domat
MEMBER OF CEZ ESCO

Designer’s handbook

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1 Prerequisites and targets

Prerequisites:

The plant technology schema is available, there is a knowledge on functions of the peripherals and their mutual bindings. The dimensions of the valves are calculated, actuators selected, and sensors and other I/O peripherals specified. The designer knows which other technologies shall be integrated into the system, if this integration follows through analogue and digital signals, or data communication buses, and what their logical functions with the HVAC control system will be. It is known where the cabinets will be located, and where the cable trays will be mounted.

Targets:

The system topology will be created, in which all types and amounts of I/O modules will be specified, together with their assignment to the I/O buses and process stations. It will be specified how the process stations are connected over the technological network with each other and with the management stations.

Based on this schema, the shop drawings will be created. They describe the wiring of the electrical panels of the control system inclusive links to the power parts.

2 Peripherals

In the Domat Control System product range there are especially input peripherals, which are senosrs, thermostats, and manostats. The most important items in the product range are temperature sensors, namely room sensors, pocket sensors and air duct sensors. They are supplied in length of 100 to 400 mm both with different passive measuring elements, and as active sensors (0…10 V, 4…20 mA output). Globe and semiglobe sensors, which measure also the radiating part, are perfect for applications with radiating panels or infrared panels. Average temperature sensors, showcase humidity and temperature sensors, and ceiling sensors are designed for special usage. Other room and duct sensors measure relative humidity, CO2 and VOC concentration, and other environmental parameters. PREM-1110-Display__tyr1_maxi-mL_4cWe also supply air pressure sensors with configurable range, air velocity sensors, and water pressure sensors (also differential sensors for pump operation monitoring or distributor pressure control). The sensors offer an LCD display as option. Room units are also available as anti-vandal or with customized prints.

Differential pressure sensor with LCD display

Other frequently used sensors are indoor and outdoor light and presence sensors. Domat also offers communicative sensors (Modbus over RS485), which may save cabling and I/O modules costs thanks to their bus topology. There are also thermostats, humidity and pressure switching sensors, and dew point sensors in the range. Dew point control is an issue at chilled ceilings and panels.

All sensors provide standard electrical interfaces, such as passive temperature measuring elements, 0...10 V and 0(4)…20 mA signals, or dry contacts, and they can be used with any control system. The measuring ranges are ususally set by DIP switches, and they can be adapted to local requirements.

When refurbishing a control system, it is usually possible to use the original sensors with Domat controllers. The Domat input modules provide configurable ranges for passive sensors:

- Pt100
- Pt500
- Pt1000
- Ni1000-5000 (Landis & Gyr)
- Ni1000-6180 (Sauter)
- T1 (Staefa)
- any passive sensor in the 0...5000 Ohm range

Details are in the respective product data sheets. Please respect the general sensor placement rules when designing.

3 I/O modules

The input and output modules, or I/O modules, are the interface between the process station and the peripherials. They are supplied in a range of types, according to their input and output signals:

Input modules:

R420 16 digital (on/off) inputs for 24 V AC/DC, common ground for all inputs

R430 32 digital (on/off) inputs for 24 V AC/DC, common ground for 24 and 8 inputs

R500 8 analogue inputs 0...10 V or 0...20 mA

R560 8 analogue inputs Pt100, Pt1000, Ni1000, 0...5000 Ohm, 0...10 V, 0...20 mA

R710 4 pulse counting inputs for dry contact or open collectors, up to 50 Hz, also for load shedding

Output modules:

R220 12 low voltage relay outputs 250 V / 5 A

R312 8 triac outputs 24 V AC binary or PWM

R313 8 triac outputs 230 V AC binary or PWM

R320 16 open collector binary outputs

R330 32 open collector binary outputs

R610 8 analogue outputs 0...10V

Combined modules:

RCIO 8 analogue inputs 0..10 V or temperature sensors Pt100, Pt1000, Ni1000, 4x also 0...20 mA

6 analogue outputs 0..10 V

8 binary inputs 24 V AC/DC

8 low voltage relay outputs 250 V / 5 A.

RMIO 4 analogue inputs Pt100, Pt1000, Ni1000, 2x also 0..10 V

2 analogue outputs 0..10 V

4 binary inputs 24 V AC/DC

7 binary outputs (5x relay 230 V AC, 2x SSR 24...230 V AC)

MLIO 4 analogue inputs Pt100, Pt1000, Ni1000, 0..10 V, or as a DI – for dry contact

1 analogue output 0..10 V

2 relay outputs 250 V / 5 A.

RXIO 16 analogue inputs 0..10 V or temperature sensors Pt100, Pt1000, Ni1000, 8x also 0...20 mA

8 analogue outputs 0..10 V

32 binary inputs 24 V AC

32 relay outputs 250 V / 5 A.

MW240-B Small I/O module for flush-box installation, with internal logic for control of 2 light groups or a blinds motor.
2 DI for dry contacts
2 DO – relay 230 V / 4 A

MW241 Same as MW240-B, but solid state relays instead of mechanical relays. The module is used for switching of LED light power supplies, which show capacitive characteristics and mechanical relays should not be used here.

