Automation & Control

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ABSTRACT

The demands made on the surface quality and thickness of steel strip have increased in recent years. At the same time, operators have had to concentrate on maintaining high annual production rates. To balance these needs, plants have to be equipped with advanced electrical systems featuring dedicated control functions.

This is a study made on the general automation and control system generally used in major Steel Industries of the world. This study deals only with the products and services provided by ABB Ltd.This Study includes the general description on Automation & Control System of Steel Industry, Drives, AC800 Power Electronics Controller, Communication Protocols & Case Study on Coil Car Pushing.

When procuring electrical equipment for a plant, consideration needs to be given not only to the first-time cost of the equipment but also to the total cost over its lifetime. This has to take into account factors such as efficiency, energy consumption, spare parts and maintenance. The industry's preference in the past for adjustable speed DC drives, which easily achieve a good torque and speed response, is giving way to a trend towards AC drives. This has come about as a result of modern electronic converters offering the same speed accuracy and fast torque response,

but with the added plus that the AC motors allow a major cost saving due to their simpler construction and high reliability, even in harsh environments, and easier maintenance.

It is not possible to define a unique control strategy for a continuous processing line that will take account of all the different drive combinations in the various line configurations; this is particularly true in the case of the process section. Nevertheless, it can be done for some of the motor drives.

This arrangement, known as indirect tension control, ensures that the required strip speed and tension are maintained. Inother words, a bridle not assigned the function of a speed master acts as an indirecttension-controlled drive.

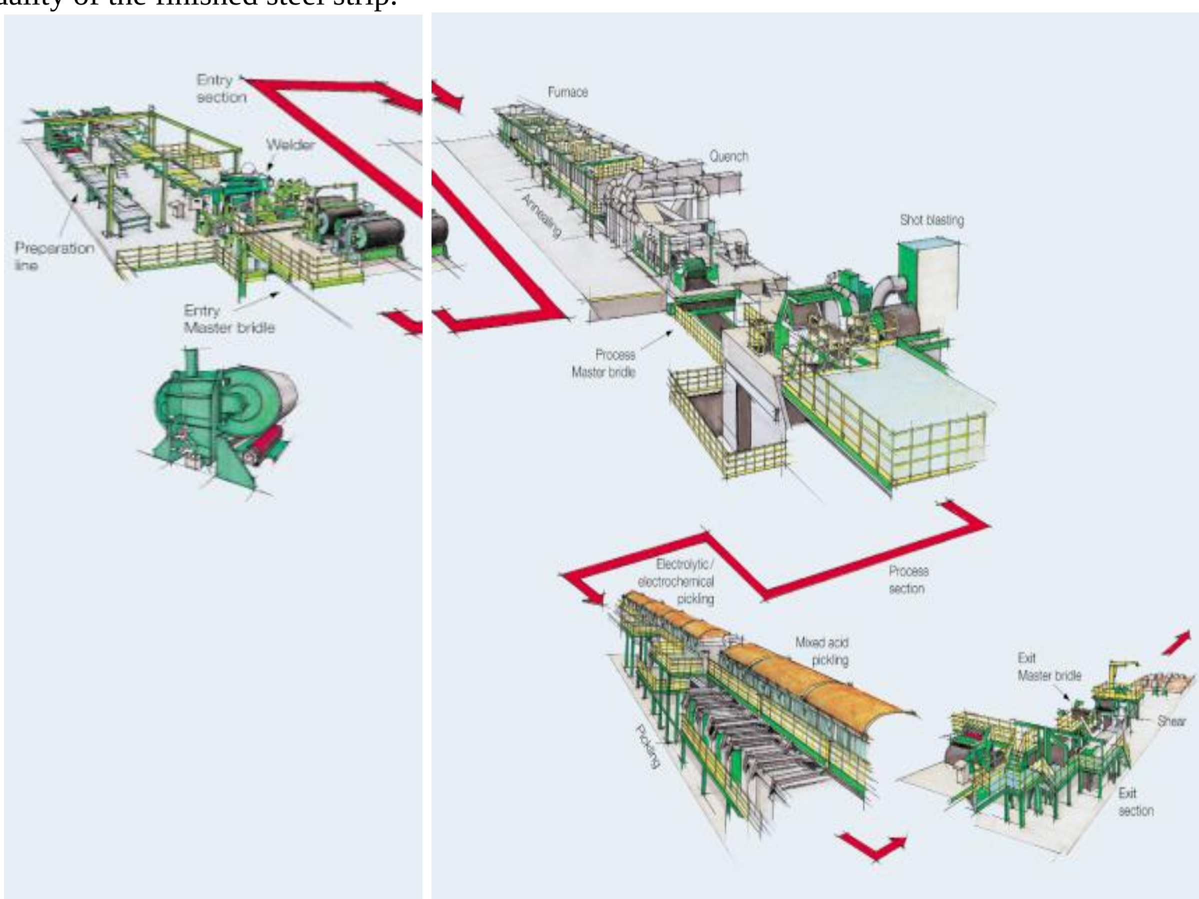
I could successfully understand the whole system of automation and control in a metal industry. I understood the products and services provided by ABB Ltd and I was even fortunate to learn the manufacturing, assembly & testing procedures of those products.

INTRODUCTION

The demands made on the surface quality and thickness of steel strip have increased in recent years. At the same time,operators have had to concentrate on maintaining high annual production rates.To balance these needs, plants have to be equipped with advanced electrical systems featuring dedicated control functions.

This is a study made on the general automation and control system generally used in major Steel Industries of the world, amongst them is ABB Ltd.

New developments in AC drive technology, including Direct Torque Control,are at the heart of advanced electrical systems developed by ABB for stainless steel treatment lines. Among the system features are operator stations for automated plant control and efficient management of the production data. Powerful software functions not only enable steel producers to control the quantity of produced material more precisely but also provide valuable information about the quality of the finished steel strip.



ENTRY TO EXIT AUTOMATION WITH ADVANCED ELECTRICAL SYSTEM IN COLD ROLLING AREA

Adjustable-speed AC drives featuring advanced DTC technology and flexible control systems are destined to make a significant contribution to process line developments in the metallurgical industry Steel producers benefit from the use of such powerful tools not only by being able to control more precisely the quantity of produced material but also due to the important information they provide about the quality of the finished strip.
This study features intodućion to automation, Standard Drive(ACS800), System Drive(ACS800), Motion Control Drive(ACS M1),Power Electronics Controller(AC800 PEC), Communication Protocols, Compact Control Builder and a Case Study on Coil Car Control.

INTRODUCTION TO METAL INDUSTRY

What is Metal ?

Greek ***Metallon***, a word of unknown origin, has a range of meanings, including 'mine' (the original sense) and 'mineral' as well as 'metal.' These were carried over into Latin ***Metallum***, but by the time the word reached English, via Old French metal, 'metal' was all that was left.
Mettle is a variant spelling of metal, used to distinguish its metaphorical senses. Closely related to **medal**, which etymologically means 'something made of metal.'

Metal : a substance that is usually shiny, a good conductor of heat and electricity, and can be made into wire, or hammered into sheets. Gold, silver, iron, copper, lead, tin or aluminum are metals" . All metals can be classified as either **Ferrous** or **Nonferrous.**

How metals are manufactured ?

Industries in the Primary Metal Manufacturing subsector smelt and/or refine ferrous and nonferrous metals from ore,or scrap, using electrometallurgical and other process metallurgical techniques. Establishments in this subsector also manufacture metal alloys and superalloys by introducing other chemical elements to pure metals. The output of smelting and refining, usually in ingot form, is used in rolling, drawing, and extruding operations to make sheet, strip, bar, rod, or wire, and in molten form to make castings and other basic metal products.

Non-Ferrous Metals

These are metals which do not contain any iron. They are not magnetic and are usually more resistant to corrosion than ferrous metals.
Example **aluminium, copper, lead. zinc and tin.**

Ferrous Metals

These are metals which contain **iron**. They may have small amounts of other metals or other elements added, to give the required properties.

Rolling Mill

Rolling: A process of working on metals to flatten or spread ,by passing them through rotating rolls.
Mill: A machine for grinding or crushing
Rolling Mill: Machine where metal is rolled in to sheets and bars.

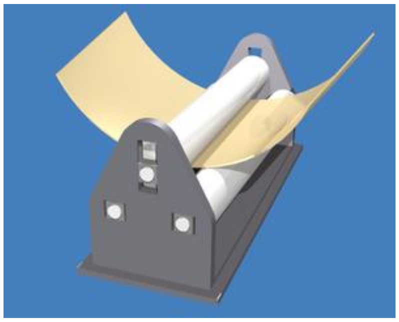
Rolling Mills…..Classification

ROLLING MILL

- FLAT MILL
  - HOT ROLLING
    - ROUGHING MILL
    - FINISHING MILL
    - DOWNCOILER
  - COLD ROLLING
    - 20Hi MILL
    - 6Hi MILL
    - 4Hi MILL
    - 2Hi MILL

- PROFILE MILL
  - HOT ROLLING
  - COLD ROLLING

Rolling is a fabricating process in which the metal, plastic, paper, glass, etc. is passed through a pair (or pairs) of rolls. There are two types of rolling process, flat and profile rolling. In **flat rolling** the final shape of the product is either classed as sheet (typically thickness less than 3 mm, also called "strip") or plate (typically thickness more than 3 mm). **In profile rolling** the final product may be a round rod or other shaped bar, such as a structural section (beam, channel, joist etc). Rolling is also classified according to the temperature of the metal rolled. If the temperature of the metal is above its **recrystallization** temperature, then the process is termed as **hot rolling**. If the temperature of the metal is below its recrystallization temperature, the process is termed as **cold rolling**. Another process also termed as 'hot bending' is induction bending, whereby the section is heated in small sections and dragged into a required radius.



Profile rolling for a cone

Heavy plates tend to be formed using a press process, which is termed forming, rather than rolling.

The process involved in a steel plant are mining of ore, steel making, slab casting, reheating, hot rolling, cold rolling, strip processing, saleable product.

HOT ROLLING

Hot rolling is a hot working metalworking process where large pieces of metal, such as slabs or billets, are heated above their recrystallization temperature and then deformed between rollers to form thinner cross sections. Hot rolling produces thinner cross sections than cold rolling processes with the same number of stages. Hot rolling, due to recrystallization, will reduce the average grain size of a metal while maintaining an equiaxed microstructure where as cold rolling will produce a hardened microstructure.

Hot Rolling Process

A slab or billet is passed or deformed between a set of work rolls and the temperature of the metal is generally above its recrystallization temperature, as opposed to cold rolling, which takes place below this temperature. Hot rolling permits large deformations of the metal to be achieved with a low number of rolling cycles. As the rolling process breaks up the grains, they recrystallize maintaining an equiaxed structure and preventing the metal from hardening. Hot rolled material typically does not require annealing and the high temperature will prevent residual stress from accumulating in the material resulting better dimensional stability than cold worked materials.

Hot rolling is primarily concerned with manipulating material shape and geometry rather than mechanical properties. This is achieved by heating a component or material to its upper critical temperature and then applying controlled load which forms the material to a desired specification or size.

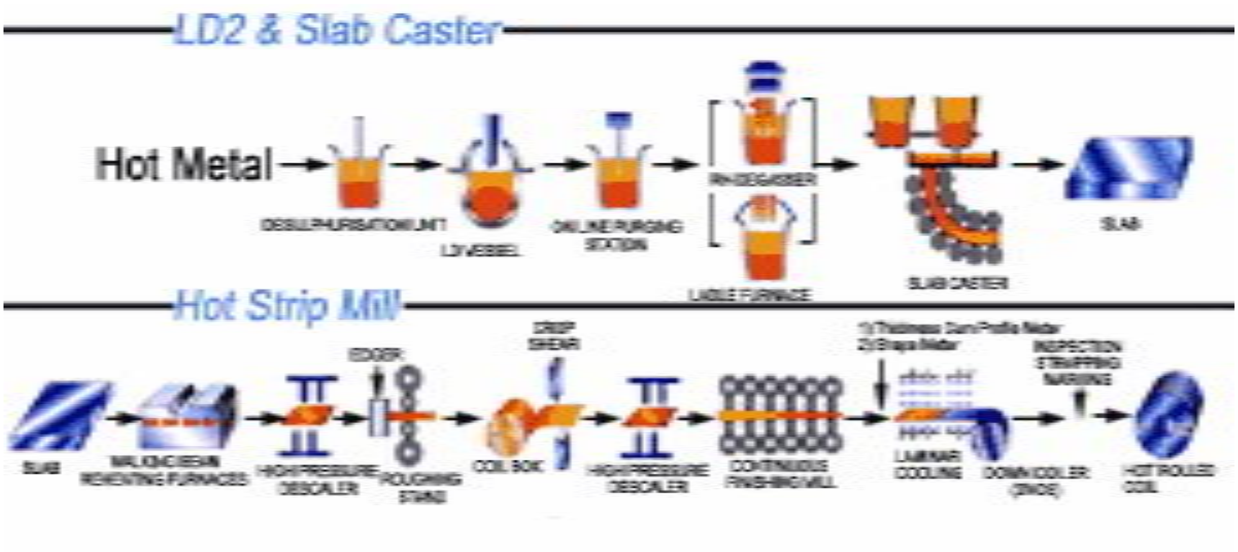
Hot Rolling Applications

Hot rolling is used mainly to produce sheet metal or simple cross sections such as rail road bars from billets.

Mechanical properties of the material in its final 'as-rolled' form are a function of:

- material chemistry,
- reheat temperature,
- rate of temperature decrease during deformation,

- rate of deformation,
- heat of deformation,
- total reduction,
- recovery time,
- recrystallisation time, and
- subsequent rate of cooling after deformation.



Types of hot rolling mill

Prior to continuous casting technology, ingots were rolled to approximately 200 millimetres (7.9 in) thick in a slab or bloom mill. Blooms have a nominal square cross section, whereas slabs are rectangular in cross section.Slabs are the feed material for hot strip mills or plate mills and blooms are rolled to billets in a billet mill or large sections in a structural mill.

The output from a strip mill is coiled and, subsequently, used as the feed for a cold rolling mill or used directly by fabricators. Billets, for re-rolling, are subsequently rolled in either a merchant, bar or rod mill.

Merchant or bar mills produce a variety of shaped products such as angles, channels, beams, rounds (long or coiled) and hexagons. Rounds less than 16 millimetres (0.63 in) in diameter are more efficiently rolled from billet in a rod mill.

COLD ROLLING

Cold rolling is a metalworking process in which metal is deformed by passing it through rollers at a temperature below its recrystallization temperature. Cold rolling increases the yield strength and hardness of a metal by introducing defects into the metal's crystal structure. These defects prevent further slip and can reduce the grain size of the metal, resulting in Hall-Petch hardening.

Cold rolling is most often used to decrease the thickness of plate and sheet metal.

HISTORY

Dates back to 1859. Initially cold rolling developed in the area of profile mills.
Later with the development of wider mills,cold flat rolling developed to what it is to-day.
Purpose of cold rolling was more to achieve mechanical properties than required end thickness.
To-day's cold rolling produces tailor made products to suit individual end product requirement.

Physical metallurgy of cold rolling

Cold rolling is a method of cold working a metal. When a metal is cold worked, microscopic defects are nucleated throughout the deformed area. These defects can be either point defects (a vacancy on the crystal lattice) or a line defect (an extra half plane of atoms jammed in a crystal). As defects accumulate through deformation, it becomes increasingly more difficult for slip, or the movement of defects, to occur. This results in a hardening of the metal.

If enough grains split apart, a grain may split into two or more grains in order to minimize the strain energy of the system. When large grains split into smaller grains, the alloy hardens as a result of the Hall-Petch relationship. If cold work is continued, the hardened metal may fracture.

During cold rolling, metal absorbs a great deal of energy. Some of this energy is used to nucleate and move defects (and subsequently deform the metal). The remainder of the energy is released as heat.

While cold rolling increases the hardness and strength of a metal, it also results in a large decrease in ductility. Thus metals strengthened by cold rolling are more sensitive to the presence of cracks and are prone to brittle fracture.

A metal that has been hardened by cold rolling can be softened by annealing. Annealing will relieve stresses, allow grain growth, and restore the original properties of the alloy. Ductility is also restored by annealing. Thus, after annealing, the metal may be further cold rolled without fracturing.

Degree of cold work

Cold rolled metal is given a rating based on the degree it was cold worked. "Skin-rolled" metal undergoes the least rolling, being compressed only 0.5-1% to harden the surface of the metal and make it more easily workable for later processes. Higher ratings are "quarter hard," "half hard" and "full hard"; in the last of these, the thickness of the metal is reduced by 50%.

Cold rolling is a common manufacturing process. It is often used to form sheet metal. Beverage cans are closed by rolling, and steel food cans are strengthened by rolling ribs into their sides. Rolling mills are commonly used to precisely reduce the thickness of strip and sheet metals.

Types Of Cold Rolling Mill

- Reversible Mill
  - 20Hi
  - 6Hi
  - 4Hi
  - 2Hi
- Non-reversible Mill
  - Tandem Mill
  - Skin Pass Mill

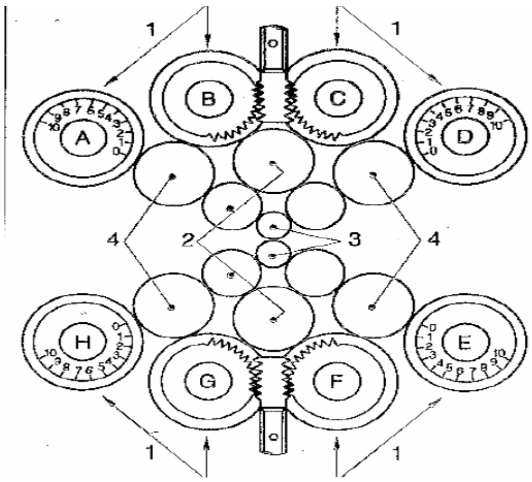
COMPONENTS

Pay-off Reel
The incoming coil which is the raw-material to be processed is loaded.This is a rotating mandrel which may be electrically or hydraulically driven.
Tension Reels
Where the strip after reduction in each pass is wound.Tension reels are electrically driven from Drives and maintain a constant tension in the strip for proper winding.
Mill Stand
Contains set of rotating rolls where reduction takes place.These rolls are rotated at constant speed and hydraulic pressure to get the desired thickness.

- **Consists of a hydraulic mandrel with segmented construction.**
- **After coil loading,mandrel is expanded to hold the coil tight.**
- **Is driven by electric motors, either AC or DC.**
- **Is required to provide a constant preset tension throughout the coil.**

Screwdown (Hydraulic or Electric)
To impart the necessary pressure on the rolls which work on the strip.

Backup rolls
Screws are in contact with these rolls.
Intermediate rolls (only for 6hi & 20hi)



For better shape correction
Work Rolls
Set of rotating rolls which are in contact with the strip.

ADVANTAGES OF COLD ROLLING

- Hot rolling cannot reduce thickness to less than 1.5mm as thin strips loses its heat while hot rolling.
- There is no scale formation in case of cold rolling,which results in loss of metal as scale.
- Hot rolling results in decarburization as strip is heated and rolled at high temperatures.This deteriorates the surface qualities of the strip.
- Cold rolling and subsequent annealing develops superior grain structure.
- Cold rolling improves permeability,is good for transformer steels.

PROCESSING LINE

Hot rolled coils needs to be surface cleaned before they can be taken for cold rolling. Cold Rolled metal will not have the necessary chemical and surface properties desired for various end products for which they will be used. Processing lines is the generic name for a machine which runs the rolled metal through a process which imparts the necessary surface or chemical qualities. Depending on the type of process,a processing line may be positioned ahead or after cold rolling.
Main processes are:

- Annealing
- Pickling
- Galvanizing
- Tinning
- Electrolytic cleaning
- Tension levelling cum inspection lines
- Cut to length/ Slitting lines
- Some times annealing is carried out as a separate process through Batch Annealing Furnaces.

Challenges In Rolling Mill

- Controlling 40 tons of rolls to a positioning accuracy of 1 µm with a roll force of up to 30 MN in a roll gap of a rolling mill
- Controlling strip thickness of 2 x 6 µm with an accuracy of ≤ ± 0,5 µm with about 15

close tight integrated control loops with a scan time between 2 and 20 msec
- Controlling the tension in a Cold Rolling Mill (CRM) or Processing Line (PCL) to a static accuracy of ± 1 % and dynamic to ± 2 %
- Coordination of 6 (CRM) to 200 (PCL) drives in a speed range of 400 ... 2000 m/min with acceleration of 100 ... 400 m/min/sec

OVERVIEW OF AUTOMATION & CONTROL SYSTEMS

One of the most important parts of an integrated steelworks is the cold rolling area, where the oils from the hot rolling mill are processed into steel strip.This area can be divided into two main sections :

• Cold rolling mills for reducing the strip thickness

• Plants for the treatment of the structure/surface of the material and for changing the strip dimensions (*Table 1*)

The electrical equipment installed for the strip treatment plant has a large influence on the quality of the finished products. For example, the line control system has to ensure very precise movement of the strip.A standstill in the process section or uncontrolled strip tension can easily cause irreversible damage to the material or loss of production.

Table 1
Plants determining the structure and surface of the material

Surface improvement	Surface treatment/ structural change	Strip dimensions
• Electrolytic tin/chrome lines • Electrolytic cleaning lines • Galvanizing and aluminizing lines • Coating lines Degreasing	• Pickling lines • Continuous annealing • Combined annealing • Electrolytic strip	• Slitting lines • Shearing lines • Recoiling lines

Main processing lines

Strip processing lines alter the characteristics,appearance and/or dimensions of flat-rolled products. Typical examples are the galvanizing line, which coats the steel with a layer of corrosion-resistant zinc, the colour coating line, which applies a layer of paint, and the slitting line, which cuts wide coils into narrow strips. Except for those lines with a shearing section at the exit end, most coil processing lines can be described as continuous coil-to-coil operations. This means that coils of metal are brought to the line entry, uncoiled, fed continuously throughout the treatment process, and recoiled at the exit.

Continuous operating lines

To ensure that the quality goals are achieved, the process sections have to operate at constant speed and the process has to be supervised from beginning to end. After preparation of the coil, eg by removing any damaged outer wraps, the strip is fed into the line. One of the first operations to be performed is the welding of the incoming coil to the tail end of the coil being processed. This is a prerequisite for continuous operation, and requires a strip storage device known as the entry looper. The entry looper, in effect a buffer between the entry and the process area, stores enough strip to keep the processing section operating during the welding. As soon as the looper has emptied, the entry section accelerates to a preselected overspeed to provide more strip to refill it.
The main functions of the exit section are strip rewinding and coil discharging. These are made possible by another looper, which stores the strip coming from the processing section. Also, the exit section is capable of working at overspeed to compensate for the excess strip stored in the exit looper during stops in this section.

Annealing and pickling line

The annealing and pickling line (APL) is one of the plants requiring a constant material processing time. To remove the hardness caused by rolling, the strip is first run through the annealing section of the APL. During the annealing process the lattice of the steel is stress-relieved and its structure rearranged. Annealing can be performed in a continuous process in which the strip is passed through a furnace with different heating zones that raise it to an exactly defined temperature and afterwards through cooling zones that gradually cool it down to its exit temperature of about 80 °C (higher temperatures cause the line to be stopped to prevent possible damage to mechanical equipment further along). The temperatures in the heating zones are varied according to the type of steel being treated and the strip gauge and width. After being annealed the strip is passed through the pickling section to give the material a clean, bright surface. This section consists of tanks containing electrolytic, electrochemical and mixed acid solutions. *Table 2* gives details, including the running speeds and annealing data, of a new APL installed recently by ABB at *Baoyong Special Steel* in Ningbo, China . **Drive control strategy** It is not possible to define a unique control strategy for a continuous processing line that will take account of all the different drive combinations in the various line configurations; this is particularly true in the case of the process section. Nevertheless, it can be done for some of the motor drives.

Normally, it is necessary to isolate the strip tensions in the various sections from each other in order to stop one section from influencing another. This is accomplished by means of speed-controlled bridle rolls. Each section has a master bridle which determines the reference speed; a speed pilot in the entry and exit sections controls the overspeed for the looper operation during stops (eg, for coil welding and finishing operations). When these operations have been completed the speed is adapted again to the process. Normally, there is one bridle operating in underspeed mode (feedbackward regulation) and another in overspeed mode (feedforward regulation), in each case referred to the master bridle of the process. This arrangement, known as indirect tension control, ensures that the required strip speed and tension are maintained. In other words, a bridle not assigned the function of a speed master acts as an indirect tension-controlled drive. Very precise control of the strip tension is necessary to avoid strip breakage in critical areas. Direct tension control, with load cells mounted directly on the rolls , guarantees this.

Table 2
Specification of the new annealing and pickling line at Baoyong Special Steel in Ningbo, China

Product data	
Strip material	Hot and cold stainless steel (AISI 300–400)
Strip thickness	0.3 mm – 5.0 mm
Strip width	650 mm – 1350 mm
Coil weight	max 31 t
Running characteristics of line	
Threading speed	25 m/min
Entry/exit speed	90 m/min
Process speed	60 m/min
Entry/process/exit acc and dec	
Normal acceleration	+ 0.13 m/s2
Normal deceleration	– 0.13 m/s2
Fast stoppage	– 0.26 m/s2
Annealing temperatures	
HR 300	1130 °C
CR 300	1090 °C
CR 400	840 °C

Pickling section of the annealing and pickling line at Baoyong Special Steel in Ningbo, China. The open tanks contain the rectifiers that generate the current flux used to clean the strip surface.

Usually, the speed control of a master bridle is based on load sharing between the two drives of the bridle. The advantage of this configuration over the solution with one drive as the speed master and the other speed-controlled is that the stability is better during acceleration and deceleration and differences in the roll diameter are compensated for at constant speed. Indirect tension control with compensation of acceleration and losses is normally used for the coiler and looper. Thus, in the entry and exit section only one bridle is designated the speed master. If there is a side trimmer in the exit section it may have (with respect to the strip direction) one bridle before and one after the side trimmer, the latter acting as master so as to ensure constant speed at the side trimmer.

There is no particular rule for the process section. In general, the speed master should be behind the most critical part (eg, the furnace). If the line has only one process, the speed master will be next to the exit of the process. If there is a stretch leveler in the section, the leveler itself should be the master.

Load cell for direct tension measurement, mounted on the bridle at the entry of the process section

Electrical solutions

When procuring electrical equipment for a plant, consideration needs to be given not only to the first-time cost of the equipment but also to the total cost over its lifetime. This has to take into account factors such as efficiency, energy consumption, spare parts and maintenance. The industry's preference in the past for adjustable speed DC drives, which easily achieve a good torque and speed response, is giving way to a trend towards AC drives. This has come about as a result of modern electronic converters offering the same speed accuracy and fast torque response, but with the added plus that the AC motors allow a major cost saving due to their simpler construction and high reliability, even in harsh environments, and easier maintenance.

