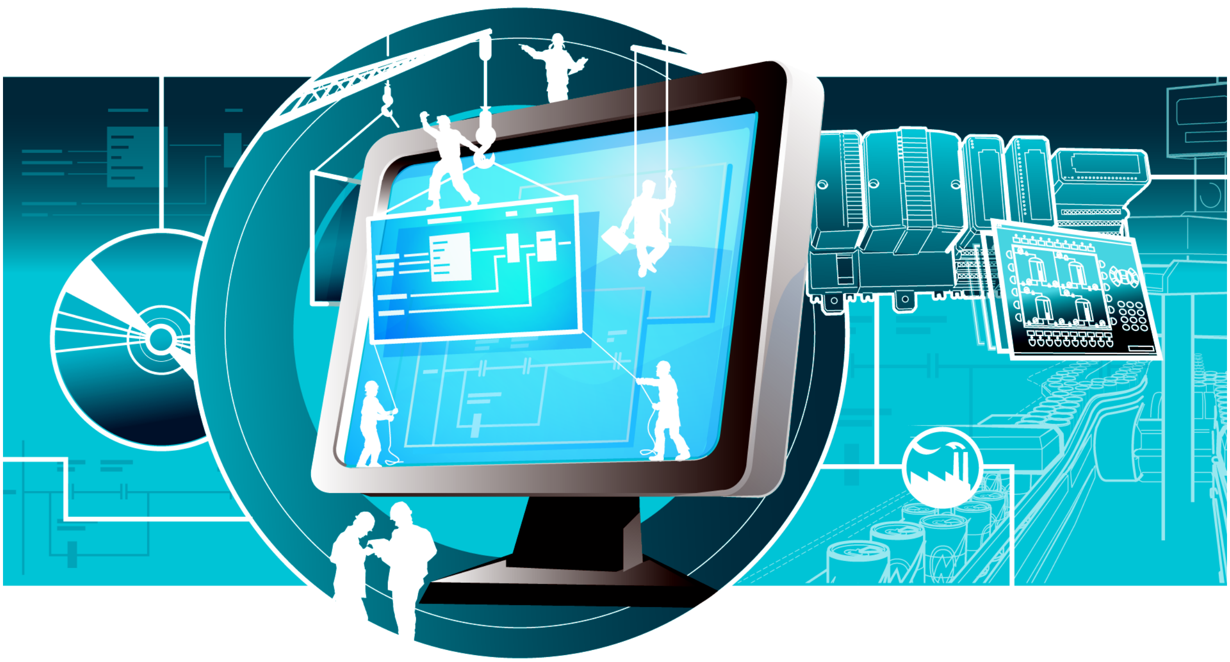
Compact 800 Engineering
Compact Control Builder AC 800M 5.1

Product Guide



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NOTICE

This product meets the requirements specified in EMC Directive 89/336/EEC and in Low Voltage Directive 72/23/EEC.

Release: June 2010
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TRADEMARKS

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Appendix B - Performance and Capacity

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 (*3BSE033044D51xx*) 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, Supported Hardware and I/O Families describes the hardware modules and I/O families supported by Compact Control Builder AC 800M.

Appendix B, Performance and Capacity describes performance and technical data for Control Software and Control Builder key functions.

New in this Release

The Compact Control Builder version 5.1 contains new and improved functionality compared to version 5.0 SP2:

- Supported on Windows 7 operating system.
- PM891
  - Support for new high performance AC 800M CPU, PM891.
- Support for Advant Fieldbus 100
  - The new CI869 module adds support for AF 100.
- Support for PROFINET IO protocol
  - The new CI871 module adds support for PROFINET IO.
- Support for EtherNet/IP protocol and DeviceNet
  - The new CI873 module adds support for EtherNet/IP and also for DeviceNet devices that are connected through the LD 800DN device.
- MODBUS TCP support for FC23.
- Increase in the maximum number of applications.
- Inter Application Communication (IAC) using Communication Variables
  - IAC uses IP based resolution for cyclic communication between programs and top level single control modules.
- Task Analysis tool to analyze the task execution before downloading the application to PLCs.
- Six new functions – ClearBit, ClearBits, SetBit, SetBits, TestBit, TestBits – for effecient bit handling.
- New process objects – MotorValve, MotorValveM, MotorValveCC.
- Enhanced support for backup media – Compact Flash card that is formatted on FAT32 and Secure Digital card.
- All AC 800M system alarms appear in cleartext.

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 Price Lists Structure on page 45.

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) and Sequential Function Chart (SFC).
- 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, and not for CI851. (However, when you upgrade a previous system offering, any included hardware types for CI851 will be upgraded as well.)

    You can also import PROFINET GSD files for CI871, and DeviceNet 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 PM861, 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 adapter for rack-based I/O boards.
  - 200-ACN unit for 200 I/O units via Satt ControlNet.
- Compact Flash (CF) and Secure Digital (SD)
  - 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.

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 18.

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
- PM856
- PM860
- PM861/PM861A
- PM864/PM864A
- PM866
- PM891
- SoftController running on PC

Software Overview

The software delivered in the CD 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 or Windows Server 2008 platform.

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 1) or be installed on a separate PC, typically together with Human Machine Interface (HMI) software.

Figure 1. 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).

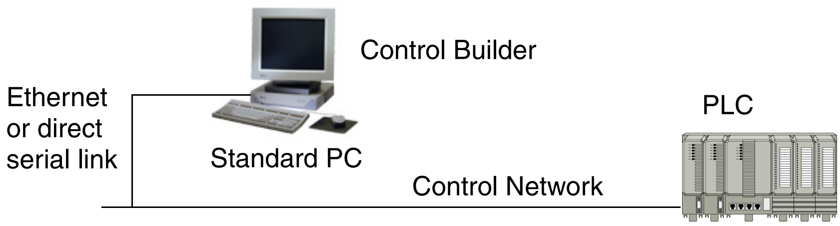


Figure 2. Downloading firmware and/or applications.

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.

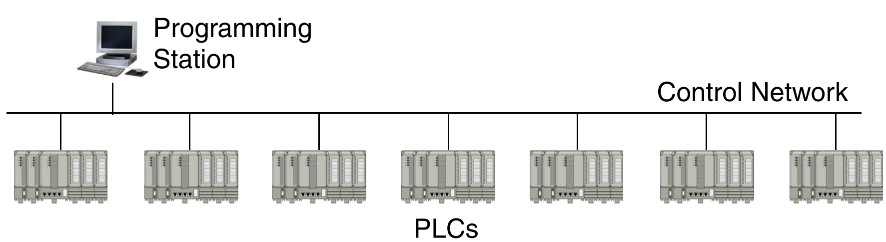


Figure 3. PLC communication in control network.

Compact Control Builder AC 800M Functions

Compact Control Builder supports a number of functions:

- Support for IEC 61131-3 Languages on page 19.
- Testing the Application on page 20.
- Downloading to a PLC on page 20.
- Multi-user Engineering on page 21.
- Alarm and Events Handling on page 21.
- I/O Connectivity and Communication on page 22.
- Supported ABB I/O Systems and Families on page 28.
- Serial Communication Protocols on page 29.
- Control Network on page 32.
- Clock Synchronization on page 33.
- Redundancy on page 33.
- Backup Media on page 35.
- Online Help and Manuals on page 36.
- Additional Software on page 37.

