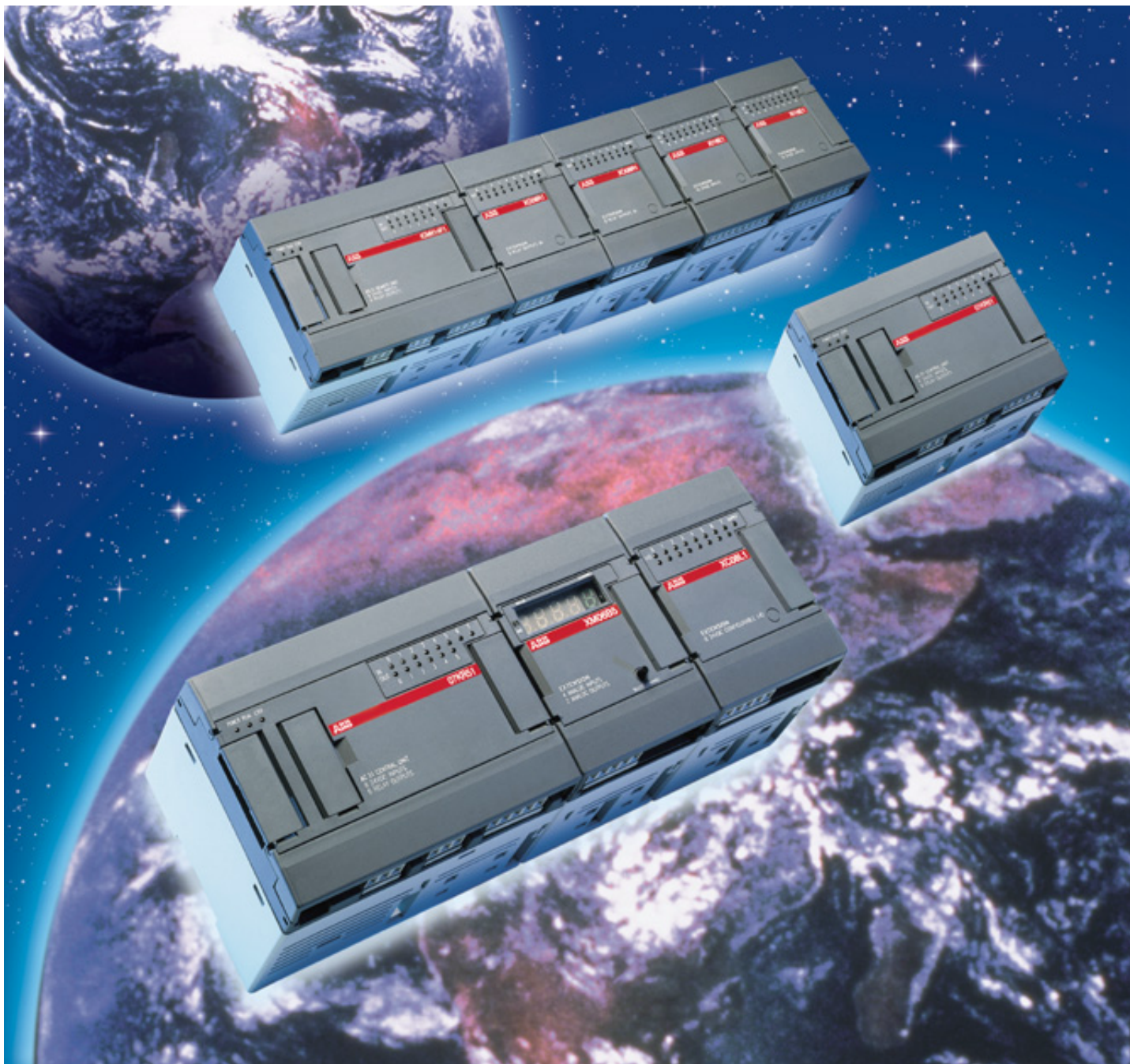


1SBC 260400 R 1001-c



Summary

Chapter 1

Presentation / operation	1-1
1. Presentation	1-2
2. General setup rules	1-3
2.1. Central units with extensions	1-5
2.2. Central units with CS 31 bus	1-5
2.3. Cabling techniques	1-5
3. Operation of the 40 and 50 series central units	1-7
3.1. Functional diagram	1-7
3.2. Program execution	1-9
3.3. Bus transmission	1-9
3.4. Refresh times / reply times	1-10
3.4.1. Bus refresh times	1-10
3.4.2. Central unit reply times	1-10
3.5. Power on / program launch	1-11
3.6. Power cuts or drops	1-12
4. References	1-13

Chapter 2

Getting started	2-1
1. Required material	2-3
2. Cabling	2-3
3. Programming	2-5
3.1. Launching the AC31GRAF software	2-5
3.2. Project creation	2-5
3.3. Variable declarations	2-7
3.4. Program editing	2-7
3.4.1. Displaying the FBD (function blocks) toolbar	2-7
3.4.2. Selecting the OR function in the program editor window	2-7
3.4.3. Inserting variables	2-9
3.4.4. Links between the variables and the function block:	2-9
3.5. Saving	2-9
3.6. Compilation	2-9
3.7. Communication with the PLC	2-11
3.7.1. Configuration of the serial interface	2-11
3.7.2. Access to the control panel	2-11
3.7.3. Configuration of the central unit:	2-11
3.7.4. Initializing the central unit	2-13
3.7.5. Sending the program to the PLC	2-13
3.7.6. On-line program tests	2-13
3.8. Quitting AC31GRAF	2-15

Chapter 3

Technical specifications	3-1
1. General operating conditions	3-3
2. CS 31 bus technical specifications	3-5
3. Central units	3-7
3.1. The front of the central unit (see Figure 3-1)	3-7
3.2. Technical specification	3-8
4. Extensible remote units	3-13
4.1. The front (see Figure 3-3)	3-13
4.2. Technical specifications of the extensible remote units	3-14
5. Binary extensions	3-17
5.1. The front (see Figure 3-5 to Figure 3-11)	3-17

Summary

5.2. Binary extensions specifications	3-18
6. Analog extensions	3-21
6.1. The front (see Figure 3-12, Figure 3-13)	3-21
6.2. Analog display (see Figure 3-14)	3-21
6.3. Technical specifications of the analog extension	3-22
6.4. Analog inputs diagrams:	3-24
6.4.1. Current 4-20mA:	3-24
6.4.2. Current 0-20mA:	3-24
6.4.3. Pt 100/Pt 1000:	3-24
6.4.4. NI 1000:	3-25
6.4.5. Balco500:	3-26
6.5. Analog outputs diagrams:	3-27
6.5.1. Current 0-20mA:	3-27
6.5.2. Current 4-20mA:	3-27
7. Accessories	3-29
7.1. Programming cables: 07 SK 50 and 07 SK 52	3-29
7.1.1. 07 SK 50 connection diagram (see Figure 3-15):	3-29
7.1.2. 07 SK 52 connection diagram (see Figure 3-16):	3-31
7.2. ASCII/MODBUS [®] communication cables: 07 SK 51 and 07 SK 53	3-33
7.2.1. 07 SK 51 connection diagram (see Figure 3-17):	3-33
7.2.2. 07 SK 53 connection diagram (see Figure 3-18):	3-35
7.3. TC50 display cables: 07 SK 54 and 07 SK 55	3-37
7.4. Connectors	3-37
7.4.1. External dual connector: 07 ST 50 (see Figure 3-19)	3-37
7.4.2. "Cage-clamp" type connectors (see Figure 3-19)	3-37
7.4.3. External dual connector: 07 ST 51 (see Figure 3-20 and Figure 3-22)	3-39
7.5. Stickers	3-40
8. TC50 Display	3-40
9. Dimensions (in mm)	3-41

Chapter 4

Installation	4-1
1. Implementation of an AC 31 system	4-3
1.1. Assembly conditions	4-3
1.2. Input/output cabling	4-3
1.3. Earthing	4-5
1.3.1. Basic earthing principles	4-5
1.3.2. Earthing principles for numerous cabinets	4-5
1.4. Cabling of the CS 31 bus	4-7
1.5. Different power supply types	4-9
2. Central unit and remote unit cabling	4-11
2.1. Power supply	4-11
2.2. Inputs/outputs cabling	4-11
2.3. Output protection	4-11
3. Cabling binary extensions	4-13
3.1. Extension XI 16 E1 (see Figure 4-18)	4-13
3.2. Extension XO 08 R1 (see Figure 4-22)	4-13
3.3. Extension XC 08 L1 (see Figure 4-20)	4-13
3.4. Extension XO 16 N1 (see Figure 4-19)	4-13
3.5. Extension XK 08 F1 (see Figure 4-21)	4-13
3.6. Extension XO 08 Y1 (see Figure 4-23)	4-13
3.7. Extension XO 08 R2 (see Figure 4-24)	4-13
4. Cabling the analog extension	4-15
4.1. Extension XM 06 B5	4-15
4.2. Extension XE 08 B5	4-15
5. Addressing	4-17
5.1. Input/Output variables	4-17

Summary

5.2. Addressing CU masters or stand-alones with extensions	4-17
5.3. Addressing slave central units or remote extension units on the CS 31 bus	4-21
5.3.1. Addressing extensible remote units	4-21
5.3.2. Addressing slave central units	4-23
5.3.3. Addressing example	4-24
5.4. Summary	4-25

Chapter 5

Programming	5-1
1. Software introduction	5-2
2. List of variables	5-4
3. Initialization	5-7
4. Configuration	5-9
4.1. AC31GRAF configuration tool	5-9
4.1.1. The central unit operative mode	5-10
4.1.2. Transmission/reception range of a slave central unit	5-11
4.1.3. Data initialization and backup	5-11
4.1.4. Initialization /Internal bits backup	5-12
4.1.5. Initialization / Internal words backup	5-12
4.1.6. Initialization / Internal double word backup	5-13
4.1.7. Initialization / Chain step backups	5-13
4.1.8. Initialization / Historical values backup	5-13
4.1.9. Central unit reaction to class 3 errors	5-14
4.1.10. Initialization of the CS 31 bus units	5-14
4.1.11. Communication mode of the COM1 serial interface	5-15
4.1.12. communication parameters:	5-17
4.1.13. The central unit cycle time	5-20
4.1.14. CS31 bus communication times	5-21
4.1.15. Clock	5-25
4.1.16. Password	5-27
4.2. CS31CO configuration function block	5-27
4.3. Analog configuration (extension)	5-29
4.3.1. Hardware configuration	5-29
5. Programming examples	5-35
5.1. Practical advice	5-35
5.2. Operation AND	5-36
5.3. NAND operation	5-37
5.4. OR operation	5-37
5.5. NOR operation	5-38
5.6. Combinations of Boolean functions	5-38
5.7. Timer functions	5-40
5.7.1. TON: on delay	5-41
5.7.2. TOF: off delay	5-41
5.7.3. TP: monostable (constant)	5-42
5.7.4. TIME_W:	5-42
5.7.5. W_TIME:	5-42
5.7.6. Oscillators	5-43
5.8. Detecting the first cycle with the M 255.15 variable	5-44
5.9. Up/Down counter function	5-45
5.10. Scaling an analog value	5-46
5.10.1. Using the potentiometers of the 40 and 50 series	5-46
5.10.2. Processing an analog input	5-47

Summary

Chapter 6

Program optimization	6-1
1. Sub-program	6-3
1.1. Programming sub-programs	6-3
1.2. Calling a sub-program	6-4
1.3. Passing parameters	6-5
1.4. Limits	6-5
2. Interruptions	6-7
2.1. Programming interruptions	6-7
2.2. Validation of interruptions	6-8
2.3. Performances	6-8
3. Step motor command	6-9
4. High speed counter with value capture, zero reset and overflow detection	6-11
5. Communication between central units on the CS 31 bus	6-15
5.1. CS 31 bus addressing	6-15
5.2. Communication type	6-15
5.3. Programming	6-16
5.3.1. Bit transmission	6-16
5.3.2. Transmission by word	6-17
5.3.3. Utilization of the function blocks	6-19

Chapter 7

Communication	7-1
1. Network communication with the incorporated MODBUS [®] interface	7-3
1.1. Protocol presentation	7-3
1.2. MODBUS [®] protocol description:	7-4
1.3. Communication configuration	7-5
1.4. Programming	7-10
1.4.1. MODBUS [®] slave unit	7-10
1.4.2. MODBUS [®] master unit	7-10
1.4.3. List of cross references	7-10
1.4.4. Example using the MODBUS [®] function	7-13
1.5. Reply times for MODBUS [®] communication	7-14
2. Point to point communication with the incorporated ASCII interface	7-17
2.1. Protocol description	7-17
2.2. Configuration of the communication	7-17
2.2.1. Using the black 07 SK 51 or 07 SK 53 cable	7-17
2.2.2. Communication parameters	7-17
2.3. Programming	7-18
2.3.1. Sending messages	7-18
2.3.2. Receiving messages	7-18
2.3.3. Programming example	7-18
3. Point to point communication with the programming protocol	7-21

Summary

Chapter 8

Diagnosis	8-1
1. Types of errors detected	8-3
2. Detection of errors	8-3
3. Status through software	8-7
4. Error management through programming	8-7
4.1. Description of the diagnosis variables	8-7
4.2. Correspondence table between the error and the diagnosis variable values	8-9
4.3. Class error descriptions:	8-10
4.3.1. Class 1 error descriptions	8-10
4.3.2. Class 2 error descriptions	8-10
4.3.3. Class 3 error descriptions	8-10
4.3.4. Class 4 error descriptions	8-11
4.4. Programming examples	8-12
4.4.1. Example of a reaction / command following a specific error	8-12
4.4.2. Example for saving numerous errors of the same class	8-13

Additional information

Annexes	1
1. List of variables	2
2. List of functions	5
3. Mapping	9
4. Historical values	12
5. Table of suitable contactors controlled by AC31 relays outputs	14
Index	1

AC 31 technical documentation

Chapter 1

Presentation / operation

Presentation / operation

This chapter gives you an introduction to the AC 31 automation, from the overall architecture to the operational rules of the 40 and 50 series central units.

1. Presentation

The AC 31 brings accessibility to beginners and experienced automation users alike, for any application with 14 to 1000 inputs / outputs and more, using the same set of basic components.

From a compact machine fitted with a few automated functions to large installations spread over hundreds of meter, and even kilometers, the AC 31 can fit your requirements.

It is therefore possible to realize distributed applications throughout a site, a workshop, or a machine where each component (input / output unit, central unit) is close to the sensors / actuators. The whole setup is connected by a single twisted pair over which all information from the sensors is sent after processing by the central unit to the actuators, as well as distributed intelligent units. The following communication interfaces are available, to extend the AC 31's possibilities and integration with the company's other automation systems: MODBUS[®], ASCII, ARCNET[®], RCOM, AF100. The developments in this field are continual.

Many users on all the continents have realized numerous applications such as:

- ⇒ Machine control
 - Manufacture of floor boards
 - Assembly of electrical contactors
 - Manufacture of ceramic products
 - Metallic pipe welding, etc.
 - ⇒ Controlling-commanding installations
 - Wharf cranes
 - Water treatment
 - Ski lifts
 - Wind power machines, etc.
 - ⇒ Systems management
 - Climatic management
 - Building power management
 - Tunnel ventilation
 - Alarms in hospital environments
 - Greenhouse lighting / humidity, etc.
-

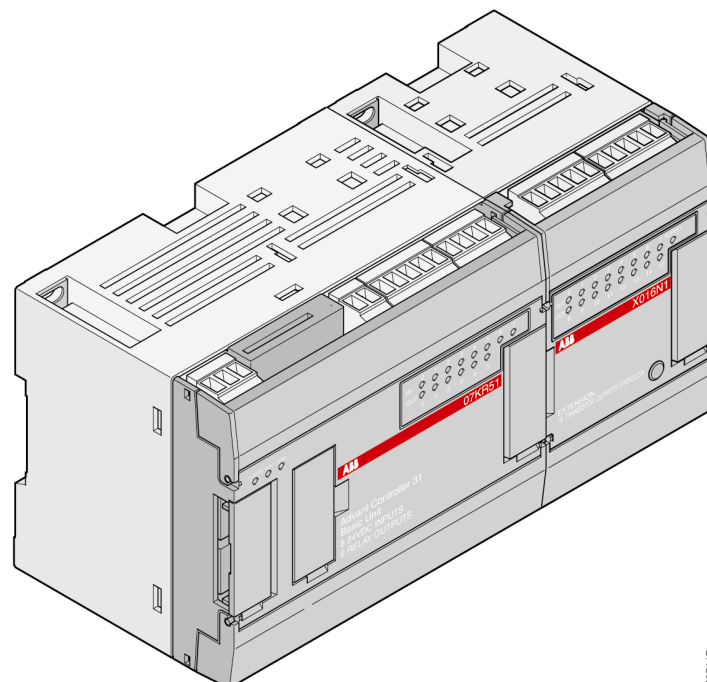
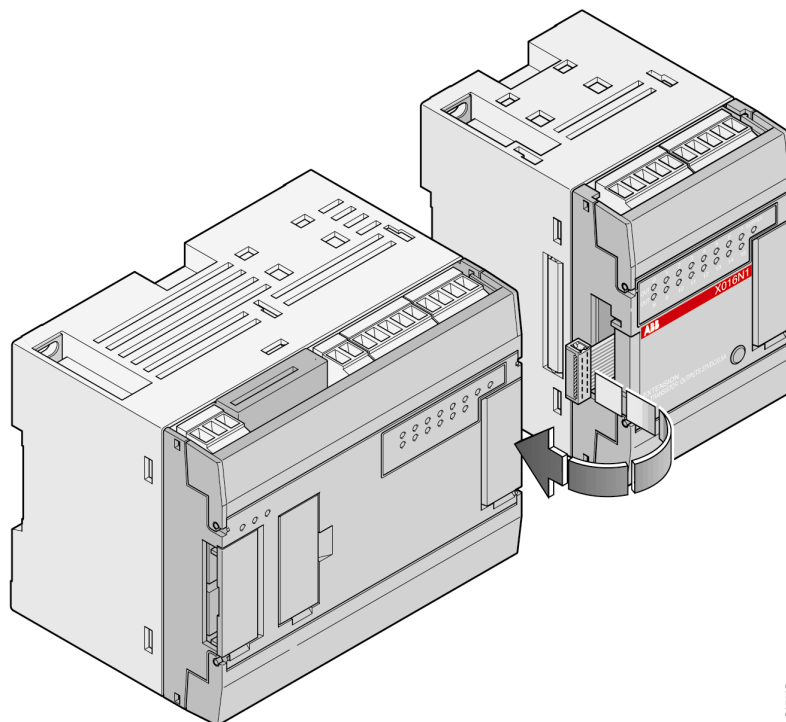
Presentation / operation

2. General setup rules

An ABB AC 31 system always includes an AC 31 central unit. There are three types of central units:

- The 40 series central unit, with a local inputs / outputs extensions interface
- The 50 series central unit, with a local inputs / outputs extensions interface and a CS 31 bus interface
- The 90 series central unit, with a CS 31 bus interface

Each central unit incorporates a specific number of binary inputs / outputs and occasionally analog. It is possible, depending on the central unit, to increase the number of inputs / outputs, to add input / output extensions connected directly to the central units or remote input / output units via the CS 31 twisted pair.



Presentation / operation

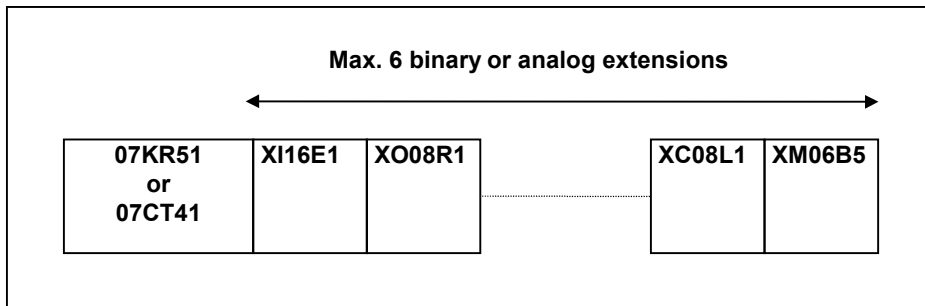


Figure 1-1 : A central unit with extensions

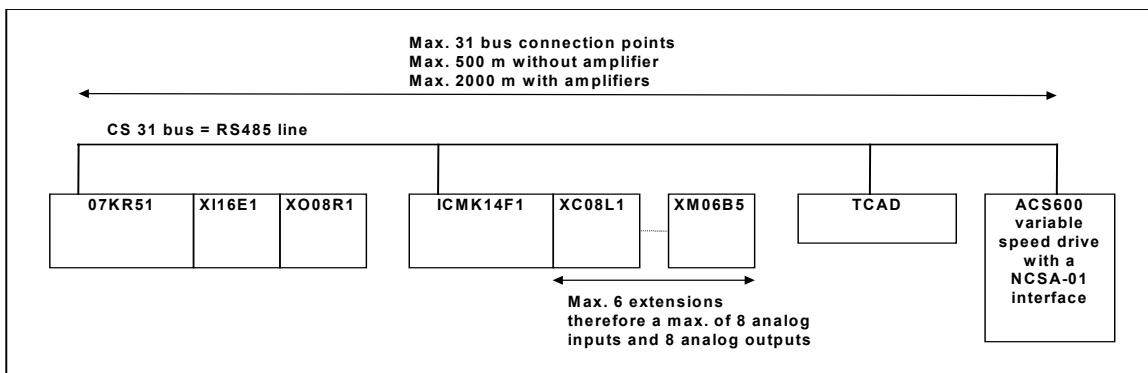


Figure 1-2 : Central unit with extensions and CS 31 bus

Presentation / operation

2.1. Central units with extensions

The 40 and 50 series. It's possible to increase the number of inputs / outputs of the basic central unit by adding up to 6 local extension units of either type, binary or analog (Figure 1-1).

2.2. Central units with CS 31 bus

The 50 and 90 series. It's possible to increase the number of inputs / outputs of the basic central unit by adding remote units. The central unit controlling the system is called the MASTER central unit. The maximum bus length is **500 m** without an amplifier and **2000 m** with 3 amplifiers (1 NCB or NCBR unit enables bus amplification for 500 m).

The master central unit can manage up to **31 connection points** called SLAVES, such as:

- A remote unit with extension possibilities: a maximum of 6 extension units comprising of a maximum of 8 analog input channels and 8 analog output channels
- A simple remote unit (without extension) with analog or binary inputs / outputs
- A remote TCAD display
- An ABB NCSA-01 variable speed drive interface
- A high speed counter unit
- A central unit (50 series with extension possibilities, 90 series and the previous 30 series)
- Or any other device which disposes of a CS 31 communication (see Figure 1-2).

Comment:

A slave fitted solely with binary channels occupies **1 connection point**.

A slave fitted with binary and analog channels occupies **2 connection points** of the available 31.

The maximum number of remote ANALOG units depends on the MASTER central unit:

- 50 series: - a maximum of **31** remote analog input units
 - a maximum of **31** remote analog output units
 - a maximum of **15** extensible remote units (ICMK14F1) with analog input / output extensions + **1** remote analog input / output unit ($15 \times 2 + 1 = 31$)
 - or a mixed binary / analog configuration within the previous limits
- 90 series: - a maximum of **12** remote analog input units
 - a maximum of **12** remote analog output units
 - or a maximum of **12** slaves with analog extensions

Other Option: You have a possibility to use and configure the CS31 bus in Modbus[®] slave or master see chapter 7 communication Modbus[®].

2.3. Cabling techniques

Connecting a central unit without a remote unit is simple and corresponds to normal electrical standards. The electrical connections of a AC 31 system which consists of remote units, notably where there are numerous electrical cubicles, should adhere to the obligatory rules. These rules are presented in chapter 4.

Presentation / operation

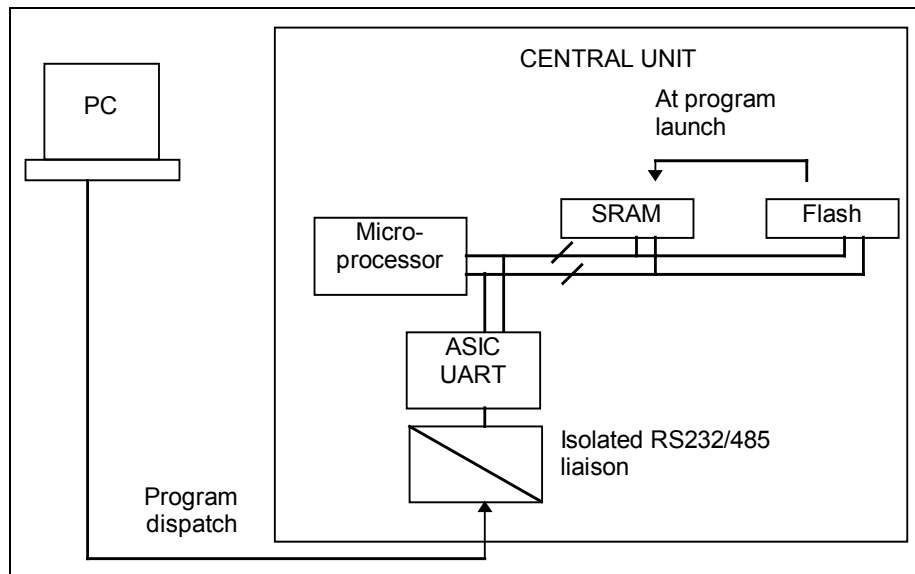


Figure 1-3 : Functional diagram of the central unit

Presentation / operation

3. Operation of the 40 and 50 series central units

3.1. Functional diagram

The 40 and 50 series central units memory is composed of two distinct areas:

- A SRAM memory where the user program and data is loaded.
- A Flash EPROM memory which contains:
 - a backup of the user program with the program constants,
 - the configuration data,
 - and the system program protected against access from the user program.

An incorporated battery, which is available only in the 50 series, also enables the backup of internal variables.

The user program is a set of universal functions conceived by the constructor to cover all applications and ensure all the basic PLC functions. It is developed with the AC31GRAF software. After being translated into instructions understandable by the central unit it is loaded in RUN or STOP mode into the SRAM and then saved from the SRAM to the Flash EPROM. Thereby, at each program launch the user program, saved in the Flash EPROM, is copied to the SRAM for processing by the microprocessor (Figure 1-3).

The structure of the system program memory, the user program, the inputs / outputs and internal variables are described in the annex (mapping).

Presentation / operation

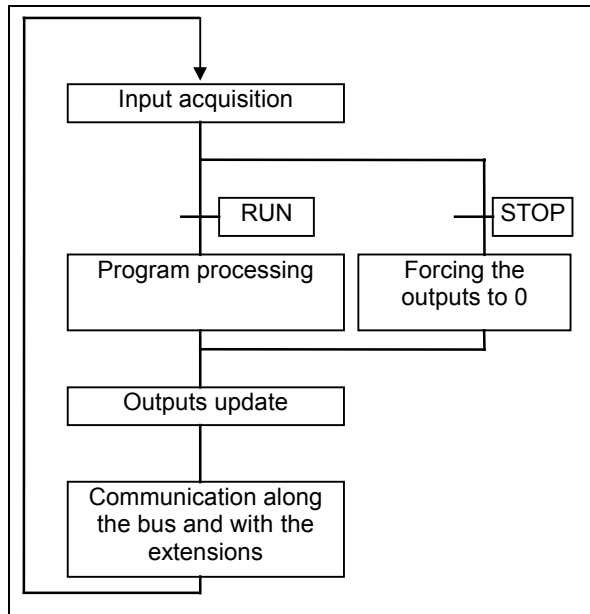


Figure 1-4 : The program execution cycle

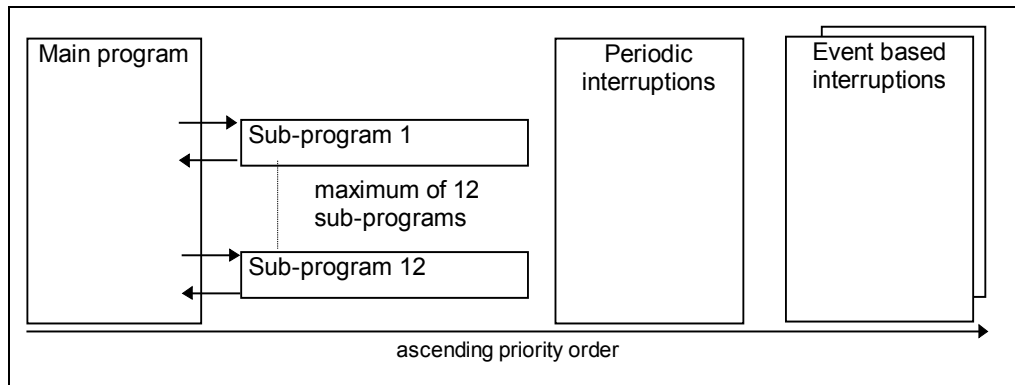


Figure 1-5 : Task priorities

Presentation / operation

3.2. Program execution

The central unit microprocessor ensures the cyclic execution of the system as shown in Figure 1-4.

The internal processing:

- PLC monitoring and control
 - and processing requests from the terminal operator,
- is executed in parallel with the previously described cycle.

The main program is processed sequentially. It may call up to a maximum of 12 sub-programs. Each sub-program may be called numerous times in the main program.

Three types of interruptions may be executed parallel to the main program:

- A cyclic interruption
- A warning interruption triggered by an event on the I 62.03 input
- A warning interruption triggered by an event on the I 62.02 input

The interruptions have priority over the main program execution. If all three interruptions are triggered simultaneously then the interruption triggered by I 62.03 has priority over the I 62.02 input interruption which in turn has priority over the cyclic interruption. Once an interruption has been launched it cannot be interrupted by another (Figure 1-5).

The execution duration of a cycle (bus cycle + program cycle) is controlled by the central unit. Any excess of the cycle time defined by the user in AC31GRAF is signaled by the ERR Led, at the front of the central unit, as of the first program cycle.

3.3. Bus transmission

The master central unit manages the transmission of messages to the various slaves over a RS485 serial liaison.

The messages are transmitted under the following format:

- Request from the master central unit:

address	data	CRC8
---------	------	------

- Request from the remote units:

start	data	CRC8
-------	------	------

The messages always end with an end of frame control: checksum CRC8.

The length of the exchanged frames depends on the type of unit. Frames exchanged with an analog unit are the longest.

Presentation / operation

The central unit interrogates the remote units in order to establish an initial image of the system configuration during initialization.

The remote units are then interrogated with each bus cycle. This enables the recognition of newly added or removed remote units and the updating of the diagnosis information.

If the central unit receives a message indicating a CRC8 error it will not be signaled immediately and the frame will not be taken into account. After nine consecutive transmission errors a "bus error" is signaled by the central unit. The bus error is also signaled to the remote units after a 250 ms time-out.

3.4. Refresh times / reply times

Bus refresh times and central unit reply times depend on the system configuration, the number and the type of remote units on the CS 31 bus. The bus refresh and the user programs are executed in series.

3.4.1. Bus refresh times

The bus refresh time corresponds to the transmission time over the bus. The calculation corresponds to the addition of all the communication times of the remote units on the bus and the base time of the master central unit which is 2 ms.

3.4.2. Central unit reply times

The central unit reply time corresponds to the time taken to activate an output after the activation of an input.

The maximum reply time is obtained by adding the filtering time of the input, the bus refresh time, the delay time for the output and twice the cycle time.

The filtering time for an input on the 40 and 50 series is 5 ms.

The delay time for a transistor output is considered as null in milliseconds and the delay time for a relay output is 6 ms.

Comment:

The inputs / outputs of central units and their extensions can be accessed, for rapid processing, independently of the cycle time with the user program functions DI and DO (see chapter 6).

The cycle time calculation is given in chapter 5 at the cycle time configuration level as well as the communication times of each unit for the bus transmission times calculation.

Presentation / operation

3.5. Power on / program launch

The central unit executes a complete series of auto tests at each startup. The program can only be launched if no errors have been detected.

The auto tests verify the following:

- the program syntax,
- the data transmission,
- the status of the extensions,
- the status of the remote units if there is a master central unit,
- the startup conditions (reset or not of internal memories).

The central unit initialization depends on the startup type:

Startup type	Initialization
Power on or software RESET or warm restart	<ul style="list-style-type: none">- Clear the program in RAM- Copy the Flash EPROM contents to RAM- Clear the data in RAM according to the configuration
Central unit STOP / RUN button	<ul style="list-style-type: none">- Copy the Flash EPROM contents to RAM The RAM remains unchanged if there isn't a program in the Flash EPROM. <ul style="list-style-type: none">- Clear the data in RAM according to the configuration
Software cold restart	<ul style="list-style-type: none">- Clear the program and data in RAM- Copy the Flash EPROM contents to RAM

The bus system is also initialized after startup if the central unit is the master on the CS 31 bus.

Presentation / operation

3.6. Power cuts or drops

The 40/50 series central unit disposes of a time delay in order to save the necessary information for the next startup should there be a power drop or cut.

Saving program internal data is only possible on the 40/50 series central unit which possesses an battery. Prior configuration of the central unit is required to save all or part of the data (see chapter 5). If the configuration is absent then all functions and internal data will be reset to 0.

The intermediate calculations of the functions used in the user program, necessary for the following cycles, are placed in variables called historic variables. It is also possible to save historic variables.

Presentation / operation

4. References

Products	Description	References
Central units		
40 Series		
07 CR 41 24VDC	Extensible stand-alone central unit, with 8 isolated inputs 24 V d.c. and 6 incorporated relay outputs 250 V a.c. / 2 A RS232 interface for programming or ASCII or MODBUS® communication 24 V d.c. power supply.	1SBP260020R1001
07 CR 41 120/230VAC	Extensible stand-alone central unit, with 8 isolated inputs 24 V d.c. and 6 incorporated relay outputs 250 V a.c. / 2 A RS232 interface for programming or ASCII or MODBUS® communication 24 V d.c. power supply output to power inputs 120 / 230 V a.c. power supply	1SBP260021R1001
07 CT 41 24VDC	Extensible stand-alone central unit, with 8 isolated inputs 24 V d.c. and 6 incorporated transistor outputs 24 V d.c. / 0.5 A RS232 interface for programming or ASCII or MODBUS® communication 24 V d.c. power supply	1SBP260022R1001
50 Series		
07 KR 51 24VDC	Extensible central unit with CS31 bus with 8 isolated inputs 24 V d.c. and 6 incorporated relay outputs 250 V a.c. / 2 A RS232 or RS485 interface for programming or ASCII or MODBUS® communication 24 V d.c. power supply	1SBP260010R1001
07 KR 51 120/230VAC	Extensible central unit with CS31 bus with 8 isolated inputs 24 V d.c. and 6 incorporated relay outputs 250 V a.c. / 2 A RS232 or RS485 interface for programming or ASCII or MODBUS® communication 24 V d.c. power supply output to power inputs 120 / 230 V a.c. power supply.	1SBP260011R1001
07 KT 51 24VDC	Extensible central unit with CS31 bus with 8 isolated inputs 24 V d.c. and 6 incorporated transistor outputs 24 V d.c. / 0.5 A RS232 or RS485 interface for programming or ASCII or MODBUS® communication 24 V d.c. power supply	1SBP260012R1001
Programming software		
ABB AC31GRAF	Programming software for central units, under Windows® 3.x, NT and 95/98. English version	1SBS260250R1001
ABB AC31GRAF	Programming software for central units, under Windows® 3.x, NT and 95/98. French version	1SBS260251R1001
ABB AC31GRAF	Programming software for central units, under Windows® 3.x, NT and 95/98. Italian version	1SBS260252R1001

Presentation / operation

Products	Description	References
Central units		
90 Series		
07 KR 91 230VAC	Extensible central unit with CS31 bus, memory 20 isolated inputs 24 V d.c. and 12 relay outputs 250 V a.c. / 2 A 120/230 V a.c. power supply.	GJR525000R0252
07 KR 91 24VDC	Extensible central unit with CS31 bus 20 isolated inputs 24 V d.c. and 12 relay outputs 250 V a.c. / 2 A 24 V d. c. power supply	GJR525000R0202
07 KT 92 24VDC	Extensible central unit with CS31 bus 12 isolated inputs 24 V d.c. and 8 transistor outputs 24 V d.c. / 0.5 A with 4 analog inputs and 2 analog outputs interface for programming or ASCII or MODBUS [®] communication 24 V d.c. power supply	GJR5250500R0202
07 KT 92 24VDC	Extensible central unit with CS31 bus 12 isolated inputs 24 V d.c. and 8 transistor outputs 24 V d.c. / 0.5 A with 4 analog inputs and 2 analog outputs interface for programming or ASCII or MODBUS [®] and ARCNET communication 24 V d.c. power supply	GJR5250500R0262
07 KT 93-S 24VDC	Extensible central unit with CS31 bus 24 isolated inputs 24 V d.c. and 16 transistor outputs 24 V d.c. / 0.5 A with security automation 24 V d.c. power supply	GJR5251300R2171
07 KT 93 24VDC	Extensible central unit with CS31 bus 24 isolated inputs 24 V d.c. and 16 transistor outputs 24 V d.c. / 0.5 A interface for programming or ASCII or MODBUS [®] communication 24 V d.c. power supply	GJR5251300R0303
07 KT 93 24VDC	Extensible central unit with CS31 bus 24 isolated inputs 24 V d.c. and 16 transistor outputs 24 V d.c. / 0.5 A interface for programming or ASCII or MODBUS [®] and ARCNET communication 24 V d.c. power supply	GJR5251300R0363
07 KT 94 24VDC	Extensible central unit with CS31 bus 24 isolated inputs 24 V d.c. and 16 transistor outputs 24 V d.c. / 0.5 A 8 channels configurable for inputs or transistor outputs 24 V d.c. / 0.5 A 8 analog inputs and 4 analog outputs interface for programming or ASCII or MODBUS [®] communication 24 V d.c. power supply	GJR5252100R0101
07 KT 94 24VDC	Extensible central unit with CS31 bus 24 isolated inputs 24 V d.c. and 16 transistor outputs 24 V d.c. / 0.5 A 8 channels configurable for inputs or transistor outputs 24 V d.c. / 0.5 A 8 analog inputs and 4 analog outputs interface for programming or ASCII or MODBUS [®] and ARCNET communication 24 V d.c. power supply	GJR5252100R0161

Presentation / operation

Products	Description	References
90 Series		
Communication couplers		
07 KP 90 *	RCOM protocol master / slave interface 24 V d.c. power supply.	GJR5251000R0202
07 KP 91 *	EIB coupler	1SAY110165R0003
07 MK 92	Two "C" programmable RS232 / RS422 or RS485 interfaces 24 V d.c. power supply	GATS110098R1161
07 KP 93	Two MODBUS [®] protocol RS232 / RS422 or RS485 interfaces slave / slave or master 24 V d.c. power supply	GATS110100R0001
07 KP 95 *	Coupler for ADVANT AF 100 network	GJR5252000R0101
07 KP 96 *	PDnet coupler in order to communicate with 24 V d.c. power supply KOAX KOAX with redundancy Optic fiber (plastic) LWL Optic fiber (plastic) LWL with redundancy Optic fiber (glass) LWL Optic fiber (glass) LWL with redundancy	GATS110112R0001 GATS110112R0011 GATS110112R0002 GATS110112R0012 GATS110112R0003 GATS110112R0013

* Special software is necessary for these products

Presentation / operation

Products	Description	References
Extensible remote units		
ICMK 14 F1 24VDC	Extensible remote unit with 8 isolated inputs 24 V d.c. and 6 relay outputs 250 V a.c. / 2 A 24 V d.c. power supply.	1SBP260050R1001
ICMK 14 F1 120/230VAC	Extensible remote unit with 8 isolated inputs 24 V d.c. and 6 relay outputs 250 V a.c. / 2 A 24 V d.c. power supply output to power inputs 120 / 230 V a.c. power supply.	1SBP260051R1001
ICMK 14 N1 24VDC	Extensible remote unit with 8 isolated inputs 24 V d.c. and 6 transistor outputs 24 V d.c. / 0.5 A 24 V d.c. power supply.	1SBP260052R1001
Extensions		
XI 16 E1	Binary extension with 16 isolated inputs 24 V d.c.	1SBP260100R1001
XO 08 R1	Binary extension with 8 relay outputs 250 V a.c. / 2 A	1SBP260101R1001
XC 08 L1	Binary extension with 8 channels configurable for inputs or transistor outputs 24 V d.c. / 0.5 A	1SBP260102R1001
XK 08 F1	Binary extension with 4 isolated inputs 24 V d.c. and 4 relay outputs 250 V a.c. / 2 A	1SBP260104R1001
XO 16 N1	Binary extension with 16 transistor outputs 24 V d.c. / 0.5 A	1SBP260105R1001
XO 08 Y1	Binary extension with 8 transistor outputs 24 V d.c. / 2 A	1SBP260108R1001
XO 08 R2	Binary extension with 4 NO relay outputs 250 V a.c. / 2 A and 4 NO/NF relay outputs 250 V a.c. / 3 A	1SPB260109R1001
XM 06 B5	Analog extension with 4 inputs configurable for current / voltage / Pt 100 / Pt 1000 and 2 outputs configurable for current / voltage resolution 12 bits	1SBP260103R1001
XE 08 B5	Analog extension with 8 inputs configurable for current / voltage / Pt 100 / Pt 1000 resolution 12 bits	1SBP260106R1001
XTC 08	Display extension with 8 channels (4 figures + sign + selected channel)	1SBP260107R1001
30 series plug-in base		
ECZ	Plug-in base for mounting series 30 remote units	FPR 370 0001 R0001

Presentation / operation

Products	Description	References
30 series binary remote units		
ICSI 08 E3 120VAC	Binary remote unit with 8 isolated inputs 120 V a.c. 120 V a.c. power supply	FPR 331 6301 R0014
ICSI 08 E4 230VAC	Binary remote unit with 8 isolated inputs 230 V a.c. 230 V a.c. power supply	FPR 331 6401 R0016
ICSO 08 Y1 24VDC	Binary remote unit with 8 transistor outputs 24 V d.c. / 2 A 24 V d.c. power supply	FPR 331 1101 R1022
ICSO 08 Y1 120VAC	Binary remote unit with 8 transistor outputs 24 V d.c. / 2 A 120 V a.c. power supply	FPR 331 1101 R0024
ICSO 08 Y1 230VAC	Binary remote unit with 8 transistor outputs 24 V d.c. / 2 A 230 V a.c. power supply	FPR 331 1101 R0026
30 series analog remote units		
ICSE 08 A6 24VDC	Analog remote unit with 8 inputs configurable current / voltage resolution 8 bits 24 V d.c. power supply	FPR 334 5601 R1012
ICSE 08 A6 120VAC	Analog remote unit with 8 inputs configurable current / voltage resolution 8 bits 120 V a.c. power supply	FPR 334 5601 R0014
ICSE 08 A6 230VAC	Analog remote unit with 8 inputs configurable current / voltage resolution 8 bits 230 V a.c. power supply.	FPR 334 5601 R0016
ICSE 08 B5 24VDC	Analog remote unit with 8 inputs configurable current / voltage resolution 12 bits 24 V d.c. power supply	FPR 334 6501 R1012
ICSE 08 B5 120VAC	Analog remote unit with 8 inputs configurable current / voltage resolution 12 bits 120 V a.c. power supply	FPR 334 6501 R0014
ICSE 08 B5 230VAC	Analog remote unit with 8 inputs configurable current / voltage resolution 12 bits 230 V a.c. power supply	FPR 334 6501 R0016
ICSA 04 B5 24VDC	Analog remote unit with 4 outputs configurable current / voltage resolution 12 bits 24 V d.c. power supply	FPR 334 1501 R1042
ICSA 04 B5 120VAC	Analog remote unit with 4 outputs configurable current / voltage resolution 12 bits 120 V a.c. power supply	FPR 334 1501 R0044
ICSA 04 B5 230VAC	Analog remote unit with 4 outputs configurable current / voltage resolution 12 bits 230 V a.c. power supply.	FPR 334 1501 R0046

Presentation / operation

Products	Description	References
90 series binary remote units		
07 DI 92	Binary remote unit with 32 binary inputs 24 V d.c. 24 V d.c. power supply	GJR 525 2400 R0101
07 DC 91	Binary remote unit with 16 binary inputs, 8 transistor outputs and 8 configurable inputs/outputs 24 V d.c. / 0,5 A	GJR 525 1400 R0202
07 DC 92	Binary remote unit with 32 configurable inputs/outputs 24 V d.c. / 0,5 A	GJR 525 2200 R0101
90 series analog remote units		
07 AI 91	Analog remote unit with 8 inputs configurable current / voltage, Pt 100, Pt 1000 or thermocouple types J, K, S resolution 12 bits 24 V d.c. power supply	GJR 525 1600 R0202
07 AC 91	Analog remote unit with 16 inputs/outputs configurable current / voltage resolution 8 / 12 bits 24 V d.c. power supply	GJR 525 2300 R1001
Remote units with IP 67 protection		
07 DI 93-I	Binary remote unit with IP 67 protection with 16 inputs 24 V d.c. 24 V d.c. power supply	GJV 307 5613 R0202
07 DO 93-I	Binary remote unit with IP 67 protection with 8 transistor outputs 24 V d.c. / 2 A 24 V d.c. power supply	GJV 307 5611 R0202
07 DK 93-I	Binary remote unit with IP 67 protection with 8 inputs 24 V d.c. and 4 transistor outputs 24 V d.c. / 2 A 24 V d.c. power supply	GJV 307 5623 R0202
Safety remote units only used with 07 KT93-S		
07 DI 90-S	Safety remote unit with 8 binary inputs 24 V d.c. 24 V d.c. power supply	GJR 525 0900 R0202
07 DO 90-S	Safety remote unit with 8 transistor outputs 24 V d.c. / 0,5 A 24 V d.c. power supply	GJR 525 0800 R0202
07 AI 90-S	Safety remote unit with 4 analog inputs, resolution 12 bits, 4..20mA 24 V d.c. power supply	GJR 525 1100 R0202
Remote counter units		
	Remote high speed counter unit, max. 50 kHz 4 inputs A/A, B/B, C/C - 5.15 or 24 V d.c. modes : incremental, A-B (32 bits), A+B (32 bits), 3 (16 bit) stand-alone counters or 3 (16 bit) frequency meters 100 ms to 6536.5 s validation, RESET, set, reference point 7 transistor (24 V d.c. / 0.5 A) outputs for local comparison management between 2 instructions and the counter value.	
ICSF 08 D1 24VDC	24 V d.c. power supply	FPR 332 3101 R1012
ICSF 08 D1 120VAC	120 V a.c. power supply	FPR 332 3101 R0014
ICSF 08 D1 230VAC	230 V a.c. power supply	FPR 332 3101 R0016

Presentation / operation

Products	Description	References
Displays		
TC 50	Display with 2 lines of 20 characters, 7 operator keys, 5 customizable keys for parameter modifications or process control IP 65 front 128 pages with 6 data/page insertion 128 help messages + 128 information messages RS232 liaison through the serial ports of the central units MODBUS [®] protocol or AC 31 programming mode 24 V d.c. power supply Delivered with connecting cable for 40 and 50 series central units	1SBP260150R1001
TC 50-2	Display with 2 lines of 20 characters, 7 operator keys, 5 customizable keys for parameter modifications or process control IP 65 front 128 pages with 6 data/page insertion 128 help messages + 128 information messages RS485 liaison through the serial ports of the central units MODBUS [®] protocol or AC 31 programming mode 24 V d.c. power supply Delivered with connecting cable for 40 and 50 series central units	1SBP260151R1001
TCWIN	Programming software for TC 50 and TC 50-2 under Windows [®] NT and 95/98. Delivered with connecting cable for 40 and 50 series central units	1SBS260280R1001
TCAD	Display connected to CS 31 bus 2 lines of 16 characters 1 buzzer and 1 programmable key 127 messages + 1 background message with 2 embedded data / message IP 65 front 24 V d.c. power supply Delivered with programming software	FPR 320 3526 R1002
CS 31 bus accessories		
NCB	CS 31 bus amplifier for 500 m max. 2 000 m with 3 amplifiers 24 V d.c. power supply	FPR 347 1200 R1002
NCBR	CS 31 bus amplifier for 500 m max. 2 000 m with 3 amplifiers with redundancy in parallel, ring or star 24 V d.c. power supply	FPR 347 1300 R1002
Cables		
07 SK 50	PC programming cable - 40 and 50 series central units SUB D9 connector to PC	1SBN260200R1001
07 SK 51	40 and 50 series central units MODBUS [®] /ASCII communication cable - SUB D9 connector to PC	1SBN260201R1001
07 SK 52	40 and 50 series central units programming cable with bare wires / terminal connection to central unit	1SBN260202R1001
07 SK 53	40 and 50 series central units MODBUS [®] /ASCII communication cable, with bare wires / terminal connection to central unit	1SBN260203R1001
07 SK 54	TC 50 cable - 40 and 50 series central units	1SBN260204R1001
07 SK 55	PC-TC 50 programming cable SUB D9 connector to PC	1SBN260205R1001
07 SK 57	TC 50 cable - 30 and 90 series central units	1SBN260207R1001
07 SK 58	TC 50-2 cable with bare wires / terminal connection to central unit.	1SBN260208R1001

Presentation / operation

Products	Description	References
Connectors		
07 ST 50	Dual connector for easy connection, to 40 and 50 series central units, of sensors or 3 wire binary actuators 2 units	1SBN260300R1001
07 ST 51	Dual connector for easy connection, to 40 and 50 series central units, of sensors or 3/4 wire analog actuators 2 units	1SBN260301R1001
07 ST 52	Cage-clamp type connectors for binary channels 2 units	1SBN260302R1001
07 ST 54	A set of cage-clamp type connectors for central or remote units	1SBN260311R1001
07 ST 55	A set of cage-clamp type connectors for XI 16 E1 or XO 16 N1 or XE 08 B5 extensions	1SBN260312R1001
07 ST 56	A set of cage-clamp type connectors for XO 08 R1 or XC 08 L1 or XK 08 F1 extensions	1SBN260313R1001
07 ST 57	A set of cage-clamp type connectors for XM 06 B5 extension	1SBN260314R1001
Various accessories		
Labels	Label for channel description by user (100 units)	1SBN260310R1001
40 and 50 series documentation	English technical documentation for the 40 and 50 series central units	1SBC260400R1001

Each of the following AC 31 products are described in their respective documentation : 90 series units, 30 series, IP 65 protection, high speed counter, robot interfaces, displays and CS 31 bus accessories.

Chapter 2

Getting started

Presentation / operation

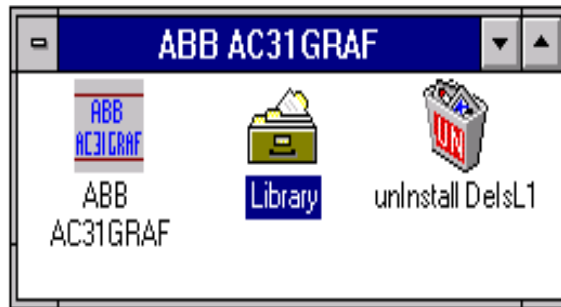


Figure 2-1 : ABB AC31GRAF group

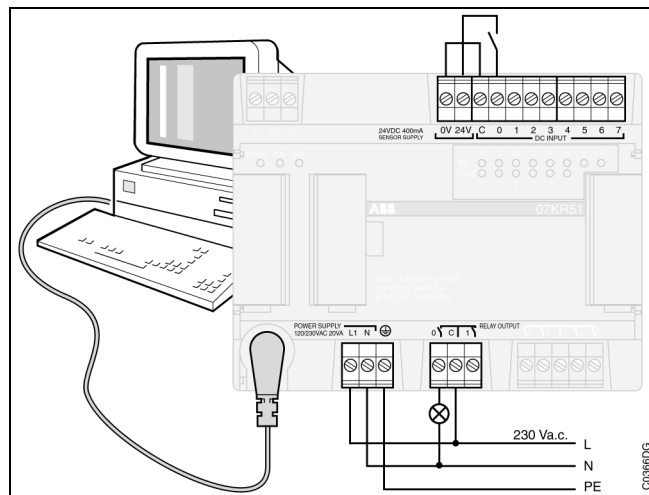


Figure 2-2 : Cabling of a 07 KR 51 230 V a.c. central unit for our example

Presentation / operation

In order to familiarize yourself with the AC 31 system this chapter details, point by point, the necessary operations for starting with a 40 or 50 series central unit. The demonstration is based on a simple example of OR function with an input (switch), an internal bit (test) and an output (lamp).