Direct torque control

Direct Torque Control (DTC) [1, 2, 3] is the motor control platform launched by ABB in 1994 as the universal solution for LV drive applications and recently adapted for MV applications. This technology is also used to control the induction motors delivered to the new annealing and pickling line of Baoyong Special Steel in Ningbo, China.
Unlike traditional vector control, in which the parameters affecting the voltage and frequency (eg, the motor current and flux) are measured indirectly and a pulse encoder has to constantly provide new data to obtain a real degree of accuracy, DTC allows fast and flexible control of the

machine without encoder feedback. Also, the variables used in flux vector control are controlled by a modulator, which delays the responsiveness of the motor to changes in torque and speed. DTC onthe other hand uses advanced motor theory to calculate the torque directly without the need for a modulator; the control variables are the stator flux and the motor torque.
When DTC open-loop drives are installed, high dynamic performance (speed accuracy and torque control) is possible in many cases without having to use a tachometer. Where a higher accuracy is required, closed-loop DTC drives are employed, but the feedback device may be less accurate and therefore cheaper than the one used in traditional flux vector drives as the speed error and not the rotor position is known by the drive. In processing lines such as the APL described, the main motors used to transport material (in the bridles, loopers, uncoilers, coilers) are fitted with pulse generators. The control variables in DTC are:

• Stator flux
• Torque, calculated on the basis of the flux and stator current
• Comparison of the flux amplitude and torque deviation with given references;

the information this provides is sufficient to determine the optimum voltage vector at each instant The high precision of the mathematical motor model makes speed feedback unnecessary. Combining high-speed signal processing with the advanced mathematical model has produced a 25 μs high-performance control loop that ensures accurate torque control and low oscillation levels. The resulting very fast torque response makes the DTC AC drive twice as fast as flux vector AC drives and at least ten times faster than open-loop AC drives with scalar control. Other benefits in the torque control area include very precise torque control at low speeds, even down to zero, and full torque at zero speed. Measurements of shaft torque (with a torque ramp from 100% to –100 % at zero speed) for different drive controls are shown in . With DTC the dynamic speed accuracy is at least eight times better than with open-loop AC drives, and static speed control accuracy is twice as good as with the existing general-purpose AC drives .

Automation systems

Modern automation systems based on an open system architecture provide userfriendly, reliable tools that support the operator in his daily work. Such systems feature a combination of field controls and higher-level information that makes it easy to interchange data between the Open Control System (OCS) and the Manufacturing Execution System (MES) . By combining these concepts, a plant automation system evolves with capabilities that extend from single motor control to overall plant control.

OCS operator stations

Advant OCS operator stations have direct access to a database in which all the data related to the processing line is stored. Located at the entry and exit pulpits of the line, the stations manage alarm reports and information arriving from each section, allowing the status of the plant to be kept under control. For example, the general starting conditions, motor torque and motor speed can be viewed and preset from these stations.
Strip tracking is one of the main functions provided by Advant OCS . It as assists the operator with routine work by keeping track of the coil welding so that the position of the strip inside the line and the amount of coil threaded in the entry section and rewound at the exit are always known.

Standard ABB solution

Programmable logic controllers manage the exchange of signals between the different process sections. The current standard ABB solution for a strip processing line consists of two PLCs (AC450RMC) dedicated to applications in the metallurgical sector. A wide choice of standardized functions and ready-made software modules makes it easy to find reliable solutions that meet customers' needs.

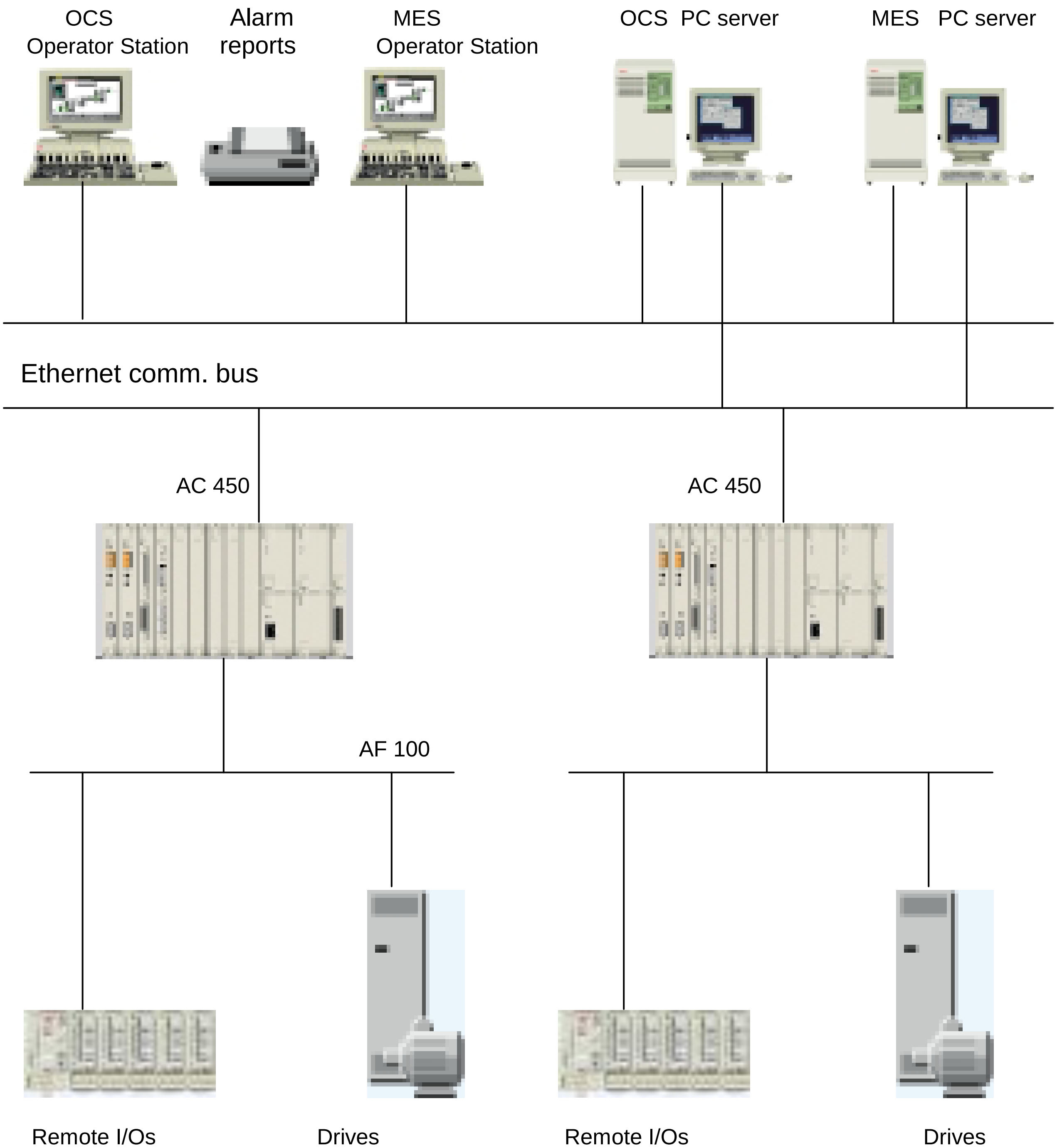
The first multi-CPU AC450 controls the entry section, the tracking and the presetting functions, while the second PLC interfaces with the process and exit sections.To relieve the CPU load of the PLCs some functions are implemented on the motor drives; these incorporate the majority of the application software for motor control. The large drive systems are, in fact, linked through a fast, dedicated fieldbus(AF100) via a control unit called the Application Controller (APC). Softwarerunning on the APC includes modules for speed control, current control and tensioncontrol. Remote I/O devices communicate through the AF100 with the overriding control CPU.

The standard overall control system function covers the generation of all sequences,velocity and acceleration references for the drives, and the signals for starting and stopping the line. Application specific modifications are made according to the project requirements.

ABB Advant® Open Control System

With its Advant® Open Control System (OCS), ABB offers a standard, state-of-the-art platform with open system architecture for the automation of industrial processes. The system is characterized throughout by an object-oriented and distributed structure, high-performance operator stations, very high availability and ease of maintenance. All process and operator stations are linked by a systembus.The process control stations communicate with I/O units by means of field buses. Every stage in the industrial process can be controlled and monitored from each of the process operator stations.

OCS: strip tracking display showing the reference and actual values of speed and tension in different sections of the line. Also shown is information on the incoming and outgoing coils (eg, the coil ID and remaining strip length).



Automation layout with two multi-CPU PLCs in control of the whole line. From the control desk it is possible to view all the operations taking place in the line.

Manufacturing Execution System

Quality control depends not only on accurate control of the technological parameters of the strip but also on overall control of the production process. The necessary coordination is achieved by means of Manufacturing Execution System (MES) functions, being divided into operator functions and process functions.

Operator functions

These functions are as follows:

• *Order management*, giving the list of coils to be worked and detailing for each coil its dimensional data, main characteristics (coil code, steel grade identification for furnace and pickling, customer code) and required final characteristics.

• *Line preset management* , comprising a set of data used to set the line up before starting production; preparations for all the electrical and mechanical devices are based on the order data. Coil data given by the order management and line preset functions assigned to the coil constitute the preset data sent to the OCS for correct coil processing.
Coil reporting , with displays and print-outs of data on worked coils. The main displays are the quality product report (thickness, flatness, elongation data) and the technological product report (furnace, pickling, thickness, flatness, elongation distribution data for the process technology engineer).
Production reporting, showing the number of coils produced and the work shifts in the plant (production reports can be displayed on a shift, daily and monthly basis). Reporting of the plant time distribution (how long the plant has been in operation and how long at standstill) and the pickling consumption is also possible.

• *Maintenance reporting*, showing the actual operating time of the mechanical and electrical equipment.

Process functions

These functions are automatically activated by the system whenever a message is received or something occurs in the plant.
• *Material tracking*, allowing monitoring of the position of the coil in each section of the line.
• *Data acquisition*, for collecting information from the OCS about the uncoiler and recoiler, tension and process sections, as well as for archiving in the system database.
APL automation systems normally make use of mathematical models that control the processing area with high precision and have a direct effect on the overall strip quality. In the case of the furnace, for example, the mathematical model uses the line speed, type of steel, strip width and thickness as information when converting the annealing curve characteristics into working parameters. A model may also be provided for the pickling area, for example to precisely control the acid dosing needed to obtain a clean, bright surface.

DRIVES

In electrical engineering, a *drive* is an electronic device to provide power to a motor or servo. A Drive (**motor controller)** is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. There are in general three types of dirves : Standard Control Drive, System Control Drive, Motion Control Drive.

Many industrial applications are dependent upon motors (or machines), which range from the size of one's thumb to the size of a railroad locomotive. The motor controllers can be built into the driven equipment, installed separately, installed in an enclosure along with other machine control equipment or installed in motor control centers. Motor control centers are multi-compartment steel enclosures designed to enclose many motor controllers. It is also common for more than one motor controller to operate a number of motors in the same application. In this case the controllers communicate with each other so they can work the motors together as a team.

The most basic is the Standard Drive. ABB manufactures standard drive control by the name of ACS800.

STANDARD DRIVE CONTROL (ACS800)

Genrally ACS800 are vertically installed and there is free space above and below the unit. The design of the cabin or cabinet of ACS800 ensures that there is sufficient cool air in the cabinet to compensate for the power losses.

In ACS800 if the supply network is floating (IT network) both grounding screws are removed otherwise it may lead to accident or damage the unit. Here the motor cables are three phase cables and shielded type. Motor cable are routed away from control wires and the power supply cable to avoid electromagnetic interference. For this kind of drive motor must be a three-phase induction motor and suitable for frequency converter use.

The control of drive may be done by a desktop or control display panel. The drive controls the speed, frequency, torque, power etc.

There are two start-up methods between which the user can select: Run the Start-up Assistant, or perform a limited start-up. Standard ID Run needs to be performed during the drive start-up. (ID Run is essential only in applications which require the ultimate in motor control accuracy.) The ID Run (STANDARD or REDUCED) should be selected if:

- The operation point is near zero speed, and/or

- Operation at torque range above the motor nominal torque within a wide speed range.

CONTROLLING STANDARD DRIVES

When power is supplied to the drive

Apply mains power. The control panel first shows the panel identification data …	CDP312 PANEL Vx.xx …….
… then the Identification Display of the drive…	ACS800 ID NUMBER 1
… then the Actual Signal Display …	1 -> 0.0 rpm O FREQ 0.00 Hz CURRENT 0.00 A POWER 0.00 %
…after which the display suggests starting the Language Selection. (If no key is pressed for a few seconds, the display starts to alternate between the Actual Signal Display and the suggestion on selecting the language.) The drive is now ready for the start-up.	1 -> 0.0 rpm O *** INFORMATION *** Press FUNC to start Language Selection

Selecting Language And starting guided start-up

Press the FUNC key.	Language Selection 1/1 LANGUAGE ? [ENGLISH] ENTER:OK ACT:EXIT
Scroll to the desired language by the arrow keys (press ENTER to accept. (The drive loads the selected language into use, shifts back to the Actual Signal Display and starts to alternate between the Actual Signal Display and the suggestion on starting the guided motor set-up.)	1 -> 0.0 rpm O *** INFORMATION *** Press FUNC to start guided Motor Setup
Press FUNC to start the guided motor set-up. (The display shows which general command keys to use when stepping through the assistant.)	Motor Setup 1/10 ENTER: Ok/Continue ACT: Exit FUNC: More Info
Press ENTER to step forward.	Motor Setup 2/10 MOTOR NAMEPLATE DATA

Follow the instructions given on the display.	AVAILABLE? ENTER:Yes FUNC:Info

Manual Start-up

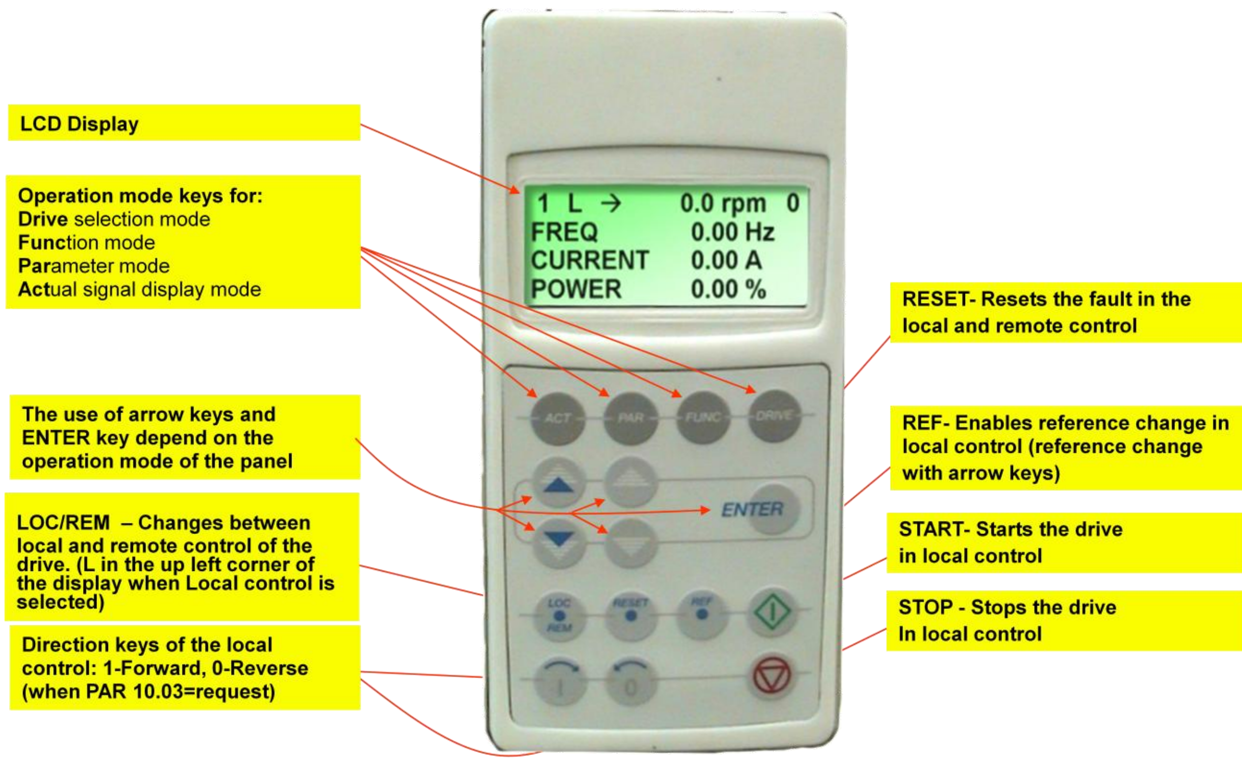
Select the language. The general parameter setting procedure is described below. The general parameter setting procedure: - Press ***PAR*** to select the Parameter Mode of the panel. - Press the double-arrow to scroll the parameter groups. - Press the arrow keys to scroll parameters within a group. - Activate the setting of a new value by ***ENTER.*** - Change the value by the arrow keys or, fast change by the double-arrow keys . - Press ***ENTER*** to accept the new value (brackets disappear).	1 -> 0.0 rpm O 99 START-UP DATA 01 LANGUAGE ENGLISH 1 -> 0.0 rpm O 99 START-UP DATA 01 LANGUAGE [ENGLISH]
Select the Application Macro. The general parameter setting procedure is given above. The default value FACTORY is suitable in most cases.	1 -> 0.0 rpm O 99 START-UP DATA 02 APPLICATION MACRO [ ]
Select the motor control mode. The general parameter setting procedure is given above. DTC is suitable in most cases. The SCALAR control mode is recommended: *- for multimotor drives when the number of the motors connected to the drive is variable* *- when the nominal current of the motor is less than 1/6 of the nominal current of the inverter* *- when the inverter is used for test purposes with no motor connected.* Enter the motor data from the motor nameplate:	1 -> 0.0 rpm O 99 START-UP DATA 04 MOTOR CTRL MODE [DTC] **Note:** Set the motor data to exactly the same value as on the motor nameplate. For example, if the motor nominal speed is 1440 rpm on the nameplate, setting the value of parameter 99.08 MOTOR NOM SPEED to 1500 rpm

Manual Start-up

Select the language. The general parameter setting procedure is described below. The general parameter setting procedure: - Press ***PAR*** to select the Parameter Mode of the panel. - Press the double-arrow to scroll the parameter groups. - Press the arrow keys to scroll parameters within a group. - Activate the setting of a new value by ***ENTER.*** - Change the value by the arrow keys or, fast change by the double-arrow keys . - Press ***ENTER*** to accept the new value (brackets disappear).	1 -> 0.0 rpm O 99 START-UP DATA 01 LANGUAGE ENGLISH 1 -> 0.0 rpm O 99 START-UP DATA 01 LANGUAGE [ENGLISH]
Select the Application Macro. The general parameter setting procedure is given above. The default value FACTORY is suitable in most cases.	1 -> 0.0 rpm O 99 START-UP DATA 02 APPLICATION MACRO [ ]
Select the motor control mode. The general parameter setting procedure is given above. DTC is suitable in most cases. The SCALAR control mode is recommended: *- for multimotor drives when the number of the motors connected to the drive is variable* *- when the nominal current of the motor is less than 1/6 of the nominal current of the inverter* *- when the inverter is used for test purposes with no motor connected.* Enter the motor data from the motor nameplate:	1 -> 0.0 rpm O 99 START-UP DATA 04 MOTOR CTRL MODE [DTC] **Note:** Set the motor data to exactly the same value as on the motor nameplate. For example, if the motor nominal speed is 1440 rpm on the nameplate, setting the value of parameter 99.08 MOTOR NOM SPEED to 1500 rpm

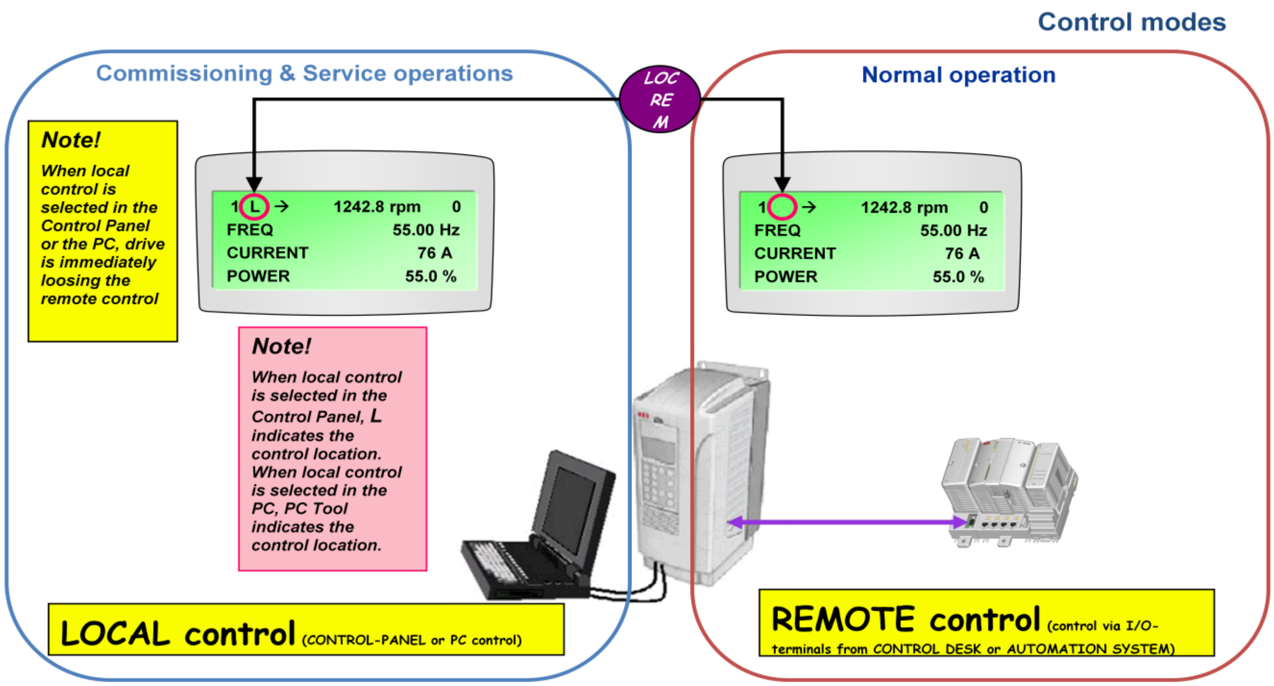
Identification Magnetisation (Motor ID Run)

Press the ***LOC/REM*** key to change to local control (L shown on the first row). Press start to start the Identification Magnetisation. The motor is magnetised at zero speed for 20 to 60 s. Three warnings are displayed: The first warning is displayed when the magnetisation starts. The second warning is displayed while the magnetisation is on. The third warning is displayed after the magnetisation is completed.	1 L -> 1242.0 rpm I ** WARNING ** MOTOR STARTS 1 L-> 0.0 rpm I ** WARNING ** ID MAGN 1 L-> 0.0 rpm O ** WARNING ** ID DONE



How to start, stop and change direction

STEP	ACTION	PRESS KEY	DISPLAY
1.	To show the status row.	*ACT* *PAR* *FUNC*	1 ->1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %
2.	To switch to local control. (only if the drive is not under local control, i.e. there is no L on the first row of the display.)	*LOC REM*	1 L ->1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %
3.	To stop	▽	1 L ->1242.0 rpm O FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %
4.	To start	◇	1 L ->1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %
5.	To change the direction to reverse.	0	1 L <-1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %
6.	To change the direction to forward.	I	1 L ->1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %



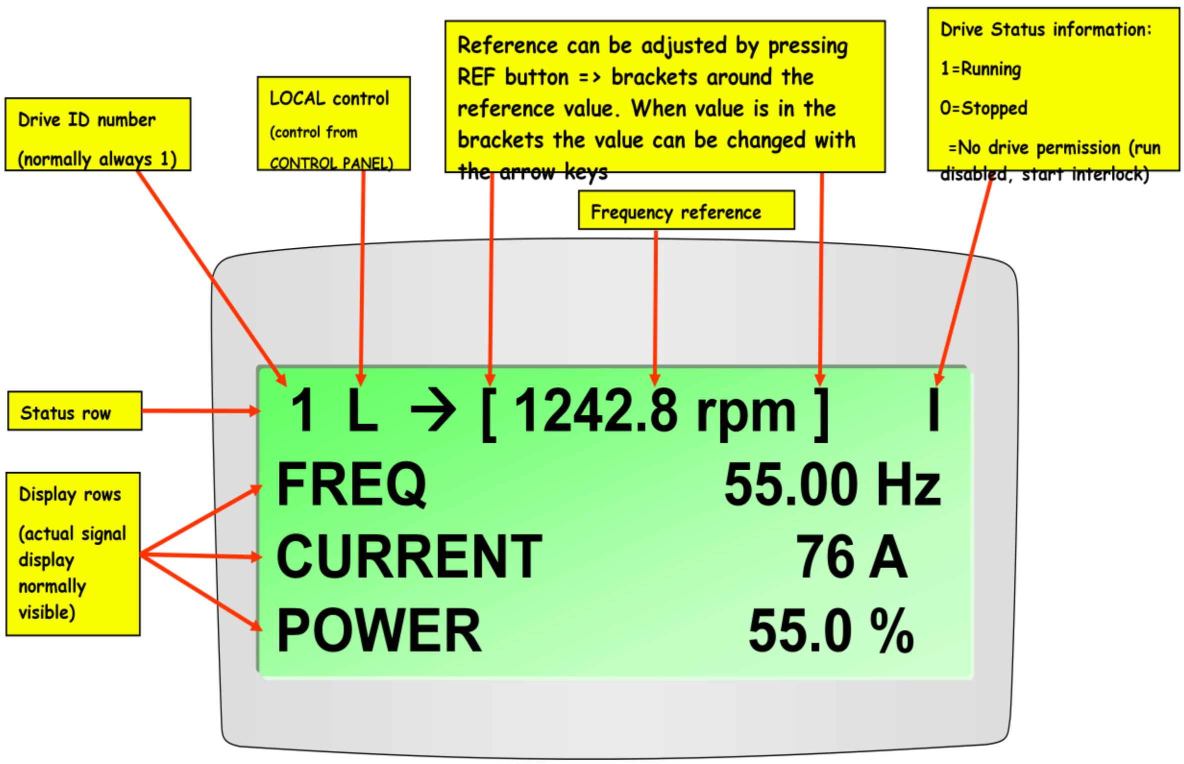
Actual signal display mode

In the Actual Signal Display Mode, the user can:

- show three actual signals on the display at a time
- select the actual signals to display
- view the fault history
- reset the fault history.

The panel enters the Actual Signal Display Mode when the user presses the ***ACT*** key, or if he does not press any key within one minute.

Actual signal panel display and setting of reference

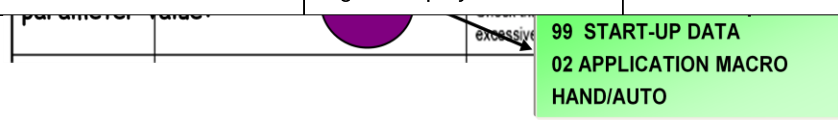


How to display the full name of the actual signals ?