Support for IEC 61131-3 Languages

The IEC 61131-3 standard defines five of the most commonly used programming languages on the market. Depending on previous experience, programmers often have their own personal preference for a certain language.

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.
Sequential Function Chart (SFC)	Sequential function chart (SFC) is a graphical language for depicting the sequential behavior of a control program.

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 37.

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 39. 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 adapters 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 4).

INSUM and Control Network must use separate physical networks.

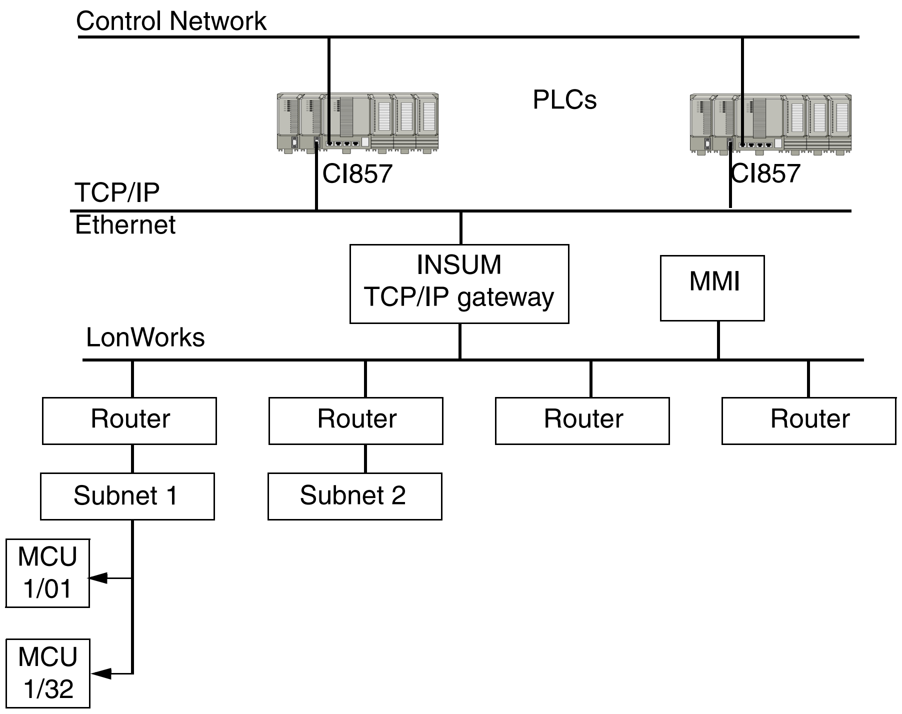


Figure 4. INSUM integration with PLCs.

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.
- Online upgrade for CI873 Firmware.

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 are supported by MODBUS TCP.

Table 2. Supported MODBUS TCP protocol commands

Protocol	Description	Protocol	Description
FC 1	Read coils	FC 8	Diagnostic
FC 2	Read input discreet	FC 15	Force multiple coils
FC 3	Read multiple registers	FC 16	Write multiple registers
FC 4	Read input register	FC 20(1)	Read file record
FC 5	Write coil	FC 21(1)	Write file record
FC 6	Write single register	FC 23	Read Write file record
FC 7	Read exception status		

(1) Supported in Master only.

- **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.

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 via CI856 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.

The Compact Control Builder software only supports ModBus RTU **master** 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 coil status	FC6	Preset single register
FC2	Read input status	FC7	Read exception status
FC3	Read holding registers	FC8(1)	Diagnostic request
FC4	Read input registers	FC15	Force multiple coils
FC5	Force single coil FC16	FC16	Preset multiple registers

(1) Some slaves do not understand FC8. To avoid problems, set Poll Time to zero (0).

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.

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.

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 33.

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 (PM861, PM864, PM866, and PM891)
- Network redundancy (RNRP)
- Line redundancy (CI854)
- Master redundancy (CI854A)
- Optical ModuleBus redundancy
- CEX-Bus redundancy (using BC810)

CPU Redundancy

PLCs with PM861, 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.

It is also possible to run a PLC in single CPU mode with PM861, PM864, PM866, or PM891.

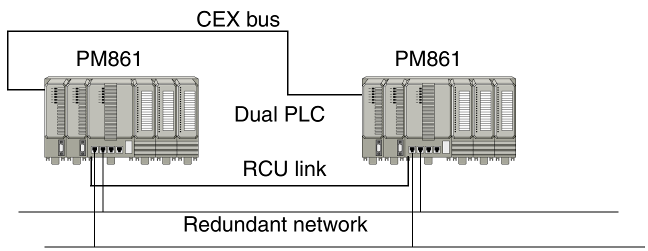


Figure 5. Example of a redundant CPU configuration.

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.

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.

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) 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 42.

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 42.

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.

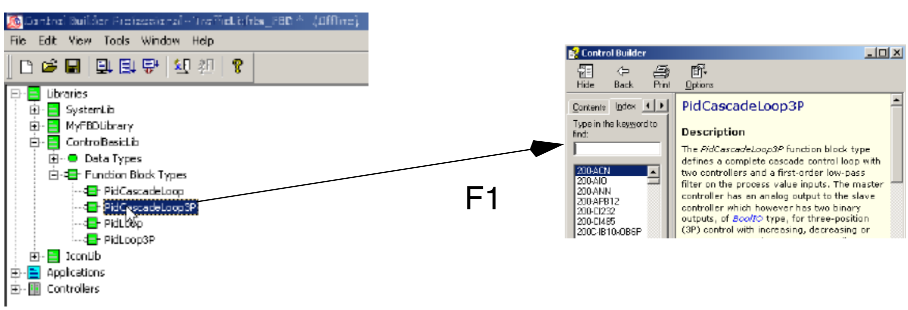


Figure 6. Context-sensitive (F1) help

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.

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, 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.

For information about hardware and I/O, see Appendix A, Supported Hardware and I/O Families.

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.

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 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 SD card used in AC 800M PLC (PM891):

- Formatted according to FAT 16 or 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
Printing project documentation	Microsoft Word 2007
Reading online manuals	Acrobat Reader 8.0 or later

OPC Server

OPC Server for AC 800M requires Windows 7 as the operating system.