1. Required material

- ⇒ 1 central unit : 07 CR 41, 07 CT 41, 07 KR 51 or 07 KT 51
- ⇒ 1 power supply depending on the central unit chosen : 24 V d.c., 120 V a.c. or 230 V a.c.
- ⇒ 1 programming cable 07 SK 50
- ⇒ 1 PC with Windows® 3.1 or greater, Windows® NT or Windows® 95/98
- ⇒ An installed version of AC31GRAF

The AC31GRAF installation requires 12 Mb of free space on your hard drive.

- ⇒ Follow the installation procedure after having executed "a:\setup.exe". Please refer to the 1SBC006099R1001 software documentation should you encounter a problem.

The AC31GRAF icon is automatically installed in the ABB AC31GRAF group (see Figure 2-1).

2. Cabling

The cabling example shown in Figure 2-2 is that of a 07 KR 51 central unit 230 V a.c.

The RUN/STOP switch of the central unit should be on STOP.

Please make sure that you have a switch and a lamp so that you can realize the cabling, as shown opposite, for the demonstration.

Presentation / operation

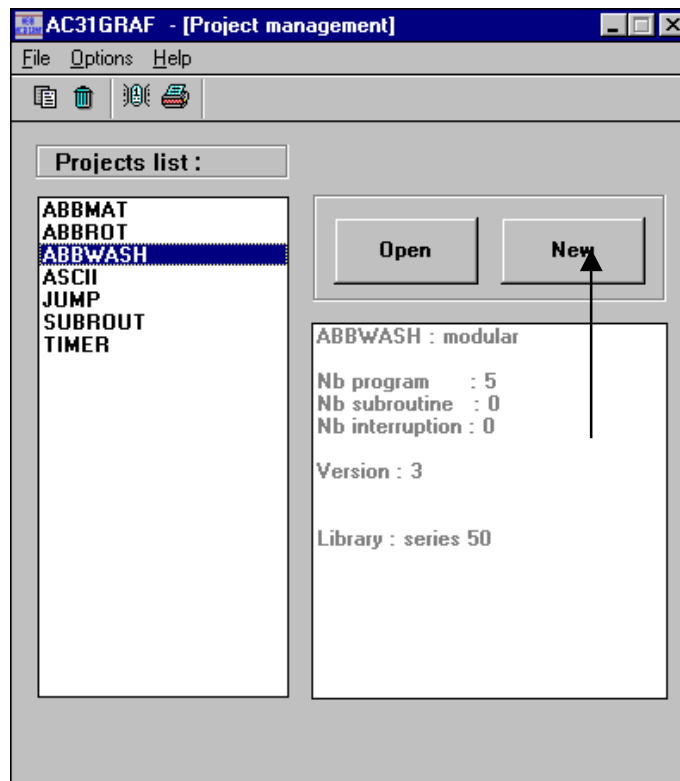


Figure 2-3 : The "Project management" window which appears after launching AC31GRAF.

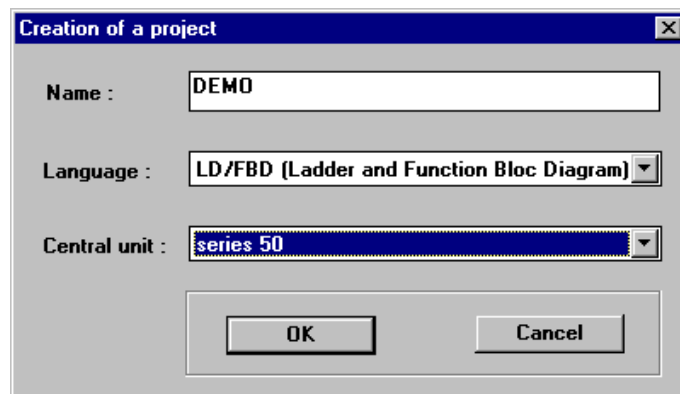


Figure 2-4 : Project creation window

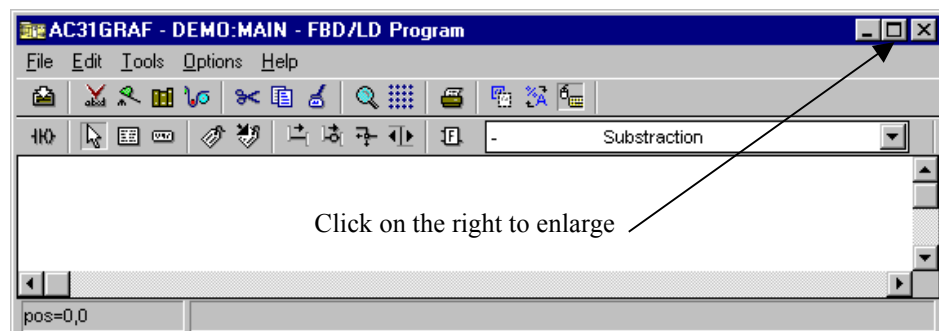


Figure 2-5 : The editor window of the main program MAIN of the DEMO project

Presentation / operation

3. Programming

3.1. Launching the AC31GRAF software

⇒ Double-click the AC31GRAF icon in the ABB AC31GRAF group (see Figure 2-1).

3.2. Project creation

⇒ Click on the "New" button in the "Project management" window (Figure 2-3).

The project is defined by its name, programming language and programmed central unit (see Figure 2-4).

⇒ Enter the project name: "DEMO".

⇒ Select, by clicking the arrows:

- the language: "LD/FBD" which corresponds to the ladder diagram and function block language,

- the central unit to be programmed: "series 40" or "series 50".

⇒ Click "OK" to validate.

The DEMO:MAIN editor window opens for the main program MAIN of the DEMO project (see Figure 2-5).

⇒ Click on the button in the top right corner to enlarge the window.

Presentation / operation

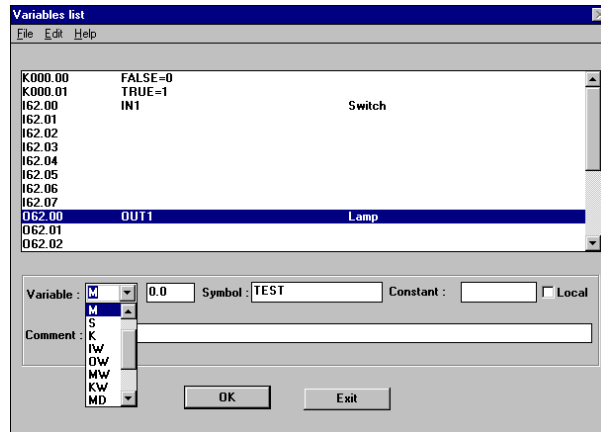


Figure 2-6 : The variables list

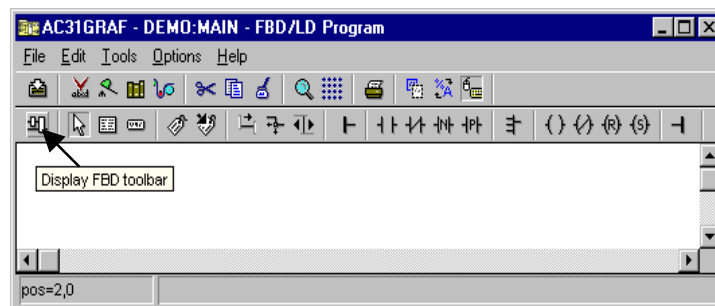


Figure 2-7 : Program editor window with LD toolbar

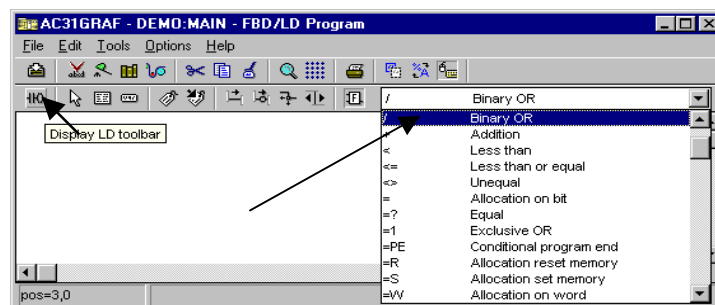


Figure 2-8 : Program editor window with FBD toolbar

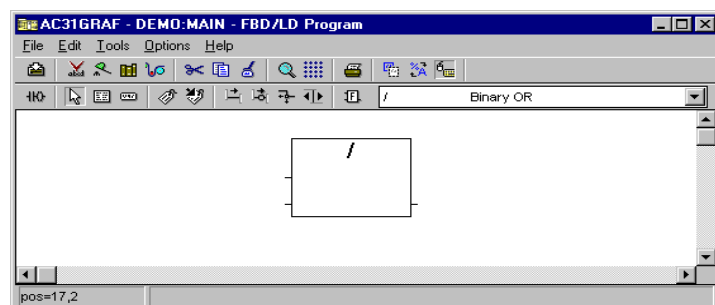



Figure 2-9 : Placing the OR function in the program editor page

Presentation / operation

3.3. Variable declarations

⇒ Select the  "Variable list" icon in the program editor window (Figure 2-6).

The pre-defined variables in the variable list are those which correspond to the chosen central unit. The variables of the 40 or 50 series central units are:

- I62.00 to I62.07 for the 8 binary inputs,
- O62.00 to O62.05 for the 6 binary outputs,
- IW62.00 and IW62.01 for the 2 potentiometers,
- M 255.00 to M255.03 for the oscillators

⇒ Enter the descriptions for the following variables:

- Select "I62.00" in the list
- Enter: "IN1" without a space and the comment: "Switch"
- Press "OK" to validate
- Create an internal bit "M00.00" by selecting "M" in the variables list available then enter "00.00"
- Enter: "TEST"
- Press "OK" to validate
- Select "O62.00" in the list
- Enter: "OUT1" and the comment: "Lamp"
- Press "OK" to validate

⇒ Press "Exit" to exit. Save by selecting "yes".

3.4. Program editing

3.4.1. Displaying the FBD (function blocks) toolbar

It may be that the LD toolbar is displayed (Figure 2-7).

⇒ Should this be the case, click on the "Display FBD toolbar" icon so that the function blocks toolbar is displayed (result Figure 2-8).

Note that clicking on the "Display LD toolbar" icon will display the LD toolbar again.

3.4.2. Selecting the OR function in the program editor window

⇒ Click on the arrow, as indicated in Figure 2-8, in order to obtain the functions list.

⇒ Select the "/" function by scrolling through the list with your mouse.

⇒ Place the cursor on the blank page (Figure 2-9) and click the mouse to place the "/" function.

The "/" function block should be completed with 2 parameters:

- an input variable (to the left of the block),
- an internal bit (to the left of the block),
- an output variable (to the right of the block).

A complete description of the function block is available by double-clicking the block and then clicking on the "Info" followed by the "Note" buttons.

Presentation / operation

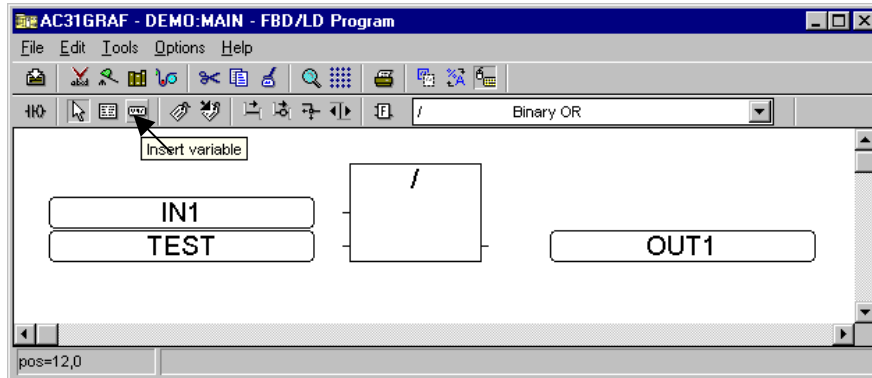


Figure 2-10 : Inserting variables

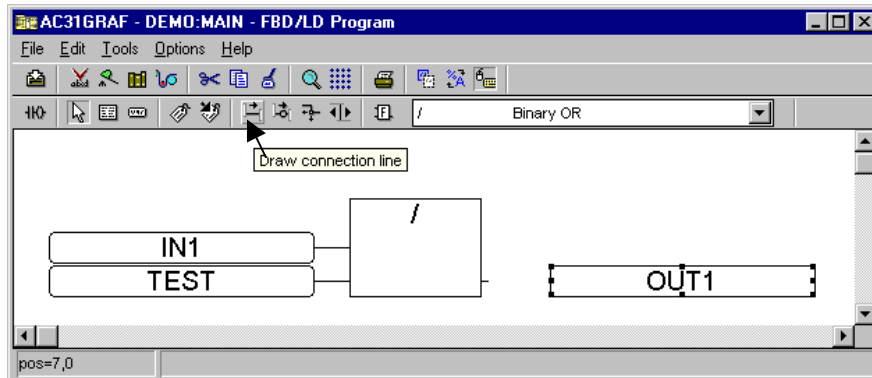


Figure 2-11 : Linking the variables and the function block

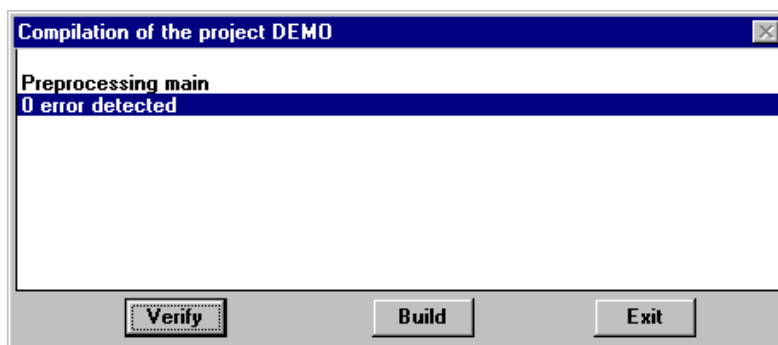


Figure 2-12 : Compiler window. Text after verification: "Verify"

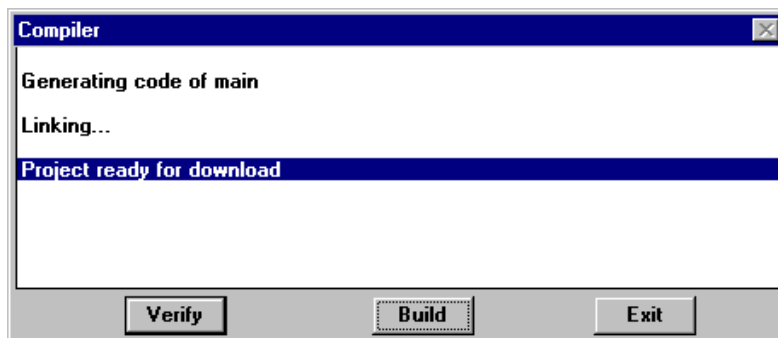



Figure 2-13 : Compiler window. Text after translation: "Build"

Presentation / operation

3.4.3. Inserting variables


- ⇒ Select the  "Insert variable" icon (Figure 2-10) in the program editor window. Then place the cursor to the left of the function block, making sure that enough space is left so that the input variable does not overlap the function block, and click on the mouse.
- ⇒ Select the "I62.00 - IN1 - Switch" variable in the variable list
- ⇒ Validate with "OK". The variable appears with its name.

Comment: If the "Cannot overlap graphic symbols" message appears instead of the variable then restart the manipulation leaving enough space to the left of the block for the variable insertion

Use the same procedure to insert the internal bit to the left of the function block and below of the input variable and select the "M00.00 - TEST" internal bit.


- ⇒ Use the same procedure to insert the output variable to the right of the function block and select the "O62.00 - OUT1 - Lamp" variable.

3.4.4. Links between the variables and the function block:

- ⇒ Select the  "Draw connection line" icon in the program editor window (Figure 2-11) and draw a line, without releasing the mouse button, between the "IN1" variable and the block.
- ⇒ The link between the "TEST" internal bit and the block is drawn in the same manner.
- ⇒ The link between the "OUT1" variable and the block is drawn in the same manner.


The programming phase is finished once the links are established. You may now save, compile and send the program to the PLC.

3.5. Saving

- ⇒ Click on the  "Save" icon in the program editor window to save your program.

3.6. Compilation

Compiling corresponds to a program verification and translation into a PLC understandable language.

- ⇒ Click the  "Verify program" icon in the program editor window.
- ⇒ Click the "Verify" button, wait for the message "0 error detected" (Figure 2-12) then click on the "Build" button.
- ⇒ Once the "Project ready for download" message has appeared (Figure 2-13), click on "Exit" to exit and return to the DEMO:MAIN program editor window.

Presentation / operation

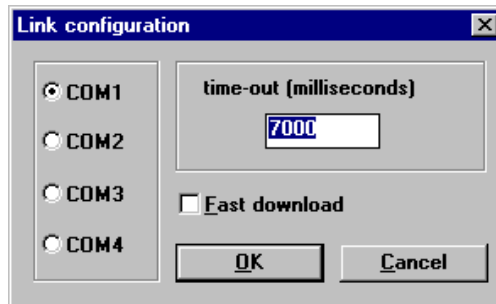


Figure 2-14 : Serial interface configuration window

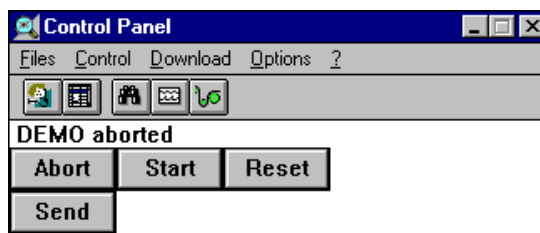


Figure 2-15 : Control window

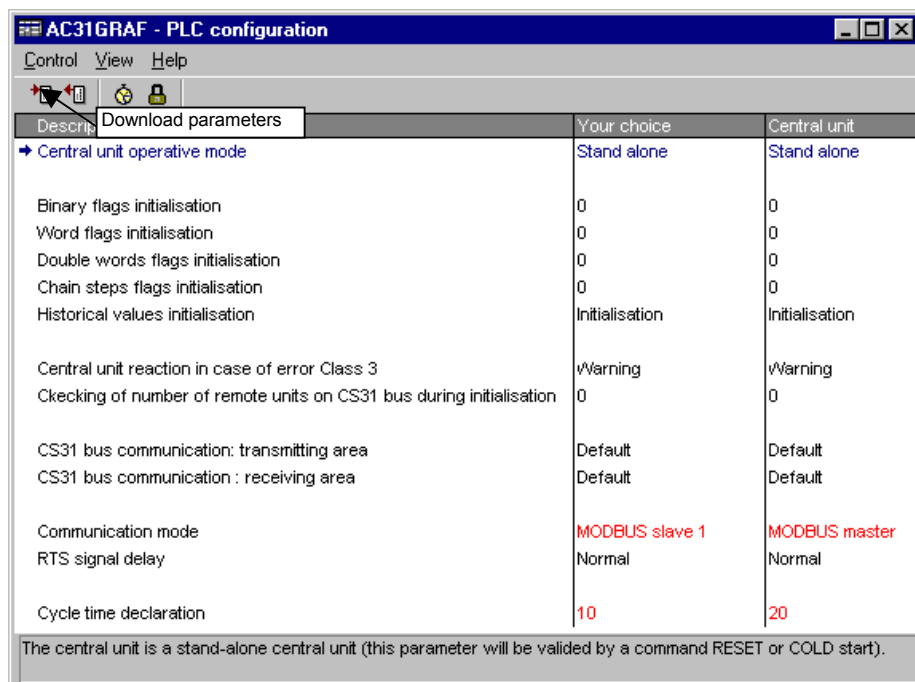


Figure 2-16 : Central unit configuration window

Presentation / operation

3.7. Communication with the PLC

3.7.1. Configuration of the serial interface

- ⇒ Select the *"Link configuration"* item of the *"Options"* menu from the program editor window.
- ⇒ Check that the communication cable is properly connected to the PC at the selected serial interface: COM1 by default. If this isn't the case then modify the configuration in the *"Link configuration"* window (Figure 2-14) according to your connection.
- ⇒ Validate with *"OK"*.

3.7.2. Access to the control panel

- ⇒ Select the  *"PLC communication"* icon in the editor window

The control window opens (Figure 2-15):

- ⇒ It may be that this window does not appear on the screen, in which case press ALT + TABULATION repeatedly until the *"Control Panel"* window appears.
- ⇒ Go to the *"Options"* menu and select *"Always on top"* in order to have this window displayed on the screen permanently.

3.7.3. Configuration of the central unit:

- ⇒ Select the  *"Launch PLC configuration tool"* icon from the control window.

The configuration window presentation varies depending on the central unit selected. The window displayed in Figure 2-16 is that of a 07 KR 51 central unit.

The configuration in the *"Your choice"* column is the default configuration which is convenient for this example.

The differences between the *"Your choice"* and *"Central unit"* (that which is in the central unit) columns are indicated in red.

- ⇒ If there are differences between the two columns, then send the default configuration by clicking the *"Download parameters"* icon. Wait until the *"Central unit"* column has updated and then select *"Exit"* from the *"Control"* menu to return to the control window.
- ⇒ If there aren't any differences, then select *"Exit"* from the *"Control"* menu to return to the control window.

Presentation / operation

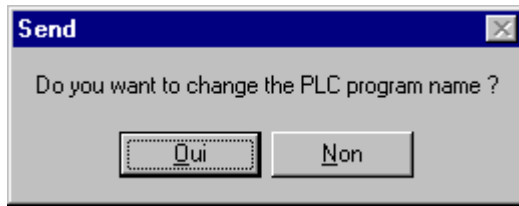


Figure 2-17 : Message 1 when sending the program to the PLC

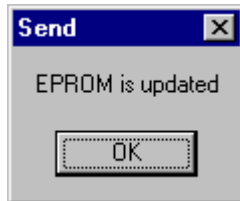


Figure 2-18 : Message 2 when sending the program to the PLC

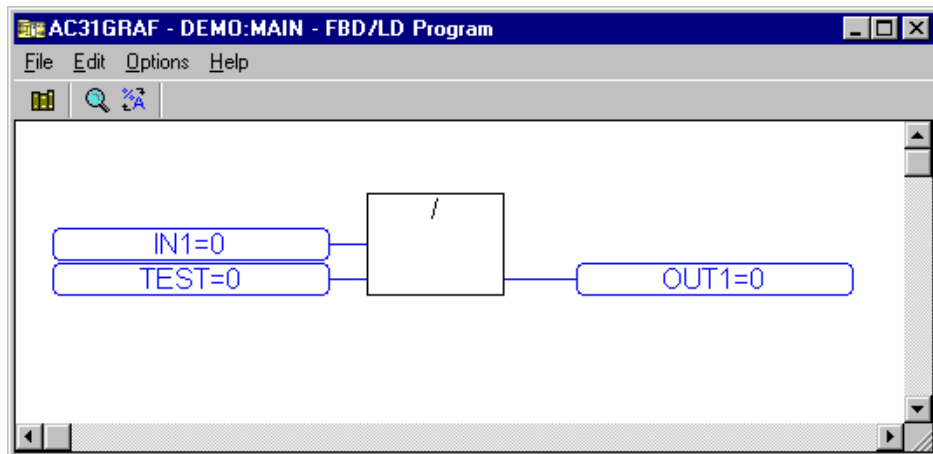


Figure 2-19 : Test window of the program on-line

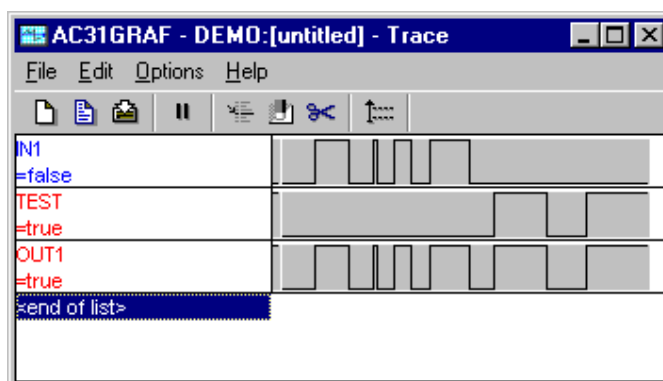


Figure 2-20 : "Trace" window for a graphic visualization of the signals

Presentation / operation

3.7.4. Initializing the central unit

Initialization of the central unit is necessary after any configuration of the central unit operative mode in order for it to startup with the correct system configuration.

- ⇒ Click the "Reset" button in the control window to re-initialize the central unit. Wait for the "Reset" window and validate "OK".



3.7.5. Sending the program to the PLC

- ⇒ Click on the "Send" button in the control window to automatically **send and save** the program to the PLC.
- ⇒ Reply "Yes" to the first message "Do you want to change the PLC program name?" (Figure 2-17).
- ⇒ Wait for the second message "EPROM is updated" and validate "OK" (Figure 2-18).

3.7.6. On-line program tests

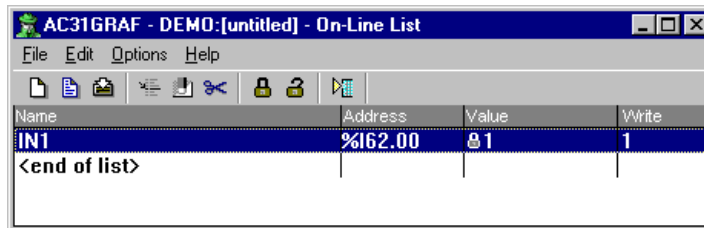
- ⇒ Set the RUN/STOP switch of the central unit to RUN.

Test 1:

- ⇒ Activation and deactivation of the input using the switch wired to the I62.00 input.
- ⇒ The output status can be visualized on the PLC as well as from the software, as shown in Figure 2-19.
- ⇒ The input, internal bit and output signals may also be visualized in time by clicking on the  "Variable time diagrams" icon in the control window.
- ⇒ Click on the  "Insert variable" icon in the "Trace" window in order to insert a variable (Figure 2-20).
- ⇒ Select the "I62.00 - IN1 - Switch" variable and validate "OK".
- ⇒ Follow the same procedure to insert the "M00.00 - TEST" internal bit.
- ⇒ Follow the same procedure to insert the "O62.00 - OUT1 - Lamp" variable.

The input, internal bit and output signals are immediately traced in the "Trace" window (Figure 2-20).

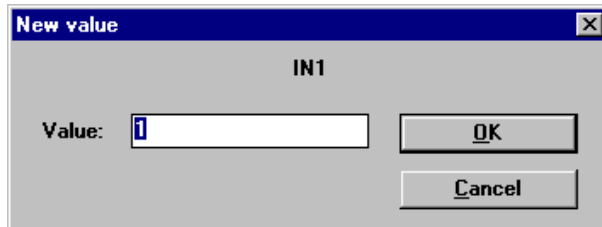
Presentation / operation



Name	Address	Value	Write
IN1	%I62.00	1	1

<end of list>

Figure 2-21 : "On-line List"



New value

IN1

Value: 1

OK

Cancel

Figure 2-22 : Forcing the input to 1

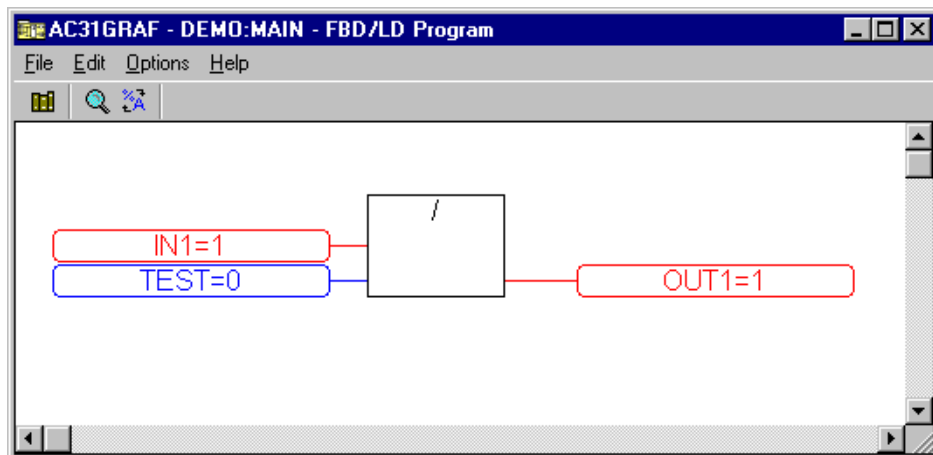
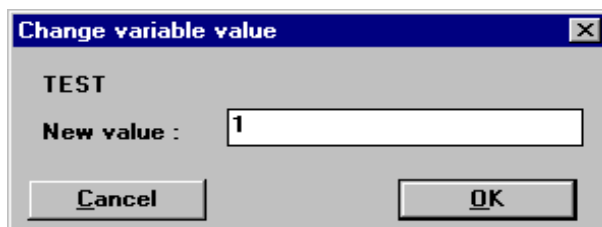


Figure 2-23 : The software result of the input forcing



Change variable value

TEST

New value : 1




Cancel

OK

Figure 2-24 : Changing the variable value to 1

Presentation / operation

Test 2: software input forcing

- ⇒ Click on the "On-Line List" button in the control panel.
- ⇒ Click on the  "Insert variable" icon to insert a variable.
- ⇒ Select the "I62.00 - IN1 - Switch" variable and validate "OK".
- ⇒ Double-click the "IN1 - I62.00" variable line in the "On-line list" window (Figure 2-21).
- ⇒ Enter 1 and validate "OK" (Figure 2-22).
- ⇒ Select the  "Lock" icon in the "On-line List" window to force the variable into the PLC.
- ⇒ The output status may also be visualized on screen or in the time graphics (Figure 2-23).
- ⇒ Do not forget to cancel the force, before quitting this step, by clicking on the  "Unlock" icon of the "On-line List" window.

The internal bit status may be visualized by clicking on the internal bit on the screen then enter its new value (Figure 2-24).

It is now possible to modify the program WITHOUT stopping the PLC, by: quitting the control window, modifying the program in the DEMO:MAIN window, recompiling and returning to the control window to send the modifications and test them. Please refer to the software documentation to continue.

For further programming help: chapter 5 contains some standard function programming examples.

3.8. Quitting AC31GRAF

- ⇒ Select "Exit Control Panel" in the "File" menu to exit the control window. This will also close all other windows linked to the control window, such as the "On-line list" and "Trace" windows.
- ⇒ To quit the program editor, go to "File" then "Exit".

To quit the "Project Management", go to "File" then "Exit"

Chapter 3

Technical specifications

Technical specifications

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Technical specifications

This chapter presents the products and their general characteristics and operating conditions.

1. General operating conditions

The AC 31 units were developed according to the European EC directives, the main national and international IEC 1131-1 and IEC 1131-2 standards and the EN61131-2 product standard concerning automation devices.

Ambient conditions - Temperature: operation: horizontal vertical storage transport - Humidity: annual average up to 30 days per year occasionally - Atmospheric pressure: operation storage	0°C to + 55°C 0°C to + 40°C - 40°C to + 75°C - 25°C to + 75°C DIN 40040 class F without condensation ≤ 75% 95% 85% DIN 40050 ≥ 800 hPA (≤ 2000 m) ≥ 600 hPA (≤ 3500 m)
Mechanical data - Protection index - Unit - Vibration stress - Shock stress	IP20 UL V2 CEI68-2-6 test Fc CEI68-2-27 test Ea
Tolerances for mains voltages - 24 V d.c. - 120 V a.c. (50 / 60 Hz) - 230 V a.c. (50 / 60 Hz)	19.2 to 30 V (- 20%, + 25%) 97.75 to 126.5 V (- 18,5%, + 5,5%) 195.5 to 253 V (- 15%, + 10%)

Technical specifications

Creepage distances and clearances	IEC 664 and DIN VDE0160
Insulation test	IEC 1131-2
Electromagnetic compatibility Immunity tests against: <ul style="list-style-type: none"> - Electrostatic discharge - Radiated fields - Fast transient bursts - High energy pulse - Conducted high frequencies 	IEC 1000-4-2 (level 3) IEC 1000-4-3 (level 3) IEC 1000-4-4 (level 3) IEC 1000-4-5 IEC 1000-4-6 (level 3)
Voltage drops and short power cutoffs <ul style="list-style-type: none"> - D.C. power supply - A.C. power supply 	Duration of the power cutoffs: ≤ 10 ms Time between 2 voltage drops: ≥ 1 s Duration of the power cutoffs: ≤ 20 ms Time between 2 voltage drops: ≥ 1 s
Clearance	IEC 664-664A DIN VDE 0160
Dielectric test	IEC 1131-2
Mountings <ul style="list-style-type: none"> - DIN rail - Screw fittings 	35 mm 4 mm diameter screw (M4)
Connections <ul style="list-style-type: none"> - Connectors - Section for: <ul style="list-style-type: none"> Earth Inputs Outputs Power supply Bus - Screws tightening torque 	Removable terminal blocks (2.5 mm ²) Rigid or multi-conductor wire AWG 14 (1.95 mm ²) Rigid or multi-conductor wire AWG 18 (0.96 mm ²) to AWG 14 (1.95 mm ²) Rigid or multi-conductor wire AWG 14 (1.95 mm ²) Rigid or multi-conductor wire AWG 14 (1.95 mm ²) Twisted pair AWG 24 (0.22 mm ²) to AWG 18 (0.8 mm ²) 0.5 Nm (given as an indication only)
Serial interface <ul style="list-style-type: none"> - For programming - For the bus 	RS 232 / RS 485 RS 485

Technical specifications

2. CS 31 bus technical specifications

Type	RS 485 multipoint serial interface
Mode	Half-duplex
Number of connection points	1 single master max. 31 slaves
Support - Section - Twists - Resistance - Impedance specification - Capacity - Shielding - Line termination	Shielded twisted pair 0.22...0.8 mm ² > 10 per meter ≤ 100 Ω / km 100 à 150 Ω < 150 nF / km Braiding Resistance 120 Ω, ¼ Watt, connected to each extremity of the bus
Protocol	ABB CS 31 (master/slave) or MODBUS master/slave or programming
Transmission control	CRC
Maximum length	up to 500 m without amplifier up to 2000 m with 3 amplifiers (NCB or NCBR)
Bus redundancy	yes with NCBR
Isolation	yes by optocoupler
Refresh time	2 ms minimum typically 12 ms with 31 CS 31 interfaces
Speed	187.5 kBauds

Technical specifications

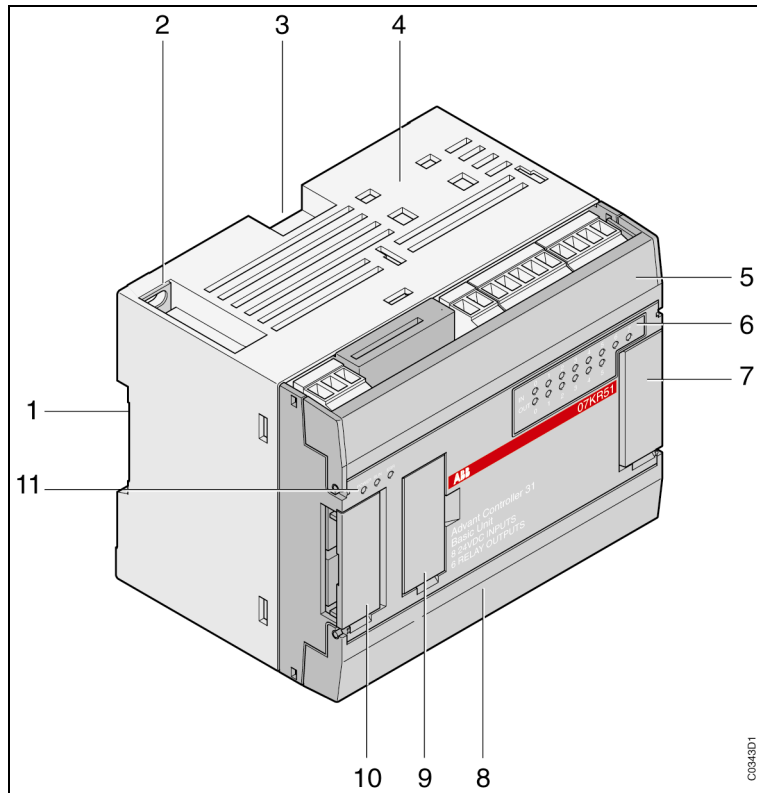


Figure 3-1 : Front of the central unit

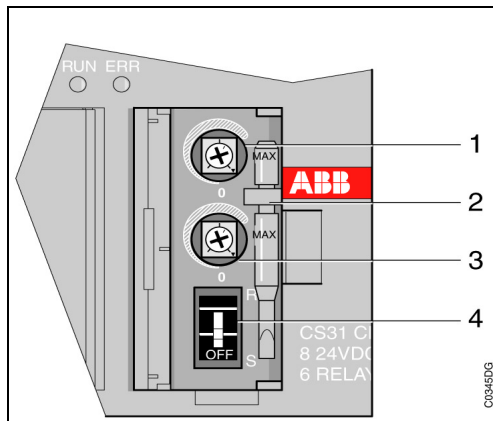


Figure 3-2 : Enlargement of item 9 without the cover

Technical specifications

3. Central units

3.1. The front of the central unit (see Figure 3-1)

- 1 - Location for DIN rail
- 2 - Plate fixture with unit earthing
- 3 - Lock for DIN rail mounting
- 4 - Location for external dual connector
- 5 - Location of the cable connectors
 - of the CS 31 bus (only available for the 50 series)
 - of the 24 V d.c. power output for the inputs (only available for the central units powered at 120 / 230 V a.c.)
 - the inputs
- 6 - Visualization set for the status of the 8 inputs / 6 outputs
- 7 - Location of the connector for the connection of input/output extensions
- 8 - Location of :
 - the serial port for programming or communication ASCII / MODBUS®
 - connector for the central unit power supply cabling
 - connectors for the outputs cabling
- 9 - Location of the potentiometers and the On/Off switch (see enlargement).
- 10 - Location of the connector for connection to a coupler.
- 11 - PLC status visualization area:
 - POWER: power on
 - RUN: program running
 - ERR: error(s) present

Enlargement of item 9 (see Figure 3-2)

- 1 - Potentiometer whose value is read into the IW62.01 variable by the program (value of 0 to 150 in the program)
- 2 - Screwdriver for potentiometer adjustment
- 3 - Potentiometer whose value is read into the IW62.00 variable by the program (value of 0 to 150 in the program)
- 4 - Central unit program ON/OFF switch

Technical specifications

3.2. Technical specification

	40 series			50 series		
	07 CR 41 24 V d.c.	07 CT 41 24 V d.c.	07 CR 41 120/230 V a.c.	07 KR 51 24 V d.c.	07 KT 51 24 V d.c.	07 KR 51 120/230 V a.c.
Number of I/O						
- Incorporated binary inputs		8			8	
- Incorporated binary outputs		6			6	
- Analog potentiometers		2			2	
- Maximum number of extension units per central unit		6			6	
- Maximum number of remote units on the CS 31 bus		-			31	
- Max. number of binary inputs		104			1096	
- Max. number of binary outputs		54			1046	
- Max. number of analog inputs		48			496	
- Max. number of analog outputs		12			136	
Interfaces						
- CS 31 interface		no			yes	
- Interface for: Programming MODBUS® or ASCII		1 RS 232			1 RS 232 / RS 485	
Memory						
- User program memory size: without ONLINE		17 000 words (typically: 8.5 kInstructions)			17 000 words (typically: 8.5 kInstructions)	
with ONLINE		8 000 words (typically: 4 kInstructions)			8 000 words (typically: 4 kInstructions)	
- User program memory and the constants		Flash Eprom			Flash Eprom	
- Data memory		SRAM			SRAM	
- Data backup:		yes with battery			yes with battery	
Backup autonomy		40 days at 25°C			40 days at 25°C	
Charge time under power		100% in 12 h			100% in 12 h	

Technical specifications

	40 series			50 series		
	07 CR 41 24 V d.c.	07 CT 41 24 V d.c.	07 CR 41 120/230 V a.c.	07 KR 51 24 V d.c.	07 KT 51 24 V d.c.	07 KR 51 120/230 V a.c.
Functionality						
- Execution time for 1kbytes:						
100% binary instructions	0.4 ms			0.4 ms		
65% binary, 35 % words	1.2 ms			1.2 ms		
- Internal bits	2016			2016		
- Internal words	2016			2016		
- Internal double words	128			128		
- Chain steps	2016			2016		
- Word constants	496			496		
- Double word constants	127			127		
- Timers:	42 simultaneously			42 simultaneously		
Time range	from 1 ms to 596 h 30 (24 days + 20 h 30)			from 1 ms to 596 h 30 (24 days + 20 h 30)		
- Counters:	unlimited			unlimited		
Counter range	- 32767 to + 32767			- 32767 to + 32767		
- High speed counter function:						
Incremental encoder	1 with max frequency 5 kHz on the I62.00 and I62.01 inputs			1 with max frequency 5 kHz on the I62.00 and I62.01 inputs		
Stand-alone counter	2 at 7 kHz on the I62.00 and I62.01 inputs			2 at 7 kHz on the I62.00 and I62.01 inputs		
- Interruptions:	250 µs delay			250 µs delay		
by alarm (on rising edge)	2 on the I62.02 and I62.03 inputs			2 on the I62.02 and I62.03 inputs		
cyclic	1 (from 1 ms to 2 s)			1 (from 1 ms to 2 s)		
max length	3 ms			or 5 ms to 2 s as master 1,5 ms as master or 3 ms as slave/standalone		
- Command output of step motor with frequency modification (cyclic ratio = 50%)	10 Hz to 2.66 kHz			10 Hz to 2.66 kHz		
- User program protection in the central unit	yes with password			yes with password		
- Clock: Drift (typical)	4.3 min / month at 25°C			4.3 min / month at 25°C		
Programming						
- Programming software	AC31GRAF under Windows® (IEC 1131-3)			AC31GRAF under Windows® (IEC 1131-3)		
- Programming language	FBD/LD : Function blocks and ladder diagrams			FBD/LD: Function blocks and ladder diagrams		
	Quick LD: Ladder diagram			Quick LD: Ladder diagram		
	IL: Instruction list			IL: Instruction list		
	SFC: Sequential function chart			SFC: Sequential function chart		
- Program execution	sequential triggered by clock or triggered by alarm (interruptions)			sequential triggered by clock or triggered by alarm (interruptions)		
- Sub-program:	12			12		
Level	1			1		
- Operation set:						
Basic functions	Boolean, arithmetic, comparison			Boolean, arithmetic, comparison		
Advanced functions	over 60			over 60		

Technical specifications

	40 series			50series		
	07 CR 41 24 V d.c.	07 CT 41 24 V d.c.	07 CR 41 120/230 V a.c.	07 KR 51 24 V d.c.	07 KT 51 24 V d.c.	07 KR 51 120/230 V a.c.
- Weight	400 g		800 g	400 g		800 g
Power supply						
- Power supply voltage:						
Nominal value	24 V d.c.		120 / 230 V a.c.	24 V d.c.		120 / 230 V a.c.
Admissible range	19.2 to 30 V		97.75 to 126.5 V or 195.5 to 253 V	19.2 à 30 V		97.75 to 126.5 V or 195.5 to 253 V
- Consumption:						
central unit alone typical.	120 mA		60/30 mA	120 mA		60/30 mA
Maximum configuration typical.	400 mA		100 mA	400 mA		100 mA
- Polarity reversal protection	yes		no	yes		no
- 24 V d.c. isolated power for the inputs:	no		yes	no		yes
Voltage range	-		19.2 to 30 V	-		19.2 to 30 V
Output current	-		400 mA	-		400 mA
Short circuit protection	-		yes	-		yes
- Dissipation	5 W (6 W for 07 CT 41)		10 W	5 W (6 W for 07 KT 51)		10 W
Incorporated binary inputs						
- Number of inputs	8	8	8	8	8	8
- Isolation of inputs / electronic	1500 V a.c.	1500 V a.c.	1500 V a.c.	1500 V a.c.	1500 V a.c.	1500 V a.c.
- Input types	PNP and NPN	PNP and NPN	PNP and NPN	PNP and NPN	PNP and NPN	PNP and NPN
- Input voltage:						
Nominal value	24 V d.c.		24 V d.c.	24 V d.c.		24 V d.c.
Signal at 0 (IEC 1131-2)	0 to + 5 V		0 to + 5 V	0 to + 5 V		0 to + 5 V
Signal at 1 (IEC 1131-2)	+ 15 to + 30 V		+ 15 to + 30 V	+ 15 to + 30 V		+ 15 to + 30 V
- Input current at 24 V d.c.:						
Inputs I62.02 to I62.07	7 mA		7 mA	7 mA		7 mA
Inputs I62.00 and I62.01	9 mA		9 mA	9 mA		9 mA
- Filtering time:						
Standard input	5 ms		5 ms	5 ms		5 ms
Input with counter configuration	70 µs		70 µs	70 µs		70 µs
Input with interruption configuration	90 µs		90 µs	90 µs		90 µs
- Cable length:						
Unshielded (not for the high speed counter inputs)	300 m		300 m	300 m		300 m
Shielded	500 m		500 m	500 m		500 m
Non standard inputs	50 m		50 m	50 m		50 m

Technical specifications

	40 series			50 series		
	07 CR 41 24 V d.c.	07 CT 41 24 V d.c.	07 CR 41 120/230 V a.c.	07 KR 51 24 V d.c.	07 KT 51 24 V d.c.	07 KR 51 120/230 V a.c.
Incorporated outputs						
- Number of outputs	6 relays	6 transistors	6 relays	6 relays	6 transistors	6 relays
- Isolation of the outputs / electronic	1500 Vrms 1 min	1500 V a.c.	1500 Vrms 1 min	1500 Vrms 1 min	1500 V a.c.	1500 Vrms 1 min
- Total charging current under voltage:						
direct 24 V d.c.						
resistive load / inrush current	2 A / 5 A	1 A for	2 A / 5 A	2 A / 5 A	1 A for	2 A / 5 A
L / R = 20 ms	2 A	O62.00 and	2 A	2 A	O62.00 and	2 A
L / R = 30 ms	1 A	O62.01 and	1 A	1 A	O62.01 and	1 A
L / R = 40 ms	0.6 A	0.5 A for	0.6 A	0.6 A	0.5 A for	0.6 A
L / R = 60 ms	0.35 A	other outputs	0.35 A	0.35 A	other outputs	0.35 A
alternate 24 to 230 V a.c.	2 A AC-1 0.5 A AC-15	-	2 A AC-1 0.5 A AC-15	2 A AC-1 0.5 A AC-15	-	2 A AC-1 0.5 A AC-15
- Total charging current	6 x 2 A	4 x 0.5 A + 2 x 1 A	6 x 2 A	6 x 2 A	4 x 0.5 A + 2 x 1 A	6 x 2 A
- Output leakage current	-	< 200 µA	-	-	< 200 µA	-
- Output waste voltage	-	0.5 V to 500 mA max.	-	-	0.5 V to 500 mA max.	-
- Minimum cut-off values	10 mA under 12 V d.c.	12 V	10 mA under 12 V d.c.	10 mA under 12 V d.c.	12V	10 mA under 12 V d.c.
- Breaking capacity under 120 V a.c. (contact rating code B300) (UL)	2 A		2 A	2 A		2 A
- Breaking capacity under 250 V a.c. (contact rating code B300) (UL)	2 A (1.5 A according to UL)		2 A (1.5 A according to UL)	2 A (1.5 A according to UL)		2 A (1.5 A according to UL)
- Number of common	2 (2+4)		2 (2+4)	2 (2+4)		2 (2+4)
- Switching frequency:						
for resistive loads	< 1 Hz	5 kHz	< 1 Hz	< 1 Hz	5 kHz	< 1 Hz
for inductive loads	< 0.2 Hz		< 0.2 Hz	< 0.2 Hz		< 0.2 Hz
for lamps	< 0.2 Hz		< 0.2 Hz	< 0.2 Hz		< 0.2 Hz
- Number of switches:						
for AC-1	1 million	-	1 million	1 million	-	1 million
for AC-15	100 000	-	100 000	100 000	-	100 000
- Short circuit and overload protection	envisage externally	yes: thermic	envisage externally	envisage externally	yes: thermic	envisage externally
- Surge voltage protection	envisage externally	yes	envisage externally	envisage externally	yes	envisage externally
- Outputs diagnosis	no	overload and short circuit	no	no	overload and short circuit	no
- Cable length:						
unshielded	150 m	150 m	150 m	150 m	150 m	150 m
shielded	500 m	500 m	500 m	500 m	500 m	500 m

Technical specifications

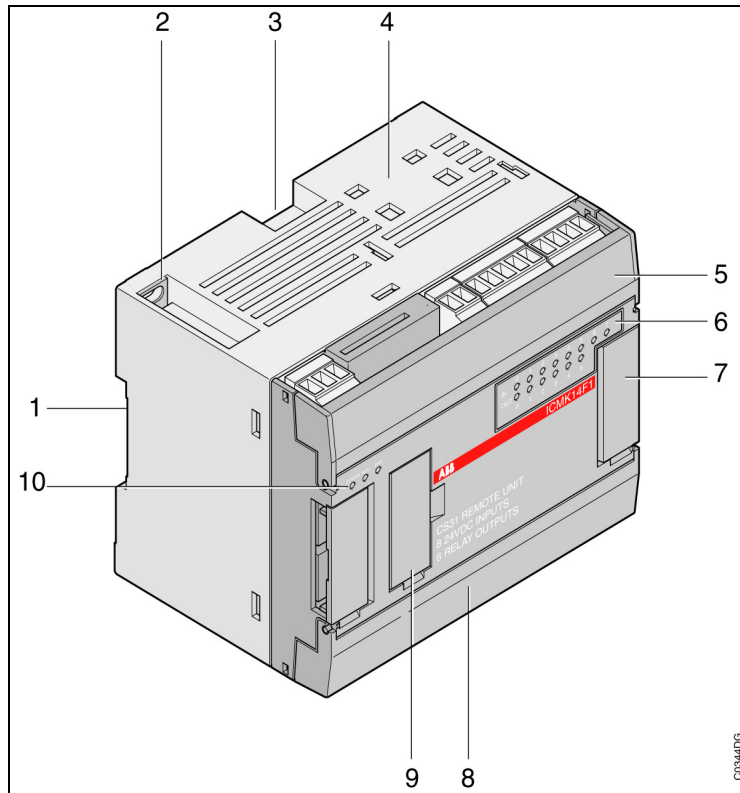


Figure 3-3 : The front of the unit

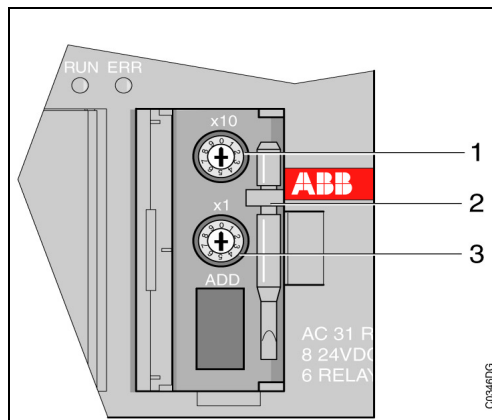


Figure 3-4 : Enlargement of item 9 without cover

Technical specifications

4. Extensible remote units

4.1. The front (see Figure 3-3)

- 1 - Location for the DIN rail
- 2 - Plate fixture with unit earthing
- 3 - Lock for DIN rail mounting
- 4 - Location for external dual connector
- 5 - Location for the cabling connectors:
 - of 24 V d.c. output power for the inputs
(available only for the remote units with 120 / 230 V a.c. power)
 - of the inputs
- 6 - Visualization set for the status of the 8 inputs / 6 outputs
- 7 - Location of the connector for the connection of input/output extensions
- 8 - Location of the cabling connectors:
 - for the central unit mains supply
 - for the outputs
- 9 - Location of the addressing rotate selectors (see enlargement)
- 10 - Unit status visualization area:
 - POWER: power on
 - RUN: always on
 - ERR: error(s) present

Enlargement of item 9 without cover (see Figure 3-4)