Step	Action	Press Key	Display
1.	To display the full name of the three actual signals.	HOLD	1 L -> 1242.0 rpm I FREQUENCY CURRENT POWER
2.	To return to the Actual Signal Display Mode.	RESET	1 L -> 1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %

FAULT ANALYSIS

Step	Action	Press key	Display
1.	To enter the Actual Signal Display Mode.	ACT	1 L -> 1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %
2.	To enter the Fault History Display.		1 L -> 1242.0 rpm I 1 LAST FAULT +OVERCURRENT 6451 H 21 MIN 23 S
3.	To select the previous UP) or the next fault/warning (DOWN). To clear the Fault History.		1 L -> 1242.0 rpm I 2 LAST FAULT +OVERVOLTAGE 1121 H 1 MIN 23 S 1 L -> 1242.0 rpm I 2 LAST FAULT H MIN S
4.	To return to the Actual Signal Display Mode.		1 L -> 1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %



Drive selection mode

In normal use the features available in the Drive Selection Mode are not needed; the features are reserved for applications where several drives are connected to one panel link. (For more information, see the *Installation and Start-up Guide for the Panel Bus Connection Interface Module, NBCI*, [3AFY58919748 (English)].

In the Drive Selection Mode, the user can:

- Select the drive with which the panel communicates through the panel link.
- Change the identification number of a drive connected to the panel link.
- View the status of the drives connected on the panel link.

How to select a drive and change its panel link ID number

Step	Action	Press key	Display
1.	To enter the Drive Selection Mode.	Drive	ACS800 ASAAA5000 xxxxxx ID NUMBER 1
2.	To select the next drive/view. The ID number of the station is changed by first pressing ***ENTER*** (the brackets round the ID number appear) and then adjusting the value with arrow buttons. The new value is accepted with ***ENTER***. The power of the drive must be switched off to validate its new ID number setting. The status display of all devices connected to the Panel Link is shown after the last individual station. If all stations do not fit on the display at once, press the double-arrow up to view the rest of them.	ARROW UP	ACS800 ASAAA5000 xxxxxx ID NUMBER 1 1o Status Display Symbols: o = Drive stopped, direction forward = Drive running, direction reverse F = Drive tripped on a fault
3.	To connect to the last displayed drive mode, press one of the mode selection keys. The selected mode is entered.	***ACT*** ***FUNC*** ***PAR***	1 L-> 1242.0 rpm I FREQ 45.00 Hz CURRENT 80.00 A POWER 75.00 %

Reading and entering packed boolean values on the display

Some actual values and parameters are packed boolean, i.e. each individual bit has a defined meaning (explained at the corresponding signal or parameter). On the control panel, packed boolean values are read and entered in hexadecimal format.

In this example, bits 1, 3 and 4 of the packed boolean value are ON:

Boolean	0000	0000	0001	1010
Hex	0	0	1	A

NAME	DESCRIPTION	SET PARAMETERS
Language Select	Selecting the language	99.01
Motor Set-up	Setting the motor data	99.05, 99.06, 99.09, 99.07, 99.08, 99.04
Application	Selecting the application macro	99.02, parameters associated to the macro
Option Modules	Activating the option modules	Group 98, 35, 52
Speed Control EXT1	Selecting the source for the speed reference (If AI1 is used: Setting analogue input AI1 limits, scale, inversion) Setting the reference limits Setting the speed (frequency) limits Setting acceleration and deceleration times	11.03 (13.01, 13.02, 13.03, 13.04, 13.05, 30.01) 11.04, 11.05 20.02, 20.01, (20.08, 20.07) 22.02, 22.03
Torque Control	Selecting the source for the torque reference (If AI1 is used: Setting analogue input AI1 limits, scale, inversion) Setting the reference limits Setting the torque ramp up and ramp down times	11.06 (13.01, 13.02, 13.03, 13.04, 13.05, 30.01) 11.08, 11.07 24.01, 24.02

PID Control	Selecting the source for the process reference (If AI1 is used: Setting analogue input AI1 limits, scale, inversion) Setting the reference limits Setting the speed (reference) limits Setting the source and limits for the process actual value	11.06 (13.01, 13.02, 13.03, 13.04, 13.05, 30.01) 11.08, 11.07 20.02, 20.01 (20.08, 20.07) 40.07, 40.09, 40.10
Start/Stop Control	Selecting the source for start and stop signals of the two external control locations, EXT1 and EXT2 Selecting between EXT1 and EXT2 Defining the direction control Defining the start and stop modes Selecting the use of Run Enable signal Setting the ramp time for the Run Enable function	10.01, 10.02 11.02 10.03 21.01, 21.02, 21.03 16.01, 21.07 22.07
Protections	Setting the torque and current limits	20.03, 20.04

Contents of the assistant displays

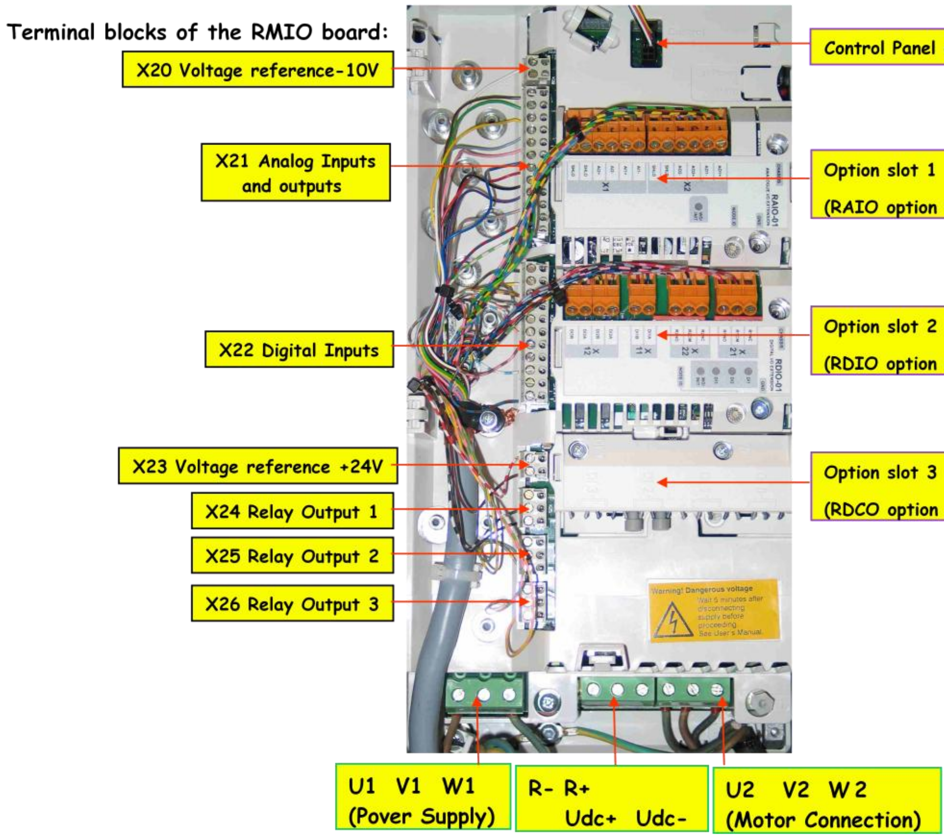
There are two types of displays in the Start-up Assistant: The main displays and the information displays. The main displays prompt the user to feed in information or answer a question. The assistant steps through the main displays. The information displays contain help texts for the main displays. The figure below shows a typical example of both and explanations of the contents.

Main Display	Information Display
Motor Setup 3/10 MOTOR NOM VOLTAGE? [0 V] ENTER:Ok RESET:Back	INFO P99.05 Set as given on the motor nameplate.

Local control vs. External control

The drive can receive start, stop and direction commands and reference values from the control panel or through digital and analogue inputs. An optional fieldbus adapter enables control over an open fieldbus link. A PC equipped with DriveWindow can also control the drive.

Terminal Interface, wall mounted (ACS800-01/-U1)



Local control

The control commands are given from the control panel keypad when the drive is in local control. L indicates local control on the panel display.

```
1 (L)->1242 rpm     I
```

The control panel always overrides the external control signal sources when used in local mode.

External control

When the drive is in external control, the commands are given through the standard I/O terminals (digital and analogue inputs), optional I/O extension modules and/or the fieldbus interface. In addition, it is also possible to set the control panel as the source for the external control.

External control is indicated by a blank on the panel display or with an R in those special cases when the panel is defined as a source for external control.

```
1 ( ) ->1242 rpm     I     1(R)->1242 rpm     I
```

External Control through the Input/ Output terminals, or through the fieldbus interfaces

External Control by control panel

The user can connect the control signals to two external control locations, EXT1 or EXT2. Depending on the user selection, either one is active at a time. This function operates on a 12 ms time level.

Reference trimming

In reference trimming, the external %-reference (External reference REF2) is corrected depending on the measured value of a secondary application variable. The block diagram below illustrates the function.

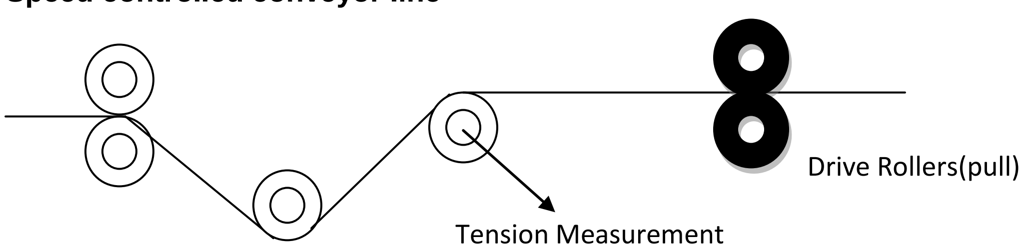
EXAMPLE:

The drive runs a conveyor line. It is speed-controlled but the line tension also needs to be taken into account: If the measured tension exceeds the tension setpoint, the speed will be slightly decreased, and vice versa.

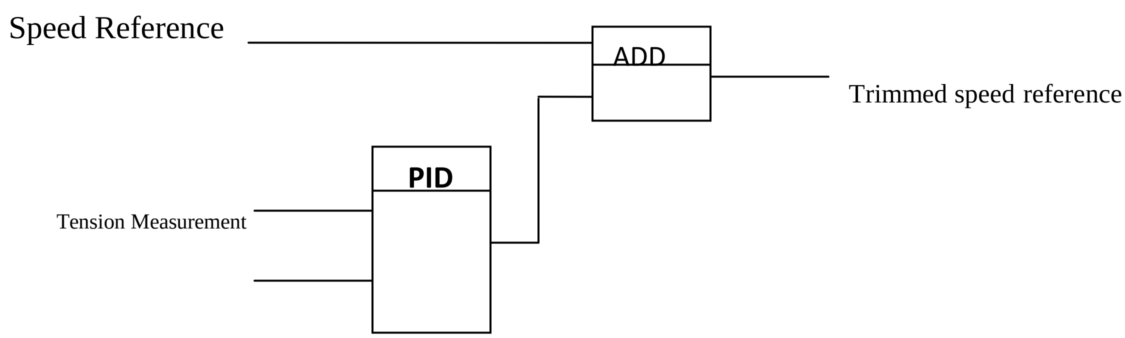
To accomplish the desired speed correction, the user:

- activates the trimming function and connects the tension setpoint and the measured tension to it
- tunes the trimming to a suitable level.

Speed controlled conveyor line



Simplified Block Diagram



Tension Setpoint

Programmable analogue inputs

The drive has three programmable analogue inputs: one voltage input (0/2 to 10 V or -10 to 10 V) and two current inputs (0/4 to 20 mA). Two extra inputs are available if an optional analogue I/O extension module is used. Each input can be inverted and filtered, and the maximum and minimum values can be adjusted.

Programmable analogue outputs

Two programmable current outputs (0/4 to 20 mA) are available as standard, and two outputs can be added by using an optional analogue I/O extension module. Analogue output signals can be inverted and filtered.

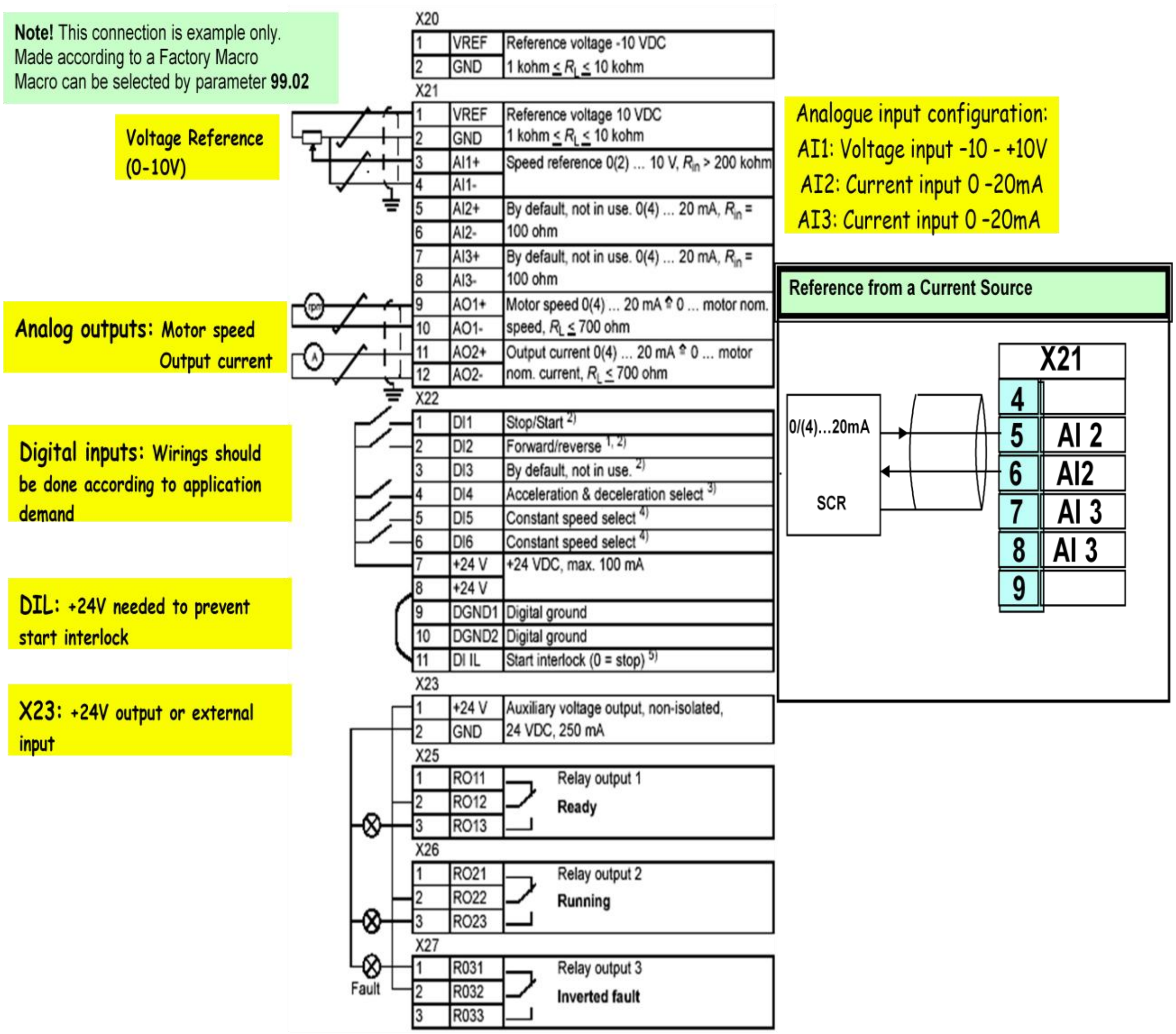
The analogue output signals can be proportional to motor speed, process speed (scaled motor speed), output frequency, output current, motor torque, motor power, etc.

It is possible to write a value to an analogue output through a serial communication link.

Update cycles in the Standard Control Program

INPUT	CYCLE
AI / standard	6 ms
AI / extension	6 ms (100 ms[1])
OUTPUT	
A0/ standard	24 ms
A0 / extension	24 ms (1000 ms[1])

Connection diagram: Factory macro



Motor identification

The performance of Direct Torque Control is based on an accurate motor model determined during the motor start-up.

A motor Identification Magnetisation is automatically done the first time the start command is given. During this first start-up, the motor is magnetised at zero speed for several seconds to allow the motor model to be created. This identification method is suitable for most applications.

In demanding applications a separate Identification Run can be performed.

Settings

Parameter 99.10.

Power loss ride-through

If the incoming supply voltage is cut off, the drive will continue to operate by utilising the kinetic energy of the rotating motor. The drive will be fully operational as long as the motor rotates and generates energy to the drive. The drive can continue the operation after the break if the main contactor remained closed.

Note: Cabinet assembled units equipped with main contactor option have a .hold circuit. that keeps the contactor control circuit closed during a short supply break. The allowed duration of the break is adjustable. The factory setting is five seconds.

DC Magnetising

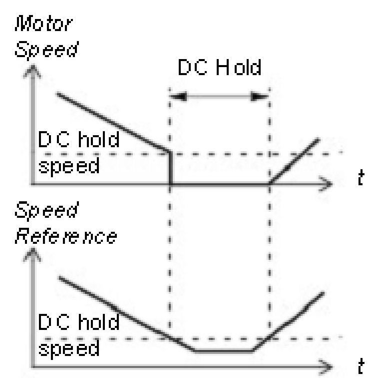
When DC Magnetising is activated, the drive automatically magnetises the motor before starting. This feature guarantees the highest possible breakaway torque, up to 200% of motor nominal torque. By adjusting the premagnetising time, it is possible to synchronise the motor start and e.g. a mechanical brake release. The Automatic Start feature and DC Magnetising cannot be activated at the same time.

Settings

Parameters 21.01 and 21.02.

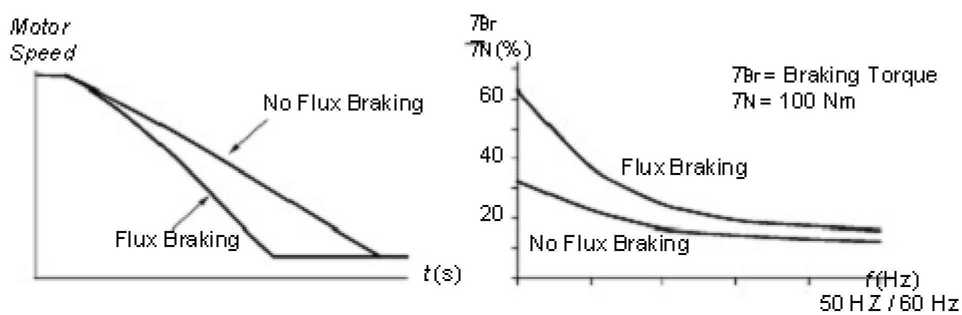
DC Hold

By activating the motor DC Hold feature it is possible to lock the rotor at zero speed. When both the reference and the motor speed fall below the preset DC hold speed, the drive stops the motor and starts to inject DC into the motor. When the reference speed again exceeds the DC hold speed, the normal drive operation resumes.



Flux Braking

The drive can provide greater deceleration by raising the level of magnetisation in the motor. By increasing the motor flux, the energy generated by the motor during braking can be converted to motor thermal energy. This feature is useful in motor power ranges below 15 kW.



The drive monitors the motor status continuously, also during the Flux Braking. Therefore, Flux Braking can be used both for stopping the motor and for changing the speed. The other benefits of Flux Braking are:

. The braking starts immediately after a stop command is given. The function does not need to wait for the flux reduction before it can start the braking.

. The cooling of the motor is efficient. The stator current of the motor increases during the Flux Braking, not the rotor current. The stator cools much more efficiently than the rotor.
Settings
Parameter 26.02.

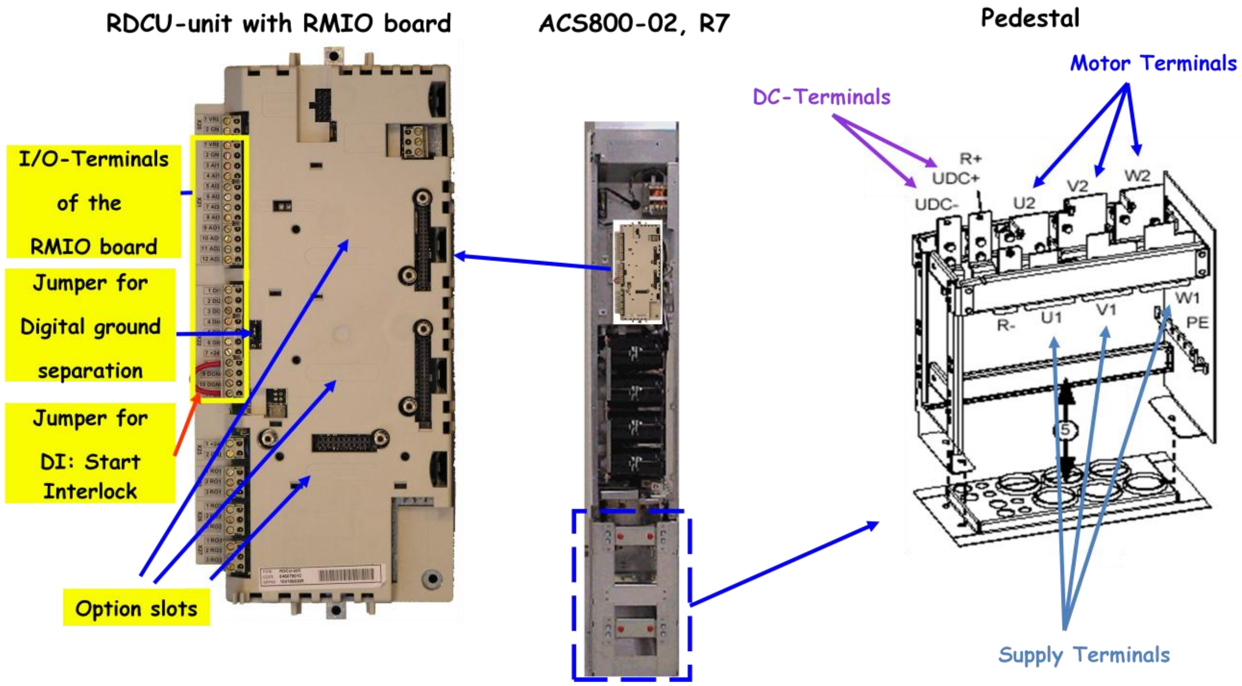
Scalar control

It is possible to select Scalar Control as the motor control method instead of Direct Torque Control (DTC). In the Scalar Control mode, the drive is controlled with a frequency reference. The outstanding performance of the default motor control method, Direct Torque Control, is not achieved in Scalar Control.
It is recommended to activate the Scalar Control mode in the following special applications:
. In multimotor drives:
1) if the load is not equally shared between the motors,
2) if the motors are of different sizes, or
3) if the motors are going to be changed after the motor identification
. If the nominal current of the motor is less than 1/6 of the nominal output current of the drive
. If the drive is used without a motor connected (e.g. for test purposes)
. The drive runs a medium voltage motor via a step-up transformer.
In the Scalar Control mode, some standard features are not available.
Settings
Parameter 99.04.

IR compensation for a scalar controlled drive

IR Compensation is active only when the motor control mode is Scalar (see section *Scalar control* on page *60*). When IR Compensation is activated, the drive gives an extra voltage boost to the motor at low speeds. IR Compensation is useful in applications that require high breakaway torque. In Direct Torque Control, no IR Compensation is possible/needed.
Settings
Parameter 26.03.

ACS800-02 Terminal interface



Motor Thermal Protection

The motor can be protected against overheating by activating the Motor Thermal Protection function and by selecting one of the motor thermal protection modes available.

The Motor Thermal Protection modes are based either on a motor temperature thermal model or on an overtemperature indication from a motor thermistor.

Motor temperature thermal model

The drive calculates the temperature of the motor on the basis of the following assumptions:

1) The motor is at the estimated temperature (value of 01.37 MOTOR TEMP TEST saved at power switch off) when power is applied to the drive. When power is applied for the first time, the motor is at the ambient temperature (30°C).

2) Motor temperature is calculated using either the user-adjustable or automatically calculated motor thermal time and motor load curve (see the figures below). The load curve should be adjusted in case the ambient temperature exceeds 30°C.

Use of the motor thermistor

It is possible to detect motor overtemperature by connecting a motor thermistor (PTC) between the +24 VDC voltage supply offered by the drive and digital input DI6. In normal motor operation temperature, the thermistor resistance should be less than 1.5 kohm (current 5 mA). The drive stops the motor and gives a fault indication if the thermistor resistance exceeds 4 kohm. The installation must meet the regulations for protecting against contact.

Settings

Parameters 30.04 to 30.09.

Stall Protection

The drive protects the motor in a stall situation. It is possible to adjust the supervision limits (torque, frequency, time) and choose how the drive reacts to a motor stall condition (warning

indication / fault indication & stop the drive / no reaction). The torque and current limits, which define the stall limit, must be set according to the maximum load of the used application.
Note: Stall limit is restricted by internal current limit 03.04 TORQ_INV_CUR_LIM.
When the application reaches the stall limit and the output frequency of the drive is below the stall frequency: Fault is activated after the stall time delay.
Settings
Parameters 30.10 to 30.12.
Parameters 20.03, 20.13 and 20.14 (Define the stall limit.)

Underload Protection

Loss of motor load may indicate a process malfunction. The drive provides an underload function to protect the machinery and process in such a serious fault condition. Supervision limits - underload curve and underload time - can be chosen as well as the action taken by the drive upon the underload condition (warning indication / fault indication & stop the drive / no reaction).
Settings
Parameters 30.13 to 30.15.

Motor Phase Loss

The Phase Loss function monitors the status of the motor cable connection. The function is useful especially during the motor start: the drive detects if any of the motor phases is not connected and refuses to start. The Phase Loss function also supervises the motor connection status during normal operation.
Settings
Parameter 30.16.

Earth Fault Protection

The Earth Fault Protection detects earth faults in the motor or motor cable. The protection is based on sum current measurement.
. An earth fault in the mains does not activate the protection.
. In an earthed (grounded) supply, the protection activates in 200 microseconds.
. In floating mains, the mains capacitance should be 1 microfarad or more.
. The capacitive currents due to screened copper motor cables up to 300 metres do not activate the protection.
. Earth fault protection is deactivated when the drive is stopped.
Note: With parallel connected inverter modules, the earth fault indication is CUR UNBAL.
Settings
Parameter 30.17.

Communication Fault

The Communication Fault function supervises the communication between the drive and an external control device (e.g. a fieldbus adapter module).
Settings
Parameters 30.18 to 30.21.

Supervision of optional IO

The function supervises the use of the optional analogue and digital inputs and outputs in the application program, and warns if the communication to the input/output is not operational.
Settings
Parameter 30.22.