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
- SFC Viewer
- High Integrity Controller for SIL applications
- CI860 for FF HSE, and CI862 for TRIO I/O
- Information routing via HART protocol
- Security (controls a user's authority to perform different operations on (Aspect) objects)
- Diagrams in the application

Section 4 Ordering and Licensing

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 800, please disregard this section completely.*

Ordering Procedure

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

Price Lists Structure

The Compact Products 800 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: Compact Products 800, 3BSE045561

Table 7. Price List

Price List	Article No.
Compact HMI 800 5.0	3BSE054246
Compact HMI 800 5.0 Expansion	3BSE054250
Compact HMI 800 4.1 Expansion	3BSE040708
Compact Control Builder AC 800M 5.1	3BSE058194
S800 I/O used for Compact Control	3BSE058195
AC 800M used for Compact Control	3BSE058196
S800 I/O used for Compact Control	3BSE058195
Panel 800	3BSE043387

Compact Control Builder AC 800M, 3BSE058194

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.
A020	Automation Sentinel Upgrade. *Automation Sentinel agreement number or SoftCare id shall be given at ordering.*	3BSE047992R1
A040	Media Box with Compact Control Builder AC 800M and OPC server for AC 800M version 5.1 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.	3BSE046066R51

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

Compact Control Builder AC 800M		
A110	Compact Control Builder AC 800M 5.1 Product Box including: - licenses for one Compact Control Builder AC 800M, one OPC Server for AC 800M, and one SoftController. - CD 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. 1 year Automation Sentinel Subscription included.	3BSE040360R51
A120	OPC Server for AC 800M 5.1 License for one OPC Server for AC 800M. 1 year Automation Sentinel Subscription included.	3BSE039915R51
User Documentation		
H130	Compact 800 Engineering, Compact Control Builder, AC 800M 5.1, Getting Started	3BSE041584-510
H140	Compact 800 Engineering, Compact Control Builder, AC 800M 5.1, Configuration	3BSE040935-510
H150	Compact 800 Engineering, Compact Control Builder, AC 800M 5.1, Planning	3BSE044222-510
H160	Compact 800 Engineering, Compact Control Builder, AC 800M 5.1, Binary and Analog Handling	3BSE041488-510

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. The product also includes one year subscription on ABBs Sentinel software maintenance program. This gives the user free upgrades of the software during this period. The period starts at the date of shipping from the factory. The Sentinel agreement can be extended by purchasing the sentinel extension pricelist items.

Software updates

To get access to software upgrades the license owner needs to register as an owner of the license. Information about how to register is delivered together with the software.

After registration software updates and product information accessible on the internet.

Upgrades

To upgrade previous versions of Control Builder to the latest version users need to purchase a subscription on ABBs Sentinel software maintenance program.

SoftCare subscriptions for System Baseline 2 Control Builder M Basic, Standard or Professional products include the right to sign up for sentinel for a discounted fee.

Each new license for Compact Control Builder AC 800M includes Sentinel subscription for one year from day of shipping from the factory. The Sentinel includes the right to get software upgrades (downloaded) during this period. Media is not included but can be purchased at a nominal fee.

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 800 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 (3BSE058194), 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, 3BSE058196.
3. From the Compact HMI price list (3BSE054246), order the following items:
   - One item A110 (Compact HMI 800)
   - One of the items B110, B120 or B130 (depending on number of signals)
   - One Compact HMI Operator Workplace Client (item C110-140, dependent of the size of the server)

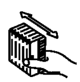
Appendix A Supported Hardware and I/O Families

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

PLCs

AC 800M

The AC 800M modules supported are shown in the following table.

The symbol  on the front of a CEX bus unit indicates support for online replacement.

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

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redund ant	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
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
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

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redundant	Redun-dant
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 unit CI854A and BC810.	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 unit CI854A and BC810.	Yes(1)	Yes	No	Yes

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redund ant	Redun-dant
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.	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.	Yes(1)	Yes	No	Yes
BC810	CEX-bus interconnection unit.	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

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redund ant	Redun-dant
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)
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

Unit	Description	Online Replace-ment	Redun-dancy	Online upgrade (only valid for Control Builder Professional in 800xA)	
				Non-redundant	Redun-dant
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)
CI868	The CI868 unit is the IEC 61850 communication interface for the AC 800M.	Yes	No	Yes(2)	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
CI873	The CI873 is the EtherNet/IP and DeviceNet communication interface for the AC 800M.	Yes	No	Yes(2)	N/A

(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 either to failsafe values, or to the values specified by OSP control (Output Set as Predetermined), if supported.
(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).

The following AC 800M modules are supported, but only for migration purposes, NOT at new installations.

Unit	Description	Online Replace ment	Redun-dancy	Online Upgrade(1)
CI851	The CI851 unit is the communication interface for PROFIBUS DP-V0 for the AC 800M. It is a master unit and you can connect up to 125 slaves to it. However, you cannot connect more than 32 units in one segment. CI851 can be removed online if it becomes faulty. CI851 is replaced by CI854A at new installations.	No	No	No
CI852	The CI852 is the communication interface for the Fieldbus Foundation H1 bus for the AC 800M. The unit acts as a Link Active Scheduler (LAS) on the H1 bus. CI852 can be removed online if it becomes faulty.	No	No	No

(1) Only valid for Control Builder Professional in 800xA.

The firmware available in Compact Control Builder 5.1 does not support CI851 and CI852. To run these modules, the corresponding firmware available in Compact Control Builder 5.0.2 must be downloaded to the connected PM8xx units. A controller containing any of these modules must not be upgraded to BasicHwLib 5.1-0, but shall be kept with BasicHwLib 5.0-2.

Adapters

Adapter	**Can be connected to**	**HART**(1)	**SOE**(2)
TB820	PM851, PM856 PM860 PM861 and PM861A (Single PLC only) PM864 and PM864A (Single PLC only) PM866 (Single PLC only) PM891 (Single PLC only)	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes
TB840	PM851, PM856 PM860 PM861 and PM861A PM864 and PM864A PM866 PM891	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes
TB840A	PM851, PM856 PM860 PM861 and PM861A PM864 and PM864A PM866 PM891	Yes Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes Yes
DSBC 173A	CI856	No	Yes
DSBC 174	CI856	No	Yes
DSBC 176	CI856	No	Yes
CI801	CI854 and CI854A	Yes	No
CI830(3)	CI851 CI854 and CI854A	No No	No No
CI840	CI854 and CI854A	Yes	No
CI840A	CI854 and CI854A	Yes	No

Adapter	Can be connected to	HART(1)	SOE(2)
RPBA-01	CI851 CI854 and CI854A	No No	No No
NPBA-12	CI851 CI854 and CI854A	No No	No No
CI920	CI851 CI854 and CI854A	No Yes	No No
200-APB12	CI851 CI854 and CI854A	No No	No No
200-ACN	CI865	No	No
200-RACN	CI865	No	No
RETA-02	CI871	No	Yes
MNS *i*S	CI871	No	Yes
LD800 DN	CI873	No	No

(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 at new installations.

Adapter	Description
TB820	ModuleBus Modem
TB840(A)	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.

Adapter	Description
CI801	The CI801 is a remote PROFIBUS DP-V1 adapter 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(A)	The CI840(A) is a remote PROFIBUS DP-V1 adapter 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	The CI920 is a remote PROFIBUS DP-V1 adapter for S900 I/O units.
200-APB12	The 200-APB12 unit is a remote PROFIBUS DP slave I/O adapter 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 controller 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.

Adapter	Description
RPBA-01	The RPBA-01 PROFIBUS-DP adapter unit is an optional device for ABB ACS 800 drives which enables the connection of the drive to a PROFIBUS network. The drive is considered as a slave on 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.
NPBA-12	The NPBA-12 PROFIBUS adapter unit is 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.
200-ACN	The 200-ACN is a remote ControlNet I/O adapter for Series 200 I/O units. 200-ACN is connected to a controller via a CI865 communication interface on the controller 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.