- 1 - Rotate switch for addressing, reserved for decade selection
- 2 - Screwdriver for settings adjustments
- 3 - Rotate switch, reserved for unit selection

Technical specifications

4.2. Technical specifications of the extensible remote units

	ICMK 14 F1 24 V d.c.	ICMK 14 F1 120 / 230 V a.c.	ICMK 14 N1 24 V d.c.
- Weight	400 g	800 g	400 g
Power supply			
- Mains voltage:			
Nominal value	24 V d.c.	120 or 230 V a.c.	24 V d.c.
Admissible range	19.2 to 30 V	97.75 to 126.5 V or 195.5 to 253 V	19.2 to 30 V
- Consumption:			
Unit alone (typical)	80 mA	30 mA	80 mA
Maximum configuration (typical)	400 mA	100 mA	400 mA
- Polarity reversal protection	yes	-	yes
- 24 V d.c. isolated power for the inputs:	no	yes	no
Range of voltage value	-	19.2 to 30 V	-
Max. Output current	-	400 mA	-
Short circuit protection	-	yes	-
- Dissipation	5 W	10 W	6 W
Incorporated binary inputs			
- Number of inputs	8	8	8
- Isolation of the inputs / electronic	1500 V a.c.	1500 V a.c.	1500 V a.c.
- Input types	PNP and NPN	PNP and NPN	PNP and NPN
- Input voltage:			
Nominal value	24 V d.c.	24 V d.c.	24 V d.c.
Signal at 0 (IEC 1131-2)	0 to + 5 V	0 to + 5 V	0 to + 5 V
Signal at 1 (IEC 1131-2)	+ 15 to + 30 V	+ 15 to + 30 V	+ 15 to + 30 V
- Input current at 24 V d.c.:			
Inputs Ixx.02 to Ixx.07	7 mA	7 mA	7 mA
Inputs Ixx.00 and Ixx.01	9 mA	9 mA	9 mA
- Minimum filtering time	5 ms	5 ms	5 ms
- Cable length:			
unshielded	300 m	300 m	300 m
shielded	500 m	500 m	500 m

Technical specifications

	ICMK 14 F1 24 V d.c.	ICMK 14 F1 120 / 230 V a.c.	ICMK 14 N1 24 V d.c.
Incorporated outputs			
- Number of outputs	6 relays	6 relays	6 transistors
- Isolation of the outputs / electronic	1500 Vrms 1 min	1500 Vrms 1 min	1500 V a.c.
- Total charging current, under voltage:	.	.	.
direct 24 V d.c.			
resistive load / inrush current	2 A / 5 A	2 A / 5 A	1 A for Oxx.00
L / R = 20 ms	2 A	2 A	and Oxx.01 and
L / R = 30 ms	1 A	1 A	0.5 A for other
L / R = 40 ms	0.6 A	0.6 A	outputs
L / R = 60 ms	0.35 A	0.35 A	
alternate 24 to 230 V a.c.	2 A AC-1 0.5 A AC-15	2 A AC-1 0.5 A AC-15	
- Total charging current	6 x 2 A	6 x 2 A	4 x 0.5 A + 2 x 1 A
- Output leakage current			< 200 µA
- Output waste voltage			0.2 V to 500 mA max.
- Minimum cut-off values	10 mA under 12 V d.c.	10 mA under 12 V d.c.	12 V
- Breaking power under 120 V a.c. (contact rating code B300) (UL)	2 A	2 A	
- Breaking power under 250 V a.c. (contact rating code B300) (UL)	2 A (1.5 A according to UL)	2 A (1.5 A according to UL)	
- Number of common	2 (2+4)	2 (2+4)	
- Commutating frequency :			
for resistive loads	< 1 Hz	< 1 Hz	< 5 kHz
for inductive loads	< 0.2 Hz	< 0.2 Hz	
for lamps	< 0.2 Hz	< 0.2 Hz	
- Number of switches:			
for AC-1	1 million	1 million	-
for AC-15	100 000	100 000	
- Short circuit and overload protection	envisage externally	envisage externally	yes: thermic
- Surge voltage protection	envisage externally	envisage externally	yes : by transient volt. suppressor
- Outputs diagnosis	-	-	overload and short circuit
- Cable length:			
unshielded	150 m	150 m	150 m
shielded	500 m	500 m	500 m

Technical specifications

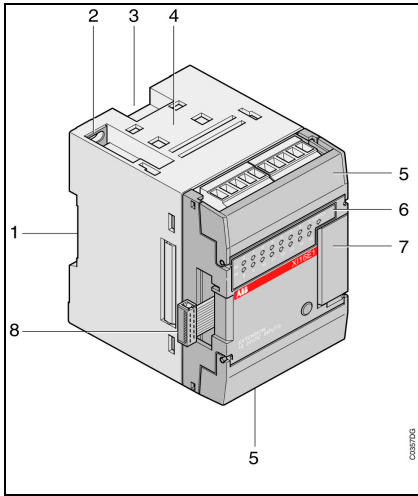


Figure 3-5 : XI 16 E1 binary extension

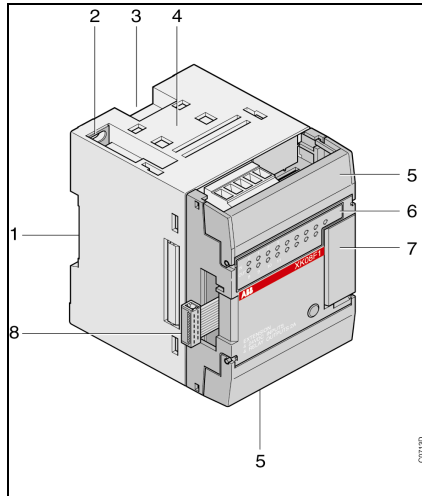


Figure 3-6 : XK 08 F1 binary extension

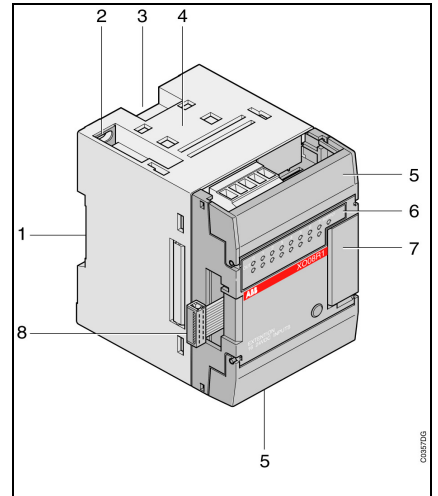


Figure 3-7: XO 08 R1 binary extension

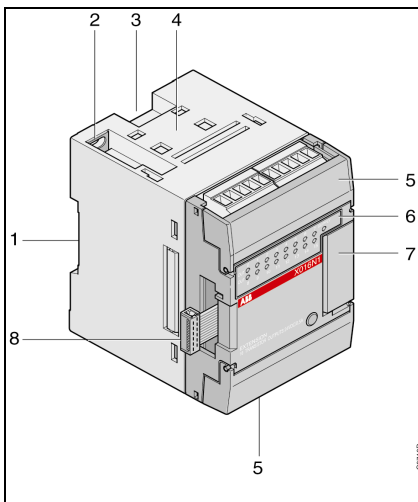


Figure 3-8 : XO 16 N1 binary extension

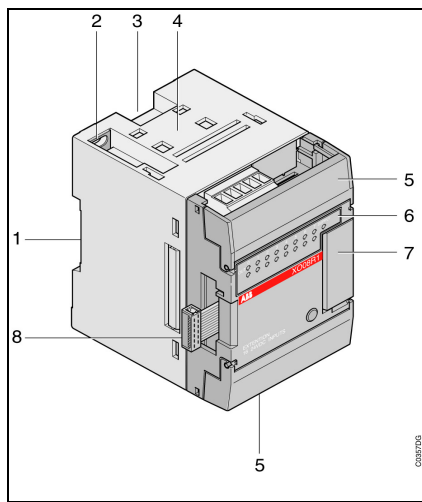


Figure 3-9 : XC 08 L1 binary extension:

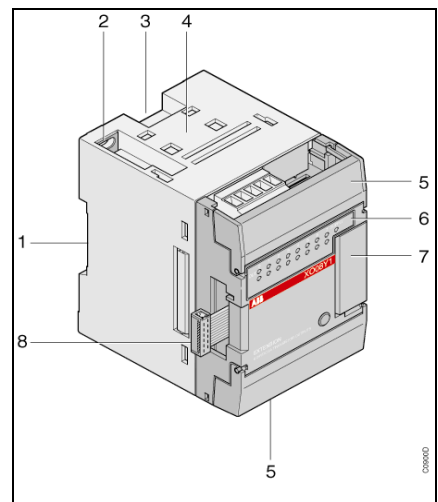


Figure 3-10 : XO 08 Y1 binary extension

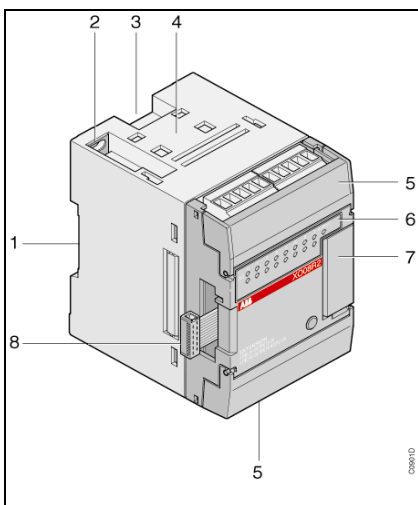


Figure 3-11 : XO 08 R2 binary extension

Technical specifications

5. Binary extensions

5.1. The front (see Figure 3-5 to Figure 3-11)

- 1 - Location for DIN rail
 - 2 - Plate fixture with unit earthing
 - 3 - Lock for DIN rail mounting
 - 4 - Location for external dual connector
 - 5 - Location of connectors for the input/output cabling
 - 6 - Status visualization area of the inputs/outputs
 - 7 - Connector location for the connection of supplementary input/output extensions
 - 8 - Connector for connection to the central unit / remote unit or to the last input / output extension connected to the central/remote unit
-

Technical specifications

5.2. Binary extensions specifications

The binary extension units are powered at 5 V by the central unit or extensible remote unit to which they are connected.

Warning: the extensions must be connected or disconnected without power supply.

	XI 16 E1	XO 08 R1	XC 08 L1	XK 08 F1	XO 08 Y1	XO 08 R2	XO 16 N1
Weight	220 g	220 g	220 g	220 g	220 g	220 g	220 g
Incorporated binary inputs							
- Number of inputs	16	-	8 configurable	4	-	-	-
- Isolation of the inputs/electronic	1500 V a.c.	-	1500 V a.c.	1500 V a.c.	-	-	-
- Types of inputs	PNP	-	PNP	PNP/NPN	-	-	-
- Input voltage:							
Nominal value	24 V d.c.	-	24 V d.c.	24 V d.c.	-	-	-
Signal at 0 (IEC 1131-2)	0 to + 5 V		0 to + 5 V	0 to + 5 V			
Signal at 1 (IEC 1131-2)	+ 15 to + 30 V		+ 15 to + 30 V	+ 15 to + 30 V			
- Input current at 24 V d.c.	4 mA	-	4 mA	7 mA	-	-	-
- Filtering time of an input	5 ms	-	5 ms	5 ms	-	-	-
- Cable length:							
unshielded	300 m	-	300 m	300 m	-	-	-
shielded	500 m	-	500 m	500 m	-	-	-
Incorporated outputs							
- Number of outputs	-	8 relays	8 transistors	4 relays	8 transistors	4 NO + 4 NO/NC relays	16 transistors
- Isolation of the outputs/electronic	-	1500 Vrms 1 min	1500 V a.c. 1 min	1500 Vrms 1 min	1500 V a.c. 1 min	1500 Vrms 1 min	1500 V a.c. 1 min
- Total charging current, under voltage:							
direct 24 V d.c.							
resistive load / inrush current	-	2 A / 5 A	0.5 A	2 A / 5 A	2 A	NO - NO/NC 2A/5A - 3A/7A	0.5 A
L / R = 20 ms		2 A	0.5 A / 0.5 Hz	2 A	2 A / 0.3 Hz	2 A	0.5 A / 0.5 Hz
L / R = 30 ms		1 A	0.5 A / 0.3 Hz	1 A	2 A / 0.2 Hz	1 A	0.5 A / 0.3 Hz
L / R = 40 ms		0.6 A	0.5 A / 0.2 Hz	0.6 A	2 A / 0.15 Hz	0.6 A	0.5 A / 0.2 Hz
L / R = 60 ms		0.35 A	0.5 A / 0.1 Hz	0.35 A	2 A / 0.10 Hz	0.35 A	0.5 A / 0.1 Hz
Per output couple Derating UL.					2,5 A 1,5 A		
alternate 24 to 230 V a.c.	-		-		-	NO - NO/NC	-
AC-1		2 A		2 A		2 A - 3A	
AC-15		0.5 A		0.5 A		0.5 A	
- Total charging current	-	8 x 2 A	8 x 0.5 A	4 x 2 A	10 A	4 x 2 A + 4 x 3 A	16 x 0.5 A
- Output leakage current	-		< 200 µA		< 200 µA		< 200 µA
- Output waste voltage	-		0.5 V to 500 mA max.		0.4 V / 2 A		0.5 V to 500 mA max.
- Minimum cut-off value	-	10 mA at 12 V d.c.	12 V	10 mA at 12 V d.c.	7 V	10 mA at 12 V d.c.	12 V

Technical specifications

	XI 16 E1	XO 08 R1	XC 08 L1	XK 08 F1	XO 08 Y1	XO 08 R2	XO 16 N1
- Breaking power under 120 V a.c. (code B300) (contact rating UL)	-	2 A		2 A		NO - NO/NC 2A - 3A	
- Breaking power under 250 V a.c. (contact rating code B300) (UL)	-	2 A (1.5 A according to UL)		2 A (1.5 A according to UL)			
- Number of common		2 (4+4)		1			
- Commutating frequency:	-						
for resistive loads		< 1 Hz	100 Hz	< 1 Hz		< 1 Hz	100 Hz
for inductive loads		< 0.2 Hz		< 0.2 Hz		< 0.2 Hz	
for lamps		< 0.2 Hz		< 0.2 Hz		< 0.2 Hz	
- Number of switches:							
for AC-1	-	1 million	-	1 million	-	1 million	-
for AC-15		100 000		100 000		100 000	
- Short circuit and overload protection	-	envisage externally	yes: thermic	envisage externally	yes: thermic	envisage externally	yes: thermic
- Surge voltage protection	-	envisage externally	yes: by transient volt suppressor	envisage externally	yes: by transient volt suppressor	envisage externally	yes: by transient volt suppressor
- Output diagnosis	-	-	overload and short circuit	-	overload and short circuit	-	overload and short circuit
- Cable length:							
unshielded	-	150 m	150 m	150 m	150 m	150 m	150 m
shielded	-	500 m	500 m	500 m	500 m	500 m	500 m

Technical specifications

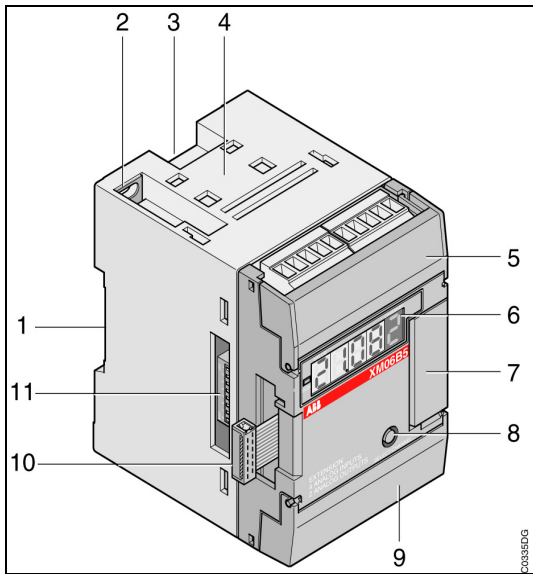


Figure 3-12 : XM 06 B5 analog extensions
XE 08 B5 analog extensions

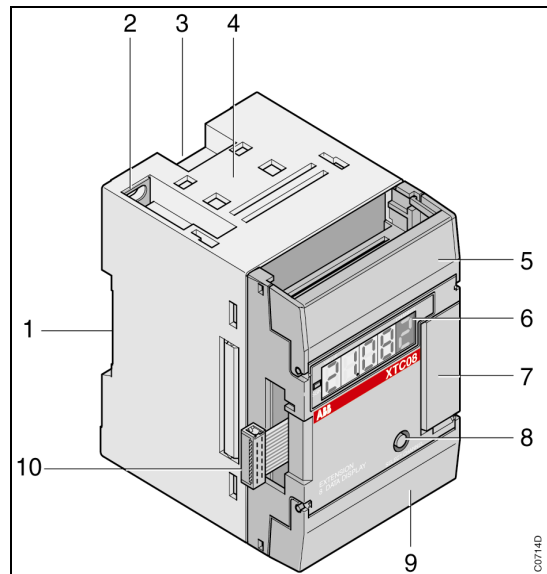


Figure 3-13 : XTC 08 analog display

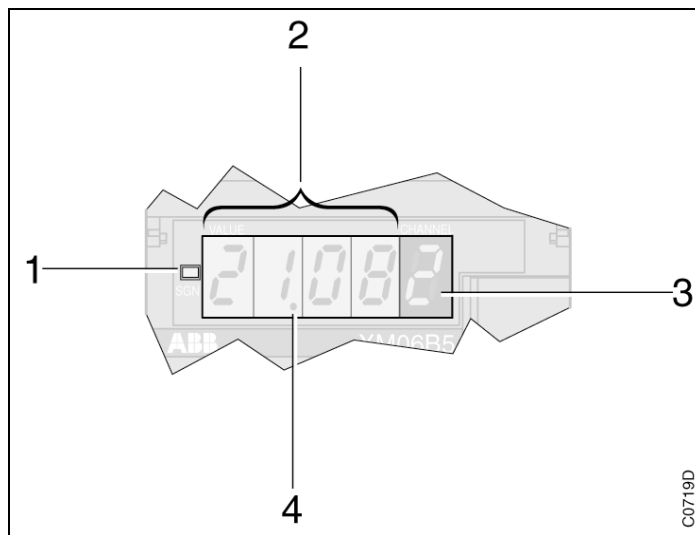


Figure 3-14 : Display description

Technical specifications

6. Analog extensions

6.1. The front (see Figure 3-12, Figure 3-13)

- 1 - Location for the DIN rail
- 2 - Plate fixture with unit earthing
- 3 - Lock for DIN rail mounting
- 4 - Location for external dual connector
- 5 - Location for the input cabling connectors
- 6 - Visualization of the channel number and the associated analog value with its sign
- 7 - Location of:
 - The connector for the supplementary input/output extensions
 - The push button used for the configuration
- 8 - push button to select the visualized channel
- 9 - Location of the connectors for the output cabling
- 10 - Connector for connection to the central unit / remote unit or to the last input / output extension connected to the central unit / remote unit
- 11 - Switches to configure the channels as current, voltage or Pt 100 / Pt 1000

6.2. Analog display (see Figure 3-14)

- 1 - Sign of the value
- 2 - Value
- 3 - Channel identification
- 4 - Dot of the value (it can be programmed by the function blocks CONFIO)

Technical specifications

6.3. Technical specifications of the analog extension

The analog extensions are powered at 5 V and 24 V d.c. by the central unit or extensible remote unit to which they are connected.

The analog value with a customized format of each channel is displayed on a 4 digit display.

The channel number is selected by the push button on the front side.

Warning: the extensions must be connected or disconnected without power supply.

Warning: In the configuration current 4 – 20 mA, the sensor should be able to provide 20 mA with min 10 V d.c. Moreover, the input is not protected against voltage between 10 up to 18 V d.c. and can give an error or destroy the input.

	XM 06 B5	XE 08 B5	XTC 08
- Number of analog inputs	4	8	-
- Number of analog outputs	2	-	-
- Number of displayed internal values		-	8
- Display values - Scale	+/- 9999	+/- 9999	+/- 9999
- Filtering of 50 / 60 Hz	yes	yes	
- Transfer time of the analog I/O	120 ms */ 50 ms	220 ms *	
- Maximum power dissipation	3 W	3 W	
- Weight	200 g	200 g	150 g

	XM 06 B5 and XE 08 B5					
Analog inputs	Voltage	Current	Pt 100	Pt 1000	NI 1000	Balco500
- Nominal range:	+/- 10 V	0...20 mA	- 200 °C	- 200 °C	- 50 °C	- 30 °C
		4...20 mA	+ 450 °C	+ 450 °C	+ 170 °C	+ 120 °C
- Maximum values	+/- 30 V	+/- 25 mA				
- Isolation of inputs / electronic	500 V	500 V	500 V	500 V	500 V	500 V
- Resolution	12 bits + sign	12 bits				
- Min resolution at input (\pm 1LSB)	+/- 2,5 mV	+/- 5 μ A	+/- 0,1 °C	+/- 0,1 °C	+/- 0,1 °C	+/- 0,1 °C
- Full scale precision	\leq +/- 0,7 %	\leq +/- 0,8 %	\leq +/- 1,5 °C	\leq +/- 1,5 °C	\leq +/- 1,5 °C	\leq +/- 1,5 °C
- Word value range read by the central unit	+/- 32767	0...32767	- 2000/+4500	- 2000/+4500	- 500/+1700	- 300/+1200
- Amplification error between two channels	70 dB	70 dB	70 dB	70 dB	70 dB	70 dB
- Input impedance	100 K Ω	100 Ω	100 K Ω	100 K Ω	100 K Ω	100 K Ω
- Linearization for Pt 100 / Pt 1000 / NI 1000 / Balco500	yes	yes	yes	yes	yes	yes
- Dissipation sensor: 0°C 450°C			0.625 mW 1.6 mW	0.0625 mW 0.16 mW	0.0625 mW 0.12 mW	0.028 mW 0.045 mW
- Acquisition time including filtering time for all channels	120 ms *	120 ms *	220 ms *	220 ms *	220 ms *	220 ms *
- Diagnosis	No	No	No	No	No	No
- Cable length:	50 m	50 m	50 m	50 m	50 m	50 m
shielded	yes	yes	yes	yes	yes	yes
short-circuited unused channels	yes	yes	yes	yes	yes	yes

* without filtering time 50 and 60 hz

Technical specifications

	XM 06 B5	
Analog outputs	Voltage	Current
- Nominal range	+/- 10 V	0...20 mA 4...20 mA
- Max. current	2 mA	20 mA
- Isolation outputs / electronic	500 V	500 V
- Resolution	11 bits + sign	12 bits
- Min output resolution (± 1 LSB)	+/- 5 mV	+/- 5 µA
- Word value range	+/- 32767	0... 32767
- Total error of full scale	1,2 %	1,3 %
- Delay on acquisition	50 ms	50ms
- Max. resistance		400 Ω
- Diagnosis	No	No
- Cable length: shielded	50 m yes	50 m yes

- Permissible total voltage drop at the sensors and lines circuited in series = Max 8 V

- Configuration:

	Voltage	Current
- With push-button	yes	yes
- With function blocks	yes (chapter 5 – configuration 4.1.12)	

The analog configuration through the central units (functions blocks CONFIO1, CONFIO4, CONFIO8) is available since the following versions

Product	Version
07KR51	H15
07KT51	G15
07CR41	E14
07CT41	D14
ICMK14F1	F14
ICMK14N1	D14

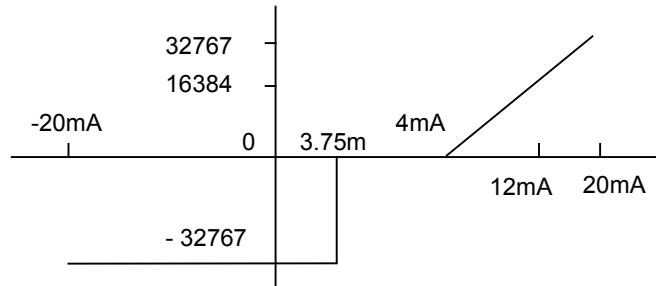
The new functionality (NI 1000, Balco500 probes) are available since the following versions.

Product	Version
XM06B5	F9
XE08B5	C3

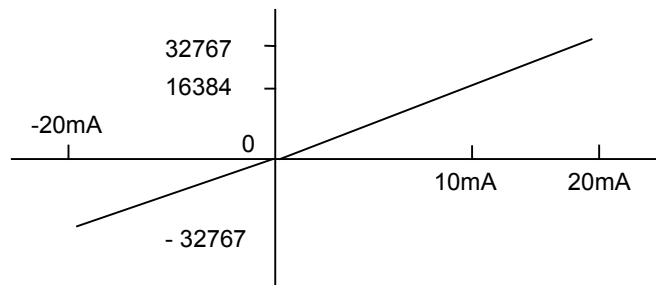
Technical specifications

6.4. Analog inputs diagrams:

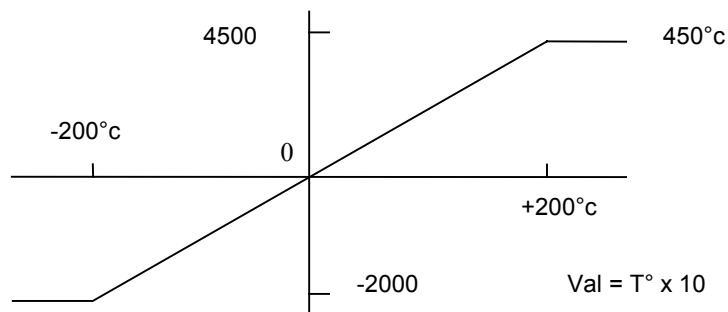
6.4.1. Current 4-20mA:



6.4.2. Current 0-20mA:



6.4.3. Pt 100/Pt 1000:



Voltage input +/- 10 V:

1 LSB = $10 / 2^{12} = 2,44 \text{ mV}$ with minimum value (step 8)

$V \text{ (in volt)} = \text{Value} \times (10 / 32767)$ with value ($- 32767 \leq X \leq + 32767$)

Current input 0-20 mA:

1 LSB = $20 \cdot 10^{-3} / 2^{12} = 4,88 \text{ } \mu\text{A}$ with minimum value (step 8)

$I \text{ (in mA)} = \text{Value} \times (20 \cdot 10^{-3} / 32767)$ with value ($0 \leq X \leq + 32767$)

Current input 4-20 mA:

Resolution is equal to 0-20 mA

$I \text{ (in mA)} = \text{Value} \times (16 / 32767) + 4$ with value ($0 \leq X \leq + 32767$)

Technical specifications

6.4.4. NI 1000:

Warning: It exists several sorts of NI 1000, with different technical characteristics, check the table of corresponding Temperature / Resistance below:

T (°Celsius)	R (Ohms)
- 50 °	790.0
- 48 °	798.8
- 46 °	806.8
- 44 °	814.7
- 42 °	822.8
- 40 °	830.8
- 38 °	838.9
- 36 °	847.1
- 34 °	855.2
- 32 °	863.4
- 30 °	871.7
- 28 °	880.0
- 26 °	888.3
- 24 °	896.7
- 22 °	905.0
- 20 °	913.5
- 18 °	922.0
- 16 °	930.5
- 14 °	939.0
- 12 °	947.6
- 10 °	956.2
- 8 °	964.9
- 6 °	973.6
- 4 °	982.4
- 2 °	991.2
- 1 °	995.6
0 °	1000.0
1 °	1004.4
2 °	1008.9
4 °	1017.8
6 °	1026.7
8 °	1035.7
10 °	1044.8
12 °	1053.9
14 °	1063.0
16 °	1072.2
18 °	1081.4
20 °	1090.7

T (°Celsius)	R (Ohms)
22 °	1100.0
24 °	1109.3
26 °	1118.7
28 °	1128.1
30 °	1137.6
32 °	1147.1
34 °	1156.7
36 °	1166.3
38 °	1176.0
40 °	1185.7
42 °	1195.5
44 °	1205.3
46 °	1215.1
48 °	1225.0
50 °	1235.0
52 °	1245.0
54 °	1255.0
56 °	1265.1
58 °	1275.3
60 °	1285.4
62 °	1295.7
64 °	1306.0
66 °	1316.3
68 °	1326.7
70 °	1337.1
72 °	1347.6
74 °	1358.2
76 °	1368.8
78 °	1379.4
80 °	1390.1
82 °	1400.9
84 °	1411.7
86 °	1422.5
88 °	1433.4
90 °	1444.4
92 °	1455.4
94 °	1466.5
96 °	1477.6

T (°Celsius)	R (Ohms)
98 °	1488.8
100 °	1500.0
102 °	1511.3
104 °	1522.6
106 °	1534.0
108 °	1545.5
110 °	1557.0
112 °	1568.5
114 °	1580.2
116 °	1591.8
118 °	1603.6
120 °	1615.4
122 °	1627.2
124 °	1639.1
126 °	1651.1
128 °	1663.1
130 °	1675.2
132 °	1687.3
134 °	1699.5
136 °	1711.8
138 °	1724.1
140 °	1736.5
142 °	1748.9
144 °	1761.4
146 °	1774.0
148 °	1786.6
150 °	1799.3
152 °	1812.0
154 °	1824.8
156 °	1837.7
158 °	1850.6
160 °	1863.6
162 °	1876.7
164 °	1889.8
166 °	1902.9
168 °	1916.2
170 °	1929.5

Technical specifications

6.4.5. Balco500:

T (°Celsius)	R (Ohms)
- 30 °	397.05
- 28 °	400.65
- 26 °	404.27
- 24 °	407.91
- 22 °	411.57
- 20 °	415.25
- 18 °	418.95
- 16 °	422.68
- 14 °	426.42
- 12 °	430.18
- 10 °	433.96
- 8 °	437.77
- 6 °	441.59
- 4 °	445.43
- 2 °	449.30
- 1 °	451.24
0 °	453.18
1 °	455.13
2 °	457.09
4 °	461.01
6 °	464.96
8 °	468.92
10 °	472.91
12 °	476.92
14 °	480.94
16 °	484.99
18 °	489.06
20 °	493.15

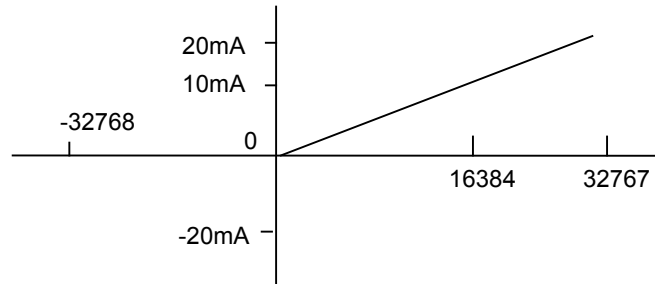
T (°Celsius)	R (Ohms)
22 °	497.25
23.33 °	500.00
24 °	503.45
26 °	505.53
28 °	509.70
30 °	513.89
32 °	518.10
34 °	522.33
36 °	526.58
38 °	530.85
40 °	535.14
42 °	539.45
44 °	543.78
46 °	548.14
48 °	552.51
50 °	556.90
52 °	561.31
54 °	565.75
56 °	570.20
58 °	572.87
60 °	579.17
62 °	583.68
64 °	588.22
66 °	592.77
68 °	597.35
70 °	601.94
72 °	606.56
74 °	611.20

T (°Celsius)	R (Ohms)
76 °	615.85
78 °	620.53
80 °	625.23
82 °	629.95
84 °	634.68
86 °	638.44
88 °	644.22
90 °	649.02
92 °	653.84
94 °	658.66
96 °	663.54
98 °	668.42
100 °	673.32
102 °	678.24
104 °	683.18
106 °	688.14
108 °	692.12
110 °	698.13
112 °	703.16
114 °	708.19
116 °	713.25
118 °	718.34
120 °	723.44

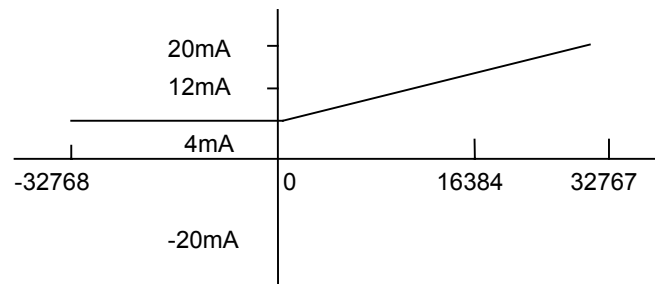
Technical specifications

6.5. Analog outputs diagrams:

6.5.1. Current 0-20mA:



6.5.2. Current 4-20mA:



Voltage output +/- 10 V:

1 LSB = $10 / 2^{11} = 4,88 \text{ mV}$ with minimum value (step 8)

$V \text{ (in volt)} = \text{Value} \times (10 / 32767)$ with value ($- 32767 \leq X \leq + 32767$)

Current output 0-20 mA:

1 LSB = $20 \cdot 10^{-3} / 2^{12} = 4,88 \text{ }\mu\text{A}$ with minimum value (step 8)

$I \text{ (in mA)} = \text{Value} \times (20 \cdot 10^{-3} / 32767)$ with value ($0 \leq X \leq - 32767$)

Current output 4-20 mA:

Resolution is equal to 0-20 mA

$I \text{ (in mA)} = \text{Value} \times (16 / 32767) + 4$ with value ($0 \leq X \leq - 32767$)

Technical specifications

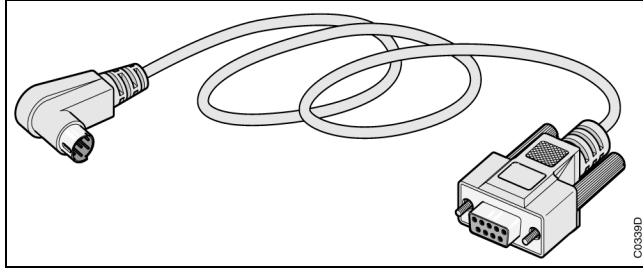


Figure 3-15 : 07 SK 50 programming cable

Technical specifications

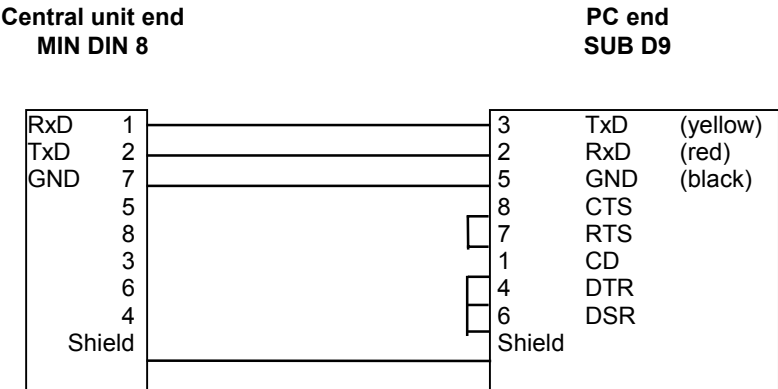
7. Accessories

7.1. Programming cables: 07 SK 50 and 07 SK 52

These cables allow you to connect the 40 and 50 series central units to a PC for programming and the tests.

They are shielded and are 2 meters long.

7.1.1. 07 SK 50 connection diagram (see Figure 3-15):



Technical specifications

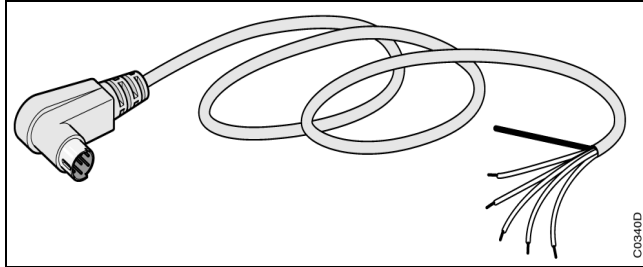


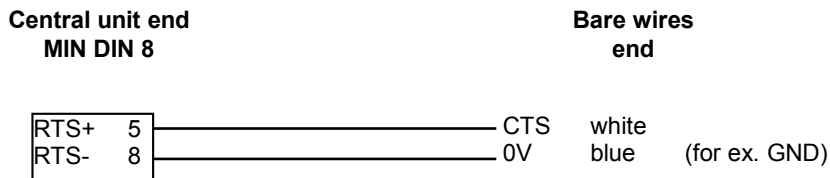
Figure 3-16 : 07 SK 52 programming cable

Technical specifications

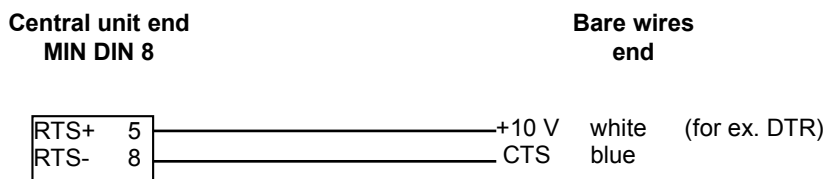
7.1.2. 07 SK 52 connection diagram (see Figure 3-16):

- Diagram of the RTS signal cabling:

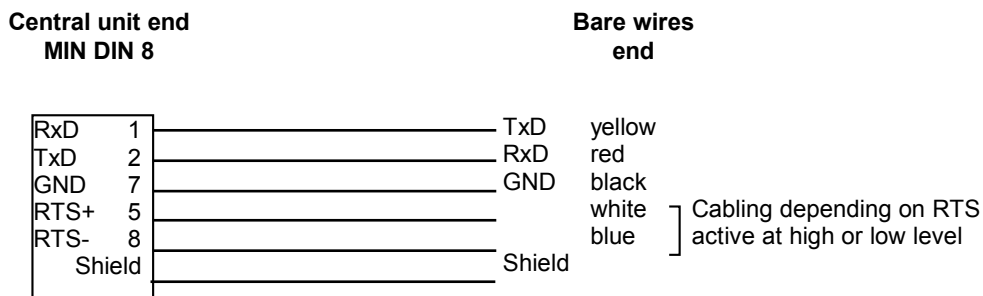
If RTS active at low level:



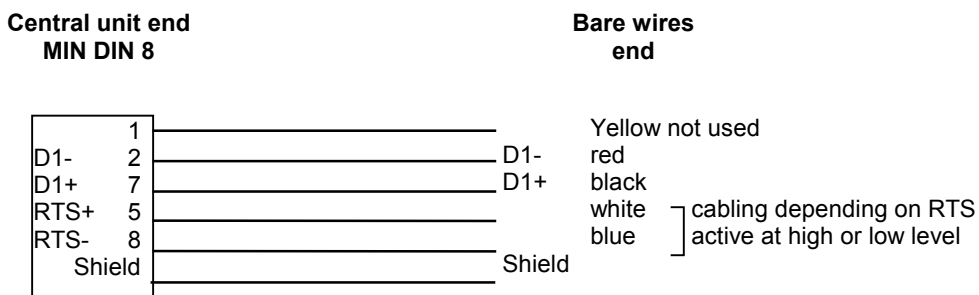
If RTS active at high level:



- Using the cable for RS 232



- Using the cable for RS 485



Comment: The programming cable is distinguished from the ASCII/MODBUS® communication cables by its grey color.

Technical specifications

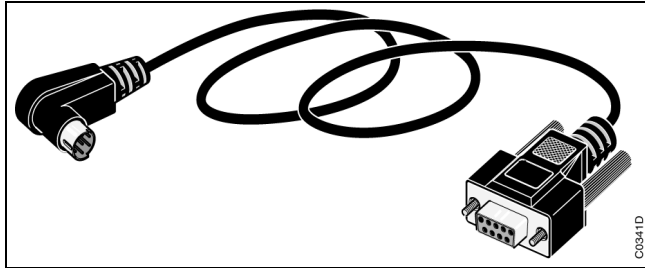


Figure 3-17 : 07 SK 51 communication cable

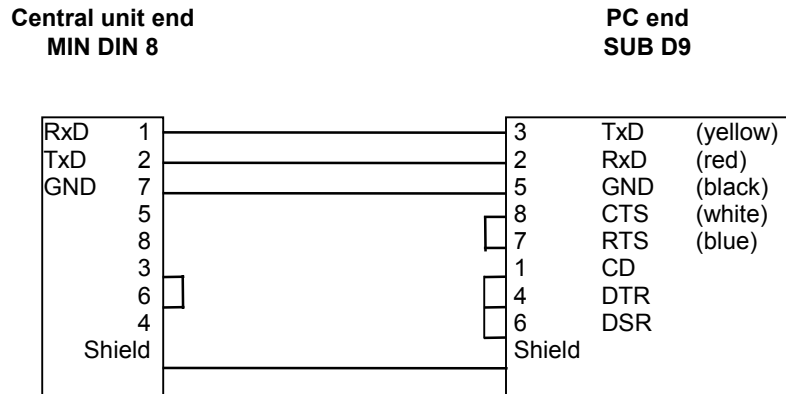
Technical specifications

7.2. ASCII/MODBUS® communication cables: 07 SK 51 and 07 SK 53

These cables allow you to connect the 40 or 50 series central units to other devices for ASCII or MODBUS® communication.

They are shielded and 2 meters long.

7.2.1. 07 SK 51 connection diagram (see Figure 3-17):



Technical specifications

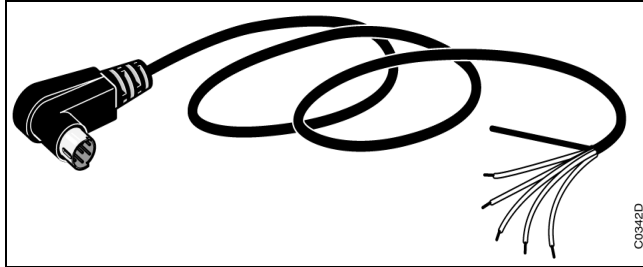


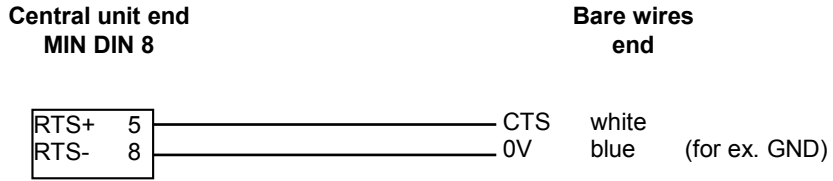
Figure 3-18 : 07 SK 53 communication cable

Technical specifications

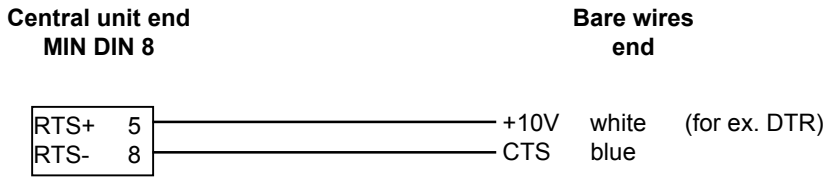
7.2.2. 07 SK 53 connection diagram (see Figure 3-18):

- Cabling diagram of the RTS signal:

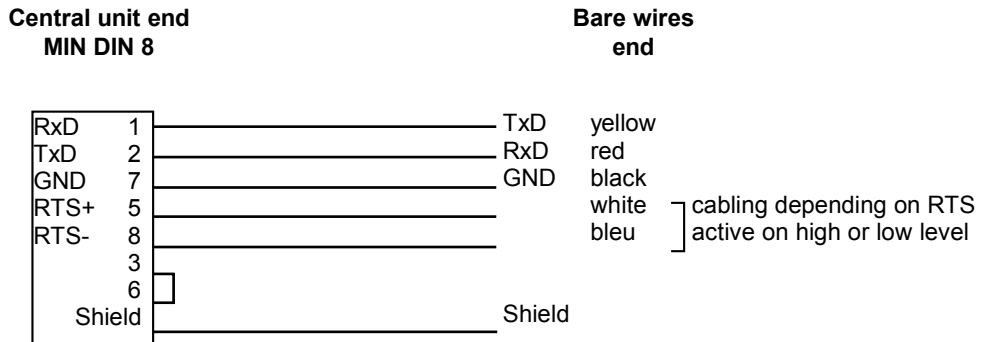
If RTS active at low level:



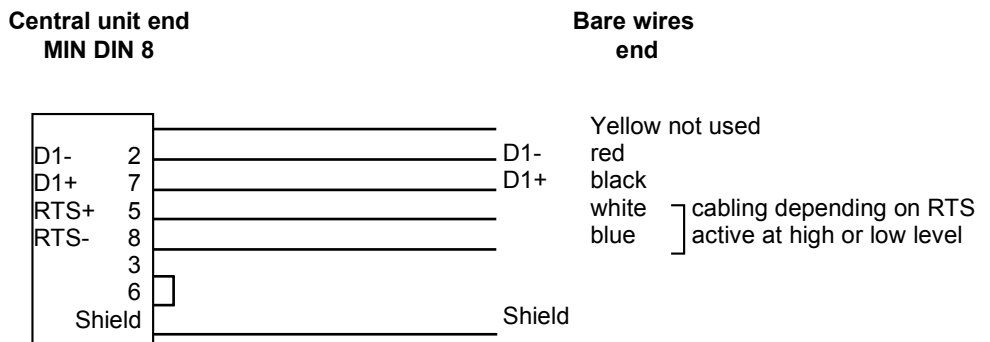
If RTS active at high level



- Using the cable for RS 232



- Using the cable for RS 485



Comment: The ASCII/MODBUS® is distinguished from the programming cables by its BLACK color.

Technical specifications

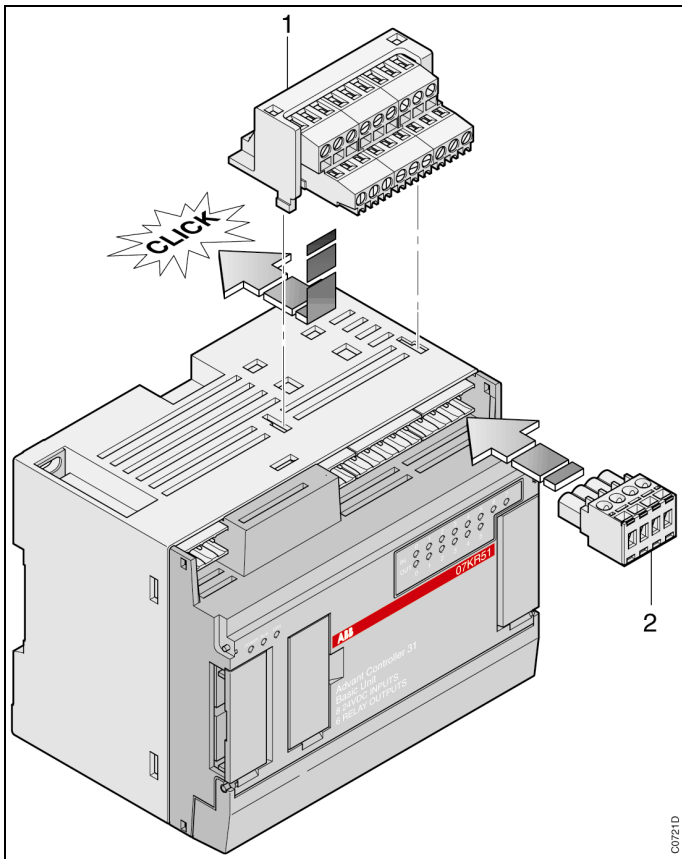


Figure 3-19 : External dual connectors (07 ST 50)

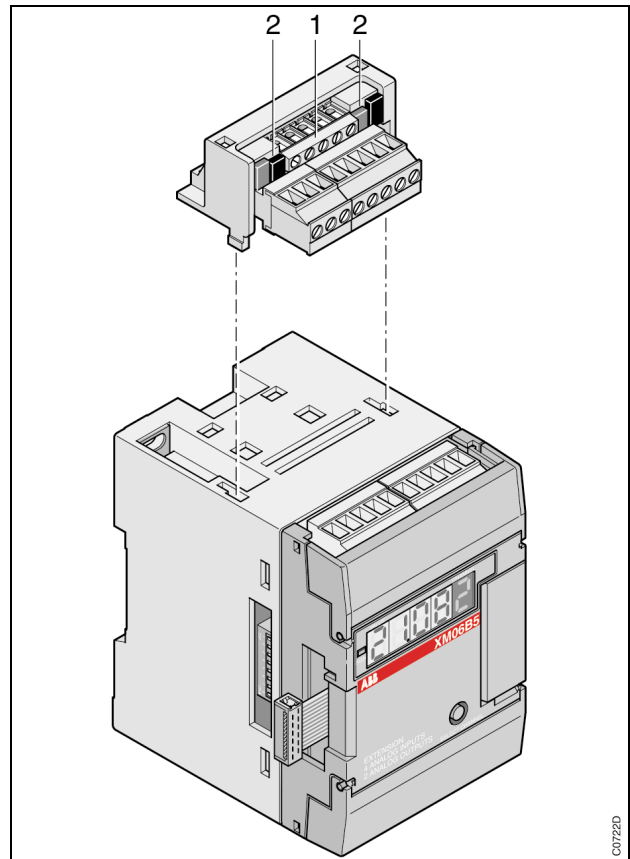


Figure 3-20 : External dual connectors (07 ST 51)

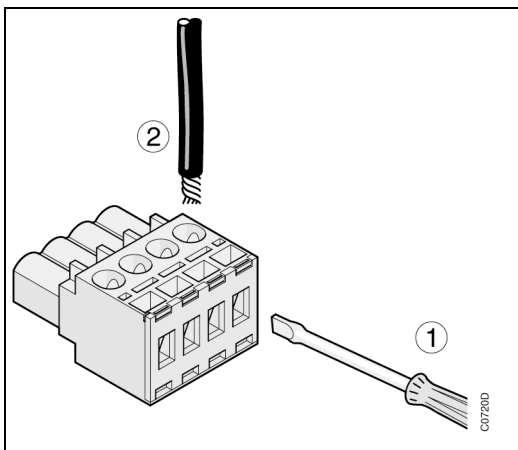


Figure 3-21 : "cage-clamp" type connectors

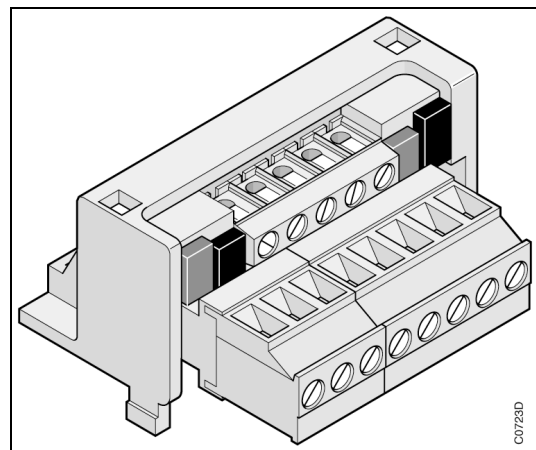


Figure 3-22 : External dual connectors (07 ST 51)

Technical specifications

7.3. TC50 display cables: 07 SK 54 and 07 SK 55

Refer to the TC 50 documentation supplied with the product.

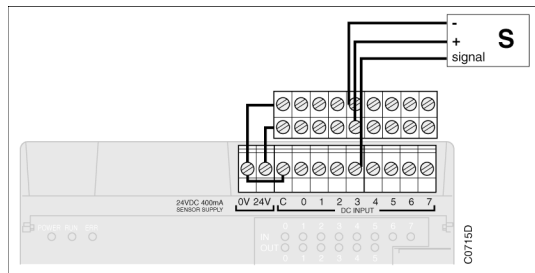
7.4. Connectors

Two types of connectors exist complementary to the removable connectors. They enable a simplified installation.

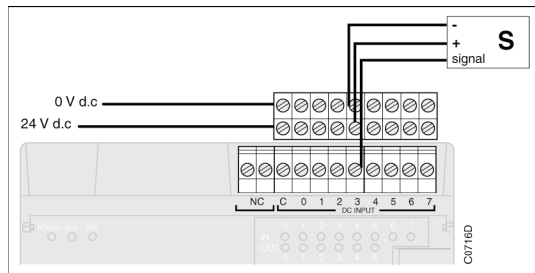
7.4.1. External dual connector: 07 ST 50 (see Figure 3-19)

This is a dual connector which enables an easy connection of sensors or three wire **binary** actuators to the 40 and 50 series products.

All the terminal blocks of the same level are linked electrically.