Compatibility for replacement of older M... modules by new R... modules, IRC controllers and converters is as follows:

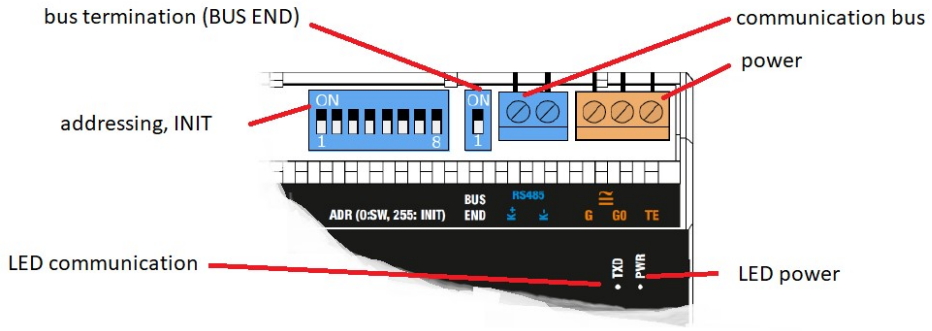
Old product	New product	Compatibility
M005	**R005**	New housing, new operating temperature range
M012	**R012**	New housing, new operating temperature range
M020	**R020**	New housing, new operating temperature range
M025	**R025**	New housing, new operating temperature range
M031	**R031**	New housing, new operating temperature range
M035	**R035**	New housing, new operating temperature range
M040	**R040**	New housing, new operating temperature range
-	**R060**	Modbus TCP – MP-Bus converter (Belimo actuators)
-	**R065**	Modbus TCP – DMX (control of lights over DMX512)
M085	**R085**	New housing, new operating temperature range
M086	**R086**	New housing, new operating temperature range
M090	**R091**	New also as multimaster. SW backward compatible. New housing: 4 DIN modules instead of 2 DIN modules!
M095	**R095**	New housing, new operating temperature range. New housing: 4 DIN modules instead of 2 DIN modules. Only 300 and 2400 bps.
M096	**R096**	New housing, new operating temperature range. New housing: 4 DIN modules instead of 2 DIN modules. Only 300 and 2400 bps.
MMIO	RMIO	Terminal reconnection necessary if module replaced. DI/AI/AO/DO6,7 now for 1,5 mm² wires, SSR now also for DC load, addressing also over DIP switches
MXIO	**RXIO**	Redesign of housing only
MCIO2	RCIO	Redesign of housing only

ECIO2	**ICIO205**	Not a 100 % replacement: customized application for ICIO205 necessary; no automatic routing, more Modbus RTU slaves must be configured manually
M200	R220	New housing, new operating temperature range. New housing: 6 DIN modules instead of 4 DIN modules. 8 more DOs.
M210	R220	More outputs, however terminals and Modbus map are compatible with M210. Now 12 DOs, new housing and new operating temperature range.
M300	R320	New housing, new operating temperature range. New housing: 6 DIN modules instead of 4 DIN modules. Small terminals instead of large terminals.
M312	R312	New housing, new operating temperature range.
M313	R313	New housing, new operating temperature range.
M320	R320	New housing, new operating temperature range. Small terminals instead of large terminals.
-	R330	New type with 32 x DO, small terminals, 6 DIN modules housing
M400	R420	New housing: 6 DIN modules instead of 4 DIN modules. Terminal reconnection necessary if module replaced. Modbus table not 100% compatible with that of M400.
M401	R420	New housing: 6 DIN modules instead of 4 DIN modules. Terminal reconnection necessary if module replaced. Modbus table not 100% compatible with that of M400.
M410	-	NO REPLACEMENT. (230 V inputs)
M411	-	NO REPLACEMENT. (230 V inputs)
M420	R420	Small terminals instead of large terminals. Common terminals for 8 and 8 inputs are now not separated. New housing, new operating temperature range.
M430	R430	New housing, new operating temperature range.
M500	R500	Small terminals instead of large terminals. DIPs for 0…20 mA at all inputs AI1-8.
M504	**R560**	Small terminals instead of large terminals, different terminal positioning. Resistance measuring ranges added. Voltage: 0…10 V only.
M560	**R560**	Small terminals instead of large terminals, different terminal positioning. DIPs for 0…20 mA at all inputs AI1-8.
M610	R610	Different terminal positioning (standardisation with other modules), new housing, new operating temperature range.
M620	-	NO REPLACEMENT. (0...20 mA outputs only)
M710	R710	Different positoining of terminals. New housing, new operating temperature range.
FC010	**FCR010**	New housing, new operating temperature range.
-	**FCR011**	Same as FCR010, with 230 V AC power and 230 V AC valve outputs
FC013	**FCR013**	New housing, new operating temperature range.
FC015	**FCR015**	New housing, new operating temperature range.

3.1 Basic properties

All modules are powered by 24 V AC, unless stated otherwise. As the module power supply contains a 2-way rectifier (Graetz bridge), the microprocessor will also work at 24 V DC, however, some outputs (e.g. triacs) require alternating current. It is thus better to keep the same power voltage across the system. The power terminals are marked **G** and **G0**. Module consumption is about 1 VA depending on module type and status of the relays, maximum consumptions for power supply dimensioning are stated in the module data sheets.

The bus communication is connected to terminals **K+** and **K-**. The RS485 is a 2-wire bus, polarity must be kept. Communication baudrate is selectable in the range of 1200 to 115200 bps, the higher value may be lower at older module types. Default factory setting is 9600 bps, which is also the recommended baudrate for normal usage.



To connect all the signals and power, removable screw terminals are used. This makes installation and service easy. The modules are snapped on a DIN rail. Most of the modules have width of 4 or 6 DIN units, see data sheets for detailed dimension description.

At the front side of the module there is a label with module name and indication LEDs. All modules have two LEDs indicating power and bus communication (transmitting), more LEDs are on modules with binary inputs and outputs to indicate states of the datapoints.

Close to the communication terminals there are switches for bus termination and initialisation. Most of the I/O modules can be addressed either using DIP switches, or software – a free program ModComTool.

3.2 Powering of I/O modules

All modules have the signal part separated from the power part by a DC/DC converter and optotransistors. This means that the signal ground is completely separated from the power part and it is possible to connect the signal ground to power supply ground, and use three-wire connection.

As some modules are able to process low voltage (relays, 230 V AC inputs), the communication part is separated as well to increase safety.

