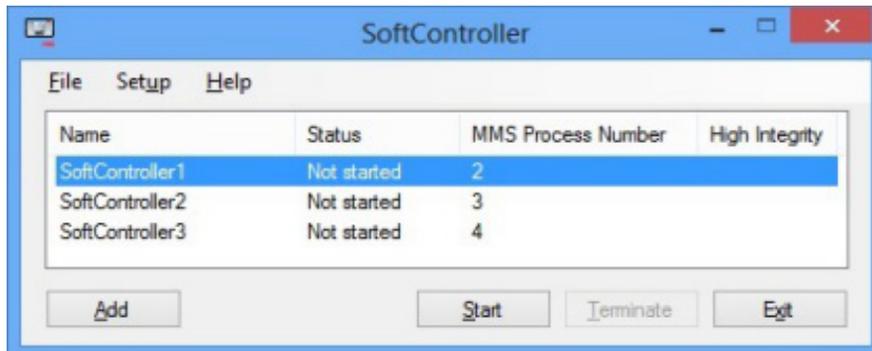
Figure 2. Multiple Soft Controllers on the same PC

Diagram Editor

The auto-routing of graphical connections in the Diagram editor has been improved. The diagram layout has been improved reducing the number of crossings, unnecessary bends and long connections. Multiple connections to the same port are handled in a better way, reducing the need for manual adjustments. Additionally there are twenty more enhancements made to the diagram editor, which are described in the Release Notes.

Communication Variable Limits Dialog

A new dialog is added in version 6.0.0-1 for configuring the compiler reaction for unresolved Communication Variables, error or warning, and enabling compilation error if certain limits of number of communication variables have been exceeded.

Simplified Upgrade

This release contains two new stand-alone tools aimed for simplifying an upgrade from earlier releases:

AC 800M Fingerprint automatically collects diagnostic data from all controllers on the network. The data is collected into tab-separated text files. It can be used in the existing system to verify load figures, hardware revisions and so on.

The **Start Values Analyzer** tool is used for verifying that cold retained variables are unchanged after the upgrade. It can, from version 6.0 and onwards, also pin-point variables holding settings that will revert back to initial value after the upgrade due to the wrong attributes. It can compare runtime values from different occasions and print out the differences.

Control and I/O

Improved Security

The AC 800M Web-server password is now stored persistently and has to be changed by the user.

> By default the Web-server is turned off and it has to be manually enabled four hours at the time.

Software support for PM858

Version 6.0.0-1 adds software support for the new PM858 CPU. PM858 has 16 MB RAM, is redundant, and has half the execution performance of PM862. PM858 can be used with BC820.

Software support for PM862

This release adds software support for the new PM862 CPU. PM862 has 32 MB RAM, can be made redundant, and has half the execution performance of PM866. PM862 can be used with BC820.

Support for Distributed Redundancy using BC820

The new BC820 has the same function as BC810, but the distance between two BC820s can be up to 200m. The CPUs in a redundant controller can by that be physically separated. The connection between the BC820s consists of one electrical and one optical link. BC820 can be used with PM862 and PM866.

Support for CI854B

The CI854B is a new PROFIBUS-DP master that replaces CI854A in new installations. CI854B has the same functionality as CI854A and requires the AC 800M controller to be of version 6.0 or later.

Use of Essential Automation Hardware is Identified and Visualized

The AC 800M identifies and visualizes hardware units of type *-eA*.

Optimized Communication between AC 800M Controller and OPC Server

The MMS communication between the AC 800M controller and OPC Server has been optimized. The length of the telegrams has been extended up to 2.5 times which results in fewer telegrams and lower controller load. The maximum variable transfer rate is almost doubled.

Support for MODBUS RTU Slave

The AC 800M controller can now act as a point-to-point MODBUS RTU slave. The communication takes place via COM3 on the CPU, or via any serial channel on CI853. The same set of Function Codes as with CI867 slave is supported.

Support for 200-AENTR through CI873 EtherNet/IP

The new *S200CI873IoHwlib* adds support for the S200 I/O adaptor 200-AENTR to be used with CI873.

The new adaptor gives a simple and cost effective upgrade path for directly connected S200 I/O on SattCon 200, SattLine 200, Advant Controller 210, Advant Controller 250 and AC 800C.

200-AENTR has two Ethernet ports with an in-built switch, which means that the adaptors can be daisy-chained to the CI873 using cross-wired Ethernet-cables without the need for external switches.

The release of the 200-AENTR adaptor will be announced separately.

Support for more S100 I/O boards

Version 6.0.0-1 adds software support for the following S100 I/O boards: DSDI 131, DSDI 141, DSDO 120, DSDO 140, DSAI 110, DSAI 135, DSAI 145, DSAI 146, DSAI 151.

Automatic replacement of PROFINET IO devices

The CI871 supports an automatic configuration and restart of a PNIO device in case of device replacement. The configured station name is assigned automatically. No usage of the AC 800M web server is needed. This functionality is available for PNIO devices that have on the one hand active support for LLDP and on the other hand these devices are connected to a switched Ethernet network also having active support for LLDP.

UMC100 with PNQ22 and PROFINET IO

The new hardware library *ABBPNQ22CI871HwLib* adds support for ABB's universal motor controller UMC100 via CI871.

Acyclic Communication on PROFINET IO

The AC 800M controller now supports acyclic data access with connected PNIO devices.

The *IOCommLib* library contains the Function Blocks for acyclic read and write of the PROFINET device data. This provides access in the controller to all data of the PNIO device that is not provided via cyclic data.

Modbus RTU Redundancy at Application Level

Version 6.0.0-1 adds support for MODBUS RTU master channel redundancy at application level. A new connect function block, *MBConnectR* has been added in *ModBusCommLib*.

Application libraries for analog control

PidCC and *PidAdvancedCC* have been enhanced to support controller types
'ClassicERF' and 'ClassicERF+D'. *PidAdvancedCC* has additionally been
enhanced for controller type 'ABBERF' and 'ABBERF+D'. These changes affect
the following libraries BasicLib, ControlSupportLib, SignalLib, ControlBasicLib,
ControlObjectLib, ControlStandardLib, ControlAdvancedLib, ControlExtendedLib,
and ControlFuzzyLib.

Maintenance

It is now possible to insert a Backup Media card after a controller crash has occurred
in order to save the content of the whole RAM memory. This is valid both for a
single/primary PM and a backup PM and requires that the "Autorestart" function
has not been enabled (default off). A halted controller without a Backup Media will
indicate by fast flashing (10Hz) on the F(ault) LED. Insert a Backup media card and
wait for slow flashing (0.5Hz) on the F(ault) LED indicating that the dump is ready
and/or press INIT to restart.

Section 1 Key Benefits

This section is focused on getting you acquainted with the key benefits for the Compact Control Builder AC 800M software products.

Compact Control Builder AC 800M

Compact Control Builder AC 800M aims to meet the customers need for a modern industrial PLC solution, capable of handling mid-sized to large applications. Its primary target market is the process automation area, where PLC products are used, however, it can also be used for other application areas.

The Compact Control Builder software product contains the following components:

- Compact Control Builder AC 800M

- OPC Server for AC 800M

- Base Software for SoftControl

These products are delivered out of the box and easy to install, run and maintain. For more information about the Compact Control Builder software product offering, see

Compact Control Builder AC 800M

Compact Control Builder AC 800M adds the following key benefits to the PLC market:

- Programming tool for AC 800M PLCs
  - Contains a compiler, programming editors, standard libraries for developing PLC applications and standard hardware types (units) in libraries for hardware configuring.

- Programming environment

  - Testing the application off-line.

  - Download to PLC via serial communication or Ethernet.

  - Online change on applications.

  - Cold retain of data (kept at cold start).

  - Backup/restore of projects.

- Support for all IEC 61131-3 languages

  - Function Block Diagram (FBD), Structured Text (ST), Instruction List (IL), Ladder Diagram (LD), Sequential Function Chart (SFC).

- Extensions to IEC 61131-3 languages

  - Function Diagram (FD) and Control Module Diagram (CMD).

- Create/Change/Insert Libraries

  - Creating self-defined libraries containing data types, function block types etc. which can be connected to any project.

  - Creating self-defined libraries with hardware types.

  - When no available hardware library is sufficient, the Device Import Wizard can be used to import a customized hardware type from a device capability description file.

    You can import PROFIBUS GSD-files with hardware types for CI854.

    You can also import PROFINET GSD files for CI871, and DeviceNet and EtherNet/IP EDS files for CI873.

- – Various functions and type solutions for simple logic control, device control, loop control, alarm handling etc. packaged as standard libraries.

  – The open library structures provide easy access to set-up and connect type solutions into self-defined libraries and/or applications before programming.

- Multi-user engineering

  – Project files can be distributed on Compact Control Builder stations (up to 32 stations).

- Redundancy functions

  – AC 800M CPU redundancy (using PM858, PM861, PM862, PM864, PM866, or PM891).

  – Redundant Control Network on MMS and TCP/IP, using Redundant Network Routing Protocol (RNRP).

  – Master and line redundancy (PROFIBUS DP-V1) for AC 800M (CI854 interface module).

  – Redundant optical ModuleBus.

- Clock synchronization

  – 1 millisecond clock synchronization accuracy between PLC nodes in control network.

  – Generating Sequence-Of-Events (SOE), using time stamps for digital I/O with high accuracy.

  – System alarm and system event functions.

- ABB Drives support

  – ABB Standard Drives.

  – ABB Application Drives.

- Interfacing with Satt I/O

  – CI865 unit for Satt I/O system (Rack I/O and Series 200 I/O) with the AC 800M PLC platform.

  – 200-RACN ControlNet I/O adaptor for rack-based I/O boards.

  – 200-ACN unit for 200 I/O units via Satt ControlNet.

- Compact Flash (CF) and Secure Digital (SD/SDHC)

  – Store a compiled PLCs configuration, that can be used at restart of the PLC.

OPC Server for AC 800M

OPC server for AC 800M is a stand-alone product that support both Data Access and Alarm/Event traffic from PLCs.

- Stand-alone OPC Server, fully OPC compliant.

  – OPC Server DA that handles run-time data.

  – OPC Server AE that handles alarm and event from the control system, via the OPC Server to the OPC client.

  – OPC Server Online help.

SoftController

- Testing tool for running applications offline.

  – SoftController provides reduced engineering and test costs.

  – It is a simulation tool that runs with Base Software for SoftControl and is automatically installed together with the Compact Control Builder.

  – Up to 25 instances per PC.

Section 2 Product Description

This section describes the Compact Control Builder AC 800M product and some of the components included when purchasing the Compact Control Builder AC 800M.

The Compact Control Builder is used to configure the AC 800M hardware. The OPC server is used to connect the AC 800M to a HMI or SCADA system.

Compact Control Builder offers amongst other things multi-user engineering and support for redundancy functions (CPU redundancy, RNRP, master and line redundancy with CI854). More information can be found in Compact Control Builder AC 800M Functions on page 24.

The OPC Server runs stand-alone and is fully OPC Data Access and Alarm/Event OPC compliant.

Compact Control Builder AC 800M supports the following CPUs:

- PM851/PM851A
- PM856/PM856A
- PM858
- PM860/PM860A
- PM861/PM861A
- PM862
- PM864/PM864A
- PM866/PM866A
- PM891
- SoftController running on PC

Software Overview

The software delivered on the DVD is divided in two parts - the Compact Control Builder AC 800M and OPC Server for AC 800M. While installing Compact Control Builder additional components and services will be installed in the background.

- Compact Control Builder AC 800M
    - Base Software for SoftControl
    - RNRP
    - User Documentation
- OPC Server for AC 800M

Compact Control Builder AC 800M

Compact Control Builder AC 800M is a programming tool for creating PLC based control solutions when using the AC 800M as hardware. It works on Windows 7 SP1 64 bit, Windows Server 2008 R2 SP1, Windows 8.1 64 bit, Windows Server 2012 R2 and Windows 10 64 bit.

Overview

Firmware and applications can be downloaded to PLCs using Ethernet or via a direct serial link. Ensure that the IP address of the PLC is configured in Control Builder, communication is set up, and the cables are connected at both ends. An OPC Server for AC 800M can be installed on the same PC as Control Builder (Figure 3) or be installed on a separate PC, typically together with Human Machine Interface (HMI) software.

Compact Control Builder AC 800M
OPC Server for AC 800M
(can also be installed stand-alone)

Windows 7 SP1 or   Windows 8.1 or Windows 10 or
Windows Server 2008 R2 SP1   Windows Server 2012 R2

Figure 3. Control Builder and supporting software.

Download from Programming Station

PLC firmware and control applications can be downloaded from a standard PC to PLCs using Ethernet or via a direct serial link (using TK212A cable).

Control Builder

Ethernet
or direct   PLC
serial link   Standard PC
                                Control Network
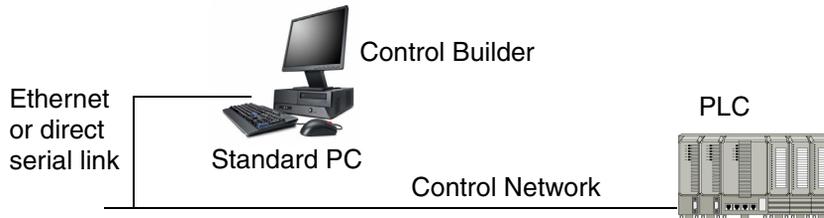
Figure 4. Downloading firmware and/or applications.

PLC Communication

PLCs, programming stations and operator stations communicate with each other through the control network. The control network is used to communicate between Control Builder stations and the PLCs, between HMI and PLCs and also for communication between the PLCs.
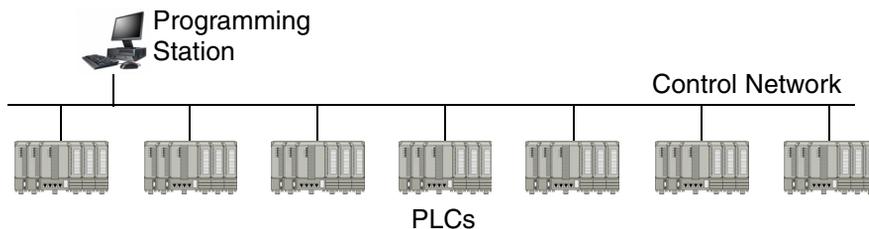
Figure 5. PLC communication in control network.

Compact Control Builder AC 800M Functions

Compact Control Builder supports a number of functions:

- Support for IEC 61131-3 Languages on page 25.

- Testing the Application on page 26.

- Downloading to a PLC on page 26.

- Multi-user Engineering on page 27.

- Alarm and Events Handling on page 27.

- I/O Connectivity and Communication on page 29.

- Supported ABB I/O Systems and Families on page 36.

- Serial Communication Protocols on page 37.

- Control Network on page 40.

- Clock Synchronization on page 41.

- Redundancy on page 41.

- Backup Media on page 43.

- Online Help and Manuals on page 44.

- Additional Software on page 45.

Support for IEC 61131-3 Languages

The IEC 61131-3 standard defines five of the most commonly used programming languages on the market. These are Function Block Diagram (FBD), Structured Text (ST), Instruction List (IL), Ladder Diagram (LD) and Sequential Function Chart (SFC). In addition to these, Control Builder supports creation of logic using Diagrams (which use the Function Diagram (FD) language) and Control Module Diagrams.

Depending on previous experience, programmers often have their own personal preference for a certain language. All the languages have advantages and disadvantages, and no single one of them is suitable for all control tasks.

Table 1. Compact Control Builder programming languages.

Language	Function
Function Block Diagram (FBD)	A graphical language for depicting signal and data flows through function blocks and functions. Function blocks and variables are interconnected graphically, which makes the resulting control diagrams easy to read.
Structured Text (ST)	A high-level programming language. ST is highly structured and has a comprehensive range of constructs for assignments, function/function block calls, expressions, conditional statements, iterations, etc. It is easy to write advanced, compact, but clear ST code, due to its logical and structured layout.
Instruction List (IL)	A traditional PLC language. It has a structure similar to simple machine assembler code.
Ladder Diagram (LD)	Ladder diagram (LD) is a graphical language based on relay ladder logic.

Table 1. Compact Control Builder programming languages.

Language	Function
Sequential Function Chart (SFC)	Sequential function chart (SFC) is a graphical language for depicting the sequential behavior of a control program.
Function Diagram (FD)	Function Diagram (FD) is a graphical language that allows mixing of functions, function blocks, control modules, and diagrams in one code block and create graphical connections between them.

Testing the Application

The Compact Control Builder provides two ways for testing an application, Test mode and simulating an application with the SoftController.

Test Mode

Test mode is normally used for testing smaller parts of an application and without performing a download to the PLC. In Test Mode, Compact Control Builder compiles and executes the code in the local PC similar to the execution on PLC.

SoftController

The Base Software for SoftControl is a software product that comes with the Compact Control Builder installation. It is used for simulating a complete application (with a complete hardware configuration done). But, instead of downloading the application to a PLC, it can be downloaded to the SoftController, thus no need for a real PLC and I/O.

Downloading to a PLC

Firmware

Firmware is the software that provides the basic functionality of the AC 800M PLC. It contains functions like operating system, real-time clock, communication etc. The

firmware is stored in electrically erasable programmable read-only memory (EEPROM).

The firmware is pre-installed in some of the hardware. The firmware can also be downloaded from Compact Control Builder to CPUs and communication modules either through Ethernet or through Serial Cable. If Ethernet is used as media, the IP address of the PLC must be set before any download. This is carried out with the IP Configuration tool, see also IP Configuration Tool on page 45.

> Ensure that the application program in the PLC is removed before downloading the new firmware to the PLC.

After the firmware is updated, the application program has to be downloaded again and a cold start of the CPU must be performed.

Applications

Applications can be downloaded to the PLC via Ethernet or direct via a serial connection (TK212A cable). An application can be distributed between several PLCs. Parts of the application are then downloaded to different PLCs.

Multi-user Engineering

Compact Control Builder supports multi-user engineering with a maximum of 32 separate Control Builder PCs. In a multi-user configuration all Control Builder PCs and the OPC Server must have access to the common project file(s). This means that a common Project folder must be created on a shared network server.

Alarm and Events Handling

Compact Control Builder handles alarm and events generated internally in the system, a PLC or other hardware unit or in applications.

Alarm and event information is communicated throughout the control network via OPC servers, that is, a number of OPC Server for AC 800M.

Alarm and event handling supports the following.

• Disabling and enabling of alarms

• Acknowledgement and cancellation of alarms

• Filtering of alarms and events

- Printing of alarm and event lists on local printer

- System events and alarms

System events and alarms created in PLC can be read and accessed by operators through HMI. The time stamps and attributes are also created in PLCs. The event or alarm has its origin attached to it.

OPC Server

Alarms and events are collected and forwarded by the Alarm and Event (AE) part of the OPC server, see also OPC Server Alarm and Event (AE) Part on page 47. PLCs then gain access to alarms and events from other PLCs by reading data from the OPC server. Alarm and event information can also be read by other OPC clients.

I/O Connectivity and Communication

Control Builder supports a number of fieldbuses and I/O systems. PLCs can be connected to fieldbuses and other I/O systems using adaptors and I/O units belonging to ABB I/O families.

I/O Connectivity

- **ModuleBus**

  ModuleBus is an integrated master unit for S800 I/O. I/O units connected to ModuleBus are divided into clusters. 12 I/O units can be directly connected to the ModuleBus on the AC 800M, while the remaining I/O units have to be connected via I/O-clusters. Up to 7 I/O-clusters can be connected to the ModuleBus. PM851 only allows up to 24 S800 I/O units on ModuleBus (12 local and 12 on cluster 1).

- **PROFIBUS DP**

  Control Builder supports the fieldbus system PROFIBUS DP. It can be connected to PLCs via the CI854 interface module, offering master and built-in line redundancy.
  Applications access the built-in fieldbus functions through corresponding I/O modules.

- **PROFINET IO**

  PROFINET is a manufacturer-independent Fieldbus standard for applications in manufacturing and process automation. PROFINET technology is described in fixed terms in IEC 61158 and IEC 61784 as an international standard.