Adapter	Description
200-RACN	The 200-RACN unit is a remote ControlNet adapter for rack based I/O units. 200-RACN is connected to a controller via a CI865 communication interface on the controller system bus. One or several adapter 200-RACN units are used as nodes. A maximum of eight I/O-racks are supported on the Satt ControlNet fieldbus.
RETA-02	The RETA-02 Ethernet Adapter module is 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 RETA-02 Ethernet Adapter module, 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.

Adapter	Description
MNS *i*S	MNS *i*S is a motor control center solution that can be used in PROFINET IO network. MNS *i*S 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 *i*S, serves as the serial gateway interface to higher level systems which communicate to all modules through PROFINET IO.
LD800 DN	The LD 800DN adapter, 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 adapters are supported, but only for migration purposes, NOT at new installations.

Adapter	Description
CI830	The unit CI830 is a remote PROFIBUS DP-V0 I/O adapter for units. CI830 is connected to a PLC via a PROFIBUS DP-V0 master unit on the controller 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.

I/O Families

All I/O units may be replaced in a running system.

I/O Family	Connects To
S800 I/O	PM851, PM856, PM860, PM861, PM861A, PM864, PM864A, PM866, PM891 TB820, TB840, TB840A CI801, CI830, CI840, CI840A
S900 I/O	CI920
ABB Standard Drives	PM851, PM856, PM860, PM861, PM861A, PM864, PM864A, PM866, PM891 TB820, CI801, CI830, CI858, RPBA-01, NPBA-12, RETA-02
ABB Engineered Drives	PM851, PM856, PM860, PM861, PM861A, PM864, PM864A, PM866, PM891 TB820, CI858, RPBA-01, NPBA-12, RETA-02
S100 I/O	CI856
S200 I/O, S200L I/O and I/O 200C	200-APB12, 200-ACN
Satt Rack I/O	200-RACN

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.
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

Name	Description
DI811	Digital input unit, 16 inputs
DI814	Digital input unit, 16 inputs
DI820	Digital input unit, 8 inputs
DI821	Digital input unit, 8 inputs
DI825	Digital input unit, 8 channels with event recording (SoE, Sequence of events)120 V DC current sinking(4)
DI830	Digital input unit, 16 inputs with event recording (SoE, Sequence of events)120 V DC current sinking(4)
DI831	Digital input unit, 16 inputs with event recording (SoE, Sequence of events)120 V DC current sinking(4)
DI840	Digital input unit 16 inputs, redundant possibilities with event recording (SoE, Sequence of events),120 V DC current sinking(5)
DI885	Digital input unit, 8 inputs(4)
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
DO820	Digital output unit, 8 outputs
DO821	Digital output unit, 8 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

(1) AI830/AI830A

(2) AI835/AI835A
(3) AO810/AO810V2
(4) Not in CI801/CI840
(5) Not in CI801, SOE not implemented in CI840

S900 I/O

Name	Description
AI910N/S	Analog input unit, 4 inputs
AI920N/S	Analog input unit, 4 inputs
AI921N/S	Analog input unit, 4 inputs
AI930N/S	Analog input unit, 4 inputs
AI931N/S	Analog input unit, 4 inputs
AI950N/S	Analog input unit, 4 inputs
AO910N/S	Analog output unit, 4 outputs
AO920N/S	Analog output unit, 4 outputs
AO930N/S	Analog output unit, 4 outputs
DI920	Digital input unit, 4 inputs
DO910N/S	Digital output unit, 4 outputs
DO930N/S	Digital output unit, 6 outputs
DO940N/S	Digital output unit, 8 outputs
DO980N/S	Digital output unit, 16 outputs
DP910N/S	Frequency input and pulse counter
DX910N/S	Bidirectional unit, 8 channels

It is not possible to detect errors such as missing module, wrong module type, error in module, from S900 I/O or S800 I/O when CI851 is used. By using a CI854 or CI854A as master these types of errors can be detected.

S100 I/O

The following selection of S100 I/O boards are supported.

Name	Description
DSBC 173A/174 DSDC 176	Bus extender slave
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
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
DSDO 110	Digital output board, 32 outputs
DSDO 115	Digital output board, 32 outputs
DSDO 115A	Digital output board, 32 outputs, OSP control
DSDO 130	Digital output board, 16 relay outputs 24 - 240 VAC/VDC
DSDO 131	Digital output board, 16 relay outputs 24 - 240 VAC/VDC
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

Name	Description
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

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

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

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

See also I/O 200C on page 73.

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

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

Name	Description
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
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

ABB Standard Drives

Name	Application
ACS400	Standard drive
ACS600	Crane application
ACS600	Pump and fan application
ACS600	Standard application
ACS800	Crane application
ACS800	Pump and fan application
ACS800	Standard application
DCS400	Standard drive
DCS500	Standard drive

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
ACS1000	Standard drive
DCS600	System application

Appendix B Performance and Capacity

General

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

The total physical memory less the executing firmware is called “Memory size” by the function block “SystemDiagnostics”. This amount of memory is sometimes also called the “heap”.

The memory usage is also displayed in the dialog “Heap Utilization” which can be displayed for each controller. The available memory is called “Non-Used Heap” and the rest is called “Used Shared Heap”.