Preprogrammed faults
Overcurrent
The overcurrent trip limit for the drive is 1.65 to 2.17 · *I*max depending on the drive type.

DC overvoltage
The DC overvoltage trip limit is 1.3 ·U_{1max}, where U_{1max} is the maximum value of the mains voltage range. For 400 V units, U_{1max} is 415 V. For 500 V units, U_{1max} is 500 V. For 690 V units, U_{1max} is 690 V. The actual voltage in the intermediate circuit corresponding to the mains voltage trip level is 728 VDC for 400 V units, 877 VDC for 500 V units, and 1210 VDC for 690 V units.

DC undervoltage
The DC undervoltage trip limit is 0.6 · U_{1min}, where U_{1min} is the minimum value of the mains voltage range. For 400 V and 500 V units, U_{1min} is 380 V. For 690 V units, U_{1min} is 525 V. The actual voltage in the intermediate circuit corresponding to the mains voltage trip level is 307 VDC for 400 V and 500 V units, and 425 VDC for 690 V units.

Drive temperature
The drive supervises the inverter module temperature. There are two supervision limits: warning limit and fault trip limit.

Enhanced drive temperature monitoring for ACS800-U2, -U4 and -U7, frame sizes R7 and R8
Traditionally, drive temperature monitoring is based on the power semiconductor (IGBT) temperature measurement which is compared with a fixed maximum IGBT temperature limit. However, certain abnormal conditions such as cooling fan failure, insufficient cooling air flow or excessive ambient temperature might cause overheating inside the converter module, which the traditional temperature monitoring alone does not detect. The Enhanced drive temperature monitoring improves the protection in these situations. The function monitors the converter module temperature by checking cyclically that the measured IGBT temperature is not excessive considering the load current, ambient temperature, and other factors that affect the temperature rise inside the converter module. The calculation uses an experimentally defined equation that simulates the normal temperature changes in the module depending on the load. Drive generates a warning when the temperature exceeds the limit, and trips when temperature exceeds the limit by 5°C.

Application macros

Application macros are preprogrammed parameter sets. While starting up the drive, the user typically selects one of the macros - the one that is best suited to his needs - by parameter 99.02, makes the essential changes and saves the result as a user macro.
There are five standard macros and two user macros. The table below contains a summary of the macros and describes suitable applications.

MACRO	SUITABLE APPLICATION
Factory	Ordinary speed control applications where no, one, two or three constant speeds are used: - Conveyors - Speed-controlled pumps and fans - Test benches with predefined constant speeds
Hand/Auto	Speed control applications. Switching between two external control devices is possible.
PID Control	Process control applications e.g. different closed loop control systems such as pressure control, level control, and flow control. For example: - pressure boost pumps of municipal water supply systems - level controlling pumps of water reservoirs - pressure boost pumps of district heating systems - material flow control on a conveyor line. It is also possible to switch between process and speed control.
Torque Control	Torque control applications. Switching between torque and speed control is possible.
Sequential Control	Speed control applications in which speed reference, seven constant speeds and two acceleration and deceleration ramps can be used.
User	The user can save the customised standard macro i.e. the parameter settings including group 99, and the results of the motor identification into the permanent memory, and recall the data at a later time. Two user macros are essential when switching between two different motors is required

Hand/Auto macro

Start/Stop and Direction commands and reference settings can be given from one of two external control locations, EXT1 (Hand) or EXT2 (Auto). The Start/Stop/Direction commands of EXT1 (Hand) are connected to digital inputs DI1 and DI2, and the reference signal is connected to analogue input AI1. The Start/Stop/Direction commands of EXT2 (Auto) are connected to digital inputs DI5 and DI6, and the reference signal is connected to analogue input AI2. The selection between EXT1 and EXT2 is dependent on the status of digital input DI3. The drive is speed controlled. Speed reference and Start/Stop and Direction commands can be given from the control panel keypad also. One constant speed can be selected through digital input DI4.
Speed reference in Auto Control (EXT2) is given as a percentage of the maximum speed of the drive. Two analogue and three relay output signals are available on terminal blocks. The default signals on the display of the control panel are FREQUENCY, CURRENT and CTRL LOC.

PID Control macro

The PID Control macro is used for controlling a process variable . such as pressure or flow . by controlling the speed of the driven motor. Process reference signal is connected to analogue input AI1 and process feedback signal to analogue input AI2.
Alternatively, a direct speed reference can be given to the drive through analogue input AI1. Then the PID controller is bypassed and the drive no longer controls the process variable.

Selection between the direct speed control and the process variable control is done with digital input DI3. Two analogue and three relay output signals are available on terminal blocks. The default signals on the display of the control panel are SPEED, ACTUAL VALUE1 and CONTROL DEVIATION.

Connection example, 24 VDC / 4.20 mA two-wire sensor

Default control connections

The figure below shows the external control connections for the PID Control macro. The markings of the standard I/O terminals on the RMIO board are shown.

1) Selection between two external control locations, EXT1 and EXT2

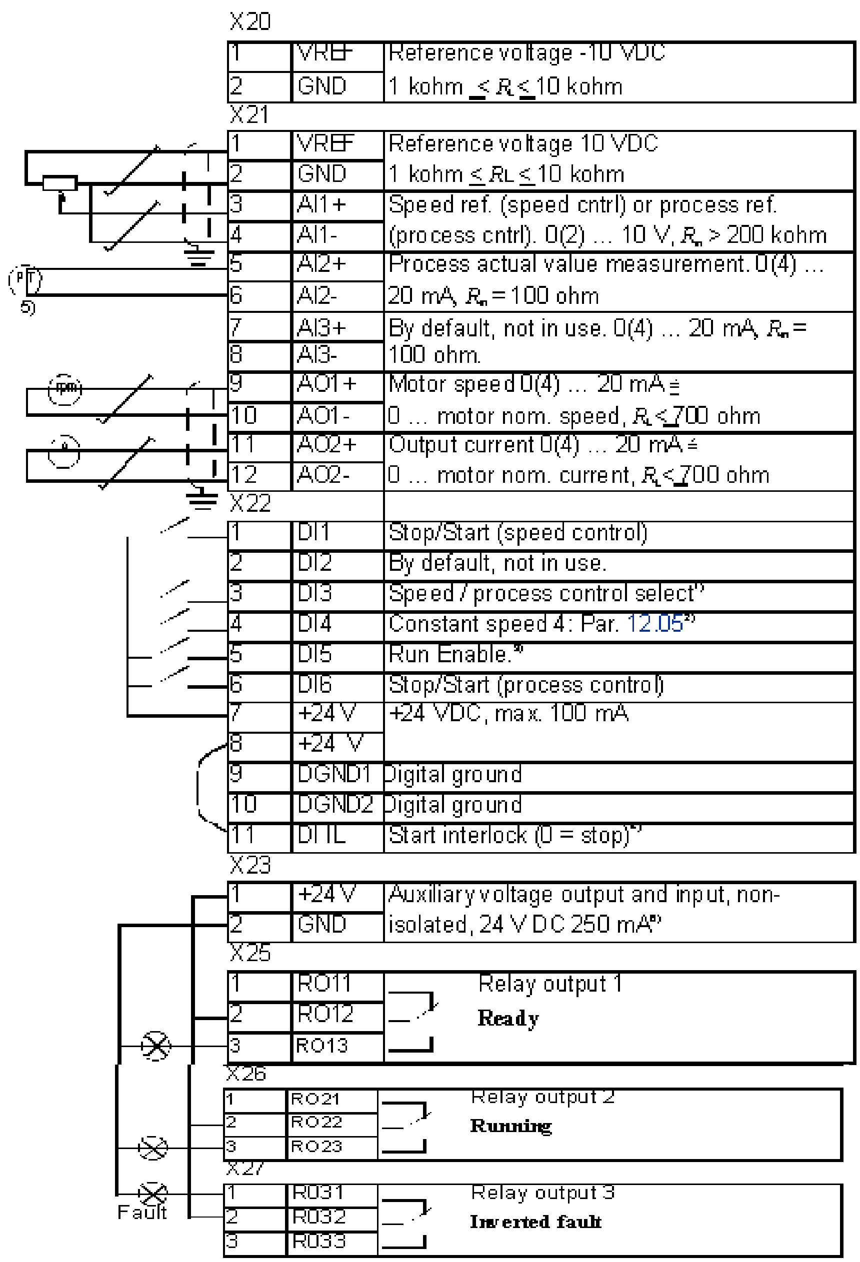
2) In use only when the speed control is active (DI3 = 0)

3) Off = Run Enable off. Drive will not start or stops. On = Run Enable on. Normal operation.

4) See parameter 21.09.

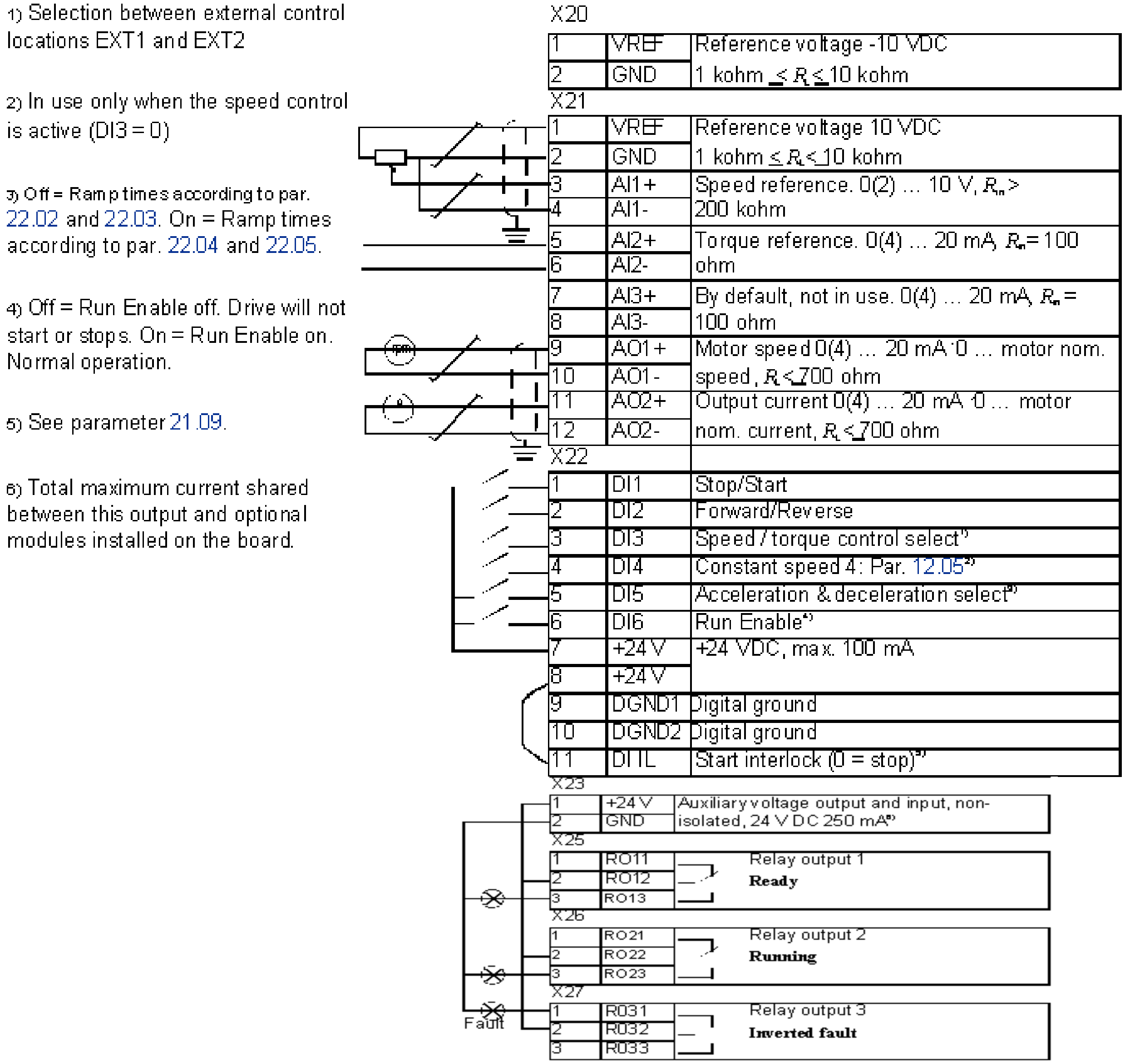
5) The sensor needs to be powered. See the manufacturer's instructions. A connection example of a two-wire 24 VDC / 4...20 mA sensor is shown on previous page.

6) Total maximum current shared between this output and optional modules installed on the board.

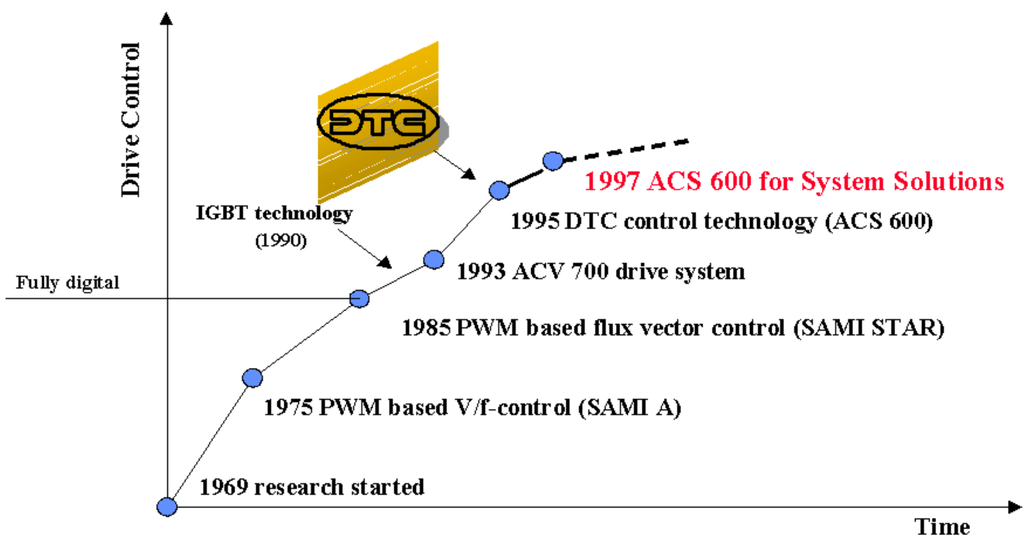


Default control connections

The figure below shows the external control connections for the Torque Control macro. The markings of the standard I/O terminals on the RMIO board are shown.



Evolution of Drives



The above picture shows the evolution of drives as manufactured by ABB. There is always a scope of research and development. Nowadays the series being manufactured is ACS800. But the usage of standard drive is becoming less and less popular as well. Now **System drives** are becoming popular and they are the one also known as **engineering drives.** The system drives are used for specific and précised work. They are generally used for servo motors as the required precission is more and tolerance is reduced.

Nowadays multidrive system is becoming popular as there is less power loss and output is more. The energy lost in converting AC to DC and DC to AC is reduced as they use IGBT. Now the direct torque control technique is the most preferred one. Day by day development is going on and system drive are replaced by **Motion Control Drive.** Nowadays in many places DC motor is also replaced by AC motor which has its following advantages:

1. High total efficiency (up to 0,94 over 100 kW)
2. Low need for maintenance
3. Use in critical environments
4. Large power and speed ranges
5. No acceleration problems
6. Optimized drive packages for each need
7. Modular construction
8. Driving and braking in both directions
9. Constructions for in-or out mounting
10. High reliability

11. Converter-/motor-voltage 0,2 -3,3 kV
12. Converter-/motor-current 3 -3000 A

MULTIMOTOR APPLICATION

- **Voltage, Frequency and Number of Pole Pairs have to be the same**
  - -Preferably similar type motors are used
- **Greater variance allowed if mechanical connection among motors**
- **Load of all motors have to be the same**
  - -Problems with rolling tables where the load varies among the motors
- **Fixed set of motor**-Motors cannot be added or removed without new identification run
  - -Less than 20% variance in cumulative nom. Current
- **User macros allow two motor set-ups**

BENEFITS OF DTC

•Fast torque step rise time
- –10 times faster torque response than any open loop drive
- –No feedback device required for most applications

•Dynamic speed accuracy
- –8 times better dynamic speed accuracy than any open loop drive
- –Better static speed accuracy than any open loop drive
- –Closed loop static speed accuracy is 0.01%

•Reliability
- –Calculates motor state every 25 µs with a powerful digital signal processor (DSP)
- –Immediate response to power loss situations and load impacts
- –Adaptive motor model automatically used if feedback device breaks in closed loop speed control

•Low audible noise
- –Each phase voltage constructed by switching between + and -DC voltage
- –Insulated Gate Bipolar Transistors (IGBT) & high switching frequency
- –Optimized switching -no predetermined switching pattern is followed
- –Heating of the motor is lower compared to PWM

Environmental Limits For ACS800 Drive

- Ambient operating temperature -15 - +40 °C
- Max. ambient temperature 50 °C if P_N and I_2 derated
- Installation altitude 0 - 1000 m
- Installation altitude 1000 - 2000 m if P_N and I_2 derated
- Relative humidity 5 - 95 % (non-condensing)

COMMUNICATION PROTOCOLS & DESIGN

Introduction

Network Communication

The recommended alternative, *Control Network*, is a private IP network domain especially designed for industrial applications. This means that all communication handling will be the same, regardless of network type or connected devices. Control Network is scalable from a very small network with a few nodes to a large network containing a number of *network areas* with hundreds of addressable nodes (there may be other restrictions such as controller performance). Control Network uses the *MMS* communication protocol on Ethernet and/or RS-232C to link workstations to controllers. MMS (Manufacturing Message Specification) is an ISO 9506 standard. In order to support Control Network on RS- 232C links, the *Point-to-Point Protocol* (PPP) is used. The *Redundant Network Routing Protocol* (RNRP) developed by ABB handles alternative paths between nodes and automatically adapts to topology changes. MMS and RNRP are described in Section 2, MMS.

In addition, other protocols such as MB 300, COMLI, Siemens 3964R, ModBus RTU, and SattBus can be used. Fieldbuses such as FOUNDATION Fieldbus H1 (according to ISA SP50), FOUNDATION Fieldbus HSE, PROFIBUS-DP (according to IEC 1158-2 and EN 50170), DriveBus, and ControlNet can be connected to the network via communication interface units.

Table 1– Table 3 give concise information to be used when selecting protocols. Subsection Prerequisites and Requirements on page 35 provides details on specific products. For further information (regarding performance, for example) refer to Sections 2–10.

The Control Network-as well as other protocols and fieldbuses-is configured by means of the project explorer in Control Builder (see the figure below). The Control Network is specified by settings in the parameter lists, accessed by right-clicking the symbols for the CPUs and the Ethernet and/or PPP symbols (see Section 2 for further information). How to specify the hardware configuration is explained in the Control Builder online help. PC nodes are specified in the PC setup wizard (from the **Start** menu, select **ABB Industrial IT** > **Engineer IT** > **Control Builder M...**> **Setup Wizard**).

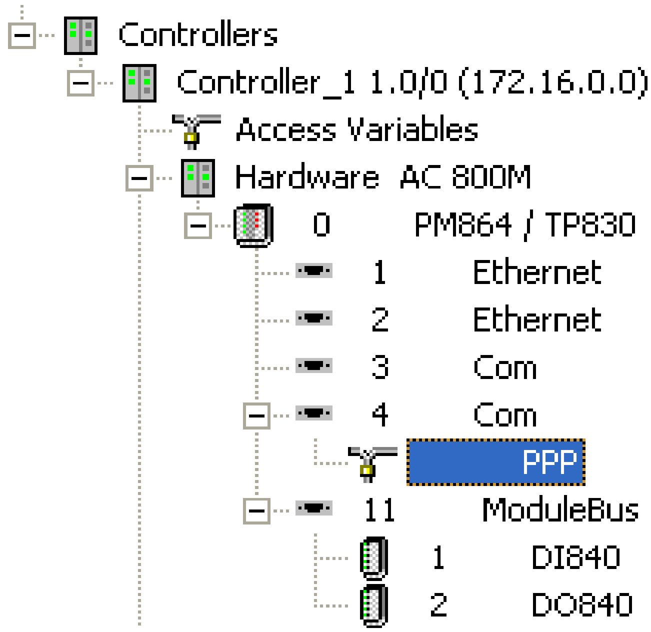


Figure 1. Project Explorer.

Protocols and Controllers Supported by Control Builder

The table below lists controllers and protocols supported by the current version of Control Builder.

Table 1. Protocols and Controllers supported by Control Builder.

Protocol	AC 800M	AC 250
MMS on Ethernet	YES	YES
MMS on RS-232C (PPP)	YES	YES
MasterBus 300	YES	NO
SattBus	NO	YES
SattBus on TCP/IP	YES	YES
COMLI(1)	YES	YES
Siemens 3964R(2)	YES	YES
ModBus RTU(3)	YES	YES
FOUNDATION Fieldbus H1	YES	NO
FOUNDATION Fieldbus HSE	YES	NO
PROFIBUS DP-V0	YES	YES
PROFIBUS DP-V1	YES	NO
DriveBus	YES	NO
INSUM	YES	NO
ControlNet	NO	YES

Properties of Different Protocols

Table 2 below shows access modes used, variable types handled and maximum message size permitted for various protocols, as well awhich protocols that require interface units with separate CPUs ,and protocols that support dial-up modems. FOUNDATION Fieldbus H1 (FF H1), FF HSE, PROFIBUS-DP, DriveBus, INSUM, and ControlNet are I/O fieldbuses that are not used for general data communication. They use communication interfaces with separate CPUs and perform according to the master/slave principle.

Protocol	Access method	Separate CPU for communication	Dial-up modem	Boolean	Integer	Real	String	Struct(2)	Max. number of bits/registers or bytes per message
MMS on Ethernet	Ethernet			×	×	×	×	×	
MMS on RS-232C (PPP)	Point-to-point			×	×	×	×	×	
MasterBus 300	Ethernet			×	×	×	×		
SattBus	Token passing	×		×	×	×	×	×	31 bytes
SattBus on TCP/IP	Token passing		×	×	×	×	×	×	31 bytes
COMLI	Multidrop			×	×				512/32
Siemens 3964R	Point-to-point			×	×				512/32
ModBus RTU	Multidrop			×	×				
Self-defined in Serial Communication Library	Point-to-point			×	×	×	×	×	140 bytes

(1) When transferring variables it is important to use data types having the same range on both client and server. However, a dInt variable on the server can be connected to an Int variable on the client if the values are within the Int variable's range.

(2) MMS and SattBus can transfer structured variables of the data types given in the table. No protocol can transfer variables of types ArrayObject or QueueObject..

Connection Methods

Function blocks from the communication libraries are used to read and write variables from a remote system:

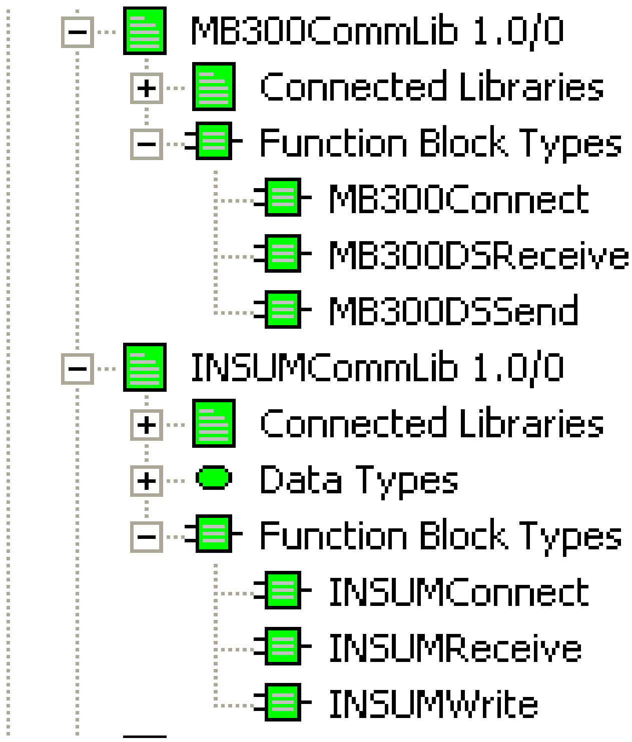


Figure 2. Function blocks in the communication libraries.

In the application program, a common *Connect* function block is used in a client (master) to establish connection to a server (slave). The function blocks *Read* and *Write* can then be used repeatedly. Refer to online help for a description of the parameters concerned. Variables to be accessed must be declared in the server *Access variable editor*.

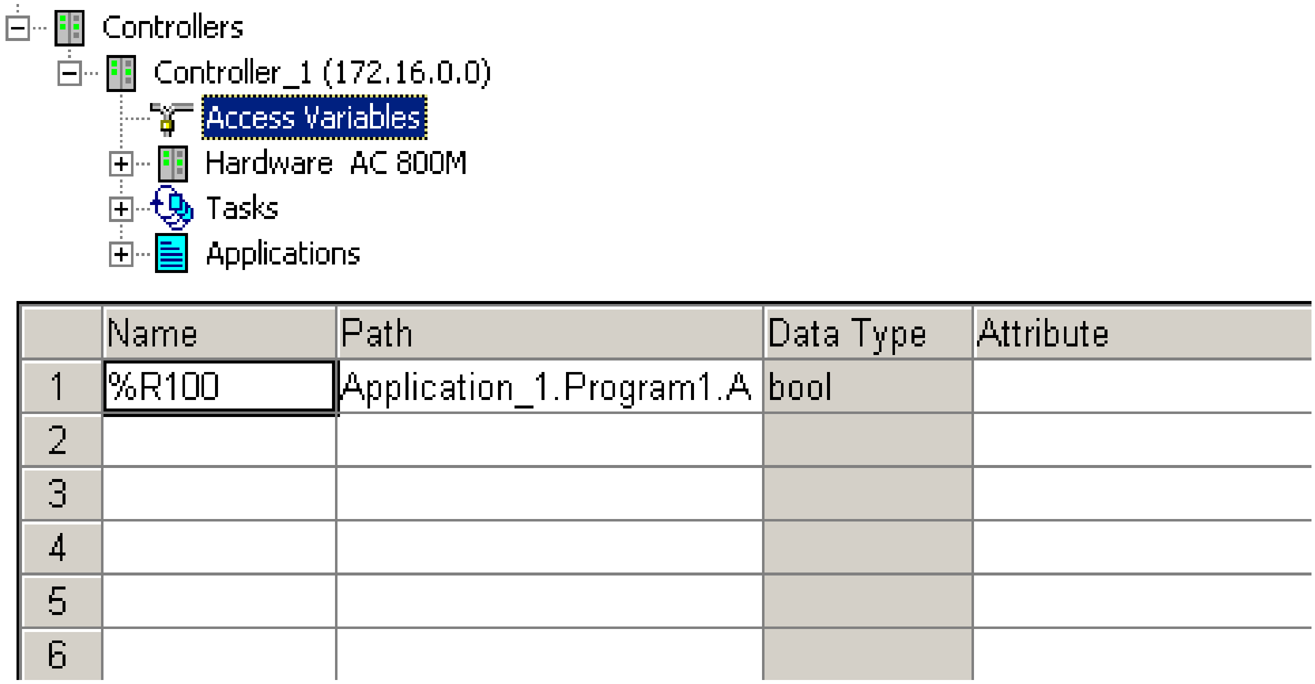


Figure 3. Access variable editor (Control Builder M Professional view).