Connection of a 07 ST 50 connector to a central unit with 230 V a.c. power supply



Connection of a 07 ST 50 connector to a central unit with 24 V d.c. power supply

7.4.2. "Cage-clamp" type connectors (see Figure 3-19)

The "cage-clamp" type connectors enable rapid cabling of all of the 40 and 50 series products.

All that is required is:

- to press with a screwdriver (see Figure 3-21)
- and insert the bare wire.

The wire should have the following specifications:

- rigid or multi-conductor wire AWG 28 (0.08 mm²) to AWG 12 (3.1 mm²)
- wire bared for a length of 8 - 9 mm

The following connector kits are available:

07 ST 52	"Cage-clamp" type connectors for binary channels. 2 units
07 ST 54	A set of "cage-clamp" type connectors for central units or remote units
07 ST 55	A set of "cage-clamp" type connectors for XI 16 E1, XO 16 N1, XE 08 B5 extensions
07 ST 56	A set of "cage-clamp" type connectors for XO 08 R1, XC 08 L1, XK 08 F1 extensions
07 ST 57	A set of "cage-clamp" type connectors for XM 06 B5 extension

Technical specifications

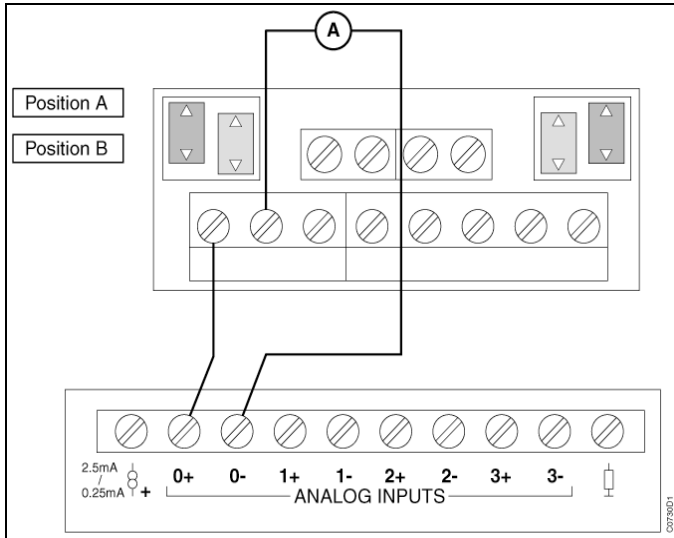


Figure 3-23 : Cabling current protection 4 – 20 mA with 07 ST 51 / XM 06 B5 or XE 08 B5

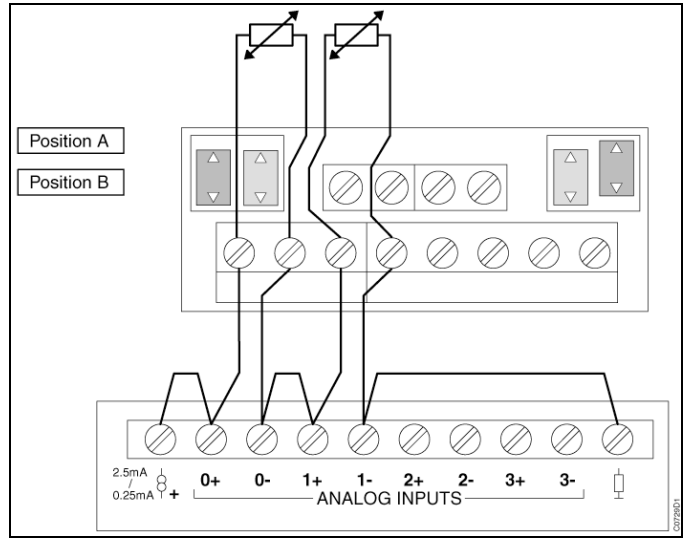


Figure 3-24 : Cabling PT100/PT1000 with 07 ST 51 and 2 wire probe

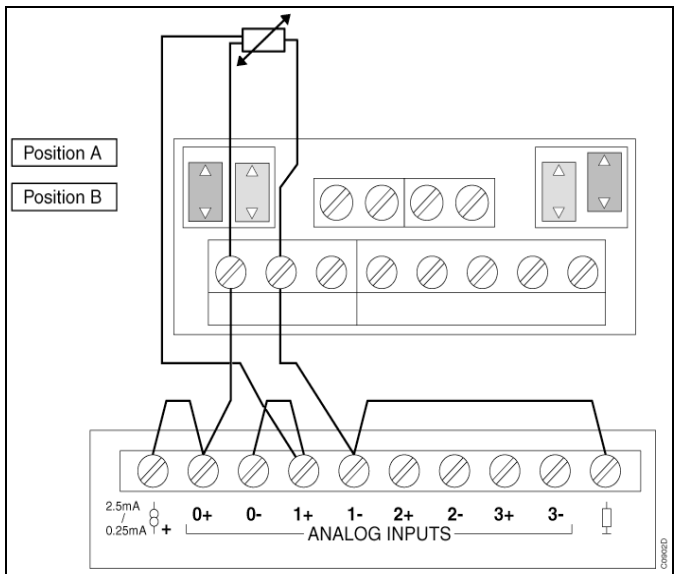


Figure 3-25 : Cabling PT100/PT1000 with 07 ST 51 and 3 wire probe

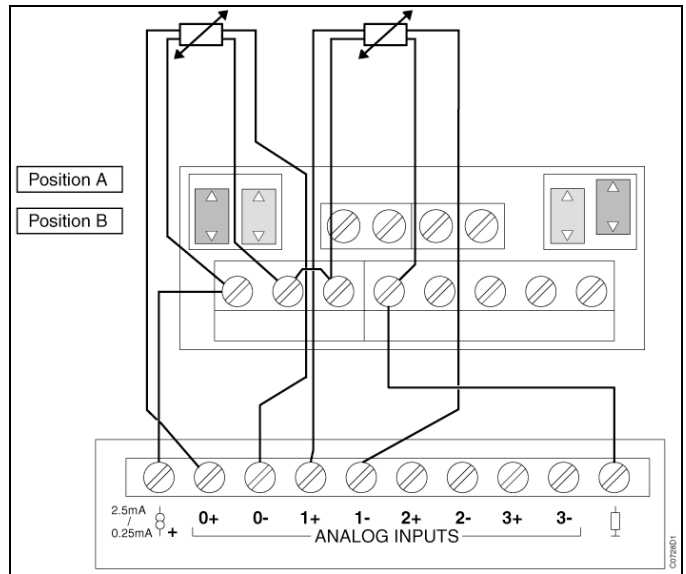


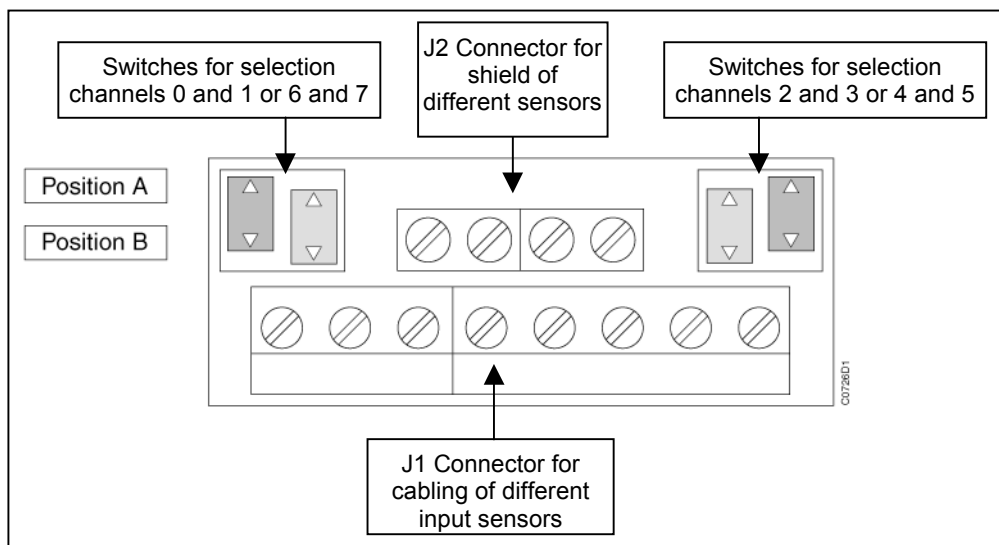
Figure 3-26 : Cabling PT100/PT1000 with 07 ST 51 and 4 wire probe

Technical specifications

7.4.3. External dual connector: 07 ST 51 (see Figure 3-20 and Figure 3-22)

This is a dual connector which enables an easy connection of **analog** sensors to the 40 and 50 series products (XM 06 B5 or XE 08 B5), some other functions are also added with this connector (See Figure 3-23 to Figure 3-26) :

- Possibility to change a sensor without fall-out the other sensors
- Additionnal protection against short-circuit in case of 4- 20 mA

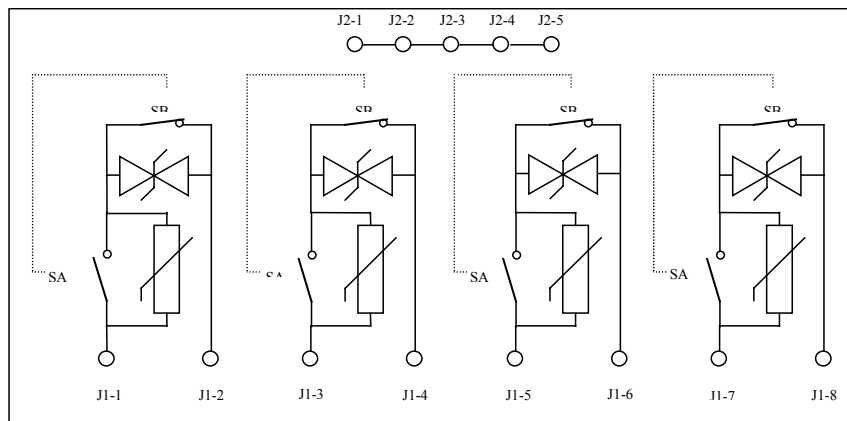


The switches on the 07 ST 51 are used to select the configuration of channels, one switch for one channel. Two possibilities of configuration, current protection or cabling PT100/PT1000.

- **Position A** : Configuration current protection for 4 – 20 mA
- **Position B** : Configuration for PT100 / PT1000

It includes two connectors, J1 connector is used to cabling the different input sensors, and J2 connector may be used to connect the shielding of the different analog cables.

Warning: In the configuration current 4 – 20 mA, the sensor should be able to provide 20 mA with min 10 V d.c. Moreover, the input is not protected against voltage between 10 up to 18 V d.c. and can give an error or destroy the input.



Electrical diagram inside of 07 ST51

Technical specifications

7.5. Stickers

A set of 100 stickers enable the description of the PLC channels used, and for up to 20 products.

The stickers are written by the user and are to be stuck inside the covers.

8. TC50 Display

The TC50 is a device that allows the user to control or simply display a productive process used to display and input data, to show status messages (for instance, dynamic tests) or alarm messages in machines or plant controlled by central unit.

The TC50 communicates directly with the central unit with MODBUS[®] protocol without requiring any additional hardware.

The TC50 is programmed using a configuration software TCWIN operating in Windows 95, 98, NT environment on a Computer.

The TC50 is available in two different versions:

- TC50 ref: 1SBP260150R1001 – RS232 interface
- TC50-2 ref: 1SBP260150R1001 – RS485 interface

See TC50 technical documentation ref: 1SBC005499R1001

See TCWIN software documentation ref: 1SBC004999R1001



Technical specifications

9. Dimensions (in mm)

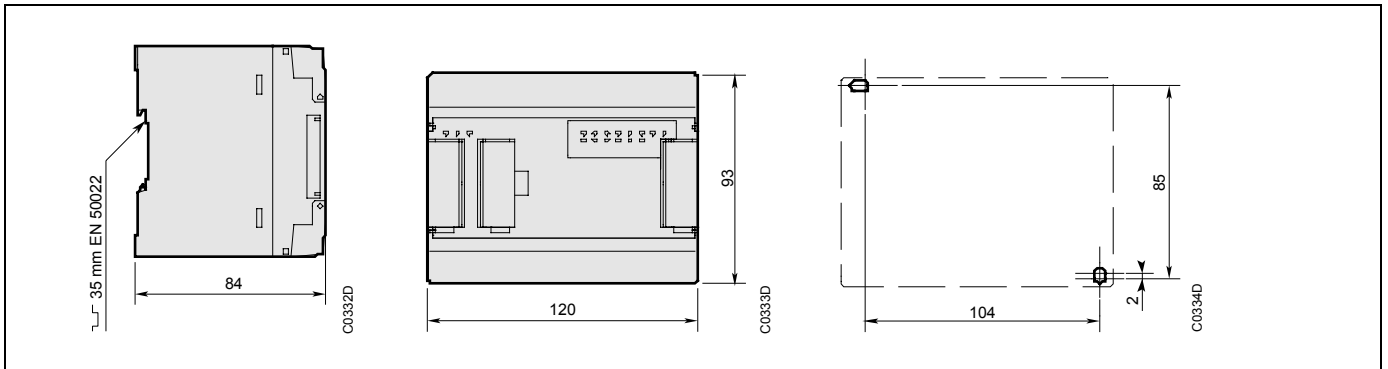


Figure 3-27 : Central unit and remote unit

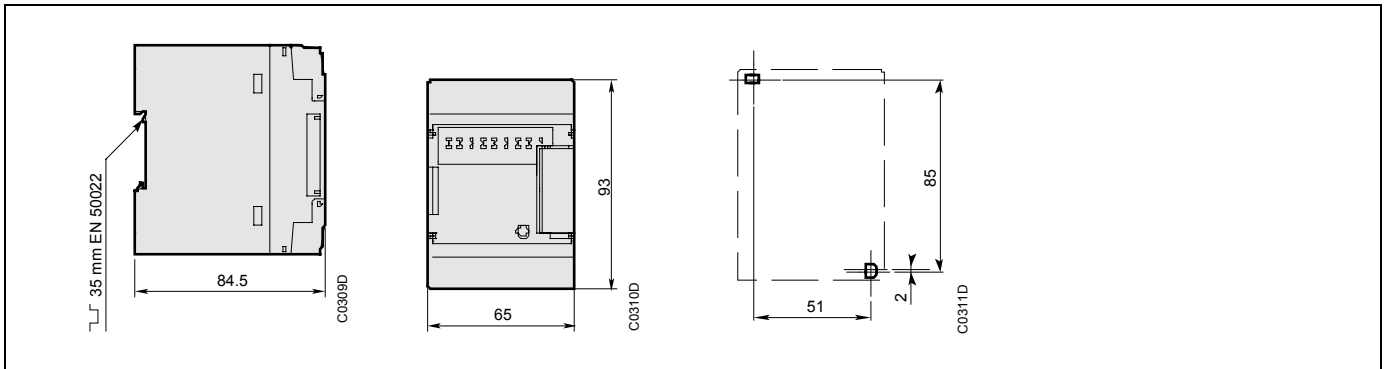


Figure 3-28 : Extension

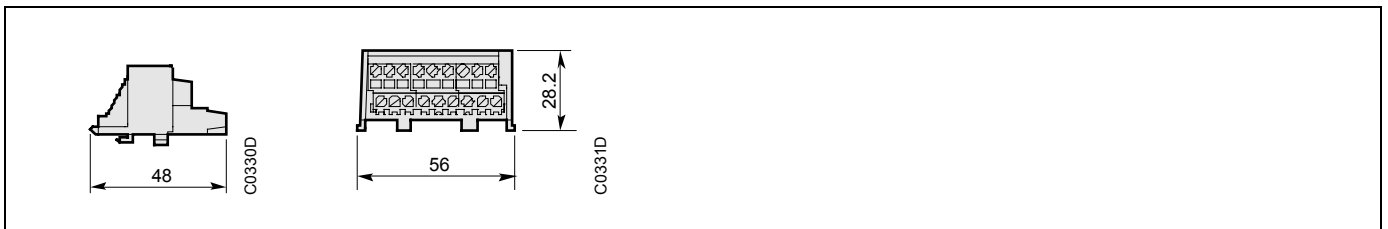


Figure 3-29 : Connector

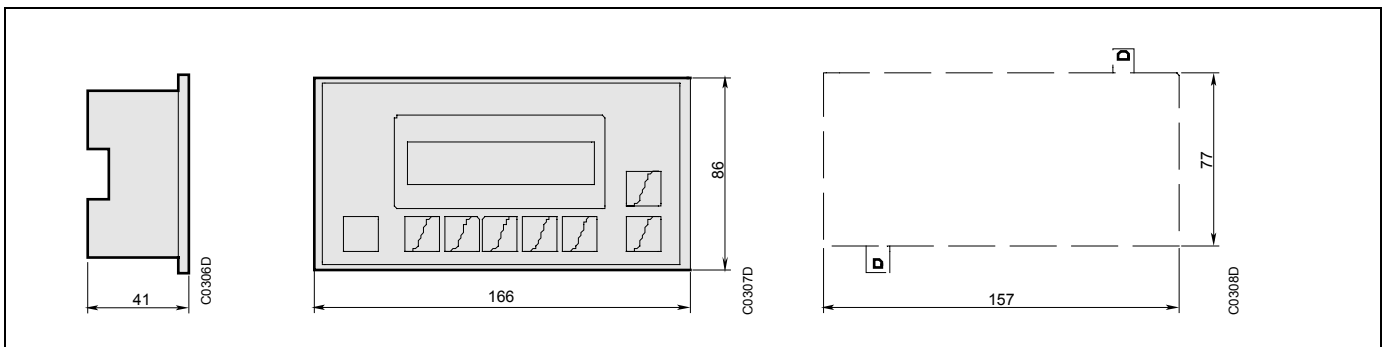


Figure 3-30 : Display

AC 31 technical documentation

Chapter 4

Installation

Installation

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Installation

This chapter presents the cabling, product by product, the main implementation rules and the addressing rules.

1. Implementation of an AC 31 system

The AC 31 product range has been conceived for operation in extreme industrial environments. The correct operation of these products is only ensured if a certain number of rules are adhered to. These rules concern the assembly conditions, the input / output cabling principle, the earthing, the connection of the CS 31 bus and the different types of power supply.

1.1. Assembly conditions

The products of the AC 31 range may be mounted on two types of fixation. They may be installed vertically or horizontally:

- either on a DIN rail (35 mm) by using the support lock.
- or by a screw (4 mm diameter M4), the fixing holes placed at the base of the units enabling plate mounting.

For a cabinet assembly:

operating temperature from 0 to 55°C, envisage sufficient free volume around the units to allow the heat to dissipate correctly. It is recommended that the cabinet be fitted with a ventilation system.

Warning: avoid placing heat generating devices next to the products (transformers, mains, power contactors, ...).

All electrical connections are effectuated through removable terminal blocks with an acceptable wire section equal to 2.5 mm².

The tightening torque, for reference, is equal to 0.5 Nm.

1.2. Input/output cabling

Use rigid wires or multi-conductor wires AWG 18 (0.96 mm²) to AWG 14 (1.95 mm²) for the inputs and rigid wires or multi-conductor wires AWG 14 (1.95 mm²) for the outputs.

Certain precautions should be taken to reduce installation disturbances from the surroundings. The cables carrying low voltage signals should not be placed in the same sleeve as the power cables.

One must distinguish between two types of signals:

- 230 V a.c. power supply
- analog signals (use shielded cables) and low voltage (24 V d.c.).

Installation

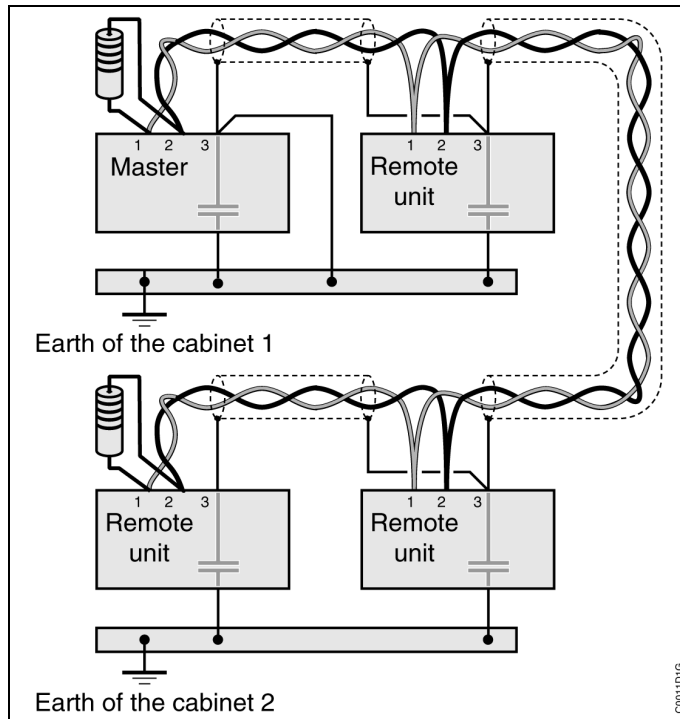


Figure 4-1 : Earthing principle for numerous cabinets

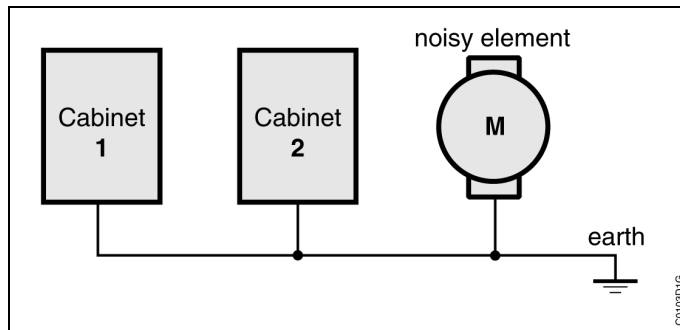


Figure 4-2 : Recommended connections with noise generating devices.

Installation

1.3. Earthing

1.3.1. Basic earthing principles

Use rigid wires or multi-conductor wires AWG 14 (1.95 mm²).

The earth and mains wires should be connected in star.

All AC 31 components of a cabinet should be connected to the same earth.

When the remote units are situated outside the cabinet they should be connected to the nearest earth.

The 40 and 50 series central units are fitted with an earth plate with the DIN rail mounting system. Also, if the central unit is screwed directly to a metal plate, the screw located at the top left of the central unit (as seen from the front) ensures an electrical connection to the earth via the earth plate.

This earthing ensures protection against electromagnetic disturbances.

The safety earthing cable (on terminal block) should be connected to the cabinet chassis.

1.3.2. Earthing principles for numerous cabinets

When the cabinets are close to each other the different earths should be connected together using a cable with a cross section of at least 16 mm² (see Figure 4-1).

The noise generating devices (actuators, motors, etc.) should not be earthed in-between two cabinets. The earthing should be done near to the element causing the most disturbance (see Figure 4-2).

Installation

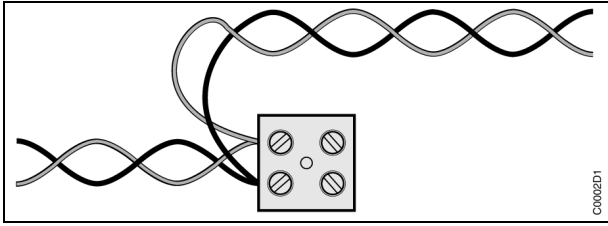


Figure 4-3 : Correct bus cabling during an interruption

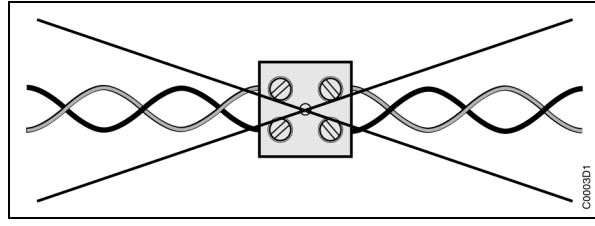


Figure 4-4 : Incorrect bus cabling during an interruption

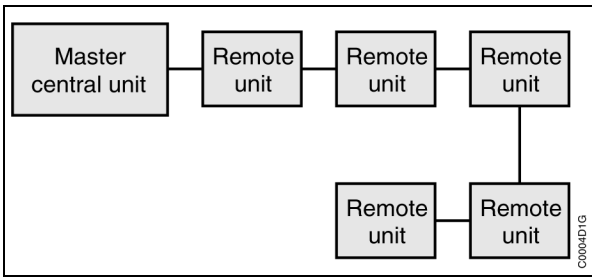


Figure 4-5 : Correct bus cabling

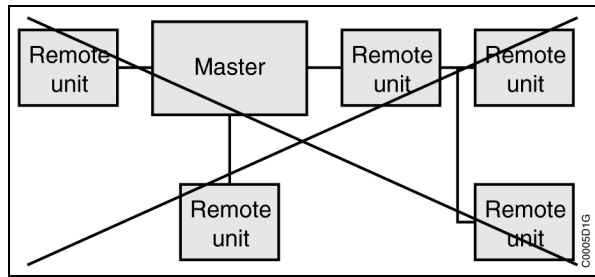


Figure 4-6 : Prohibited star bus cabling

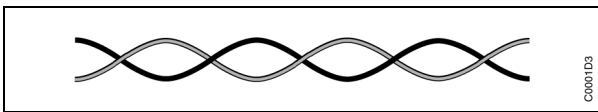


Figure 4-7 : Correct symmetrical twisted pair



Figure 4-8 : Incorrect twisted pair

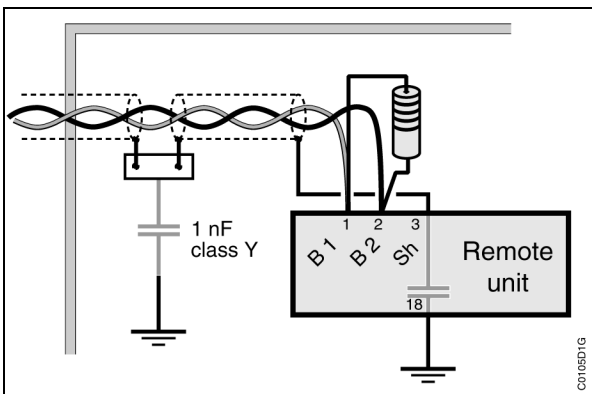


Figure 4-9 : Bus shielding connection diagram

Installation

1.4. Cabling of the CS 31 bus

The CS 31 bus is a RS 485 serial interface and consists of a shielded twisted pair. This bus is a master slave bus and only accepts a single master.

Use a AWG 24 (0.22 mm²) to AWG 18 (0.18 mm²) twisted pair.

The maximum length is 500 m.

The same cable type should be used for the whole system bus setup.

Bus interruptions should be avoided, during cabinet cable connections for instance, otherwise it should be cabled to the same side of the terminal block (see Figure 4-3 and Figure 4-4).

Warning: STAR connection of the bus is not permitted!

(see Figure 4-5 and Figure 4-6).

The central and remote units may be connected at any point of the bus:

- bus 1 on bus 1
- bus 2 on bus 2
- shielding (preferably braided) on terminal 3 of terminal block 1 and earth connected at the master level (cable < 1 m)

The bus should be terminated with a 120 Ω 1/4 W resistance connected to the bus extremities. The twisted pair should be symmetrical (see Figure 4-7 and Figure 4-8).

Connecting the bus shielding to the earth is recommended, with the intercalation of a 1 nF class Y capacitor directly at the cabinet entry, according to the assembly diagram (see Figure 4-9), if noise generating devices are near to the cabinet.

As the CS 31 bus is opto-isolated, it is possible to place elements with different voltage power on the bus.

Refer to the respective descriptions if a bus amplifier or amplifier with bus redundancy is used.

Installation

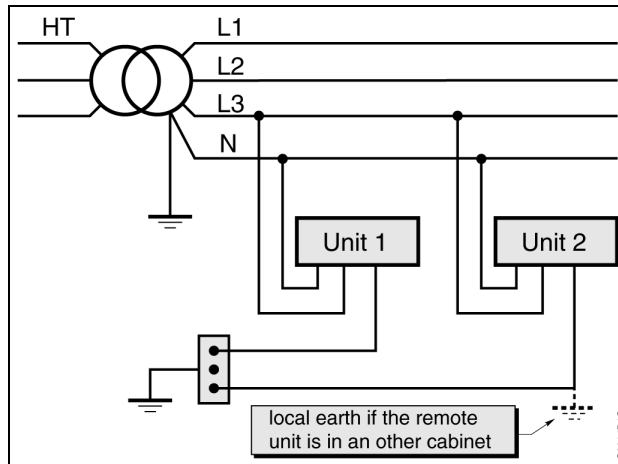


Figure 4-10 : Power supply T-T

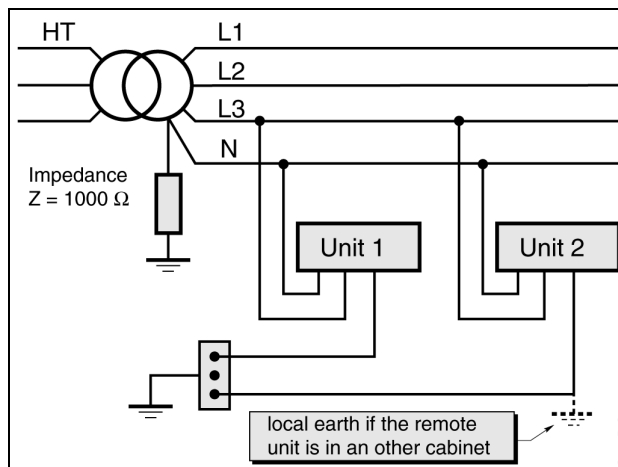


Figure 4-11 : Power supply I-T

Installation

1.5. Different power supply types

The main differences between them concerns the connection of the neutral and the metallic parts to the earth:

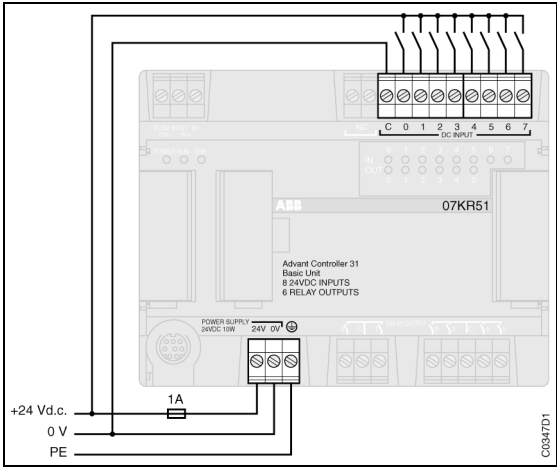
- T-T neutral: The neutral is connected to the earth. All the metallic parts are earthed (see Figure 4-10).

- I-T neutral: The neutral is isolated in relation to the earth and the metallic parts are earthed (see Figure 4-11).

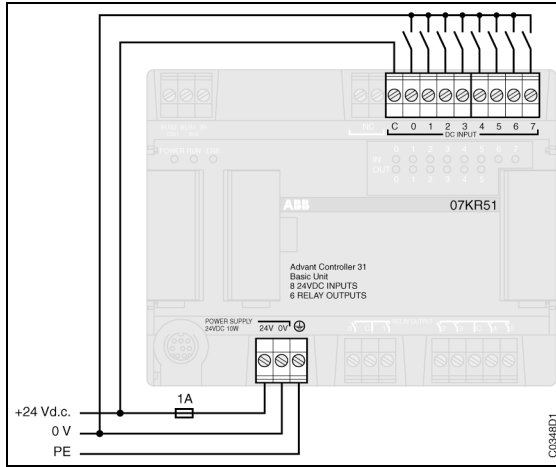
Each cabinet (including the 24 V version), in a disturbed environment, should be fitted with an isolated shielded transformer.

Installation

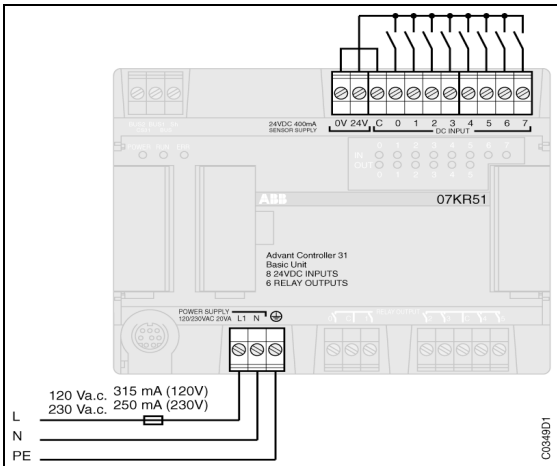
Cabling central and extensible remote units inputs/outputs:



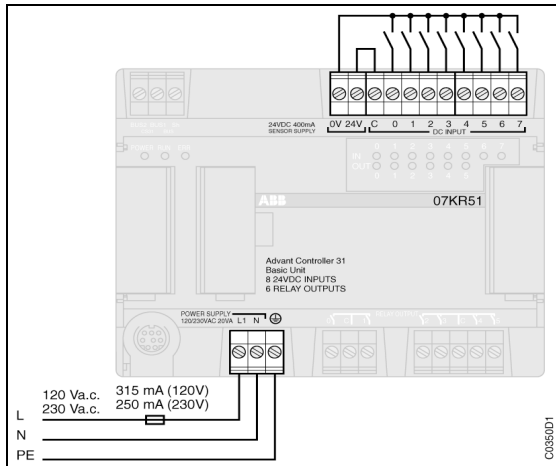
**Figure 4-12 : Positive logical inputs PNP
24 V d.c. unit power supply**



**Figure 4-13 : Negative logical inputs NPN
24 V d.c. unit power supply**



**Figure 4-14 : Positive logical inputs PNP
120/230 V a.c. unit power supply**



**Figure 4-15 : Negative logical inputs NPN
120/230 V a.c. unit power supply**

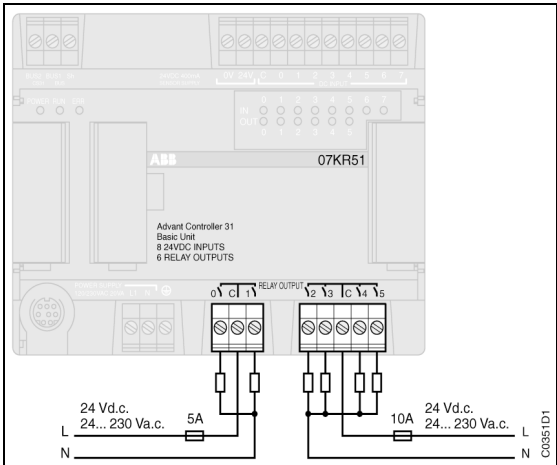


Figure 4-16 : Relay outputs

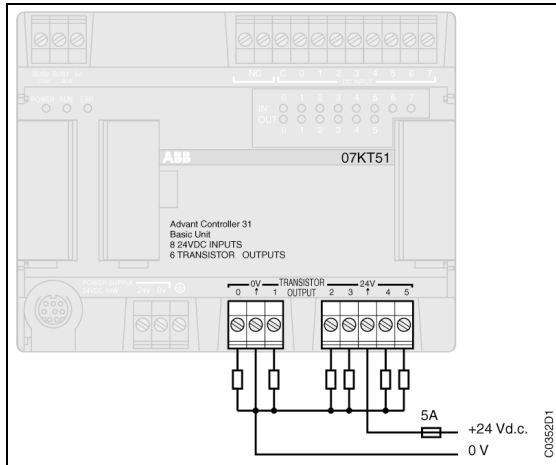


Figure 4-17 : Transistor outputs.

Installation

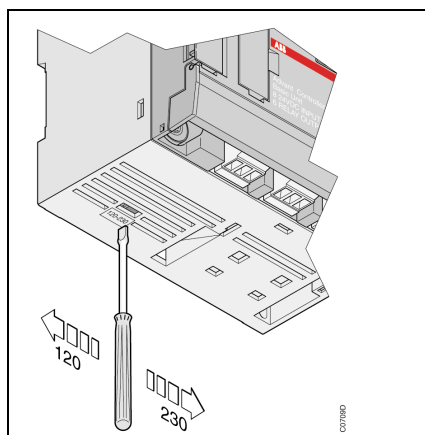
2. Central unit and remote unit cabling

2.1. Power supply

Use rigid or multi-conductor AWG 14 (1.95 mm²) wires.

The connection of an external thermal fuse is necessary to provide material protection.

It is possible to select 230 V a.c. or 120 V a.c. with the selector switch situated underneath the central units or extensible remote units. The products are delivered with the selector in the 230 V a.c. position.



An internal 24 V d.c. power supply is available on 120 / 230 V a.c. versions. This power supply feeds the binary inputs of the unit and its extensions. This internal power supply is protected against short circuits and overloads. In the case of a short circuit or overload it is available 10 seconds after the fault elimination.

It is also possible to use an external 24 V d.c. power supply. In this case do not forget to connect the earth of the external 24 V d.c. to that common to the inputs (terminal C).

2.2. Inputs/outputs cabling

Use rigid or multi-conductor AWG 18 (0.96 mm²) to AWG 14 (1.95 mm²) wires for inputs and the rigid or multi-conductor AWG 14 (1.95 mm²) wires for the outputs.

- Input cabling: see Figure 4-12 to Figure 4-15. The common C of inputs has to be linked to the 0 V or 24 V d.c. according to the sensor type.
- Output cabling: see Figure 4-16 and Figure 4-17.

2.3. Output protection

The relay outputs may be protected externally against parasites generated by an inductive load with:

- a varistor or an RC module, in alternating current
- a free-wheel diode, in direct current

The presence of an external thermal fuse, connected to the common power supply of the outputs, protects the output connected devices.

The transistor outputs are protected internally against short circuits and overloads. However with an inductive load, with L/R greater than 40 ms, it is necessary to add a free-wheel diode.

If an error occurs at one of the transistor outputs, it is indicated by the status of the central unit.

The presence of an external thermal fuse, connected to the common power supply of the outputs, protects the output connected devices and also avoids unit damage should numerous outputs overload.

Warning: In the case of the terminal 0 V is disconnected and in the same time the 24 V d.c. is connected, the leakage current on output is 16 mA.

Installation

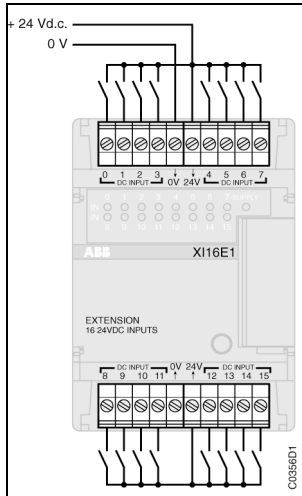


Figure 4-18 : Extension XI 16 E1

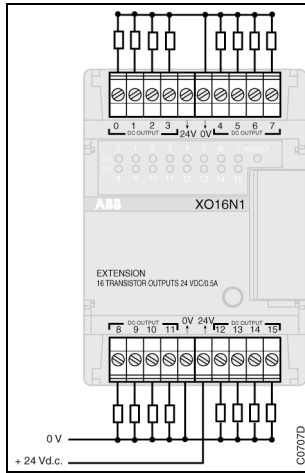


Figure 4-19 : Extension XO 16 N1

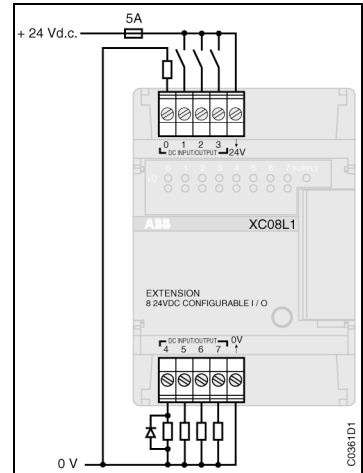


Figure 4-20 : Extension XC 08 L1

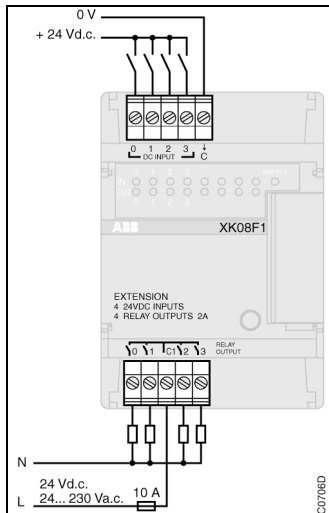


Figure 4-21 : Extension XK 08 F1

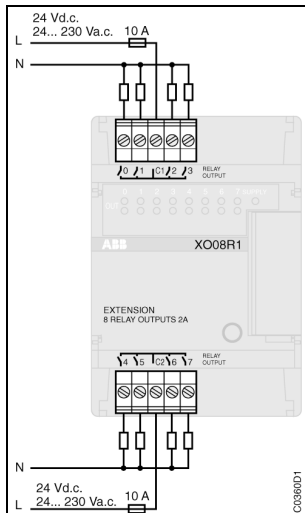


Figure 4-22 : Extension XO 08 R1

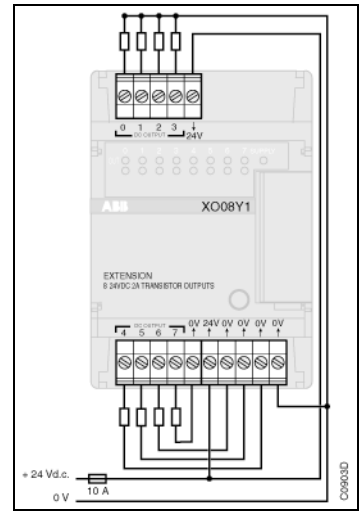


Figure 4-23 : Extension XO 08 Y1

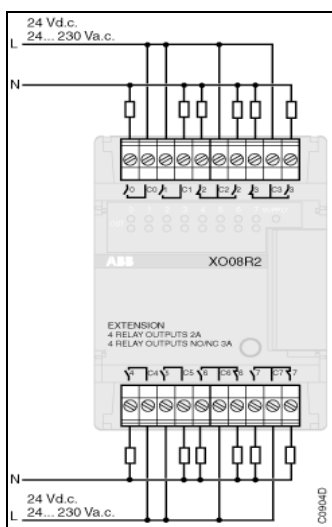


Figure 4-24 : Extension XO 08 R2

Installation

3. Cabling binary extensions

The extensions are powered with 5 V by the central unit or the remote unit. The connection between the extension and the central unit is effected with the cable situated on the left side of the extension.

Warning: The extensions must be connected or disconnected without power supply.

3.1. Extension XI 16 E1 (see Figure 4-18)

The 24 V d.c. power supply used for the sensors should be linked to the 0 V and 24 V terminals situated on the top or bottom terminal blocks. These terminals are linked internally, therefore it just requires linking one 0 V and one 24 V d.c. terminals.

3.2. Extension XO 08 R1 (see Figure 4-22)

The connection terminals named C1 and C2 are independent.

3.3. Extension XC 08 L1 (see Figure 4-20)

An external 24 V d.c. power supply has to be used if the total current exceeds the capacity of the 24 V d.c. power supply of the central unit. In this case, it is necessary to connect together the 0 V and 24 V d.c. of the external power supply and central unit.

If the external power supply is not connected, the supply led (green) is blinking.

Warning: In the case of the terminal 0 V is disconnected and in the same time the 24 V d.c. is connected, the leakage current on output is 16 mA.

3.4. Extension XO 16 N1 (see Figure 4-19)

The 24 V d.c. power supply used for the loads should be linked to the 0 V or 24 V d.c. terminals situated on the top or bottom terminal blocks. These terminals are linked internally, therefore it just requires linking one 0 V and one 24 V d.c. terminals

Warning: In the case of the terminal 0 V is disconnected and in the same time the 24 V d.c. is connected, the leakage current on output is 16 mA.

3.5. Extension XK 08 F1 (see Figure 4-21)

The common C of inputs has to be linked to the 0 V or 24 V d.c. according to the sensor type.

3.6. Extension XO 08 Y1 (see Figure 4-23)

The 24 V d.c. power supply used for the loads should be linked to the 0 V or 24 V d.c. terminals situated on the top or bottom terminal blocks. These terminals are linked internally, therefore it just requires linking one 0 V and one 24 V d.c. terminals

Warning: In the case of the terminal 0 V is disconnected and in the same time the 24 V d.c. is connected, the leakage current on output is 16 mA.

3.7. Extension XO 08 R2 (see Figure 4-24)

Extension with 4 relay NO and 4 relay NO/NC

The connection terminals named C0, C1, C2, C3, C4, C5, C6, and C7 are independents.

Installation

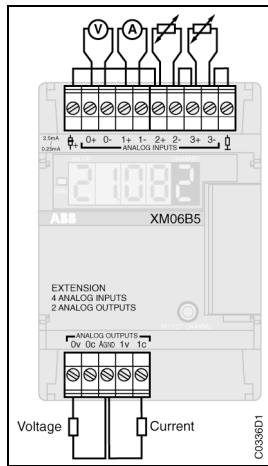


Figure 4-25 : XM 06 B5 with 2 wire probe

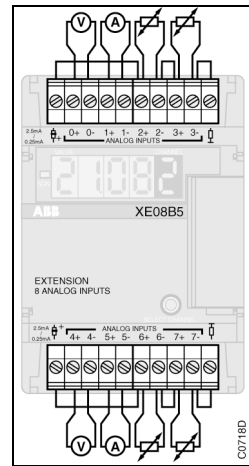


Figure 4-26 : XE 08 B5 with 2 wire probe

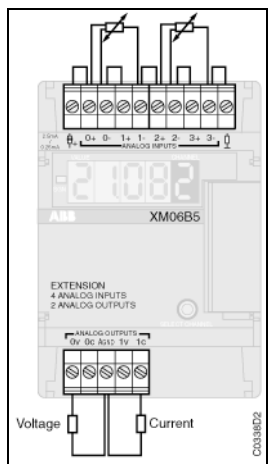


Figure 4-27 : XM 06 B5 with 3 wire probe

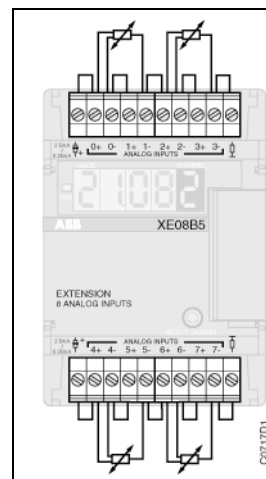


Figure 4-28 : XE 08 B5 with 3 wire probe

Installation

4. Cabling the analog extension

4.1. Extension XM 06 B5

The extension is powered with 5 V by the central unit or the remote unit. The connection between the extension and the central unit is effected with the cable situated on the left side of the extension.

Warning: The extensions must be connected or disconnected without power supply.

4.2. Extension XE 08 B5

The extension is powered with 5 V by the central unit or the remote unit. The connection between the extension and the central unit is effected with the cable situated on the left side of the extension.

Warning: The extensions must be connected or disconnected without power supply.

The PT 100 or PT 1000 probes connected to the XM 06 B5 or XE 08 B5 extension may be the 2 wire, 3 wire sensors (see Figure 4-25 to Figure 4-28).

Usage of the connectors 07 ST 51 is recommended for mounting a 4 wire probe or use the function current protection against short-circuit in case of 4-20 mA or to have the possibility to change a sensor without fall-out the other sensors (see chapter 3 : § 7.4.3)

Installation

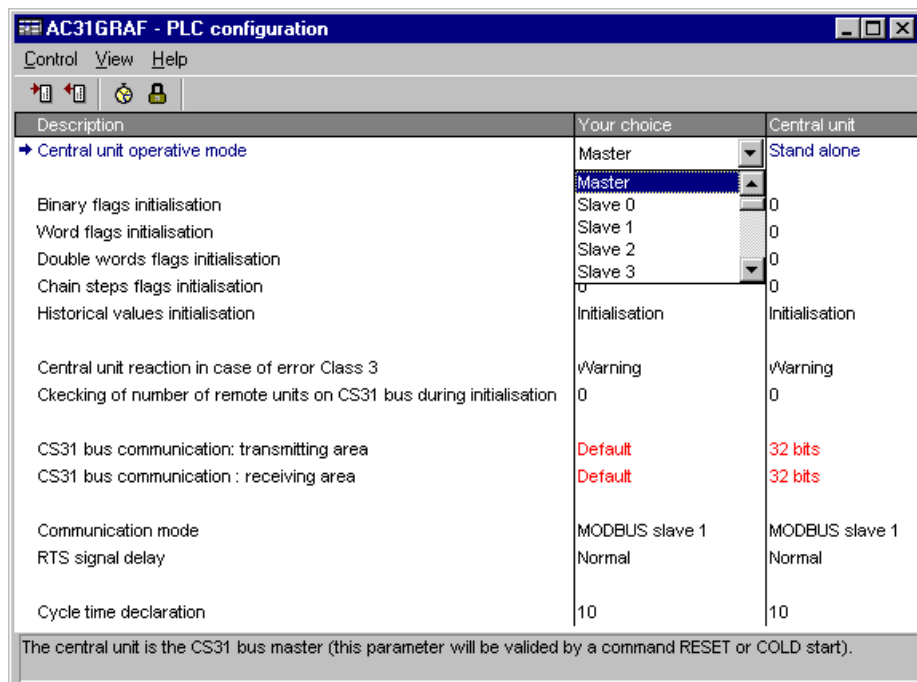


Figure 4-29 : AC31GRAF "PLC Configuration" window

Installation

5. Addressing

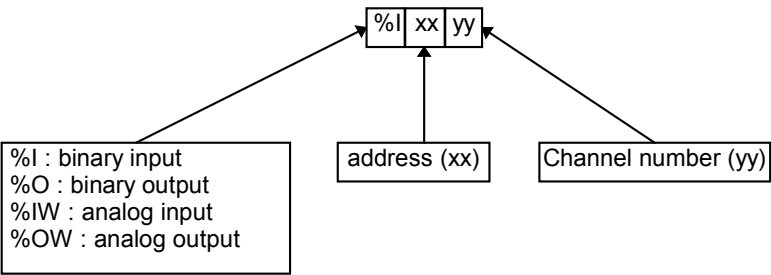
5.1. Input/Output variables

Addressing the CS 31 bus enables programming the utilization of the inputs/outputs in a manner completely transparent to the user.

The inputs/outputs of an AC 31 remote unit are defined by:

- ⇒ - their type (input or output, binary or analog),
- ⇒ - the unit address,
- ⇒ - their channel number on the unit.

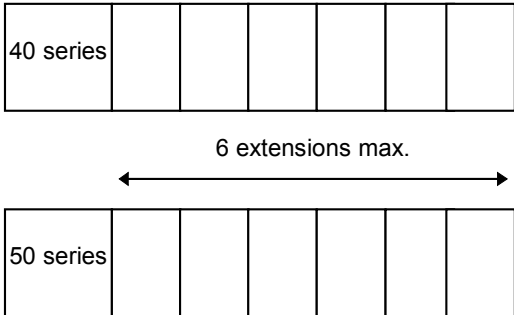
They are recognized in the following manner by the program: %I xx.yy



5.2. Addressing CU masters or stand-alones with extensions

Utilization of the *standalone, master or slave* mode of the central unit is **software** defined in the "PLC configuration" window of the control menu of the AC31GRAF programming software (see Figure 4-29).

A maximum of 6 binary or analog extensions may be connected to a central unit in any order.



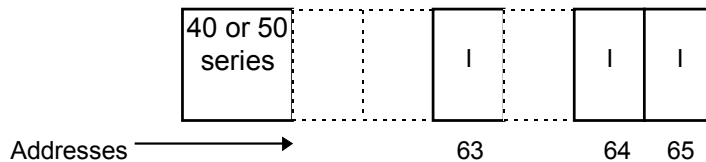
Installation

- **Master or stand-alone central unit**

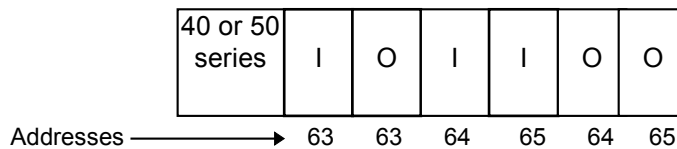
⇒ The address 62 is assigned to the inputs / outputs of a central unit.

⇒ The addresses of the extensions are assigned automatically according to the order of the extensions:

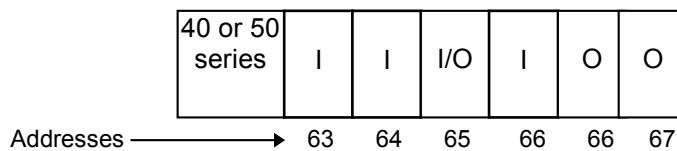
- the first binary inputs extension takes the address 63, and those that follow are incremented by 1, up to 68.