  PROFINET IO uses Ethernet communication to integrate simple distributed I/O and time-critical applications.

  PROFINET IO describes a device model oriented to the PROFIBUS framework, which consists of places of insertion (slots) and groups of I/O channels (subslots). The technical characteristics of the field devices are described by the General Station Description (GSD) on an XML basis. The PROFINET IO engineering is performed in a way familiar to PROFIBUS. The distributed field devices are assigned to the PLCs during configuration.

The PROFINET IO is interfaced to the IEC 61131 PLC AC 800M, using the PROFINET IO module CI871.

- **DriveBus**

   The CI858 unit is the communication interface for the DriveBus protocol. ABB Drives and Special I/O units communicate with the AC 800M PLC via the CI858 unit. The CI858 Drive channel can be used to connect up to 24 drives.

- **S100 I/O**

   The CI856 is the AC 800M communication interface for the S100 I/O system The CI856 unit handles the I/O configuration and I/O scanning of up to five S100 I/O racks where each I/O rack can hold up to 20 I/O boards.

- **Satt I/O**

   The CI865 unit is the AC 800M communication interface for Satt I/O. The CI865 unit makes it possible to use older Satt I/O system (Rack I/O and Series 200 I/O) with the PLC.

- **INSUM**

   INSUM (INtegrated System for User-optimized Motor control) is a system for motor and switch gear control and protection from ABB. PLCs can be integrated with INSUM by means of a TCP/IP gateway and a CI857 interface module (Figure 6).

   INSUM and Control Network must use separate physical networks.
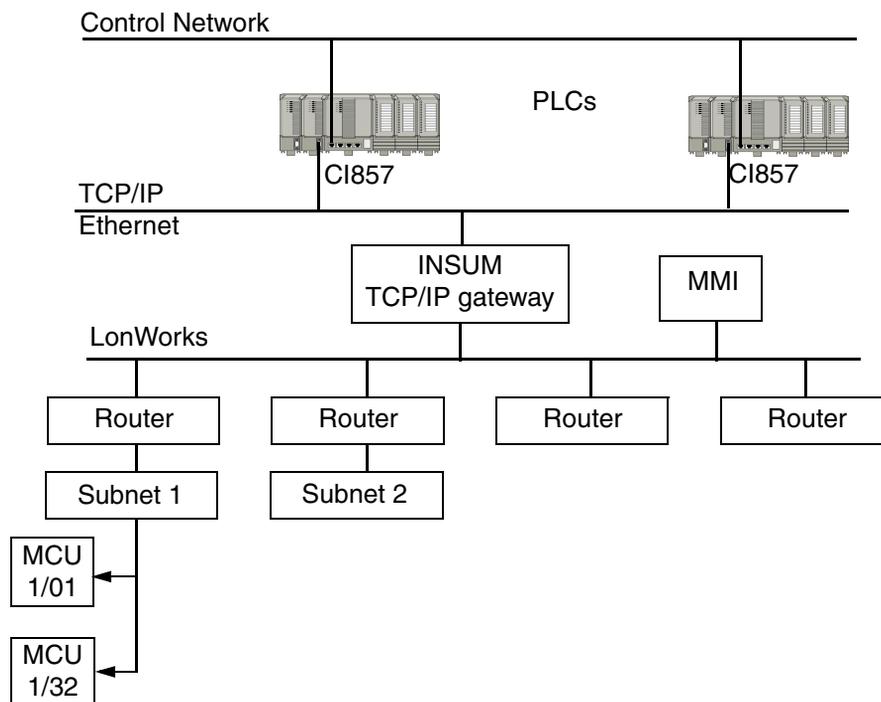
Figure 6. INSUM integration with PLCs.

The TCP/IP gateway connects PLCs to the Local Operating Network (LON) fieldbus. Motor Control Units (MCUs) are grouped into sub-networks accessed through a number of routers.

INSUM applications handle motor and switch gear control. They can also be set to send alarm and event information to a PLC through the TCP/IP gateway.

The INSUM operator station gives direct access to INSUM functions. PLCs also have access to INSUM functions through the function blocks in the INSUM library.

• **IEC 61850**

The IEC 61850 for Substation Automation System (SAS) defines communication between intelligent Electronic Devices (IED) in the substation and other related equipment. The IEC 61850 standard itself defines the superset of what an IEC 61850 compliant implementation might contain.

- **Advant Fieldbus 100**

  Advant Fieldbus 100 (AF 100) is a high performance fieldbus, which is used for:

  – Communication between Advant Controllers.
  – Communication between Advant Controllers and S800 I/O Stations, AC 800M PLCs, AdvaSoft for Windows, and the equipments developed and sold by other ABB companies.

  The CI869 communication interface that is attached to the AC 800M PLC provides connectivity to other AC 800M, AC 160 or connectivity server over AF 100. An AC 800M PLC with the communication interface CI869 behaves as an AF 100 station, receiving data from other AF 100 stations/devices. The CI869 has integrated Twisted Pair modems.

- **EtherNet/IP and DeviceNet**

  The Industrial Ethernet Protocol (EtherNet/IP) is an application layer protocol built on the standard TCP/IP protocol suite used to communicate with high-level industrial devices.

  DeviceNet is an application layer protocol built on the standard Controller Area Network (CAN). It is used to communicate with low-level industrial devices.

  DeviceNet and EtherNet/IP are based on Common Industrial Protocol (CIP) and share all the common aspects of CIP.

  The following are the software components implemented in EtherNet/IP:

  – CI873 EtherNet/IP Hardware Library (CI873EthernetIPHWLib).

  – Device Import Wizard (DIW) to import the EDS files into Control Builder.

  The CI873EthernetIPHWLib integrated with AC 800M provides CEX based Communication interface along with three components of CI873 protocol for the Control Builder, PLC, and CEX module CI873.

  The CI873EthernetIPHWLib provides the following functionalities:

  – Configuring CI873 as EtherNet/IP scanner.

  – Class 1 connection to LD 800DN for I/O communication with DeviceNet devices.

- System command to change the Run/Idle state of LD 800DN.

- LD 800DN Scanner diagnostics.

- Status supervision of devices.

- Hot swap of CI873, LD 800DN and DeviceNet devices.

- Logging of CI873 messages.

- CI873 Scanner diagnostics.

- CI873 Firmware Upgrade.

The Device Import Wizard (DIW) is an integrated component of the Control Builder. The DIW converts the device description files – EDS files of DeviceNet devices – into Hardware Definition (HWD) files. These unit types can be instantiated in the Hardware tree of Control Builder.

Communication

- **IAC**

  Inter Application Communication (IAC) is defined as the variable communication between applications that use a special category of variables called communication variables. The applications can reside in the same PLC or in a different PLC in the project. IAC is possible within an application also. IAC is supported by the MMS protocol, and it uses an IP based resolution for communication between applications.

  IAC is based on the name of the communication variables and the IP address of the controllers to which the applications are downloaded.

- **MMS**

  The MMS protocol defines communication messages transferred between PLCs as well as between engineering stations (such as Compact Control Builder) and the PLC (e.g. downloading an application or reading/writing variables).

- **MasterBus 300**

  The MB 300 supports both network redundancy and clock synchronization (with the accuracy offered by MB 300).

  Note that MasterBus 300 and Control Network must use separate physical networks.

- **MODBUS TCP**

  MODBUS is an open industry standard widely spread due to its ease of use. It is a request response protocol and offers services specified by function codes. MODBUS TCP combines the MODBUS RTU with standard Ethernet and universal networking standard TCP. It is an application-layer messaging protocol, positioned at level 7 of the OSI model.

  MODBUS TCP communicates via the CI867 communication interface unit. CI867 is a dual channel Ethernet unit; Ch1 and Ch2. Ch1 supports full duplex with 100 Mbps speed and Ch2 supports half duplex with 10 Mbps speed.

  Both master and slave functionality are supported. A maximum of 70 slave and 8 master units per CI867 (on Ch1 and Ch2 together) can be used.

  Function blocks are used for master communication and access variables is used for slave communication.

  A number of MODBUS TCP commands are supported. Protocol functions are accessible through function blocks.

  Table 2 describes the protocol commands that are supported by MODBUS TCP.

Table 2. Supported MODBUS TCP Protocol Commands

Function code	Name	Supported in
FC 1	Read coils	Master and Slave
FC 2	Read input discreet	Master and Slave
FC 3	Read multiple registers	Master and Slave
FC 4	Read input register	Master and Slave
FC 5	Write coil	Master and Slave
FC 6	Write single register	Master and Slave
FC 7	Read exception status	Master and Slave
FC 8	Diagnostic	Master and Slave
FC 15	Force multiple coils	Master and Slave
FC 16	Write multiple registers	Master and Slave
FC 20	Read file record	Master
FC 21	Write file record	Master
FC 23	Read Write file record	Master

- **SattBus**

Compact Control Builder supports SattBus on Ethernet only!

SattBus is a network standard for PLC communication. SattBus can be used as a low-cost fieldbus for collection of small amounts of data under hard conditions.

- **Self-defined UDP Communication**

    The UDP hardware library (UDPHwLib) contains the UDPProtocol hardware type that is used for self-defined UDP communication. The following function block types are available:

    – UDPConnect

    – UDPWrite

    – UDPRead

- **Self-defined TCP Communication**

    The TCP hardware library (TCPHwLib) contains the TCPProtocol hardware type that is used for self-defined TCP communication. The following function block types are available:

    – TCPClientConnect

    – TCPServerConnect

    – TCPWrite

    – TCPRead

Supported ABB I/O Systems and Families

Control Builder supports the following common ABB I/O systems and families.

- S800 I/O, a distributed modular I/O system for communication via ModuleBus and PROFIBUS DP.

- S900 I/O, a remote I/O system (for hazardous areas) that can be connected to PLCs via PROFIBUS DP.

- S200 I/O and S200L I/O, two compatible, modular I/O systems. S200 I/O modules can be connected through CI856, or EtherNet/IP CI873, or PROFIBUS DP to PLCs.

- S100 I/O, a rack-based I/O system that can be connected to PLC using the CI856 interface module.

- Satt I/O, makes it possible to use Satt Rack I/O (an older Satt I/O system) connected to PLC using the CI865 communication interface.

Serial Communication Protocols

Control Builder supports a number of serial communication protocols for Compact Control Builder products and third party HMI. These protocols can be used for communication between PLCs, as well as with other devices.

ModBus RTU

ModBus is a wide-spread communication protocol that can be used on a variety of media, such as wire, fiber optics, radio and telephony. ModBus is an asynchronous serial master/slave protocol that is executed in half-duplex.

i The Compact Control Builder software supports ModBus RTU master and slave functionality.

ModBus RTU protocol functions are accessible through function blocks. The following protocol commands are supported:

Table 3. Supported MODBUS Protocol Commands

Protocol	Description	Protocol	Description
FC1	Read Coils	FC6	Write Single Register
FC2	Read Discrete Inputs	FC7	Read Exception Status (Serial Line only)
FC3	Read holding registers	FC8[1][2]	Diagnostics (Serial Line only)
FC4	Read input registers	FC15	Write Multiple Coils
FC5	Write Single Coil	FC16	Write Multiple registers

(1) Some slaves do not understand FC8. To avoid problems, set Poll Time to zero (0).
(2) For slave functionality in FC8 (Diagnostics) the sub function codes supported are: Read diagnostics and Query Data.

COMLI

COMLI is a protocol for data transmission between PLCs from ABB. It is designed for asynchronous master/slave communication in half-duplex. COMLI can be used for serial communication.

ℹ️ The Compact Control Builder software supports COMLI master and slave functionality.

The following COMLI services are supported:

Table 4. Supported COMLI services

Message Type	Description	Limitation
0	Transfer I/O bits or a register	Bit 0 to 37777 (octal) and register 0 to 3071 (decimal)
2	Request several I/O bits or registers	Bit 0 to 37777 (octal) and register 0 to 3071 (decimal)
3	Transfer individual I/O bits	Bit 0 to 37777
4	Request individual I/O bits	Bit 0 to 37777
<	Request high registers	Registers 0 to 65535 (decimal)
=	Transfer high registers	Registers 0 to 65535 (decimal)
J	Transfer date and time	Clock synchronization of COMLI slave

Siemens 3964R

Siemens 3964R is a standard serial, point-to-point master/slave protocol. It can be used on any RS-232C or RS-485 channel. It is suitable for communicating with PLCs and devices with Siemens 3964R support. Communication requires installation of the RK512 interpreter in the slave system.

ℹ️ Compact Control Builder software supports only the Siemens 3964R **master** protocol, thus no support for slave protocols.

The following Siemens 3964R services are supported:

Table 5. Supported Siemens 3964R Services

Service	Direction	Comment
"E" message, data type D	AC 800M to Siemens PLC	Request for data, register
"E" message, data type E, A, M	AC 800M to Siemens PLC	Request for data, byte
"E" message, data type E, A, M	AC 800M to Siemens PLC	Request for data, bit
"E" message, data type D, E; A, M	Siemens PLC to AC 800M	Answer to request for data
"A" message, data type D	AC 800M to Siemens PLC	Transfer of data, register
"A" message, data type D	AC 800M to Siemens PLC	Transfer of data, bit
"A" message, data type D	Siemens PLC to AC 800M	Answer to transfer of data

Modem Communication

There are two types of modem that can be used with Control Builder:

- Short-distance modems using PPP, COMLI, Siemens 3964R, ModBus RTU or PROFIBUS DP.

- Dial-up modems using public telephone communications, COMLI is the only protocol for which dial-up modem communication is supported.

    If COMLI is not used, it is still possible to set up serial modem communication using a phone line. In this case, the communication can be between Control Builder and a PLC, or between an external system and a PLC (using AutoConnect).

There are two main reasons for using modem communication:

1. A need for increasing the maximum length of RS-232C, RS-485 and Ethernet twisted-pair connections.

2. A need for using fiber-optic communication, to eliminate either electromagnetic interference or the risk of intrusion.

Self-defined Serial Protocol

Function blocks in SerialCommLib allow implementation of a personal character oriented protocol on a serial port. It supports writing an application that both controls the characters sent and checks that the correct answer is received by using various checksum algorithms. The serial protocol can only be executed in half duplex. Accordingly it can not send and receive simultaneously. The following function block types are available:

*   SerialConnect

*   SerialSetup

*   SerialWriteWait

*   SerialListenReply

*   SerialWrite

*   SerialListen

A maximum 140 characters is supported. ASCII telegrams are recommended, since binary telegrams are difficult to implement.

Control Network

The recommended alternative for communication with PLCs and other devices, is Control Network, a private IP domain designed for industrial applications. Control Network is based on MMS via Ethernet or PPP on RS-232C.

Routing and redundancy functions are handled by the Redundant Network Routing Protocol (RNRP), an ABB protocol for handling redundancy and for routing between nodes in a control network, see Redundancy on page 41.

Clock Synchronization

In cases where all PLCs must use the same time, for example when time stamps are useful, clock synchronization is needed. AC 800M supports clock synchronization by five different protocols – CNCP, SNTP, SNTP on CI, MB 300 Clock Sync and MMS Time Service.

CNCP is the normal protocol for clock synchronization on the Control Network. An AC 800M PLC selected as Clock Master multicasts synchronization messages on the network. CNCP is used if relative accuracy is needed, that is, the clocks between all AC 800M PLCs are synchronized with an accuracy of <1ms.

In addition SNTP is used if absolute accuracy of <1ms is needed. SNTP is a standardized protocol that typically is used by AC 800M PLCs that need to be synchronized from an external time server (for example a GPS receiver) which is connected to the Control Network.

SNTP on CI is a protocol that is used by AC 800M PLCs that have communication interfaces that can handle clock synchronization independently (for example, the CI869 that communicates with AF 100).

The AC 800M OPC Server supports the MMS Time Service for small systems where no AC 800M is used for backward compatibility with older products.

MB 300 Clock Sync is a protocol for clock synchronization of Advant/Master products on a MasterBus 300 network.

Redundancy

Control Builder supports the following redundancy functions:

- CPU redundancy for PLC (PM858, PM861, PM862, PM864, PM866, and PM891)

- Network redundancy (RNRP)

- Line redundancy (CI854)

- Master redundancy (CI854A/CI854B)

- Optical ModuleBus redundancy

- CEX-Bus redundancy (using BC810 and BC820)

CPU Redundancy

PLCs with PM858, PM861, PM862, PM864, PM866 and PM891 processors can be configured for CPU redundancy. Two CPU modules are then run in parallel, one as primary and one as secondary. If the primary CPU fails, the secondary CPU automatically takes over.

ℹ️ It is also possible to run a PLC in single CPU mode with PM858, PM861, PM862, PM864, PM866, or PM891.
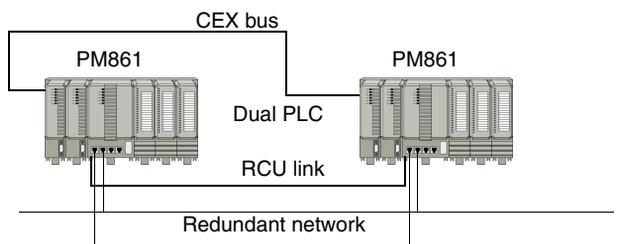
Figure 7. Example of a redundant CPU configuration.

Network Redundancy

Network redundancy is based on the Redundant Network Routing Protocol (RNRP). This protocol is an ABB protocol for handling redundancy functions and routing between nodes in a control network. The protocol is designed for rapid detection of network failure and instant switching to alternative paths.

ℹ️ The maximum number of RNRP nodes in a network area is limited to 50 nodes.

Network redundancy requires two independent IP networks, one primary and one secondary. Whenever the maximum number of lost messages is exceeded, the traffic is switched to the secondary network.

ℹ️ All devices with network redundancy must be connected to both networks. The node number must be identical in both networks.

Network redundancy can be implemented in part of the network. Nodes with one connection only must be connected to the primary network.

Line Redundancy

Line redundancy support is provided by PROFIBUS DP communication, through dual ports on the CI854 interface module. Line redundancy may be achieved for other communication by adding extra equipment.

Backup Media

The AC 800M PLCs contain a card slot located at the front of the PLC. This card slot supports backup media cards. It is possible to restore the saved configuration data and firmware data from the backup media card to the PLC.

The supported backup media cards for AC 800M PLCs are:

- Compact Flash (CF) card (supported in all AC 800M PLCs except PM891).

- Secure Digital (SD/SDHC) card (supported only in PM891).

The CF/SD memory card helps to store a compiled PLC configuration to the card and then install it into the PLC by inserting the CF/SD card. This makes it easy to distribute new software upgrades to PLCs in different locations which are not networked. The control software is installed without requiring any tool.

Compact Flash

Before downloading the application to CF card, an external Compact Flash Writer must be connected to the USB port of the Control Builder PC, if the PC does not have a built-in card reader. See also Compact Flash Requirements on page 50.

Secure Digital

Before downloading the application to SD card, an external Secure Digital Writer must be connected to the USB port of the Control Builder PC, if the PC does not have a built-in card reader. See also Secure Digital Requirements on page 50.

Cold Retain Values

The cold retain values saved by Compact Flash/ Secure Digital can either be saved cyclic via settings in the hardware editor or from the code via the function block (SaveColdRetain) located in BasicLib. Either way, these values are only saved on files located on the CF/SD card. These settings do not apply for the cold retain values saved by Control Builder or OPC Server during a download.

Cold Retain Values from a Redundant CPU Configuration

If you have a redundant CPU configuration; you cannot save cold retain values cyclic or by the function block.

However, you can always save cold retain values via the Tool menu in Control Builder so that your cold retain values will be part of the application and gets loaded to the CF or SD card.