Clock Synchronization

Depending on the type of controller, it is possible to perform clock synchronization by four different protocols: CNCP, SNTP, MB 300 TS, and MMS Time Service. The preferred protocol of service is chosen in the Hardware Editor of the Control Builder M.

CNCP is the base protocol for clock synchronization on the Control Network. An AC 800M controller selected as Clock Master multicasts synchronization messages on the network (see Figure 6). All nodes that have CNCP "enabled" gets synchronization from the Clock Master.

AC 800M controllers that needs to be synchronized from an external time server are configured as SNTP clients. The time server is typically an GPS Time Server connected to the network.

Custom devices that needs synchronization from the Control Network can get time from the SNTP server function running in every AC 800M controller. CNCP and SNTP can both operate at the same time on the network.

MMS Time Service supported for small systems where no AC 800M is used for backward compatibility with older products.

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

If a GPS time source exists, time is sent from the GPS to all AC 800M controllers in the system. One of the AC 800M controllers then acts as a TimeSync Master for the rest of the controllers and distributes the time to them.

If no external time source exists, the controller which is set up as TimeSync Master gives the reference time for the system.

Intermediate Clock Master

An Intermediate Clock Master (a node that can relay time synchronization between two Network Areas) shall have a Clock Master order number that is at least two numbers higher than any ordinary Clock Master (AC 800M). The standard and recommended synchronization interval is 20 seconds.

Clock Synchronization in Controllers

The controllers are synchronized in the following ways:
• AC 800M:
An AC 800M is set up to be the TimeSync Master which can be set up to either give the reference time to the system, or receive the reference time from an external time source. The time is distributed from the TimeSync Master to the other controllers.
For AC 800M, the following is valid:
– SNTP:
Slave with high precision for synchronization from an external source. Master with less accuracy for synchronization of third part equipment.
– CNCP:
Master and Slave with high accuracy
– MB 300 TS:
Master with high accuracy ,Slave with high accuracy
• Advant Controller 250:
The following is valid:
– CNCP:
Slave with medium accuracy. Synchronization from AC 800M (TimeSync Master).
• Advant Controller 400:
Time is sent to every AC 400 controller via MB 300 TS from the TimeSync Master.
• Plant Explorer Workplace:
The following is valid:
– CNCP:
Slave with medium accuracy. Synchronization from AC 800M (TimeSync Master).
• External Source:
Clock Synchronization from an external source where the external source is SNTP:
– Accuracy depends on the selected source

Prerequisites and Requirements

When selecting communication methods and hardware in a control network the following features of and restrictions on the currently available hardware must be considered.

AC 800M

• Max. two Ethernet links integrated in the CPU unit are supported.
• A maximum of four PPP links are allowed:
One tool port link and one PPP link (integrated in the CPU unit), plus
additional PPP links via a CI853 unit, can be used.

Advant Controller 250 (AC 250)

• Ethernet links can be connected via 200-CIE communication units, and PPP links via 200-CI232 communication units.
• Only two 200-CIE units supported simultaneously.
• The serial port integrated in the CPU unit does not support PPP.
SattCon60 × ×
SattCon90 × ×
SattCon115 × × ×
SattCon125 × × ×
SattCon200 × × × ×
(1) Systems supporting COMLI can be connected to SattBus via the SattBus Connector Unit BC.
(2) Supported message types differ between the controllers; refer to the relevant programmer's manuals.
(3) With control board CU05-25SB or CU05-45SB.
(4) With control board CU05-25, CU05-45 or CU05-65.
TCP/IP Section 1 Introduction 36 3BSE 030 821 R201

TCP/IP

• Control Builder and MMS on TCP/IP **are not** compatible with Advant Controller 250 programmed with ACB version 1.
• Control Builder and MMS on TCP/IP **are** compatible with SattLine.
• SattBus on TCP/IP **is** compatible with SattCon 200 and Advant Controller 250 programmed with ACB version 1.

Intended User

The reader is assumed to have general knowledge of control methods and relevant literature regarding specific protocols and fieldbuses.

MMS

Introduction

Control Network uses the MMS protocol and a reduced OSI stack with the TCP/IP protocol in the transport/network layer, and Ethernet and/or RS-232C as physical media. MMS (Manufacturing Message Specification) is an ISO 9506 standard. This means that all communication handling will be the same, regardless of network type and connected devices. The protocol defines communication messages transferred between controllers as well as between the engineering station (such as Control Builder) and the controller (e.g. downloading an application or reading/writing variables). It has been developed especially for industrial applications.

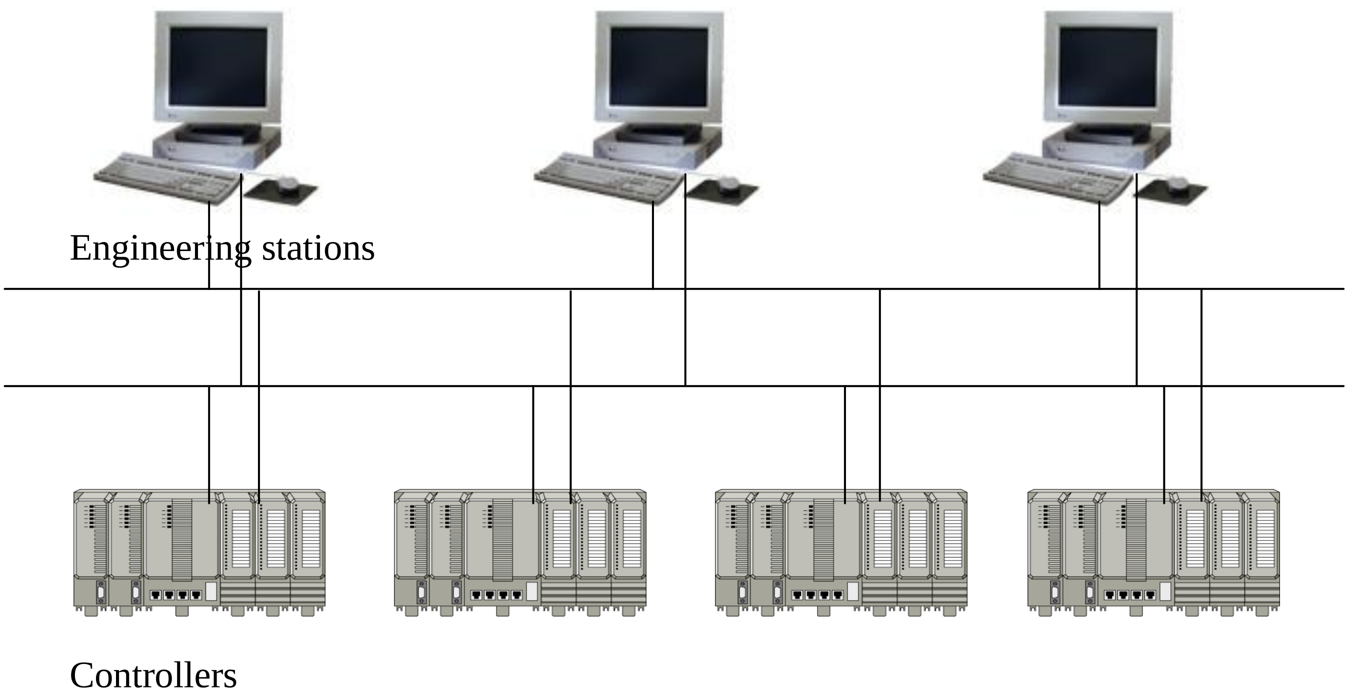


Figure 7. The MMS protocol defines communication messages transferred between controllers as well as between engineering stations and controllers.

Services Provided

The MMS protocol provides several services1 within a network:
• Downloading an application, e.g. executable code and data from an engineering station (such as Control Builder) to a controller.
• Creating, deleting, starting, and stopping programs over the network.
• Reading and writing variables located in other systems on the network.

• Obtaining information about applications being executed and about error conditions in remote systems.
• Reading and writing files over the network.
• Handling alarm conditions.
• Obtaining information on remote system capability, model identification and revision of remote systems.
Main advantages:
• The MMS protocol is an ISO 9506 standard protocol, which means all communication handling will be the same, regardless of network type and connected devices.
• The protocol can be used on many different networks, but preferably on the TCP/IP network, which is the most commonly used network today.

Design

Configuration Parameters

The Control Network is configured by means of the Project Explorer in Control Builder. Any controller supported by Control Builder can also be connected to Ethernet. The different alternatives are described in the hardware manual for the respective controller. Settings for the controller and the communication channel (Ethernet or PPP) are entered via the Control Builder. PC nodes are configured in the PC setup wizard (see the Setup Wizard Online Help).
To display the *parameter list* from the hardware tree, expand *Controllers*, find your controller, expand *Hardware AC 800M*, expand the processor unit, click the *Ethernet* channel and select the Settings tab.
The *IP address* and *IP subnet mask* are standard IP terms, whereas the remaining parameters are used by the *Redundant Network Routing Protocol (RNRP)*. Figure 8.

Parameter	Value	Type	Unit	Min	Max
IP address	172.16.0.0	string			
IP subnet mask	255.255.0.0	string			
Network Area	0	dint		0	35
Path Number	0	dint		0	3
Node Number	0	dint		0	500
Network Area Local	false	bool			
Send Period	1	dint	s	1	60
Max Lost Messages	3	dint		1	10
Proxy router	0.0.0.0	string			
Target address	0.0.0.0	string			

Figure 8. Ethernet parameter list in Control Builder

The *IP address* and *IP subnet mask* are standard IP terms, whereas the remaining parameters are used by the *Redundant Network Routing Protocol (RNRP)*. Figure 8. Ethernet parameter list in Control Builder Devices such as controllers and engineering stations are connected to the network at network *nodes*. Each node must have a unique *IP address* making it possible to communicate with other nodes. If the recommended private address space is not used (see page 42) then the IP address must be globally unique.

The network ID must be identical for all nodes on the same network. It is recommended that an address be selected from the private IP address space, which has the following advantages:
• There is no requirement to apply to the licensing authorities for an IP address.
• Some protection is gained against illegal access, since private addresses are not permitted on the public Internet.
• The firm connection between IP and RNRP parameters lessens the risk of inconsistency.

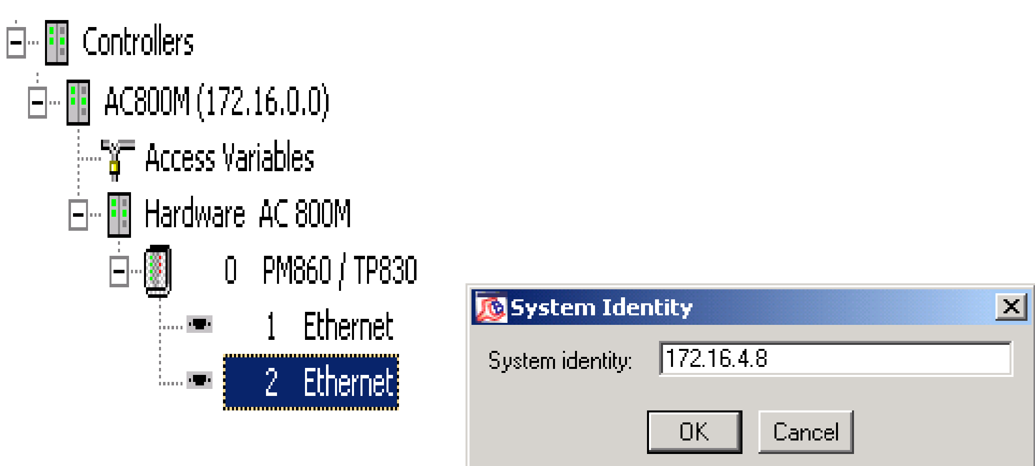
Network Areas

The Control Network, identified by its network ID, normally covers one manufacturing plant. A large Control Network can be divided into *network areas* (subnetworks), for example to keep most of the time-critical communication within smaller areas, thereby improving performance. The Control Network can contain up to 32 network areas, each with a maximum of 500 addressable nodes (different number series can be used for different plant areas [check the controller performance for restrictions on the total number of nodes that can be used]). Subnetworks are not permitted within a network area. Network areas must be interconnected by controllers (used as routers). A controller running the RNRP protocol with two Ethernet ports having the same node number connected to different network areas, has router capability. If the node detects that it is connected to more than one network area, it automatically starts routing without any need for extra configuration data.

Example:

The two Ethernet channels of an AC 800M with node number 8 are used to connect network areas 1 and 3.

Figure 10. Entering system identity.



To enter the correct controller *system identity* right-click the controller and select System Identity. This must be identical to the IP address of the communication port used by Control Builder (the first Ethernet port in the example below).

Port 1

Parameter	Value	Type	Unit	Min	Max
IP address	172.16.4.8	string			
IP subnet mask	255.255.252.0	string			
Network Area	1	dint		0	31
Path Number	0	dint		0	3
Node Number	8	dint		0	500
Network Area Local	false	bool			
Send Period	10	dint	0.5s	1	12000
Max Lost Messages	3	dint		1	10

Parameter	Value	Type	Unit	Min	Max
IP address	172.16.12.8	string			
IP subnet mask	255.255.252.0	string			
Network Area	3	dint		0	31
Path Number	0	dint		0	3
Node Number	8	dint		0	500
Network Area Local	false	bool			
Send Period	10	dint	0.5s	1	12000
Max Lost Messages	3	dint		1	10

Port 2

Figure 11. AC 800M used as a router between two network areas.

The third part of the IP address in binary notation is LAAAAANN, where AAAAA is the local area number (see page 40). Since we have not used very large node numbers and the local flag is false (=0), the third part of the IP address is 00000100 for local area 1 and 00001100 for local area 3. The decimal equivalent is 4 for area 1 and 12 for area 3.

MasterBus 300

Introduction

MasterBus 300 (MB 300) can be used for communication between AC 800M and controllers such as AC 400 Master, MasterPiece 200 and other AC 800M controllers. A communication unit CI855 for AC 800M provides connectivity to AC 400 via MB 300. Refer to the relevant user's guides and reference manuals regarding the process interface that can be used with AC 400.
The CI855 unit is configured by means of Control Builder in the hardware configuration tree. CI855 has two Ethernet channels to provide network redundancy.

Services Provided

• DataSet (DS) communication with other controllers on MasterBus 300.
• Function blocks in the AC 800M are used to cyclically send and receive DataSets on MB 300.
• Time synchronization on MB 300 is supported in the AC 800M with the accuracy provided on MB 300.
• The CI855 unit status, watchdog supervision and logged system messages are reported to the AC 800M for display in the Control Builder and the Plant Explorer Workplace status system.
• Support of MB 300 network redundancy.

Design

Introduction

The three function blocks *MB300Connect*, *MB300DSSend* and *MB300DSReceive*, handle communication between DataSets belonging to different controllers connected to MasterBus 300. A DataSet consists of an address part and up to 24 elements (32-bit values). A value can be a 32-bit integer, a 16-bit integer or a real or 32 Boolean. The address part is the destination network node, the source network and a DataSet identity.
Each CI855 unit behaves as a unique node on the MB 300 network to which it is connected and must be configured accordingly in the Control Builder hardware configuration tree. Parameters downloaded to CI855 are:
• A personal node number
• Network numbers for the two network links
• The MB 300 Protocol type, i.e. MB 300, MB 300E or MB 300F
• End node or no end node
• Clock-synchronization function

Communication Function Blocks

An AC 800M on Control Network connects to a controller on MB 300 by means of an *MB300Connect* function block. The *MB300DSReceive* and *MB300DSSend* function blocks with the same *Id* parameter value as the *MB300Connect* function block can then be used repeatedly for communication with that controller. See the example in Fig. 23. Refer to the online help for an explanation of the function block parameters.

The *CIPos* parameter specifies the position number of the *CI855* unit in the hardware tree (identical to its position on the CEX bus).
CAPos specifies the MB300 network number, and *NodePos* the node position of the controller on the network.
DataSetId is an integer specifying the DataSet identity. *SupTime* specifies the time interval between receive or send operations. The extensible parameters *Rd* and *Sd* of *AnyType* data type indicate the total number of application variable names. They allow the user to specify personal parameters, the only restriction being that the total number of parameters must equal the total number of allocated elements in the DataSet.

Redundancy

The CI855 unit houses two Ethernet channels to provide network redundancy. The routing tables in CI855 that indicate the network, node address and port to use when sending to an MB 300 node, are continuously recalculated according to the latest topology information in the routing messages. In the case of link/node failures, switch-over to redundant links is automatic.

Limitations

MasterBus 300 in AC 800M is used for communication with other nodes such as AC 400 Master, MP 200 and AC 800M.
A DataSet consists of up to 24 elements (32-bit values).

Performance

Transmission speed: 200 packets/sec.
Clock synchronization: 3 ms.

Hardware

• MasterBus 300 interface unit CI855 connects to the CEX bus of the AC 800M.
• Twisted pair 10BASE-T Ethernet cable with RJ45 connector is used. The installation should comply with Category 5 specification according to IEEE 802.3.

Advanced

Time synchronization on MasterBus 300 is supported in the AC 800M by the accuracy provided on MB 300.
The CI855 editor in the Control Builder is used to specify the clock synchronization mode:
• No synchronization
• CI855 is synchronized by AC 800M; CI855 does not synchronize MB 300 network.
• CI855 is synchronized by MB 300; AC 800M may be synchronized by CI855.
• CI855 is synchronized by AC 800M; CI855 is clock-master in the MB 300 network.
If AC 800M is to be synchronized from the CI855 unit, it is also necessary to select MB 300 as clock synchronization type in the CPU hardware editor.

Troubleshooting

The CI855 device status, watchdog supervision and logged system messages are reported to the AC 800M for displaying in the Control Builder and Plant Explorer Workplace status system. Watchdog mechanisms are used by the AC 800M to supervise the CI855, which supervises the AC 800M. The watchdog function is cyclically called and interrupts the CI855 unit, which, if it does not receive an interrupt within a certain time, stops communication at its ports. The CI855 responds with a watchdog signal to the AC 800M, which expects the CI855 unit to cyclically generate watchdog interrupts. The unit is considered out of function if an interrupt is missing. The CI855 operating system has its own watchdog/stall handling, which will halt the CI855 processor in the event of hardware or software errors.

SattBus

Introduction

SattBus is a robust communication network for linking controllers, intelligent I/O devices, sensors, etc. It is the ideal solution for users seeking a low-cost field bus capable of tolerating harsh environments to be used to collect small amounts of data. The name SattBus is used both for the application multimaster protocol and the physical layer. It is also possible to use the application protocol SattBus on TCP/IP in those cases where ordinary SattBus can not be used. SattBus is an open protocol, easy to configure and connect to, and can be implemented by any manufacturer. Due to its low memory requirements, SattBus can be integrated with an application in a single-chip microcontroller. Different types of interfaces, for example for PCs, are also available.

The multimaster operation allows event communication, which increases the efficiency and lowers utilization of the network. SattBus is optimized for the transfer of small amounts of data. All this contributes to making SattBus a high performance network for systems with highly distributed data reaching a maximum effective data transmission rate of 3000 bytes per second. In the physical layer context, SattBus is a fieldbus based on token passing, which is easy to configure and connect to. Connection to the unshielded twisted pair cable is achieved via a simple terminal block. Unless the cable is cut, network operation is not interrupted when connecting and disconnecting nodes. The nodes are automatically included in the token passing when connected, and automatically excluded if they fail.

Services Provided

SattBus provides the following services:

• Variable names.

• Managing and accessing variables in remote nodes.

• COMLI transparent messages over SattBus (see also Section 5, COMLI, subsection Services Provided on page 83).

In total, 16 services are defined in the SattBus protocol. The most important ones relate to variable transfer.

All nodes on SattBus are equipped with the basic ability to identify the node by a short, five-character name. This service also provides the program version and defines the other SattBus services the node can handle. Nodes with different sets of variables have different identities.

Design

Introduction

SattBus is a fieldbus based on token passing and uses frequency shift keying at 62.5 kHz to transmit at a bit rate of 62.5 kbits per second.

Communication is performed via SattBus function blocks, e.g. SBConnect, SBRead and SBWrite or COMLI function blocks. COMLI function blocks are used for directly addressed communication (e.g. X100, R1000). SBRead/SBWrite are used for named SattBus communication.

In named SattBus, a structured variable can have 254 components of simple data types.

Design Examples

Before SattBus communication can be started, certain parameters must be set for the board in the Control Builder. (Refer to the online help for further information.)

Example 1:

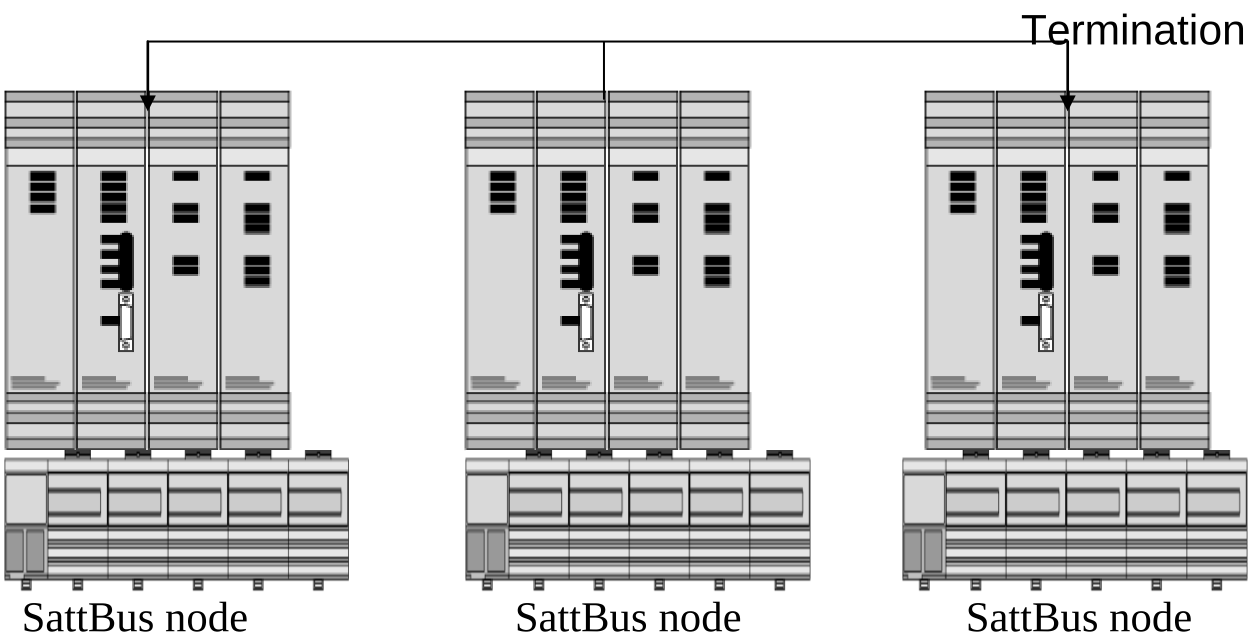


Figure 24. Normal SattBus network

Redundancy

SattBus does not support redundancy explicitly, but it is possible to use fiber optic modems to obtain cable redundancy.

Limitations

- Physical SattBus can only be used in the Advant Controller 250, but SattBus on TCP/IP can be used in all AC 800M controllers.
- An unshielded twisted pair cable should be used (see Table 11).
- A maximum of 120 nodes over a distance of 2000m can be connected.
- The two outermost nodes must be terminated.
- Redundancy only with fiber modems.

Performance

A SattBus channel can handle a maximum of 20 messages per second, but the performance varies in different systems. SattConXX systems can handle about 5-10 messages per second.
If each node is allowed a maximum of one message frame per token rotation, then the SattBus data link layer can transfer up to 3000bps within message frames.
Transfer efficiency is over 30%. SattBus is stable in an overload situation, i.e. the throughput does not decrease as the load increases and the system does not become blocked.

SattBus on TCP/IP

When SattBus communication uses the Ethernet network, SattBus messages are transferred using TCP/IP. Communication is also possible using COMLI function blocks via SattBus on TCP/IP.
SattBus application messages are sent ‘as is’ using the User Datagram Protocol (UDP) of the TCP/IP suite. A small heading is added for a transport protocol implemented on top of UDP. This protocol is responsible for sequence and transport control, assuring that SattBus messages are received in order, and that they are transmitted up to 4 times until they are acknowledged (on the transport level) by the receiver.
The node status supervision of physical SattBus is simulated on the transport level above UDP by sending background supervision traffic a number of times per minute (in the absence of other traffic). This enables node status reports to perform in a similar way to physical SattBus, although the time resolution is lower. However, this applies only to nodes where logical connections exist.

COMLI

Introduction

COMLI (COMmunication LInk) is a standard protocol, designed by ABB Automation, for data transmission/communication between controllers. It is a conventional communication link using serial, asynchronous data transmission according to the master/slave principle, in one direction at a time (half duplex mode). It is used mainly for reading and writing variables between control network devices, using point-to-point communication or multidrop communication. COMLI can be used in serial communication (RS-232C and RS-485) as well as in SattBus- TCP/IP. COMLI is suitable for communication with controllers such as SattConXX, and has been adapted to ensure that:

- maximum use is made of the communication line, resulting in compact storage of data transmitted or received,
- by checking every character as well as the entire message, the transmission is secure.

Services Provided

Master

- COMLI ReadPhys (Read Physical Value) (message G)
- COMLI WriteDT (Write Date and Time) (message J)
- Read and Write in registers and bits (messages 0, 2, 3, 4)

Slave

- Only Read and Write in registers and bits (messages 0, 2, 3, 4)

Design

Introduction

Master and slave can be linked together in different ways to achieve the desired function, e.g. point-to-point or multidrop (multipoint).
Master and slave are linked via the serial channels on the different systems that are to communicate with each other. The master and slave need not use the same physical channel numbers in both systems. They must, however, have the same character format, transmission speed, etc.
When the slave receives a message, it responds either by sending the information requested or by acknowledging the information received. The slave does not respond if it receives an error message.
To change the status of a system/device from master to slave, a new configuration must be downloaded from Control Builder.

Design Examples

Multipoint Communication

In multipoint communication several slave systems are connected to a master. Communication takes place between the master and one slave at a time. Direct communication between slave systems is not possible. A particular message from the master is sent to all slaves, but only the slave whose unique identity corresponds to the identity contained in the message accepts the data. The number of slaves that can be connected to each master is limited by the communication interface. The RS- 485 interface must be used in multipoint communication. The master transmit line is connected to all slave receive lines and all slave transmit lines are made common and connected to the master receive line.