- the first binary outputs extension also takes the 63 address and those that follow are incremented by 1, up to 68.

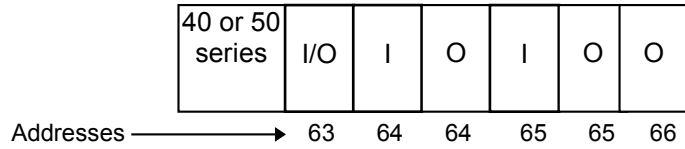


- an extension with mixed or configurable inputs / outputs is considered by the addressing as an input extension **and** an output extension => The address of the following binary extension, whether it is input or output, is incremented by 1.

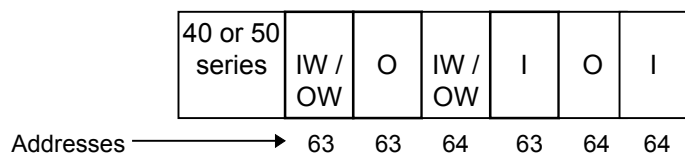


Installation

In order to optimize the addressing, the mixed or configurable inputs/outputs extension, or extensions, will be situated at the extremities.



- the address of the first analog extension starts at 63 and is incremented for the following by 1, up to 68.



Installation

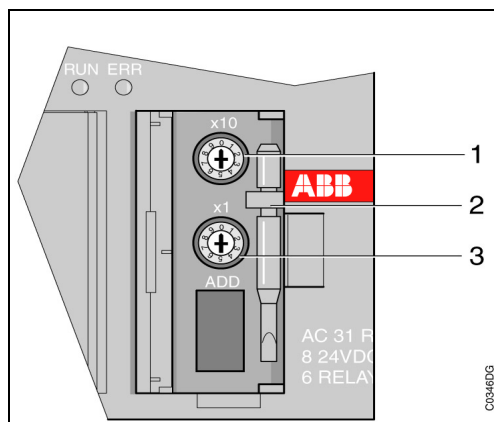


Figure 4-30 : Rotative switches for addressing the remote extension unit

Installation

5.3. Addressing slave central units or remote extension units on the CS 31 bus

The CS 31 protocol is a master / slave protocol: the master sends requests to the slaves which are indicated by an address between 0 to 61.

The master central unit can manage up to 31 connection points (CS 31 bus addresses).

A connection point may be:

- ⇒ - a non-extensible remote unit
- ⇒ - an extensible remote unit with binary extensions
- ⇒ - a remote TCAD display
- ⇒ - a variable speed drive ABB NCSA-01 interface
- ⇒ - a high speed counter
- ⇒ - a central unit (50 series with extension possibilities, 90 or 30 series).

Warning: an extensible remote unit with analog extensions counts 2 connection points.

The master central unit, as well as the remote units, may be positioned in any order on the bus. The order of the extensions on the central units and remote extensible units is free.

The addressing is not according to the order of the units on the bus. The addresses from 1 to 61 may be attributed in any order to the slaves: the first remote unit on the CS 31 bus can have address 5 followed by a remote unit with address 3 followed by another remote unit with address 12, and so on.

5.3.1. Addressing extensible remote units

The slave number of the extensible remote units is given by the rotative switches situated beneath the first cover on the front face. Each switch can be set to 0 to 9. The switch 1 is for tens and the switch 3 is for units (see Figure 4-30). Values greater than 61 are not allowed. $0 \leq X \leq 61$.

Limitation for analog extension:

The maximum number of analog channel per extensible remote unit is:

- 8 analog inputs and 8 analog outputs

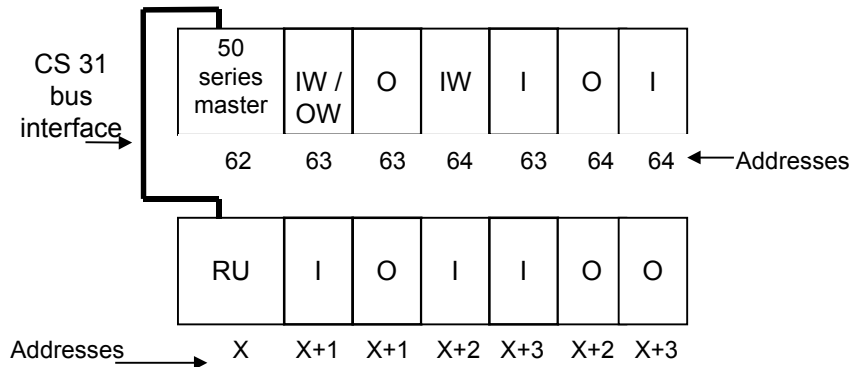
The maximum configuration per extensible remote unit is:

- a maximum of 1 XE 08 B5 extension unit + 5 binary extension units may be used.
- a maximum of 1 XTC 08 extension unit + 5 binary extension units may be used.
- a maximum of 1 XE 08 B5 and 1 XTC 08 extension units + 4 binary extension units may be used.
- a maximum of 2 XM 06 B5 extension units + 4 binary extension units may be used.

Installation

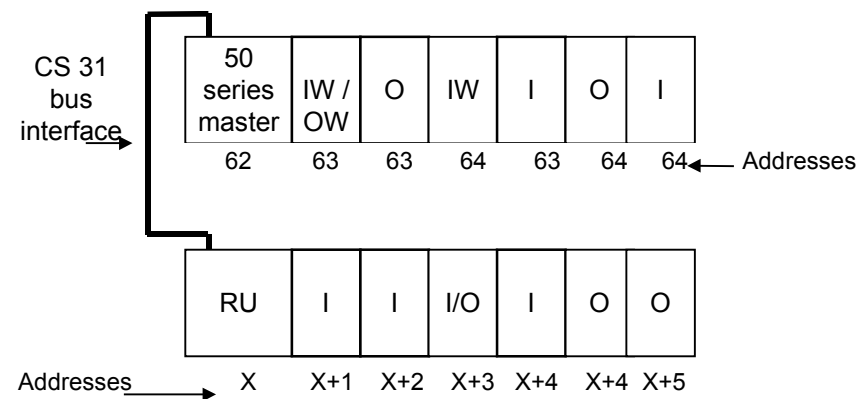
Addressing rule

- The first binary input extension takes the address X+1, the following is incremented by 1 and so on until 61.
- The first binary output extension also takes the X+1 address and those that follow are incremented by 1, up to 61.



- A mixed or configurable input/output extension is considered, for addressing, as an input extension **and** an output extension => the address of the following binary extension, whether input or output, is incremented by 1.

None of the addresses defined by the configuration may be used by another remote unit of the 30 or 90 series. In the following example an output unit of the 30 or 90 series can not have the address X+1 or X+2. It's address has to be greater than X+5.

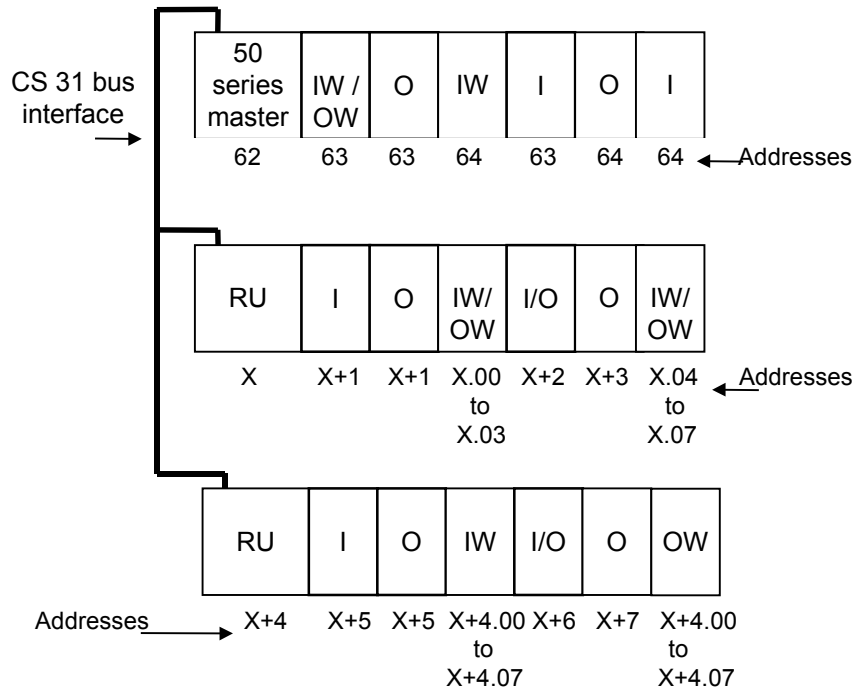


When an analog extension unit is present amongst the extensions, the unit takes the same address value as that of the extensible remote unit to which it is associated.

Address values = ($0 \leq X \leq 61$)

When an XM 06 B5 type analog extension unit is used, it is possible to associate a maximum of two units to the extensible remote unit, because the number of inputs and outputs of this unit is less than eight.

Installation



5.3.2. Addressing slave central units

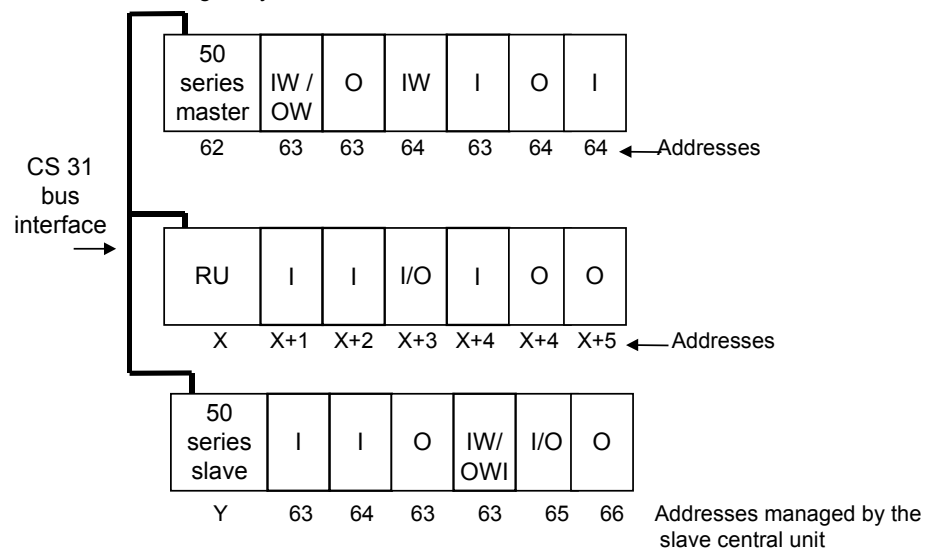
Information exchanges between a master central unit and a slave central unit isn't limited to the exchange of physical input/output variables. It is possible to exchange a data table, whose size may be defined in bits or words, as follows:

- bit exchange in 8 bit packets (1 byte) = from 2 bytes to 15 bytes.
Address = ($0 \leq Y \leq 61$)

- word exchange from 1 to 8 words. Address = ($0 \leq Y \leq 61$)
(see chapter 6 - Program Optimization).

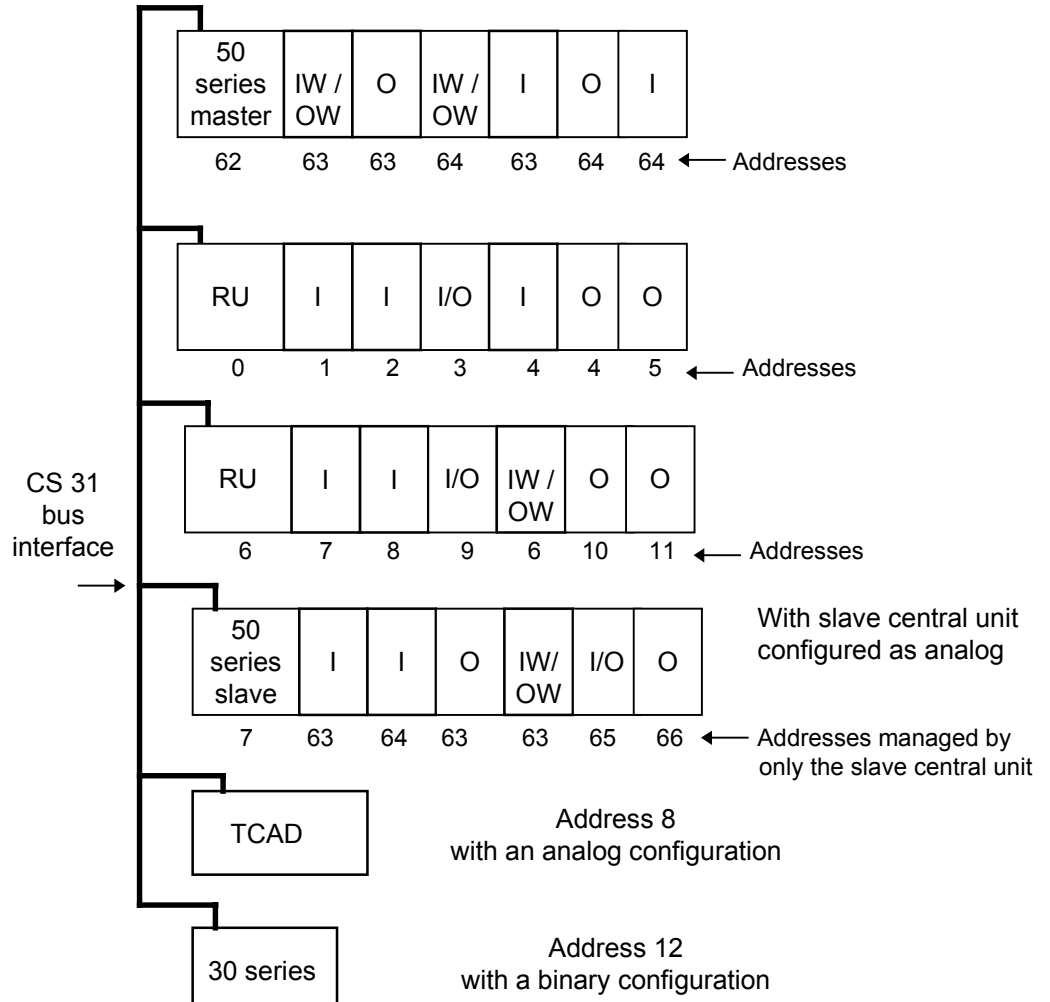
⇒ The addressing of the slave central unit is done in the AC31GRAF software.

The addressing of the central unit extensions is independent of the CS 31 bus addressing. It is defined and managed by the slave central unit.



Installation

5.3.3. Addressing example



This example takes 6 connection points (CS 31 bus addresses).

Installation

5.4. Summary

Master central unit 40 and 50 series	addresses	address configuration
- Incorporated Inputs/Outputs	62	standard
- Binary extension	63 to 68	automatically
- Analog extension	63 to 68	automatically

Analog channel addressing:

	On central units	On extensible remote units (address Y)	
Address	$63 \leq X \leq 68$	$0 \leq Y \leq 61$	
XM 06 B5	Max 6 extensions	Max 2 extensions	
		First extension	Second extension
- inputs	IW X.00 to IW X.03	IW Y.00 to IW Y.03	IW Y.04 to IW Y.07
- outputs	OW X.00 and OW X.01	OW Y.00 and OW Y.01	OW Y.04 and OW Y.05
- internal values	OW X.02 and OW X.03	OW Y.02 and OW Y.03	OW Y.06 and OW Y.07
XE 08 B5	Max 6 extensions	Max only one	
- inputs	IW X.00 to IW X.07	IW Y.00 to IW Y.07	
XTC 08	Max 6 extensions	Max only one	
- internal values	OW X.00 to OW X.07	OW Y.00 to OW Y.07	



Addresses → Y

N

With Y = address of the extensible remote unit,

and N = maximum number of extensions of one type on an extensible remote unit.

	Master central unit		address configuration
	50 series	90 series	
- Extensible remote unit			by rotative switches
If solely binary extension	$0 \leq Y+N \leq 61$	$0 \leq Y+N \leq 61$	automatically
If at least one analog extension	$0 \leq Y+N \leq 61$	$0 \leq Y \leq 5$	automatically
- 50 series slave central unit			
Binary configuration	0 to 61	0 to 61	by programming software
Analog configuration	0 to 61	0 to 5 and 8 to 15	by programming software
- 90 series slave central unit			
Binary configuration	0 to 61	0 to 61	by programming software
Analog configuration	0 to 5 and 8 to 15	0 to 5 and 8 to 15	by programming software

Chapter 5

Programming

Programming

1. Software introduction

The **AC31GRAF** software is used with all of the AC 31 central units.

This software runs under Windows® (3.1, NT or 95). 12 Megabytes of free disk space are required for the installation. Execute the *setup.exe* for an automatic installation.

The software allows you to create, send, test, recover and print user programs as well as initializing, starting and stopping the central unit.

● Four programming languages exist:

- LD and Quick LD: are graphic languages based on the symbols of contact diagrams. They are adapted for combinatorial processing and offer the basic symbols and automation function blocks as defined in the IEC 1131-3 standard (contacts, timers, counters).

- FBD: is a graphical language of function blocks which allows complex procedure programming by combining existing library functions of the AC31GRAF software.

- SFC: is a graphical language for describing sequential operations. The process is represented by diagrams which represent steps linked with transitions which correspond to a binary condition. The actions associated with the steps may be written in a different language.

- IL: an instruction list language. This is particularly aimed at the more experienced automaticians.

● Organization of a project:

A project can be:

⇒ Non modular: the project therefore consists of one single and unique main program.

⇒ Modular: the project consists of

- numerous programs

- level 1 sub-programs (a maximum of 12 on the 40 and 50 series)

- and interruption programs (a maximum of 2 hardware and 1 software)

The programs in a modular project may be written in different languages.

Programming

● **An existing library with more than 150 functions:**

The list of available functions depends on the chosen central unit. Once the central unit has been defined the list is common for the different programming editors.

The 40 and 50 series have 80 functions split into the following:

- Binary functions
- Timer functions
- Counter functions
- Word / Double Word comparison functions
- Word / Double Word arithmetic functions
- Word / Double Word logical functions
- Program control functions
- CS 31 bus configuration and acknowledgment functions
- Communication functions
- Control functions
- Format conversion functions
- Special functions
- Memory access functions

All the functions are comprehensively described in AC31GRAF online help as well as in the documentation.

Refer to the "AC31GRAF User's guide" for software utilization.

Programming

2. List of variables

There are 5 types of variables used in the user program:

- ⇒ The physical, binary or analog, Input / Output variables
- ⇒ The internal bit, word or double word variables used in the user program for the intermediate calculations.
- ⇒ The indirect bit, word or double word constants.
- ⇒ The chain steps: a chain step enables running sequential operations. Each chain step enables the definition of a step. One single step may be active at a time.
- ⇒ The historical values: certain functions require the execution of numerous program cycles in order to execute. A historical value is an internal register used by this type of function to store the result, of the function, in the program cycle n-1 during the functions process.

The historical values are not directly accessible, in the user program, with the 40 and 50 series central units.

Comments on the historical values:

The maximum number of historical values allowed in a project is 1000 inside main program and 256 inside sub-program.

A list of the functions and their historical values is available in the annex.

The historical values of the timer functions are independent from the list of historical values of the other functions. The number of authorized timer functions is unlimited, however the number of simultaneous timer functions is limited to 42.

Programming

Type	Variables from to	Description
Binary inputs	I 00.00 I 61.15	CS 31 bus binary inputs
	I 62.00 I 62.07	binary inputs on the central unit I62.00 and I62.01 may be configured for counting I62.02 and I62.03 may be configured for input captures for the interruptions
	I 63.00 I 68.15	binary inputs on the central unit extensions
Analog inputs	IW 00.00 IW 61.15	CS 31 bus analog inputs
	IW 62.00	1 st potentiometer of the central units
	IW 62.01	2 nd potentiometer of the central units
	IW 62.02 IW 62.07	reserved variables
	IW 62.08	seconds (0...59)
	IW 62.09	minutes (0...59)
	IW 62.10	hours (0...23)
	IW 62.11	days of the week (1...7)
	IW 62.12	days of the month
	IW 62.13	months
	IW 62.14	years
	IW 62.15	Information word : bit 0: for class 2 error detection bit 1: used in the slave central units for CS 31 bus recognition bits 8 to 15: used on the master central units ; they indicate the number of remote units recognized on the CS 31 bus.
	IW 63.00 IW 68.15	analog inputs on the extensions of a central unit

Programming

Type	Variables		Description
	from	to	
Binary outputs	O 00.00	O 61.15	binary outputs on the CS 31 bus
	O 62.00	O 62.05	binary outputs on the central units
	O 63.00	O 68.15	binary outputs on the extensions of the central units.
Analog outputs	OW 00.00	OW 61.15	analog outputs on the CS 31 bus
	OW 62.00	OW 62.15	reserved variables
	OW 63.00	OW 68.15	analog outputs on the extensions of the central units.
Chain steps	S 000.00	S 125.15	chain steps
Internal bits	M 000.00	M 099.15	internal bits useable in the program
	M 230.00	M 254.15	internal bits useable in the program
	M 255.00		2 Hz oscillator variable
	M 255.01		1 Hz oscillator variable
	M 255.02		0.5 Hz oscillator variable
	M 255.03		0.01667 Hz oscillator variable (period = 1 minute)
	M 255.04	M 255.05	reserved variables
	M 255.06		Switch MODBUS® / active Mode for COM2
	M 255.07		Watchdog MODBUS® COM2
	M 255.08		Watchdog MODBUS® COM1
	M 255.09		Switch MODBUS® / active Mode for COM1
	M 255.10	M 255.14	diagnosis bits
	M 255.15		variable, always set to "0" on startup, which may be used for the detection of the first program cycle
Internal words	MW 000.00	MW 099.15	internal words useable in the program
	MW 230.00	MW 253.15	internal words useable in the program
	MW 254.00	MW 254.07	class 1 errors information
	MW 254.08	MW 254.15	class 2 errors information
	MW 255.00	MW 255.07	class 3 errors information
	MW 255.08	MW 255.15	class 4 errors information
Internal double words	MD 00.00	MD 07.15	double words useable in the program
Bit constants	K 00.00	K 00.01	indirect bit constants
Word constants	KW 00.00	KW 00.15	system word constants reserved for the configuration
	not accessible by AC31GRAF		
	KW 01.00	KW 31.15	indirect word constants
Double word constants	KD 00.00		system double word constant reserved for the cycle time
	not accessible by AC31GRAF		
	KD 00.01	KD 07.15	indirect double word constants
System internal historical values	Not accessible		historical values

Programming

3. Initialization

The old program on the PLC is automatically overwritten when a new program is sent. However, it is advisable to reconfigure the central unit with the factory parameters before sending a **new** program:

- ⇒ Stand-alone central unit
- ⇒ The default system configuration of the central unit (see following chapter).
- ⇒ No program.

A **complete** initialization of the central unit with the factory parameters is obtained by selecting the *"Control"* menu in the AC31GRAF *"Control panel"* window:

- ⇒ **Delete PROM**

followed immediately by:

- ⇒ **Cold restart of the PLC**

The other possible initializations are:

Initialization type	Definition
power on or software "RESET" or "Warm"	- Clear the program in RAM - Copy the Flash EEPROM contents to RAM - Clear the data in the RAM depending on the configuration
Central unit STOP / RUN button	- Copy the Flash EEPROM contents to RAM If there is no program in the Flash EEPROM, then the RAM remains unchanged. - Clear the RAM data depending on the configuration
Software <i>"Cold restart"</i>	- Clear the program and data in the RAM - Copy the Flash EEPROM contents to RAM

Programming

Description	Your choice	Central unit
Central unit reaction in case of error Class 3	Warning	Warning
Communication mode	MODBUS slave 1	MODBUS slave 1
RTS signal delay	Normal	Normal
Cycle time declaration	10	10

Figure 5-1 : List for the 40 series

Description	Your choice	Central unit
Central unit operative mode	Master	Stand alone
Binary flags initialisation	Slave 0	0
Word flags initialisation	Slave 1	0
Double words flags initialisation	Slave 2	0
Chain steps flags initialisation	Slave 3	0
Historical values initialisation	Initialisation	Initialisation
Central unit reaction in case of error Class 3	Warning	Warning
Ckecking of number of remote units on CS31 bus during initialisation	0	0
CS31 bus communication: transmitting area	Default	32 bits
CS31 bus communication : receiving area	Default	32 bits
Communication mode	MODBUS slave 1	MODBUS slave 1
RTS signal delay	Normal	Normal
Cycle time declaration	10	10

The central unit is the CS31 bus master (this parameter will be validated by a command RESET or COLD start).

Figure 5-2 : List for the 50 series

Programming

4. Configuration

Before sending the program to the PLC you should make sure that the central unit has been correctly configured for the application. There are two configuration tools:

- The configuration menu in the AC31GRAF programming software for configuring the central unit's usage parameters;
- The CS31CO function block to configure certain remote units through programming.

4.1. AC31GRAF configuration tool

⇒ A configuration tool is available in the AC31GRAF software by calling the "*PLC configuration tool*" window which enables the display, entry, loading, recovery and verification of all the configurable parameters of the central unit.

Only this configuration editor allows you to send or receive the configuration of the central unit.

⇒ Check that the central unit is correctly connected to the PC before calling the configuration tool.

A list of default parameters is proposed every time a new project is opened. This list varies according to the type of central unit chosen (see Figure 5-1 and Figure 5-2).

The configuration is done in the "*Your choice*" column.

On opening the configuration window the "*Your choice*" column proposes a default configuration.

⇒ A parameter can be modified by double-clicking the line to be modified in the "*Your choice*" column. You can modify the parameter from the keyboard or select it in the displayed list, depending on the parameter to be modified (see Figure 5-2 : the list of parameters for the "*Central unit operative mode*"), and then validate your choice.

The "*Central unit*" column displays the current configuration present in the central unit.

⇒ The differences between the "*Your choice*" and "*Central unit*" columns are indicated in red.

⇒ The configuration parameters are sent by clicking the "*Download parameters*" icon. The parameters are automatically saved to the Flash EEPROM of the central unit. It is necessary to initialize the central unit, so that it can start with the right configuration, if the "*Central unit operative mode*" parameter was modified.

Programming

Here is a complete description of the central unit's configurable parameters:

4.1.1. The central unit operative mode

As the 40 series central unit is used solely in stand-alone mode it does not have a CS 31 bus connection

The 50 series central units, on the other hand, have three operative modes:

- Master central unit
- Slave central unit
- or Stand-alone

A slave central unit has a bus address *n* between 0 and 61. The address is chosen by the user according to the application and configured in the "*Central unit operative mode*" by selecting **slave n**.

Comment:

⇒ Any configuration of the slave central unit is accompanied by the configuration of the transmission / reception range between the master and the slave.

Recognition of a slave central unit is signaled in bit 1 of the IW 62.15 variable. If the value of IW 62.15 is such that the bit 1 is set to 1 (xxxx xxxx xxxx xx1x), then the slave central unit was accepted by the CS 31 bus.

Important!

It is necessary to initialize the central unit, so that it can start with the right system configuration, after any configuration of the central unit operative mode.

Two phases are necessary for a change in the central unit operative mode:

- ⇒ Change and send the configuration. While sending, the backup in the Flash EEPROM of the central unit is carried out automatically.
- ⇒ Activation of the new central unit mode via a central unit cold or warm start.

The MODBUS[®] and programming protocols are also available via the CS31 connection (RS485) in the 50 Serie central units, (MODBUS[®] Master or Slave).

Programming

4.1.4. Initialization /Internal bits backup

Value n to choose	Internal bits backed up	Internal bits initialized
n = 0 (default value)	no backup	M 000.00...M 099.15 M 230.00 M 255.15
n = 1...99	M 000.00...M n-1.15	M n.00...M 099.15 M 230.00...M 255.15
n = 100...229	M 000.00...M 099.15	M 230.00...M 255.15
n = 230...254	M 000.00...M 099.15 M 230.00...M n-1.15	M n.00...M 255.15
n < 0, n > 254	M 000.00...M 099.15 M 230.00...M 254.15	M 255.00...M 255.15

Comments:

- ⇒ The bits M 255.00 to M 255.03 are oscillator variables which always start at 0.
- ⇒ The bits M 255.06 and M 255.09 are status of COM1 & COM2 (MODBUS[®] or active mode)
- ⇒ The bits M 255.07 and M 255.08 are Watchdog MODBUS[®] for COM1 & COM2
- ⇒ The bits M 255.10 to M 255.14 are reserved for the diagnosis.
- ⇒ The M 255.15 bit cannot be backed up and is always reset to 0 at the launch of any program. Consequently, it may be used to detect the first program cycle.

4.1.5. Initialization / Internal words backup

Value n to choose	Internal words backed up	Internal words initialized
n = 0 (default value)	no backup	MW 000.00...MW 099.15 MW 230.00...MW 239.15 MW 255.00...MW 255.15
n = 1...99	MW 000.00...MW n-1.15	MW n.00...MW 099.15 MW 230.00...MW 239.15 MW 255.00...MW 255.15
n = 100...229	MW 000.00...MW 099.15	MW 230.00...MW 239.15 MW 255.00...MW 255.15
n = 230...255	MW 000.00...MW 099.15 MW 230.00...MW n-1.15	MW n.00...MW 255.15
n < 0, n > 255	MW 000.00...MW 099.15 MW 230.00...MW 239.15 MW 255.00...MW 255.15	no initialization

Programming

4.1.6. Initialization / Internal double word backup

Value n to choose	Internal double words backed up	Internal double words initialized
n = 0 (default value)	no backup	MD 000.00...MD 007.15
n = 1...8	MD 000.00...MD n-1.15	MD n.00...MD 007.15
n < 0, n > 8	MD 000.00...MD 007.15	no initialization

4.1.7. Initialization / Chain step backups

Value n to choose	Chain steps backed up	Chain steps initialized
n = 0 (default value)	no backup	S 000.00...S 125.15
n = 1...125	S 000.00...S n-1.15	S n.00...S 125.15
n < 0, n > 125	S 000.00...S 125.15	no initialization

4.1.8. Initialization / Historical values backup

Value n to choose	Historical values backed up	Historical values initialized
n = 0 (default value)	no backup	initialization of all the historical values
n < 0, n > 0	backup of all the historical values	no initialization

A change in the data initialization parameters is take into account immediately.

Programming

4.1.9. Central unit reaction to class 3 errors

The AC 31 central units possess a diagnosis system aimed at ensuring a rapid and efficient localization of faults. This diagnosis system is divided into 4 error classes:

- Class 1: fatal error
- Class 2: serious error
- Class 3: light error
- Class 4: warning

In the case of a class 1 or 2 error, the program has aborted or has not launched. For a class 4 error, the program has not stopped.

In the case of a class 3 error, it is possible to abort or continue the program:

- ⇒ No stoppage if the "PLC reaction to class 3 errors" configuration parameter is set to "Warning" (configuration by default).
- ⇒ Automatic program stoppage by selecting "**Abort**".

A change of this parameter is taken into account immediately

4.1.10. Initialization of the CS 31 bus units

This parameter only acts on the 50 series central units if the central unit has been configured as a **master**.

The central unit interrogates the remote units, one after the other, thereby composing an image of the system configuration during initialization.

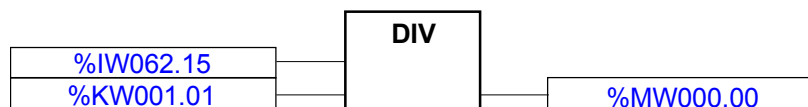
By default, the program launches independently of the initialization of the CS 31 bus remote units and without taking them into account in the bus cycle:

- ⇒ The "Initialization of the CS 31 system after power ON, warm start or cold start" configuration parameter = 0.

It is possible to configure the user program launch according to the initialization and taking into account the remote units in the CS 31 bus cycle:

- ⇒ If the "Initialization of the CS 31 system after power ON, warm start or cold start" configuration parameter = n ($1 \leq n \leq 31$), the user program will not launch before a minimum number of n remote units have not been initialized in the CS 31 bus cycle.

The number of units effectively recognized by the central unit is accessible in the bits 8 to 15 of the variable IW 062.15. The following example shows how to read this value in MW 000.00 (KW 001.01 = 256).



Any change to this parameter becomes effective as from the next initialization of the master central unit.

Programming

4.1.11. Communication mode of the COM1 serial interface

The serial port of the central unit may be used in different modes:

- ⇒ Programming mode to program and test the central unit
- ⇒ ASCII mode for communicating between the central unit and another ASCII device
- ⇒ MODBUS® for communicating between the central unit and another MODBUS® device.

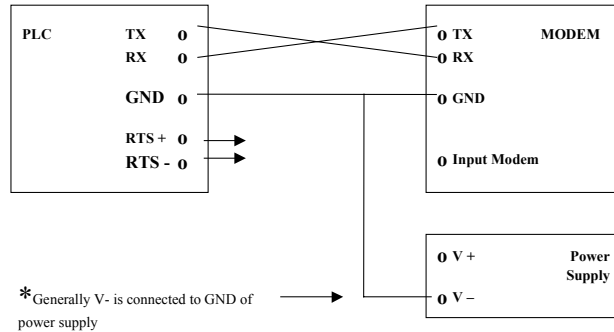
To use one of these communication modes you must:

- ⇒ Configure the serial interface by selecting one of the proposed parameters in the configuration window
- ⇒ Know the position of the RUN/STOP button
- ⇒ Use the right cable:
 - For programming : 07 SK 50 or 07 SK 52
 - For ASCII / MODBUS® : 07 SK 51 or 07 SK 53

Parameter selection	RUN/STOP position	Cable	Communication mode
Standard	STOP	x	programming
	RUN	programming	programming
		ASCII/MODBUS®	ASCII
Programming	x	x	programming
ASCII	RUN	x	ASCII
	STOP	x	programming
MODBUS®	x	ASCII/MODBUS®	MODBUS®
		programming	programming

x: choice with no effect

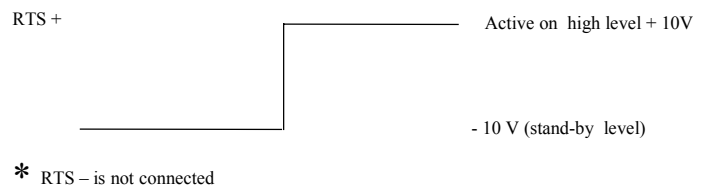
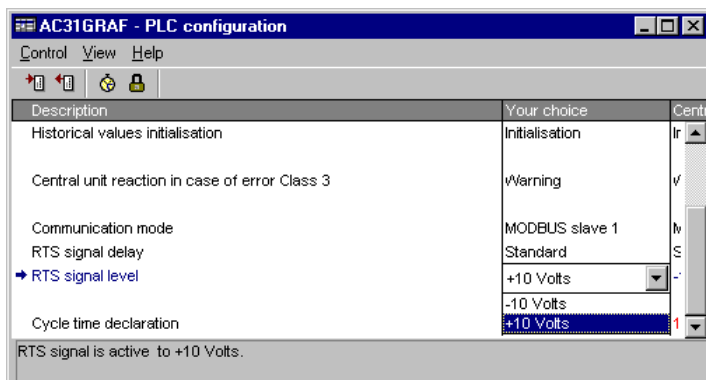
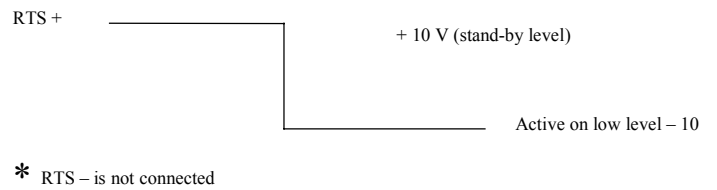
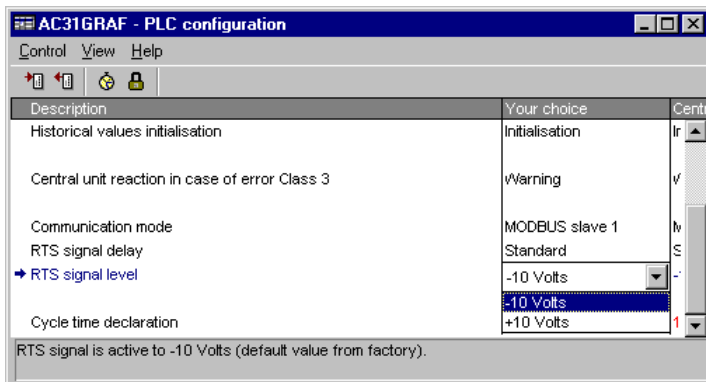
Programming



General cabling between PLC / Modem

RTS with 40 series:

you have the choice of the RTS signal level (-10 V or +10 V)



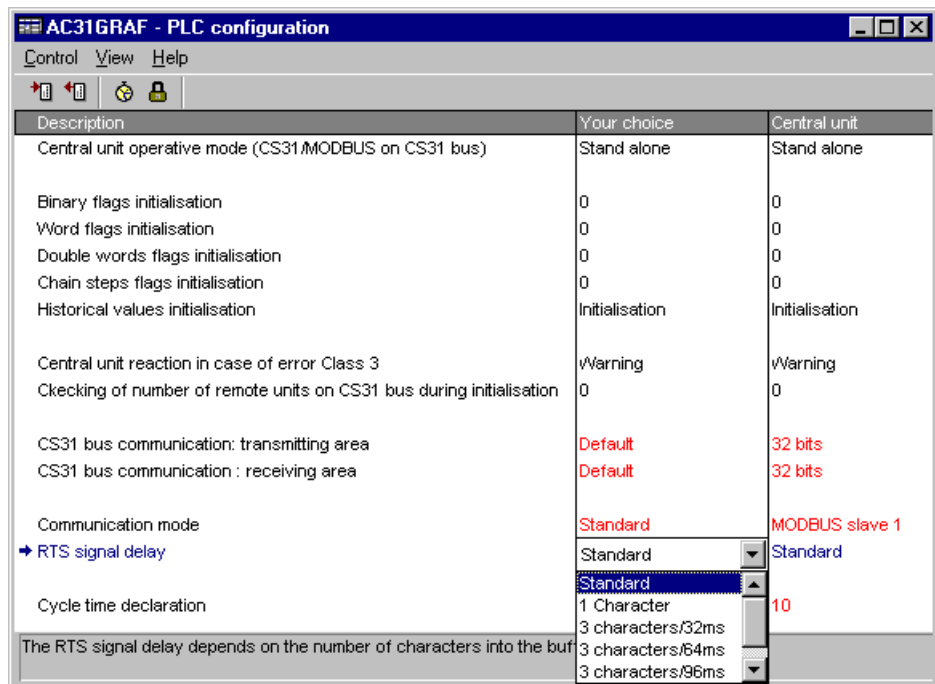
Programming

4.1.12. communication parameters:

They are defined as follows, according to the mode:

Mode	Default parameters	Modification of parameters
Programming	9 600 Bauds no parity 8 data bits 1 stop bit	parameters non modifiable
ASCII	no default parameters defined	parameters are defined by using the SINIT function in the user program
MODBUS®	9 600 Bauds no parity 8 data bits 1 stop bit	modification of parameters by using the SINIT function in the user program

It is possible to choose the delay time of the RTS signal whichever communication mode is chosen, select this delay from the list of the "RTS signal delay": line. The default parameter is "normal", in this case the RTS signal delay depends on the number of characters in the buffer.



Mode	Delay time	System constant KW 00.06
Programming or ASCII	3 characters	KW 00.06 > 1000
MODBUS®	1 character	1101 < KW 00.06 < 1355
	32 ms	2101 < KW 00.06 < 2355
	64 ms	3101 < KW 00.06 < 3355
	96 ms	4101 < KW 00.06 < 4355
	128 ms	5101 < KW 00.06 < 5355

Programming

RTS with 50 series: (First case)

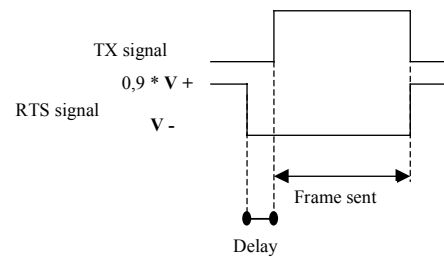
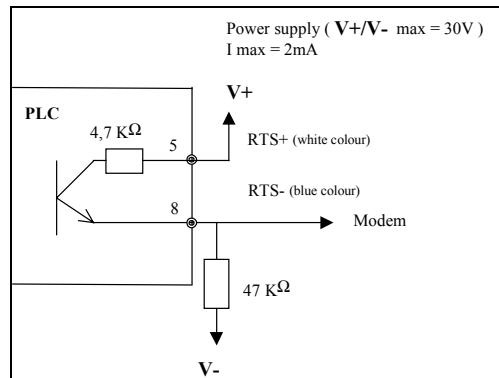
Warning: Available on version inferior with:

Designation of products	Index of version
07 KR 51 - 24VDC	Q22 and Q30
07 KR 51 - 120/230 VAC	Q22 and Q30
07 KT 51 - 24VDC	P22 and P30

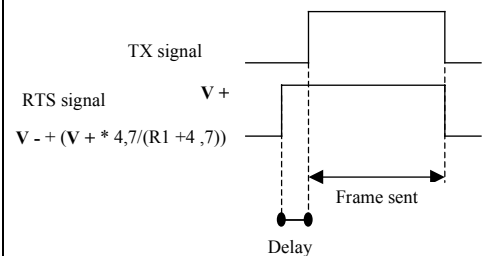
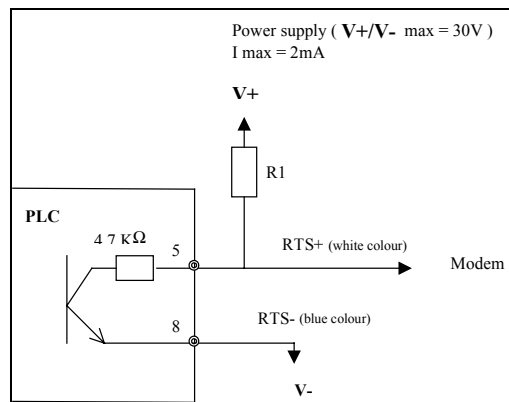
How to verify which version do you have ?

You can find this information on the label, on the left side of the 50 series central unit.

1) Active on high level:



2) Active on low level:



Programming

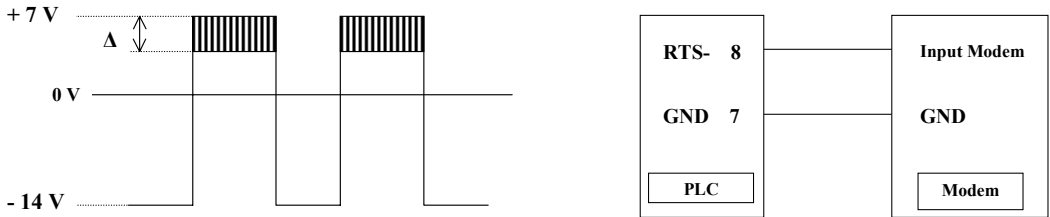
RTS with 50 series: (Second case)

Warning: Available starting from version:

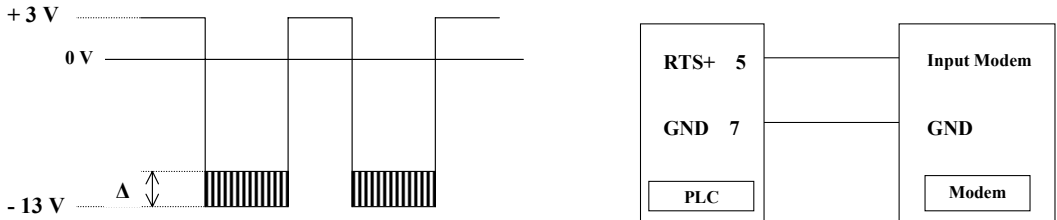
Designation of products	Index of version
07 KR 51 - 24VDC	Q22 and Q30
07 KR 51 - 120/230 VAC	Q22 and Q30
07 KT 51 - 24VDC	P22 and P30

How to verify which version do you have ?
 You can find this information on the label, on the left side of the 50 series central unit.

1) Active on high level:



2) Active on low level:



Programming

4.1.13. The central unit cycle time

The central unit program executes in cycles for the duration which is defined in the "*Cycle time declaration*" system parameter. The value is expressed in milliseconds.

- For a master central unit : the cycle is between 0 and 100 ms where only multiples of 5 ms are authorized.
- For a slave or stand-alone central unit : the cycle time is between 0 and 250 ms.

When the 0 value is selected the cycle time is the minimum time which the central unit requires for each cycle. In this case the cycle time is not constant.

Calculation of a cycle time:

The cycle time T_c can be calculated by the user by using the following equation:

$$T_c \geq T_b + T_p$$

where T_b = the CS 31 bus transmission time

and T_p = the program execution time.

The program execution time corresponds to the addition of all the times of the functions present in the user program (see the list of times in the annex).

In general, the program execution time for 1 000 bytes is:

- ⇒ 0.4 ms for 100% of binary instructions
- ⇒ 1.2 ms for 65% of binary instructions and 35% of word instructions.

The bus transmission time is calculated from the installation configuration. It requires adding together the times of all the units on the bus. The total time for the extensible remote units is given by adding the unit time and the times of the connected extensions.

Programming

4.1.14. CS31 bus communication times

CS 31 bus communication times	
Basic time of the master central unit	2000 µs
Slave central units without extensions	
07 KR 51*	750 µs
07 KT 51*	750 µs
07 KR 91*	750 µs
07 KT 92*	750 µs
07 KT 93*	750 µs
<small>* with default configuration</small>	
Times according to configuration:	
2 bytes on transmission and 2 bytes at reception	516 µs
4 bytes on transmission and 4 bytes at reception	750 µs
8 bytes on transmission and 8 bytes at reception	1 300 µs
12 bytes on transmission and 12 bytes at reception	1 850 µs
8 words on transmission and 8 words at reception	2 500 µs
Remote binary input units	
ICSI 08 D1	323 µs
ICSI 08 E1	323 µs
ICSI 08 E3 / E4	323 µs
ICSI 16 D1	387 µs
ICSI 16 E1	387 µs
Remote output units	
ICSO 08 R1	260 µs
ICSO 08 Y1	260 µs
ICSO 16 N1	340 µs
Remote Input / Output units	
ICSC 08 L1	387 µs
ICFC 16 L1	516 µs
ICSK 20 F1	452 µs
ICSK 20 N1	452 µs
07 DC 92	516 to 590 µs depending on configuration
Remote extensible Input / Output units	
ICMK 14 F1	340 µs without extension
ICMK 14 N1	340 µs without extension

Programming

CS 31 bus communication times			
Extension Input / Output units	On master central unit	On extensible remote units	On slave central units
XI 16 E1	1000 µs	1000 µs	2500 µs
XO 08 R1	1000 µs	1000 µs	2500 µs
XC 08 L1	1000 µs	1000 µs	2500 µs
XO 16 N1	1000 µs	1000 µs	2500 µs
XK 08 F1	1000 µs	1000 µs	2500 µs
XO 08 Y1	1000 µs	1000 µs	2500 µs
XO 08 R2	1000 µs	1000 µs	2500 µs
XM 06 B5	1000 µs	1000 µs	2500 µs
XE 08 B5	1000 µs	1000 µs	2500 µs
XTC 08	1000 µs	1000 µs	2500 µs
IP67 binary Input / Output units			
07 DI 93-I	387 µs		
07 DO 93-I	260 µs		
07 DK 93-I	340 µs		
Remote analog units			
ICSM 06 A6	1 162 µs		
ICSE 08 A6	1 355 µs		
ICSE 08 B5	1 355 µs		
ICST 08 A7	1 355 µs		
ICST 08 A8	1 355 µs		
ICST 08 A9	1 355 µs		
07 AI 91	1 355 µs		
ICSA 04 B5	700 µs		
High speed counter			
ICSF 08 D1	1 300 µs		

Programming

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Programming

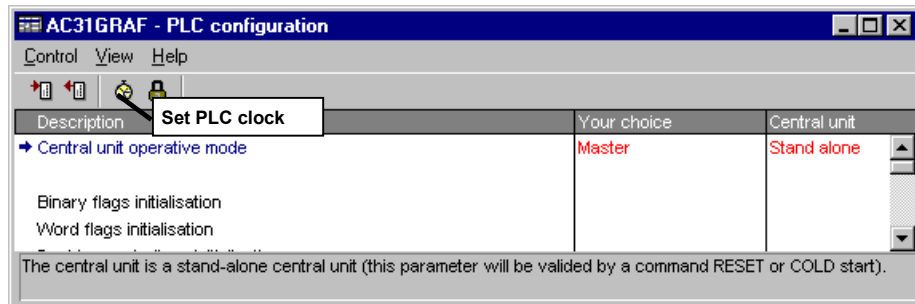


Figure 5-3 : Clock setup

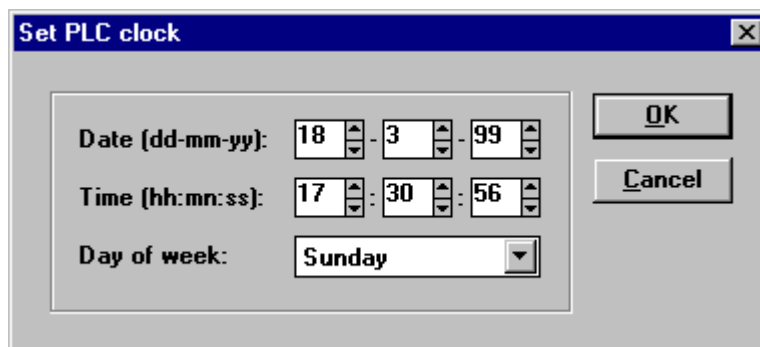


Figure 5-4 : Update of the clock

Programming

4.1.15. Clock

A clock is available on the 40 and 50 series central units (see Figure 5-3).

The clock parameters are accessible:

⇒ Either in the following variables:

IW 62.08	seconds (0...59)
IW 62.09	minutes (0...59)
IW 62.10	hours (0...23)
IW 62.11	days of the week (1...7) Monday = 1
IW 62.12	days of the month (1...depending on the month)
IW 62.13	months (1...12)
IW 62.14	years (00...99)

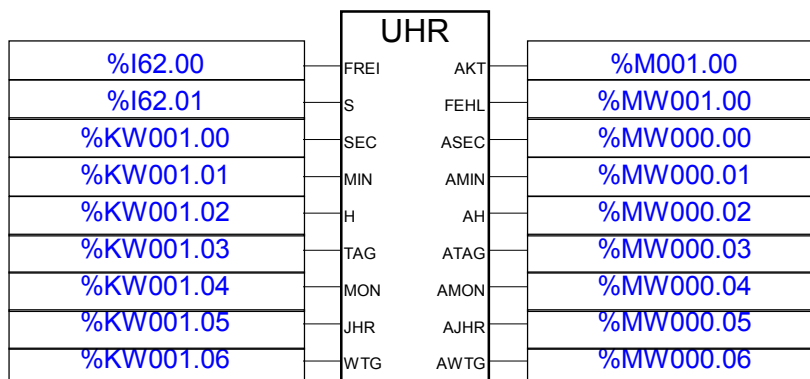
⇒ Or by using the UHR function

Updating the clock

The clock update can be effectuated in two ways:

- ⇒ Through the AC31GRAF software in the configuration window, by clicking on the "Set PLC clock" icon (see Figure 5-4).
- ⇒ Through programming using the UHR function.

Here is an example using the UHR function:



Programming

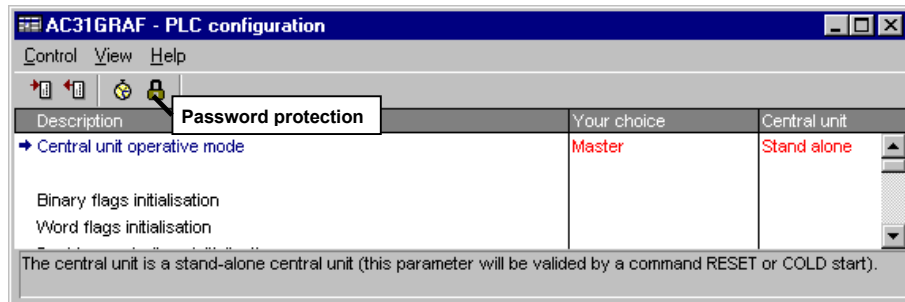


Figure 5-5 : Write access denied



Figure 5-6 : Password composed of 4 values



Figure 5-7 : Re-enter the password to unlock

Programming

The clock update is carried out with each validation of the I 62.01 input, and as long as that input is active. The information in the KW001.00 to KW001.07 inputs are then copied to the clock .