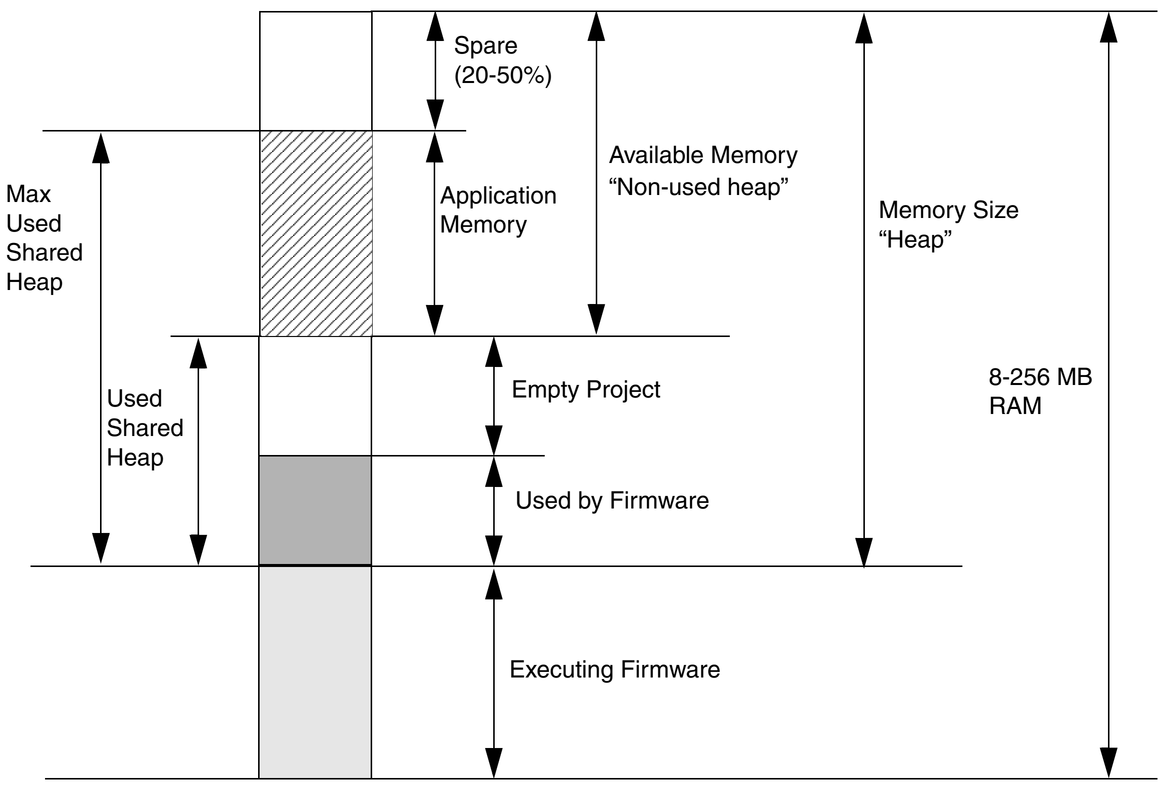


Figure 7. The memory organization

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 without IAC and 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 Controller AC 800M (without protocol handlers)

Controller	Execution Performance Factor	Total RAM (kbytes)	Firmware and an Empty Project (kbytes)	Available Memory (kbytes)
PM851	0.5	8192	5570	2622
PM856	0.5	8192	5570	2622
PM860	1.0	8192	5570	2622
PM861	1.0	16384	8520	7864
PM861A	1.0	16384	8520	7864
PM864	1.5	32768	8531	24237
PM864A	1.5	32768	8531	24237
PM866	2.1	65536	13864	51672
PM891	4.5	262144	61029	199650

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	90	6	90	6	82	6
COMLI	80	7	80	7	70	6
S3964R	75	13	75	13	67	5
SerialLib	66	18	66	18	56	10
CI854	243	27	242	27	162	13
CI855	105	10	103	10	98	4
CI856	108	9	108	9	102	3
CI857	198	11	197	11	189	4
CI858	71	25	71	25	62	15
CI865	145	76	145	76	145	75
CI867	185	50	185	50	158	21
CI868	160	61	160	61	104	5
CI869	158	60	158	60	104	7
CI871	194	17	195	17	124	11
CI872	222	67	223	67	166	11
CI873	209	108	-	-	-	-
IAC	179	n.a.	183	n.a.	171	n.a.

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

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

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

The PM864 processor unit, in single configuration, has performance data which theoretically peaks at twice the performance compared to the PM860. 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. 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.

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, see Figure 7. 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.

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 and execution time for function blocks and control modules

Object	First Object (kbytes)	Next Object (kbytes)	PM864 (μs)	PM866 (μs)	PM891 (μs)
Function Blocks					
ACStdDrive	82.5	18.0	584	404	228
AlarmCond	6.9	1.9	34	26	15
AlarmCondBasic	5.0	1.4	21	16	9
Bi	60.0	13.1	316	279	133
McuExtended	110.8	29.8	566	360	240
MotorBi	71.8	16.2	386	284	164
MotorUni	60.8	11.9	311	223	133

Table 11. AC 800M memory consumption and execution time for function blocks and control modules (Continued)

Object	First Object (kbytes)	Next Object (kbytes)	PM864 (µs)	PM866 (µs)	PM891 (µs)
PidCascadeLoop	67.7	12.7	490	330	147
PidCascadeLoop3P	71.6	12.9	481	351	141
PidLoop	55.6	6.2	269	189	88
PidLoop3P	59.6	6.3	298	214	96
PidSimpleReal	9.0	1.8	63	51	16
SDBool	22.9	5.7	115	97	48
SDInBool	23.8	5.8	85	66	35
SDInReal	42.9	14.4	262	187	92
SDLevel	23.3	5.7	77	55	35
SDOutBool	26.4	7.6	114	83	52
SDReal	38.8	13.2	224	159	82
SDValve	28.5	6.6	159	138	60
SignalBasicBool	4.3	0.7	8	6	3
SignalBasicInBool	4.2	0.8	9	6	4
SignalBasicInReal	10.0	1.5	62	43	18
SignalBasicOutBool	4.2	0.8	8	6	4
SignalBasicOutReal	6.1	1.1	15	11	5
SignalBasicReal	3.9	0.9	17	12	5
SignalInBool	23.3	4.4	64	47	28
SignalInReal	59.2	12.1	166	121	65
SignalOutBool	22.7	4.2	43	32	18
SignalOutReal	53.1	10.9	107	76	39
SignalSimpleInReal	22.4	3.7	64	47	24

Table 11. AC 800M memory consumption and execution time for function blocks and control modules (Continued)

Object	First Object (kbytes)	Next Object (kbytes)	PM864 (μs)	PM866 (μs)	PM891 (μs)
SignalSimpleOutReal	16.4	3.3	29	24	14
StatusRead	10.8	3.5	37	27	13
Uni	52.4	9.5	196	155	82
ValveUni	50.9	8.8	188	134	83

Table 11. AC 800M memory consumption and execution time for function blocks and control modules (Continued)

Object	First Object (kbytes)	Next Object (kbytes)	PM864 (μs)	PM866 (μs)	PM891 (μs)
Control Modules					
ACStdDriveM	87.6	18.4	582	451	229
AlarmCondBasicM	5.9	1.2	36	26	17
AlarmCondM	5.5	1.4	24	17	11
AnalogInCC	21.3	4.0	119	89	47
AnalogOutCC	19.1	4.1	91	65	34
BiM	64.9	13.9	419	253	149
CascadeLoop	214.6	64.3	-	-	-
Detector2Real	81.1	14.6	373	290	155
DetectorBool	35.5	6.7	159	114	69
FeedForwardLoop	208.1	50.7	-	-	-
Level2CC	21.7	5.5	125	75	46
Level4CC	29.8	7.7	153	109	72
Level6CC	38.1	10.0	206	153	94
McuExtendedM	114.5	30.4	509	420	239
MidRangeLoop	208.0	51.2	-	-	-
MotorBiM	73.3	16.0	400	289	169
MotorUniM	63.8	12.0	309	227	136
OverrideLoop	283.3	118.8	-	-	-
PidAdvancedCC	206.4	26.7	833	602	280
PidCC	94.5	15.7	483	349	168
PidSimpleCC	12.4	2.7	102	71	33
SignalInBoolM	26.1	4.6	59	47	25

Table 11. AC 800M memory consumption and execution time for function blocks and control modules (Continued)

Object	First Object (kbytes)	Next Object (kbytes)	PM864 (μs)	PM866 (μs)	PM891 (μs)
SignalInRealM	67.2	12.0	248	201	103
SignalOutBoolM	26.0	5.0	76	55	33
SignalOutRealM	61.9	11.8	231	155	88
SingleLoop	184.8	37.7	-	-	-
ThreePosCC	20.6	4.5	153	110	51
UniM	55.1	10.2	208	152	90
ValveUniM	53.6	9.6	251	158	104