Point-to-Point Communication

In point-to-point communication, only one slave system is connected to the master via one communication interface. Several slaves can be connected to the master but this must take place via different communication interfaces. This form of point-topoint configuration can reach a capacity higher than that achieved with multipoint communication.
The electrical interface can be either RS-232C or RS-485.

Redundancy

Redundancy is not built in, but can be implemented on application level or physical (cable) level by the user.

Limitations

• A maximum of 31 slave systems can be connected to each serial channel via the RS-485 electrical communication interface (the COMLI communication protocol can administer a maximum of 247 slave identities, see Figure 28).
• The maximum message size is 512 bits or 32 16-bit registers (integer reading).

Performance

Performance is affected by *transmission speed, message length* and *application load*.
For RS-232C channels a *baud rate* can be selected between 2400 and 19200 bits per second. To send a byte requires 11 bits (start bit, 8 data bits, parity bit and stop bit). Consequently 9600/11 = 872 bytes per second can be sent if the baud rate is 9600. The maximum transmission distance depends on the interface used (RS-232C or RS-485) and the transmission speed. The table below provides guidelines for the different interfaces and speeds. Note that a noisy electrical environment may require shorter distances.

Values given for shielded, twisted pair cables of type Belden 8723 or Belden 9502. Longer distances require a short-range modem.

In AC 800M, servicing the S800 I/O via ModuleBus has highest priority. Execution of the application program (IEC 1131-code written by the user) has next highest priority. Depending on the amount of code and the requested execution intervals, the application program may require up to 70% of CPU capacity. Communication handling has lowest priority, though normally at least 30% of CPU capacity will be reserved for this purpose.
Communication takes place serially and asynchronously according to the master/slave (or client/server) principle. The *master channel* of a system initiates the message transmission sequence, while a system acting as a slave simply responds to the calls from the master via a *slave channel*. Master functionality is implemented by function blocks provided by the communication libraries, such as COMLIWrite and COMLIRead, used to write/read data between controllers. In a system acting as master, the communication performance is of course affected by the execution interval of the communication function blocks in the application program. Response is handled in the background; it is not triggered by the application program in the slave system, but is slowed if the application load is high.
The terms register (16 bit integer 0-65535) and bits refer to the COMLI protocol and are mapped to the data types dint (double integer) and bool (Boolean) in the AC 800M world. The number of variables that can be sent in one COMLI message is 1- 512 bool or 1-32 dint. Boolean variables must be transferred either as a single variable or in multiples of eight, maximum 512. Variables of type bool and dint cannot be mixed within the same function block. A long message takes longer to transmit than a short one, but it is always more efficient to use long messages if a large data area is to be transmitted.

Hardware

A standard RS-232C/485 communication channel is required. The cable length can be extended considerably (to several km) using a fiber optic converter. One of the following standard communication interfaces is used for serial communication with COMLI:
• RS-485
• RS-232C
• When using multipoint communication, ports must support RTS (hardware handshake) or CTS.

Advanced

Procedure for Linking Control Systems with COMLI

The procedure for connecting different control systems to a common COMLI communication network can be summarized as follows:
• Select the message types by establishing the type of information to be transmitted between systems.
• Select the network configuration. Select multipoint or point-to-point and the communication interface to be used, i.e. RS-485 or RS-232C.
• Select the channel (channels) to be used. The choice depends on which channels are available and whether the channel can transfer the required information at the required speed.
• Decide which system is to be master and which is to be slave. This is specified in the channel parameter list. The master controls data transmission operations since only the master can initiate a message transmission sequence.
• Connect the systems to the network with suitable cables.

When the above has been completed, the various communication parameters can be defined in a number of data fields.

COMLI Message Format

General

COMLI defines the handshaking procedure, the message start and stop characters used, whether or not the message has a header, the contents of the acknowledgement message, etc.
The formats for different types of messages are similar. Each message starts with a start character (STX) followed by characters for destination, time stamp, message type and data.
Messages are divided into the following types of transactions:
• *Request* message from master to slave (13 characters), followed by a *Transmission* message,
• *Transmission* message from master to slave or slave to master (14–77 characters), followed by an *Acknowledgement* message,
• *Acknowledgement* message (transfer OK) from slave to master (8 characters). A master only transmits a request when it requires data from a slave. If the slave cannot carry out the request or an error occurs in the request message, no reply is sent by the slave.
A master or a slave can transmit a transfer message. When a master needs to change data in a slave, it transmits a message, which results in an acknowledgement by the slave. The slave does not respond if the message is not received correctly or if the data transmitted cannot be processed. A reply from a slave to a master can be sent as a result of a request for data. In this case, the reply containing the data is also an acknowledgement that the request was received and processed correctly. A slave will only send an acknowledgement when data from the master is correctly received.

Message Format

Regardless of whether it consists of a request, a transfer of data, or an acknowledgement, a message is made up of three blocks: start block, information block, and end block. The start and end blocks have the same format in all types of messages, whereas the information block varies depending on message type. The characters in the start and end blocks are always in ASCII format, the contents of the information block in binary format.

Start Block

The start block comprises three parts, namely *STX*, *identity* and *stamp*. For further information, refer to the COMLI System description.

Binary Communication

In supported binary communication, two characters occupy one byte, thereby doubling the packing density of the data block. Any combination of eight bits can be used. Thus the eight bits representing a character can assume any value between 00 and FFH.

Channel Definition

Each channel to be used for communication must then be defined so the channels used in the different systems are set up in the same manner. This is specified in the channel parameter list. Channel definition also includes selecting which system is to control the network, i.e. the master station. Each network contains only one master, but several slaves can be included. When more than one slave is included, the channel definition for each slave must stipulate the slave identity. This identity must be unique in each communication network.

INSUM

Introduction

INSUM (INtegrated System for User-optimized Motor control) utilizes microprocessor-based technology for protection and control of motors and switchgear, and for the transmission of messages and measured values. Each motor has a motor control unit (MCU) located in the motor starter module. The INSUM devices (such as MCUs) are arranged in up to four subnets, each one supporting up to 32 units at a 78kb/s transfer rate. A network (LonWorks) transfers messages at 1.25Mbps between the subnet units via routers. One INSUM MMI (man-machine interface) can be connected to LonWorks; also one or more AC 800M controllers equipped with INSUM TCP/IP interface units CI857.

Services Provided

• Multiple controllers can access the same MCU in an INSUM system.
• Three IEC 61131 function blocks are available for initialization of and exchanging data with the INSUM system, namely INSUMConnect (establishes connection), INSUMReceive (reads a process data value from an INSUM device), and INSUMWrite (writes a value to an INSUM device).
• A number of different motor types are supported, such as reversing motors, two-speed drives, actuators, and solenoid valves.
• Protection against thermal overload, underload, phase loss, ground fault, high motor temperature, locked rotor, etc.
• Protection functions can be parameterized to specify pre-warnings before a motor is tripped. The reset can be selected as automatic, remote, local or remote and local.

Design

Introduction

INSUM hardware is configured by means of the project explorer in Control Builder (see figure below). The AC 800M is equipped with two INSUM TCP/IP CI857 interface units, located as numbers 3 and 4 to the left of the PM860 CPU unit. Unit No. 3 is connected to three INSUM gateways, each supervising an INSUM motor control system.

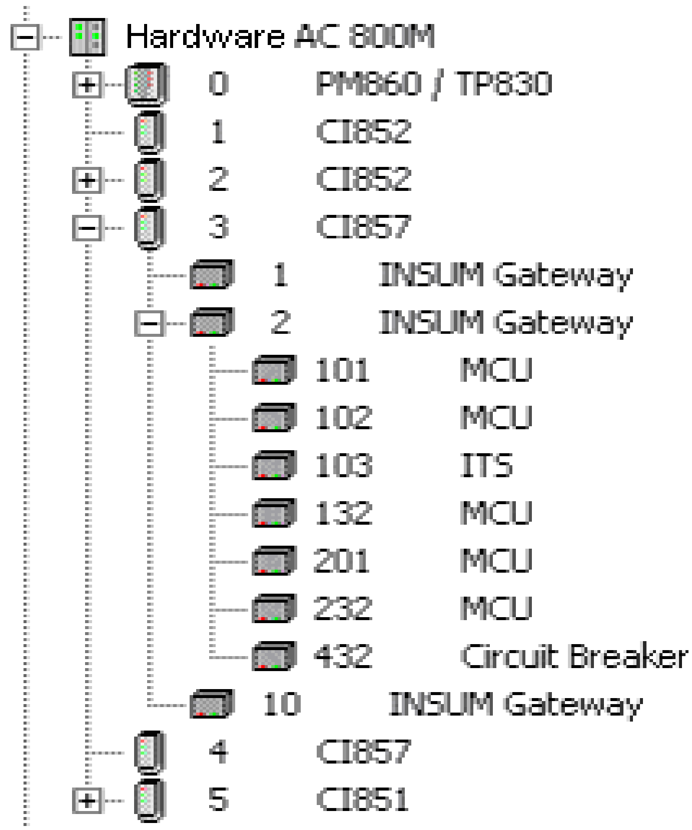


Figure 30. Project explorer.

Gateway No. 2 has three MCUs and one tier switch connected to its subnet No. 1, with node numbers 1, 2, 3 and 32. Two MCUs are also connected to subnet No. 2 and one circuit breaker to subnet No. 4. The CI857 units and the INSUM gateways have IP addresses that must be specified in the parameter lists.

Hardware

• INSUM TCP/IP interface units CI857 connect to the CEX bus of the AC 800M.
• Twisted pair 10BASE-T Ethernet cable with RJ45 connector. The installation should comply with the Category 5 specification according to IEEE 802.3.
• The LonWorks bus is integrated in the INSUM system backplane.
• INSUM routers and gateways, power supply, motor control units, circuit breakers, tier switches and man-machine interfaces are devices belonging to the INSUM system.
• INSUM routers, gateways and power supplies are connected directly to the INSUM backplane. Motor control units, circuit breakers, tier switches and man-machine interfaces are connected by means of prefabricated cables.

Siemens 3964R

Introduction

Siemens 3964R1 is a rather widespread communication protocol designed by Siemens. It is a standard serial point-to-point master/slave protocol. No special hardware is required apart from standard RS-232C/485 communication channels. Siemens 3964R is convenient for communication with instruments (e.g. scales) or controllers also using this protocol.

Services Provided

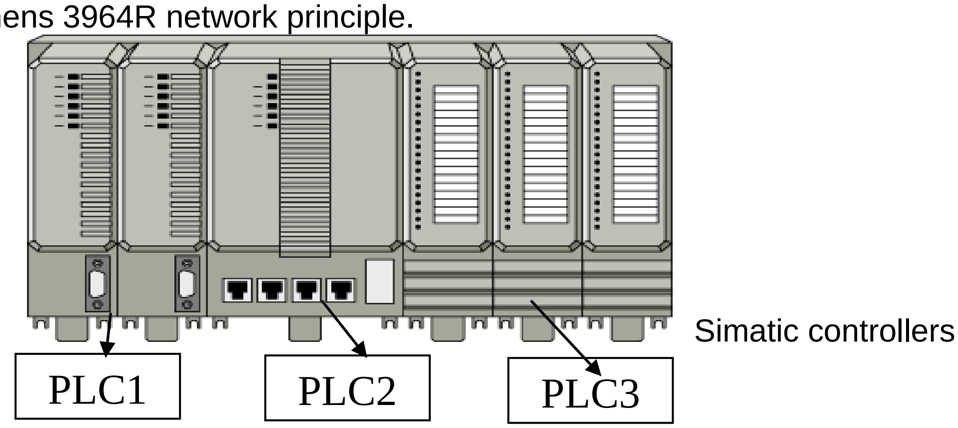
• Multiple registers can be read/written.
• Multiple I/O bits can be read.
• One message can handle a maximum of 512 I/O bits or a maximum of 32 registers.
• Writing of single I/O bits is also supported, with the following limitation: writing of a single I/O bit is done to data block 222, using a special bit message which is not implemented in Siemens 3964R. Special application software is needed in the Siemens system to handle this. It is possible to change the data block via the SiemensBitTransferDB system variable in the controller.
• Messages can have 32 registers, but they must not exceed data block boundaries. This means that the data blocks in Siemens systems communicating with this system are limited to data blocks 3-14.

Design

Introduction

Communication is performed via function blocks. The controller sends one read or write message to the subsystem and then awaits the answer. This means only one message will be outstanding per channel, i.e. master/slave principle The figure below shows a Siemens 3964R network in principle.

Figure 32. Siemens 3964R network principle.



Before Siemens 3964R communication can be started, the normal RS-232C parameters must be set for the Control Builder Com port. Refer to the online help for details.

Redundancy

Redundancy is not built in, but can be implemented on application level or physical (cable) level, by the user.

Limitations

• The controller can act only as master; i.e. only client functionality is supported for Siemens systems.
• Only point-to-point communication is possible; i.e. only one slave may be connected to each communication channel.
• "Interpreter RK512" must be installed on the Siemens system (the slave).
• Writing of multiple I/O bits is not supported.

Performance

Similar to COMLI, see Performance on page 87.

Hardware

A standard RS-232C/485 communication channel is required.
Cable lengths: RS-232C: 15m, RS-485: 1200m. The length can be extended considerably (to several km), using a fiber optic converter.
Both 2-thread and 4-thread communication can be used for the RS-485 port.

ModBus RTU

Introduction

ModBus RTU is a standard protocol widely spread because of its ease of use and the fact that it supports communication over a wide variety of media, such as wire, fiber optics, radio and the telephone.
ModBus is executed serially and asynchronously according to the master/slave principle, and in one direction at a time. However, only master functionality is implemented in the ControlIT controllers. Modbus is used mainly for reading and writing variables between control network devices, using point-to-point or multidrop communication. Message framing is implemented in RTU mode, which is a binary format. The ModBus protocol is designed to transfer data securely by checking each byte as well as the entire message for transmission errors.

Services Provided

A number of ModBus commands are supported. The application programmer can access the protocol functions through function blocks, according to the IEC 61131-5 standard. The protocol software translates the request from connect, exception, read, and write blocks into ModBus protocol commands.

Design

Introduction

Communication with ModBus takes place serially and asynchronously according to the master/slave principle.
• The *master channel* of a system controls the communication of devices with *slave function*.
• A device with *slave function* is connected via a *slave channel* and its communication is controlled from a master channel.

Note that a specific device may have some channels specified for a master and some for a slave. Consequently the device may act as master in relation to some devices and as slave in relation to others. See also Figure 35 & 36 for a graphical view of the concept.

Redundancy

Redundancy is not supported in this release.

Limitations

• Only master functionality is implemented.
• Only RTU mode is implemented (only binary values are used).

• Communication using a dial-up modem is not possible.

Performance

Similar to COMLI,

Hardware

An RS-232C communication channel is required (and possibly an RS-232C/485 converter). Maximum cable lengths are 15m for RS-232C and 1200m for RS-485. Cable length can be extended considerably (to several km) using a fiber optic converter.

Advanced

More information and references to literature concerning ModBus can be accessed from http://www.modicon.com.

Troubleshooting

The operator can monitor the status of all hardware units using the Project Explorer in the Control Builder.

FOUNDATION Fieldbus HSE

Introduction

FOUNDATION Fieldbus, developed by The Fieldbus Foundation, was introduced in 1995. It is a bi-directional protocol used for control system communication and meets ISA SP50 requirements. It is a fieldbus used for communication with distributed I/O units and fulfills the rigorous regulations and safety demands in high-risk (explosive) environments, and supports process control without involving a controller. It is an open protocol, which means that devices from different certified manufacturers are compatible (interoperability).
FF defines two communication profiles, H1 and HSE The H1-Profile with a data transmission rate of 31.25 kBit/s is preferably used for direct communication between field devices in one link (H1 link). The HSE profile with a transmission rate of 100 Mbit/s serves first and foremost as a powerful backbone for the link between H1 segments. The first devices that are already available on the market and support the HSE profile are FF linking devices. They serve as a gateway between the field devices on the H1 segments and the HSE backbone.

Advantages

FOUNDATION Fieldbus H1

According to the Fieldbus Foundation (http://www.fieldbus.org), the benefits of FOUNDATION Fieldbus include reduced wiring (many devices can be connected to a single wire-pair), multi variables from a single field instrument, enhanced field level control, as well as facilitated integration and system maintenance procedures such as calibration and asset optimization predictive maintenance. For example, through function blocks, FOUNDATION Fieldbus offers PID control via process objects (even if the controller goes down). FOUNDATION Fieldbus is widely supported by process object suppliers and allows integrated distribution of process object functionality. The distribution of control between the process objects may reduce the number of I/O units and other control devices. Furthermore, FOUNDATION Fieldbus is convenient for slow processes. It can communicate large packets of device data and is suitable for complex control/automation applications. FOUNDATION Fieldbus has no distortion (no A/D or D/A conversion) and provides very reliable control functionality. In addition, the loop performance is improved because the control is kept within the devices themselves.

FOUNDATION Fieldbus HSE

Fieldbus Foundation claims the same life cycle benefits for FOUNDATION Fieldbus HSE as for H1. In addition HSE provides the control backbone that integrates all of the systems in the plant. FOUNDATION Fieldbus offers the performance needed by those users employing permanently connected online asset management software and other maintenance management operations gathering large amounts of information in real-time. Due to the open protocol, plant subsystems, even from different suppliers, may be easily integrated and information can be accessed without custom programming as data integrity, diagnostics and redundancy management are part of HSE. Linking devices bring data from one or more H1 links directly onto the HSE backbone. Thus HSE can bridge information between devices on different H1 links. Communication requires no central computer. HSE can replace enterprise, control and remote-I/O networking levels, thus flattening the enterprise communication structure. Standard Ethernet cable and wiring practises are used for HSE devices. Standard Commercial Off-The-Shelf Ethernet components may be used, which guarantees for extremely low costs, compared to proprietary solutions.

Design

Introduction

FOUNDATION Fieldbus is flexible, supporting function block scheduling, which means that basic control and measurement features can be implemented similarly regardless of the device manufacturer.
Self-test and communication capabilities of microprocessor-based fieldbus devices reduce downtime and improve plant safety.
FOUNDATION Fieldbus (FF) is integrated into the controllers by the communication interface module for FOUNDATION Fieldbus HSE (CI860). In Control Builder, the CI860 is a hardware object created and configured in the project explorer.
The configuration of FF HSE subnets is carried out with the Fieldbus Builder FOUNDATION Fieldbus (FBB FF). Thus configuration of CI860 requires both Fieldbus Builder FF and Control Builder M.

Design Example

Figure 38 shows the architecture of a system including engineering and operator station workplaces, controllers with FOUNDATION Fieldbus HSE CI860 communication interface units, linking devices, FF HSE devices, and H1 devices. FF HSE configuration requires Control Builder M Professional. In larger configurations, it is important to separate operator station and controller networks. In smaller configurations, operator stations and controllers may use the same network. As an alternative, in smaller configurations, operator stations and FF HSE devices may use the same network.
FOUNDATION Fieldbus HSE
Subnets **must never** be combined with the controller network.
FOUNDATION Fieldbus
HSE multicasts create too much load on the controller network.

General

• Multiple HSE subnets may be connected to a system.
• The CPU module of the AC 800M Controller must be connected to the controller network.
• The FOUNDATION Fieldbus HSE CI860 communication interface units in the AC 800M Controller must be connected to a HSE Subnet.
• Up to six FOUNDATION Fieldbus HSE Communication Interface Modules may be connected to one AC 800M controller.
• The FOUNDATION Fieldbus HSE Communication Interface Module CI860 may be used in redundant controllers, but it does not support module redundancy.
• The Linking Device LD 800HSE connects H1 links to an HSE subnet.

• FOUNDATION Fieldbus HSE subnets should be physically separated from other networks as FOUNDATION Fieldbus HSE multicasts cause high load on the network.
• OPC Server FF provides tool routing functionality.

Fieldbus Builder FF provides tool routing only if no OPC server FF has been added to the HSE subnet configuration in Fieldbus Builder FF.
– If the Client Server Network and FOUNDATION Fieldbus HSE subnet(s) are separated from each other, which is the recommended configuration, the Connectivity Server(s) running OPC Server FF are required, to provide tool routing functionality for the workplaces running Fieldbus Builder FF, so that these can access the FF subnet(s).
– If the Client Server Network and a FOUNDATION Fieldbus HSE subnet are separated from each other without a Connectivity Server running OPC Server FF, the workplace running Fieldbus Builder FF needs to be connected directly to the HSE subnet, and to the Client Server network.
This is not recommended and should be used in small configurations only. Only a single HSE Subnet can be configured.
– If the Client Server Network and a FOUNDATION Fieldbus HSE subnet are not separated from each other (separating the networks is recommended in production environments) and no OPC Server FF is configured, the Fieldbus Builder FF provides tool routing functionality.

Operator Station Network (Client Server Network)

• The following components are connected to the operator station network:
– Aspect Server,
– Plant Explorer workplaces with Control Builder M and Fieldbus Builder FF,
– Connectivity server with OPC Server AC 800M.

Controller Network (Control Network)

• The following components are connected to the controller network:
– Engineering station(s) with Control Builder M, Fieldbus Builder FF,
– Operator station(s) with Plant Explorer Workplace,
– AC 800M Controller(s),
– AC 800M OPC Server.

Device Network (HSE Subnet)

• The following components are connected to the HSE subnet:
– FOUNDATION Fieldbus HSE communication interface unit(s) CI860,
– Connectivity Server(s) with OPC Server FOUNDATION Fieldbus,
– FOUNDATION Fieldbus linking device(s) LD 800HSE.
• Multiple FOUNDATION Fieldbus Linking Devices can be used in an HSE Subnet. It is recommend that a maximum of 10 Linking Devices is connected to a single HSE Subnet.
• Multiple HSE Host Devices may be connected to an HSE Subnet.
• HSE Subnets are based on the Ethernet standard. Therefore standard Ethernet components can be used to build an HSE subnet.

• All components used in an HSE Subnet must be capable of handling multicasts as FOUNDATION Fieldbus uses multicast.

Limitations and Performance

Dimensioning Limits, Linking Device

For information on linking device limitations, please refer to the FF Linking Device LD 800HSE documentation.

Dimensioning Limits, FOUNDATION Fieldbus HSE Communication Interface Module CI860

FOUNDATION Fieldbus HSE Communication Interface Module CI860, HSE Level

• The CI860 can handle a maximum of 1000 VCRs (Virtual Communication Relationships).
• Each VCR can be assigned to an I/O channel.
• For each CI860 a maximum of 500 signals per second can be read/written.

FOUNDATION Fieldbus HSE Communication Interface Module CI860, Controller Level

• Please refer to the AC 800M hardware documentation.

Hardware

The communication interface unit CI860 can only be used in AC 800M controllers.

Advanced

For more information, please refer to Device Integration FF and FOUNDATION Fieldbus HSE documentation.

Troubleshooting

Status of Hardware Units

The user can monitor the status of AC 800M hardware units using the Control Builder Project Explorer in online mode. The Fieldbus Builder FF can be used to monitor FF HSE and H1 devices as well as the H1 links. Some status information is automatically collected by the system in the controller; some is collected if so programmed and some can only be viewed using the Fieldbus Builder FF or the OPC Server FF.

FOUNDATION Fieldbus H1

Introduction

FOUNDATION Fieldbus, developed by The Fieldbus Foundation, was introduced in 1995. It is a bi-directional protocol used for control system communication and meets ISA SP50 requirements. It is a fieldbus used for communication with distributed I/O units and fulfills the rigorous regulations and safety demands in high-risk (explosive) environments, and supports process control without involving a controller. It is an open protocol, which means that devices from different certified manufacturers are compatible (interoperability).
According to The Fieldbus Foundation (http://www.fieldbus.org), the benefits of FOUNDATION Fieldbus include reduced wiring (many devices can be connected to a single wire-pair), multivariables from a single field instrument, enhanced fieldlevel control, and facilitated integration/maintenance. For example, through function blocks, FOUNDATION Fieldbus offers PID control via process objects (even if the controller goes down).
FOUNDATION Fieldbus is widely supported by process object suppliers and allows integrated distribution of process object functionality. The distribution of control between the process objects may reduce the number of I/O units and other control devices. Furthermore, FOUNDATION Fieldbus is convenient for slow processes. It can communicate large packets of device data and is suitable for complex control/automation applications.
FOUNDATION Fieldbus has no distortion (no A/D or D/A conversion) and provides very reliable control functionality. In addition, the loop performance is improved because the control is kept within the devices themselves. For new installations, it is recommended to use the FOUNDATION Fieldbus HSE protocol. However, the FOUNDATION Fieldbus H1 protocol is still supported.
FOUNDATION Fieldbus (FF) is integrated into the controllers by the communication interface for FOUNDATION Fieldbus unit (CI852). In Control Builder, the CI852 is a hardware object created and configured in the project explorer. See the online help for further details.

Services Provided

Services provided include variable traffic incl.configuration and diagnostics.

Design

Introduction

FOUNDATION Fieldbus is flexible, supporting function block scheduling, which means that basic control and measurement features can be implemented similarly regardless of device manufacturer. In addition, FOUNDATION Fieldbus makes possible adding new devices without disrupting active fieldbus control functions. Thus, plant operation can be improved without costly shutdowns. FF links may be configured using an external FF configuration tool such as the National Instruments Fieldbus Configurator (NI tool). In addition, device description (DD) and capability files are required for CI852 and FF devices. Self-test and communication capabilities of microprocessor-based fieldbus devices reduce downtime and improve plant safety.

Redundancy

Redundancy is not supported in this release.

Limitations

• Only supported in AC 800M.
• Up to 12 CI852 units can be connected to an AC 800M, that is to say up to 12 FF H1 segments can be connected (one per CI852 unit).
• The number of devices on a single segment is limited by the FF specification to 32, and in volatile (Ex) environments to about 4–10. The actual number will be dependent on the number of parameters accessed from each device and the speed of that access. The interface unit is a link master device for the FF H1 bus.
• IS (Intrinsic Safety) barriers must be provided as external devices. This also applies to adapters used to connect power supplies to field devices and redundant power supplies to the bus.

Performance

• Publisher/subscriber model, 1000 accesses of a specific parameter in a custom function block (CI852): real/dint/DS65, 10% last->30s,
69% last->39s, 70% last->58s
• Client/server model, 1000 accesses of a specific parameter in a function block in a FF device:
real70% last->5min30s, 50% last->5min40s
dint70% last->5min30s, 50% last->5min50s
DS65 70% last->5min8s, 50% last->5min30s

Hardware

The communication unit CI852 can be used in AC 800M.

Advanced

See the manuals “FOUNDATION Fieldbus User’s Guide” and “FOUNDATION Fieldbus Wiring and Installation User’s Guide”.

Troubleshooting

Status of Hardware Units

The operator monitors the status of all hardware units using the Project Explorer in the Control Builder. The FF configuration tool, developed by National Instruments (NI tool), can also be used for monitoring. The hardware units that can be monitored are:
• The communication interface unit (CI852)
• The FOUNDATION Fieldbus H1 bus
• The field devices
Some status information is automatically collected by the system in the controller;some is collected if so programmed and some can only be viewed using the FOUNDATION Fieldbus configuration tool.