A parameter error is signaled in the output variable M001.00 and the exact error description in MW001.00.

The current values of the central unit clock are accessible in MW 000.00 to MW 000.06. These are the same values that are in IW 62.08 to IW 62.14.

The UHR block will only execute if the I 62.00 input is active.

Passage to the year 2000

The passage into the year 2000 will not generate a system stoppage at any time. The clock ensures a continued passage without ambiguity between the years 1999 and 2000.

The clock parameters will change from:

- Year 99, month 12, 23 h 59 min 59 s
- to year 00, month 01, 00 h 00 min 00 s.

The years 2000, 2004, 2008 and so on are recognized as leap years.

4.1.16. Password

A password can be defined to deny central unit write access to unauthorized persons.

The password is given by the AC31GRAF software in the configuration window by clicking on the "*Password protection*" icon (see Figure 5-5). The password is composed of 4 hexadecimal values (from 0 to F) (see Figure 5-6). It is invalidated by clicking on the "*Password protection*" again and re-entering the password (see Figure 5-7).

4.2. CS31CO configuration function block

The CS31CO function block enables the configuration of certain remote units and obtains their current configuration.

The description of each unit indicates whether a remote unit or extension requires configuration with the CS31CO block.

The possible configurations, depending on the units, are:

- Configuration for detecting a cut wires on an input or binary output
- Configuration, for configurable Input / Output units, of a channel as an input or output
- Configuration of analog Inputs / Outputs as current or voltage (**30 and 90 series**)
- Configuration of the filtering time of a binary input.

A detailed description of the function block is available in the AC31GRAF software help as well as in the documentation.

Programming

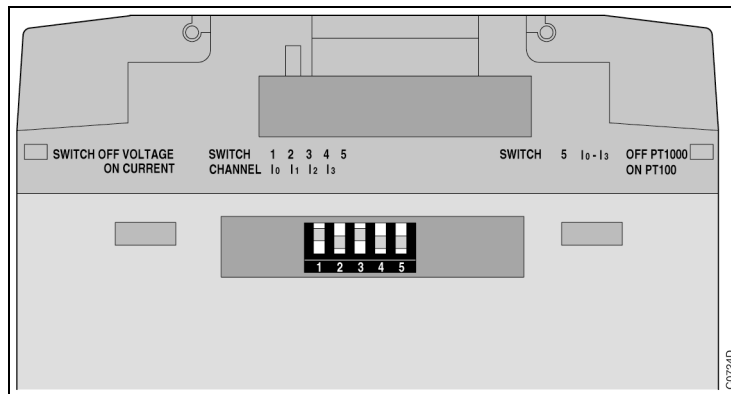


Figure 5-8 : Dip switches configuration on XM 06 B5

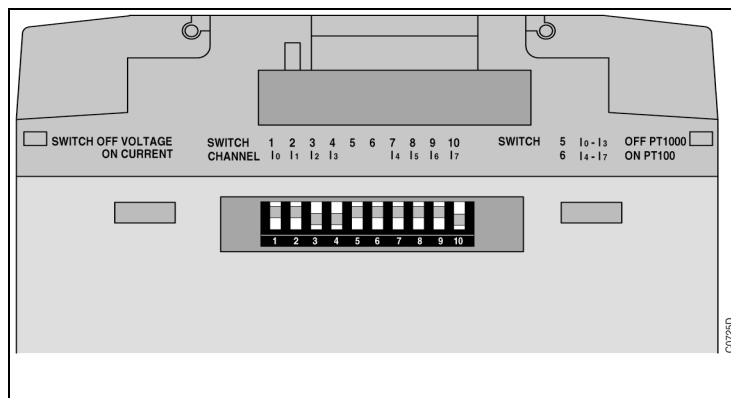


Figure 5-9 : Dip switches configuration on XE 08 B5

Programming

4.3. Analog configuration (extension)

The channel type and the display value can be configured.

The channel type has to be chosen between voltage (-/+ 10 V), current (0-20mA or 4-20mA) or temperature measurement (Pt100 or Pt1000 2, 3 or 4 wires, NI1000, Balco500). This configuration is selected channel by channel with the position of a dip switch, the push button on the front plate or by the user program.

The display value can also be configured. The scale and the position of the dot can be modified. Therefore, it is possible to display a process data, i.e. Pressure, speed, etc.

It is also possible to change the filtering : the choice is 50hz, 60Hz, integration or standard

4.3.1. Hardware configuration

Dip switches on the left side of the extension have to be set on the right position.
(see Figure 5-8 and Figure 5-9)

Dip switch N°1 for input 0	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°2 for input 1	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°3 for input 2	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°4 for input 3	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°5	OFF	current source is set to 0.25mA for Pt1000/NI1000/Balco500
	ON	current source is set to 2.5mA for Pt100 (Used for channels 0 to 3)

Warning: The XM06B5 product can be delivered with a dip switch component with 6 dip switches, in this case, the dip switch N°6 will be without functionality.

In case of 8 analog inputs extension

Dip switch N°7 for input 4	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°8 for input 5	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°9 for input 6	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°10 for input 7	OFF	voltage or Pt100/Pt1000
	ON	current
Dip switch N°6	OFF	current source is set to 0.25mA for Pt1000/NI1000/Balco500
	ON	current source is set to 2.5mA for Pt100 (Used for channels 4 to 7)

Programming

- Push button description

The push button is used to choose the channel to display the value.

The value is always displayed according to the selected format.

Channel numbers are scrolled every time the push button is pressed.

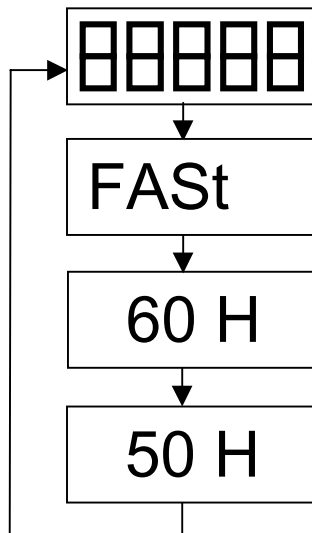
The 2 analog outputs have the number 4 and 5

The display is tested (all segments ON) after each revolution without 50 or 60 hz filtering.

The filtering type and fast refresh time can be selected when the push button is pressed for 5 seconds when the segments test

This choice of 50, 60 hz or Fast mode is selected for all channels of module. When you chose a filtering configuration you increase the acquisition time (5 seconds) of all channels.

With the mode Fast, the refresh time is 50 ms instead of 120ms, but the value is less stable that means the value is moving a little bit (1LSB).



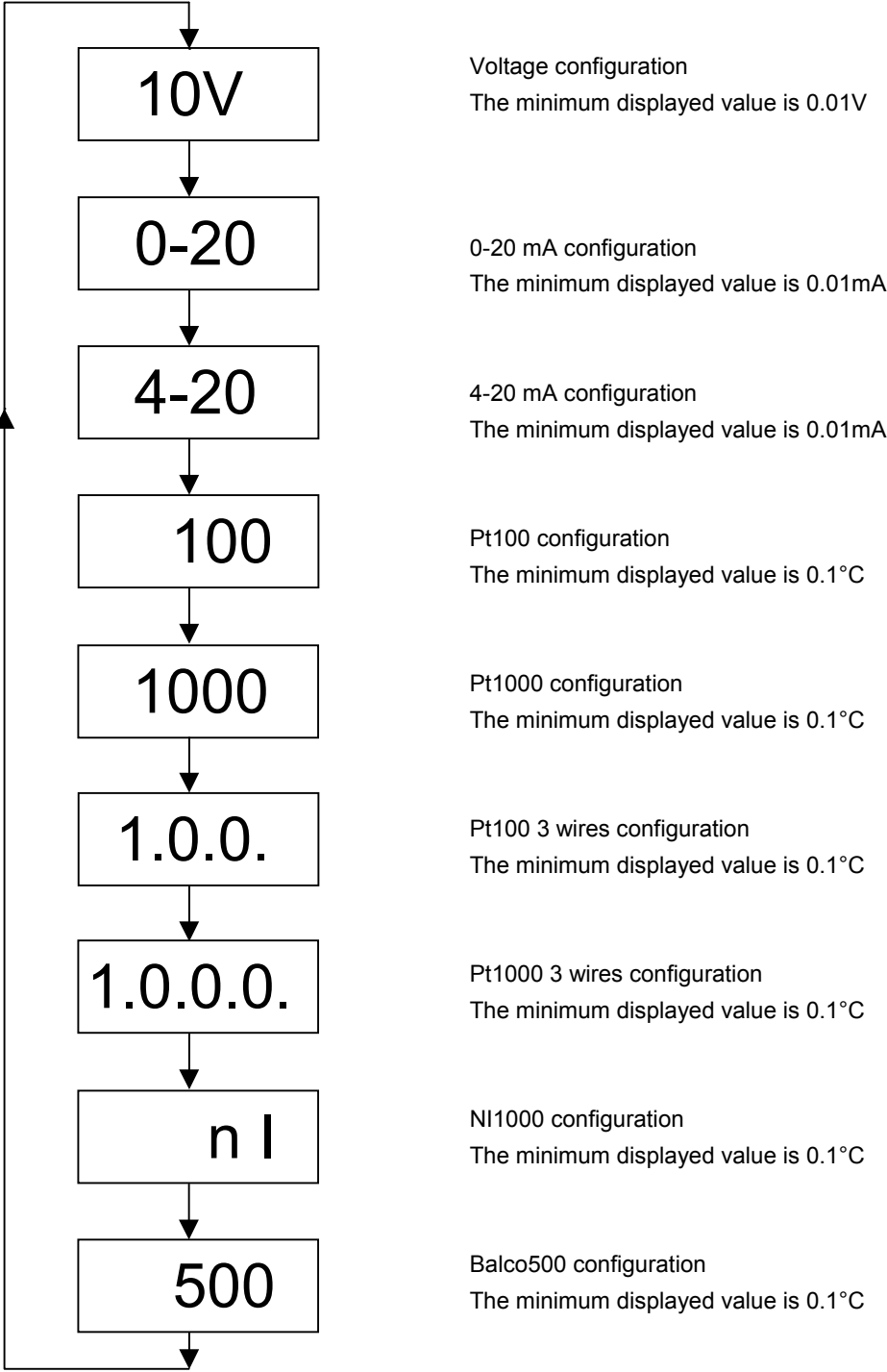
When the choice is selected , release the push button for 5 seconds and the new filtering is stored in the EEPROM

Programming

- Standard display format

The channel type can also be set with the pushbutton.

The configuration mode is set when the push button is pressed for 10 seconds.
 The display starts to blink and the current format is displayed (the factory setting is +/-10V)



Programming

When the push button is not pressed during 10 seconds, the configuration mode is closed and the display value mode is again active

The configuration is stored in an internal EEPROM and it is saved in case of power fail. This configuration can also be set by the user program.

● Configuration by the user program

It is possible to configure the type of each channel by the user program with the function blocks CONFIO1, CONFIO4 or CONFIO8. If the analog extension is removed, then its configuration can be load again to the new one.

The type of the channel is written in the TYPE parameter:

TYPE =	0	+/- 10V configuration
	1	0-20 mA configuration
	2	4-20 mA configuration
	3	Pt100 configuration
	4	Pt1000 configuration
	5	Pt100 3 wires configuration
	6	Pt1000 3 wires configuration
	8	NI1000 configuration
	9	Balco500 configuration
	14	the configuration is unlocked (all channels)
	15	the configuration is locked (all channels)

It is also possible to lock the configuration. The lock function means that the configuration can not be modified with the push button. The locked function is never stored and has to be sent every time that the extension is supplied.

The display value is calculated according to the formula:

$$\text{DISPLAY} = (\text{ANALOG value} * \text{MULT}) / 32767 + \text{OFFS}$$

The position of the dot can also be set. (0...3)

If the parameter MULT = 0 the parameters OFFS and DOT are not used, in this case, the scale is set to the factory setting scale.

For example:

ANALOG value is 8000 (2V in voltage configuration)

MULT =100

OFFS= 25

DOT=1

$$\text{DISPLAY} = (8000 * 100) / 32767 + 25 = 49$$

The display value is **4.9**

The latest configured channel on one extension is always the channel number displayed. It is possible to select a channel number to the display from the user program.

Programming

Filtering time

0 : internal filter according to the documentation of analog extension

1-127 : integration number

160 : Fast refresh time (50ms instead of 120 ms in standard)

192 : 60Hz Filter

224 : 50Hz Filter

All channels of one extension will be affected by this parameter.

The time filter formula is

$K = \text{FILTO}$

$V_n = \text{result (T)}$

$V_{n-1} = \text{result (T-1)}$

$V_{ins} = \text{analog value without filtering}$

$V_n = \Sigma_n / K$

With $\Sigma_n = (V_{ins} - V_{n-1}) + \Sigma_{n-1}$

Initial value is : $V_1 = V_{ins}$

$$\Sigma_1 = K V_1$$

WARNING: The second extension XM06B5 connected to a remote unit can not be configured by the user program.

Only one analog extension can be configured on a remote unit.

Programming

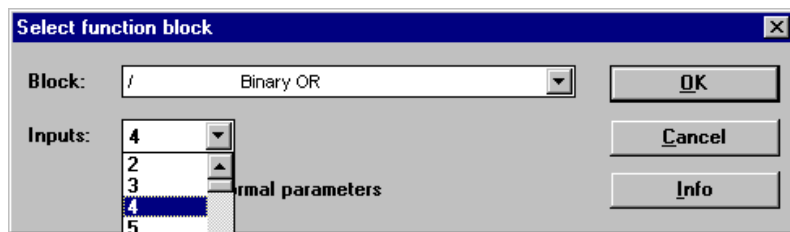


Figure 5-10 : Duplicating inputs of a function block

Programming

5. Programming examples

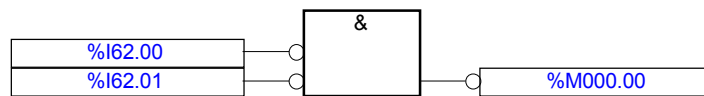
Here are some programming examples to help you familiarize yourself with simple automation functions.

5.1. Practical advice

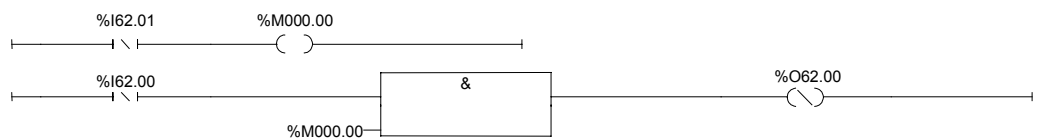
● For complementing

⇒ To complement a variable or the result of a Boolean function just double-click on the right extremity of the linking line between a variable and a block.

In this example, the *I62.00* and *I62.01* variables are complemented as well as the result of the Boolean function.



⇒ In order to effectuate the complement of a variable in Quick LD, just select the contact or output and press the space bar. Each time you press the space bar the property of the contact or output is modified.



● Duplicating

⇒ The duplication of inputs is carried out by modifying the block property with a double-click and selecting the number of inputs from the scrolling *"Number of inputs"* menu (see Figure 5-10).

The duplication number varies depending on the block used.

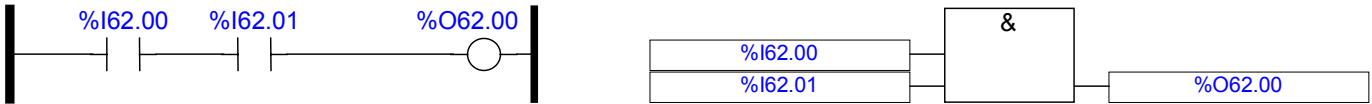
Programming

5.2. Operation AND

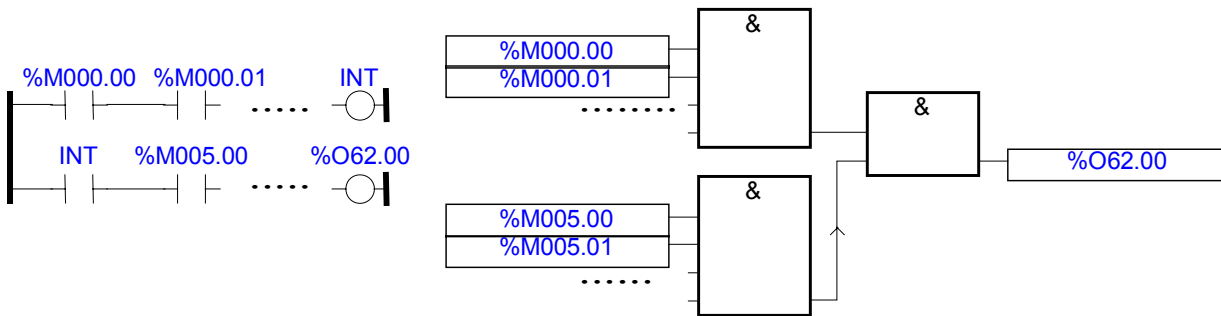
The output status of an AND diagram is 1 if all the inputs are at 1

The figure to the left represents a ladder diagram AND operation. The number of contacts, which may be placed in series, is limited by the size of the editor.

The figure to the right represents the same function with a function block. The maximum number of inputs on the AND function block is 128.



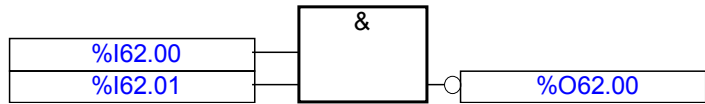
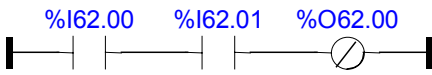
If the number of inputs to an AND is greater than the editor limit an internal variable can be used as a relay or a second AND function can be used.



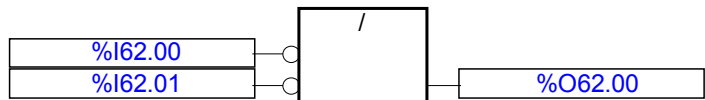
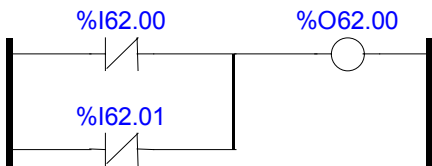
Programming

5.3. NAND operation

The output has a 0 status if all the inputs have a 1 status.



A NAND diagram has the same function as an OR diagram with the inputs inverted.

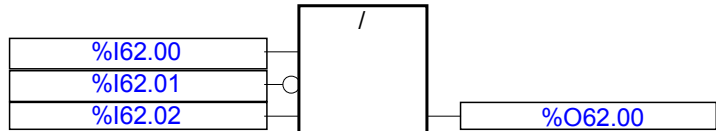
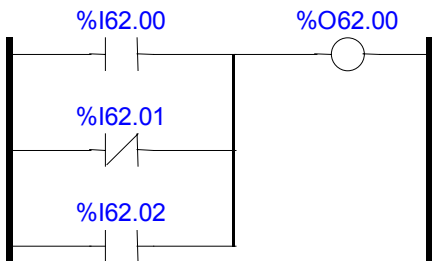


5.4. OR operation

The status of an OR diagram output is 1, if at least one of the inputs has a status of 1.

The figure to the left represents a ladder diagram OR operation with three inputs. The number of contacts, which may be placed in parallel, is unlimited.

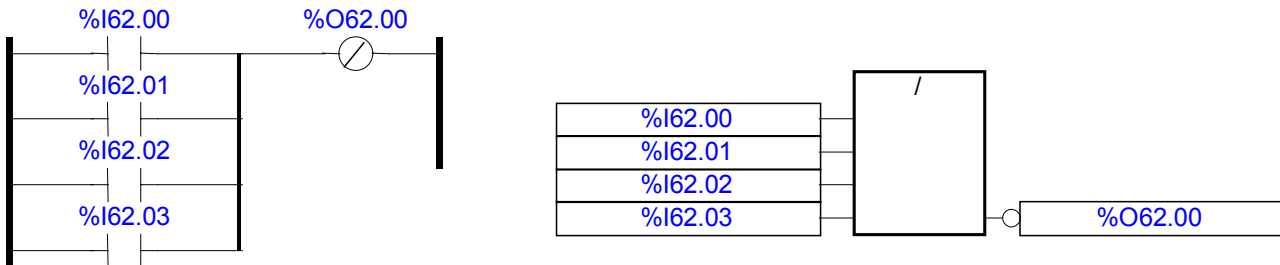
The diagram to the right represents the same function with a function block. The number of inputs for an OR function block is limited to a maximum of 128.



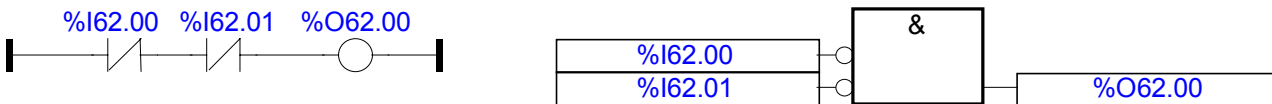
Programming

5.5. NOR operation

The NOR diagram has a status of 0 if one of the inputs has a status of 1.



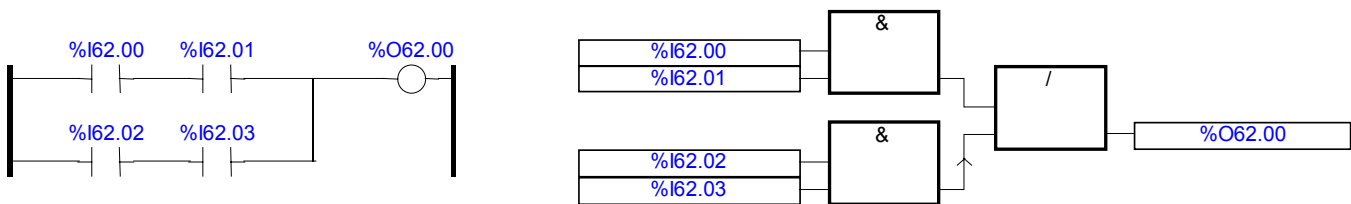
A NOR diagram has the same function as an AND diagram with complemented inputs.



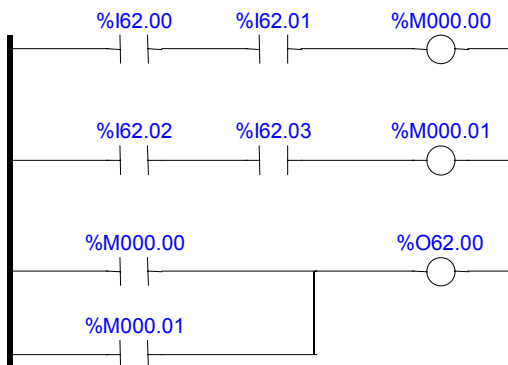
5.6. Combinations of Boolean functions

The following example describes the association between Boolean functions.

It is not necessary to pass via intermediate variables as shown in the figure below.



If the intermediate result is required further on in the program, the result of each base function is placed in the intermediate variables as shown following:



Programming

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Programming

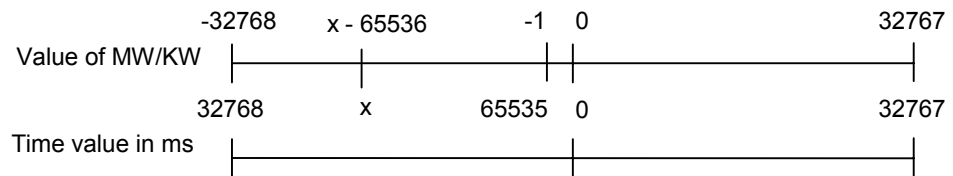
5.7. Timer functions

Each of the following described functions is time dependent.

The temporal value is placed in an indirect constant *KD* or in a double word variable *MD*. In the case of word arithmetic calculations or MODBUS[®] protocol communication, it is possible to use, for timer functions described below, the words *KW* or *MW* instead of double words. In this case, you should not use the word with the address *KW+1* or *MW+1* in the program.

The temporal values may vary from 1 ms to 596 hours and 30 minutes for a double word and from 1 to 65 535 ms for a word type variable. The chosen values on the master central unit should be multiples of 5 ms.

To achieve the 65 535 ms value with a word type variable you have to enter the value -1 as shown in the graph below. By analogy, you have to enter the value (x-65536) for the time values (x) between 32 768 and 65 535.



The time unit used for the entry is in milliseconds.

The number of timers in a program is unlimited but there may not be more than 42 timers running at the same time on the central unit.

When switching from RUN mode to STOP mode the time values of incomplete timers are not saved. The timers are therefore reset to zero at the next passage to RUN mode.

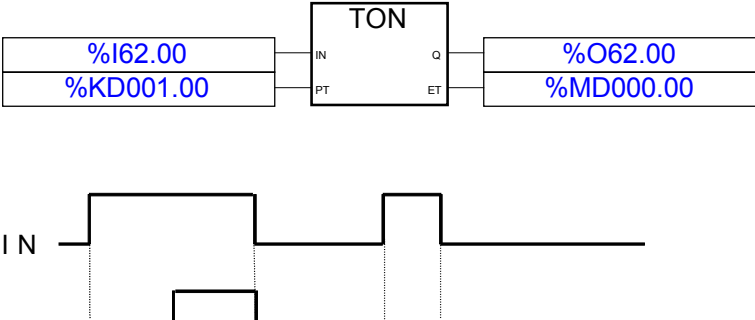
Two cases present themselves if a timer value is modified while the timer is running:

- If the time of the new value has already been exceeded the timer stops and the new time value is not taken into account until the next time the timer is activated.
- If the time of the new value has not yet been exceeded then the time already passed is taken into account and the timer stops when it has attained the new value.

Programming

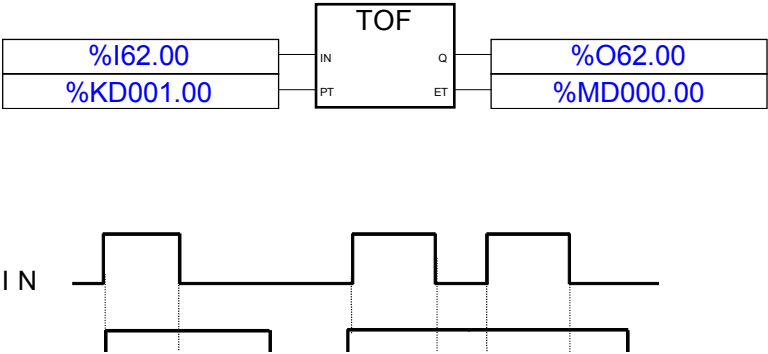
5.7.1. TON: on delay

The TON function delays the IN command signal passing to 1.
The TON block adheres to the IEC1131-3 standard. The AND output allows you to see the time passed.



5.7.2. TOF: off delay

The TOF function enables delaying the command IN passage to 0.
The TOF block adheres to the IEC1131-3 standard. The AND output allows you to see the time passed.



Programming

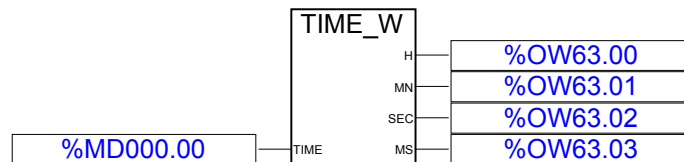
5.7.3. TP: monostable (constant)

This block enables the activation of an output during a fixed time as from the moment when a rising edge appears on the input. A new rising edge will not be taken into account if it appears on the input before the timer time has been completed.



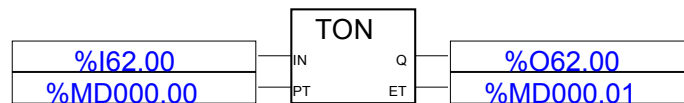
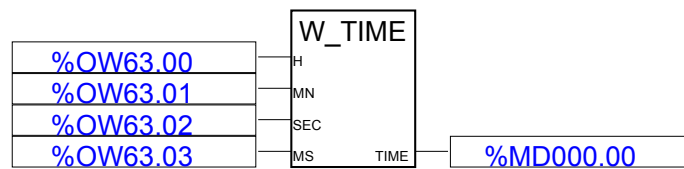
5.7.4. TIME_W:

The function TIME_W can be used to display elapse time on the display extension XTC 08



5.7.5. W_TIME:

The function W_TIME is needed when the time value has to be modified during program (i.e. Control panel, supervisor, set point validation...)



Programming

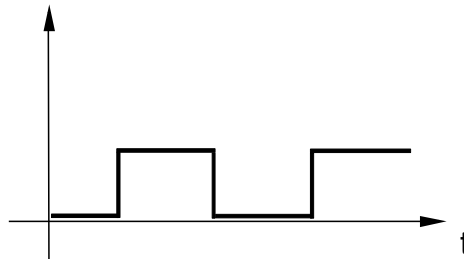
5.7.6. Oscillators

There are four oscillator variables on the 40 and 50 series central units, which supply a fixed frequency signal of a ½ cyclic ratio:

- M 255.00: frequency 2 Hz (period 500 ms.)
- M 255.01: frequency 1 Hz (period 1 s.)
- M 255.02: frequency 0.5 Hz (period 2 s.)
- M 255.03: frequency $16.67 \cdot 10^{-3}$ Hz (period 1 min.)

Each oscillator starts at a low level on startup.

The oscillators can be used , for example, to flash a lamp or to provide a rhythm.



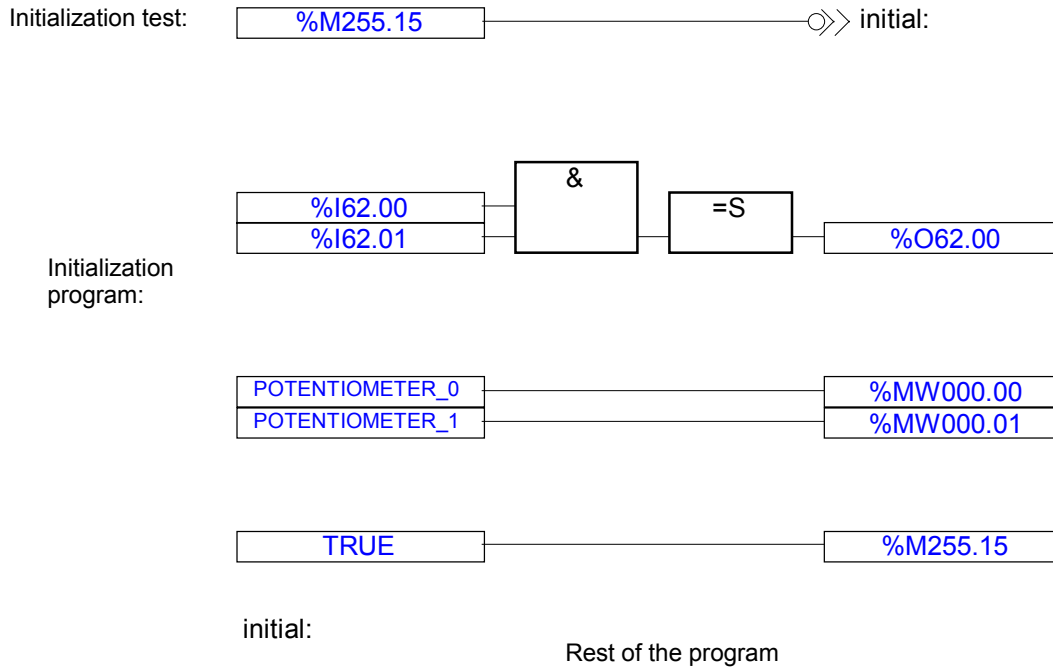
Programming

5.8. Detecting the first cycle with the M 255.15 variable

The bit M 255.15 should be used when the detection of the first cycle is required, for example, to initialize certain parameters or set certain values to zero.

The description of how to use this bit is given in the following example.

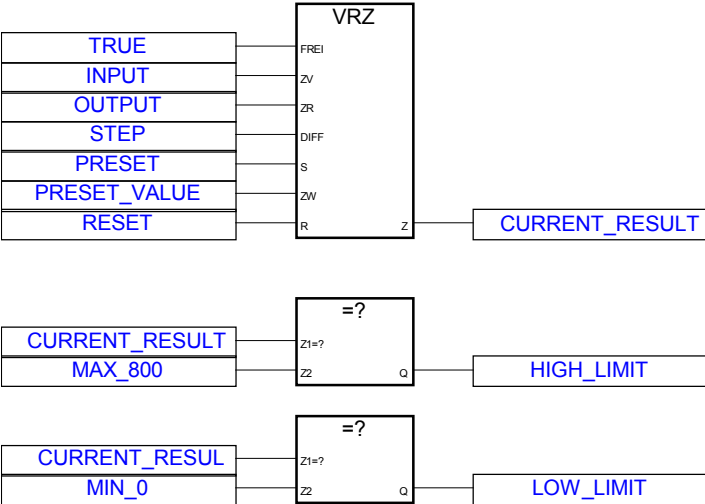
The bit M 225.15 should be set to 1 before the end of the first cycle. This bit has the particularity of being set to zero systematically, whatever the backup configuration, at the central unit startup.



Programming

5.9. Up/Down counter function

The following example shows how to set up the Up/Down counter block VRZ. The result of the VRZ block may vary from -32768 to 32767. In this example, the outputs LOW_LIMIT or HIGH_LIMIT are respectively at 1, when the counter arrives at the value 0 or 800.



Programming

5.10. Scaling an analog value

5.10.1. Using the potentiometers of the 40 and 50 series

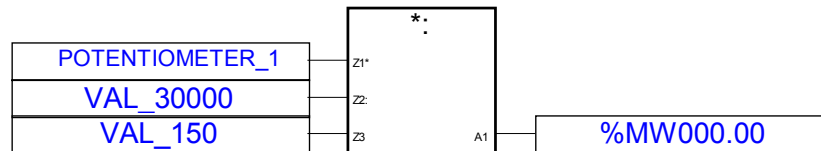
The 40 and 50 series central units each have two potentiometers, which allow the adjustment of parameters without a programming tool.

⇒ The MULDI function block may be used for scaling.

The desired setting range in this example is from 0 to 30 000:

Setting range	Value read in the central unit
30000	150
y	x
0	0

The value y set is such that: $y = (30\ 000 * x) / 150$. The result y is placed in the variable MW 000.00.



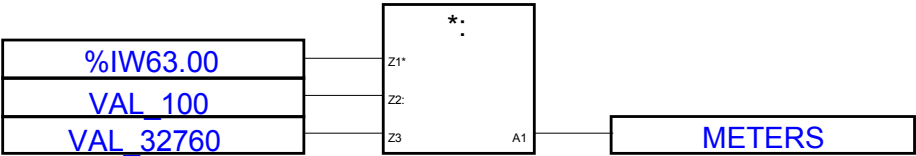
Programming

5.10.2. Processing an analog input

The following example shows how to process the measurement of a distance sensor.

Measured physical value	Voltage +10/-10V	Power +20/-20mA	Power 4-20mA	Value read in the central unit
100 m	10	20	20	32760
y m				x
0 m	0	0	4	0
	-10	-20		-32760

The value read in the central unit should be scaled in order to be expressed in meters so that the information may be sent, for example, to a display. In this case the measured value y is such that: $y = (100 * x) / 32760$



It is not necessary to scale values to carry out comparison tests (equal, greater, lesser...). The compared values can be those read in the central unit.

Chapter 6

Program optimization

Program Optimization

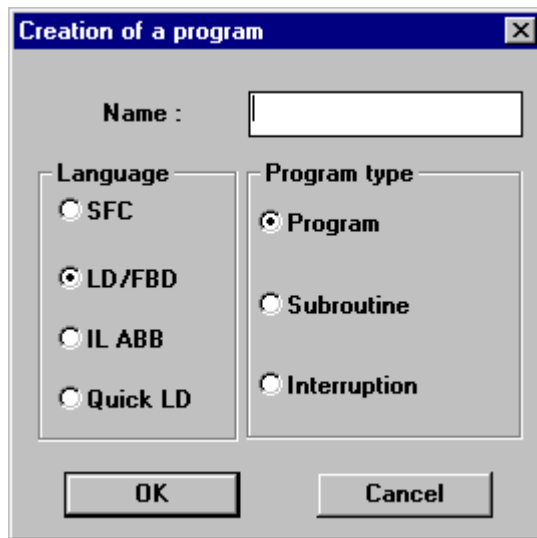


Figure 6-1 : Creation of a sub-program

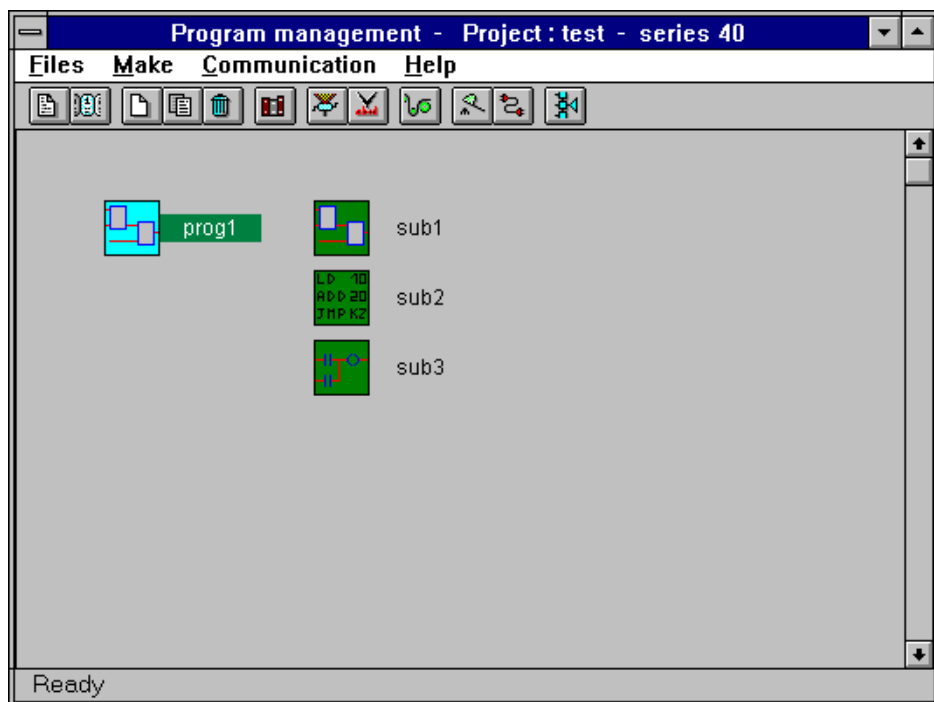


Figure 6-2 : A sub-programs example

Program Optimization

This chapter is aimed at describing the supplementary characteristics of the CS 31 bus, which improve the performances of your application. These, easy to set up, functions allow you to easily reduce the cycle time, the program size and simplify motor control and event counting.

1. Sub-program

Using sub-programs, when programming enables the reduction of central unit time cycles. The central unit only executes the necessary sub-programs depending on the operative conditions or process.

Sub-programs also allow you to easily treat repetitive tasks. These tasks are only detailed once and may be called numerous times within the program.

The total size of the program can be , therefore, considerably reduced.

1.1. Programming sub-programs

Sub-programs are defined in the AC31GRAF software using the *"Modularize"* option in the *"New"* menu, followed by *"Create a new program"* (see Figure 6-1).

The programming language used is either Quick Ladder, or FBD/LD or IL (Instruction List).

A sub-program is defined by name (see Figure 6-2).

All of the functions or instructions may be used in a sub-program.

Program Optimization

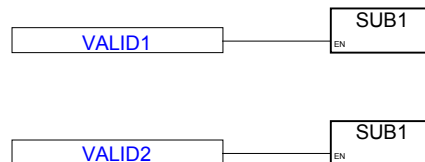
1.2. Calling a sub-program

Once a sub-program is defined, its name is automatically inserted into the list of function blocks as a function block.

A sub-program is called by using the function block in the main program.

For example: calling the SUB1 program:

The SUB1 is called twice by 2 different conditions.



The Instruction List syntax is detailed in the AC31GRAF software documentation.

All of the functions used in the sub-programs have their own values belonging to the sub-program call. For example, calling a sub-program, which contains a counter, is written twice, the counter will have 2 different values.

The only exception concerns all of the time based functions such as TON, TOF, ... where their status is unique, independently of the number of times the sub-program is called within the program.

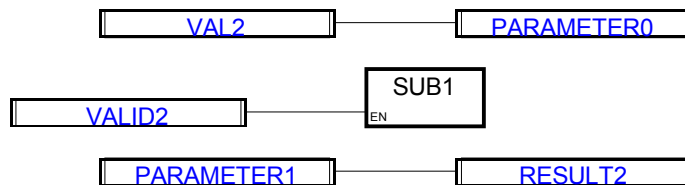
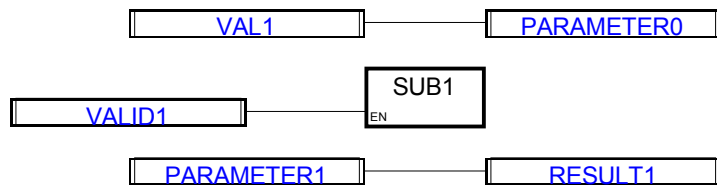
Program Optimization

1.3. Passing parameters

The following syntax is used when parameters are to be exchanged between a sub-program and a program:

- Values -> parameters
- The sub-program call
- Parameters -> result

In the example below:



VAL1 and VAL2 should be transmitted to the SUB1 sub-program and the results RESULT1 and RESULT2 received. VAL1 and VAL2 are transferred to the variable PARAMETER0 for processing in the sub-program. The result of this process, PARAMETER1, is transferred to the variables RESULT1 and RESULT2 for use later in the program.

1.4. Limits

A sub-program may not be called from a sub-program.

The total number of historical values in a sub-program is limited to 128. The timer functions are not included in this limit.

The total is obtained by multiplying the number of historical values in the sub-programs by the number of calls.

Should this number be exceeded a class 4 code 145 error will appear and the central unit will not be able to pass to RUN.

The maximum number of sub-programs is 12.

Should this number be exceeded a class 4 code 144 error will appear and the central unit will not be able to pass to RUN.

Program Optimization

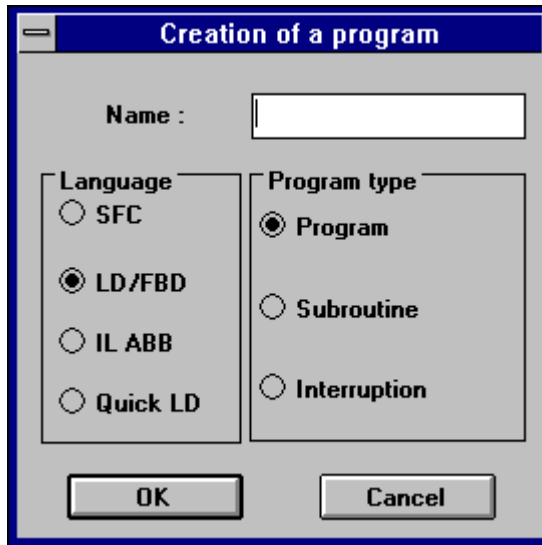


Figure 6-3 : Creating an interruption

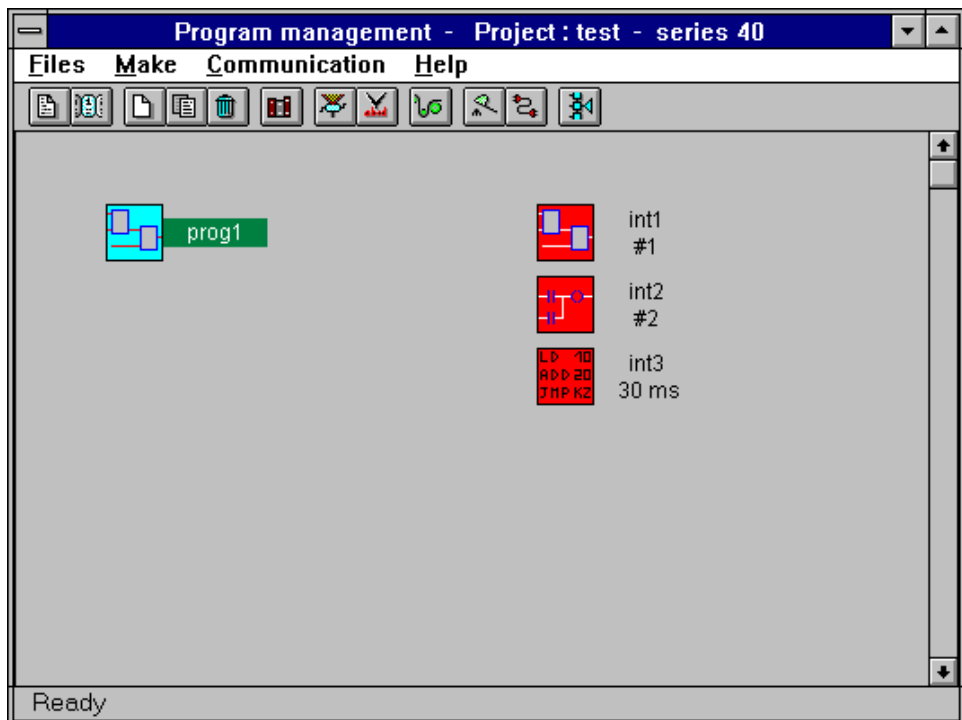


Figure 6-4 : An interruptions example

Program Optimization

2. Interruptions

The immediate treatment of information and rapid execution of certain tasks may be necessary and are processed with interruptions.

Their processing, in this case, is independent of the central unit cycle time.

The central units can manage 2 interruption types:

- Alarms, through the I62.02 and I62.03 inputs
- Cyclic, based on a time

The alarms allow you to immediately take into account an external information, independently of the central unit cycle time.

A cyclic interruption allows you to execute tasks at regular intervals. For example, control management.

2.1. Programming interruptions

Interruptions are defined in the AC31GRAF programming software with the *"Modularize"* option in the *"New"* menu followed by *"Create a new program"* (see Figure 6-3).

The programming language is either Quick Ladder, FBD/LD or Instruction List.

The interruption on the I62.02 input is designated by #1 and by a name. The one on the I62.03 input is designated by #2 and a name. A cyclic interruption is designated by a name and a time value in milliseconds.

For example: the interruption on the I62.02 input is called INT1, that on the I62.03 input is called INT2 and the cyclic interruption is called INT3 with a time base of 30 ms (see Figure 6-4).

All of the functions or instructions may be used in an interruption.

Program Optimization

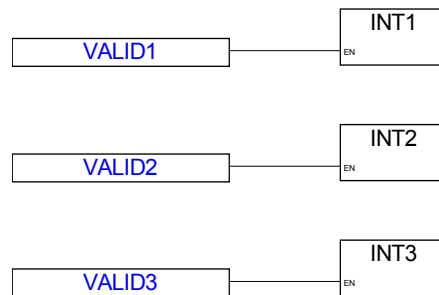
2.2. Validation of interruptions

The interruptions may, or may not, be validated (activated) depending on the process.

Once an interruption has been defined the name is automatically placed in the function block list as a function block

An interruption is validated through the utilization of the function block.

Taking the previous example; the interruptions INT1, INT2 and INT3 are validated in the following manner in the program:



2.3. Performances

The delay, for considering the interruption, depends on the central unit configuration.

In fact, when the central unit is configured as master the CS 31 bus management has the highest priority.

	AC 31 master central unit	AC 31 slave central unit	stand-alone central unit
Alarm (hardware interruption)	max. time. 2,5 ms	max. time 2,5 ms	max. time 250 µs
Cyclic interruption	min. time. 5 ms	min. time 1 ms	min. time 1 ms
Max length	1,5 ms	3 ms	3 ms

It is recommended that the DI and DO functions are used when immediate access to physical inputs/outputs becomes necessary, in an interruption, for immediate information execution (attention, these functions can only be used for the inputs/outputs of the central unit and its extensions).

Example: the physical command of an output may be carried out independently of the central unit cycle time.

The unit cannot effectuate more than one task at a time.

Certain tasks have a higher priority than others.

The descending priority is:

- Communication with a unit on the CS 31 bus
- Interruption on the I62.02 input
- Interruption on the I62.03 input
- Cyclic interruption

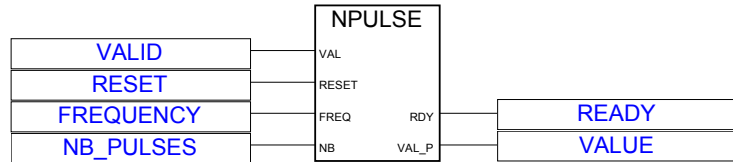
Program Optimization

3. Step motor command

The 40 and 50 series central units allow the command of a step motor.

Usage of the NPULSE function block automatically validates the step motor command.

In this case the O62.00 output is used.



The VAL input of the NPULSE function validates the pulse generation.

The pulse train always starts with a high level signal (+ 24 V d.c. in the case of a transistor output) with a 50% cyclic ratio (see Figure 6-5).

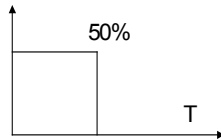


Figure 6-5 : 50 % cyclic ratio

The frequency of the pulse generator lies between 10 Hz and 2.6 kHz.

The frequency is determined in the following manner:

$$\text{Frequency (Hz)} = 1 / (256 - \text{FREQUENCY}) \times 384 \cdot 10^{-6}$$

FREQUENCY=0 Frequency = 10.1 Hz

FREQUENCY=1 Frequency = 10.212 Hz

FREQUENCY=2 Frequency = 10.253 Hz

...

FREQUENCY=10 Frequency = 10.586 Hz

...

FREQUENCY=100 Frequency = 16.693 Hz

...

FREQUENCY=254 Frequency = 1.302 kHz

FREQUENCY=255 Frequency = 2.604 kHz

The number of pulses is between 0 and 32767.

The number of pulses already generated may be visualized. The error of the value currently being executed is ± 1 .

Program Optimization

The frequency and number of pulses may be modified during the execution of the NPULSE function.

With each change of the validation input status 0 -> 1, the pulse generation restarts for the predefined pulse number.

A second output commanding an external relay, which enables the commutation of the direction, should be used when a motor requires a second pulse generator for half duplex operation.

The output of the step motor command is available on all of the 40 and 50 series central units transistor or relay output versions.

In the case of relay outputs you must ensure that the maximum frequency of relay commutation, which is a resistive load of 100 Hz, is not exceeded,.

The motor command is ensured whatever the other functions are that are used by the central unit, for example the interruptions.

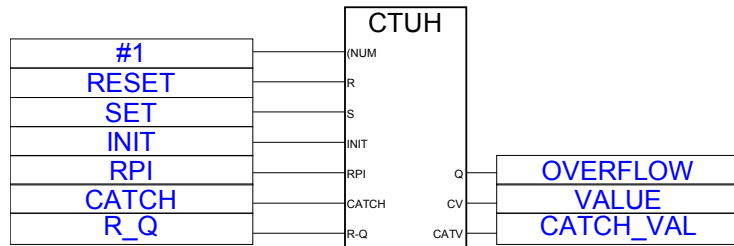
Program Optimization

4. High speed counter with value capture, zero reset and overflow detection

The counter input enables counting the signals which have a frequency greater than that of the cycle time. The capture inputs also enable real time reading of the counter value.

The 40 and 50 series central units also contain an incremental up/down counter encoder input with direction discrimination, or 2 independent counter inputs.

The counter function, as well as the counter mode, is validated by the CTUH function block. In this case the I62.00 and I62.01 inputs are reserved for counting.



Mode #1 validates the I62.00 input counter and the capture by I62.02.

Mode #2 validates the I62.01 input counter and the capture by I62.03.

Mode #3 validates the counter in 2 channel incremental mode and the capture by I62.02.

Two CTUH functions are therefore necessary for 2 independent counters.

The counter value varies from 0 to 32767 then from -32768 to 0.

The counter incrementation is never blocked.