The **RCIO, RMIO** and **RXIO** compact modules have all internal parts (power – analogue inputs – analogue outputs – binary inputs – binary outputs – communication) separated from each other. Note that if active sensors are connected with 0...10 V output, the AI ground must be connected to the G0 (24 V AC ground) so that the sensor output signal has a reference potential. The same applies for analogue outputs: when the valves and damper actuators use three-wire connection (G, Y, G0) the AO ground terminal must be connected to G0.

In general, it is recommended to use a separate transformer for supplying of the peripherals at larger installations.

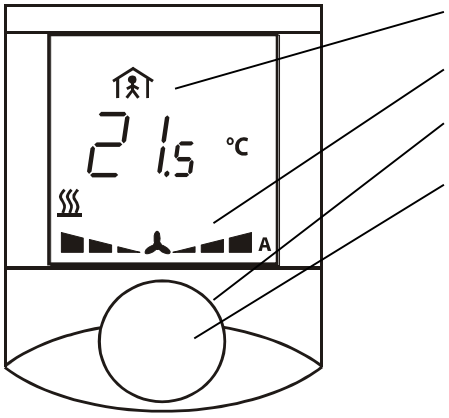
3.3 Other devices on the I/O bus

3.3.1 Room units

UI... Comunicative room units (**UI011**, **UI012**...)

The room unit has a knob for setting of temperature setpoint or setpoint correction, and a display. Its typical usage is for control of a HVAC unit or heating circuit. The room unit contains an internal temperature and humidity sensor, selected types (**UI9...**) also have a CO2 sensor. In the bottom there are two terminal bars, at some types there is only one. The terminals connect power and communication and for some types, also hardware inputs and outputs. The control unit is snapped on the base with terminals which is fixed to a flush-mount box or directly to the wall. See data sheets for details.

The room unit can be mounted directly to the wall if cable installation allows.



1 operating modes

2 fan stages

3 turn – setpoint correction

4 push – fan stage or operation mode setting

The units communicate over a 2-wire RS485 bus with Modbus protocol, same as all the other modules on the bus, and they can be connected on the same bus together with I/O modules. However, note that the response time may be slower with more units on the bus, it is advisable to use a separate bus for room units for that reason.

For installations where no user intervention is required, the room units are supplied also with no knob or with no knob nor display. In this version, they actually work as communicative sensors with additional I/Os (according to the type used). See data sheet for the complete overview and type names.

UX... Communicative room units with blinds control (**UX011**, **UX041**)

The room units are derived from the UI... range, with extra blind control functionality. The room unit has five pushbuttons instead of the knob, and two triac outputs which control the motors using power relay modules **ME200** (2 pcs. of 230 V / 5 A AC relays controlled by 24 V AC from the unit, in a small housing for flush-mount box installation).

3.3.2 Communicative controllers

UC... Communicative room controllers with Modbus / RS485 (types **UC102**, **UC200**, **UC300,** etc.)

The controllers communicate over RS485 using Modbus, same as the other I/O modules, and they can be connected to the same bus. However, this is advisable only under following conditions:

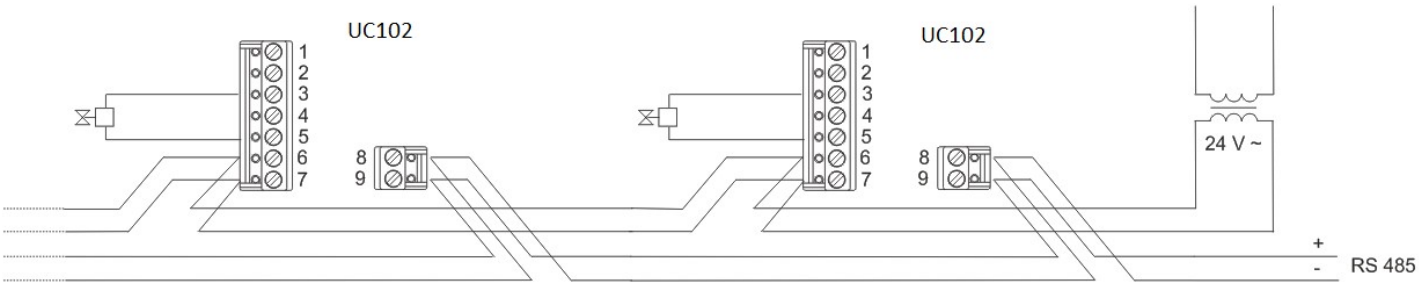
- their number is small (up to about 10), so that they do not slow down communication with the other I/O modules
- the risk of bus short circuit is acceptable (most of the bus wiring goes outside of the panel and if there is a short circuit, communication with all the I/O modules is broken)
- a connection on the process level is required, e.g. for change-over signals, heating / cooling demand signals etc.

In general, it is advisable to use a process station with more COM ports, and connect all room units and controllers to a separate bus. Even so, the last condition is met.

Note that the **UC120** and **UC220** (with 0..10 V output) use 24 V DC power only.

US... A communicative controller, derived from the UC… controllers, with blind control functionality.

All controllers can be supplied with no knob / display – please specify **.../DK** when ordering.