DriveBus

Introduction

The DriveBus protocol is used for communication between ABB Drives and SpecialI/O units on the one side, and an AC 800M controller, via the CI858 communicationinterface unit, on the other side. The data exchange between the units is cyclic.
DriveBus communication is especially designed for sectional drive applications, for example ABB rolling mill drive systems and ABB paper machine control systems.
Supported media:
• DDCS (Distributed Drives Communication System) protocol,
• Optical fibers for improved interference immunity and large network distances,
• The CI858 communication interface unit is CE-marked, and meets the requirements specified in EMC Directive 89/336/EEC according to the standards EN 50081-2 and EN 61000-6-2.

Services Provided
• Dataset communication,
• Cyclic output/input to/from drives,
• Cyclic data to/from I/O units,

Advantages

• Supports many different types of drives and I/O units.
• Time synchronization of drives to common calendar time,
• Easy configurability of drives and Special I/O's, to be used with AC 800M,
• Identification method, self-checking and preventive systems to avoid incorrect configurations,
• Communication diagnostics for the application,
• No additional adapters required.

Design

DriveBus has specific definition parameters, required for device configuration. Examples of such parameters are Configured application ID and Dataset priority.
The user connects all inputs and outputs to variables. DriveBus communication is automatically created when the application is downloaded to the controller.

Limitations

When a modified hardware configuration is downloaded to the controller, communication with hardware units may be interrupted:
• If modified CI858 parameters are downloaded to the controller, DriveBus communication is interrupted, and the affected CI858 will reboot.
• If modified drive parameters are downloaded to the controller, communication with the drive is interrupted, and a drive fault message, indicating communication loss, might be activated. If

BusManager is not selected to monitor the connection, the fault can be avoided by adjusting the time delay of the drive communication loss supervision.
• If modified I/O parameters are downloaded to the controller, communication with the I/O unit is interrupted.
• If a drive or an I/O unit is added to or deleted from the hardware tree, and the changes are downloaded to the controller, the affected CI858 will reboot.
• If the hardware tree positions of different types of drives or I/O's are changed, and the changes are downloaded to the controller, the affected CI858 will reboot. Switching the position of two similar units will not result in a reboot of the affected CI858.
• Changing the connected channels of a drive or an I/O causes recalculation of the connections.

Performance

For each drive connected to the CI858 communication interface unit, 8 dataset pairs can be defined. The number of datasets per drive can be extended using special applications.
riveBus is able to transfer a maximum of 8 dataset pairs/ms

Hardware

The maximum number of CI858 units connected to the AC 800M is two.The unit has three channels:
Drive channel can be used for controlling up to 24 drives. The following drives are supported.
• ACS 800 / ACS 600 SingleDrive,
• ACS 800 / ACS 600 MultiDrive,
• ACS 800 / ACS 600 IGBT supply units,
• ACS 600 thyristor supply units,
• ACS 140 … ACS 400,
• DCS 600 and DCS 400,
• ACS 6000 product family / large drives,
• ACS 1000 product family,
• future drive types which are provided with DDCS interface,
• special drive applications which require more than eight dataset pairs (the number of datasets is user-defined).
Special I/O channel can be used to connect up to 12 I/O per unit. The following drives are supported.
• NAIO-03 Analogue I/O Extension,
• NBIO-21 Basic I/O Unit 2,
• NBIO-31 Basic I/O Unit 3,
• NCTI-01 Crane Transducer Interface,
• NDIO-02 Digital I/O Extension,
• NPCT-01 Pulse Counter and Timer,
• NWIO-01 Watchdog I/O,
• Special I/O applications, with user-defined number of datasets.
• NTAC-02 Pulse Encoder Interface,

ControlNet

Introduction

ControlNet is a high-performance I/O network for industrial applications; a standard used for fast communication between control systems and distributed I/O units.

Services Provided

• Deterministic (reliable prediction of data delivery) and repeatable (constant delivery times) performance for both discrete and process applications
• Reading and writing I/O data
• Simple installation requiring no special tools to install or tune the network
• Network access from any node
• Flexibility in topology (bus, tree, star) and type of medium (coax, optical fiber, other)

Design

Introduction

The ControlNet network with all devices is defined in Control Builder. For this purpose a hardware definition file, which defines inputs, outputs and other parameters for the device, is required. Definition files for all ControlNet devices are delivered with Control Builder. Once the user has connected all inputs and outputs to variables, ControlNet communication is automatically created and started when the application is downloaded to the controller. ControlNet can be constructed in the topologies linear trunk (bus), tree, star, or any combination of these.

Limitations

• ControlNet can be used only in AC 250.
• Only the 200-CICN scanner (master) is supported.
• A maximum of 31 nodes per 200-CICN unit is allowed.
• Supported slaves are 200-ACN adapters and the rack-based 200-RACN are supported.
• The network can have a maximum of 99 (48 without repeater) addressable nodes (the 200-CICN communication interface unit limits the number of nodes in a network).
• A maximum 1000m segment length without repeaters is possible with coax cable.
• Fiber optic links can be included to increase network length and obtain galvanic isolation. The length can be increased to about 7000m.
• The number of racks per CICN is limited to 8.
• The number of CICN per controller is limited to 4.
• Number of repeaters:
– 5 (maximum) in series

– 6 segments (5 repeaters) in series
– 48 segments in parallel
• Maximum length with repeaters:
– 5000m (coax) at 5Mbps
– at least 30km (optical fiber)

Performance

The high ControlNet bus speed (5Mbps maximum) and configurable data transmission capabilities significantly enhance I/O performance and peer-to-peer communication.
The cyclic communication (scan time) can be as fast as 5ms. The minimum cycle time is dependent on the number of slaves and the amount of data to be sent.

Hardware

• Fiber modems can be used to increase the cable length and obtain a more robust network.
• RG6 coaxial cable and BNC connectors are simple to install.
• 62.5/125mm, multimode optic fiber is used with ST connectors, operating at 1300nm wavelength.
• Repeaters for coax can be used.

Advanced

See the "ControlNet Planning and Installation" manual.

Troubleshooting

If the ControlNet I/O watchdog is not triggered at one-second intervals it will abort. Consequently a system reset must take place in the controller. When the watchdog aborts, all connections are disconnected and the connection outputs are set to their defined SafeState.

PROFIBUS DP

Introduction

PROFIBUS (PROcess FIeld BUS) is a fieldbus standard, especially designed for communication between systems and process objects. This protocol is open and vendor-independent. With PROFIBUS, devices from different manufacturers can communicate without special interface adjustments. PROFIBUS can be used for both high-speed, time-critical transmission and extensive, complex communication tasks.

Supported media:

• RS-485 transmission for universal applications in manufacturing automation

• IEC 61158-2 transmission for use in process automation

• Optical fibers for improved interference immunity and large network distances The PROFIBUS DP (Decentralized Peripheral) fieldbus is based on European standard EN 50 170, and has been designed especially for communication between automation control systems and distributed peripherals at the device level.

PROFIBUS DP-V0

The PROFIBUS DP communication profile is designed for efficient data exchange at the field level. The central automation devices, such as controllers, communicate through a fast serial connection with distributed field devices such as I/Os, drives, valves and measuring transducers. Data exchange with distributed devices is mainly cyclic. The communication functions required are defined by the basic PROFIBUS DP functions in accordance with EN 50170.

PROFIBUS DP-V1

PROFIBUS DP-V1 is suitable as a replacement for conventional, parallel-signal transmission with 24V in manufacturing automation, as well as for analog signal transmission with 4-20mA or HART in process automation.

The PROFIBUS- DP-V1 communication profile is designed for efficient data exchange at the field level. The central automation devices, such as controllers, communicate through a fast serial connection with distributed field devices such as I/Os, drives, valves and measuring transducers.

Services Provided

• PROFIBUS DP-V0 and PROFIBUS DP-V1 are supported.

• For PROFIBUS DP-V0, only cyclic services are supported. The master unit is of Class 1.

• For PROFIBUS DP-V1, acyclic services are supported. The master unit is of Class 2.

Advantages

PROFIBUS DP-V0

• High information transfer rate,
• Supports many different types of I/O units.

PROFIBUS DP-V1

• High information transfer rate,
• Supports many different types of I/O units,
• Acyclic services (Tool Routing),
• Master redundancy,
• PROFIBUS Diagnostics,
• Line redundancy,
• Slave redundancy.

Design

Introduction

PROFIBUS DP-V0

A PROFIBUS DP-V0 device has specific definition parameters required for device configuration. Examples of such parameters are device version, baud rate, data format and I/O length. For ABB devices - such as the S800 I/O, S900 I/O, and S200 I/O unit families - these parameters are already defined and delivered in the Control Builder M hardware definition file. Automatic calculation of PROFIBUS master parameters is performed for all controllers in a project and for all PROFIBUS masters connected to the respective controllers. For further information see Troubleshooting on page 156. For a device from another manufacturer the configuration parameters are stored in a .GSD file delivered with the device. The ControlIT for AC 800M software includes GSD Import Tool (included on the ControlIT for AC 800M CD-ROMs), which translates the information contained in the .GSD file. The .GSD file format is given in European standard EN 50170.
The user connects all inputs and outputs to variables. The PROFIBUS-DP communication is automatically created when the application is downloaded to the controller. PROFIBUS-DP is primarily used for cyclic I/O communication. When communication is defined, the master will begin to cyclically ask the slaves for data and send data. The two outermost nodes must be terminated.

PROFIBUS DP-V1

A PROFIBUS DP-V1 device has specific definition parameters, required for device configuration. Examples of such parameters are device version, baud rate, data format and I/O length. For ABB devices - such as the S800 I/O, and S900 I/O unit families - these parameters are already defined and delivered in the Control Builder hardware definition file.

Automatic calculation of PROFIBUS master parameters is performed for all controllers in a project and for all PROFIBUS masters connected to the respective controllers. For further information see Troubleshooting on page 156. For a device from another manufacturer the configuration parameters are stored in a .GSD file delivered with the device. The ControlIT for AC 800M software includes GSD Import Tool (included on the Control IT for AC 800M CD-ROMs) which translates the information contained in the .GSD file. The .GSD file format is given in European standard EN 50170. The two outermost nodes must be terminated.

Redundancy

PROFIBUS DP-V0
Redundancy is not built in, but can be implemented on application level or physical (cable) level by the user.

PROFIBUS DP-V1
Both line redundancy and slave redundancy are built in. Using two CI854A communication interface units adds master redundancy.

Limitations

- PROFIBUS DP-V0 can be used in all controllers, but act only as Class 1 masters.
- PROFIBUS DP-V1 can be used for AC 800M only, and act only as master.
- The network can have a maximum of 126 nodes.
- CI854, connected to CI840 and/or CI920, supports cable redundancy without using fiber optic modems.
- If a PROFIBUS master unit, CI851 or 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.
- If the PROFIBUS DP-V0 is reconfigured, for example when an I/O unit is added or removed or if certain parameters are changed, then the PROFIBUS DP-V0 master, CI851, will automatically reset, affecting the whole network.
- Reset of PROFIBUS DP-V1 master, CI854, and the complete PROFIBUS is done, if one of the following bus parameter settings are changed: Node address of CI854, Baudrate or Highest station address (HSA). A change of the other bus parameters does not affect the running communication.
- When using CI851, data might be lost if the slave configuration is changed.

Performance

Cyclic communication can be as fast as 1ms and is typically less than 2ms. The minimum cycle time, however, is configuration-dependent (for example on baud rate, number of slaves and the amount of data to be sent).
PROFIBUS-DP messages connect to devices with addresses from 0-125. They can be used to transfer up to 244 bytes of data per in-message and 244 bytes of data per out-message.

Hardware

A shielded twisted pair cable with terminating resistors, or a fiber optic cable with optical link units is required.
The physical medium for PROFIBUS-DP is RS-485, which allows 32 nodes in a segment and 126 nodes in a network. Cable length may vary from 100-1200m depending on transmission speed. Cable length can be extended using fiber optic modems (yielding a more robust network). Segment couplers can be used to attach PROFIBUS-PA devices.
For a product guide presenting all available hardware, visit the PROFIBUS web site: http://www.profibus.com

Advanced

Layers

PROFIBUS is located both at the cell supervisor level, named Layer 7 (application layer) and at the field network level Layer 1 (physical layer) and Layer 2 (data link layer).

Optical Link

For electrical media (half-duplex), an error in a single wire of the two-wire cable blocks data transfer in both directions. To get the same functional behavior in case of a disturbed optical medium, the fibre optical converter (full duplex) must be able to switch off the receiver port when detecting an error at the transmitting port, and vice versa. Otherwise it may happen that the PROFIBUS slave will not detect an error and activate the OSP mode.

Troubleshooting

Automatic Calculation of PROFIBUS-DP Parameters

During compilation and simulation, PROFIBUS master parameters will be automatically calculated. The calculation is performed for all controllers in the project and for all PROFIBUS masters connected to the controllers. The result is sent to a text file named 'Profibus_DP_Calculation.txt' or ‘Profibus_DPV1_Calculation.txt’, which is stored in the root directory of the hard disk drive (C:\ or similar). The text file has no backup, and is replaced at every compilation and simulation. The parameters are calculated according to the formulas in the PROFIBUS-DP specification, and should be regarded as suggestions. The calculations are based on the actual hardware configuration and settings supplied by the user, such as baud rate and quiet time. For every printout, the complete set of parameters is presented, including those given by the user. To use the automatically-calculated parameters for PROFIBUS masters, read the text file and manually edit the parameters in the HW editor.

AC800 PEC (POWER ELECTRONICS CONTROLLER)

We are surrounded by electronic devices of all types and descriptions, and expect these to perform autonomously and correctly. In power electronics, the demands on such devices are especially tough. The time domain, which must be handled, ranges from nanoseconds for the triggering and monitoring of the individual switching actions to seconds for long-term operational transients. Designing a single, slim and efficient controller to handle all this is no easy task.
ABB's AC 800PEC controller was designed specifically with such applications in mind. The model can flexibly be adapted to handle different time domains and code can efficiently be created from Matlab/SimulinkTM models.
The processing unit inside the early AC 800PEC controllers was the PP D103. However, specifically targeting smaller systems where both space and costs are critical, ABB has produced a new controller based on the PP D104 processor – an ultra-compact device taking up less space than a credit card.
In 2002, ABB introduced its high-end control platform, AC 800PEC, to target the important field of high-performance control.
The market required a combination of several features:

- High processing power
- Short cycle-time (<100 μs)
- Fast time-to-market for applications
- Suitable for small series
- Industrial grade hardware
- High integration of devices

Large-scale power converters and drives must be reliable, fast and precise. That calls for a control system with outstanding performance, such as the AC 800PEC. But why should the same controller not cope with slow processes, too, such as cooling circuits, monitoring and balance of plant? The AC 800PEC does it all: when it comes to high-speed processes in an industrial environment with all related ancillary tasks, it is the ideal controller.

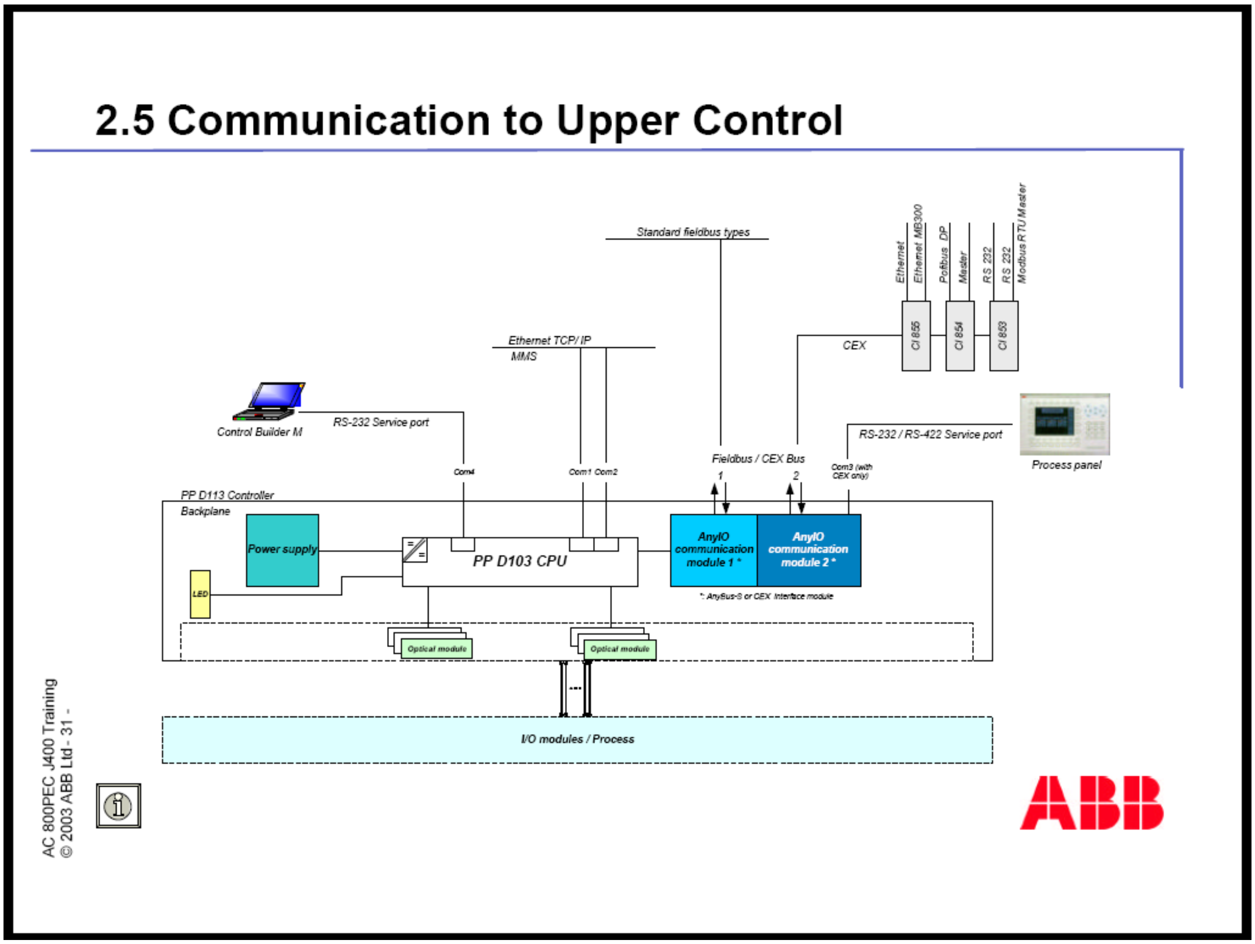
Principle of AC 800PEC

The AC 800PEC is a powerful control platform. On the hardware side, it combines the floating-point computing performance of the CPU with the high-speed flexibility of an FPGA.1) On the software side, it combines the system design capabilities of ABB's ControlIT with the application control and simulation capabilities of MATLAB/Simulink ™ (from The

Mathworks®).2) From a user's perspective, the system is separated into three levels, representing different tasks in the development life-cycle of a product:

System engineering (Level 1)

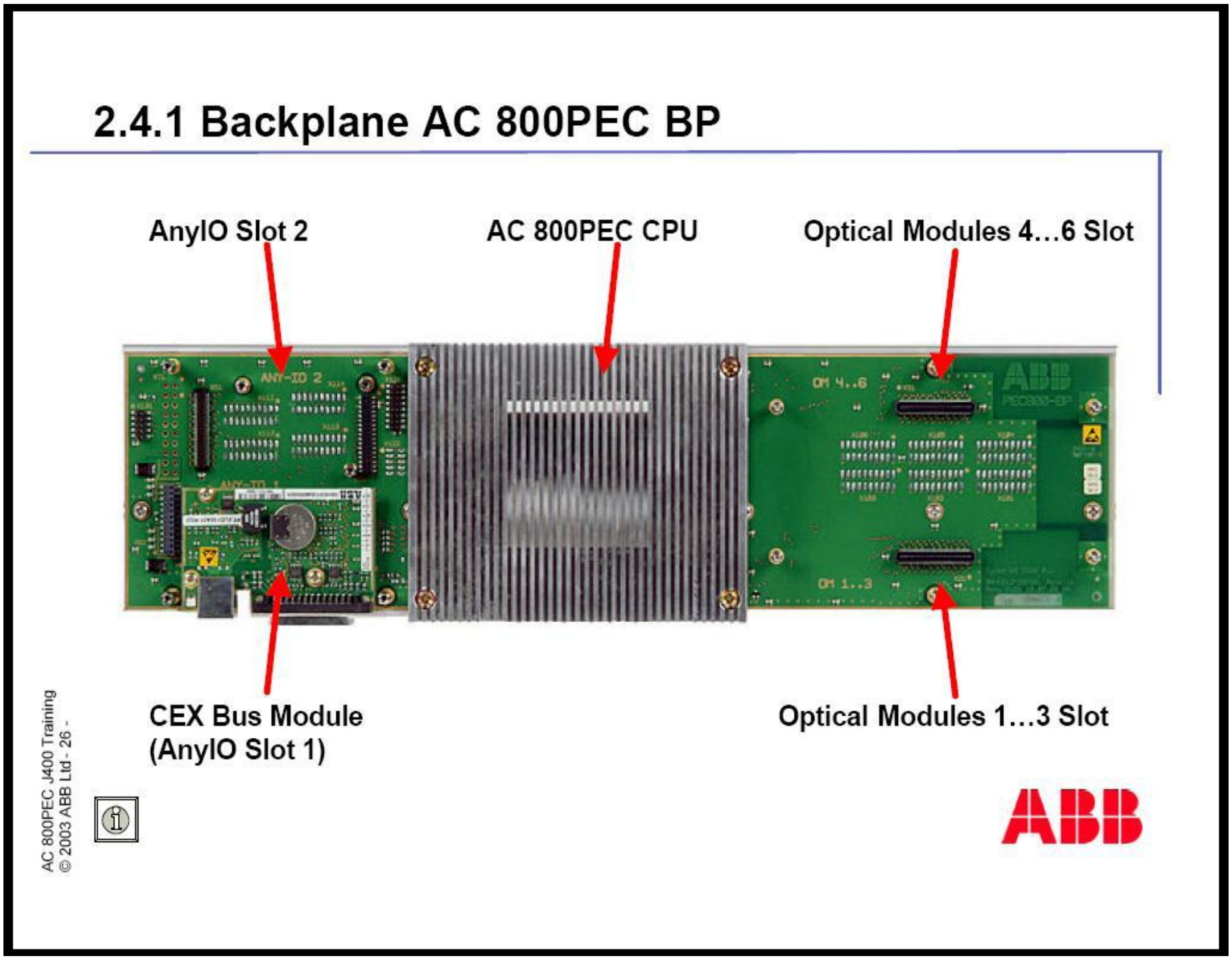
ABB's ControlIT is based on the IEC61131-3 programming language and uses ABB's Control Builder as programming tool. This is the level on which system engineers implement functions not demanding real-time performance but needing to remain flexible during the lifecycle of the product/system. Another important attribute of this level is the integration of the AC 800PEC controllers in ABB's 800xA system. AC 800PEC controllers are integrated by means of "800 Connect," which provides native access of 800xA nodes to the application entities within the AC 800PEC controller.



Product development (Level 2)

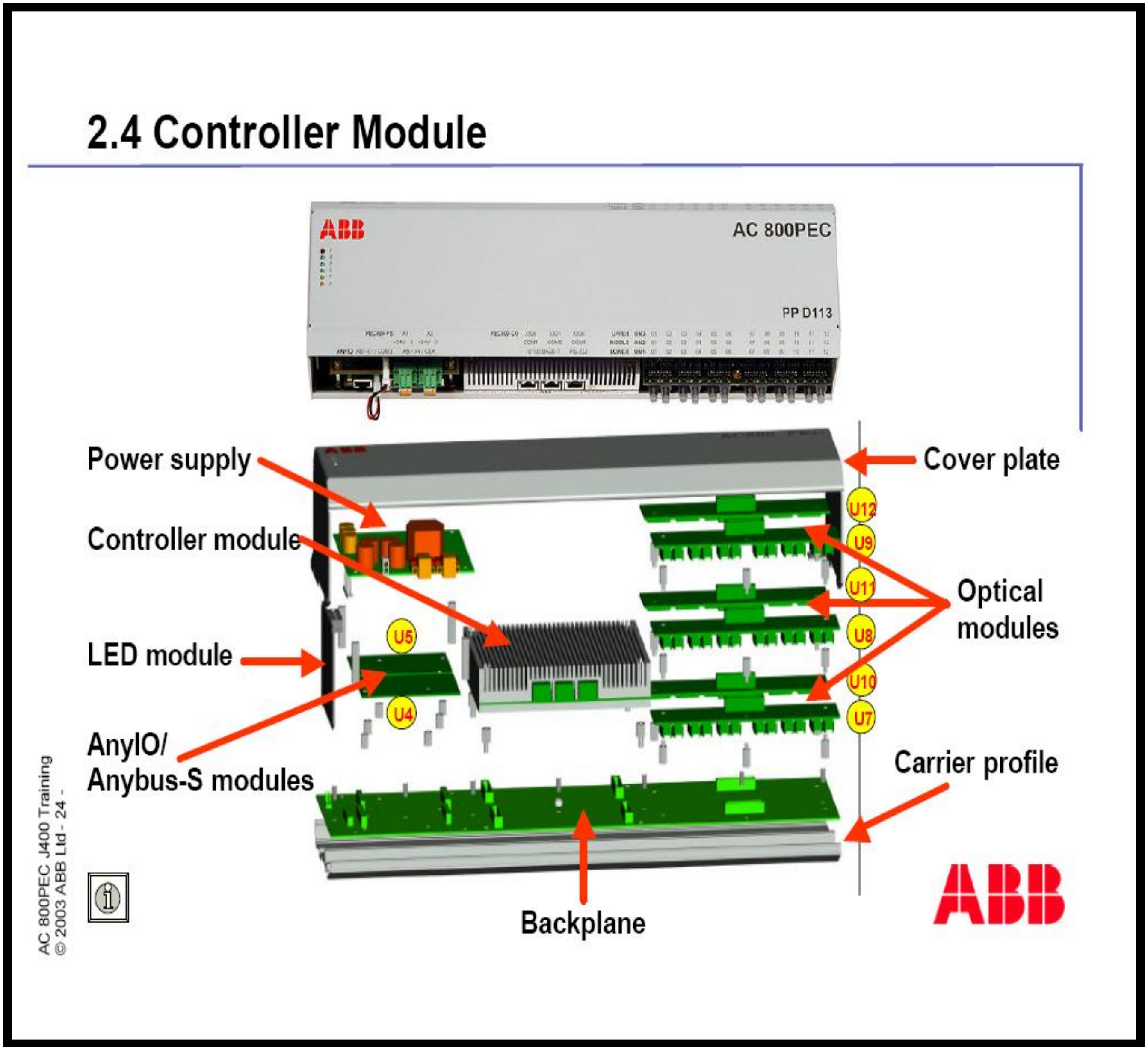
Fast closed-loop control applications are programmed using MATLAB/Simulink. C code is then generated from this using MATLAB/Simulink's Real- Time Workshop. This is compiled to an executable code using a C-Compiler and then downloaded to the controller device where the control application will start immediately after the controller is started-up. If the control application is part of a large control system requiring the presence of a ControlIT IEC61131-3 application, engineering will supervise the execution of the fast control application.