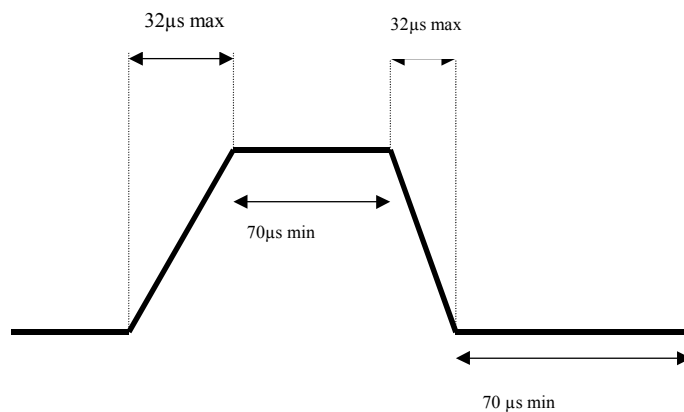
The overflow indication allows the detection of the passages of -1 to 0 of the counter in independent mode and the passage of -1 to 0 and 0 to -1 in 2 channel incremental mode.

The overflow thereby enables counting the counter "rotations". As soon as the overflow bit is used by the program it can be reset to zero by the R-Q input of the CTUH function.

The capture inputs are used in the place of the I62.02 and I62.03 inputs.

When the RPI input of the CTUH function is validated the I62.02 or I62.03 capture input catches the counter value and then resets it to 0.

The characteristic of the encoder must be:



The frequency max is 7 kHz (ie. The time between 0 and 1 is around 0), in case of encoder the minimum time for 0 and 1 is 100 µs (instead of 70 µs). The limit of voltage is 15...26 V.d.c. to garranty the performance of 7 kHz.

Program Optimization

Comment:

The interruption inputs, I62.02 and I62.03, may still be used.

The maximum counter frequency is 5 kHz and the typical delay of the capture inputs is 10 μ s.

Utilization faults:

If one of the two cables of the incremental encoder is cut or not connected, the counter value is incremented by + 1 and then decremented by - 1 with each new pulse.

Program Optimization

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Program Optimization

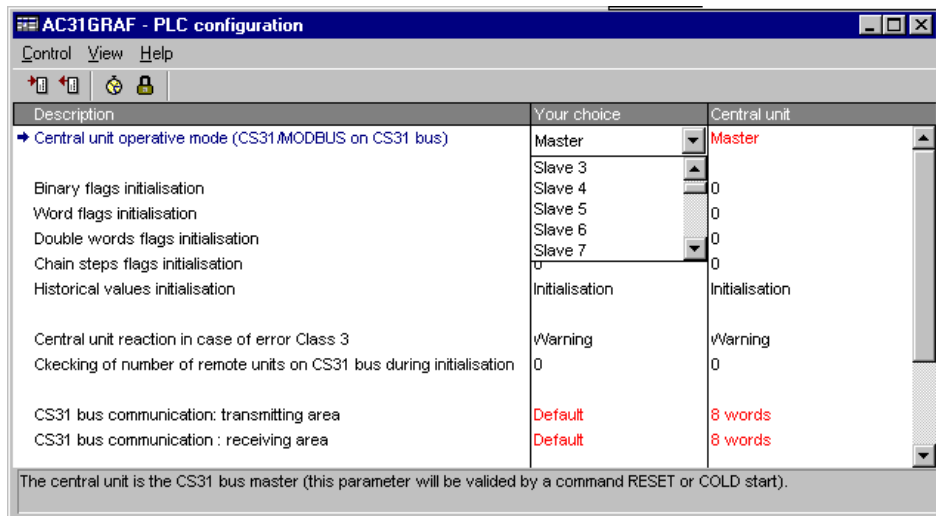


Figure 6-6 : Slave CS31 number choice

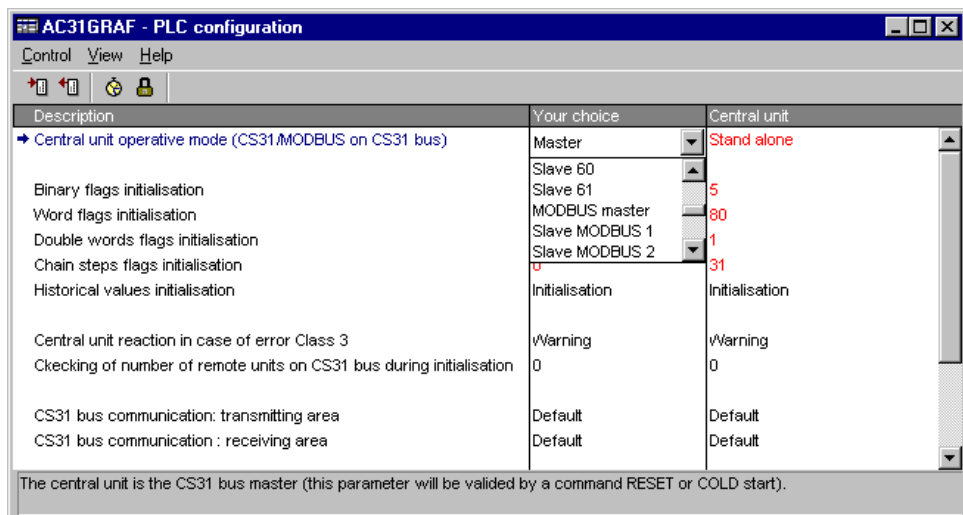


Figure 6-7 : Slave Modbus® number choice

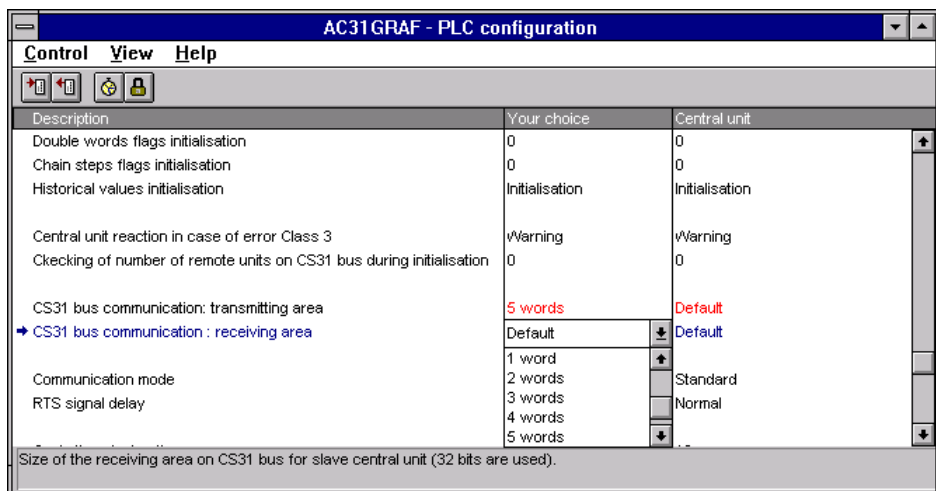


Figure 6-8 : Choice of type and number of data to exchange on the CS 31 bus

Program Optimization

5. Communication between central units on the CS 31 bus

The central units possess the CS 31 bus interface which may be used, just as well, as master of the CS 31 bus or as slave of the CS 31 bus.

These configurations enable a considerable performance improvement by processing a part of the process locally. The execution of the program is much faster and the availability of the application is improved because a slave can continue with the partial control of the process alone.

These configurations also enable the simplification of the conception, the setup as well as the application maintenance by dividing the program into relatively independent parts.

5.1. CS 31 bus addressing

The configuration as, master or slave, of a central unit is effectuated in the "Configuration" menu of the AC31GRAF software "CONTROL PANEL (see Figure 6-6).

The authorized CS 31 addresses are:

Master central unit	Slave central unit			
	50 series		90 series	
	binary	analog	binary	analog
50 series	0 to 61	0 to 61	0 to 61	0 to 5 and 8 to 15
90 series	0 to 61	0 to 5 and 8 to 15	0 to 61	0 to 5 and 8 to 15

Warning: You have also the possibility to use the CS31 bus in Modbus[®] masters or slave. This configuration as Modbus[®] master or slave is also effectuated in the "Configuration" menu of the AC31GRAF software "CONTROL PANEL (see Figure 6-7).

See chapter 7 communication Modbus[®].

5.2. Communication type

A slave central unit is seen by the master central unit as a binary or analog input/output unit.

The number of data exchanged between the master and slave central units, on each CS 31 bus cycle, can be configured. This number should be adapted to the real data volume to be transmitted in order to optimize the CS 31 bus communication times.

The maximum number for a bit configuration is 120 inputs and 120 outputs and the maximum for an analog configuration is 8 word inputs and 8 word outputs.

This choice is made in the "CONTROL PANEL" "PLC configuration tool" menu of the AC31GRAF software (see Figure 6-8).

Program Optimization

5.3. Programming

Data exchange may be carried out directly through the inputs/outputs or by using function blocks.

Exchange through inputs/outputs is particularly well adapted with a low number of data.

5.3.1. Bit transmission

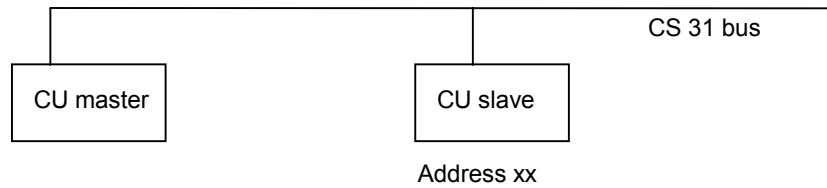


Figure 6-9 : Bit transmission

The master central unit will receive the binary information from the slave central unit in the $I_{xx}.00$ to $I_{xx+N}.15$ inputs, $N+1$ being the number of bits to transmit from the slave central unit to the master slave unit modulo 16.

The slave unit will send the information through the $O_{00}.00$ to $O_N.15$ outputs.

The master central unit will send the binary information to the slave central unit through the $O_{xx}.00$ to $O_{xx+M}.15$ outputs, $(M+1)$ being the number of bits to transmit from the master central unit to the slave central unit modulo 16.

The slave central unit will receive this information in the $I_{00}.00$ to $I_M.15$ inputs.

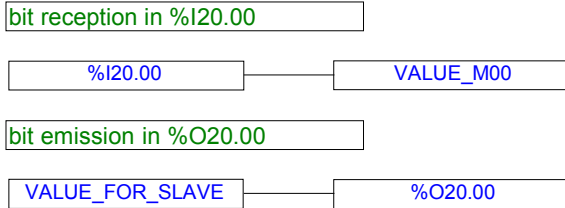
The N and M values may be different.

For example : The transmission of the "VALUE_M00" bit value from the slave 20 central unit to the master central unit and the transmission of the "VALUE_FOR_SLAVE" bit value from the master central unit to the slave 20 central unit.

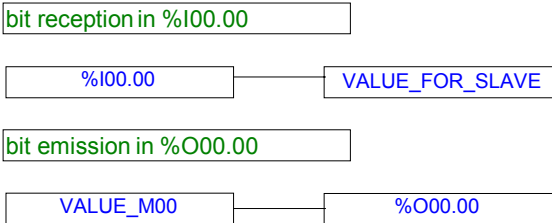
Program Optimization

The program:

- On the master central unit:



- On the slave central unit at the address 20:



5.3.2. Transmission by word

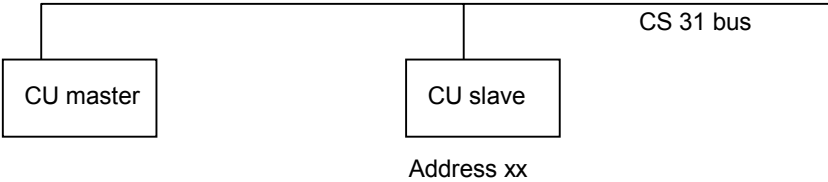


Figure 6-10 : Transmission by words

The master central unit will receive the analog information from the slave central unit in the IWxx.00 to IWxx.N inputs, (N+1) being the number of words to transmit from the slave central unit to the master central unit.

The slave central unit will send this information through the OW00.00 to OW00.N outputs.

Program Optimization

The master central unit will send the analog information to the slave central unit via the OWxx.00 to OWxx.M outputs, (M+1) being the number of words to transmit from the master central unit to the slave central unit.

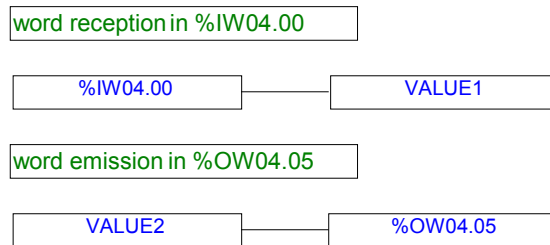
The slave central unit will receive the information in the IW00.00 to IW00.M inputs.

The N and M values may differ but have to be between 0 and 7.

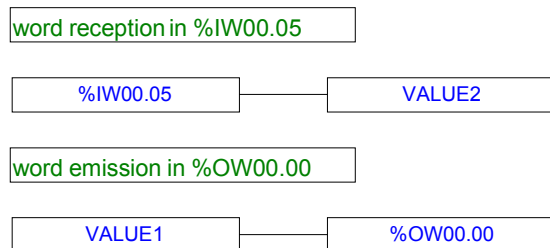
For example : the transmission of the word value "VALUE1" from the slave 4 central unit to the master central unit and the transmission of the word value "VALUE2" from the master central unit to the slave 4 central unit.

The program is:

- In the master central unit:



- In the slave central unit at address 4:



Program Optimization

5.3.3. Utilization of the function blocks

Use of the function blocks simplifies the communication between the master/slave central units and enables a large exchange of data.

The data exchange takes place from the master to the slave as well as from the slave to the master.

A data zone may thereby be transmitted from one central unit to another.

The exchange of a complete data table is totally transparent for the user.

The slave central unit should be configured for CS 31 bus communication, 8 words on emission and 8 words on reception.

The exchange of words is effectuated 7 words by 7 words at the most, the 8th word being reserved for the handshake which controls the dataflow.

A total of 4 function blocks is required for a transfer from one central unit to another.

The following function blocks are available:

- for the master : MT_CS31 (data transmission to the slave)
MR_CS31 (data reception from the slave)
- for the slave : ST_CS31 (data transmission to the master)
SR_CS31 (data reception from the master)

The MT_CS31(master) and SR_CS31(slave) function blocks are used for a data transfer from the master central unit to the slave central unit (see Figure 6-11).

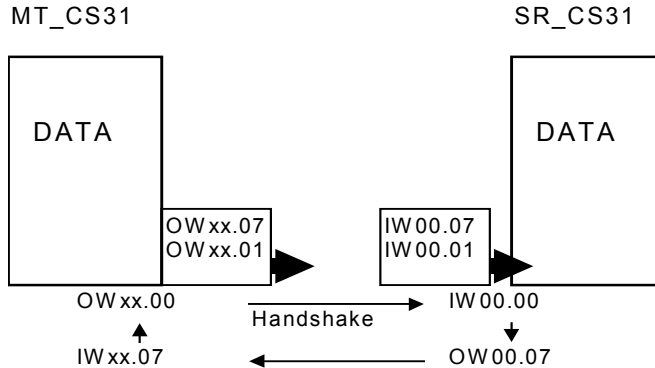


Figure 6-11 : Data transfer from master to slave

The following information is necessary for these blocks:

- Slave number.

- The number of words to use per exchange : a data table may be transmitted over the CS 31 bus 7 words by 7 words or, 6 words by 6 words or, 5 words by 5 words, etc. It is therefore possible to use the unused words for a rapid data transfer between central units at each CS 31 bus cycle. The data transfer may therefore be carried out with 2 different time bases. A typical application is the transfer of parameters from the CS 31 master to the slave 4 words by 4 words, the 3 remaining words being reserved for the rapid transfer of the inputs/outputs. The available outputs on the master are OWxx.07, OWxx.06, etc. and the corresponding inputs on the slave are IW00.07, IW00.06, etc. This number should be identical for both functions.

Program Optimization

The variables OWxx.00 and Iwxx.07 on the master and IW00.00 and OW00.07 on the slave are reserved for the dataflow control between the central units.

- Total number of data to transmit between the master and slave central unit
- Memory address of the first data to transmit or the memory address of the first variable to receive the first data. The memory address list can be found in the annex.

The MR_CS31(master) and ST_CS31(slave) function blocks are used for a data transfer from the slave central unit to the master central unit (see Figure 6-12).

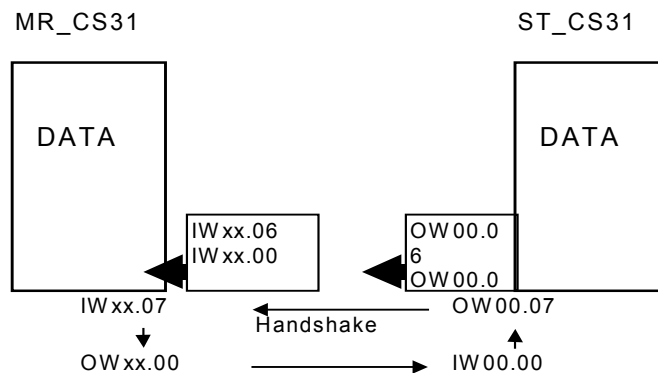


Figure 6-12 : Data transfer from the slave to the master

The following information is required for these blocks:

- The slave number.
- The number of words to use per exchange : a data table may be transmitted over the CS 31 bus 7 words by 7 words or, 6 words by 6 words or, 5 words by 5 words, etc. It is therefore possible to use the unused words for a rapid data transfer between central units at each CS 31 bus cycle. The data transfer may therefore be carried out with 2 different time bases. A typical application is the transfer of parameters from the CS 31 master to the slave 4 words by 4 words, the 3 remaining words being reserved for the rapid transfer of the inputs/outputs. The available outputs on the slave are OW00.06, OW00.05, etc. and the corresponding inputs on the master are IWxx.06, IWxx.05, etc. This number should be identical for both functions.

The variables OWxx.00 and IWxx.07 on the master and IW00.00 and OW00.07 on the slave are reserved for the dataflow control between the 2 central units.

- Total number of data to transmit between the master and slave central unit
- Memory address of the first data to transmit or the memory address of the first variable to receive the first data. The memory address list can be found in the annex

The function blocks for the data exchange master/slave and slave/master may be used at the same time by the same program.

Chapter 7

Communication

Communication

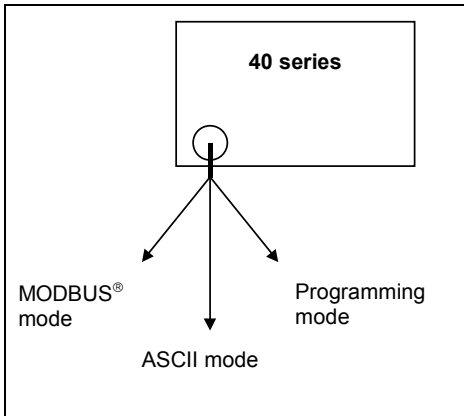


Figure 7-1 : Communication protocols with the 40 series

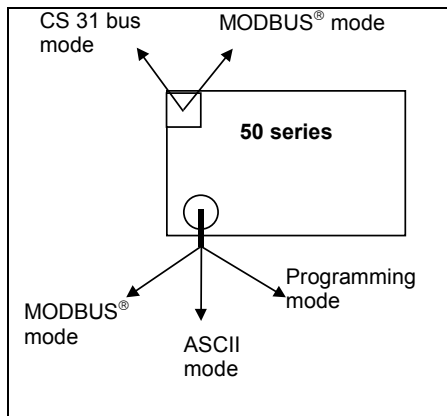


Figure 7-2 : Communication protocols with the 50 series

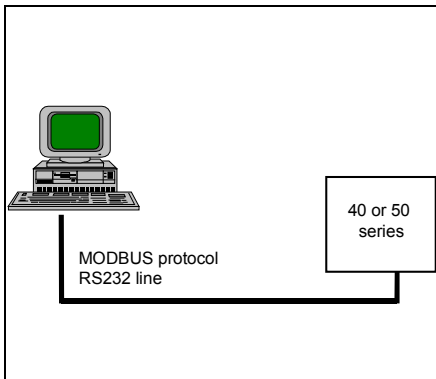


Figure 7-3 : Point to point connection with a PC

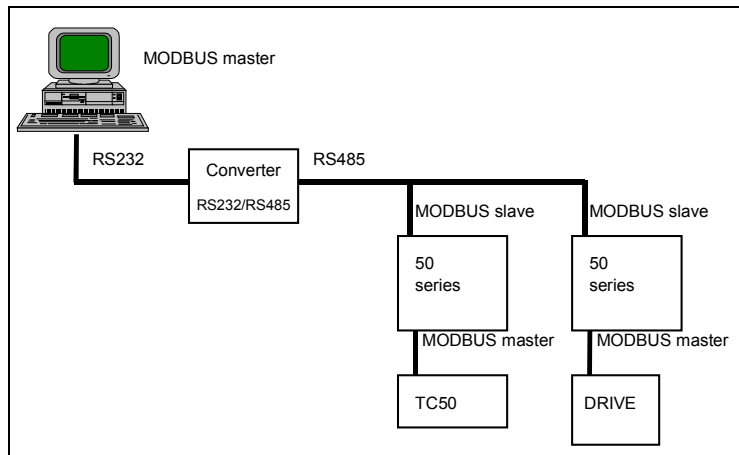


Figure 7-4 : Network connection with a PC

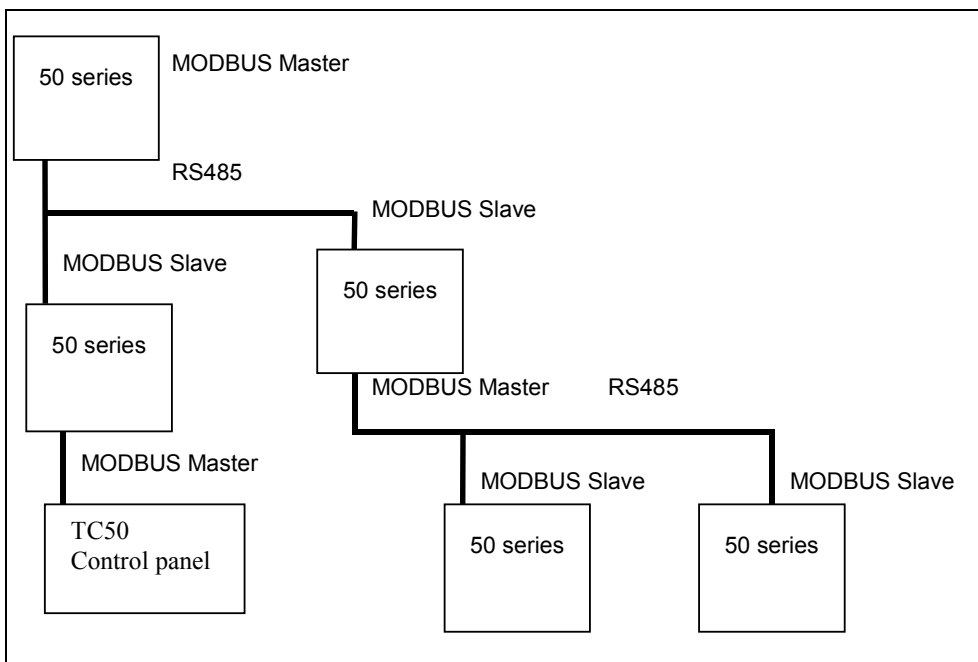


Figure 7-5 : Network connection between Central units

Communication

Communication is of greater importance in wide area installations. The AC 31 system possesses other interfaces, apart from the CS 31 bus, adapted to different communication modes.

This chapter presents, in particular, the interface available with the 40 series central units which possess three communication protocols on the same serial interface (Figure 7-1) and the interfaces available with the 50 series central units which possess three communication protocols on two different serial interface (Figure 7-2). The MODBUS[®] mode is the easiest and most powerful of the three for communicating with other devices.

1. Network communication with the incorporated MODBUS[®] interface

1.1. Protocol presentation

The MODBUS[®] protocol, which is known worldwide, incorporated in the 40 and 50 series central units is the **MODICON MODBUS[®] RTU** protocol.

Numerous automation devices, such as PLCs, displays, variable speed drives or monitoring systems possess a standard, or optional, MODBUS[®] RTU interface and can therefore easily communicate with the 40 or 50 series central units via the serial interface (RS232 or RS485) or via the CS31 connection configured in MODBUS[®] mode.

On series 50:

MODBUS[®] slave via the CS31 connection is available starting from software **version 1.7**

Designation of products	Index of version
07 KR 51 - 24VDC	From K17
07 KR 51 - 120/230 VAC	From K17
07 KT 51 - 24VDC	From J17

MODBUS[®] master via the CS31 connection is available starting from software **version 2.0**

Designation of products	Index of version
07 KR 51 - 24VDC	From N20
07 KR 51 - 120/230 VAC	From N20
07 KT 51 - 24VDC	From M20

How to verify which version you have ?

You can find this information on the label, on the left side of the 50 series central unit.

Opposite are three configuration examples:

- **Point to point connection with a PC (see Figure 7-3)**
- **Network connection with a PC (see Figure 7-4)**
- **Network connection between central units (see Figure 7-5)**

MODBUS[®] is a question / answer type protocol, or still occasionally called master / slave : the master sends a request to the slave and awaits the slave's reply.

The master devices on a MODBUS[®] network are generally central units, displays or supervisory systems. The slaves on the MODBUS[®] network are generally PLCs, variable speed drives, etc.

Communication

1.2. MODBUS[®] protocol description:

Support	Serial line (Com1)	CS31 connection (Com2)
Mode	half-duplex	
Number of connection points	1 single master max. 1 slave with RS232 interface max. 12 slaves with build-in RS485 interface max. 255 slaves with repeaters	1 single master 1 slave with RS485 interface 31 slaves without repeater max. 255 slaves with repeaters
Protocol	MODBUS [®] (master / slave)	
Transmission control	CRC 16	
Speed	up to 19 200 Bauds	up to 187 500 Bauds
Maximum length	on RS485: 1 200 m at 19 200 Bauds 1 500 m at 300 Bauds	on RS485: 600 m at 76 800 Bauds 1 200 m at 19 200 Bauds 1 500 m at 300 Bauds

The MODBUS[®] frames transmitted by the master contain the following information:

- The MODBUS[®] address of the interrogated slave (1 byte)
- The function code defining the master request (1 byte)
- The data to exchange (N bytes)
- The CRC16 control code (2 bytes)

The frame has a maximum total length of 240 bytes thereby enabling the exchange of a maximum of 100 data words or 255 binary data.

The slave's reply contains the request confirmation, the data to be returned and also a frame control code. The slave returns an error code in the case of an error.

Only the following MODBUS[®] operation codes may be processed by the 40 and 50 series central units:

Function codes		Description
In hexadecimal	In decimal	
01 or 02	01 or 02	Read n bits
03 or 04	03 or 04	Read n words
05	05	Write a bit
06	06	Write a word
07	07	Fast reading of 8 bits
08	08	Diagnosis / initialization
0F	15	Write n bits
10	16	Write n words

Communication

The codes generated on error are:

Error codes	Description
00	No error
01	Unknown function code
02	Address error
03	Data error
09	Time-out
10	Checksum error

1.3. Communication configuration

With Serial line:

MODBUS® Communication, with the 40 and 50 series central units, is only allowed if the **black 07 SK 51 or 07 SK 53 cables** are used.

With CS31 connection:

MODBUS® Communication on the CS 31 connection, with the 50 series central units, is a RS485 interface and consists of a shielded twisted pair.

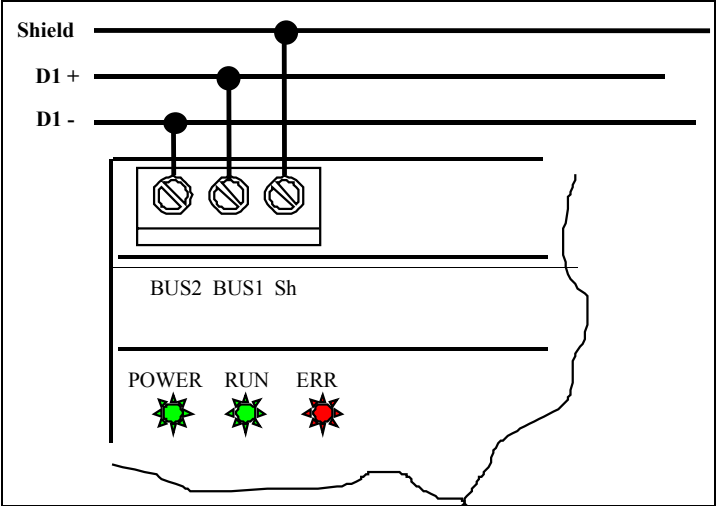


Figure 7-6 : Cabling Modbus network on CS31 connection (RS485)

Communication

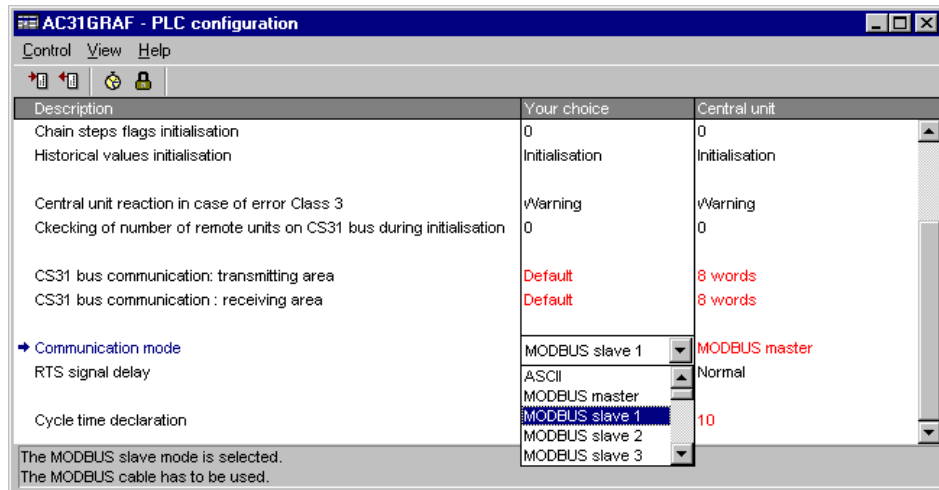


Figure 7-7 : Configuration of COM1 through PLC configuration window in AC31GRAF

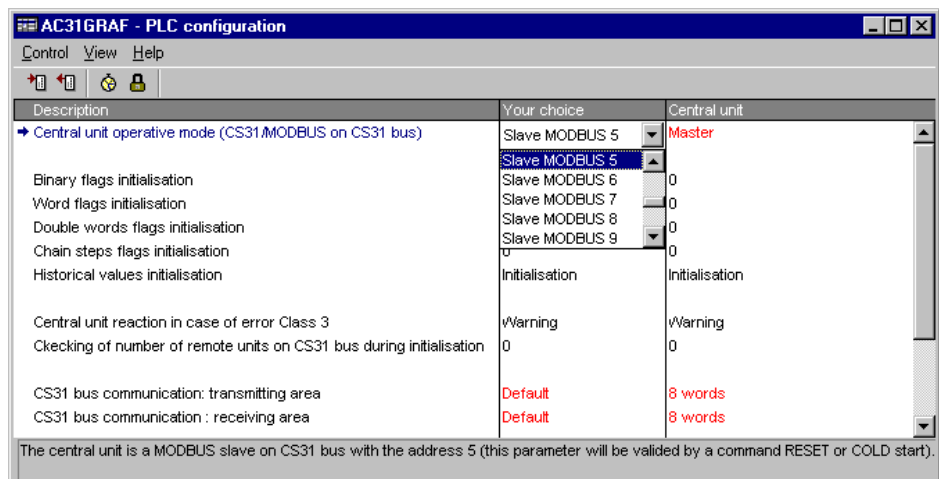


Figure 7-8 : : Configuration of COM2 through PLC configuration window in AC31GRAF


Communication

The interfaces of the 40 and 50 series central units have a default MODBUS[®] configuration with the following parameters:

	Serial line	CS31 connection
- Mode:	MODBUS [®] slave 1	standalone
- Transmission speed :	9 600 Bauds	19 200 Bauds
- Number of stop bits :	1	1
- Number of data bits :	8	8
- Parity :	None	None

With the serial line, it is not necessary to configure the communication if your application uses these default parameters. However, any mode change requires a software interface configuration or directly with terminal mode and managed system constant.

Software interface configuration:

Click on the  "Launch PLC configuration tool" icon in the AC31GRAF software control window

- ⇒ If you use the serial interface: Select the MODBUS[®] address from the list of the "Communication mode" line (see Figure 7-7)
- ⇒ If you use the CS31 connection: Select the MODBUS[®] address from the list of the "Central unit operative mode (CS31 MODBUS[®] on CS31 bus)" line (see Figure 7-8)

Terminal mode / system constants:

Serial line: KW00.06

- MODBUS[®] Master = KW00.06 = 100
- MODBUS[®] Slave = KW00.06 = MODBUS[®] Slave address + 100

Example: MODBUS[®] Slave address N°5

$$KW00.00 = 7 + 100 = \mathbf{107}$$

CS31 connection: KW00.00

- MODBUS[®] Master = KW00.00 = 1100
- MODBUS[®] Slave = KW00.00 = MODBUS[®] Slave address + 1100

Example: MODBUS[®] Slave address N°5

$$KW00.00 = 5 + 1100 = \mathbf{1105}$$

Communication

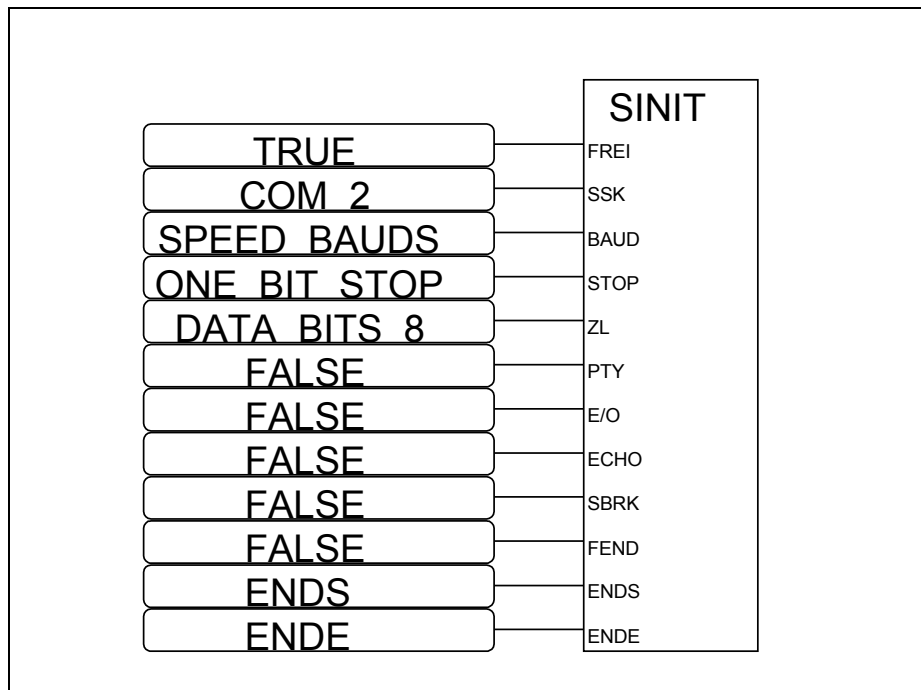


Figure 7-9 : Example of SINIT function in AC31GRAF Software

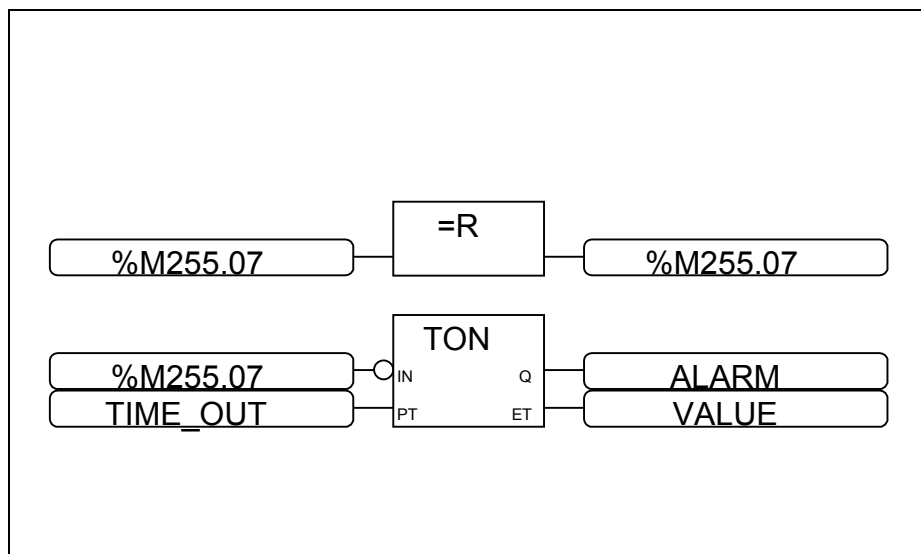


Figure 7-10 : Example of programming with M255.07 in AC31GRAF Software

Communication

The MODBUS[®] mode remains available, even if the central unit program is stopped (the front switch on OFF), when the black 07 SK 51 or 07 SK 53 cable is connected and the serial interface is configured for MODBUS[®] communication. The programming mode for tests and modifications becomes available when the grey 07 SK 50 or 07 SK 52 cable is used.

A change in the speed, stop bits, data bits or parity parameters is programmed with the **SINIT function**. The usage of the SINIT function is not necessary when communication uses the default parameters.(see Figure 7-9)

Description of parameters with SINIT function:

SSK parameter = COM1 initialization of Serial line port
= COM2 initialization of CS31 port

BAUD parameter = 9600 up to 19200 the value of the speed is written directly.

33600	the value of the speed is written through Code 44
38400	the value of the speed is written through Code 38
57600	the value of the speed is written through Code 25
75000	the value of the speed is written through Code 19
76800	the value of the speed is written through Code 18
125000	the value of the speed is written through Code 11
187500	the value of the speed is written through Code 7
375000	the value of the speed is written through Code 3
750000	the value of the speed is written through Code 1

Detection of communication default:

Two different binary flags can be used as watch-dog:

- M255.07 watch-dog Modbus[®] COM2
- M255.08 watch-dog Modbus[®] COM1

Example of use:

The binary flag M255.07 can be used as a watch-dog for the MODBUS[®] Slave on the CS31 bus connection.

This binary flag is set to 1 when the slave sends answer to the master.

The example (see Figure 7-10) shows how to use it for detection.

Communication

1.4. Programming

1.4.1. MODBUS® slave unit

All the data may be read or written in MODBUS®. **A program** isn't required for MODBUS® communication management. The MODBUS® slave central unit automatically converts the request sent by the master MODBUS® and returns a message once it has recognized the address.

The SINIT function is only required in the program when changing communication parameters.

1.4.2. MODBUS® master unit

The **MODBUS function** enables sending data read / write requests to MODBUS® slaves

A change of communication parameters also requires the usage of the SINIT function in the program.

1.4.3. List of cross references

An exchange of MODBUS® data is realized in a table defined by:

- The MODBUS® address of the first exchanged variable
- The list size = the total number of variables in the list.

All the variables of the 40 and 50 series central units, as described in the following table, can be read or written by the master MODBUS®.

- MODBUS® addressing method :

VAR 00.00 \longrightarrow ADDR 0
(VAR = type I,O,S,M,IW,OW,MW,KW) (Address of the first selected variable in decimal)

$$\text{VAR XX.YY} = \text{ADDR 0} + (16 * \text{XX}) + \text{YY}$$

(VAR = type MD,KD) (Address of the first selected variable in decimal)

$$\text{VAR XX.YY} = \text{ADDR 0} + (32 * \text{XX}) + (2 * \text{YY})$$

Example : Find the MODBUS® address of variables O62.15 and M232.01 and MD002.07

$$\text{O 62.15} = 4096 + (16 * 62) + 15 = \mathbf{5103}$$

$$\text{M 232.01} = 8192 + (16 * 232) + 1 = \mathbf{11905}$$

$$\text{MD002.07} = 4000 + (32 * 2) + (2 * 7) = \mathbf{16462}$$

Communication

Variable types	Variables	MODBUS® addresses in hexadecimal	MODBUS® addresses in decimal
Binary inputs	I 00.00	0000	0000
	I 00.01	0001	0001

	I 00.15	000F	0015
	I 01.00	0010	0016

	I 61.15	03DF	0991
	I 62.00	03E0	0992
Binary outputs	O 00.00	1000	4096
	O 00.01	1001	4097

	O 00.15	100F	4111
	O 01.00	1010	4112

	O 61.15	13DF	5087
	O 62.00	13E0	5088
Internal bits	M 000.00	2000	8192
	M 000.01	2001	8193

	M 000.15	200F	8207
	M 001.00	2010	8208

	M 099.15	263F	9791
	M 230.00	2E60	11872

	M 254.15	2FEF	12271
	M 255.00	2FF0	12272
Steps	S 00.00	3000	12288
	S 00.01	3001	12289

	S 00.15	300F	12303
	S 01.00	3010	12304
...	
S125.15	37DF	14303	

Communication

Variable types	Variables	MODBUS® addresses in hexadecimal	MODBUS® addresses in decimal
Analog inputs	IW 00.00	0000	0000
	IW 00.01	0001	0001

	IW 00.15	000F	0015
	IW 01.00	0010	0016

	IW 62.15	03EF	1007
Analog outputs	OW 00.00	1000	4096
	OW 00.01	1001	4097

	OW 00.15	100F	4111
	OW 01.00	1010	4112

	OW 62.15	13EF	5103
Internal words	OW 63.00	13F0	5104

	OW 68.15	144F	5199
	MW 000.00	2000	8192
	MW 000.01	2001	8193

	MW 000.15	200F	8207
	MW 001.00	2010	8208

	MW 099.15	263F	9791
Internal double words	MW 230.00	2E60	11872

	MW 254.15	2FEF	12271
	MW 255.00	2FF0	12272

	MW 255.15	2FFF	12287
	MD 00.00	4000	16384
	MD 00.01	4002	16386
Indirect word constants
	MD 00.15	401E	16414
	MD 01.00	4020	16416

	MD 07.15	40FE	16638
Indirect double word constants	KW 00.00	3000	12288
	KW 00.01	3001	12289

	KW 00.15	300F	12303
	KW 01.00	3010	12304
Indirect double word constants
	KW 31.15	31FF	12799
	KD 00.00	5000	20480
	KD 00.01	5002	20482

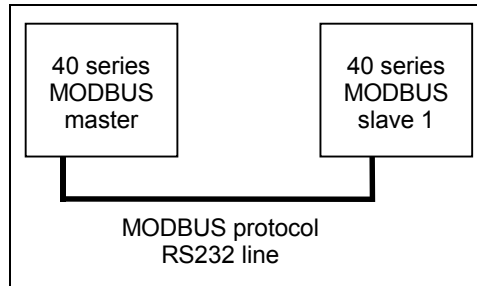
Indirect double word constants	KD 00.15	501E	20510
	KD 01.00	5020	20512

	KD 07.15	50FE	20734

Communication

1.4.4. Example using the MODBUS® function

An example of MODBUS® communication between two 40 series central units.



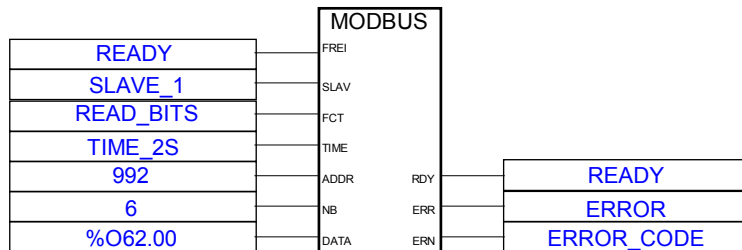
- A program isn't required in the slave central unit.
- A program example in the master central unit:

Read the 6 bits I62.00 to I62.05 in the slave 1 central unit.

The information is placed in O62.00 to O62.05 of the master central unit.

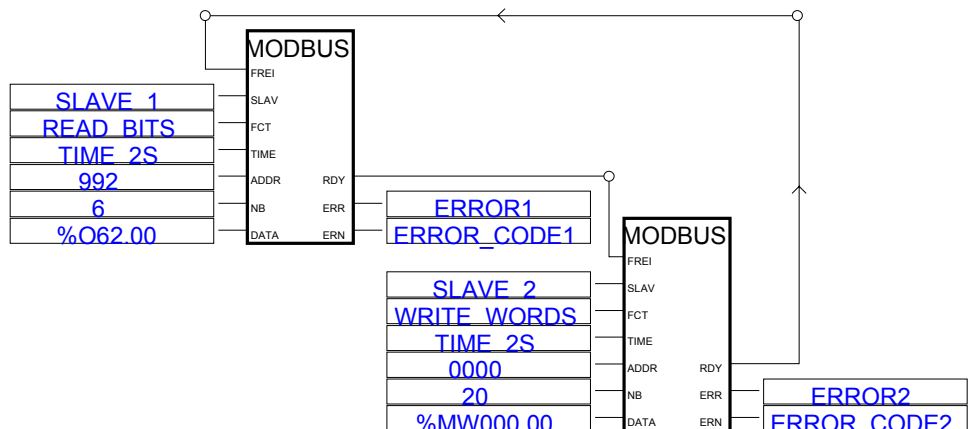
The MODBUS® address of variable I62.00 in the slave 1 is 992 in decimal.

A delay should be defined to enable re-sending the MODBUS® message in case of error. This delay is called TIME_OUT and is generally 2 seconds.



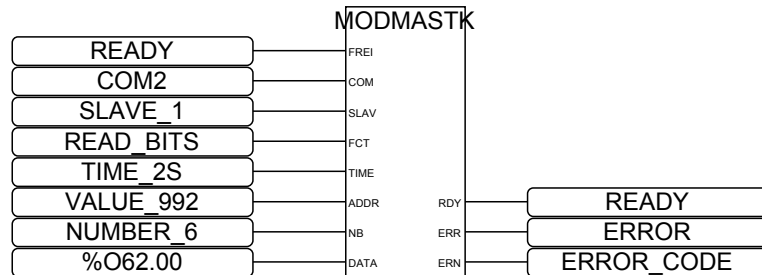
In case of MODBUS® communication between one master 50 series central unit and different slaves 50 series central units, different MODBUS® functions can be used. It is possible to link them together to optimize the refresh time.

Check example : Read 6 bits continuously I62.00 to I62.05 in the slave 1 central unit. The information is placed in O62.00 to O62.05 of the master central unit. Write 20 words continuously IW02.00 to IW03.04 in the slave 2 central unit. The information is received from master central unit in MW00.00 to MW01.04.



Communication

In case of MODBUS[®] communication is used on the CS31 connection with 50 series, you have to use the function block **MODMASTK**, this function is the same as the function block **MODBUS** with the possibility to select the right port (COM1 for serial line, COM2 for CS31 connection)



1.5. Reply times for MODBUS[®] communication

The MODBUS[®] processing time depends on:

- The transmission speed
- The number of frame bytes
- The central unit cycle time
- The central unit load factor

The following times are for indication purposes only.

● Reply times with a 40 or 50 series central unit

Cycle time = 10 ms

Load factor = 80%

Speed = 9 600 Bauds

Nr. of variables	Bits		Words	
	read (ms)	write (ms)	read (ms)	write (ms)
1	10 - 60	50	10 - 60	60
10	10 - 60	60	10 - 60	110
50	10 - 60	110	110 - 170	220
100	50 - 60	110	220 - 280	390
150	50 - 110		-	-
255	50 - 110		-	-

Communication

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Communication

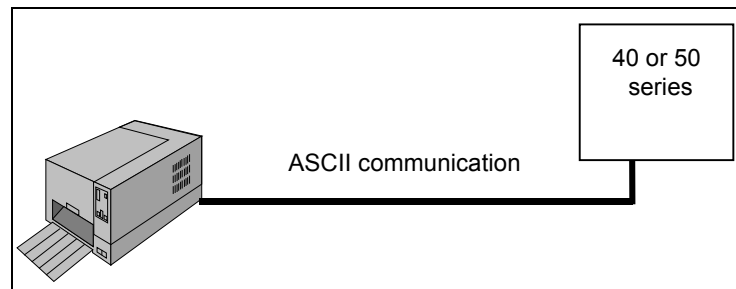


Figure 7-11 : ASCII configuration example

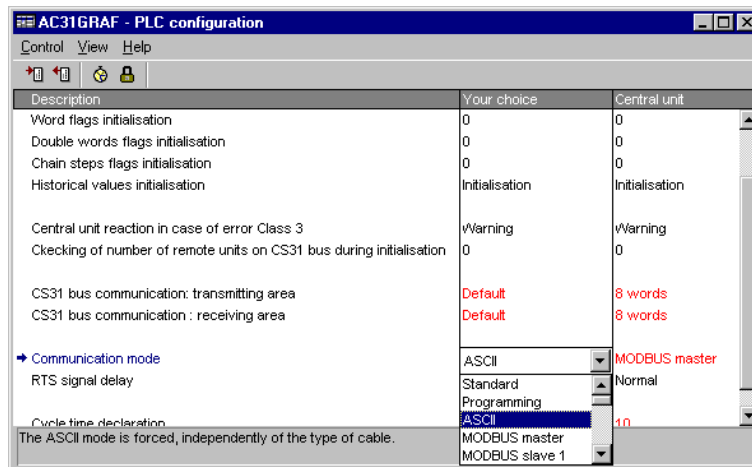


Figure 7-12 : AC31GRAF configuration window of the central unit.

Communication

2. Point to point communication with the incorporated ASCII interface

2.1. Protocol description

ASCII communication is a protocol which enables exchanging text coded in ASCII (American Standard Code of Information Interchange) between two devices for example.


It may be used by the 40 and 50 series central units to communicate with a printer or a terminal fitted with an ASCII interface (see Figure 7-11).

2.2. Configuration of the communication

2.2.1. Using the black 07 SK 51 or 07 SK 53 cable

The serial interface of the 40 and 50 series central units is configured by default in programming and test mode with the grey 07 SK 50 or 07 SK 52 cable and in MODBUS[®] mode with the black 07 SK 51 or 07 SK 53 cable.

Changing the programming mode to ASCII mode requires a serial interface configuration through the software:

⇒ Click on the  "Launch PLC configuration tool" icon in the AC31GRAF control window and select "ASCII" or "Standard" from the list of the "Communication mode " line (see Figure 7-12).

ASCII mode is available when the central unit is running. Programming mode is, once again, available for test or modifications once the central unit program is stopped or when the grey 07 SK 50 or 07 SK 52 cable is used.

Comments:

When the central unit program is running:

- Choosing "ASCII" validates the communication whichever cable is being used.
- Choosing "Standard" validates the ASCII mode with the black 07 SK 51 or 07 SK 53 cable and the programming mode with the grey 07 SK 50 or 07 SK 52 cable.

2.2.2. Communication parameters

There isn't a default configuration. It is therefore **necessary** to configure the communication parameters (speed, stop bits, data bits, parity, end of frame) with the **SINIT function** in the user program.

Communication

2.3. Programming

Two other functions for ASCII communication exist, apart from the obligatory SINIT function, for parameter configuration.

2.3.1. Sending messages

Sending an ASCII message from one 40 or 50 series central unit to another device is done with the **SEND function** in the user program.

2.3.2. Receiving messages

Receiving an ASCII message on a 40 or 50 series central unit is done with the **REC function** in the user program.

A detailed description, of the SINIT, SEND and REC functions, is available in the help file of the AC31GRAF software or in the AC31GRAF software documentation.

2.3.3. Programming example

The communication interface is configured by the SINIT block with the following parameter values:

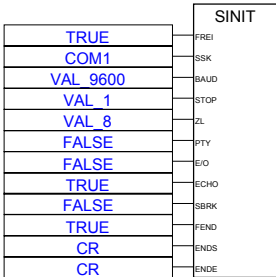
- Interface COM1
- 9 600 Bauds
- 1 stop bit
- 8 data bits
- No parity

An echo is defined for visualizing the message on the terminal. The end of the message is set to a carriage return (CR).