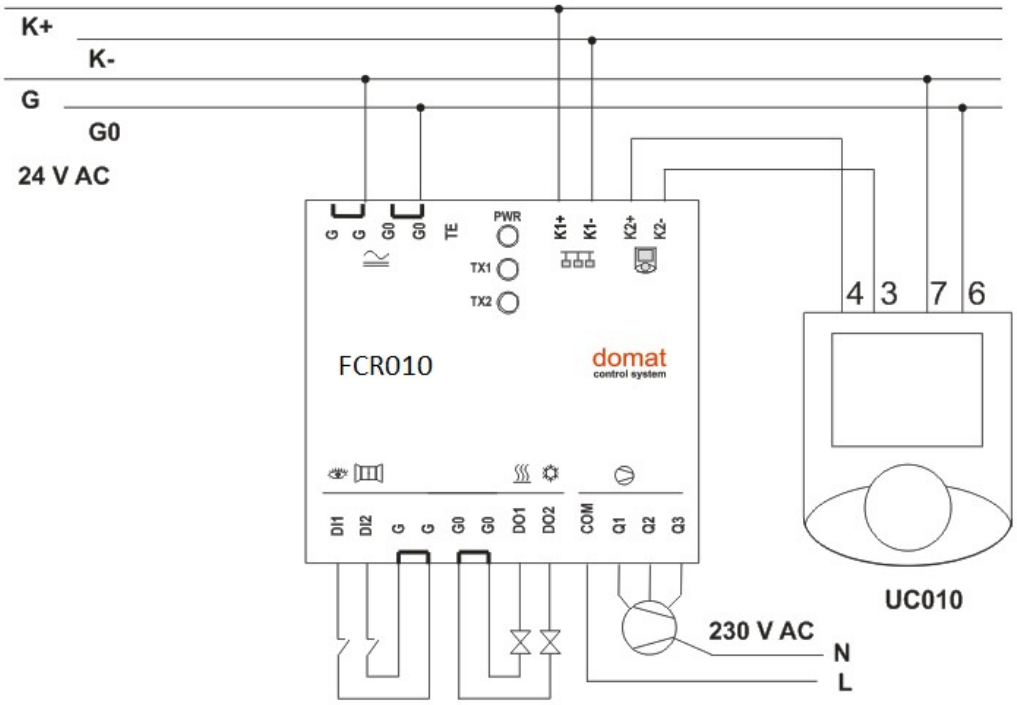
Connection of more UC102 controllers on the bus.

FC... Communicative fancoil controllers **FCR010, FC020**

The fan coil controllers feature two communication interfaces: K2 for communication with the room unit UC010 (marked by the room unit symbol), and K1 for connection to a PLC or management station (marked by a bus symbol with controllers).

The room unit interface does not need any configuration, the room unit always has Modbus address 1. As the K2 bus length is several meters only, the cable type is not critical.

The K1 interface shall be connected according to the same rules which apply for the UC.... controllers.



Typical FCR010 connection. Details see the FCR010 data sheet.

3.4 Communication speed and response, amount of data points on a bus

A frequently asked question is: **How many I/O modules can be connected to a bus?** Physically, up to 255 addresses with several thousands of I/Os would be possible. However, regarding the system response time the reasonable number of modules (addresses) is about 60. Datapoint amounts for usual HVAC applications are:

- Up to 50 physical datapoints (inputs and outputs) for a **mark100, mark120, mark150, mark150/485, ICIO200, IMIO100**
- Up to 100 physical datapoints (inputs and outputs) for a **ICIO205, IMIO105, mark130**
- Up to 400 physical datapoints (inputs and outputs) for a **mark220(LX), mark320(LX), markMX, markMX.2, IMIO105.2, IMIO110.2**
- Up to 200 physical datapoints (inputs and outputs) for a MiniPLC (**IPLC201**, **IPLC301**)
- Up to 400 physical datapoints (inputs and outputs) for a MiniPLC (**IPLC500**, **IPLC510**)
- Up to 500 physical datapoints (inputs and outputs) for a **IPLC.1** (industrial PC with a touch screen).

An example of a I/O module set for a **IPLC201** is

3x RCIO (3x 30 I/O)
1x R420 (16 DI)
2x R220 (12 DO).

The rule of thumb is that e.g. a **mark220LX** can host **four compact modules RCIO** plus some extra binary I/O modules for the required I/O mix.

The response for one I/O module, using default communication speed of 9600 bps, is about 20 ms, so to refresh all I/Os the PLC needs about (3 + 1 + 2) * 20 ms = 120 ms plus 300 ms to process the function blocks application, thus the input – PLC – output response is lower than 500 ms.

The bus response can be accelerated by

- setting higher communication speed, which, in general, is using non-default values together with higher risk of EMC problems. It is recommended to use higher communication speeds only if necessary, and at modules within the panel. The sensitivity to correct bus termination increases at the same time (the first and the last modules must have the BUS END switch set to ON).
- separating the bus to 2 segments and their connecting to two ports of the process station (e.g. IPCT.1).

With standard HVAC systems using maximum amounts of datapoints per bus (see above) the system response is fast enough.

For monitoring systems (data collecting only) or integrated room controls (with no control loops over the bus), the datapoint amounts may be up to twice as high. However, to bring more than about 100 Modbus addresses on the bus is not advisable, because of difficullt diagnostics in case of short circuit or EMC problems.

3.5 Addressing

The modules must be addressed individually so that the bus communication is possible. Addressing follows the standard Modbus addressing rules.

Each module has an address ranged **1 to 255**. It acts as a slave, i.e. it is waiting until being addressed by the process station, and then responds back. Address of 0 is reserved for

software address setting, it can not be used for regular communication. The master (process station) does not have an address.

The default module address (factory settings) of every module and room unit is 1. The I/O modules must be readdressed at the commissioning phase or prior to it. It is convenient if the designer assigns the module addresses in the drawings for easier reference. If he or she does not do this, the addressing plan must be set up by the software engineer. The engineer must know the address assignment not later than the software project is being designed, and the input and output variables are defined.

The modules may be addressed with gaps, it is not necessary that the addresses physically follow each other on the bus.

Note

It is highly recommended to define the addresses as soon as in the system topology drawings and in the shop drawings, so that the modules may be referred to and there are no ambiguities. If the modules connected to one bus are located in more panels, it is recommended to allocate a separate addressing space for each panel so that there is a reserve for future expansions.

Example:

RM1 addresses 1...50
RM2 addresses 51...100
RM3 addresses 101...150

etc.