Table 12. Execution time for a number of standard operations and function calls

Operation/Function	Data Type	PM864 (ns)	PM866 (ns)	PM891 (ns)
a:= b or c	bool	156	105	9
a:= b and c	bool	155	106	9
a:= b xor c	bool	150	142	9
a := b	string	7237	4671	507
a := b + c	string	4041	2921	328
a := b + c	string[10]	2455	1790	204
a := b + c	string[140]	9924	7243	773
a := b + c	dint	148	109	10
a := b + c	real	1210	869	12
a := b - c	dint	148	107	10
a := b - c	real	1308	927	13

Table 12. Execution time for a number of standard operations and function calls

Operation/Function	Data Type	PM864 (ns)	PM866 (ns)	PM891 (ns)
a := b * c	dint	152	108	9
a := b * c	real	1199	854	11
a := b / c	dint	319	236	65
a := b / c	real	3426	2481	58
a:= b <> c	dint	172	128	13
a:= b <> c	real	1016	735	18
a := real_to_dint(b)	dint	7203	5161	116
a := dint_to_real(b)	real	1252	902	63
a := real_to_time(b)	time	18355	12977	953
a := time_to_real(b)	real	5493	3915	210

Hardware and I/O

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 start to seriously influence CPU load.

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 CI854 PROFIBUS adapter.

In AC 800M, Modulebus scanning has the highest priority. The cyclic load presented for IEC 61131-3 applications includes extra load caused by Modulebus interrupts.

Calculation of Scan Time on the Modulebus and CPU Load

The following definitions are used in the calculations:

1. Amount of module:

- n_1 = amount of drives and DP, DI, DO, AI and AO modules (except AI880, DI880 and DO880)

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

- n_2 = amount of AI880, DI880 and DO880 modules

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)

3. Load caused by n_2 module types:

   L = 8[1][2]% (PA controller)

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 non-High Integrity I/O modules.

Calculation of the Modulebus CPU Load

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

$Load_{(fastest)} = (n_1 / (n_1 + n_2) * 20$[1][2] $+ (n_2 / (n_1 + n_2) * L)$

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

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

The formulas are valid for all AC 800M processor unit types.

Example Scan Time and CPU Load

Assume that following units are used:

1 AI810: 0.5*1 = 0.5 ms
1 redundant DO880: 1.3*2= 2.4 ms
1 redundant DP840: 0.5*9 = 4.5 ms

1. For PM866, the values will be approximately half, that is, L = 4% and replace 20 with 10 in the $Load_{(fastest)}$ formula.
2. For PM891, the values will be approximately one third, that is, L = 3% and replace 20 with 7 in the $Load_{(fastest)}$ formula.

This gives a scan cycle time of 8 ms (resolution = 1 ms).

CPU Load for a PA Controller will be: $(10/12)*20^{(1)(2)} + (2/12)*8^{(1)(2)} = 18\%$

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 AI880 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 13. 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

Table 13. Scan cycles for ABB Engineered Drives DDS Pair 3 (Continued)

Scan Cycle	DDS Pair 3
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)

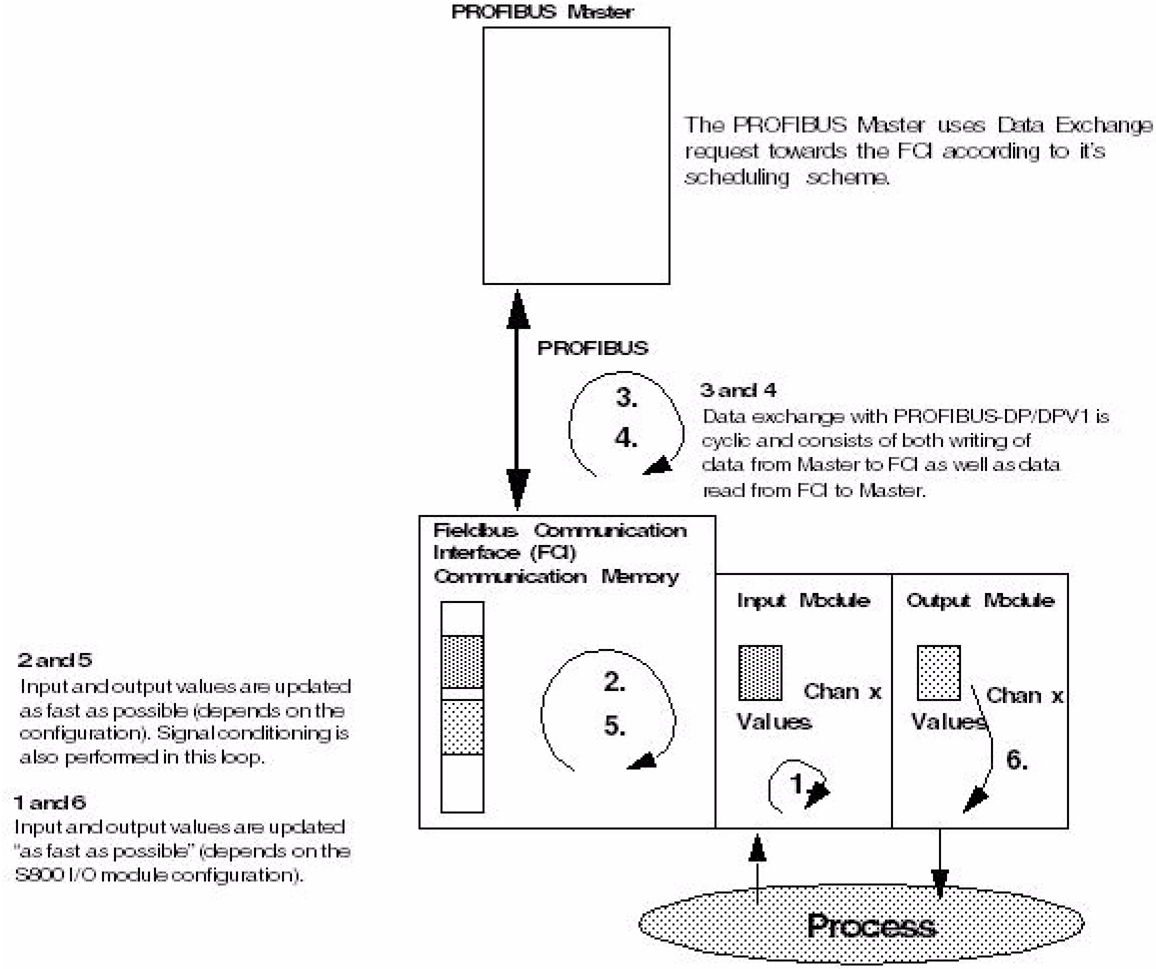
For ABB Standard Drives, all data sets (DDS 1/2 and DDS 3/4) are scanned in each scan cycle. It takes 2 * 0.5 = 1.0 ms to scan a single Standard Drive.

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 CI854

The transportation of dynamic data between PROFIBUS-DP/DPV1 master and the S800 I/O modules, see figure.



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.