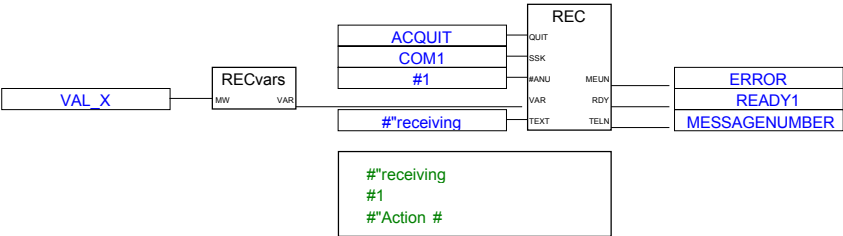
The example consists of receiving the message with the REC block whose text is "Action x" where x varies from 0 to 9, and then to validate by replying "Action x OK" or to return "error message" in the case of a message error using the SEND block.

Communication

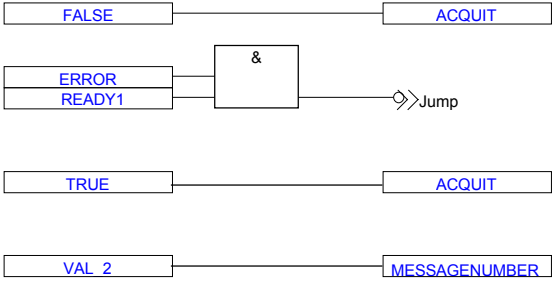
Serial interface initialization for ASCII



Message receiving

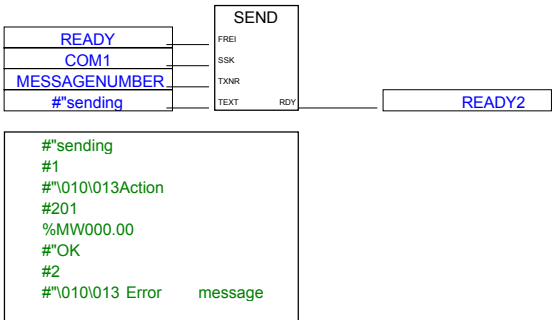


Error handling



Jump

Message sending



Communication

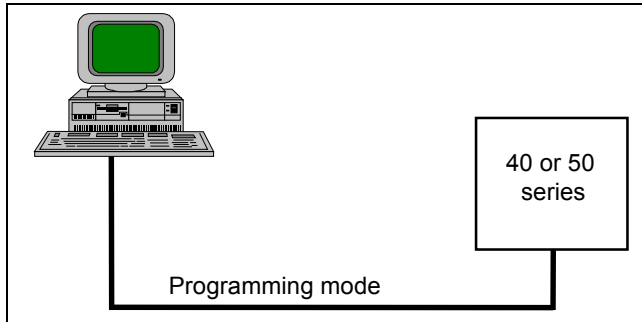


Figure 7-13 : programming protocol configuration on serial line (COM1)

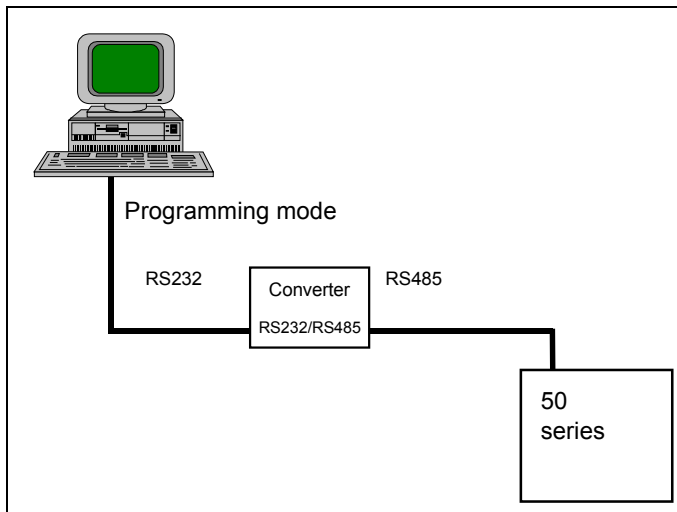


Figure 7-14 : programming protocol configuration on CS31 connection (COM2)

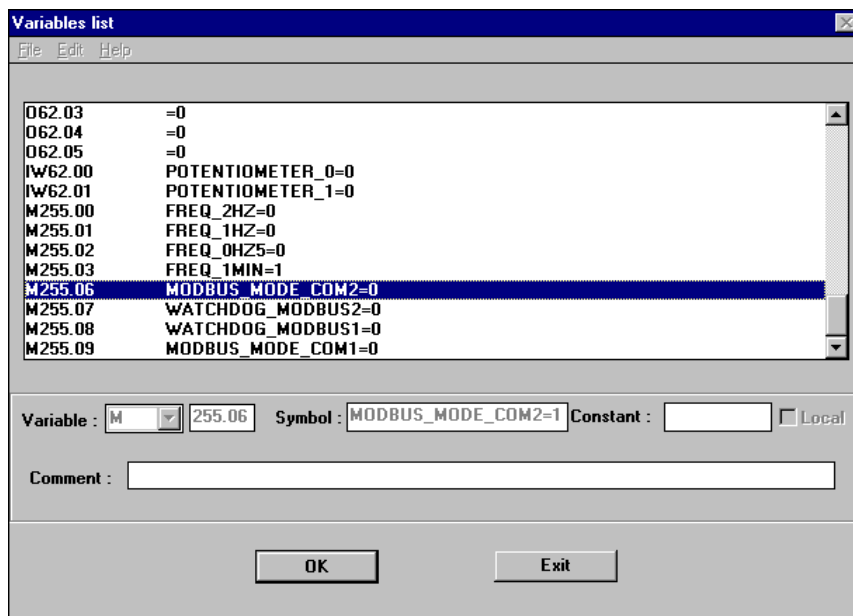


Figure 7-15 : Special internal bits available in variables list

Communication

3. Point to point communication with the programming protocol

- This protocol uses the serial interface (COM1) of the central unit and is reserved for devices which dispose of an ABB programming interface (see Figure 7-13).

All variable values can be read or written by this protocol without any configuration or any particular program in the central units. You simply use the grey 07 SK 50 or 07 SK 52 programming cable.

The communication parameters are:

- 9 600 Bauds
- 8 data bits
- 1 stop bit
- No parity

- This protocol can be also used on the CS31 connection (COM2) (see Figure 7-14).

To activate this mode, it is necessary to be already in MODBUS[®] slave configuration on CS31 connection (COM2) and to change the status of special internal bit M255.06

Programming protocol via the CS31 connection is available starting from software **version 2.0**

Designation of products	Index of version
07 KR 51 - 24VDC	From N20
07 KR 51 - 120/230 VAC	From N20
07 KT 51 - 24VDC	From M20

How to verify which version you have ?

You can find this information on the label, on the left side of the 50 series central unit.

Special internal bits available: (see Figure 7-15).

These internal bits can be used to change the protocol on the serial ports (COM1 or COM2).

The changing of status of these internal bits can be managed through the user program, programming interface or MODBUS[®] interface...

M255.06 Switch MODBUS[®] / active mode for COM2

M255.09 Switch MODBUS[®] / active mode for COM1

Communication

Restriction :

Mode on Serial Line COM1	Mode on CS31 connection COM2	Status
Programming Mode	Modbus Master Mode	Available
Programming Mode	Modbus Slave Mode	Available
Programming Mode	Programming Mode	Only COM2 active
Man Machine Communication (ASCII)	Modbus Master Mode	Available
Man Machine Communication (ASCII)	Modbus Slave Mode	Available
Man Machine Communication (ASCII)	Programming Mode	Not Available
Modbus Master Mode	Modbus Master Mode	Available
Modbus Master Mode	Modbus Slave Mode	Available
Modbus Master Mode	Programming Mode	Available
Modbus Slave Mode	Modbus Master Mode	Available
Modbus Slave Mode	Modbus Slave Mode	Available
Modbus Slave Mode	Programming Mode	Available

Chapter 8

Diagnosis

Diagnosis

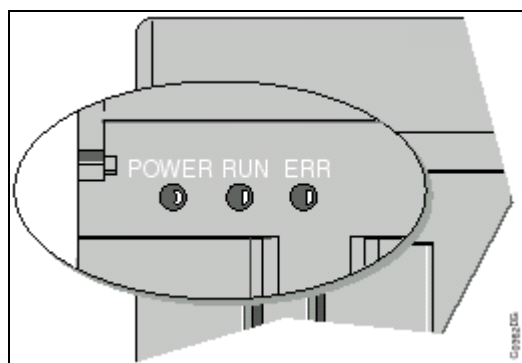


Figure 8-1 : Error detection LEDs

Diagnosis

The aim of the diagnosis, for the 40 and 50 series central units, is to ensure a rapid and efficient localization of breakdowns.

1. Types of errors detected

The detected errors are grouped by type into four error classes.

Class 1 errors: fatal errors	Class 2 errors: serious errors	Class 3 errors: light errors	Class 4 errors: warnings
Access to the Flash EPROM is no longer assured. - Flash EPROM checksum error	The operating system functions correctly but the execution of the user program is not guaranteed. Detected errors: - Defective RAM - Too many timers active simultaneously	Communication errors. Stopping the program depends on the users choice during configuration according to the application. Detected errors: - Disconnected unit - Bus error - NCB / NCBR error - Cycle time too short - Addressing fault	Errors occurring on the units or syntax errors whose effects will only become apparent later. The user decides which actions to initialize according to the application. - Internal unit error - Cut wire ^{*1} overload, short-circuit - Analog output level error - Defective 10V output - Program size, program syntax, sub-program or interruption program error - Too many historical values - All of the units on the bus are not initialized ^{*2}

*1 error detected if prior configuration by programming with the CS31CO block

*2 error detected if prior software configuration with the "PLC configuration" menu of the Control window.

2. Detection of errors

The detected errors are transmitted to the central unit which signals their presence on the red ERR led situated on the front of the central unit (see Figure 8-1).

An error on a remote unit is also signaled by the ERR led of the unit concerned.

The SUPPLY led flashes on the extension when an error occurs on the extension.

As soon as the error has been detected and corrected by the user it can be acknowledged:

- ⇒ By restarting the central unit
- ⇒ Through the software
- ⇒ Or by program.

Diagnosis

Only one error per class is memorized. If more than one error of the same class occurs at the same time:

- ⇒ Only the first is memorized.
- ⇒ The first error should be acknowledged to allow the following to be read. And so on through to the last error.
- ⇒ Those following errors which disappear, before the acknowledgment of the first error, are never signaled.

Diagnosis

A recapitulative table:

	Class 1 errors: fatal errors	Class 2 errors: serious errors	Class 3 errors: light errors	Class 4 errors: warnings
Detection:	Immediate	Immediate	<ul style="list-style-type: none"> - Bus error: if the central unit detects a frame control error (CRC) during 9 successive cycles or a timing error or the absence of a reply from a unit. - Cycle timing error: if the system detects the overriding of the pre-defined cycle time after 16 consecutive cycles. 	<ul style="list-style-type: none"> - Unit error: the central unit queries one slave per cycle. An error is detected between 1 and 31 cycles. - Program syntax error: The central unit detects this type of error when passing from STOP to RUN via the switch or via the software or by on-line validation of a program modification.
LED status - on the central unit: - on the extensible remote units : - on the extensions: - on non-extensible remote units:	ERR led on RUN led off even if the RUN/STOP switch is on RUN	ERR led on RUN led off even if the RUN/STOP switch is on RUN	ERR led on According to the configuration, the RUN led is off even if the RUN/STOP switch is on RUN ERR led on or flashing according to the case Flashing SUPPLY led Error led on or flashing according to the case	ERR led on Following a program syntax type error, the RUN led is off. ERR led on Flashing SUPPLY led Error led on
Reaction while powering up or during central unit usage:	All outputs remain on, or are set to, 0. The programming software no longer has access to the central unit. The central unit remains on RESET while the error remains present.	All outputs remain on, or are set to, 0. The programming software retains access to the central unit. The user program has not started or is stopped.	The inputs of a unit on error retain the old values for 9 cycles and are then reset to 0. The outputs of a remote unit or extension are reset to 0. No program stoppage by default. It's possible to prepare an automatic program stoppage with prior configuration (see chapter 5)	No program stoppage
Acknowledgment after error removal:	- Power on	<ul style="list-style-type: none"> - Power on - Software cold restart - Software warm start or RESET - Software acknowledgment 	<ul style="list-style-type: none"> - Switch RUN/STOP from STOP to RUN - Program launch through software - Software warm restart - Software cold restart - Power on - Software acknowledgment in the "STATUS" window - Acknowledgment through programming - Test button on the 30 and 90 series remote units 	<ul style="list-style-type: none"> - Automatic acknowledgment if the error code ≤ 15

Diagnosis

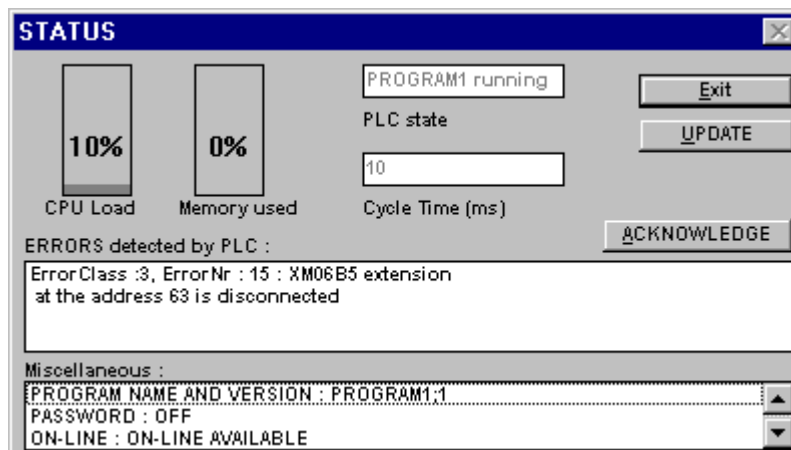


Figure 8-2 : AC31GRAF status window

Diagnosis

3. Status through software

Detailed information concerning the status of the central unit can be obtained in AC31GRAF by clicking the *"PLC status information (diagnosis)"* icon in the Control window.

Once the status window is opened (Figure 8-2), the data remains until the window is opened again or until updated using the *"UPDATE"* button.

- ⇒ The errors are described under the *"Errors detected by PLC"* message.
 - ⇒ An error can be acknowledged by the software as soon as it has been detected and corrected by clicking on the *"ACKNOWLEDGE "* button.
-

4. Error management through programming

Programming error management enables the central unit to, immediately, take an error into account and allows the programming of an instantaneous reaction.

4.1. Description of the diagnosis variables

Each error is identified by a class number, an error code within that class and the arguments. Only one error per class may be memorized and detailed by the central unit within a pre-defined group of internal variables.

The variable values can be accessed by the user for program error management.

Comment: The class and error codes can also be accessed through the "STATUS" window in AC31GRAF. The arguments are converted and displayed in text form.

Diagnosis

	Class 1 errors: fatal errors	Class 2 errors: serious errors	Class 3 errors: light errors	Class 4 errors: warnings
Error signaled by the error bit:	M 255.10 = 1			
Type of error signaled by:	M 255.11 = 1	M 255.12 = 1	M 255.13 = 1	M 255.14 = 1
Error code in:	MW 254.00	MW 254.08	MW 255.00	MW 255.08
Detailed information in :				
Information 1	MW 254.01	MW 254.09	MW 255.01	MW 255.09
Information 2	MW 254.02	MW 254.10	MW 255.02	MW 255.10
Information 3	MW 254.03	MW 254.11	MW 255.03	MW 255.11
Information 4	MW 254.04	MW 254.12	MW 255.04	
Hard version of unit*	MW 254.05	MW 254.13	MW 255.05	} } } MW 255.12 MW 255.13 & MW 255.14
Soft version of unit*	MW 254.06	MW 254.14	MW 255.06	
Unit serial number*	MW 254.07	MW 254.15	MW 255.07	
Acknowledgment through programming in the central unit This acknowledgment only acknowledges the errors on the central unit not those signaled by a remote unit			By setting M 255.13 to 0 after the disappearance of the error	By setting M 255.14 to 0 after the disappearance of the error
Acknowledgment through programming in the central unit and remote units			With the CS31QU function block	

* Information unavailable on certain AC 31 units

The error bit M 255.10 is 1 if any of the error bits M 255.11 to M 255.14 are at 1. The central unit has not found an error if M 255.10 = 0.

The error bit M 255.10 is automatically reset to 0 when the error type bits are acknowledged.

A class 4 error (M 255.14=1) when MW 255.08 ≤ 15 acknowledges automatically. Class 3 or 4 type errors may be acknowledged by setting M 255.13 or M 255.14 to 0.

The information word values are updated with each new error. Resetting these words to 0 is not automatic when acknowledged but may be achieved by writing, on-line or through programming, a 0 value in these words.

MW 255,12 gives information about versions (hard & soft) value in decimal and must be interpreted in hexadecimal.

Diagnosis

4.2. Correspondence table between the error and the diagnosis variable values

Signification of the error tables:

- Memory address = program memory address where the error was detected.

- Address = unit or defective extension address

- Channel number = number of the defective channel

- Unit type: 000 Binary inputs

001 Analog inputs

002 Binary outputs

003 Analog outputs

004 Binary inputs / outputs

005 Analog inputs / outputs

016 XO 08 R1

017 XI 16 E1

018 XC 08 L1

019 ICMK 14 F1

020 ICMK 14 N1

023 XK 08 F1

024 XO 16 N1

025 XO 08 Y1

026 XO 08 R2

080 XM 06 B5

081 XE 08 B5

082 XTC 08

192 ASI-GATEWAY

224 07 CR 41

225 07 KR 51

226 07 CT 41

227 07 KT 51

255 Master or slave central unit where the error was detected and memorized.

Diagnosis

4.3. Class error descriptions:

4.3.1. Class 1 error descriptions

Class 1 error descriptions	Error code in MW254.00		Info 1 in MW 254.01	Info 2 in MW 254.02	Info 3 in MW 254.03
	Dec	Hex			
Flash EPROM checksum error	-	-	-	-	-

4.3.2. Class 2 error descriptions

Class 2 error descriptions	Error code in MW254.08		Info 1 in MW 254.09	Info 2 in MW 254.10	Info 3 in MW 254.11
	Dec	Hex			
Defective RAM (user program or data memory)	128 _D	80 _H	Memory address	-	-
Too many simultaneous timers active on the central unit during program execution (maximum 42)	255 _D	FF _H	-	-	-

4.3.3. Class 3 error descriptions

Class 3 error descriptions	Error code in MW255.00		Info 1 in MW 255.01	Info 2 in MW 255.02	Info 3 in MW 255.03
	Dec	Hex			
Unit disconnected	15 _D	0F _H	Unit type	Address	-
CS 31 bus error (no units connected to the bus) Note: If there are only analog units connected to the CS 31 bus, then this error could occur when powering up while the analog units aren't initialized. Reason: Analog units have a lengthy initialization period. They are recognized thereafter by the central unit	16 _D	10 _H	-	-	-
NCB or NCBR error Note: one of the CS 31 lines is defective. Check the red Led status of the NCB or NCBR to find out which one is at fault.	17 _D	11 _H	-	-	-
Superposed address	18 _D	12 _H			
Cycle time too short	200 _D	C8 _H	-	-	-

Diagnosis

4.3.4. Class 4 error descriptions

Class 4 error descriptions	Error code in MW255.08		Info 1 in MW 255.09	Info 2 in MW 255.10	Info 3 in MW 255.11
	Dec	Hex			
Internal unit error	1 _D	01 _H	Unit type	Address	Channel number
Cut wire (detection of open circuit)*	2 _D	02 _H	Unit type	Address	Channel number
Analog output level error	3 _D	03 _H	Unit type	Address	Channel number
Overload	4 _D	04 _H	Unit type	Address	Channel number
Defective 10V output	5 _D	05 _H	Unit type	Address	Channel number
Overload and cut wire*	6 _D	06 _H	Unit type	Address	Channel number
Short circuit	8 _D	08 _H	Unit type	Address	Channel number
Short-circuit + cut wire*	10 _D	0A _H	Unit type	Address	Channel number
Overload + short-circuit	12 _D	0C _H	Unit type	Address	Channel number
Short-circuit + overload + cut wire*	14 _D	0E _H	Unit type	Address	Channel number
The end of the program is not detected by the system during startup.	129 _D	81 _H	-	-	-
A program syntax error is detected by the system during startup	131 _D	83 _H	Program address	-	-
Too many historical values are detected by the system during startup (max. 256)	132 _D	84 _H	-	-	-
The cycle time is missing and detected by the system during startup	133 _D	85 _H	-	-	-
A missing label for a conditional step is detected by the system during startup.	135 _D	87 _H	Program address	-	-
The program is not launched due to the number of units initialized on the CS 31 bus being inferior to the number specified during the configuration	138 _D	8A _H	Number of units chosen during configuration	Number of actual units on the CS31 bus	-
The program is too large for the memory size	140 _D	8C _H	-	-	-
The system detects a missing end of sub-program or missing program during startup	142 _D	8E _H	-	-	-
The system detects a missing program interrupt or an interrupt validation.	143 _D	8F _H	-	-	-
The system detects too many sub-programs (max. 12) during startup.	144 _D	90 _H	-	-	-
The system detects too many historical values in the sub-programs during startup. (max. 128 = Sum of nb of calls x nb of historical values in the sub-programs)	145 _D	91 _H	-	-	-
The system does not detect a sub-program, corresponding to a call, during startup	146 _D	92 _H	-	-	-

* error detected if previously configured through programming the CS31CO block

Diagnosis

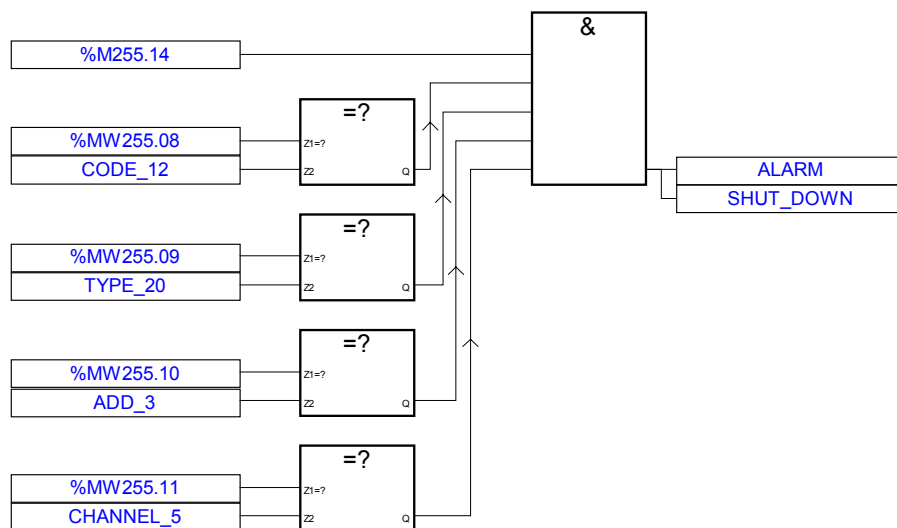
4.4. Programming examples

4.4.1. Example of a reaction / command following a specific error

The following example enables commanding an alarm following an overload or short circuit on the number 5 output of a ICMK 14 N1 remote unit with address 3 on the CS 31 bus. Another output is also activated at the same time as the alarm in order to, for example, issue a cut the actuators power command.

This is a class 4 type error and uses the following variables:

- *M 255.14* : class 4 error presence bit
- *MW 255.08* : the error code
- *MW 255.09* : the unit type
- *MW 255.10* : the unit address
- *MW 255.11* : the defective channel number



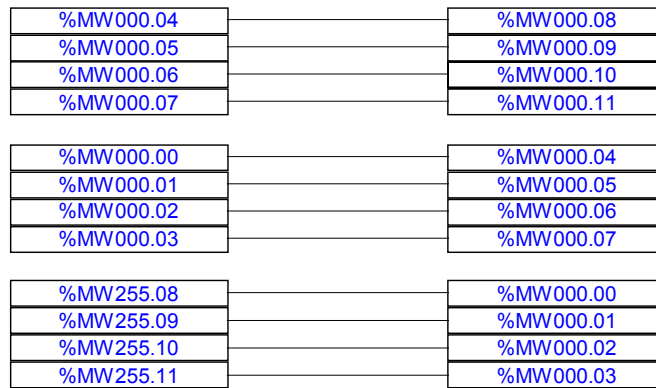
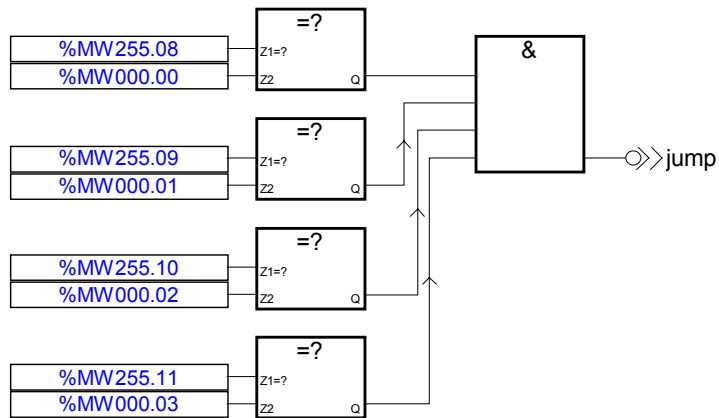
Diagnosis

4.4.2. Example for saving numerous errors of the same class

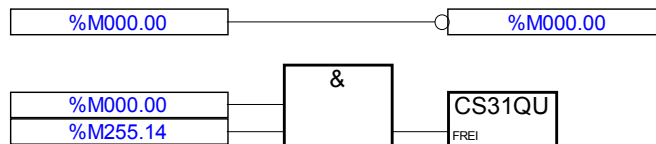
Only one error can be memorized and detailed in the internal diagnosis on the 40 and 50 series central units. An automatic programmed acknowledgment enables reading other eventual errors. An adapted program enables saving them when necessary.

The program in this case is applied to class 4 errors but may also be applied to class 3 errors. In the present case the last three errors are only saved if the occurred error is different to the previous.

The *M 255.14* bit signals the error presence. At that moment, if the *M 000.00* status is 1 then the error is acknowledged due to the CS31QU block.



jump:



AC 31 technical documentation

Additional information

Annexes

Annexes

1. List of variables

The variables used by the AC 31 central units are of different types:

- Bit variables (status 0 or 1)
- Word variables (range -32768 to 32767)
- Double word variables (range -2147483648 to 2147483647)
- Texts (ASCII characters)

The authorized variables for the 40 and 50 series are:

Inputs

I00.00...I61.15	binary inputs of the remote units on the CS 31 bus
I62.00...I62.07	binary inputs of the central unit
I63.00...I68.15	extension binary inputs on a central unit
IW00.00...IW61.15	analog inputs of the remote units on the CS 31 bus
IW62.00	value of potentiometer 0 (range 0-150)
IW62.01	value of potentiometer 1 (range 0-150)
IW62.08...IW62.14	Clock read
IW62.15	CS 31 bus status
IW63.00...IW68.15	extension analog inputs on a central unit

Outputs

O00.00...O61.15	binary outputs of the remote units on the CS 31 bus
O62.00...O62.05	binary outputs of the central unit
O63.00...O68.15	extension binary outputs on a central unit
OW00.00...OW61.15	analog outputs of the bus remote units
OW63.00...OW68.15	extension analog outputs on a central unit

Annexes

Internal variables

M00.00...M99.15

M230.00...M254.15

internal bits

M255.00...M255.15

system bits

S00.00...S125.15

chain steps

K00.00...K00.01

bit constants

MW00.00...99.15

MW230.00...MW253.15

internal words

MW254.00...MW255.15

diagnosis words

KW01.00...KW31.15

word constants

MD00.00...MD07.15

internal double words

KD00.01...KD07.15

double word constants

Constants

xxxxx

direct value (for example #123)

#H

hexadecimal direct value (#H 0000 ...#H FFFF)

Time values for the timer functions

KD01.00...KD07.15

double word constants

MD00.00...MD07.15

internal double words

Text

Any ASCII character. These variables are only used for emission and reception of ASCII frames via the serial interface (refer to the SEND and RECEIVE functions).

Annexes

The KW00.00...KW00.15 and KD00.00 variables are called system constants and are only accessible through the configuration menu of the AC31GRAF programming software or directly through Windows HyperTerminal

Diagnosis variables

sum of errors		M255.10 indicates that the central unit has detected an error
fatal error	Class 1	M255.11 detailed information in MW254.00...MW254.07
serious error	Class 2	M255.12 detailed information in MW254.08...MW254.15
light error	Class 3	M255.13 detailed information in MW255.00...MW255.08
warning	Class 4	M255.12 detailed information in MW255.08...MW255.15

M255.00	oscillator with a frequency of 2 Hz
M255.01	oscillator with a frequency of 1 Hz
M255.02	oscillator with a frequency of 0.5 Hz
M255.03	oscillator with a 1 minute period

M255.06	Switch MODBUS [®] / active Mode for COM2
M255.07	Watchdog MODBUS [®] COM2
M255.08	Watchdog MODBUS [®] COM1
M255.09	Switch MODBUS [®] / active Mode for COM1

M255.15 this bit may be used for detecting the first cycle. It is always reset to "zero" at each program launch independently of the bit backup area chosen. This bit may be read by the user and set to 1 at the end of the first cycle.

Status of the CS 31 bus

IW62.15	
bit 0:	not used
bit1 = 1:	the central unit was initialized on the CS 31 bus (only valid for the slave central units)
bits 2 to 7:	not used
bit 8 to 15:	maximum number of units initialized on the CS 31 bus (only significant for the CS 31 bus master central units).

Clock

IW62.08:	seconds (0...59)
IW62.09:	minutes (0...59)
IW62.10:	hours (0...23)
IW62.11:	day of the week (1...31)
IW62.13:	month (1...12)
IW62.14:	year (0...99)

The clock may be updated with the configuration editor of the AC31GRAF programming software or by the UHR function.

Annexes

2. List of functions

Binary functions		Runtimes (time in μs)
&, AND	AND	5.1
/, OR	OR	6
=	Allocation	3.9
=1	Exclusive OR	8.8
=R	Allocation reset memory	4.4
=S	Allocation set memory	4.45
I+	Pulse positive edge	8.95
I-	Pulse negative edge	10.6
MAJ	Majority	-
RS	Set memory dominating to 1	8.8
SR	Set memory dominating to 0	8.8

Timer functions		Runtimes (time in μs)
ASV	OFF delay	124
ESV	ON delay	124
MOA	Monostable element "abort"	167
MOAT	Monostable element "abort" with time	213
MOK	Monostable element "constant"	170
PDM	Pulse duration modulator	640
TIME_W	Conversion Time into words	
TOF	OFF delay with time visualization	167
TON	ON delay with time visualization	210
TP	Monostable element "constant with time visualization"	208
W_TIME	Conversion words into time	

Annexes

Counter functions		Runtimes (time in μs)
CTU	Counter	430
CTUH	Counter for encoder inputs	560
VRZ	Up/down counter	190

Comparison functions		Runtimes (time in μs)
<	Less than	13.1
<=	Less than or equal to	12.4
<>	Unequal	13.3
=?	Equal to	13.3
>	Greater than	12.4
>=	Greater than or equal to	13.1
<D / VKLD	Less than, double word	107
=?D / VGLD	Equal, double word	110
>D / VGRD	Greater than, double word	108

Arithmetic functions		Runtimes (time in μs)
=W	Word allocation	8.1
+	Addition	12.8
-	Subtraction	13.8
*	Multiplication	31.8
: / DIV	Division	142
*: / MULDI	Multiplication with division	186
BETR	Absolute value	23.3
MUL2N	Multiplication by 2 to the power of N	36.2
NEG	Negation	10.6
ZUDKW	Allocation of a direct constant to a word	17
+D / ADDD	Addition, double word	114
-D / SUBD	Subtraction, double word	116
*D / MULD	Multiplication, double word	380
:D / DIVD	Division, double word	504
=D / ZUWD	Allocation, double word	40.5
SQRT	Square root	572

Annexes

Word logical functions		Runtimes (time in μs)
WAND	AND bit to bit	22.7
WOR	OR bit to bit	22.7
WXOR	Exclusive OR bit to bit	22.6
DWAND	AND combination, double word	38
DWOR	OR combination, double word	39
DWXOR	Exclusive OR combination, double word	38

Program control functions		Runtimes (time in μs)
=PE	Conditional program end	100
CAL_FB	Sub-program call	
DI	Read direct input	
DO	Write direct output	
VTASK	Interruptions validation	

CS 31 bus functions		Runtimes (time in μs)
CONFIO1	Configuration of one analog channel	
CONFIO4	Configuration of four analog channels	
CONFIO8	Configuration of eight analog channels	
CS31CO	Configuration of the CS 31 bus units	180
CS31QU	Error acknowledgment of units on the CS 31 bus	27.5
MT_CS31	Data sent by CS 31 master	895
MR_CS31	Data received by CS 31 master	
ST_CS31	Data sent by CS 31 slave	
SR_CS31	Data received by CS 31 slave	

Communication functions		Runtimes (time in μs)
MODBUS [®]	MODBUS [®] master (for serial line COM1)	
MODMASTK	MODBUS [®] master (for different ports)	
REC / EMAS	ASCII character receptions via the serial interface and RECvars	
SEND / DRUCK	Sending ASCII characters via the serial interface	
SINIT	Initialization and configuration of the serial interface	100

Regulation functions		Runtimes (time in μs)
PI	Proportional-integral controller	1600
PIDT1	Proportional-integral controller with derivative	1600

Annexes

Format conversion functions		Runtimes (time in μs)
BCDDUAL / BCDBIN	BCD to binary conversion	72.5
DUALBCD / BINBCD	Binary to BCD conversion	107
DWW	Double word to word conversion	97
PACK4	Pack 4 bits in a word	355
PACK8	Pack 8 bits in a word	650
PACK16	Pack 16 bits in a word	1220
UNPACK4	Unpack a word to 4 bits	325
UNPACK8	Unpack a word to 8 bits	615
UNPACK16	Unpack a word to 16 bits	1200
WDW	Word to double word conversion	

High order functions		Runtimes (time in μs)
AWT	Word selection gate	22
AWTB	Bit selection gate	38.4
BEG	Limiter	
BMELD	Binary values change indicator	1430
IDLB	Read binary variable, indexed	209
IDSB	Write binary variable, indexed	201
IDLm / IDL	Indexed reading of words	27.4
IDSm / IDS	Indexed writing of words	38.6
LIZU	List allocation	139
MAX	Maximum value	426
MIN	Minimum value	430
NPULSE	Pulse generator for a step motor	386
UHR	Clock	430

Memory access		Runtimes (time in μs)
COPY	Copy a memory area	258
WOL	Read word with validation	21.5

Annexes

3. Mapping

This paragraph describes the correspondence between the variables and their physical memory addresses. This information is necessary for certain functions such as COPY, data exchange between CS 31 bus master and slave central units.

The variable address is given by the segment and offset value.
These values are expressed in hexadecimal and decimal formats.

H0000 is the segment for all variables.

The correspondence between the variable and the offset is given in the following table:
8 bits used 1 byte – 1 word used 2 bytes.

Mapping addressing method:

VAR 00.00 \longrightarrow ADDR 0

1- Bits: (VAR = type I,O,S,M,) (Address of the first selected variable in decimal)

$$\text{VAR XX.YY} = \text{ADDR 0} + (\text{XX} * 2)$$

Warning: for variable type M, you have two area and you have to use M 000.00 = ADDR 0 for the first area, and M 230.00 = ADDR 0 for the second area.

2- Words: (VAR = type IW,OW,KW,MW,) (Address of the first selected variable in decimal)

$$\text{VAR XX.YY} = \text{ADDR 0} + (\text{XX} * 32) + (\text{YY} * 2)$$

Warning: for variable type KW the ADDR 0 is 28672 and for variable type MW, you have two area and you have to use MW 000.00 = ADDR 0 for the first area, and MW 230.00 = ADDR 0 for the second area.

3- Double words: (VAR = type MD,KD) (Address of the first selected variable in decimal)

$$\text{VAR XX.YY} = \text{ADDR 0} + (\text{XX} * 64) + (\text{YY} * 4)$$

Example : Find the mapping address of variables O 62.00 and OW 62.15, MW 240,15 and MD002.07

$$\text{O 62.00} = 6912 + (62 * 2) = \mathbf{7036}$$

$$\text{OW 62.15} = 18432 + (62 * 32) + (15 * 2) = \mathbf{20446}$$

$$\text{MW 240.15} = 10368 + (10 * 32) + (15 * 2) = \mathbf{10718}$$

$$\text{MD 002.07} = 15872 + (2 * 64) + (7 * 4) = \mathbf{16028}$$

Annexes

Mapping (Cont.)

Variables	Physical addresses	
	In hexadecimal	In decimal
I00.00...I00.07 / I00.08...I00.15 I01.00...I01.07 / I01.08...I01.15 I02.00...I02.07 / I02.08...I02.15	1900 / 1901 1902 / 1903 1904 / 1905	6400 / 6401 6402 / 6403 6404 / 6405
I61.00...I61.07/ I61.08...I61.15 I62.00...I62.07/ I62.08...I62.15	197A / 197B 197C / 197D	6522 / 6523 6524 / 6525
I68.00...I68.07/ I68.08...I68.15	1988 / 1989	6536 / 6537
M00.00...M00.07/M00.08...M00.15 M99.00...M99.07/M99.08 M99.15	1A00 / 1A01 1AC6 / 1AC7	6656 / 6657 6854 / 6855
M230.00...M230.07/M230.08 M230.15 M255.00...M255.07/M255.08 M255.15	1AC8 / 1AC9 1AFA / 1AFB	6856 / 6857 6906 / 6907
O00.00...O00.07/ O00.08...O00.15 O01.00...O01.07/ O01.08 O01.15 O02.00...O02.07/ O02.08 O02.15 O61.00...O61.07/ O61.08 O61.15 O62.00...O62.07/ O62.08 O62.15 O68.00...O68.07/ O68.08 O68.15	1B00 / 1B01 1B02 / 1B03 1B04 / 1B05 1B7A / 1B7B 1B7C / 1B7D 1B88 / 1B89	6912 / 6913 6914 / 6915 6916 / 6917 7034 / 7035 7036 / 7037 7048 / 7049
S00.00...S00.07/ S00.08...S00.15 S01.00...S01.07/ S01.08 S01.15 S125.00...S125.07/ S125.08 S125.15	3D00 / 3D01 3D02 / 3D03 3DFA / 3DFB	15616 / 15617 15618 / 15619 15866 / 15867

Annexes

Mapping (Cont.)

Variables	Physical addresses	
	In hexadecimal	In decimal
OW00.00 OW00.01	4800 4802	18432 18434
OW00.15	481E	18462
OW62.00	4FC0	20416
OW68.15	509E	20638
KW01.00 KW01.01	7020 7022	28704 28706
KW01.15	703E	28734
KW31.15	73FE	29694
KD00.00 KD00.01	7400 7404	29696 29700
KD00.15	743C	29756
KD07.15	75FC	30204
IW00.00 IW00.01	5200 5202	20992 20994
IW00.15	521E	21022
IW62.00	59C0	22976
IW68.15	5A9E	23198
MW00.00 MW00.01	1C00 1C02	7168 7170
MW99.00	2860	10336
MW99.15	287E	10366
MW230.00	2880	10368
MW230.15	289E	10398
MW255.15	2BBE	11198
MD00.00 MD00.01	3E00 3E04	15872 15876
MD00.15	3E3C	15932
MD07.15	3FFC	16380

Annexes

4. Historical values

Historical values are central unit specific internal variables which enable memorizing a functions intermediate results required for numerous cycles.

In fact, certain functions require the results obtained during cycle N-1 so that cycle N will execute correctly (for example: the PI and PIDT1 controllers).

The total number of available historical values, in the 40 and 50 series central units, is 256.

The functions and the number of historical values which they use are given in the following table:

Timer functions	
-----------------	--

ASV	2 (supplementary memory for the timers limited to 42 variables)
ESV	2 (supplementary memory for the timers limited to 42 variables)
MOA	2 (supplementary memory for the timers limited to 42 variables)
MOK	2 (supplementary memory for the timers limited to 42 variables)
PDM	1 (supplementary memory for the timers limited to 42 variables)
TOF	2 (supplementary memory for the timers limited to 42 variables)
TON	2 (supplementary memory for the timers limited to 42 variables)
TP	2 (supplementary memory for the timers limited to 42 variables)

Counter functions	
-------------------	--

CTU	2
CTUH	2
VRZ	3

Annexes

CS 31 bus functions

CONFIO1	3
CONFIO4	3
CONFIO8	3
CS31CO	1
MT_CS31	
MR_CS31	
ST_CS31	
SR_CS31	

Communication functions

MODBUS®	2
REC / EMAS and RECvars	1
SEND / DRUCK	2
SINIT	1

Controller functions

PI	3
PIDT1	5

High order functions

BMELD	3 + number of inputs E
NPULSE	1
UHR	1

Annexes

5. Table of suitable contactors controlled by AC31 relays outputs

Contactor Type	Pull-in power VA	AC Voltage coil				Max. allowable current on AC15 (I / Ie = 10)					
		230	115	48	24	All coil voltages		5 (up to 250 Vac)			
A9	80	direct	direct	direct	direct	Max. allowable current on DC13 (I / Ie = 1)					
A12	80	direct	direct	direct	direct	Ie (240V)	Ie (160V)	Ie (130V)	Ie (92 V)	Ie (48V)	Ie (24V)
A16/UA16	80	direct	direct	direct	direct	0,04	0,04	0,4	0,4	1,5	2
A26/UA26	140	direct	direct	direct	B6						
A30/UA30	140	direct	direct	direct	B6						
A40	140	direct	direct	direct	B6						
A45	210	direct	direct	direct	B6						
A50/UA50	210	direct	direct	direct	B6						
A63/UA63	210	direct	direct	direct	B6						
A75/UA75	210	direct	direct	direct	B6						
A95/UA95	450	direct	direct	B6	B6						
A110/UA110	450	direct	direct	B6	B6						
A145	700	direct	B6	B6	B6						
A185	700	direct	B6	B6	B6						
A210	1700	B6	B6	B6	B6						
A260	1700	B6	B6	B6	B6						
A300	1700	B6	B6	B6	B6						
EK110	900	direct	B6	B6	B6						
EH145	490	direct	direct	B6	B6						
EK150	900	direct	B6	B6	B6						
EH175	900	direct	B6	B6	B6						
EH210	900	direct	B6	B6	B6						
EK175	1200	B6	B6	B6	B6						
EK210	1200	B6	B6	B6	B6						
EH260	1200	B6	B6	B6	B6						
EH300	1200	B6	B6	B6	B6						
EH370	2900	B6	B6	B6	B6						
EK370	4000	B6	B6	B6	B6						
EH550	2900	B6	B6	B6	B6						
EK550	4000	B6	B6	B6	B6						
EH700	4000	B6	B6	B6	B6						
EH800	4000	B6	B6	B6	B6						
Contactor Type	Pull-in power W	DC Voltage coil									
		220	110	48	24						
BC9	7	direct	direct	direct	direct						
BC16	7	direct	direct	direct	direct						
BC25	7	direct	direct	direct	direct						
BC30	7	direct	direct	direct	direct						
AE50	200	BC6	BC6	BC6	BC6						
AE63	200	BC6	BC6	BC6	BC6						
AE75	200	BC6	BC6	BC6	BC6						
AE95	400	BC6	BC6	BC6	BC6						
AE110	400	BC6	BC6	BC6	BC6						
TAE75	450	BC6	BC6	BC6	BC6						
TAE110	950	BC6	BC6	BC6	BC6						
Contactor Type	Pull-in power VA/W	AC Voltage coil				DC Voltage coil					
		240	160	130	92	240	160	130	92		
AF45	210	direct	direct	direct	direct	BC6	BC6	BC6	BC6		
AF50	210	direct	direct	direct	direct	BC6	BC6	BC6	BC6		
AF63	210	direct	direct	direct	direct	BC6	BC6	BC6	BC6		
AF75	210	direct	direct	direct	direct	BC6	BC6	BC6	BC6		
AF95	450	direct	direct	direct	direct	BC6	BC6	BC6	BC6		
AF110	450	direct	direct	direct	direct	BC6	BC6	BC6	BC6		

Index

Index

Index

07 CR 41,1-13, 3-8, 3-9, 3-10, 3-11, 8-9
07 CT 41,1-13, 3-8, 3-9, 3-10, 3-11, 8-9
07 KR 51,1-13, 3-8, 3-9, 3-10, 3-11, 5-21, 7-3, 8-9
07 KT 51,1-13, 3-8, 3-9, 3-10, 3-11, 5-21, 8-9
07 ST 51,1-20, 3-36, 3-38, 3-39, 4-15

40 series,1-3, 1-13, 3-8, 3-9, 3-10, 3-11, 5-8, 5-10, 7-13

50 series,1-3, 1-5, 1-7, 1-13, 3-7, 3-8, 3-9, 3-11, 3-29, 3-33, 3-37, 3-39, 4-5, 4-21, 4-25, 5-3, 5-8, 5-10, 5-11, 5-14, 5-24, 5-25, 5-42, 5-45, 6-9, 6-11, 6-15, 7-2, 7-3, 7-4, 7-5, 7-7, 7-10, 7-13, 7-14, 7-17, 7-18, 8-3, 8-13, 2, 12

A

AC31GRAF,1-7, 1-9, 1-13, 2-2, 2-3, 2-4, 2-5, 2-15, 3-9, 4-16, 4-17, 4-23, 5-2, 5-9, 5-17, 5-25, 5-27, 6-3, 6-4, 6-7, 6-15, 7-6, 7-7, 7-8, 7-16, 7-17, 7-18, 8-6, 8-7, 4
Acknowledgment,8-5, 8-8
Acquisition time,3-22
Addressing,4-17, 4-21, 4-22, 4-23, 4-24, 8-3
Ambient conditions,3-3
Analog input,3-8, 3-20, 3-22, 3-24, 5-5, 7-12, 8-9
Analog output,3-8, 3-20, 3-23, 3-27, 5-6, 7-12, 8-3, 8-9, 8-11
ASCII,3-31, 3-33, 3-35, 5-15, 5-17, 7-16, 7-17, 7-18, 2, 3, 7

B

Balco500,3-22, 3-26
Binary input,3-8, 3-17, 5-5, 7-11, 8-9
Binary output,3-8, 3-17, 5-6, 7-11, 8-9

C

Cable,1-19, 3-10, 3-11, 3-14, 3-15, 3-18, 3-19, 3-22, 3-23, 3-29, 5-15
Cabling,1-5, 3-31, 3-35, 3-38, 4-7, 4-10, 4-13, 4-15
Cage-clamp,1-20, 3-37
Central unit,1-5, 1-10, 1-11, 1-13, 1-14, 2-10, 2-11, 3-7, 3-41, 4-11, 5-7, 5-10, 5-14, 7-7
Chain,3-9, 5-6, 5-13
Channel,3-21, 5-30, 8-9, 8-11
Clock,3-9, 5-25, 2, 4, 8
Communication mode,5-15, 7-7, 7-17
Configuration,2-11, 3-23, 3-39, 4-16, 5-9, 5-27, 5-32, 6-15, 7-17, 7
Connector,1-20, 3-4, 3-17, 3-21, 3-37
Consumption,3-10, 3-14
Counter,3-9, 5-3, 6, 12
CS31 bus,1-5, 5-21, 6-15, 7-7, 8-11
Current,3-22, 3-23, 3-24, 3-27
Cycle time,5-20, 7-14, 8-3, 8-10

D

Data,3-8, 5-11, 6-16, 6-19, 6-20, 7-5, 7
Data backup,3-8, 5-11
Diagnosis,3-22, 3-23, 7-4, 8-1, 4
Display,1-16, 1-19, 2-7, 3-20, 3-22, 3-40, 3-41

E

Earthing,4-4, 4-5
Error,7-5, 8-2, 8-3, 8-5, 8-7, 8-8, 8-10, 8-11, 7
Exchange,6-16
Extensible remote unit,1-16, 3-13, 4-25
Extension,1-16, 3-41, 4-12, 4-13, 4-15, 5-22

F

Filtering time,3-10, 3-18, 5-33
Flash EEPROM,5-7, 5-9, 5-10

H

Hardware,5-29
High speed counter,3-9, 5-22, 6-11
Historical value,5-13, 12

I

Initialization,1-11, 2-13, 5-7, 5-12, 5-13, 5-14, 7
Interruption,3-9, 6-7, 6-8, 7

L

List of functions,5
List of variables,5-4, 2

M

Master,4-18, 4-25, 5-10, 6-15, 8-9
Memory,3-8, 5-3, 6-20, 8-9, 8-10, 8
MODBUS,1-15, 3-7, 3-8, 3-31, 3-33, 3-35, 3-40, 5-15, 5-17, 7-3, 7-4, 7-5, 7-7, 7-9, 7-10, 7-11, 7-12, 7-13, 7-14, 7-17, 7-21, 7, 13
Modular,5-2

N

Network,7-2, 7-3
NI 1000,3-22, 3-25

O

Oscillator,5-42
Overload,8-11

Index

P

Password,5-26, 5-27
Physical addresses,10, 11
Potentiometer,3-7
Programming,2-5, 3-8, 3-9, 3-29, 5-1, 5-15, 5-17, 5-35,
6-3, 6-7, 6-16, 7-10, 7-17, 7-18, 8-7, 8-12
Project,2-4, 2-5, 2-9, 2-15
Protocol,3-5, 7-3, 7-4, 7-17
Pt 100 / Pt 1000,3-22, 3-24, 5-31
Push button,5-30

R

RAM,1-11, 5-7, 8-3, 8-10
Reception,5-11
Reference,1-13, 1-14, 1-15, 1-16, 1-17, 1-18, 1-19, 1-20
Refresh time,1-10, 3-5
Relay,4-10
relays outputs,14
Reply time,7-14
RS232,1-13, 1-15, 1-19, 3-8, 7-3, 7-4
RS485,1-9, 1-13, 1-15, 3-8, 7-3, 7-4
RTS signal,3-31, 3-35, 5-17

S

Scale,3-22
Serial interface,2-10, 3-4
Short circuit,3-10, 3-11, 3-14, 3-15, 3-19, 8-11
Slave,5-10, 5-21, 6-14, 6-15, 6-19
Software,1-11, 5-2, 5-7, 8-5
Stand-alone,3-9, 5-7, 5-10
Step motor,6-9, 6-10
Sub-program,3-9, 6-3, 7
Switches,3-21

T

TC50,3-37, 3-40
Timer,3-9, 5-3, 5-39, 5, 12
Transistor,4-10
Transmission,3-5, 5-11, 6-17, 7-4, 7-7

V

Voltage,3-4, 3-10, 3-22, 3-23, 3-24, 3-27, 5-31, 5-46

W

Warm,5-7
Warning,3-18, 3-22, 3-39, 4-3, 4-7, 4-11, 4-13, 4-15, 4-21,
5-14, 6-15, 9
Weight,3-10, 3-14, 3-18, 3-22
Word,3-9, 3-22, 3-23, 5-6, 7-14, 2, 6, 7, 8, 9

X

XC 08 L1,1-16, 1-20, 3-16, 3-18, 3-19, 3-37, 4-13, 5-22,
8-9
XE 08 B5,1-16, 1-20, 3-20, 3-22, 3-37, 3-38, 4-14, 4-15,
4-21, 4-25, 5-22, 5-28, 8-9
XI 16 E1,1-16, 1-20, 3-16, 3-18, 3-19, 3-37, 4-13, 5-22,
8-9
XK 08 F1,1-16, 1-20, 3-16, 3-18, 3-19, 3-37, 4-13, 5-22,
8-9
XM 06 B5,1-16, 1-20, 3-20, 3-22, 3-23, 3-37, 3-38, 4-14,
4-15, 4-21, 4-22, 4-25, 5-22, 5-28, 8-9
XO 08 R1,1-16, 1-20, 3-16, 3-18, 3-19, 3-37, 4-13, 5-22,
8-9
XO 08 R2,1-16, 3-16, 3-18, 3-19, 4-13, 5-22
XO 08 Y1,1-16, 3-16, 3-18, 3-19, 4-13, 5-22
XO 16 N1,1-16, 1-20, 3-16, 3-18, 3-19, 3-37, 4-13, 5-22,
8-9
XTC 08,1-16, 3-20, 3-22, 4-21, 4-25, 5-22, 5-41, 8-9




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