Online Help and Manuals

Online Help

Control Builder has an extensive online help system with context-sensitive (F1) help for objects displayed in the Project Explorer. Online help can also be displayed by clicking **Help** in dialog boxes or selecting it under the **Help** menu.
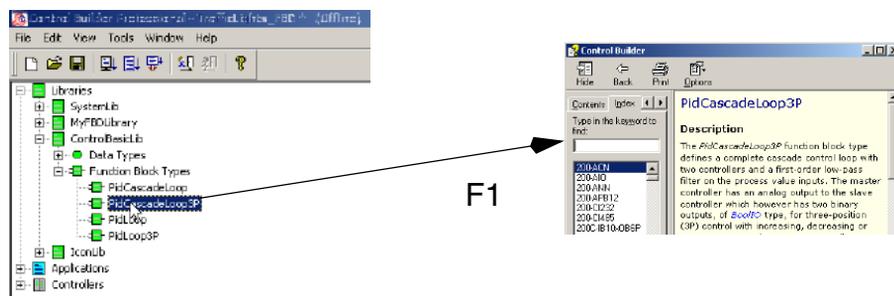
Figure 8. Context-sensitive (F1) help

Customized help can be added for self-defined libraries, applications and components of externally added applications, as well as for non-standard hardware.

Added customized files for user-defined libraries with data types, function block types and control module types as well as for applications are displayed under **User Help** on the **Help** menu.

Context-sensitive help on user-defined libraries with hardware and non-standard hardware is available if a help file (HTML or WinHelp file with any file name) is added to the library or to the hardware type.

Online Manuals

User manuals are available from Control Builder AC 800M, in Adobe Acrobat PDF format.

Additional Software

Compact Control Builder AC 800M also contains a number of additional tools and products:

- IP Configuration tool
- Serial Firmware Upgrade tool
- RNRP tool

IP Configuration Tool

The IP Configuration tool is used to set PLC IP addresses via a direct serial channel. The initial IP address must be set before downloading firmware and applications to the PLC.

Serial Firmware Upgrade Tool

The Serial Firmware Upgrade tool is used to upgrade PLC CPU firmware via a direct serial channel.

ℹ️ Serial Firmware Upgrade Tool cannot be used for firmware upgrade of PM891. The firmware upgrade of PM891 can be done using an SD card or from the Remote System dialog in Control Builder.

RNRP Tool

Wizard for setting up routing between two PC stations on a redundant network.

OPC Server for AC 800M

OPC Server for AC 800M gives OPC clients access to PLC data they subscribe to. The OPC server can also be used to transfer alarm and event information. It consists of two parts:

- Data Access (DA) part
- Alarm and Event (AE) part

The OPC server exposes data to the clients (DA part) and supports the transfer of alarm and event information from attached PLCs to subscribing OPC clients (AE part).

OPC Server Data Access (DA) Part

The Data Access (DA) part of the OPC server gives all OPC clients access to run-time data in PLCs.

The OPC server exposes the following data to OPC clients.

- Variables and parameters used in applications, programs, diagrams, control modules, function blocks, data structures, etc.
- Hardware configurations
- Access variables

It can also be used to store cold retain data.

The OPC server detects the following events and updates data on each.

- A new version of an application and/or a PLC configuration is downloaded.
- A new application (an application that did not previously exist) is downloaded.
- An application is deleted from a PLC.
- One application or several new ones and a PLC configuration are downloaded to a previously empty PLC.

The DA part of OPC Server for AC 800M supports the OPC Data Access 1.0a and OPC Data Access 2.05 standards.

OPC Server Alarm and Event (AE) Part

The Alarm and Event (AE) part of the OPC server subscribes to alarms and events generated by PLCs and other devices in the control network. All these alarms and events are then stored and made accessible to OPC clients.

The AE part of the OPC server also collects acknowledgements and cancellations of alarms from OPC clients and forwards them to the PLC or device in question. Clients may also disable or enable alarm conditions in PLCs or devices through the OPC server.

The AE part of OPC Server for AC 800M supports the OPC Alarm and Events 1.02 standard.

Section 3 Technical Data and Performance

This section describes prerequisites and requirements that must be fulfilled, in order for Compact Control Builder AC 800M and OPC Server for AC 800M, to function properly. It also contains a list of functions that, compared to 800xA System with Control Builder Professional, are not included in Compact Control Builder AC 800M.

ℹ️ For information about hardware and I/O, see Appendix A, Control and I/O.

Type solutions for simple logic control, device control, loop control, alarm handling etc. are located in standard libraries. An overview of all standard libraries are described in the manual Extended Control Software, Binary and Analog Handling.

General

The PLC hardware to be used for Compact Control Builder is AC 800M only.

ℹ️ AC 800M High Integrity controllers are not supported, thus SIL (Safety Integrity Level) applications cannot be handled in Compact Control Builder AC 800M.

Firmware can be downloaded to PLC using Ethernet or via a direct serial link. Serial communication between Compact Control Builder and PLC is done by using the TK212A cable.

Compact Control Builder AC 800M Performance

A project in Compact Control Builder can handle up to 1024 applications. Each application can handle 64 programs and 128 diagrams at the most. A maximum of 32 Control Builder PCs can be used together in multi-user environment and up to 32 PLCs can be created and handled within a project.

OPC Server Performance

An OPC Server can handle up to 24 PLCs, while a PLC can handle up to 3 OPC Servers.

Compact Flash Requirements

Compact Flash Writer

- It is typically an external device, and not an onboard PC function.

Compact Flash Card

The following are the specifications required for the CF card used in AC 800M PLCs (PM8xx, except PM891):

- Formatted according to FAT16 or FAT32.

- Minimum read speed – 8MB/second.

- Minimum write speed – 6MB/second.

- Same (or better) ambient temperature operative range compared to the PM8xx that uses the card.

Secure Digital Requirements

Secure Digital Writer

- It is typically an external device, and not an onboard PC function.

Secure Digital Card

The following are the specifications required for the SDSC/SDHC/SDXC card used in AC 800M PLC (PM891):

- Formatted according to FAT32.

- Minimum read speed – 8MB/second.

- Minimum write speed – 6MB/second.

- Same (or better) ambient temperature operative range compared to the PM891 that uses the card.

Prerequisites and Requirements

Compact Control Builder AC 800M

The following software requirement must be fulfilled in order for Compact Control Builder AC 800M to function properly. Using other software than recommended may affect performance.

Table 6. Compact Control Builder AC 800M software requirements

Software	Requirement
Operating system	• Windows 7 SP1 64 bit or Windows Server 2008 R2 SP1. • Windows 8.1 64 bit or Windows Server 2012 R2. • Windows 10 64 bit (from version 6.0.0-1)
Printing project documentation	Microsoft Word 2010 or 2013 or 2016
Reading online manuals	Adobe Reader version 9.0 or later

OPC Server

OPC Server for AC 800M requires the following operating system:

• Windows 7 SP1 64 bit or Windows Server 2008 R2 SP1.

• Windows 8.1 64 bit or Windows Server 2012 R2.

• Windows 10 64 bit (from version 6.0.0-1).

Not Supported Functions

Compact Control Builder AC 800M is similar to the 800xA System and
Control Builder Professional, with a few exceptions. The Control Builder
Professional in 800xA adds the following functions, to the set of functions available
in Compact Control Builder:

- Online Upgrade

- Load Evaluate Go

- Batch Handling

- Audit Trail

- Access Management / Privilege handling

- Version and State for User Libraries

- Instance specific initial values

- Reserve mechanisms, that is check-out / check-in

- SFC Viewer

- High Integrity Controller for SIL applications

- CI860 for FF HSE, and CI862 for TRIO I/O

- Information routing via HART protocol

Section 4 Ordering and Licensing

ℹ️ *This section is intended for sales representatives. It merely presents internal identity numbers for ABB price books and price lists. If you are **not** involved in selling Compact Products, please disregard this section completely.*

Ordering Procedure

One purpose of the Product Guide is to support the sales representatives when ordering Compact Products. The price lists used can all be found in the price book of the Compact Products V6. The price book includes Compact HMI, Compact Control Builder AC 800M, S800 I/O, AC 800M and Panel 800.

Price Lists Structure

The Compact Products offering and related price lists are organized in a price book. This price book consists of the price lists as described in Table 7.

Price Book: 3BSE045561 includes the following Price List:

Table 7. Price List

Price List	Article No.
Panel 800, Version 6	3BSE070940
Panel 800, Version 5	3BSE043387
AC 800M used for Compact Control	3BSE078500
Compact Control Builder AC 800M 6.0	3BSE078498
S800 I/O used for Compact Control	3BSE078499
Compact HMI 5.1	3BSE064096
Compact HMI 5.1 Expansion	3BSE064097
Compact HMI 5.0 Expansion	3BSE054250
Extended Warranty Time - S800 I/O, S900 I/O, Fieldbus and AC 800M	3BSE049908

Compact Control Builder AC 800M, 3BSE078498

Table 8 describes the items in the price list for Compact Control Builder AC 800M.

Table 8. Items in the price list for Compact Control Builder

Item No.	Description	Article No.
A040	Media Box with Compact Control Builder AC 800M and OPC server for AC 800M version 6.0 This item can be ordered by users with a valid Automation Sentinel agreement for Compact Control Builder AC 800M or OPC Server for AC 800M. It includes media and documentation for Compact Control Builder AC 800M and OPC server for AC 800M. No license is included.	3BSE046066R60

Table 8. Items in the price list for Compact Control Builder (Continued)

Compact Control Builder AC 800M		
A110	Compact Control Builder AC 800M 6.0 Product Box including: - licenses for one Compact Control Builder AC 800M, one OPC Server for AC 800M, and one SoftController. - DVD with software for Compact Control Builder AC 800M, OPC Server for AC 800M, and SoftController. - firmware for AC 800M and its communication units. - manuals as pdf-files. - a Getting Started manual.	3BSE040360R60
A120	OPC Server for AC 800M 6.0 License for one OPC Server for AC 800M.	3BSE039915R60
User Documentation		
H130	Compact Product Suite, Compact Control Builder AC 800M 6.0, Getting Started	3BSE041584-600
H140	Compact Product Suite, Compact Control Builder AC 800M 6.0, Configuration	3BSE040935-600
H150	Compact Product Suite, Compact Control Builder AC 800M 6.0, Planning	3BSE044222-600
H160	Compact Product Suite, Compact Control Builder AC 800M 6.0, Binary and Analog Handling	3BSE041488-600

The other price lists in the price book contain selected products that work together with the AC 800M for Compact Control.

Licensing

The software license is delivered as part of selected product package (A110 or A120), see Table 8 for details.

Control System Lifecycle Support Program

Automation Sentinel is the ABB control system lifecycle management program. An introductory trial period to the Automation Sentinel program will be included, at no additional cost, with each new ABB control system software delivery. Please contact your designated Automation Sentinel responsible for any questions or please refer to the Automation Sentinel 3.0 product guide (3BSE047996*) for detailed information on the program and on how to calculate and order Automation Sentinel subscriptions.

Customer Trial Subscription

The customer is entitled to get a 3 months Automation Sentinel trial subscription. This Trial subscription is free of charge and should be requested by customers through the My Control System. The purpose of this trial subscription is to give a chance to the customers (with newly purchased control systems) to try out and to become more familiar with Automation Sentinel. The trial subscription allows the customer to have access to many of the deliverables provided by the Automation Sentinel program.

Ordering Example

A system integrator gets an order for a control solution where the end customer requires two PC based HMI and three AC 800M PLCs. The PLCs are configured by two engineers and the end user does not need any PLC configuration functionality. Below are the required items.

System integrator:

- Two Compact Control Builder AC 800M (license is bought by, and kept by the system integrator)

End user:

- Three AC 800M PLCs for Compact Control

- One Compact HMI license including one Server Workplace and one Client Workplace (AC 800M OPC server is included in the HMI server workplace)

Price List Items

1. From the Compact Control Builder AC 800M price list (3BSE078498), order the following items:
   - Two items A110 (Compact Control Builder AC 800M)

2. The AC 800M PLC items (CPUs, communication interfaces, accessories etc.) can be found in the price list, 3BSE078500.

3. From the Compact HMI price list (3BSE064096), order the following items:
   - One item A110 (Compact HMI)
   - One of the items B110, B120 or B130 (depending on number of signals)
   - One Compact HMI Operator Workplace Client (item D110-D160, dependent of the size of the server)

Appendix A Control and I/O

This section presents performance and technical data for Control Software and Control Builder key functions, configuration, and items.

⚠ Late changes might affect performance and/or functionality. For information on late changes and restrictions on the use of the product, please refer to the Release Notes.

Memory and Execution Performance

Memory Size

Figure 9 shows the memory organization. The total physical memory less the executing firmware is called "Memory size" by the "SystemDiagnostics" function block. This amount of memory is sometimes also called the "heap".

The memory usage is also displayed in the Control Builder Heap Utilization dialog which can be displayed for each controller. The available memory is called "Non-Used Heap" and the rest is called "Used Shared Heap".
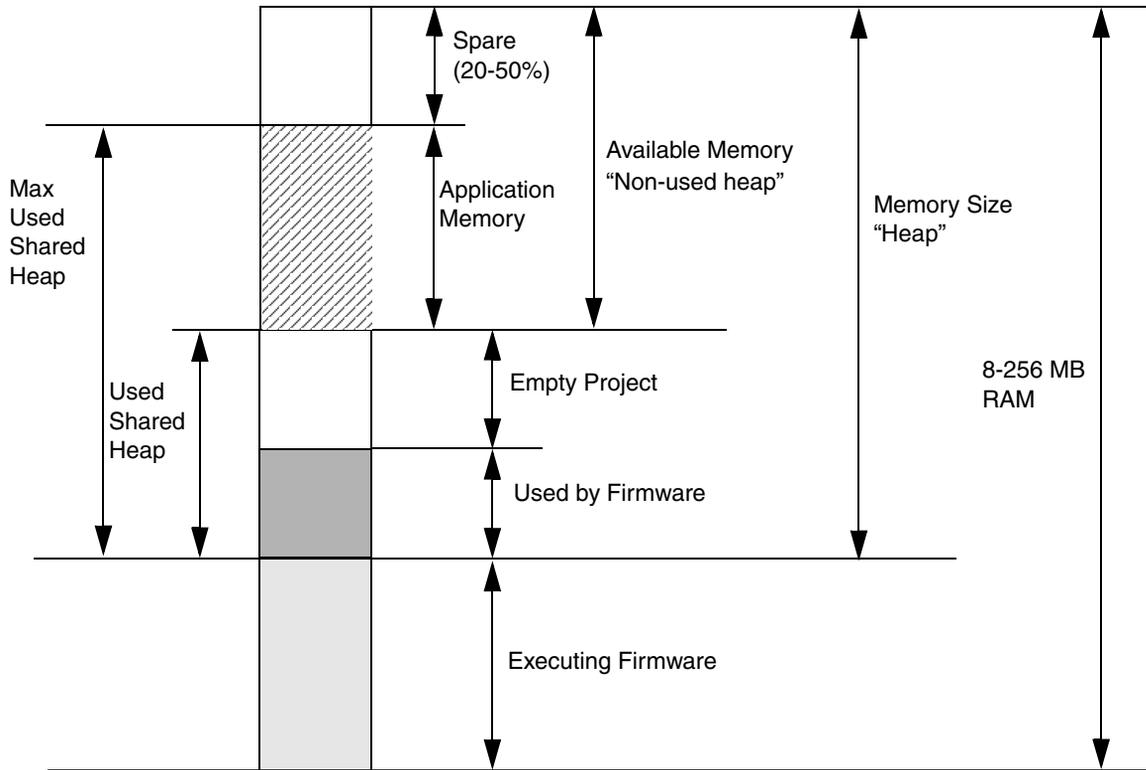
Figure 9. The Memory Organization

Available Memory

The amount of free memory in the controller decreases when the controller has started up, and an empty project has been downloaded from Control Builder M.

The remaining memory is what can be used for application code, and is hereafter referred as to "Available memory".

The measurement results in Table 9 are made <u>with</u> IAC, but <u>without</u> any configured communication protocols and CEX units. Memory consumptions for used protocols and CEX units have to be added, according to Table 10.

Table 9. Available RAM Memory and Performance in AC 800M Controller (without Protocol Handlers)

Controller	Execution Performance Factor	Total RAM (kbytes)	Firmware and an Empty Project (kbytes)	Available Memory (kbytes)
PM851	0.5	8192	5963	2228
PM851A	0.5	12288	5973	6314
PM856	0.5	8192	5963	2228
PM856A	0.5	16384	5983	10400
PM858	0.6	16384	9143	7240
PM860	1.0	8192	5963	2228
PM860A	1.0	16384	5979	10404
PM861	1.0	16384	9143	7240
PM861A	1.0	16384	9143	7240
PM862	1.2	32767	14147	18620
PM864	1.5	32767	9165	23602
PM864A	1.5	32767	9165	23602
PM866	2.1	65535	14146	51390
PM866A	2.1	65535	14147	51389
PM891	4.5	262144	53159	208985

Table 10. Memory Consumptions of Protocols and CEX Units

Protocol/ CEX Unit	PM864		PM866		PM891	
	First Unit (kbytes)	Next Unit (kbytes)	First Unit (kbytes)	Next Unit (kbytes)	First Unit (kbytes)	Next Unit (kbytes)
MODBUS RTU	96	14	95	14	84	4
COMLI	72	15	71	15	60	4
S3964R	65	13	63	13	54	4
SerialLib	61	18	60	17	48	6
IAC*	167	NA	174	NA	148	NA
UDP	43	NA	42	NA	35	NA
TCP	53	NA	46	NA	44	NA
CI853	2	4	5	4	5	4
CI854A/B	247	33	247	32	167	14
CI855	94	12	96	11	95	3
CI856	103	13	103	13	97	5
CI857	182	12	178	13	173	4
CI858	62	19	64	19	60	7
CI865	148	73	132	73	140	73
CI867	166	35	169	36	175	33
CI868	174	75	177	74	114	4
CI869	153	64	157	63	97	5
CI871	185	38	190	38	189	29
CI872	208	68	213	67	160	8
CI873	200	101	208	101	155	42
NOTE: *In addition, each communication connection requires about 40 kbytes memory.						

Execution Performance

Cyclic CPU load is calculated as a percentage using the following formula.

Cyclic CPU load (%) = 100*(Total execution time / Total interval time)

Depending on the amount of code and requested task interval times, applications may demand up to 70% of CPU capacity (never more)[1]; the execution of IEC 61131-3 code is called *Cyclic Load*. Should an application require more than 70% of CPU capacity, the task scheduler automatically increases the task interval times to re-establish a 70% load.

Load balancing can be disabled (see the manual *Compact Control Builder Configuration, 3BSE040935*).*

It is important to consider CPU load if communication handling is vital to the application. Running at the maximum cyclic load will result in poor capacity and response times for peer-to-peer and OPC Server communication.

Communication handling has the lowest priority in a controller. It is therefore important to consider controller CPU load if the communication handling is vital to the application. Running close to 100% total load will result in poor capacity and response times for peer-to-peer and (OPC Server for AC 800M) communication. It is recommended that peak total load will be kept below 100%.

Among the communication protocols, the IAC MMS protocol will be the last to be affected if there is a communication data starvation.

CPU load is also influenced by other factors, such as Modulebus scan interval and the number of modules on Modulebus (AC 800M), or the scanning of ABB Drives.

The PM860/PM860A and PM861/PM861A processor units have the same internal design and the same performance when execution application program.

The PM851/PM851A, PM856/PM856A and PM860/PM860A processor units have the same design. They differ only in performance when executing an application program. The execution time in PM851/PM851A and PM856/PM856A is approximately two times the execution time in PM860/PM860A.

The execution time in PM858 is four times the execution time in PM866.

The execution time in PM862 is two times the execution time in PM866.

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1. This is **not** true if load balancing is set to false. The controller will run until it is forced to stop.

The PM864/PM864A processor unit, in single configuration, has performance data which theoretically peaks at twice the performance compared to the PM860/PM860A. The useful sustained performance improvement is, however, a bit lower and dependent on the actual application program but can be expected to be 10 to 50% compared to PM860/PM860A. The difference in execution performance is dependent on how much CEX bus accesses, and how much communication is running in the controller (both communication running as CEX bus interfaces and communication running on the built in ports on the CPU i.e. ModuleBus, Ethernet and RS-232). CEX bus access and communication decreases execution performance.

In redundant configuration the execution performance is lower than in single configuration (reduction is typically less than 10%). Switch over time from primary controller to backup controller, in redundant configuration, is less than 10 ms.

The PM866 processor unit has performance data which is approximately 1.4 times the performance of PM864/PM864A.

The PM891 processor unit has performance data which is approximately 2 times the performance of PM866.