At the commissioning time it is useful to attach a label with module address to the cable tray above the module, or a removable sticker to the module front.

4 I/O bus

The bus for communication with the I/O modules is a 2-wire RS485, using Modbus RTU protocol. It is necessary to keep some basic rules for design, installation, and commissioning, to avoid communication dropouts or complete data loss.

4.1 Recommended cable

The total bus length *should not exceed 1200 m*. It is recommended to use line topology, or to bring the bus from one module to another without stubs. To terminate the bus properly, the first and the last device on the bus shall have set the BUS END switches ON. See also data sheets of the modules.

Recommended cable types are e.g.

- JY(st)Y 2x0.8
- LAM Datapar 1x2x0.8

When designing the cable layouts, it should be kept in mind that the EMC influences increase strongly with increase of the parallel cable run length and decreasing of the distance between cables. If there is a common cable tray for power lines and communication, it is advisable to separate both cable types using a shielding wall or kep them at least 20 cm apart. In fact, the communication is robust enough to work properly mostly even at parallel cable runs. Problems may arise at sites with unshielded photovoltaic inverters, variable speed drives etc.

It is not recommended to combine different cable types, there are signal reflections at the connecting points and it is very difficult if not impossible to balance the bus properly. This is relevant especially at higher bus lengths (hundreds of meters).

4.2 Overvoltage protection

Parallel cable runs within panels are irrelevant because of their low length.

If the bus is lead between the cabinets in a highly EMC critical environment, such as outdoor installations, PV plants, wiring between buildings, etc., it is recommended to use some of the commercially available overvoltage protections, or a galvanically separated RS485 repeater.

The bus is permanently short-circuit resistant. Of course the communication is down when the bus is short-circuited, but the modules will not be damaged.

4.3 Wiring rules

Note the correct polarity. Wrong bus polarity, or interchanging of the wires, leads to communication malfunction and may block communication with more modules or even with all modules on the bus (depending on the distances between the modules and their amount). The modules will not be damaged.

There is no maximum distance between the modules. The only limitation is the total bus length of 1200 m.

4.4 Tools for addressing of the modules

For **hardware** addressing, no special tools are necessary. The address is set by setting the DIP switches on the module, see module data sheets.

For **software** addressing, the I/O modules are addressed using

- configuration software ModComTool, and
- a RS232/RS485 converter (e.g. **R012**) or USB/RS485 converter (e.g. **M080**).

If the converter is not available, the modules may be addressed and configured using the process station switched into Ethernet / RS485 converter mode (*commissioning mode* at Merbon, *converter mode* at SoftPLC) – see help for Merbon IDE, or data sheets of SoftPLC process stations and *Special functions* in SoftPLC IDE.

5 Process stations

Process stations are programmable devices which contain the project – application software which controls the technology over the I/O modules. Domat supplies two families of process stations, SoftPLC (IPLC... controllers), and more recent, Merbon (mark... controllers).

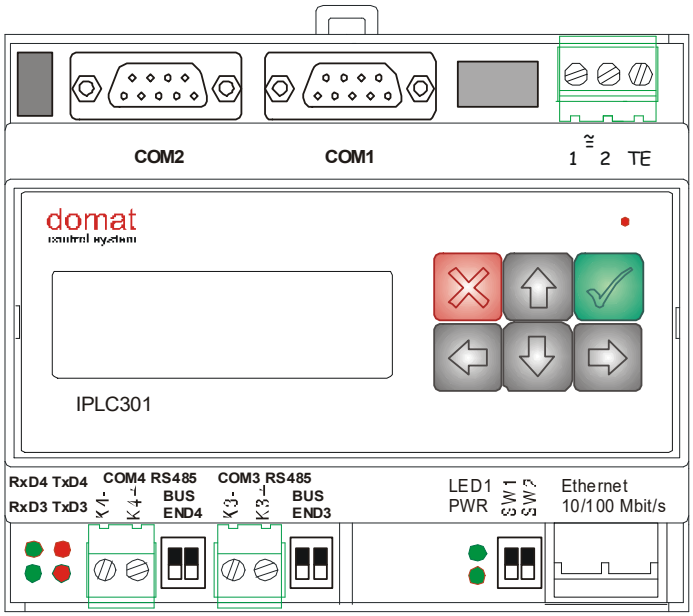
It is recommended to use the Merbon controllers in new projects. The SoftPLC IDE is not actively maintained anymore, yet fully supported and available.

5.1 SoftPLC process stations

The SoftPLC family contains both the MiniPLC controllers (PLCs), and industrial PC-based process stations for projects requiring more resources.

5.1.1 MiniPLC

MiniPLC is a platform with embedded real time operating system, containing SoftPLC runtime, compiled application, and other services like web server, Modbus serial server etc. The devices are powered by 12...30 V DC, or 12...24 V AC. They contain 1 or 3 serial ports and an Ethernet interface, a configurable LCD display and 6 pushbuttons. Currently supported types are **IPLC201, IPLC301, IPLC500, IPLC501** and their modifications (with no LCD display). A compact PLC (with integrated inputs and outputs) offering excellent price / performance ratio is a **MXPLC**.



IPLC301 – connector layout

MiniPLC is delivered in two ranges which offer different computing power: the basic range with a BECK OS (IPLC201, IPLC301), and a more powerful platform using Linux (IPLC500, IPLC510).

Note: The process stations **IPLC500**, **IPLC510** and **MXPLC-L** (with OS Linux) do NOT have the web server.

MiniPLCs communicate with the I/O modules over serial interfaces:

IPLC201(500) 1× RS485 (COM4)

IPLC301(510) 2× RS232 (COM1,2), 2× RS485 (COM3, 4)

The RS485 interface can be connected directly to the I/O bus. The interface is galvanically separated and terminated by a connector with removable screw terminals marked **K+** and **K-**. There are 2 LEDs for each RS485:

TX (red) – transmitting data
RX (green) – receiving data

When communicating properly, both LEDs are flashing fast in turns with no larger breaks.