Typically, control developers will implement the control, the protection, the state machine and other algorithms on this product level. An important aspect to note is that this fast closed-loop control application runs in parallel with an 1131 application (from Level 1). Control engineers and system engineers can exchange signals in either direction via an efficient software interface. This interface is realized using a standard Control Protocol handler.
The devices of the AC800PEC platform can be integrated into an 800xA system, thus allowing plant-wide data exchange and control.



Technology development (Level 3)

Very fast processes are programmed in VHDL Protocols and some control logic requiring very short cycle times are implemented on Level 3. In many cases, suitable code already exists that can be combined according to the customer's need.
Levels 1 and 2 can access the signals (realized as a dual port memory) and specific blocks. In Control IT, the so called "FPGA Protocol handler" was developed to allow intermediate access to the fast signals of the I/Os. This feature is intended primarily for very fast peer-to-peer communication of AC 800PEC controllers (in the range of a one to few milliseconds).
In addition, the devices of the AC 800PEC platform can be integrated into an 800xA system, thus allowing plant-wide data exchange and control. It is important to note that the two controller modules described below use a common software architecture, thus allowing exchange of control code and system engineering data.



High-end controller

The first devices to be used in applications were PP D113 controllers. These are based on the PP D103 processor unit and form the high-end solution in which controllers and fast- I/O are separate devices. The CPU is a PowerPC 750FX with a clock speed of up to 600 MHz. These devices currently form the controller backbone of the power electronics business.

Low-end controller

This article is primarily concerned with solutions based on the PP D104 processor board, in which controller and fast-I/O are integrated into a single device. This solution is targeted at

small systems, in which limited space and controller cost are critical to the success of the end-product.
The PP D104 processor board contains a microcontroller MPC5200 (Freescale, Power PC core 603) with a clock speed of 396 MHz, a 10/100 Mbps Ethernet MAC, two CAN controllers, 3 serial interfaces (UART) and a large programmable logic device (FPGA) – all on an area less than the size of a credit card.
In contrast to the high-performance controller, the design of the PP D104 is consequently trimmed for the sharing of the duties within a control system. A small, but powerful controller unit forms the brain of the control system. It is optimized for performance per space and supported by application specific communication and application boards or a combination of both – depending on the application's needs. All of these sub devices constitute the controller package, and are optimized for the application's specific purpose.
It has been shown in the past that this design is a door opener for a number of applications that were not previously thinkable due to cost and performance restrictions. The following two application discussions outline the opportunities that PP D104 has created.

Application in excitation systems

Excitation systems are typically used in power-plants for generator control. This is an application in which reliability is the most important requirement. As opposed to the previous example, these systems can be very large and incorporate several subsystems. In this case, the introduction of the PP D104 permitted the division of the entire system into several independent sub-systems, each dedicated to a particular subset of tasks, and with each subsystem being controlled by a separate controller. The total system is then controlled and coordinated by a powerful main controller based on the PP D103 processor module. This modularization not only greatly reduced the complexity of the overall system, but presents two further main advantages: scalability and reliability. Traditionally, systems that are scalable over a very broad range of sizes come at the cost of a complex architecture and hence impose difficulties for the engineering staff. The modularization made possible by the low-end extension of AC 800PEC allows the implementation of a very natural scalability over a broad range. Each sub-system can be instantiated several times without further complicating the software in the main controller. As already mentioned, reliability of the system is a key issue in power generation, and often full redundancy is required. Whereas in slower systems, the controllers themselves can be realized as redundant devices, the cycle-times found in and required by power electronic systems make traditional redundancy concepts for controllers unworkable. Here, the solution of choice to achieve redundancy is no longer on a device level, but on a system level. For the redundancy concept implemented in ABB’s UNITROL® excitation systems, each subsystem is available n-times. In case of a problem in one subsystem, the main controller switches over to the remaining subsystems, which are scaled in such a way that the overall task can still be fulfilled . Should the main controller fail, there is always a second controller available in hot-standby.

Key benefits

The AC 800PEC is a modular high-speed control system. The modules are arranged according to the required I/O configuration and the process. The AC 800PEC I/O modules are connected via optional high-speed point-to-point connections. The AC 800PEC supports up to 36 bi-directional fiber-optic PowerLinks.

Performance

The AC 800PEC excels with a very high processing speed. It provides
• Very fast analog and digital process I/Os with a typical cycle time of 25 μs
• Fast closed-loop control and regular process logic implemented in one controller
• Low-speed I/Os with a typical cycle time of 10 ms
• Very fast analog/digital conversion and nominal/actual value comparison, directly on the peripheral I/O module.

Connectivity

The AC 800PEC features outstanding ability to communicate with other control devices:
• Two Ethernet ports for connection to a plant control network, other processor modules, the Control Builder M programming tool and to the PECView service tool

• RS-232 / RS-422 serial ports for a local process panel and/or service terminal • Up to two on-board AnyIO ports for ABB Communications Expansion bus (CEX) and AnyBus®-S modules for all common fieldbus types.
• Up to 36 terminals for optical PowerLinks and ABB S800 optical ModuleBus for costeffective, noise-immune connections to I/O systems and power converters.

Modular configuration

The modular-design AC 800PEC comes with:
• Units mounted onto a DIN rail or equipped for direct wall mounting
• Hardware and communication modules according to process needs
• Any combination of fast and slow I/Os, large and small topologies, installed locally and remotely.

The AC 800PEC hardware

The AC 800PEC system incorporates equipment that meets the most challenging – and also contradictory – requirements in process control. It includes a wide range of I/O modules to cover all power electronics control requirements.
The different I/O modules can be connected to the AC 800PEC controller to cover most automation requirements in:
• Process industry
• Power generation and distribution
• Transportation and traction.
The modular, energy-efficient design of the AC 800PEC allows operation without forced cooling. The modules are mounted on standard DIN rails and can easily be installed in distributed processes. The number of directly connectable I/O systems is limited only by the maximum available fiber-optic links to the processor (36 bidirectional links).
Depending on the required performance, single, multiple or redundant bidirectional links are used between modules. Each module comprises a mechanical carrier, a base module and a configurable set of submodules which provide the required I/O terminals or communication interfaces.

AC 800PEC Controller PP D113

The controller comprises a low power circuit with high reliability. The hardware can be configured freely, depending on the process ***AC 800PEC*** *Combi IO* for fast signal exchange ***S800 I/O*** modules for low speed signal exchange ***AC 800PEC INT*** interface system for direct IGCT converter contol requirements and the selected communication with the upper control.
The AC 800PEC controller module contains the processor, the optical interfaces to the peripheral I/O, the fieldbus, and interfaces to the upper control:
• **Base unit AC 800PEC BP** (backplane with slots for mounting the processor, the power supply, and the optical and communication modules)
• **Processor module AC 800PEC CPU**
mounted on the AC 800PEC BP. The CPU is a fully-featured 600 MHz RISC processor with

a 64-bit IEEE Floating-Point-Unit (FPU). It is optimized for applications with very fast control cycles

• Two **AnyIO interfaces,** each consisting of – an AnyBus®-S slot – an additional AnyIO extension slot for an AC 800PEC CEX interface or special applications

• Up to 6 **AC 800PEC optical modules** for fiber-optic links to various I/O modules.

Programs and data are stored in a robust solidstate 16 MB Flash memory, which is formatted as a file disk. Active programs are operating out of the cached 64 MB SDRAM.

Communication modules

Communication with external systems (i.e. the upper control via fieldbus) is via CEX or AnyBus®-S fieldbus interface module, or via Ethernet ports on the processor module.

The CEX interface provides optimum connectivity with the complete ABB AC 800 CEX program, such as:

• MB300
• Profibus master
• Ethernet

The supported AnyBus®-S fieldbus types are:

• Profibus slave
• CANopen slave
• Lon Works slave
• Interbus slave
• Modbus slave etc.

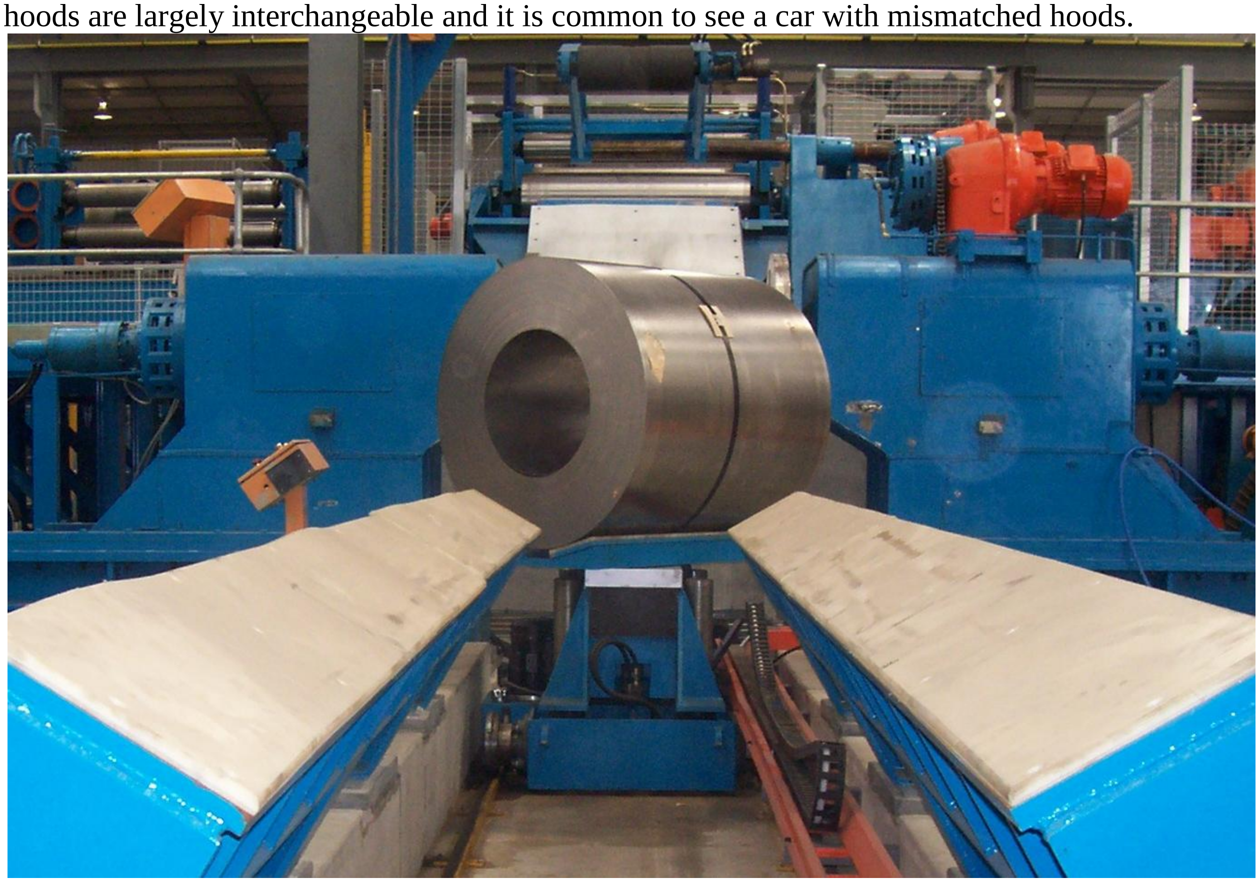
CASE STUDY (COIL CAR PUSHING)

Coil cars (also referred to as "steel coil cars" or "coil steel cars") are a specialized type of rolling stock designed for the transport of coils (i.e., rolls) of sheet metal, particularly steel. They are considered a subtype of the gondola car, though they bear little resemblance to a typical gondola.Prior to the invention of this type, coils of sheet steel were carried on end or in cradles in open or covered gondolas. Load shifting, damage, and awkward loading and unloading were all problems with this type of loading, and since so much sheet steel is transported, a specialized car was designed for this use.

These cars started to appear in the 1960s. Early examples include the Pennsylvania Railroad G40 and G41 class cars, built in 1964-65.

The body of a coil car consists of a trough or series of troughs. Most commonly these run lengthwise, but there are transverse variants as well; in either case they may be lined with wood or other material to cushion the load.[2] The coils are set on their sides in the trough, and stops may be applied across the trough to keep the coils from shifting.

The cars are equipped with hoods to cover the load. Some cars use a single hood, but more commonly a pair of hoods is provided. Each hood has a lifting point at its center, and often has brackets on the top at the corners in order to allow the hoods to be stacked when not in use. The hoods are largely interchangeable and it is common to see a car with mismatched hoods.



To design a control for the this coil car.

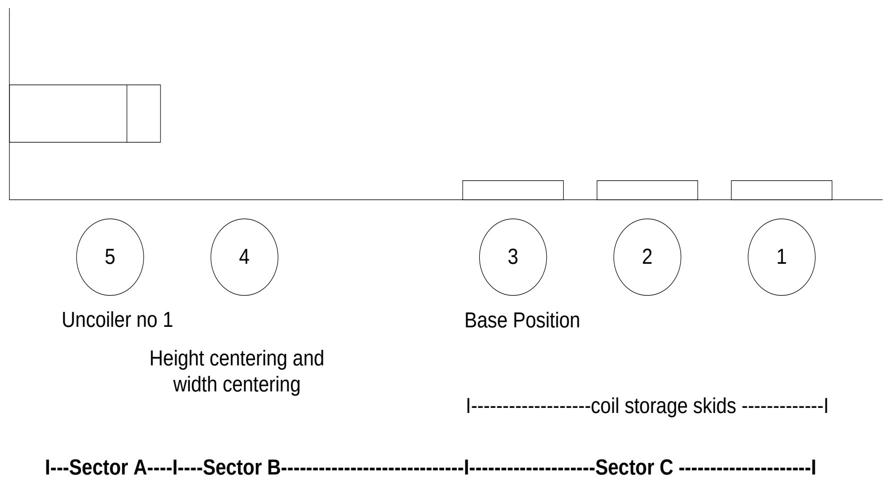
CoilCar

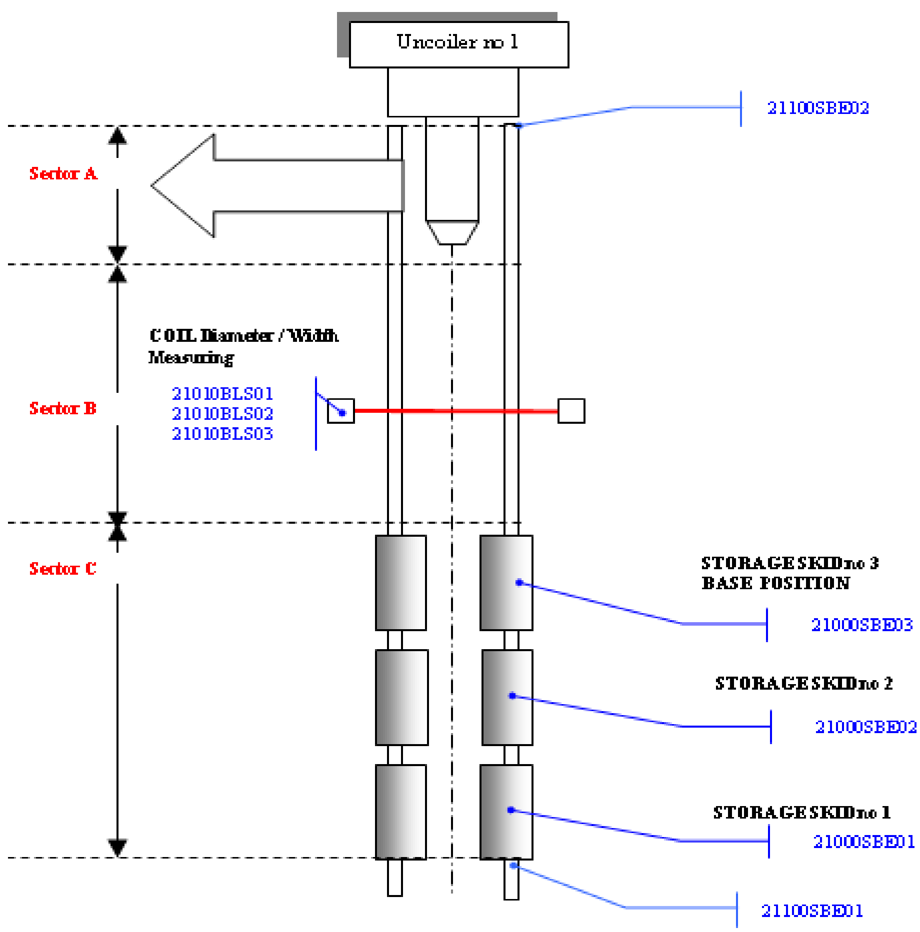
Equipments	Purpose
Drive	Fwd / Bwd
Hydraulic valve Control	Up / Down
Proximity (21000SBE01)	To Sense Coil in Skid 1
Proximity (21000SBE02)	To Sense Coil in Skid 2
Proximity (21000SBE03)	To Sense Coil in Skid 3
Limit Switch (21100SBE01)	To Sense end position at coil ramp
Limit Switch (21100SBE02)	To Sense end position at uncoiler
Absolute Encoder (Traverse of Coil car)	To calculate the distance traversed
Absolute Encoder (Position of Coil)	To calculate the distance Moved
Photo Sensor (in Swing arm at Centering area)	For height centering

Total Length of Coil Car Traversing area (mm)	**12000**
Distance at Saddle 1 (mm)	**100**
Distance at Saddle 2 (mm)	**3000**
Distance at Saddle 3 (mm)	**5000**
Distance at Centering area (mm)	**9000**
Distance at Mandrel Center (mm)	**11800**

Vertical Center position of mandrel (mm)	**900**

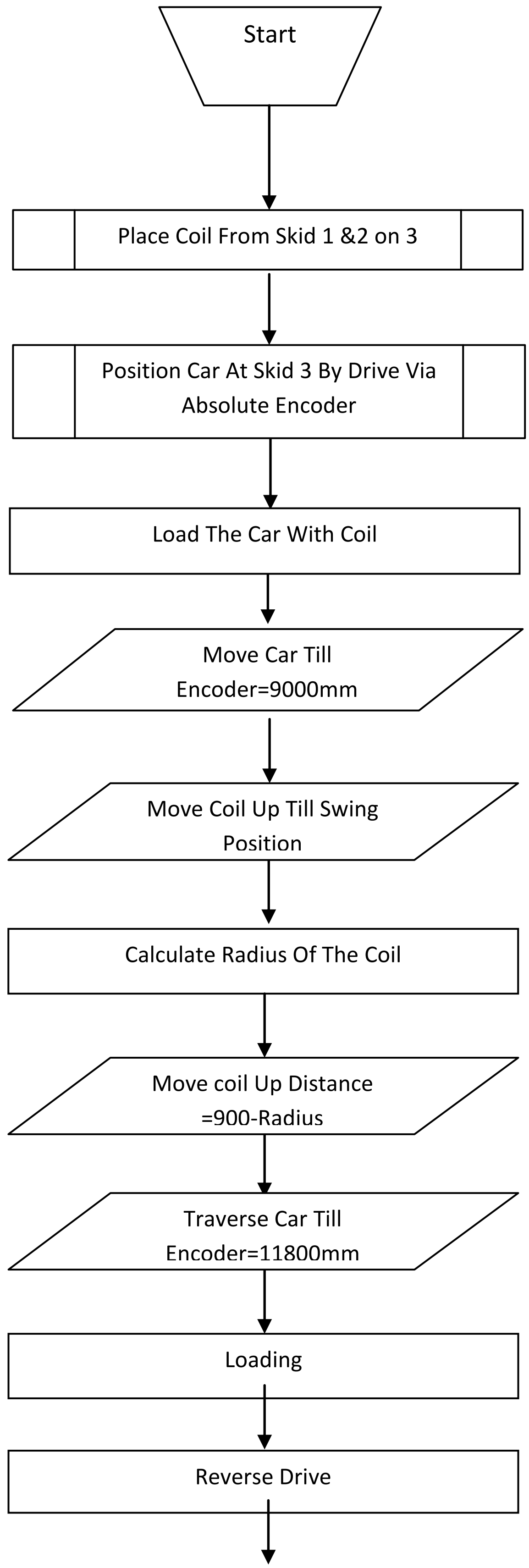
Swing Position	2200

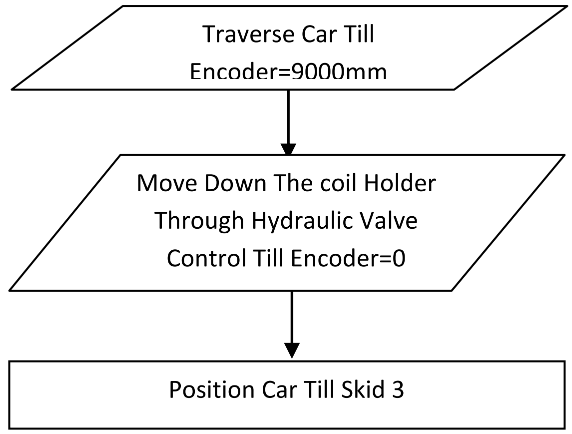




To Load the coil from Skid 3 to uncoiler 1 Mandrel

Flowchart


Start
Place Coil From Skid 1 &2 on 3
Position Car At Skid 3 By Drive Via Absolute Encoder
Load The Car With Coil
Move Car Till Encoder=9000mm
Move Coil Up Till Swing Position
Calculate Radius Of The Coil
Move coil Up Distance =900-Radius
Traverse Car Till Encoder=11800mm
Loading
Reverse Drive


Traverse Car Till Encoder=9000mm
Move Down The coil Holder Through Hydraulic Valve Control Till Encoder=0
Position Car Till Skid 3

COMPACT CONTROL BUILDER

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:

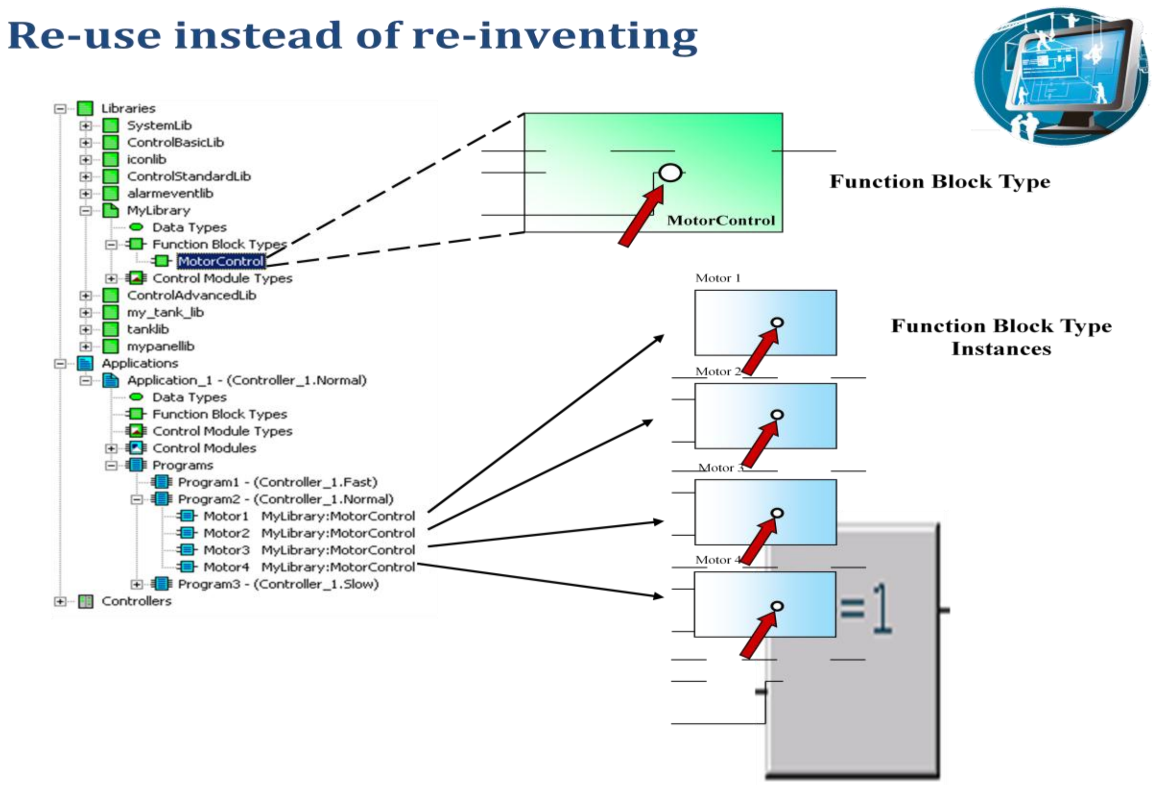
• Compact Control Builder AC 800M
• OPC Server for AC 800M
• Base Software for SoftControl

These products are delivered out of the box and easy to install, run and maintain.

Terminology

The following is a list of terms associated with Compact Control Builder AC 800M. The list contains terms and abbreviations that are unique to ABB or have a usage or definition that is different from standard industry usage.

TERM	DESCRIPTION
Access variables	Variables that can be accessed remotely, for example from another PLC.
Application	Contain the code to be compiled and downloaded for execution in the controller.
Cold retain	An attribute for variables that maintain the variable value after a warm or cold retain. Cold retain overrides the retain attribute in a structured data type.
Control module	A program unit that supports object-oriented data flow programming. Control modules offer free-layout graphical programming, code sorting and static parameter connections.
GSD file	Geräte Stamm Datei, a hardware description file for a PROFIBUS DP-V0 or PROFIBUS DP-V1 slave type
Industrial^{IT}	ABB's vision for enterprise automation.
INSUM	Integrated System for User-optimized Motor control, an ABB system for motor control.
MMS	Manufacturing Message Specification. A standard for messages used for industrial communication
OPC	OLE for Process Control, a standard for exchange of process control information.
Compact Control Builder	A programming tool used for configuration control logic as well as hardware in a PLC control system.
PLC	AC 800M controller.
Program	A program contains written execution code. Programs are connected to tasks with the same name.
RNRP	Redundant Network Routing Protocol, an ABB protocol for redundancy handling and routing in Control Network.
Project Explorer	The part of the Control Builder user interface used to create, modify and navigate a project. All objects such as data types, functions and function block types can be selected and displayed in an editor. All software and hardware is configured in the Project Explorer.
Type	The type is a general description of a unit that defines a behavior.



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

• Programming tool for AC 800M controllers

– Contains a compiler, programming editors, standard libraries for developing controller 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 library is sufficient, the Device Import Wizard can be used to import a customized hardware type from a device capability description file. Currently, you can only 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.)

– 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 or PM864).

– 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).

• 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 controller 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

– Store a compiled controllers configuration, that can be used at restart of the controller.

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