Spare Memory Needed for Online Changes

As a general rule, an application should never exceed half the size of the available memory. The reason for this is the manner in which applications are updated online.

1. The modifications (the difference between the old and the updated application) are downloaded to the controller memory.

2. A new version of the application is created in controller memory, based on the old application and the modifications.

3. The controller switches from the old to the new application.

4. The old application is deleted.

This technique handles all updates in a controlled and efficient way. Free memory equal to the size of the largest application is required.

If an application comes close to this limit, it should be divided into two parts so that they can be updated separately.

One Application in the Controller

There must be spare memory in the available memory in order to be able to make on-line changes shown in the Figure 9. The amount of spare memory must be at least 20% of available memory, and may require up to 50%.

A minimum of 20% spare available memory may be sufficient, depending on a number of factors, such as the complexity of the application and the number of defined alarms.

> ℹ The function block "SystemDiagnostics" reports used memory based on the memory size, not on the available memory, but the dialog "Heap Utilization" will show the available memory as "Non-Used Heap".

The function block *SystemDiagnostics* also presents another figure: the "Maximum used memory". This figure is presented in actual bytes, and as a percentage of the memory size. This figure is far more useful to look at when determining how close you are to being unable to make on-line changes. Several on-line changes must be made in order to catch the maximum memory need in the controller.

It is still possible to make on-line changes as long as the maximum used memory value is less than 100%.

More than One Application in the Controller

Less spare memory is needed when there is more than one application in the controller.

The on-line changes are done to one application at the time. This means that if changes are done to more than one application in the controller, these changes will not take effect in a synchronized way.

Example: One application requires 50% used memory and 70% maximum used memory. If you split this application into two equally smaller applications, it will still require 50% used memory, but only 60% maximum used memory, since the extra memory needed for the on-line changes will be half.

Comparing Memory Allocations Made with Different Versions

From the discussions above, you can see that the "used memory" value provided by the *SystemDiagnostics* function block cannot be used to compare different versions.

The amount of available memory in the controller varies between versions for a number of reasons, one being the number of functions implemented in the firmware.

Memory Consumption and Execution Times

Memory is reserved for each function block type defined. When another instance is created, the amount of memory reserved for the instance is very small in relation to the type. This means that the memory consumed by the type itself is of great importance.

The following tables show memory consumption and execution time for AC 800M PM864/PM866/PM891 controllers, for a number of common function blocks and control modules.

In the tables the *First Object* column shows the required memory for the object type and one function block or control module and *Next Object* column shows the required memory for every further function block or control module.

Table 11. AC 800M Memory Consumption for Function Blocks and Control Modules

Library	Object	PM864		PM866		PM891	
		First Object (kbyte)	**Next Object (kbyte)**	**First Object (kbyte)**	**Next Object (kbyte)**	**First Object (kbyte)**	**Next Object (kbyte)**
Function Blocks							
AlarmEventLib	AlarmCondBasic	4,1	0,6	5,3	0,8	4,3	1,8
AlarmEventLib	AlarmCond	5,4	0,9	7,2	1,5	5,7	2,0
ControlBasicLib	PidLoop	62,2	5,5	64,1	5,8	54,4	6,3
ControlBasicLib	PidLoop3P	64,0	7,5	67,4	6,8	56,7	7,3
ControlBasicLib	PidCascadeLoop	75,2	11,4	76,5	13,7	66,8	14,0
ControlBasicLib	PidCascadeLoop3P	76,7	14,3	80,5	13,7	70,1	14,2
ControlSimpleLib	PidSimpleReal	10,7	1,2	24,1	1,8	10,1	2,2

Table 11. AC 800M Memory Consumption for Function Blocks and Control Modules (Continued)

Library	Object	PM864		PM866		PM891	
		First Object (kbyte)	Next Object (kbyte)	First Object (kbyte)	Next Object (kbyte)	First Object (kbyte)	Next Object (kbyte)
ProcessObjectDrive Lib	ACStdDrive	80,7	12,1	93,7	17,2	80,9	16,6
ProcessObjectExtLib	Uni	53,5	6,0	66,1	8,7	52,3	9,0
ProcessObjectExtLib	Bi	62,0	8,0	59,0	14,2	60,6	12,5
ProcessObjectExtLib	MotorUni	63,5	7,6	59,7	11,5	62,0	11,3
ProcessObjectExtLib	MotorBi	73,3	9,9	68,2	14,5	71,9	15,4
ProcessObjectExtLib	ValveUni	52,8	5,5	47,3	8,1	51,3	8,6
ProcessObjectInsum Lib	McuExtended	109,2	25,5	107,4	28,5	112,0	28,5
SignalBasicLib	SignalBasicBool	4,4	0,3	3,9	0,5	2,2	1,1
SignalBasicLib	SignalBasicInBool	5,6	0,4	4,2	0,7	4,8	1,2
SignalBasicLib	SignalBasicInReal	10,6	1,9	9,4	1,9	8,9	1,9
SignalBasicLib	SignalBasicOutBool	6,0	1,2	4,3	1,2	2,6	1,2
SignalBasicLib	SignalBasicOutReal	6,9	1,6	5,7	1,6	4,8	1,5
SignalBasicLib	SignalBasicReal	5,9	1,3	4,1	1,3	4,3	1,4
SignalLib	SignalInBool	29,1	2,8	20,8	3,6	26,6	4,2
SignalLib	SignalOutBool	28,8	2,7	20,1	3,7	26,0	4,3
SignalLib	SignalSimpleInReal	29,0	2,3	20,3	3,3	25,5	3,9
SignalLib	SignalInReal	64,0	7,6	55,2	10,6	60,5	10,6
SignalLib	SignalSimpleOut Real	17,8	2,0	17,8	2,9	22,1	3,5
SignalLib	SignalOutReal	58,9	6,9	52,9	9,0	57,0	9,5
SupervisionBasicLib	SDBool	24,4	4,9	24,3	4,9	23,1	5,5

Table 11. AC 800M Memory Consumption for Function Blocks and Control Modules (Continued)

Library	Object	PM864		PM866		PM891	
		First Object (kbyte)	**Next Object (kbyte)**	**First Object (kbyte)**	**Next Object (kbyte)**	**First Object (kbyte)**	**Next Object (kbyte)**
SupervisionBasicLib	SDInBool	31,7	4,0	25,2	5,3	29,8	5,9
SupervisionBasicLib	SDInReal	49,7	10,7	43,6	12,6	47,8	12,8
SupervisionBasicLib	SDLevel	23,6	3,4	24,9	5,2	26,3	5,6
SupervisionBasicLib	SDOutBool	34,2	5,8	28,1	6,8	32,7	7,3
SupervisionBasicLib	SDReal	45,1	10,1	39,0	11,8	43,4	12,3
SupervisionBasicLib	SDValve	36,9	4,8	30,8	5,9	35,4	6,4
SupervisionBasicLib	StatusRead	20,4	3,3	14,3	3,2	18,7	3,7

Table 11. AC 800M Memory Consumption for Function Blocks and Control Modules (Continued)

Library	Object	PM864		PM866		PM891	
		First Object (kbyte)	**Next Object (kbyte)**	**First Object (kbyte)**	**Next Object (kbyte)**	**First Object (kbyte)**	**Next Object (kbyte)**
Control Modules							
AlarmEventLib	AlarmCondBasicM	5,1	1,8	5,8	1,4	12,5	0,9
AlarmEventLib	AlarmCondM	6,8	1,1	5,7	0,9	13,3	2,8
ControlAdvancedLib	PidAdvancedCC	209,0	23,4	198,3	31,4	199,4	22,9
ControlSolutionLib	CascadeLoop	232,8	60,9	229,6	64,3	224,7	58,9
ControlSolutionLib	FeedforwardLoop	233,1	43,8	234,6	47,4	214,3	52,3
ControlSolutionLib	MidRangeLoop	232,5	44,6	233,6	48,1	218,4	47,7
ControlSolutionLib	OverrideLoop	319,0	114,4	318,8	114,5	300,6	113,7
ControlSolutionLib	SingleLoop	229,9	36,0	227,4	36,4	205,7	36,0
ControlStandardLib	AnalogInCC	20,9	3,6	21,3	3,7	20,1	3,8
ControlStandardLib	AnalogOutCC	19,3	3,6	16,2	3,6	14,4	3,8
ControlStandardLib	Level2CC	22,6	4,6	21,7	4,7	18,3	4,6
ControlStandardLib	Level4CC	30,0	6,5	29,8	6,6	27,6	6,5
ControlStandardLib	Level6CC	37,4	8,5	37,5	8,2	35,7	8,1
ControlStandardLib	PidCC	109,5	16,0	145,3	16,1	125,5	15,6
ControlStandardLib	PidSimpleCC	16,0	2,6	14,1	2,5	12,2	2,6
ControlStandardLib	ThreePosCC	42,1	4,2	56,5	4,6	44,4	4,2
ProcessObjectDriveLib	ACStdDriveM	83,3	16,8	118,0	17,8	109,4	16,2
ProcessObjectExtLib	UniM	51,7	9,4	90,2	9,3	78,5	9,2
ProcessObjectExtLib	BiM	61,0	12,1	96,5	15,8	87,3	12,6
ProcessObjectExtLib	MotorUniM	61,9	10,1	63,9	13,4	87,7	10,8
ProcessObjectExtLib	MotorBiM	71,4	14,3	106,1	17,6	97,1	14,4

Table 11. AC 800M Memory Consumption for Function Blocks and Control Modules (Continued)

Library	Object	PM864		PM866		PM891	
		First Object (kbyte)	Next Object (kbyte)	First Object (kbyte)	Next Object (kbyte)	First Object (kbyte)	Next Object (kbyte)
ProcessObjectExtLib	ValveUniM	51,1	8,8	88,2	10,7	77,7	25,6
ProcessObjectInsum Lib	McuExtendedM	111,0	28,6	145,4	32,8	138,3	27,8
SignalLib	SignalInBoolM	24,8	4,1	24,4	3,7	51,4	4,1
SignalLib	SignalOutBoolM	24,4	3,8	24,7	4,4	51,2	3,8
SignalLib	SignalInRealM	64,1	10,0	63,9	11,8	90,2	9,9
SignalLib	SignalOutRealM	59,1	10,3	62,2	10,3	84,7	10,2

Table 12. AC 800M Execution Time for Function Blocks and Control Modules

Library	Object	PM864 (υs)	PM866 (υs)	PM891 (υs)
Function Blocks				
AlarmEventLib	AlarmCondBasic	20	15	9
AlarmEventLib	AlarmCond	32	23	15
AlarmEventLib	ProcessObjectAE	21	15	9
AlarmEventLib	SignalAE	31	23	14
AlarmEventLib	SimpleEventDetector	38	28	16
BasicLib	CTD	8	5	2
BasicLib	CTU	8	5	3
BasicLib	CTUD	10	8	4
BasicLib	ErrorHandler	9	6	3
BasicLib	F_Trig	5	4	2
BasicLib	ForcedSignals	29	21	12
BasicLib	PulseGenerator	8	6	3
BasicLib	R_Trig	5	4	2

Table 12. AC 800M Execution Time for Function Blocks and Control Modules (Continued)

Library	Object	PM864 (υs)	PM866 (υs)	PM891 (υs)
BasicLib	RS	5	3	2
BasicLib	SR	5	4	2
BasicLib	SystemDiagnostics	160	445	187
BasicLib	TimerD	45	31	15
BasicLib	TimerU	34	26	10
BasicLib	TOf	8	6	3
BasicLib	TOn	8	6	4
BasicLib	TP	8	6	3
ControlBasicLib	PidLoop	343	244	103
ControlBasicLib	PidLoop3P	410	281	113
ControlBasicLib	PidCascadeLoop	618	428	179
ControlBasicLib	PidCascadeLoop3P	666	486	173
ControlSimplelib	PidSimpleReal	71	52	18
ProcessObjBasiclib	BiSimple	191	137	81
ProcessObjBasiclib	UniSimple	120	85	50
ProcessObjDriveLib	ACStdDrive	584	402	217
ProcessObjExtLib	Bi	320	248	134
ProcessObjExtLib	MotorBi	417	286	166
ProcessObjExtLib	MotorUni	311	217	134
ProcessObjExtLib	Uni	197	131	87
ProcessObjExtLib	ValveUni	205	150	93
ProcessObjInsumLib	McuExtended	534	356	226
SignalBasicLib	SignalBasicBool	7	5	2
SignalBasicLib	SignalBasicInBool	7	5	3
SignalBasicLib	SignalBasicInReal	79	36	17
SignalBasicLib	SignalBasicOutBool	7	5	3
SignalBasicLib	SignalBasicOutReal	13	9	4
SignalBasicLib	SignalBasicReal	15	12	4

Table 12. AC 800M Execution Time for Function Blocks and Control Modules (Continued)

Library	Object	PM864 (υs)	PM866 (υs)	PM891 (υs)
SignalLib	SignalBool	55	41	24
SignalLib	SignalInBool	46	34	17
SignalLib	SignalInReal	210	145	82
SignalLib	SignalOutBool	48	33	22
SignalLib	SignalOutReal	125	90	52
SignalLib	SignalReal	154	112	60
SignalLib	SignalSimpleInReal	84	58	34
SignalLib	SignalSimpleOutReal	40	30	18
SupervisionBasicLib	SDBool	127	83	49
SupervisionBasicLib	SDInBool	94	65	37
SupervisionBasicLib	SDInReal	266	185	109
SupervisionBasicLib	SDLevel	77	56	38
SupervisionBasicLib	SDOutBool	129	86	49
SupervisionBasicLib	SDReal	230	182	74
SupervisionBasicLib	SDValve	165	121	66
SupervisionBasicLib	StatusRead	35	25	14
Control Modules				
AlarmEventLib	AlarmCondBasicM	30	21	15
AlarmEventLib	AlarmCondM	25	16	10
BasicLib	CVAckISP	47	33	20
BasicLib	ErrorHandlerM	16	11	5
BasicLib	ForcedSignalsM	36	25	15
ControlAdvancedLib	PidAdvancedCC	994	722	316
ControlSolutionLib	CascadeLoop	2016	1452	709
ControlSolutionLib	FeedforwardLoop	1677	1161	546
ControlSolutionLib	MidrangeLoop	1505	1066	483
ControlSolutionLib	OverrideLoop	3859	2805	1370

Table 12. AC 800M Execution Time for Function Blocks and Control Modules (Continued)

Library	Object	PM864 (υs)	PM866 (υs)	PM891 (υs)
ControlSolutionLib	SingleLoop	1187	863	406
ControlSolutionLib	AnalogInCC	104	78	36
ControlSolutionLib	AnalogOutCC	87	62	33
ControlSolutionLib	Level2CC	63	46	28
ControlSolutionLib	Level4CC	89	64	39
ControlSolutionLib	Level6CC	119	96	52
ControlSolutionLib	PidCC	595	419	218
ControlSolutionLib	PidSimpleCC	110	77	37
ControlSolutionLib	ThreePosCC	179	125	59
ProcessObjBasicLib	BiSimpleM	205	133	75
ProcessObjBasicLib	UniSimpleM	126	97	50
ProcessObjDriveLib	ACStdDriveM	594	428	237
ProcessObjExtLib	BiM	333	235	141
ProcessObjExtLib	MotorBiM	401	306	162
ProcessObjExtLib	MotorUniM	318	220	130
ProcessObjExtLib	UniM	211	148	97
ProcessObjExtLib	ValveUniM	205	145	96
ProcessObjInsumLib	McuExtendedM	521	378	238
SignalLib	SDLevelAnd4	27	20	10
SignalLib	SDLevelBranch4	19	14	7
SignalLib	SDLevelM	104	71	45
SignalLib	SDLevelOr4	23	16	8
SignalLib	SignalBoolCalcInM	70	48	31
SignalLib	SignalBoolCalcOutM	87	62	35
SignalLib	SignalInBoolM	62	44	24
SignalLib	SignalInRealM	246	181	103
SignalLib	SignalOutBoolM	67	50	31

Table 12. AC 800M Execution Time for Function Blocks and Control Modules (Continued)

Library	Object	PM864 (υs)	PM866 (υs)	PM891 (υs)
SignalLib	SignalOutRealM	210	140	88
SignalLib	SignalRealCalcInM	228	165	88
SignalLib	SignalRealCalcOutM	236	183	97
SignalLib	Vote1oo1Q	222	158	80
SignalLib	VoteBranch4	41	30	17
SignalLib	VotedAnd4	36	27	15
SignalLib	VotedBranch4	25	17	10
SignalLib	VoteXoo2D	256	179	92
SignalLib	VoteXoo3Q	289	186	90
SignalLib	VoteXoo8	302	265	103

Table 13. Execution Time for a Number of Standard Operations and Function Calls

Operation/Function	Data Type	PM864 (υs)	PM866 (υs)	PM891 (υs)
a:= b or c	bool	0,7	0,5	0,2
a:= b and c	bool	0,6	0,5	0,3
a:= b xor c	bool	0,7	0,5	0,2
a := b + c	dint	0,6	0,5	0,3
a := b + c	real	1,9	1,3	0,2
a := b - c	dint	0,6	0,5	0,2
a := b - c	real	1,7	1,2	0,2
a := b * c	dint	0,6	0,5	0,3
a := b * c	real	1,7	1,2	0,3
a := b / c	dint	1,0	0,7	0,5

Table 13. Execution Time for a Number of Standard Operations and Function Calls

Operation/Function	Data Type	PM864 (υs)	PM866 (υs)	PM891 (υs)
a := b / c	real	4,0	2,9	0,6
a:= b <> c	dint	0,8	0,6	0,3
a:= b <> c	real	1,8	1,3	0,3
a := b	string[140]	8,5	6,3	2,8
a := b + c	string[10]	17,5	12,0	3,5
a := b + c	string[40]	17,8	13,0	2,7
a := b + c	string[140]	28,1	20,0	5,8
a := AddSuffix (b + c)	string[10]	4,0	3,2	1,4
a := AddSuffix (b + c)	string[40]	7,7	5,1	2,4
a := AddSuffix (b + c)	string[140]	16,1	12,1	4,1
a := real_to_dint(b)	dint	15,4	11,6	1,0
a := dint_to_real(b)	real	1,9	1,4	0,3
a := real_to_time(b)	time	22,0	15,5	1,5
a := time_to_real(b)	real	6,1	4,4	0,8

Hardware and I/O Performance

Modulebus Response Time and Load

Modulebus scanning has a considerable influence on CPU load, since I/O copying on Modulebus is handled by the controller CPU.
The scan time increases as modules are added, and at a certain point Modulebus scanning will have high impact on the CPU load.

The Modulebus scanning is mainly part of the total CPU load. But the cyclic CPU load is indirectly affected by the Modulebus interrupts, as the Modulebus scanning has the highest priority in the AC 800M controller.

The Modulebus scan cycle time can be set in Control Builder. The cycle time must be set to suit the module requiring the shortest scan interval. A solution to this problem is to connect I/O variables requiring shorter scan intervals via the CI854A/B PROFIBUS adaptor.

Calculation of Scan Time on the Modulebus and CPU Load

The following definitions are used in the calculations:

1. Amount of modules:

* n_1 = amount of Drives and DP, DI, DO, AI and AO modules (except AI880A, DI880 and DO880)

* n_2 = amount of AI880A, DI880 and DO880 modules

For the modules below, the following number of modules should be accounted:
* AO845 (redundant) = 2
* DO840 (redundant) = 2
* DO880 (redundant) = 2
* DP820 = 4
* DP840 (single) = 8
* DP840 (redundant) = 9
* ABB Engineered Drives = 3
* ABB Standard Drives = 2

For other redundant modules, only one should be accounted.

2.   Scan time for different modules:

$t_1 = 0.5$ ms (scan time for n_1)

$t_2 = 1.3$ ms (scan time for n_2)

Calculation of Fastest Possible Scan Time

The fastest possible scan time is $n_1 * t_1 + n_2 * t_2$.

Example:
It can never take less than $10 * 0.5 = 5.0$ ms to scan 10 I/O modules.