At en 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 14 below.
- `ChannelLoad` = the additional load for each I/O channel used on the board, see Table 14 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 14. 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 AC800M (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 15. Response times each Dataset

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

PROFIBUS DP Limitations and Performance

For PROFIBUS DP there are some limitations and performance to take into consideration.

Limitations

- CI854 can only act as master.
- The network can have a maximum of 126 nodes. A maximum of 124 slaves can be connected to a CI854 since the node addresses 0 and 1 are reserved for CI854.
- S800 I/O connected to CI840 and/or S900 I/O connected to CI920 supports cable redundancy together with slave redundancy.
- If the PROFIBUS master unit, CI854, 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, CI854, and the complete PROFIBUS is done if one of the following bus parameter settings are changed: Node address of CI854, baud rate or highest station address (HSA). A change of the other bus parameters does not affect the running communication.
- If the CI854 is running with 12 Mbit/s, then in total 4000 bytes input and output data for the cyclic communication are allowed to be configured. For lower Baudrate than 12 Mbit/s there is no limitation.

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

Performance

The cycle time on PROFIBUS depends on the baud rate, the summary of I/O data and the slave timing parameter. The fastest cycle time is about 1 ms with a baud rate of 12 Mbit/s and only one slave device. The typical cycle time is about 10-20 ms with 1,5 Mbit/s and some slave devices.

CI854 slave devices can have node addresses in the range 2-125 (the node addresses 0 and 1 are reserved for the CI854). The baud rate can be configured to be in the range of 9,6 kbit/s - 12 Mbit/s. There is a maximum length of I/O data at 4000 bytes of input and output data in total when using 12 Mbit/s. For slower baud rate, up to 1,5 Mbit/s, there is no limitation of the length of the I/O data.

PROFINET IO Limitations and Performance

The following limitations apply for PROFINET IO configurations with CI871 in AC 800M.

- Up to 12 CI871 per AC 800M controller.
- Up to 126 PROFINET IO devices per CI871.
- Up to 512 modules per device.
- One IOCR for each direction (Input and Output) per device,
  each IOCR up to 1440 bytes of I/O data.
- Update time down to 1 ms (only if CI871 has only one device configured).
- For CPU-load calculation of CI871, the Ethernet frames for inputs and outputs need to be calculated. CI871 can handle as a maximum one frame per ms in each direction.
  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.

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.

Services Provided

AC 800M with the communication interface CI868 is modeled as an IED receiving data from other IED's to the 1131 variables and sending data from its own 1131 variables to other IED's as per the IEC 61850 data modeling. This is achieved using the IEC 61850 hardware library.

According to the IEC 61850 Data model the following can be said:

- An IED is a host for one or more Servers or access points (AC 800M).
- A Server or access point has one or many Logical Devices (CI868).
- A Logical Device has one or many Logical Nodes.
- A Logical Node has one or many Data Objects.

IEC 61850 Performance

Table 16. Performance and Capacity of IEC 61850 solution using CI868

Limitations	Max Limit	Comments
Max Access Points per Controller	4	One access point per CI868 non-redundant units
Max Connected IEDs to one access point	80	
Max Datasets (Receive and Send) in one Access Point	max GOOSE datasets Receive: 150 Send: 60	Can be split across multiple LDs
Max Data Attributes per DataSet	150	

Table 16. Performance and Capacity of IEC 61850 solution using CI868 (Continued)

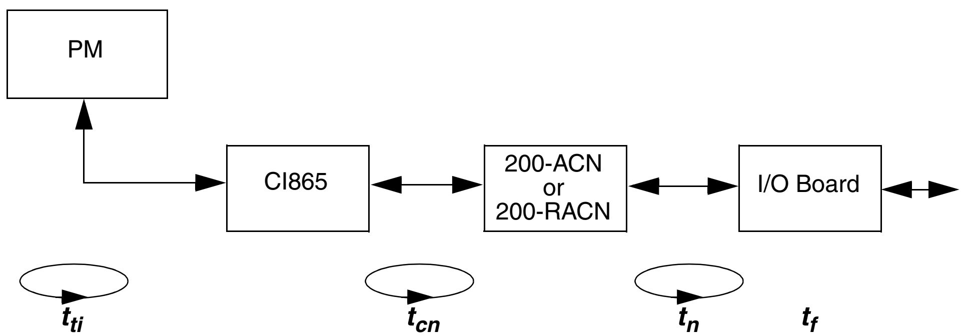
Limitations	Max Limit	Comments
Max Send Data attributes under all LNs in one Access point	5500	
Max LD's per access point	10	
Max LN's per access point	253	
Max CDC groups per CI868	254	Max. number of Data Attributes supported in a receiving CI868 will be 254 * 5 = 1270.

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.



I/O Copy Time = $t_{ti} + t_{cn} + t_n + t_f$

Figure 8. 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 $\approx$ 3.6ms

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 $\approx$ 2.4ms

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 $\approx$ 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 $\approx$ 8.4ms

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 ≈ 4.0ms

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

Filter Time

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

EtherNet/IP and DeviceNet

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

- A maximum of four non-redundant CI873 can be connected to each AC 800M controller.
- CI873 can act only as a scanner.
- A maximum of fourLD 800DN linking devices can be connected under one CI873.
- Up to 63 slaves can be connected to each LD 800DN and the data length for each LD 800DN shall not exceed 497 bytes.
- The performance of CI873 depends on the RPI setting. The command execution time for DeviceNet is 50ms when the RPI is set at 10 ms.
- The maximum number of IO modules supported per Modular Adaptor device is 10.
- The maximum number of configuration parameters supported per device is 100.

Communication

MMS Communication

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

MMS communication takes place serially and asynchronously, according to the client/server (or master/slave) principle. The *client channel* of a system initiates the message transmission sequence, while a system acting as a server simply responds to the calls from the client via a *server channel*.

The following table gives the performance of MMS communication in terms of transactions per second for *MMSWrite* or *MMSRead* commands.

Note that MMS communication includes both data communication between controllers, and OPC Server and controllers.

Table 17. Performance of the MMS client/server system

AC 800M 50% load	Max. Transmission Rate [transactions/second]		
	300 Booleans in each transaction		
As MMS Client	PM864A	PM866	PM891
Write	45.2	29.5	234
Read	31.6	40.0	102
As MMS Server	PM864A	PM866	PM891
Write	50.6	74.7	171
Read	126.4	163.8	169

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

The values presented here were obtained under optimized conditions, and in only one direction at a time. Several function blocks have been triggered in parallel at a short interval time (10 ms) to obtain the maximum transmission rate. It is important to consider this when using these values for your communication design. The application internal communication load can be monitored from Control Builder M.

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).

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.

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 we 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.

MMS Connections Cannot Block Each Other

The controller can handle a number of concurrent MMS connections. All MMS 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 MMS 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 20 or less connections the performance decrease per additional connection is however small. With more than 20 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.

Inter Application Communication (IAC) - External Communication

The communication performance with IAC for external communication (communication between controllers) is affected by *bandwidth, message length* and *cyclic load*.

With IAC, which uses communication variables (CVs), the communication is based on the client/server principle. 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.

Table 18 provides the performance data for IAC when the controller functions as client or server in external communication.