The RS232 interfaces are mostly used for metering readouts over M-Bus converters (**R095**, **R096**) or for GSM modem to send alarm SMS. If the PLC is installed in the panel door, use **RS232L** , a L-piece to connect the CANNON9 cable comfortably..

The **Ethernet** interface is used for links to the management level (SCADA, web, OPC server etc.) and for configuration and program upload. The communication follows over *Platform configurator*, which is part of the SoftPLC IDE, the engineering software. For communication there is only an Ethernet cross cable necessary, or the MiniPLC must be connected in a local LAN. No other converters / communication cards / cables are necessary. The computer (notebook), which hosts the IDE, must have an Ethernet card.

The MiniPLC is installed

- **in a panel** on a DIN rail, so that the LCD display and buttons are accessible only after the panel door is open, or
- **in an aperture** sized 107 x 47 mm **in the panel door** using a metal frame (type ID FRAME) and a piece of DIN rail (150 mm length), then the display and buttons are accessible from outside of the panel.

5.1.2 PC-based process stations

These are typically embedded PCs with 8“ touch screen and *Windows 7 Embedded*, which host the application software runtime. Their processing power is substantially higher than that of the MiniPLC. The touch screen works as a HMI which may control also other (Mini)PLCs in the network.

IPCT.1 uses power of 12 DC / 2 A or 230 V AC with a switched power supply which is part of delivery. Exceptions see below.

Note: The SoftPLC Runtime may run on any PC with OS Windows XP / XP Embedded / 7 / 8 / 10; this is used when the SoftPLC is utilized as a protocol converter: the SoftPLC Runtime is installed at the management station, collecting data from 3rd party systems e.g. over BACnet and acts as an OPC server for SCADA integration..

The most used one is the **IPCT.1**, a process station with a 8“ LCD touch screen. It contains following interfaces:

2x Ethernet
2x RS232 (COM1, COM2)
4x USB

For applications where HMI is not required the **IPCB.1** can be used, which has 4 serial ports. IPCB.1 is suitable e.g. as a data concentrator for more M-Bus lines.

IPCT.1 is installed into panel door or any other suitable box. Make sure that there is sufficient air circulation for cooling, especially around the back part and sides of the unit. In most cases, apertures in the panel with no forced air circulation are enough. When installing into watertight plastic boxes, air circulation holes in the upper and lower part of the box are necessary.

The front panel aperture shall be of 222 x 167 mm, panel thickness 10 mm maximum. Part of delivery are six metal clamps which fix the process station from the inner side of the panel door.

The process stations are powered either from

- attached switching power supply 230 V AC / 12 V DC, or from
- a stabilised power supply of 11 ... 28 V DC in the panel providing at least 35 VA extra power.

Remember to install a 230 V / 6 A power socket in the panel for the power adapter.

As the IPCT.1 is equipped by RS232 ports, to connect to a bus with the I/O modules, a RS232 / RS485 converter is necessary, e.g. domat **R012**. The converter also provides galvanic separation between the RS485 (I/O bus) and COM ports of IPCT.1.

The converter has two screw terminals to connect the RS485 bus: **K+**, **K-**. Close to the connector are two BUS END switches used to terminate the bus.

The converter is powered through terminals G and G0 by 10..35 V DC, or 12...24 V AC. If the converter is located in a separate box together with the process station (at the managers’ office, in a reception etc.), and the I/O modules are in a remote epanel close to the controlled technology, the converter may be powered from the same power source as the IPCT.1. If the converter is in the panel together with I/O modules, it is powered from the same transformer or power supply as the I/O modules.

The converter is connected to the process station using a zero modem cable, terminated by 2x CANNON9 F connectors. (Connection of pins 2, 3, and 5 is enough.) The cable is supplied on request free of charge together with the R012.

Converter R012

The baudrate is set by DIP switches, accessible after the upper cover is removed. The default communication speed is 9600 bps, 8 bit, which is also the default for the Domat I/O modules.

Other devices, like GSM modems for sending and receiving of SMS messages, are connected using cables which are part of delivery of these devices. If connecting 3rd party devices, make sure that the communication bus is protected from other voltage.

If a GSM modem or router is part of the installation, remember to install a 230 V power socket for the power adapter supply, and enough space in the panel, especially in the installation boxes with IPCT.1 where there is usually not much space left.

Operating system: There is a CF card in the process station, containing an image of Windows 7 Embedded and a second disk used as data storage space for SoftPLC projects.

During normal operation the Touchscreen application occupies the entire display area, and the OS icons are not visible. The operating system is not accesssible using just the touch screen. It is possible to shut down the Touch screen application using a service code and operate the system. The service code is set up in the commissioning phase by the software engineer who installs the device.

The runtime (process control logic) and HMI are run automatically after the operating system boots up.

5.2 Merbon process stations: mark… and wall…

Thanks to modern technologies, Domat offers compact controllers **IMIO100** (16 I/O) and **ICIO200** (30 I/O) with Ethernet and RS485 in the new range of PLCs, and **IMIO105.2** (or its predecessor **IMIO105**) and **ICIO205** with an extra RS485 interface for room units, expanding I/O modules, or 3rd party integration. The **IMIO110.2** (or its predecessor **IMIO110**) also offers a display and buttons for easy operation. For larger sites, the **markMX.2** (or its predecessor **markMX**) with 88 I/O is the right choice. Compact process stations combine the control unit and I/O modules in one housing, which makes installation easier. It is still possible to extend the system with standard I/O modules over the RS485 interface. The Ethernet interface is used for programming and client communication, such as SCADA, web browser, or 3rd party programs.