Calculation of the Modulebus CPU Load

The maximum load caused by n_1 (non High Integrity I/O) module types:

$L_1 = 31\%$

The maximum load caused by n_2 (High Integrity I/O) module types:

$L_2 = 20\%$

The L_1 and L_2 values are valid for all AC 800M processor unit types, except for the ones listed below.

PM866, PM862 and PM858: $L_1 = 16\%$ and $L_2 = 10\%$
PM867: $L_1 = 26\%$ and $L_2 = 19\%$
PM891: $L_1 = 10\%$ and $L_2 = 7\%$

The Modulebus scanning causes the following CPU load if the chosen scan cycle time is less or equal to the fastest possible scan time:

Load$_{(fastest)}$ = (n_1 / ($n_1 + n_2$) * L_1 + (n_2 / ($n_1 + n_2$) * L_2)

The following CPU load is caused for other scan cycle times:

Load$_{(chosen)}$ = Fastest Possible Scan Time / Chosen Scan time * Load$_{(fastest)}$

The Fastest Possible Scan Time to be used in the formula is without the SIL3 addition.

Example Scan Time and Cyclic Load

Assume that following units are used:

1 AI810: 0.5*1 = 0.5 ms
1 redundant DO880: 1.3*2 = 2.6 ms
1 redundant DP840: 0.5*9 = 4.5 ms

This means that n_1=10 and n_2=2, and fastest possible scan cycle time is 8 ms (resolution of 1 ms).

CPU Load will be: (10/12)*31 + (2/12)*20 = 29.16%

Updating Rate of Data to an Application

The rate in milliseconds at which all channels of an I/O module are updated in the controller to be used in the IEC 61131-3 application, as a function of the scan time in milliseconds is as follows:

- For AI, AO and AI843 (except AI880A and other temperature measuring I/O than AI843) the updating time is equal to number of channels divided by two multiplied by the scan time.

- For temperature measuring I/O (except for AI843) the updating time is equal to number of channels multiplied by the scan time.

- For Standard Drives the updating time is equal to scan time.

- For Engineered Drives the updating time is equal to scan time multiplied by 12.

- For DI, DO, DP the updating time is equal to scan time.

ModuleBus Scanning of ABB Drives

Scanning of ABB Drives on Modulebus also influences CPU load.

Modulebus Scanning of ABB Engineered Drives (AC 800M)

Scanning of an engineered Drive is distributed over 3 * 12 scan cycles. Three channels (DDS pairs) are scanned in each scan cycle. The first two are always channels 1 and 2 (i.e. DDS pairs 10/11 and 12/13); the third will be different for each scan cycle.

Table 14. Scan cycles for ABB Engineered Drives DDS Pair 3

Scan Cycle	DDS Pair 3
1, 5, 9	14/15
2, 6, 10	16/17
3, 7 11	18/19
4	20/21
8	22/23
12	24/25

To scan the three DDS pairs each cycle takes 3 * 0.5 = 1.5 ms. It is not possible to have a scan interval less then 2 ms (=PA controller) / 5 ms =HI controller) for the Modulebus scanner. Thus, for one drive the scan time will be 2 ms.

Example

For four drives, the scan time will be 1.5 ms * 4 = 6.0 ms for the DDS pairs 10/11 and 12/13, and the scan time for the remaining of the DDS pairs will be 1.5 ms * 4 * 12 = 72.0 ms.

ModuleBus Scanning of ABB Standard Drives (AC 800M)

For ABB Standard Drives, all data sets (DDS 1/2 and DDS 3/4) are scanned in each scan cycle. It takes 2 * 0.5 = 1.0 ms to scan a single Standard Drive.

Example

For four ABB Standard Drives the scan time will be 1.0 ms * 4 = 4.0 ms.

Dynamic Data Exchange S800 I/O Connected via CI854A/B

The transportation of dynamic data between PROFIBUS-DP/DPV1 master and the S800 I/O modules shown in the Figure 10.
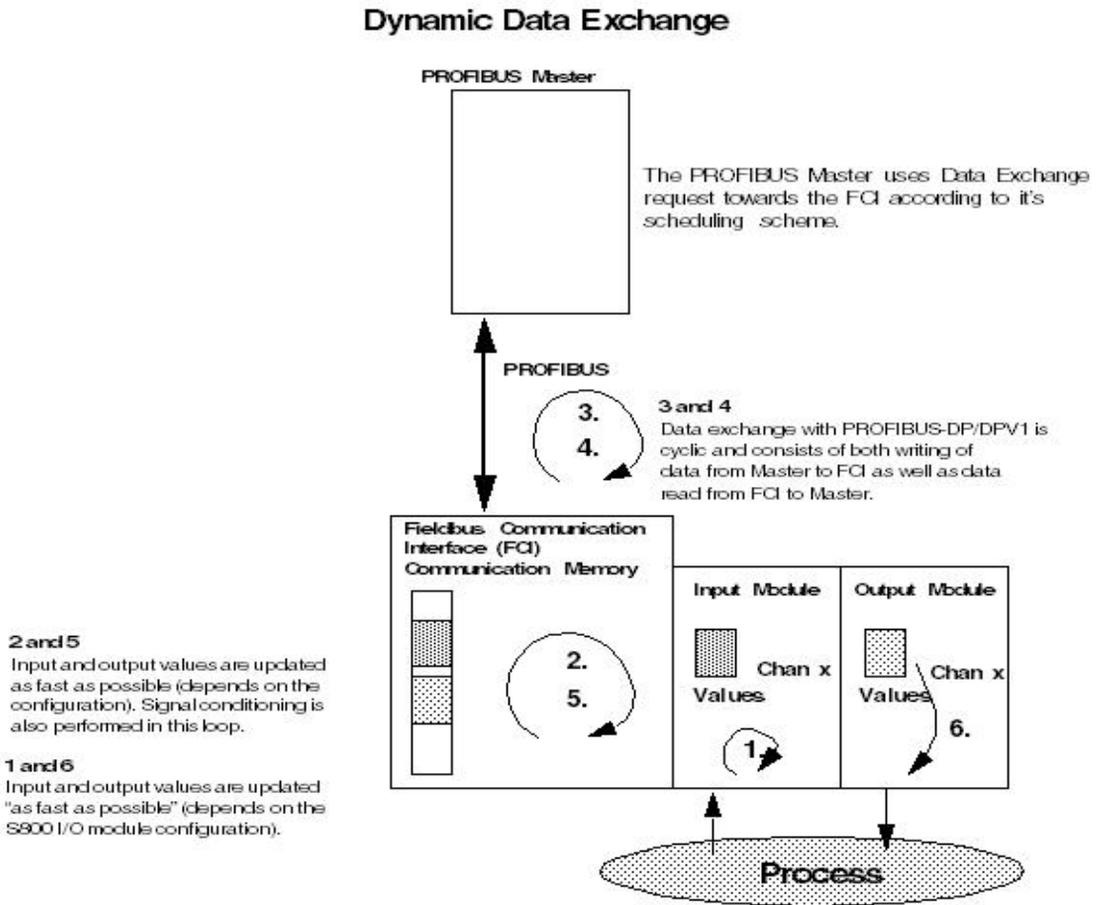
Figure 10. Transportation of dynamic data between PROFIBUS-DP/DPV1 master and S800 I/O modules.

The transportation of dynamic data between PROFIBUS-DP/DPV1 and the ModuleBus is the main task for the Field Communication Interface FCI. The FCI

has a dedicated memory area where it sends the output values and reads the input values.

The CPU in the FCI performs the rest of the data transportation. It reads output values from the memory and writes to the I/O Modules via the ModuleBus and vice versa.

Data Scanning Principles

The data transfer between PROFIBUS-DP/DPV1 and the ModuleBus (3 and 4 in the figure) is not synchronized. Read and write operations are performed from and to a dual port memory in the FCI.

The ModuleBus data is scanned (read or written) (2 and 5 in the figure) cyclically, depending on the I/O module configuration. On one scan all digital modules, 1/4 of the analog modules and 1/10 of the slow analog modules (modules for temperature measurement) are scanned. It takes 4 scans to read all analog modules and 10 scans to read all slow analog modules.

In a typical configuration with 3 AI, 2 AO, 3 DI and 2 DO modules the data scan time will be 18 ms.

For calculation of the ModuleBus data scanning in the FCI, see S800 I/O User's Guide Fieldbus Communication Interface PROFIBUS-DP/DPV1 Section 3 Configuration and Chapter Data Scanning.

The internal data scanning (1 and 6 in the figure) on the I/O modules is not synchronized with the ModuleBus data scanning.

Typical data scanning on S800 I/O modules (filter times not included):

Digital modules 1ms.

Analog modules 10ms.

Slow analog modules 1s.

Data scanning on S800 I/O modules see, S800 User's Guide Module and termination Units Appendix A Specifications.

Calculation of Signal Delay

Signal delay from process to controller and vice versa can be calculated according to following:

Signal delay = Controller scan time + Profibus scan time + FCI scan time + Module scan time + Filter time.

For example:

Signal delay digital signal = Controller scan time + Profibus scan time + FCI scan time + Module scan time + Filter time.

Signal delay analog signal = Controller scan time + Profibus scan time + 4 * FCI scan time + Module scan time + Filter time.

Signal delay slow analog signal = Controller scan time + Profibus scan time + 10 * FCI scan time + Module scan time + Filter time.

S100 I/O Response Time and Load

The response time is the time it takes for a signal to go from the input terminals on a S100 I/O board to the double port memory on the CI856 unit or vice versa for output signals. The delay caused by the filtering of the input signals is not included.

The S100 I/O response time is the sum of the following times:
`Conversion Time + Internal Scan Time + Scan Interval CI856`

- `Conversion Time` = 0.1 ms for DSAI 130/130A. For other I/O boards it can be ignored.

- `Internal Scan Time` = The internal scan time on DSAX 110 and DSAX 110A is 20 ms for input signals and 8 ms for output signals. For other I/O boards it is 0 ms.

- `Scan Interval CI856` = The scan interval on the CI856 is set for each I/O board or I/O channel and is determined by "scan interval" or "update interval" in the I/O hardware editor, under settings tab for selected I/O unit.

Calculation of CI856 CPU Load

For each I/O board the load on CI856 is calculated as:

```
BoardLoad = (BaseLoad + N*ChannelLoad)/CycleTime
```

- `BoardLoad` = the CPU load on the CI856 caused by the board (unit = percent).
- `BaseLoad` = the base load to handle the board, see Table 15 below.
- `ChannelLoad` = the additional load for each I/O channel used on the board, see Table 15 below.
- `N` = number of used I/O channels on the board.
- `CycleTime` = the cycle time or update interval set for the board or I/O channel (unit = 0.1 ms).

Table 15. BaseLoad and ChannelLoad of S100 I/O

Board	BaseLoad	ChannelLoad
DSAI 130/130A	20	125
DSAI 130D, DSAI 133/133A	20	40
DSAO	7	3.5
DSDI	35	0
DSDO	45	0
DSDP 010	12	22
DSDP 170 Function Mode = Pulse25	25	30
DSDP 170 Function Mode = Frequency	25	30
DSDP 170 Function Mode = Pulse + Frequency	25	61
DSDP 170 Function Mode = Pulse light2513	25	13

To allow scan task overhead and event treatment, the total load from all I/O boards should not exceed 80%.

Drivebus Communication with CI858 Unit

Data transfer on Drivebus is managed through datasets pairs. For standard drives 2 dataset pairs can be used and for Engineered drives up to 8 data set pairs can be defined.

Dataset Priority

Datasets can be given two priorities, High and Normal. High priority datasets are associated with the high priority execution table which is scanned every 2 ms. Normal priority datasets are associated with the normal priority execution table. This table is built-up of several channels (slots). The number of channels depends on the maximum number of normal priority Datasets defined in any drives unit on the bus. Every 2 ms one of the normal priority table channels is scanned.

Example Dataset Priority

If the maximum number of low priority datasets defined in a drives unit on the bus is 6, the normal priority execution table contains 6 channels, each channel is scanned every 12th millisecond (`2ms * 6=12ms`).

Dataset Pairs

The transfer times for dataset pairs, for example, DS10/DS11, includes transferring the message from the drive to the AC 800M (DS10) and the response message, including return value, back to the drives unit (DS11).

Drivebus (CI858) Response Time and Load

When calculating the response times between drives units and AC 800M on Drivebus the following has to be considered:

- Application task interval time in the host system, that is PM86x.
- Dataset execution queue and communication handler in the CI858,
- Bus transfer time, including data handling time in the communication ASICs on the CI858 and in the drives units.
- Drives unit application program.

Drivebus Response Time Formula

#DS_Channels: Max number of normal priority datasets in one drives unit on the bus.

AC 800M Application Program

Application program: Task interval time

High Priority Datasets

High priority dataset execution queue and communication handler: 2 ms

Drivebus transfer time: 1 ms

Inverter system application program:

> DS10/11: 2 ms
> DS12/13: 4 ms
> (Other DS: 10 - 500 ms)

Normal Prio Datasets

Normal Prio dataset execution queue and communication handler:
`2 * #DS_Channels`

Drivebus transfer time: 1 ms

Inverter system application program:

> DS10/11: 2 ms
> DS12/13: 4 ms
> Other DS: 10 - 500 ms

The response time on Drivebus consists of the sum of the following:

`TaskInterval + DataSet + DrivebusTransfTime + ApplTime`

- `TaskInterval` = Application task interval

- `DataSet` = DataSet Execution queue and communication handler

- `DrivebusTransfTime` = Drivebus transfer time

- `ApplTime` = Inverter system application time

Example

Consider a Drivebus containing five drive units. Each drives unit is using one high priority dataset pair (DS10/DS11). One of the drives units is using five normal priority dataset pairs DS12/DS13 to DS20/DS21. The other drives are using four normal priority dataset pairs DS12/DS13 to DS18/DS19. In the drives units the application program is using an update time of 100 ms for the normal priority datasets.

In the AC 800M the high priority datasets are attached to a high priority application task using a task interval time of 10 ms. The normal priority datasets are attached to a normal priority task using a task interval time of 250 ms.

Table 16. Response Times for each Dataset

Dataset	Application Task Interval	DataSet Execution Queue and Comm. Handler	Drivebus Transfer Time	Inverter System Application Time	Response Time (ms)
DS10/DS11	10	2	1	2	15
DS12/DS13	250	2*5	1	4	265
DS14/DS15	250	2*5	1	100	361
DS16/DS17					
DS16/DS17					
DS18/DS19					
DS20/DS21					

Calculation of I/O Copy Time Estimate for ControlNet with CI865 Unit

Each ControlNet node (200-ACN, 200-RACN and CI865) has its own I/O data memory that is asynchronously updated.

Different configurations and parameters, depending on the I/O system type that is used, determine the total I/O update time.

To estimate the maximum time, from I/O point status change until it is processed in the application program, all times from I/O point to Task Interval Time, t_{ti}, have to be added according to the formula below.

$$\text{I/O Copy Time} = t_{ti} + t_{cn} + t_n + t_f$$
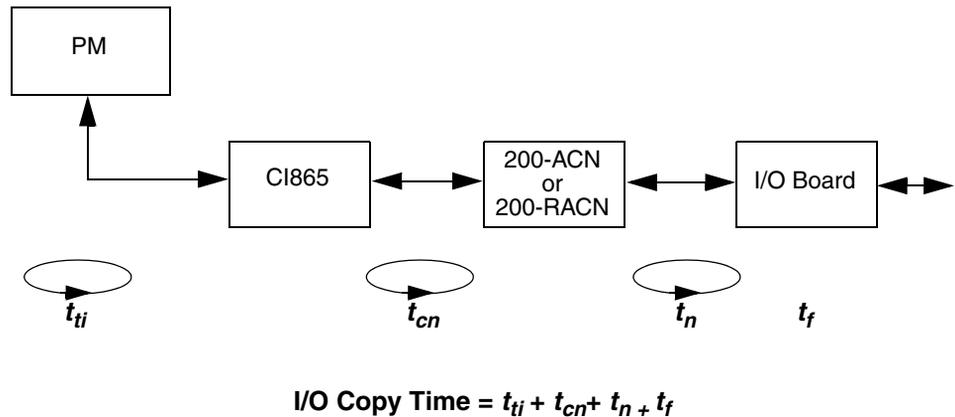
Figure 11. I/O Copy Schedule

Remote Series 200 I/O and Rack I/O

The transmission on the ControlNet network, t_{cn}, runs asynchronously with the execution of the application program and the I/O copy cycles on 200-ACN and 200-RACN, and is determined by the network parameters.

t_{cn} for input signals equals the EPR (Expected Package Rate) for the specific node. The EPR is a user definable setting, 5-60ms.

t_{cn} for output signals equals the NUT (Network Update Time) for the specific node. The NUT is a user definable setting, 5-60ms.

Series 200 I/O

The 200-ACN I/O memory is updated cyclically, asynchronously with the execution of the application program. The node update time, t_n, is determined by the number and type of I/O units. The approximate copying times are 0.05ms for digital I/O units and 0.2ms for analogue I/O units. There is an overhead of about 2ms for each cycle.

Example 1:
A 200-ACN configured with 8 analogue I/O units gives the following node update time:

$t_n \approx 2+8*0.2 \approx 3.6$ms

Example 2:
A 200-ACN configured with 8 digital I/O units gives the following node update time:

$t_n \approx 2+8*0.05 \approx 2.4$ms

Rack I/O

The 200-RACN I/O memory is updated cyclically, asynchronously with the execution of the application program. The node update time, t_n, is determined by the number and types of connected to 200-RACN.

The copying of the analogue input boards is spread out in time due to the relative long copying time. One analogue input board is copied each cycle (for example, if there are three analog input boards, each one of them will be copied every third cycle).

The approximate copying times are 0.14 ms for digital boards and analogue output boards and 1.2 ms for analogue input boards. There is an overhead of about 1ms for each cycle.

Example 1:
A 200-RACN is configured with 12 digital boards, 2 analogue output boards and 2 analogue input boards. The node update time, t_n, for this rack is calculated according to the following:

One cycle corresponds to: $1+14*0.14+1*1.2$ ms ≈ 4.2ms

Two cycles are needed to copy all analogue input boards, which gives the total node update time for this node: $t_n \approx 2*4.2 \approx 8.4$ms

Example 2:

A 200-RACN is configured with 11 digital boards, 2 analogue output boards and 3 analogue input boards. The node update time, t_n, for this rack is calculated according to the following:

One cycle corresponds to: $1+13*0.14+1*1.2$ ms ≈ 4.0 ms

Three cycles are needed to copy all analogue input boards which gives the total node update time for this node: $t_n \approx 3*4.0 \approx 12$ ms

Filter Time

The I/O filter time, t_f has to be added for input boards/units.

Communication

IAC and MMS Communication

Communication performance is affected by *bandwidth, message length* and *cyclic load*.

Higher load on the CPU will cause lower throughput in the communication, and lower load will give higher throughput.

The 10 Mbit/s is an ethernet speed which is in balance with the performance of the AC 800M controller. The maximum data flow to and from the software in an AC 800M is less than 10 Mbit/s. This means that the data flow for one AC 800M is not limited due to its ethernet speed of 10 Mbit/s.

The Ethernet standard allows bandwidth transmission at 10 Mb/s, 100 Mb/s (fast Ethernet), and 1000 Mb/s (Gbit Ethernet) and AC 800M supports 10 Mb/s and 100 Mb/s (PM891 only).

In a system with several controllers and PCs a switched network should be used between the nodes. If hubs are used instead of switches the number of connected nodes plays an important role for the throughput of the network and a single node may get an ethernet throughput which is less than the nominal network speed. With switches this is however not the case. Each node gets an ethernet throughput which is more or less independent of the number of connected nodes. This means that the data flow in the complete system is also not limited by AC 800M's ethernet speed of 10 Mbit/s.

For networks with several switches ABB recommend to use 100 Mbit/s or 1 Gbit between switches since those ports need to manage data from several nodes to several nodes. 10 Mbit/s should only be used on the ports where AC 800M controllers are connected. Those ports only need to manage data for one node.

The actual communication throughput for a controller thus mainly depends on other factors than the ethernet speed, for example the cycle times of the applications and the CPU load in the controller.