The CVs used in this performance test belong to the *VeryFast* category, with an interval time of 100ms. The values presented here were obtained under optimized conditions, and in only one direction at a time.

Table 18. Performance of the IAC client/server in external communication

AC 800M 50% load	300 Booleans in each structured CV		
As IAC Client	PM864A	PM866	PM891
Max. no. of structured CVs	28	34	36
Max. Read transactions/sec.	60	80	89
Max. Read Booleans/sec.	84000	102000	108000
As IAC Server	PM864A	PM866	PM891
Max. no. of structured CVs	25	36	44
Max. Read transactions/sec.	62	90	104
Max. Read Booleans/sec.	75000	108000	132000

Data Transfer Capacity on Control Network

Figure 9 shows an overview of the communication performance, which is either limited by the CPU application load or limited by the network bandwidth:

- above around 1Mbit on the Control Network, the data throughput is mainly limited by how loaded the CPU is. The time to send the data bits on the cable is more or less insignificant.
- below around 1 Mbit on the Control Network, is the time to send the data bits over the network cable that dominates.

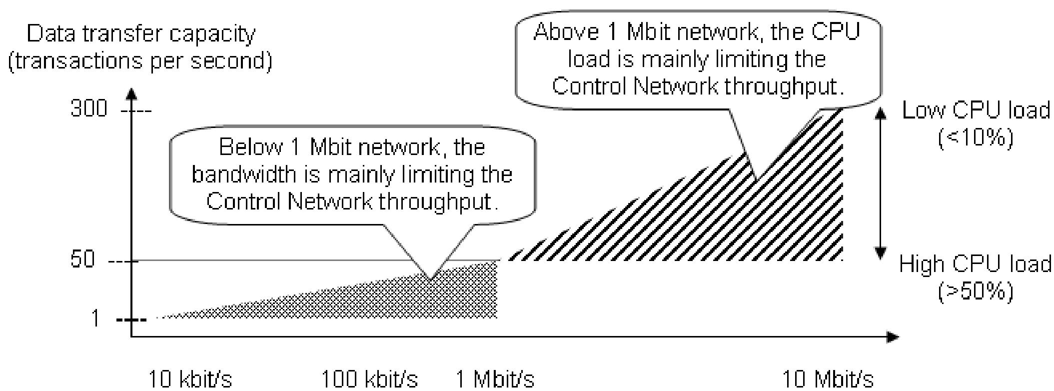


Figure 9. Data transfer capacity on Control Network

Data Transfer Capacity on Control Network >1 Mbit/s

The Control Network throughput with 1 - 10Mbit network is defined by "Transactions per second". The CPU load is mainly limiting the throughput:

- With a 10 Mbit/s Control Network and a PM864A controller with 50% application load is the throughput estimated to about 50 read/write transactions per second (see Table 17 on page 109).
- With a 10 Mbit/s Control Network and a PM864A controller with less than 5% application load is the throughput estimated to about 300 read/write transactions per second.
- With a 1 Mbit network and a PM864A controller with 50% application load is the throughput estimated to about 50 read/write transactions per second (see Table 17 on page 109).

Table 19 shows an overview of how many variables of different data types can be transferred per transaction.

Table 19. Number of data variables/transaction for different types

Data Type	Number of Variables/Transaction
Boolean	190-475
dint, real, word	190-250
Uint, word	190-475

Figure 9 and Table 19 can be used to calculate the maximum number of data variables, that can be subscribed to by a client from an AC 800M controller.

An example:
If a customer specifies “control notification to system” to be < 1 second, then the update rate from an AC 800M controller to the AC 800M OPC server is recommended to be 50% of the “control notification to system” time, which mean 500ms.

Figure 9 and Table 19 shows that the maximum number of data variables (with 500ms update rate) via a 10 Mbit/s Control Network and a PM864A controller with 50% application load, is estimated to be:

25 * 475 Bool = 11 875 Bool or 25 * 250 dint = 6250 dint or 25 * 250 real = 6250 real or a mixed combination.

It is important to understand that only data used by an OPC client are subscribed for the client and transferred from the AC 800M controller.

The network bandwidth is normally also used for other activities such as the transfer of alarm/events, peer-to-peer communication or downloading application/s to the controller. These activities will also reduce the update rate of AC 800M data items to the AC 800M OPC.

Data Transfer Capacity on Control Network <1 Mbit/s

The Control Network throughput with a < 1 Mbit/s Control Network is mainly limited by the network bandwidth.

A formula is developed to calculate the required bandwidth depending on:

- number and data types of transferred variables
- requested AC 800M OPC update rate

The following chapters are showing the required bandwidth for 500ms and 10 seconds OPC update rate for different data types in the range of 100-10.000 variables.

AC 800M OPC Update Rate

The OPC Server for AC 800M is used for accessing run-time data and/or alarms and events from controllers and making the data available for clients, for example Process Portal.

The OPC Server should always have its update rate set twice as fast as the OPC client(s) requested update rate.

The update rate controls how often the OPC Data Access Server updates its internal cache with data from a certain controller.

Clock Synchronization on Control Network with Reduced Bandwidth

The accuracy of the clock synchronization of nodes on Control Network by CNCP or SNTP is depending on the speed on Control Network.

The clock synchronization has normally accuracy down to 1ms with 10Mbit/s Control Network.

If the speed on Control Network is reduced to e.g. 9.6 kbit/s, the accuracy will be about 100ms.

Modbus RTU Master Communication

AC 800M **50% load in the controller** **300 Booleans in each telegram**	**Max Transmission Rate (total transactions/second)**			
	PM864 / PM866 / PM891			
	MBWrite		**MBRead**	
	1 channel	4 channels	1 channel	4 channels
1200 baud (8 data bits, 1 stop bit, odd parity)	1.1	2.2	1.0	4.0
19200 baud (8 data bits, 1 stop bit, odd parity)	6.1	21.3	6.1	21.1

MODBUS TCP

Table 20. 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 21. 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 22. 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 23. 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
8 task time=50 ms	50		20
8 task time=50 ms	100		20

Table 24. 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

Table 24. MODBUS TCP Performance. Data. Reading Boolean using one CI867 as Slave (Continued)

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

Control Network Clock Synchronization

Table 25. 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
CNCP (AC 800M to AC 800C/Advant Controller 250)	200 ms
CNCP (AC 800M to PPA)	200 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 26. 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 27. 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 Intel® 2 Duo CPU, 3.16GHz 3.39GHz processor and 4Gbyte RAM.

Table 28. OPC Read Performance

Limitation type	Value
Maximum number of subscribed variables in total	300 000
Maximum number of successfully subscribed items at 1000 ms update rate	70 000
Maximum number of MMS transactions/second in total	161
Maximum OPC Servers for one controller	3
Maximum OPC Clients for one OPC Server[1]	5

1 Five clients containing five groups each, subscribing for items evenly distributed over the different clients and groups.

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 29. 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 PM864 controller when the OPC server already subscribes to 0, 50 000 and 100 000 variables from that controller.

Table 30. OPC Write Performance

Number of Subscribed Items at 1000 ms requested update rate	Simultaneous Write of 1000 Items
0	6 ms
50 000	10 ms
100 000	13 ms

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