Process station with no integrated I/Os can be used both in standard control system with I/O modules, and as free programmable protocol converters and communicators. Models with one RS485 port (**mark100**, **mark130**, **mark220LX** (or its predecessor **mark220**)), with two RS485 and two RS232 ports **mark320LX** (or its predecessor **mark320**), and with integrated M-Bus converter for up to 10 M-Bus slaves (**mark150**, **mark150/485**) are availab-

le. These process stations are perfect for small sites, such as compact heat exchange stations, small home controllers, or heat pump and small AHU controllers.

mark220LX and **mark320LX** are fully compatible with **mark220** and **mark320**, they are based on the iMX 6UL processor. The redesign made this platform available and future-proof.

If a **mark220LX** or **mark320LX** controller is installed in panel door, use the **markKit** to fix it.

Merbon process station, type mark320.

The controllers use different operating systems depending on the processors used in the hardware. ARM® Cortex® with real-time operating system FreeRTOS is used at the smallest platforms (for about 20 to 30 physical datapoints), in the more powerful process stations MPC5200 with OS Linux can be found. Controllers for panel door installation (**mark120**, **mark130**) feature IP65 protection degree.

All process stations feature a web server for customer visualisation. The web pages are presented in HTML 5 standard, which gives compatibility with all modern browsers. The web pages editor has the same look & feel as the SoftPLC HMI Editor, so the transition to Merbon IDE is seamless.

All controllers also have an Ethernet port which is used for client connections, web access, and configuration. The SSCP protocol, which is used for configuration, programming, and process data communication, is fit for Internet communication because of autentification. It also makes possible to upload new software to the controllers on a remote basis. The controllers also support direct writing into Merbon DB database .

Type	Display	RS232	RS485	I/O	Others	Performance
mark100	no	-	1	-		*
mark120	LCD 4×20	-	-	-		*
mark130	LCD 4×20	1	1	-	larger RAM	**
mark150	no	-	-	15	M-Bus	*
mark150/485	no	-	1	15	M-Bus	*

mark220LX, mark220	LCD 3×16	-	1	-		***
mark320LX, mark320	LCD 3×16	2	2	-		***
markMX, markMX.2	no	2	2	88		***
IMIO100	no	-	-	16		*
IMIO105, IMIO105.2	no	-	1	16	larger RAM	** / 105.2***
IMIO110, IMIO110.2	LCD 3×16	-	1	16	larger RAM	** / 110.2***
ICIO200	no	-	-	30		*
ICIO205	no	-	1	30	larger RAM	**

Merbon process stations and their performance

To estimate the maximum physial I/O amount for a process station. a following rule of thumb applies:

Performance:

* - about 30 physical data points
** - about 100 physical data points
*** - about 400 physical data points.

The **wall** range features high modularity. The main unit (left) is extended with input/output cards, which makes the required I/O mix. The pack is terminated by the **750-600** terminating module.

A wall... process station - set wMX

To simplify ordering, the process stations are supplied also as preconfigured sets with following amount of data points:

Type	I/O	AI	AO	DI	DO	RS232/RS485
wMX	mix	16	8	32	32	-
wCIO	mix	8	8	8	8	-
wMXcom	mix	16	8	32	32	1
wCIOcom	mix	8	8	8	8	1

w750-8101	0	0	0	0	0	-
w750-8102	0	0	0	0	0	1

Types **w750-81...** are only main processor units, with no physical I/Os. Both the main units and sets can be extended by more I/O cards until the software load limit of about 400 physical I/Os is reached. When adding more modules, please check the maximum current which the cards are supplied from the main unit (see data sheets of the I/O cards). Should this maximum load be reached, another power supply module **750-613** must be inserted into the card pack.

Example:

A set with processor module 750-8101 should be installed with 20 relay modules (750-517) and 10 digital input modules (750-405). The consumption of the I/O modules can be found in their data sheets.

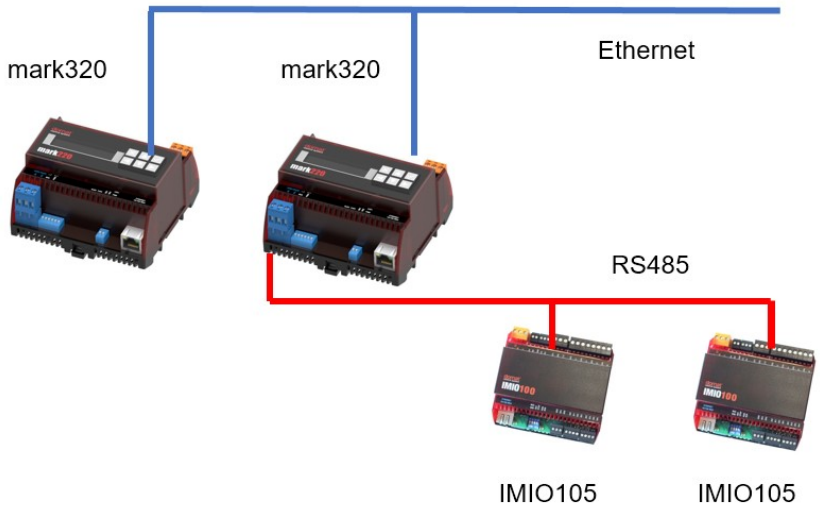
Power:

20* 90 mA = 1800 mA
10* 2 mA = 20 mA
Total 1820 mA

According to its data sheet, the processor module is able to provide maximum current of 1700 mA to the modules. As a result, an extra powering module for the internal bus (750-613) must be inserted e.g. in the middle of the card pack, and powered separately. The power may be derived from the same 24 V power supply as for the main unit 750-8101.