Inter Application Communication (IAC) uses communication variables (CVs). The controller with the application that holds the **out** communication variable is the Server. The controller with the application that holds the **in** communication variable is the Client. The communication with IAC is based on cyclic reading only.

Connections Cannot Block Each Other

The controller can handle a number of concurrent communication connections. All connections are handled in a round robin fashion. This means that no connection can block communication for any other connection.

For example this means that it is guaranteed that variable access from one controller to another can always be executed even if a Control Builder is downloading a very large application domain to one of the controllers.

Number of Connections

The controller's communication stack handles several simultaneous connections. Messages are treated in a round robin fashion that guarantees that no connection is starved, but the transmission rate through the stack decreases slightly with the number of active connections. With 40[1] or less connections the performance decrease per additional connection is however small. With more than 40[1] connections the amount of buffers per connection is reduced. This may decrease the performance for the connections substantially more, at least for connections transmitting much data.

---

1.   20 in PM85x and 100 in PM891.

Communication Load

Table 17 shows the execution time for transferring one variable of type dword between two AC 800M controllers using IAC or MMS, server or client.
It also tells the resulting cyclic and total load for communicating one dword per second.

The measurements were done by transferring as many dwords as possible in each transaction, that is, IAC = 350 dwords, MMS = 166 dwords.
The task interval time was set to 200ms, and the IAC interval time to 100 ms.

Table 17. Load Caused by External IAC and MMS Communication

	PM864	PM891
IAC Server, Out variables		
Execution time/dword [us]	0.74	0.08
Cyclic load /(dword/sec) [%]	3.5E-05	0.0E+00
Total load /(dword/sec) [%]	4.1E-04	1.4E-04
IAC Client, In variables		
Execution time/dword [us]	0.13	0.03
Cyclic load /(dword/sec) [%]	3.2E-06	0.0E+00
Total load /(dword/sec) [%]	1.0E-04	7.9E-06
MMS Server, Read		
Execution time/dword [us]	0.00	0.00
Cyclic load /(dword/sec) [%]	0.0E+00	0.0E+00
Total load /(dword/sec) [%]	1.9E-03	6.6E-04
MMS Client, Read		
Execution time/dword [us]	0.30	0.00
Cyclic load /(dword/sec) [%]	0.0E+00	0.0E+00
Total load /(dword/sec) [%]	3.9E-03	8.2E-04

> ℹ️ Defined Cyclic and Total Load in the table are based on measured values, and they are not calculated based on Execution Time

Communication Throughput at 40% Cyclic Load

Table 18 shows how many dwords an AC 800M can transfer via IAC or MMS, to or from, another controller in case its cyclic load (without communication) is at 40%.

The number of dwords were increased until the controller was considered to be throttled. The criteria for throttling were set to:

- Max. cyclic load

  – Controller: 70%

- Numbers of transactions/sec is maximized and does not increase anymore

The measurements were done by transferring as many dwords as possible in each transaction, that is, IAC = 350 dwords, MMS = 166 dwords.
The task interval time was set to 200ms, and the IAC interval time to 100 ms.

Table 18. External IAC and MMS Communication Throughput at 40% Cyclic Load

	PM864	PM891
IAC Server, Out variables		
Max no of dwords communicated	4900	10150
Transactions/sec	89	169
Cyclic load [%]	42	41
Total load [%]	71	52
IAC Client, In variables		
Max no of dwords communicated	2800	5600
Transactions/sec	45	97
Cyclic load [%]	40	40
Total load [%]	66	49

Table 18. External IAC and MMS Communication Throughput at 40% Cyclic Load (Continued)

	PM864	PM891
MMS Server, Read		
Max no of dwords communicated	1992	1992
Transactions/sec	62	62
Cyclic load [%]	40	40
Total load [%]	67	50
MMS Client, Read		
Max no of dwords communicated	1162	2490
Transactions/sec	37	77
Cyclic load [%]	40	40
Total load [%]	71	55

Control Network Clock Synchronization

Table 19. Control Network Clock Synchronization

Type of Clock Synchronization	Accuracy per node
High Precision SNTP	1 ms
SNTP	200 ms
CNCP (between AC 800M)	1 ms
MB300 Network	3 ms

MasterBus 300 Network

The MasterBus 300 network can have maximum 100 nodes on a CI855 in a control area. The maximum performance is 200 data set per second. Switch over time to a redundant bus is 3 seconds.

INSUM Network

Table 20. INSUM Design Limitations

Limitation		
Limitation type	**Value**	**Reason**
Number of MCUs per controller	128	Execution time for IEC 61131-3 application and system heap memory
Number of MCUs per CI857	128	CPU performance on CI857
Number of Gateways per CI857	2	CPU performance on CI857 and memory on CI857
Number of CI857 per AC 800M	6	CPU performance

Table 21. INSUM Communication Interface CI857 Performance

Response time			
Action	**Result**	**Condition**	**Comments**
Start/stop, - 64 MCUs - 128 MCUs	5-8 s 15-16.5 s	Five NVs subscribed per MCU	Time measured inside the IEC 61131-3 application, from the time it sends the first command with INSUMWrite to NVDesState until it receives the last state change with INSUM Receive from NVMotorStateExt.
Stop one MCU due to chain interlock from other MCU	500 ms	Task cycle 250 ms, 66 MCUs, five NVs subscribed per MCU	Time measured on electrical state signals on the MCUs from the time the first MCU stop until the second MCU stop.

OPC Server for AC 800M

The OPC Server for AC 800M collects data from controllers via MMS, and makes it available to OPC clients. Performance depends on the amount of MMS traffic between the OPC server and controllers. This, in turn, depends on the number of items and the rate at which the items are updated in the OPC Server. The following information is based on an OPC Server for AC 800M running on a PC with an Intel Xeon®, 2.40 GHz processor and 4Gbyte RAM.

Table 22. OPC Read Performance

Limitation type	Value
Number of subscribed variables in total at 1000 ms update rate	300 000
Maximum OPC Servers for one controller	3
Maximum OPC Clients for one OPC Server	5

Performance also depends on the controllers ability to provide the OPC server with data. This ability is controller-dependent and is shown in the table below.
The table shows how many variables (bool) that can be subscribed to, with an update rate of 1000 ms, from a controller with 50 % cyclic load, and how many MMS telegrams this corresponds to.

Table 23. Controller Response Performance

CPU	Number of subscribed items (Boolean)	Max. number of MMS transactions/second	Total System Load	Cyclic Load
PM864	40 000	75	89	50
PM866	42 000	82	78	50
PM891	60 000	120	67	50

The table below tells how long time it takes to write 1000 boolean variables to a controller when the OPC server already subscribes to 1 000, 50 000 and 100 000 variables from that controller.

Table 24. OPC Write Performance

Number of Subscribed Items at 1000 ms requested update rate	Simultaneous Write of 1000 Items
1 000	5 ms
50 000	71 ms
100 000	146 ms

Supported Hardware and I/O Families

For some hardware units a certain product revision is required, as described in Release Notes.

PLCs

Figure 12 shows the symbol on the front of a CEX bus unit which indicates support for online replacement.
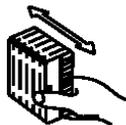
Figure 12. CEX Symbol

All communication interface units support firmware download by the Control Builder except CI858, which is upgraded with an external tool.

Supported AC 800M modules are shown in the Table 25.

Table 25. Supported Modules

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redun-dant	Redun-dant
PM851	PLC unit PM851 is a 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus (one electrical and one optical) and one communication interface. PM851 supports a maximum of one CEX bus module.	No	No	No	N/A
PM851A	This is a replacement for PM851 having 12 Mbyte RAM in total.	No	No	No	N/A
PM856	PLC unit PM856 is a 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. PM856 supports a maximum of twelve CEX bus modules.	No	No	No	N/A
PM856A	This is a replacement for PM856 having 16 Mbyte RAM in total.	No	No	No	N/A
PM858	PLC unit PM858 (Redundant and Singular) is a high-performance, 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. The unit has one optional Redundancy Control Link for redundant configuration. The PM858 processor unit has performance data which is 0.5 times the performance of PM862. PM858 supports a maximum of twelve CEX bus modules.	Yes	Yes	No	Yes

Table 25. Supported Modules (Continued)

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redun-dant	**Redun-dant**
PM860	PLC unit PM860 is a 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. PM860 is twice as fast as PM856 in executing an application program. PM860 supports a maximum of twelve CEX bus modules.	No	No	No	N/A
PM860A	This is a replacement for PM860 having 16 Mbyte RAM in total.	No	No	No	N/A
PM861	PLC unit PM861 (Redundant and Singular) is a 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. The unit has one optional Redundancy Control Link for redundant configuration. PM861 supports a maximum of twelve CEX bus modules.	Yes [1]	Yes	No	Yes
PM861A	This is a replacement for PM861 and can use redundant communication units.	Yes [1]	Yes	No	Yes

Table 25. Supported Modules (Continued)

Unit	Description	Online Replace- ment	Redun- dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non- redun- dant	Redun- dant
PM862	PLC unit PM862 (Redundant and Singular) is a high-performance, 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. The unit has one optional Redundancy Control Link for redundant configuration. The PM862 processor unit has performance data which is approximately 1.2 times the performance of PM861. PM862 supports a maximum of twelve CEX bus modules.	Yes[1]	Yes	No	Yes
PM864	PLC unit PM864 (Redundant and Singular) is a 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. PM864 is 50% faster than PM861 in executing an application program. PM864 supports a maximum of twelve CEX bus modules.	Yes[1]	Yes	No	Yes
PM864A	This is a replacement for PM864 and can use redundant communication units.	Yes[1]	Yes	No	Yes

Table 25. Supported Modules (Continued)

Unit	Description	Online Replacement	Redundancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redundant	Redundant
PM866	PLC unit PM866 (Redundant and Singular) is a high-performance, 32-bit, Single Board Computer, which directly connects to the S800 I/O system via ModuleBus. The unit has one optional Redundancy Control Link for redundant configuration. The PM866 processor unit has performance data which is approximately 1.4 times the performance of PM864. PM866 supports a maximum of twelve CEX bus modules.	Yes [1]	Yes	No	Yes
PM866A	This is a replacement for PM866.	Yes [1]	Yes	No	Yes
PM891	PLC unit PM891 (Redundant and Singular) is a high performance PLC, with four times higher memory than PM866, and about two times faster performance than PM866. PM891 is capable of handling applications with high requirements. PM891 connects to the S800 I/O system through the optical Modulebus. It can act as a stand-alone Process Controller, or as a PLC performing local control tasks in a control network. PM891 supports a maximum of twelve CEX bus modules.	Yes [1]	Yes	No	Yes

Table 25. Supported Modules (Continued)

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redun-dant	Redun-dant
BC810	CEX-bus interconnection unit. BC810 can be used with PM861A, PM862, PM864A, PM865, PM866, PM866A, PM867.	Yes	N/A	N/A	N/A
BC820	CEX-Bus and RCU-Link Interconnection Unit. BC820 can be used with PM858, PM862, PM866 (PR:F or later), PM866A.	Yes	N/A	N/A	N/A
CI853	The CI853 is the RS-232C serial communication interface unit for the AC 800M. Two possible settings of the serial ports on the CI853 unit are not valid and must not be used. These are 7 data bits, no parity, 1 stop bit or 8 data bits, parity, 2 stop bits.	Yes	No	Yes[2]	N/A
CI854	The CI854 unit is the communication interface for PROFIBUS DP/V1 for the AC 800M with redundant PROFIBUS lines and DP/V1 communication. It is a master unit and you can connect up to 124 slaves to the master. However, you cannot connect more than 32 units in one segment.	No	No	Yes[3]	N/A
CI854A	The CI854A unit is the communication interface for PROFIBUS DP/V1 for the AC 800M with redundant PROFIBUS lines and DP/V1 communication. It is a master unit and you can connect up to 124 slaves to the master. However, you cannot connect more than 32 units in one segment.	Yes	Yes	Yes[3]	Yes[4]

Table 25. Supported Modules (Continued)

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redun-dant	Redun-dant
CI854B	This is a replacement for CI854A.	Yes	Yes	Yes [3]	Yes [4]
CI855	The CI855 unit is the communication interface for MasterBus 300 for the AC 800M. CI855 houses two Ethernet ports to support MasterBus 300 Network redundancy.	Yes	No	Yes [2]	N/A
CI856	The CI856 is a communication interface for the S100 I/O system for the AC 800M. Up to five S100 I/O racks can be connected to one CI856 where each I/O rack can hold up to 20 I/O boards.	Yes	No	Yes [3]	N/A
CI857	The CI857 unit is the communication interface for INSUM for the AC 800M.	Yes	No	Yes [5]	N/A
CI858	The CI858 unit is the communication interface for ABB Drives using DDCS protocol for the AC 800M.	Yes	No	Yes [3]	N/A
CI865	The CI865 is the communication interface to Satt I/O on ControlNet for AC 800M.	Yes	No	Yes [3]	N/A
CI867	The CI867 unit is the MODBUS TCP communication interface for the AC 800M. CI867 houses two Ethernet ports. One port supports full duplex with 100 Mbps speed and one port supports half duplex with 10 Mbps speed.	Yes	Yes [6]	Yes [2]	Yes [2]

Table 25. Supported Modules (Continued)

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redun-dant	Redun-dant
CI868	The CI868 unit is the IEC 61850 communication interface for the AC 800M.	Yes	No	Yes [2,7]	N/A
CI869	The CI869 is the AF 100 communication interface for AC 800M.	Yes	Yes	Yes [2]	Yes [2]
CI871	The CI871 is the PROFINET IO communication interface for the AC 800M.	Yes	No	Yes [2,3]	N/A
CI872	The CI872 is a MOD5 Communication interface on AC 800M that is used to communicate to MOD5 controllers. The CI872 can be used in a AC 800M HI Integrity system.	Yes	Yes	Yes [2]	Yes [2]
CI873	The CI873 is the EtherNet/IP and DeviceNet communication interface for AC 800M.	Yes	Yes	Yes [2]	Yes [4]

NOTES:
1. Online replacement is only supported in a redundant configuration, the unit to replace MUST NOT be energized.
2. During an online upgrade, the communication between the communication interface and the connected sub units are interrupted.
3. During an online upgrade, the communication interface sets the outputs of connected I/O units to values specified by OSP control (Output Set as Predetermined).
4. Full support of online upgrade. One of the redundant communication interface units is always active during the online upgrade process.
5. During an online upgrade, CI857 is disconnected from INSUM Gateway and the connected INSUM devices keep on running with the values they have just before the switch.
6. Module redundancy only. It is not possible to get media redundancy by enabling the second Ethernet port (Ch2).
7. For CI868 Firmware Upgrade scenarios applicable during Control Builder project migration from earlier versions, refer to *AC 800M IEC 61850 Engineering and Configuration (9ARD171385*)* Manual.

Adaptors for I/O Types

Table 26 shows the supported adaptors for I/O types.

Table 26. Adaptors for I/O Types

Adaptor	Can be connected to	HART[1]	SOE[2]
TB820	PM851 and PM851A	Yes	Yes
	PM856 and PM856A	Yes	Yes
	PM858	Yes	Yes
	PM860 and PM860A	Yes	Yes
	PM861 and PM861A (Single PLC only)	Yes	Yes
	PM862 (Single PLC only)	Yes	Yes
	PM864 and PM864A (Single PLC only)	Yes	Yes
	PM866 and PM866A (Single PLC only)	Yes	Yes
	PM891 (Single PLC only)	Yes	Yes
TB840 TB840A	PM851 and PM851A	Yes	Yes
	PM856 and PM856A	Yes	Yes
	PM858	Yes	Yes
	PM860 and PM860A	Yes	Yes
	PM861 and PM861A	Yes	Yes
	PM862	Yes	Yes
	PM864 and PM864A	Yes	Yes
	PM866 and PM866A	Yes	Yes
	PM891	Yes	Yes
DSBC 173A	CI856	No	Yes
DSBC 174	CI856	No	Yes
DSBC 176	CI856	No	Yes
CI801	CI854, CI854A, CI854B	Yes	No
CI830[3]	CI854, CI854A, CI854B	No	No

Table 26. Adaptors for I/O Types (Continued)

Adaptor	Can be connected to	HART[1]	SOE[2]
CI840	CI854, CI854A, CI854B	Yes	No
CI840A	CI854, CI854A, CI854B	Yes	No
CI920	CI854, CI854A, CI854B	Yes	No
CI920A	CI854, CI854A, CI854B	Yes	No
200-APB12	CI854, CI854A, CI854B	No	No
200-ACN	CI865	No	No
200-AENTR	CI873	No	No
200-RACN	CI865	No	No
RPBA-01	CI854, CI854A, CI854B	No	No
NPBA-12	CI854, CI854A, CI854B	No	No
FPBA-01	CI854, CI854A, CI854B	No	No
RETA-02	CI871	No	Yes
FENA-11	CI871	No	Yes
MNS *i*S	CI871	No	Yes
PNQ22	CI871	No	Yes
LD800 DN	CI873	No	No

NOTES:
1.   Only valid for Control Builder Professional in 800xA.
2.   OPC Server for AC 800M must be used for alarms and events.
3.   CI830 is replaced by CI801 in new installations.

Table 27 provides a description of the supported adaptors.

Table 27. Adaptor Description

Adaptor	Description
TB820	ModuleBus Modem
TB840 TB840A	ModuleBus Modem, primarily for redundant ModuleBus.
DSBC 173A	The DSBC 173A unit is the bus extender slave inserted in the last position of a S100 I/O rack.
DSBC 174	The DSBC 174 unit is the bus extender slave inserted in the last position of a S100 I/O rack.
DSBC 176	The DSBC 176 unit is the bus extender slave inserted in the last position of a S100 I/O rack.
CI801	The CI801 is a remote PROFIBUS DP-V1 adaptor for S800 I/O units. The CI801 does not support redundancy. The CI801 can handle up to 24 S800 I/O-units. 12 I/O-units can be directly connected to the ModuleBus on the CI801, while the remaining I/O-units have to be connected via I/O-clusters. Up to 7 I/O-clusters can be connected to one CI801, and the numbering of I/O-units connected to a cluster will start with 101 for cluster 1, 201 for cluster 2 and so on.
CI840 CI840A	The CI840(A) is a remote PROFIBUS DP-V1 adaptor for S800 I/O units, with redundancy capabilities. CI840 supports redundant I/O modules. The CI840(A) can handle up to 24 S800 I/O-units. 12 I/O-units can be directly connected to the ModuleBus on the CI840, while the remaining I/O-units have to be connected via I/O-clusters. Up to 7 I/O-clusters can be connected to one CI840(A), and the numbering of I/O-units connected to a cluster will start with 101 for cluster 1, 201 for cluster 2 and so on.
CI920 CI920A	The CI920(A) is a remote PROFIBUS DP-V1 adaptor for S900 I/O units.

Table 27. Adaptor Description (Continued)

Adaptor	Description
200-APB12	The 200-APB12 unit is a remote PROFIBUS DP slave I/O adaptor for S200 I/O and S200L I/O units. 200-APB12 is connected to the PLC via a PROFIBUS DP/V0 master unit on the PLC system bus. A 200-APB12 unit can have up to eight S200 I/O units. The number of 200-APB12 slaves are, by the DIP switches, limited to 99.
200-ACN	The 200-ACN is a remote ControlNet I/O adaptor for Series 200 I/O units. 200-ACN is connected to a PLC via a CI865 communication interface on the PLC system bus. 200-ACN units are used as nodes on the Satt ControlNet fieldbus. Each 200-ACN unit can handle up to eight Series 200 I/O units.
200-AENTR	The 200-AENTR is a remote EtherNet/IP I/O adaptor for Series 200 I/O units. 200-AENTR is connected to a PLC via a CI873 communication interface on the PLC system bus. Each 200-AENTR unit can handle up to eight Series 200 I/O units. 200-AENTR has two Ethernet ports with an in built switch, which means that the adaptors can be daisy-chained to the CI873 using cross-wired Ethernet-cables without the need for external switches.
200-RACN	The 200-RACN unit is a remote Concurrent adaptor for rack based I/O units. 200-RACN is connected to a PLC via a CI865 communication interface on the PLC system bus. One or several adaptor 200-RACN units are used as nodes. A maximum of eight I/O-racks are supported on the Satt Concurrent fieldbus.
RPBA-01 NPBA-12 FPBA-01	These PROFIBUS-DP adaptor units are an optional device for ABB drives which enables the connection of the drive to a PROFIBUS system. The drive is considered as a slave in the PROFIBUS network. It is possible to: • give control commands to the drive (Start, Stop, Run enable, etc.) • feed a motor speed or torque reference to the drive • give a process actual value or a process reference to the PID controller of the drive • read status information and actual values from the drive • change drive parameter values • reset a drive fault.

Table 27. Adaptor Description (Continued)

Adaptor	Description
RETA-02 FENA-11	These Ethernet Adaptor modules are an optional device for ABB drives, which enables the connection of the drive to a PROFINET IO (PNIO) network. The drive is considered as a PNIO device on the PROFINET IO network, and it is compatible with all PNIO controller stations that support PROFINET IO and sub-slots. Through the Ethernet Adaptor module, it is possible to: • give control commands • give control commands to the drive (Start, Stop, Run enable, etc.) • feed a motor speed or torque reference to the drive • give a process actual value or a process reference to the PID controller of the drive • read status information and actual values from the drive • change drive parameter values • reset a drive fault.
MNS *iS*	ABB MNS *iS* is a motor control center solution that can be used in PROFINET IO network. MNS *iS* delivers all the functions for control, protection, and monitoring of motors and motor starters using software and hardware modules for the specific tasks. M*Link*, one of the interface modules in MNS *iS*, serves as the serial gateway interface to higher level systems which communicate to all modules through PROFINET IO.
PNQ22	The PNQ22 Ethernet adaptor module provides PROFINET IO connectivity for ABB Universal Motor Controller UMC100 and ABB soft starters PST and PSE. The PNQ22 allows the connection of four devices to PROFINET IO.
LD800 DN	The LD 800DN adaptor, which functions as a gateway to connect control level networks with device level networks, provides a router or bridge functionality to connect EtherNet/IP to DeviceNet. The LD 800DN provides centralized data storage for data that is shared between the DeviceNet and Ethernet/IP networks.

The following adaptors are supported (Table 28), but only for migration purposes, NOT at new installations.

Table 28. Supported Adaptors for Migration

Adaptor	Description
CI830	The unit CI830 is a remote PROFIBUS DP-V0 I/O adaptor for units. CI830 is connected to a PLC via a PROFIBUS DP-V0 master unit on the PLC system bus.
	The CI830 can handle up to 24 S800 I/O-units. 12 I/O-units can be directly connected to the ModuleBus on the CI830, while the remaining I/O-units have to be connected via I/O-clusters. Up to 7 I/O-clusters can be connected to one CI830, and the numbering of I/O-units connected to a cluster will start with 101 for cluster 1, 201 for cluster 2 and so on.
	CI830 is replaced by CI801 at new installations. CI830 does not have full support for all S800 I/O-types.

I/O Families

All I/O units may be replaced in a running system. Table 29 shows the different I/O families.

Table 29. I/O Families

I/O Family	Connects To
S800 I/O	PM851, PM851A, PM856, PM856A, PM858, PM860, PM860A, PM861, PM861A, PM862, PM864, PM864A, PM866, PM866A,PM891 TB820, TB840, TB840A CI801, CI830, CI840, CI840A
S900 I/O	CI920, CI920A
ABB Standard Drives	PM851, PM851A, PM856, PM856A, PM858, PM860, PM860A, PM861, PM861A, PM862, PM864, PM864A, PM866, PM866A,PM891 TB820, CI801, CI830, CI858, RPBA-01, NPBA-12, FPBA-01, RETA-02, FENA-11

Table 29. I/O Families (Continued)

I/O Family	Connects To
ABB Engineered Drives	PM851, PM851A, PM856, PM856A, PM858, PM860, PM860A, PM861, PM861A, PM862, PM864, PM864A, PM866, PM866A,PM891 TB820, CI858, RPBA-01, NPBA-12, FPBA-01, RETA-02, FENA-11
S100 I/O	CI856
S200 I/O, S200L I/O and I/O 200C	200-APB12, 200-ACN, 200-AENTR
Satt Rack I/O	200-RACN

S800 I/O

Table 30 shows the different S800 I/Os support.

Table 30. S800 I/O

Name	Description
AI801	Analog input unit, 8 inputs
AI810	Analog input unit, 8 inputs
AI815	Analog input unit, 8 inputs
AI820	Analog input unit, 4 differential inputs
AI825	Analog input unit, galvanic isolated analog input unit, 4 channels
AI830[1]	Analog input unit, 8 RTD inputs
AI835[2]	Analog input unit, 8 TC inputs
AI843	Analog input unit, 8 TC inputs, redundant possibilities
AI845	Analog input unit, 8 inputs, redundant possibilities, HART
AI890	Analog input unit, 8 inputs, Intrinsic Safety interface
AI893	Analog input unit, 8 RTD/TC inputs, Intrinsic Safety interface

Table 30. S800 I/O (Continued)

Name	Description
AI895	Analog input unit, 8 inputs, Intrinsic Safety interface, HART
AO801	Analog output unit, 8 outputs
AO810[3]	Analog output unit, 8 outputs
AO815	Analog output unit, 8 outputs
AO820	Analog output unit, 4 outputs
AO845	Analog output unit, 8 outputs, redundant possibilities, HART
AO890	Analog output unit, 8 outputs, Intrinsic Safety interface.
AO895	Analog output unit, 8 outputs, Intrinsic Safety interface, HART
DI801	Digital input unit, 16 inputs
DI802	Digital input unit, 8 inputs
DI803	Digital input unit, 8 inputs
DI810	Digital input unit, 16 inputs
DI811	Digital input unit, 16 inputs
DI814	Digital input unit, 16 inputs
DI818	Digital input unit, 32 inputs
DI820	Digital input unit, 8 inputs
DI821	Digital input unit, 8 inputs
DI825[4]	Digital input unit, 8 channels with event recording (SoE, Sequence of events)
DI828	Digital input unit, 16 inputs
DI830[4]	Digital input unit, 16 inputs with event recording (SoE, Sequence of events)
DI831[4]	Digital input unit, 16 inputs with event recording (SoE, Sequence of events)

Table 30. S800 I/O (Continued)

Name	Description
DI840[4]	Digital input unit 16 inputs, redundant possibilities with event recording (SoE, Sequence of events)
DI885[4]	Digital input unit, 8 inputs
DI890	Digital input unit, 8 inputs, Intrinsic Safety interface
DO801	Digital output unit, 16 outputs
DO802	Digital output unit, 8 outputs
DO810	Digital output unit, 16 outputs
DO814	Digital output unit, 16 outputs
DO815	Digital output unit, 8 outputs
DO818	Digital output unit, 32 outputs
DO820	Digital output unit, 8 outputs
DO821	Digital output unit, 8 outputs
DO828	Digital output unit, 16 outputs
DO840	Digital output unit 16 outputs, redundant possibilities
DO890	Digital output unit, 8 outputs, Intrinsic Safety interface
DP820	Digital pulse counter
DP840	Pulse/Frequency input, 8 inputs, redundant possibilities, supported in CI830 but without redundancy

NOTES:
1.   AI830/AI830A.
2.   AI835/AI835A.
3.   AO810/AO810V2.
4.   No support in CI801 and CI840.

S900 I/O

Table 31 shows the different S900 I/Os.

Table 31. S900 I/O

Name[1]	Description
AI910N/S	Analog input unit, 4 inputs, 4-20 mA
AI920N/S	Analog input unit, 4 inputs, 4-20 mA, isolated
AI921N/S	Analog input unit, 4 inputs
AI930N/S	Analog input unit, 4 inputs, 4-20 mA, HART
AI931N/S	Analog input unit, 4 inputs, 0/4-20 mA, HART
AI950N/S	Analog input unit, 4 inputs, temperature sensor
AO910N/S	Analog output unit, 4 outputs, 4-20 mA
AO920N[2]/S	Analog output unit, 4 outputs, 4-20 mA, isolated
AO930N/S	Analog output unit, 4 outputs, 4-20 mA, HART
AI910	Analog input, 1 x 4 channels, active
AI920	Analog input, 4 x 1 channel
AI930	Analog input, 1 x 4 channels, active, HART
AI931	Analog input, 1 x 4 channels, passive, HART
AI950	Temperature input, 4 x 1 channel, resistor and thermocouple
AO910	Analog output, 1 x 4 channels
AO920	Analog output, 4 x 1 channel (isolated)
AO930	Analog output, 1 x 4 channels, HART
DI920N	Digital input unit, 4 inputs, (NAMUR), isolated
DO910N/S	Digital output unit, 4 outputs, (for solenoid valves)
DO930N[2]/S	Digital output unit, 4/6 outputs, dry contacts (relay)
DO940N/S	Digital output unit, 8 outputs

Table 31. S900 I/O (Continued)

Name[1]	Description
DO980N/S	Digital output unit, 16 outputs
DP910	Frequency input and counter, 2 blocks
DP910N/S	Frequency input and pulse counter, 2 inputs
DX910N/S	Bidirectional unit, 8 channels, (programmable) for digital input, 8 inputs, NAMUR/dry contacts or digital output, 8 outputs, for low power valves
DO910	Digital output, 4 x 1 channel (Solenoid driver)
DO930	Relay output, 6 x 1 channel
DX910	Digital input/output, 1 x 8 channels
1) Modules referenced without S,B or N in the ending are valid for all three S900 I/O series. 2) Available and supported only by N-Series'	

S100 I/O

Table 32 shows the different S100 I/Os supported by AC 800M.

Table 32. S100 I/O

Name	Description
DSBC 173A[1], DSBC 174, DSBC 176	Bus extender slave inserted in the last position of an S100 I/O rack.
DSAI 110	Analog input Unit. 32 channels, resolution 8 bit, Single ended, 0 to ±10 V or 0 to ±20 mA
DSAI 130 DSAI 130A	Analog input board, 16 inputs
DSAI 130D	Analog input board, 16 inputs with 4 sets of filter times
DSAI 133 DSAI 133A	Analog input board, 32 inputs

Table 32. S100 I/O (Continued)

Name	Description
DSAI 135	Analog input Unit.16 channels, resolution 8 bit, differential, 0 to ±10 V or 0 to ±20 mA.
DSAI 145	Analog input Unit.31 (+ 1 ref.) channels for Pt100, 3-wire, resolution 12 or 13 bits, -100/ +320 or -200/ + 640°C. Galvanic isolation between channel and system.
DSAI 146	Analog input unit. 31 (+ 1 ref.) channels for Pt100, 3-wire, resolution 12 or 13 bits, -100/ +320, -40/+40 or -200/ + 640°C. Galvanic isolation between channel and system.
DSAI 151	14 (+ 2 ref.) channels for Pt100, 4-wire, resolution 12 or 13 bits, -100/ +320, -40/+40 or -200/ + 640°C. Galvanic isolation between channel and system.
DSDI 110, DSDI 110A DSDI110AV1	Digital input board, 14 inputs, 24V
DSDI 115	Digital input board, 32 channels, 24 V
DSDI116	Digital input board, 32 channels, 24 V non-isolated
DSDI 120, DSDI 120A DSDI 120AV1	Digital input board, 32 inputs, 48 V
DSDI 125	Digital input board, 32 channels, 48 V
DSDI 126	Digital input board, 32 channels, 48 V non-isolated
DSDI 131	Digital input unit. 16 channels, 110 VAC/VDC., controlled by scanning or interrupt, pulse extension. Local time tagging of process events. Galvanic isolation between channel and system.
DSDI 141	Digital input unit. 16 channels, 220 VAC/VDC., controlled by scanning or interrupt, pulse extension. Local time tagging of process events. Galvanic isolation between channel and system.
DSDO 110	Digital output board, 32 outputs

Table 32. S100 I/O (Continued)

Name	Description
DSDO 115	Digital output board, 32 outputs
DSDO 115A	Digital output board, 32 outputs, OSP control
DSDO 120	Digital output unit. 16 channels, 24-48 VDC. 1A. Galvanic isolation between channel and system.
DSDO 130	Digital output board, 16 relay outputs 24 - 240 VAC/VDC
DSDO 131	Digital output board, 16 relay outputs 24 - 240 VAC/VDC
DSDO 140	Digital output unit. 16 channels, 48-240 VDC. Galvanic isolation between channel and system.
DSAO 110	Analog output board, 4 outputs
DSAO 120	Analog output board, 8 outputs
DSAO 120A	Analog output board, 8 outputs, OSP control
DSAO 130	Analog output board, 16 outputs
DSAO 130A	Analog output board, 16 outputs, OSP control
DSAX 110 DSAX 110A	Analog input/output board, 8 inputs 8 outputs
DSDP 010	Absolute binary decoder with hardware strobe, 2 channels
DSDP 140B	Positioning control board for one positioning loop
DSDP 160	Loop transducer interface board, 4 channels
DSDP 161	Loop transducer interface board, 4 channels
DSDP 170	Pulse counter board, 4 channels
NOTE: 1. Product Revision PR:B or later.	

S200 I/O

Table 33 shows the different S200 I/Os.

Table 33. S200 I/O

Name	Description
200-DUTB	Dummy I/O unit
200-IA8	Digital input unit, 8 inputs
200-IB10xOB6	Digital combined unit, 10 inputs and 6 outputs
200-IB16	Digital input unit, 16 inputs
200-IB16xOB16P	Digitally combined unit, 16 inputs and 16 outputs
200-IB32	Digital input unit, 32 inputs
200-IE4xOE2	Analog combined unit, 4 inputs and 2 outputs
200-IE8	Analog input unit, 8 inputs
200-IF4I	Analog input unit, 4 inputs
200-IM8	Digital input unit, 8 inputs
200-IP2	Pulse counter board, 2 x 4 inputs
200-IP4	Pulse counter board, 4 x 2 inputs
200-IR8	Analog input unit, 8 inputs
200-IR8R	Analog input unit, 8 inputs
200-IT8	Analog input unit, 8 inputs
200-OA8	Digital output unit, 8 outputs
200-OB16	Digital output unit, 16 outputs
200-OB16P	Digital output unit, 16 outputs
200-OB32P	Digital output unit, 2 x 16 outputs
200-OB8EP	Digital output unit, 8 outputs
200-OE4	Analog output unit, 4 outputs

Table 33. S200 I/O (Continued)

Name	Description
200-OF4I	Analog output unit, 4 outputs
200-OM8	Digital output unit, 8 outputs
200-OW8	Digital output unit, 8 outputs

S200L I/O and I/O 200C

Table 34 shows the different S200L I/Os and Table 35 shows I/O 200C.

Table 34. S200L I/O

Name	Description
AI210	Analog input unit, 8 inputs
AO210	Analog output unit, 4 outputs
AX210	Analog combined unit, 4 inputs and 2 outputs
DI210	Digital input unit, 16 inputs
DO210	Digital output unit, 16 outputs
DX210	Digital combined unit, 10 inputs and 6 outputs

Table 35. I/O 200C

Name	Description
200C-IB10xOB6P	Digital combined unit, 10 inputs and 6 outputs
200C-IB16	Digital input unit, 16 inputs
200C-IE4xOE2	Analog combined unit, 4 inputs and 2 outputs
200C-IE8	Analog input unit, 8 inputs
200C-OB16P	Digital output unit, 16 outputs
200C-OE4	Analog output unit, 4 outputs

Satt Rack I/O

Table 36 shows the different Satt Rack I/Os.

Table 36. Satt Rack I/Os

Name	Description
IAPG	Digital input board with 16 inputs
IDLD	Digital input board with 16 inputs
IDP	Digital input board with 32 inputs
IDPG	Digital input board with 32 inputs
IDN	Digital input board with 32 inputs
IDI	Digital input board with 32 inputs
PTC	Digital input board with 32 inputs
ORG	Digital output board with 16 outputs
ORGH	Digital output board with 16 outputs
OATG	Digital output board with 16 outputs
ODP2	Digital output board with 16 outputs
ODPG2	Digital output board with 16 outputs
ORM	Digital output board with 16 outputs
ODP.5	Digital output board with 32 outputs
ODP.8	Digital output board with 32 outputs
ODPG.8	Digital output board with 32 outputs
ODPL.5	Digital output board with 32 outputs
ODPLD	Digital output board with 32 outputs
ODN.2	Digital output board with 32 outputs
ODLD.5	Digital output board with 32 outputs

Table 36. Satt Rack I/Os (Continued)

Name	Description
ODSG	Digital output board with 32 optocoupled outputs, short circuit proof
IBA	Analog input board with 8 inputs
IRA	Analog input board with 8 inputs
ICA	Analog input board with 8 inputs
IVA	Analog input board with 8 inputs
IVAPOT	Analog input board with 8 inputs
OCVA	Analog output board with 2 outputs
OCAHG	Analog output board with 4 outputs
OCAH	Analog output board with 4 outputs
OCAH with handstation	Analog output board with 4 outputs
IPA4	Input pulse analyzer board with 4 inputs, 8 bit counters

Drives System

There are two types of drives systems, ABB standard and ABB engineered.

ABB Standard Drives

Table 37 shows the ABB standard drives.

Table 37. ABB Standard Drives

Name	Application
ACS400	Standard drive
ACS600	Crane application
ACS600	Pump and fan application
ACS600	Standard application

Table 37. ABB Standard Drives (Continued)

Name	Application
ACS800	Crane application
ACS800	Pump and fan application
ACS800	Standard application
ACS880	Standard application
DCS400	Standard drive
DCS500	Standard drive

ABB Engineered Drives

Table 38 shows the ABB engineered drives.

Table 38. ABB Engineered Drives

Name	Application
ACS600	IGBT supply (ISU) application
ACS600	System application
ACS600AD	Asynchronous drive
ACS600C	Cycle converter drive
ACS600SD	Synchronous drive
ACS800	IGBT supply (ISU) application
ACS800	System application
ACS880	System application
ACS1000	Standard drive
DCS600	System application

Appendix B Fieldbus

The sections of this chapter describe the capacity limits and constraints for the application design that need to be considered when using standardized fieldbus protocols to connect field devices to AC 800M.

MODBUS

MODBUS RTU Master Communication

The table show the maximum transmission rate when CI853 acts as MODBUS RTU master at a base controller load of 50%.

AC 800M 50% Load in the Controller 300 Booleans in Each Telegram	Max Transmission Rate (Total Transactions/second)			
	PM864A			
	MBWrite		MBRead	
	1 channel	4 channels	1 channel	4 channels
1200 baud (8 data bits, 1 stop bit, odd parity)	1.0	2.4	2.1	4.8
19200 baud (8 data bits, 1 stop bit, odd parity)	8.2	24.9	8.9	38.4

AC 800M 50% Load in the Controller 300 Booleans in Each Telegram	Max Transmission Rate (Total Transactions/second)			
	PM866			
	MBWrite		MBRead	
	1 channel	4 channels	1 channel	4 channels
1200 baud (8 data bits, 1 stop bit, odd parity)	1.0	8.4	1.0	9.1
19200 baud (8 data bits, 1 stop bit, odd parity)	2.2	21.1	4.8	32.3

AC 800M 50% Load in the Controller 300 Booleans in Each Telegram	Max Transmission Rate (Total Transactions/second)			
	PM891			
	MBWrite		MBRead	
	1 channel	4 channels	1 channel	4 channels
1200 baud (8 data bits, 1 stop bit, odd parity)	1.4	2.4	1.2	5.0
19200 baud (8 data bits, 1 stop bit, odd parity)	9.2	22.2	9.3	37.4

MODBUS TCP

The tables show the maximum transmission rate when CI867 acts as MODBUS TCP master or slave.

Table 39. MODBUS TCP Performance Data. Reading Dint using one CI867 as Master

Number of Slaves Connected and Communicating	Message Length (in Dint)	Total Transactions/s (Sum of all Slaves)	Average Transaction/Slave[1]
1 task time=100 ms	60	149	149
1 task time=250 ms	60	89	89
5 task time=100 ms	60	158	31
5 task time=250 ms	60	160	33
10 task time=100 ms	60	150	15
10 task time=250 ms	60	160	17
20 task time=100 ms	60	94	6
20 task time=250 ms	60	110	9
30 task time=100 ms	60	97	3
30 task time=250 ms	60	123	4

1   Cyclic read at maximum possible rate is used.

Table 40. MODBUS TCP Performance Data. Reading Boolean using one CI867 as Master

Number of Slaves Connected and Communicating	Message Length (in Boolean)	Total Transactions/s (Sum of all Slaves)	Average Transaction /Slave[1]
1 task time=100 ms	60	114	114
1 task time=250 ms	60	104	104
5 task time=100 ms	60	130	26
5 task time=250 ms	60	129	26
10 task time=100 ms	60	113	11
10 task time=250 ms	60	121	12
20 task time=100 ms	60	100	5
20 task time=250 ms	60	141	7
30 task time=100 ms	60	113	3
30 task time=250 ms	60	124	4

1   Cyclic read at maximum possible rate is used.

Table 41. MODBUS TCP Performance.Data. Reading Real using one CI867 as Master

Number of Slaves Connected and Communicating	Message Length (in Real)	Total Transactions/s (Sum of all Slaves)	Average Transaction /Slave[1]
1 task time=100 ms	60	104	104
1 task time=250 ms	60	95	95
5 task time=100 ms	60	120	24
5 task time=250 ms	60	120	24

1   Cyclic read at maximum possible rate is used.

Table 42. MODBUS TCP Performance Data. Reading Dint using one CI867 as Slave

Number of Masters Connected and Communicating	Number of Data in Dint	Total Transactions/s (Sum of all Slaves)	Average Transaction /Master
1 task time=50 ms	50		20
1 task time=50 ms	100		20
2 task time=50 ms	50		20
2 task time=50 ms	100		20

Table 42. MODBUS TCP Performance Data. Reading Dint using one CI867 as Slave (Continued)

Number of Masters Connected and Communicating	Number of Data in Dint	Total Transactions/s (Sum of all Slaves)	Average Transaction /Master
8 task time=50 ms	50		20
8 task time=50 ms	100		20

Table 43. MODBUS TCP Performance. Data. Reading Boolean using one CI867 as Slave

Number of Masters Connected and Communicating	Number of Data in Boolean	Total Transactions/s (Sum of all Slaves)	Average Transaction /Master
1 task time=100 ms	1		10
1 task time=100 ms	525		10
2 task time=100 ms	1		10
2 task time=100 ms	525		10
8 task time=100 ms	1		10
8 task time=100 ms	525		10

PROFIBUS

Network Connection through Communication Interface

Communication Interface for PROFIBUS DP: CI854A/B

CI854A/B acts as a PROFIBUS Master only.

For PROFIBUS DP following limits and performance figures need to be taken into account:

Table 44. PROFIBUS and CI854A/B Parameters

Communication	Parameter	Limits
General Limits	Maximum no. of CI854A/B in an AC 800M (CEX Bus)	12 (a redundant pair consumes two of them)
	Max. number of nodes per network	126
	Max. number of slave nodes supported	124
	Reserved node addresses for CI854A/B	0 (1 for redundant CI)
	Available node addresses for slaves	2 -125
	Supported Baudrates on PROFIBUS	9,6 kbit/s - 12 Mbit/s
Configuration Limits		
PROFIBUS DP cyclic communication	Max. length of I/O data for CI854A/B	>1,5 Mbit/s: 4000 byte input and output data <= 1,5 Mbit/s: no limitation in CI
Performance Limits		

Table 44. PROFIBUS and CI854A/B Parameters

Communication	Parameter	Limits
PROFIBUS DP cyclic communication	Fastest possible cycle time	1 ms at 12 Mbit/s with one slave supporting 1ms
	Typical cycle times	10 – 20 ms at 1,5 Mbit/s

The cycle time on PROFIBUS depends on the baud rate, the sum of I/O data, and the slave timing parameter and is therefore application-specific.

Further features and constraints to be considered during application design:

- S800 I/O connected to CI840 and/or S900 I/O connected to CI920 supports cable redundancy together with slave redundancy.

- S900 (CI920) and S800 (CI840 and CI801) support configuration change (changing the parameters) without disrupting the cyclic data communication.

- If the PROFIBUS master unit, CI854A/B, loses contact with a slave unit, for example due to a disconnected cable, input values are set according to ISP configuration. If the I/O unit does not support ISP, all input values will freeze.

- Reset of PROFIBUS DP master, CI854A/B, and the complete PROFIBUS is done if one of the following bus parameter settings are changed:

  – Node address of CI854A/B,

  – baud rate.

  – highest station address (HSA).

A change of the other bus parameters does not affect the running communication.

PROFINET

Network Connection through Communication Interface

Communication Interface for PROFINET: CI871

For PROFINET following limits and performance figures need to be taken into consideration:

Table 45. PROFINET and CI871 Parameters

Communication	Parameter	Limits
General Limits	Maximum no. of CI871 in an AC 800M (CEX Bus)	12 **Note**: Only application redundancy supported.
	Maximum number of PROFINET devices per CI871	126
	Maximum supported modules per PROFINET device	512
Configuration Limits		
PROFINET IO cyclic Real Time communication	Number of IOCR (IO Communication Relationship) per device	1 Input 1 Output
	Maximum length of IOCR	1440 bytes
PROFINET IO acyclic communication	Maximum frame length for each service	4096 bytes
Performance Limits		
PROFINET IO cyclic Real Time communication	Fastest possible cycle time	1 ms with one device supporting 1ms
	Maximum frame transfer rate	1 frame per ms in each direction
PROFINET IO acyclic communication	Maximum total frame rate transfer	25 per second

The cycle time on PROFINET depends on the number of devices and Ethernet frames that will be communicated and is therefore application-specific.

Examples for typical configurations:

- Example 1: Update times for all devices is configured to 32 ms (default), then up to 32 devices can be connected to CI871.

- Example 2: Update times for all devices is configured to 8 ms, then up to 8 devices can be connected to CI871.

The limitation for the CPU load of CI871 is checked by the system during download. If the system detects that there is a CPU overload, then it is indicated in the Compilation Summary window and the download is blocked. The CI871 may not function properly when there is an overload. The user can check the CPU load before and after download by use of the Web Interface. The limit for the CPU load is 100%. Up to that value the CI871 works stable without any problems or restrictions.

Further features and constraints to be considered during application design:

PROFINET IO connectivity through CI871 supports application redundancy. That means a second CI871 module needs to be configured separately to communicate the same data with the voting implemented in the controller application.

IEC 61850

Network Connection through Communication Interface

Communication Interface for IEC61850-ED.1: CI868.

CI868 General Configuration Data

CI868 is modeled as an IED with one Access point and supports communicating with other IEDs through IEC 61850 GOOSE as well as IEC 61850 MMS client protocol.

The CI868 IEC 61850 Hardware Library 3.x available in Control Builder, supports CI868 to communicate over IEC 61850 GOOSE and MMS client protocols.

Figure 13 illustrates the data modeling in IEC61850 to explain the terms used in the following sections to define the performance and capacity limits with IEC61850 in AC 800M:
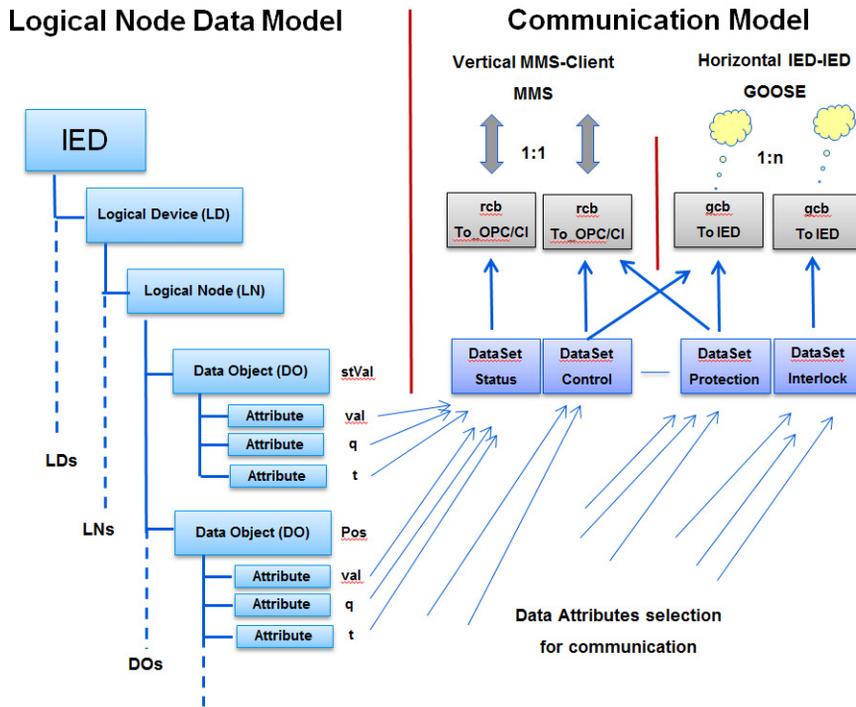
Figure 13. Logical Node Data and Communication Model

For IEC61850 communication with CI868 following limits and performance figures need to be taken into account independent of what communication protocol should be used:

Table 46. IEC 61850 CI868 General Parameters

Communication	Parameter	Limits
	Maximum no. of CI868 in an AC 800M (CEX Bus)	12 **Note**: Only application redundancy supported.
	Maximum number of LDs under MyIED	10
	Maximum number of LNs per LD	253
	Maximum number of Data Objects per Dataset	10 Analog, Integer or Boolean type of Data objects. Increasing the number of Data Objects per Dataset would overload CI868. For more data signals to CI868 from same IED, use additional Datasets

Further features and constraints to be considered during application design:

IEC 61850 connectivity through CI868 supports application redundancy. That means a second CI868 module needs to be configured separately to communicate the same data with the voting implemented in the controller application.

The CPU load on CI868 shall be less than 85% for satisfactory performance of CI868 module with all types of communication.

CI868 Performance for GOOSE Protocol Usage

In addition to the General Configuration Data for CI868 following limits and performance figures need to be taken into account when using the CI868 for GOOSE protocol communication only:

The limits with respect to the IEC61850 data model entities need to be considered already while engineering the Substation Configuration Description (SCD) file with the substation engineering tool.

Table 47. Performance Parameters of CI868 with GOOSE Protocol only

Communication	Parameter	Limits
Configuration Limits		
GOOSE communication	Maximum number of IEDs connected per CI868	80
	Maximum number of GOOSE Datasets per CI868	150 Subscribed dataset count checked by the IEC 61850 Wizard during engineering
	Maximum Number of CI868 Receive Group per IED	254 Each CI868 GOOSE Receive Group constitutes 5 Data Objects. Each Data Object constitutes the Data Attributes, for example: stVal / mag.f , q, t
	Maximum number of Data Objects (signals) configured	800 Data Objects of types Analog, Integer, or Boolean.

Table 47. Performance Parameters of CI868 with GOOSE Protocol only (Continued) (Continued)

Communication	Parameter	Limits
Performance Limits		
GOOSE communication	Maximum number of changing Data Objects Received	160 / sec Data Objects of types Analog, Integer, or Boolean. See also CI868 GOOSE Performance Graph
	Maximum number of changing Data Objects Sent	10 / sec Data Objects of types Analog, Integer, or Boolean. See also CI868 GOOSE Performance Graph

CI868 GOOSE Performance Graph

The GOOSE performance of CI868 module is a function of the following parameters:

CI868 Receive

• Number of Static signals configured in scd-file for CI868 Receive.
  This is the sum of all Data Objects (DO) signals subscribed to CI868 in all Datasets in all IEDs.
• Number of changing signals out of static signals for CI868 Receive.
  This is the sum of all Data Objects signals subscribed to CI868 changing at a given moment across all IEDs.

CI868 Send

• Number of Static Signals configured in scd-file from CI868 to other IEDs.
  This is the sum of all Data Objects signals in all Datasets from CI868 to other IEDs.

- • Number of changing send signals out of static signals from CI868 to other IEDs.
  This is the sum of all Data Objects signals changing at a given moment from CI868.

Figure 14 provides the CI868 GOOSE performance for different configurations of Static and Changing Receive signals for operating within optimal load of CI868 CPU (85%).

This chart is applicable for CI868 configured for GOOSE communication.
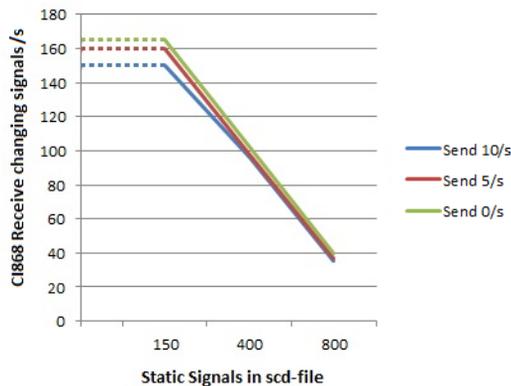
Figure 14. CI865 GOOSE Performance Chart

CI868 Performance for MMS Client Protocol Usage

In addition to the General Configuration Data for CI868 following limits and performance figures need to be taken into account when using the CI868 for MMS protocol communication only:

The limits with respect to the IEC61850 data model entities need to be considered already while engineering the Substation Configuration Description (SCD) file with the substation engineering tool.

Table 48. Performance Parameters of CI868 with MMS Client only

Communication	Parameter	Limits
Configuration Limits		
MMS communication	Maximum number of IEDs connected per CI868	20
	Maximum number of MMS Datasets	150 Subscribed dataset count checked by the IEC 61850 Wizard during engineering
	Maximum number of LDs under other IEDs	50 Starting from Position 200 under other IED in Control Builder hardware tree
	Maximum number of Data Objects (signals) configured	1000 Data Objects of types Analog, Integer, or Boolean.
Performance Limits		
MMS communication	Maximum number of changing Data Objects Received	80 / sec Data Objects of types Analog, Integer, or Boolean.
	Maximum number of MMS Control Command sent	1 / sec MMS Control Commands sent from CI868 via CSWI and XCBR LNs

Further features and constraints to be considered during application design:

• High load on CI868 with MMS signals can be avoided by grouping the frequently changing signals in the same dataset when creating the SCD file.

For Example: Measurement signals shall be grouped into one dataset, Status signals shall be grouped into another dataset.

MMS performance of CI868 module functions are as follows:

CI868 Receive

- **Memory**: Number of Static Datasets (sent via RCB (Record Control Block) signals configured in SCD file for CI868 Receive.
  This is the sum of all Data Objects signals subscribed to CI868 in all Datasets in all IEDs.
- **Load**: Number of changing DO signals for CI868 Receive.
  This is the sum of all DO signals subscribed to CI868 changing at a given moment across all IEDs. The number of MMS signals changing in lesser number of Datasets consumes less CI868 load as against the same number of signals changing in more number of datasets.

CI868 Performance for MMS Client and GOOSE Protocol Combined Usage

Following limits and performance figures that are different from the figures given in the respective sections for GOOSE protocol and MMS protocol need to be taken into account in addition when using the CI868 for parallel GOOSE and MMS protocol communication:

Table 49. Performance Parameters of CI868 with both GOOSE and MMS Client

Communication	Parameter	Limits
Configuration Limit		
MMS & GOOSE communication MMS & GOOSE communication (Continued)	Maximum number of IEDs connected per CI868	20
	Maximum number of Datasets per CI868 (GOOSE & MMS in total)	150 Subscribed dataset count checked by the IEC 61850 Wizard during engineering
	Maximum number of LDs under other IEDs	50 Starting from Position 200 under other IED in Control Builder hardware tree
	Maximum Number of CI868 Receive Group per IED	254 Each CI868 GOOSE Receive Group constitutes 5 Data Objects. Each Data Object constitutes the Data Attributes, for example: stVal / mag.f , q, t
	Maximum number of GOOSE Data Objects (signals) configured	20 Send direction 20 Receive direction Data Objects of types Analog, Integer, or Boolean.
	Maximum number of MMS Data Objects (signals) configured	600 Data Objects of types Analog, Integer, or Boolean.

Table 49. Performance Parameters of CI868 with both GOOSE and MMS Client (Continued)

Communication	Parameter	Limits
Performance Limit		
MMS & GOOSE communication	Maximum number of changing MMS Data Objects Received	60 / sec Data Objects of types Analog, Integer, or Boolean
	Maximum number of changing Data Objects Sent via GOOSE	10 / sec Data Objects of types Analog, Integer, or Boolean.
	Maximum number of changing Data Objects Received via GOOSE	20 / sec Data Objects of types Analog, Integer, or Boolean.
	Maximum number of MMS Control Command sent	1 / sec MMS Control Commands sent from CI868 via CSWI and XCBR LNs

EtherNet/IP and DeviceNet

For EtherNetIP / DeviceNet configurations with CI873 the following dimensioning guidelines needs to be taken into account.

General

The limitations, with respect to the various devices in general are:

- CI873 can act only as a scanner.
  It does not accept class 1 and class 3 connections from any other scanner.

- The number of I/O modules that can be connected under Ethernet/IP or DeviceNet device adaptor type device is 63.

- The number of configuration parameters supported per EtherNet/IP or DeviceNet device is 1000.

- The CI873 supports Listen only connection with EtherNet/IP device, provided there is already Exclusive owner connection in the device. The CI873 does not support Redundant owner connections for EtherNet/IP devices.

- The Read only parameter and monitoring parameters in EDS file are not supported in this release.

- The tag based Class 1 information should be there in EDS file for communication with Allen Bradley PLC where Class 3 tag can be added along with Class 1 connection.

- The total number of Input and Output bytes along with channel status bytes should not exceed more than 80Kb per CI873.

- The Configuration assembly size of 200 is supported per EtherNet/IP or DeviceNet device.

- The CI873 supports 20 CIP connections (including Class 1 and Class 3) per EtherNet/IP device. CI873 supports total of 128 connections.

- The CI873 only supports devices which uses EtherNet/IP encapsulation of CIP.

- CI873 does not support PCCC, Modbus encapsulation.

- CI873 supports CH1 Ethernet interface with a speed of 100 Mbps.
  CH2 is not supported.

- A maximum of 6 non redundant CI873 can be connected to each AC 800M controller.

Performance Data

Typical performance of the CI873 is:

- CI873 can handle a maximum of 10 CIP connections with 10ms RPI. However it can handle a maximum of 128 CIP connections.

- The reaction time of CI873, that is, the time from changed input channel to the time setting an output channel is less than 100ms at a maximum CI873 CPU Load of 80%, provided the data is sent over a connection operating at an RPI of 50ms or less.

- Data throughput of 1000 CIP I/O packets receive/second and 500 CIP I/O Packets sent/second can be achieved at an optimum load of 85%. Each I/O packet can have data size ranging from 4 to 500 bytes.

- Redundancy Switchover time is 120ms for 10 CIP connections operating at 10ms RPI, that is, the time I/O communication stops in primary to the time I/O communication starts in switched primary.

EtherNet/IP

The limitations, with respect to the EtherNet/IP device involved are:

- EtherNet/IP supports three Class 1 connection and three Class 3 tag per Allen Bradley Control Logix PLC. The CI873 supports three Class 3 tags with 100ms cycle time.

- The data transfer, using the Class 3 connection is slower than the Class 1 connection.

- The Class 3 connection is not supported for any EtherNet/IP devices except Allen Bradley Control Logix PLC. The CI873 uses tag based Class 3 to write data to it.

- The maximum number of bytes support for Class 1 read tag is 496 and for Class 3 write tag is 432.

- 1000 bytes per Class 1 connection is supported, for example O->T: 500 and T->O : 500.

DeviceNet

The limitations, with respect to the LD 800DN linking device (for DeviceNet) are:

- The maximum number of input bytes supported by LD 800DN is 496 bytes. If the total number of input bytes of all DeviceNet slaves configured under the linking device exceeds 496 bytes, download is stopped.

- The maximum number of output bytes supported by LD 800DN is 492 bytes. If the total number of output bytes of all DeviceNet slaves configured under the linking device exceeds 500 bytes, download is stopped.

- A maximum of four LD 800DN linking devices can be connected under one CI873.

- Multiple CI873 cannot listen to same LD 800DN data.

- The maximum number of DeviceNet connections per device is restricted to 5.

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