5.3 Connecting the process station to network

The process stations feature one or two Ethernet interfaces which connect the stations to a technological network. The Merbon process stations can exchange data using the SSCP protocol either over Ethernet, or using serial port, if it is available (i.e. not occupied by I/O modules, room units, or a 3rd party device). Using serial ports makes sense if an existing RS485 communication infrastructure is available and installation of an Ethernet network is not possible. All process stations connected to the serial line are available over the Ethernet through a PLC configured as a SSCP router: it is possible to read data, change values, upload program, perform commissioning etc. Note that the serial communication offers slower communication response due to the lower data throughput.



Example of a SSCP communication over serial. The mark320(LX) is used as a SSCP router.

5.3.1 Data exchange between the process stations

The process stations may exchange data (outside temperature, heating / cooling demands etc.) between each other over the network. No other hardware nor software components are necessary, the only condition is that the process stations must be “visible” for each other in the network..

The number of variables has no physical limitation, however, it is recommended not to use more than about 20 variables per process station to keep the software simple and easy to understand.

Every open connection takes one communication channel. There is a limitation for maximum number of open channels at some PLC: **IPLC201, IPLC301** and **MXPLC** accepts max. 5 incoming connections, including connections from SCADA, SoftPLC IDE, OPC server and other clients. **IPLC500, IPLC510** and **SoftPLC Runtime** on Windows there is no limitation, although it is recommended not to exceed about 15-20 connections.

For **Merbon** PLCs there are following limitations: the maximum number of incoming connections is 5. At more powerful platforms, which are **mark220LX, mark320LX IMIO105.2, IMIO110.2, markMX.2** and **markMX**, it is 20 connections.

It is not a good idea to configure communication between the process stations inside of the control loops, e.g. a sensor in one station and the controlled valve in another station. The problem is not the data transport delay, which is hundreds of milliseconds. It should be avoided to configure the control loops dependent on the functionality of the network.

5.3.2 Communication between SoftPLC and Merbon

If there are both SoftPLC and Merbon PLCs in the network, they can excchange data under certain conditions.

server client	**IPLC201,301,MXPLC** (Beck OS)	**IPLC5xx, ...-L, RT** (Linux, Windows)	**Merbon**
IPLC201,301,MXPLC (Beck OS)	yes	yes	**no**
IPLC5xx, ...-L, RT (Linux, Windows	yes	yes	yes
Merbon	yes	yes	yes

Communication between SoftPLC and Merbon.

In other words, the SoftPLC process stations with Beck OS can not connect as clients to Merbon PLCs over the SSCP protocol. All other combinations are possible. The data exchange requires an open communication channel at each PLC, and this has to be considered regarding to the performance limitations above.

5.4 Technological network

The technological network is physically a standard Ethernet network. It is used for communication of the process stations between each other, with the management station, and for data exchange with 3rd party systems. General rules for Ethernet network design apply. It is to be noted that the network may be exposed to stronger EMC load (e.g. because of variable speed drives, or PV inverters) than office networks, and therefore optical links are preferred at longer distances.

5.4.1 Cabling

The network has a star structure, where at the ends of the branches there are process stations and other network devices, and in the center there are active elements – switches.

The process stations are connected to a switch by standard UTP (unshielded twisted pair) or FTP (foil-shielded twisted pair) cables, category 5E or 6.

In the panel, the cable is terminated either by a standard Ethernet socket with a RJ45 connector for base plate installation, or in a patch panel which contains more sockets in a single frame. The process stations are connected to the sockets using patch cables, ready-made RJ45 straight cables of different lengths, usually supplied and installed by the panel supplier.

If there are more process stations in a single panel, it has to be considered if more Ethernet sockets have to be installed with separate cables from the main switch, or if a single cable and a separate switch directly in the panel connecting all process stations is a better solution.

The maximum length of a single Ethernet cable is 100m, which may be a limiting factor. Then it is possible to insert an active element (switch), or use a optic fibre link. The optic fibre may be more expensive than a UTP cable, but it is less susceptible to EMC immissions and provides higher possible cable length (up to 20 km or more). To convert the signal from a metallic link to optic fibre and vice versa, media converters are used, which are available also in industry grade versions (installation on a DIN rail, power by low SELV voltage).

Note

Check the compatibility of all passive and active network devices, or consult an IT expert when designing the network.

At some projects, it is possible to take use of the local IT infrastructure or its parts. It is also possible (and advisable) to outsource the entire network to an IT company which supplies hardware and installation of all network components, and hands over a completely functional network system inclusive all tests and protocols with measured parameters of all installed sockets. The interface between the control system designer and the IT infrastructure designer is basically a floor plan with a list of panels and deployment of the network sockets.

To keep the network secure, it is recommended to install it as a separate system which is connected to the building network or/and to the Internet using a router with firewall, configured according to the recommendations of the local IT administrator.

5.4.2 Addressing

There may be different components of the control system connected to the network:

- process stations
- management stations
- wireless access points
- routers to connect to other networks
- terminal servers for remote connection of I/O buses
- etc.

The devices must be addressed properly to be able to communicate to each other.

IP version 4 addressing is used, which provides addresses as 4 numbers ranged 0...255, separated by dots. For private networks, which is the case of technological networks, the following ranges are reserved:

10.0.0.0 – 10.255.255.255

172.16.0.0 – 172. 16. 255.255

192.168.0.0 - 192.168.255.255

The exception may be embedding of the process stations into a customer network with its own numbering rules, e.g. as part of an international infrastructure. Consult the IT administrator for details.

If the control system designer is responsible for the network numbering plan, addresses of 192.168.1.10 and higher are usually used, with network mask of 255.255.255.0. It is also possible to state in the project that the network numbering is up to the software engineer who commissions the site and who should consult the numbering plan with the customer or end user.

6 Design step by step

The control system is designed so as to make plant design and components specification as simple as possible. It is not necessary to use bus supply modules, external bus terminators, etc. – all functions are settable either by software, or by DIP switches. See data sheets for modules and process stations.

The basic steps when designing are as follows:

Specify the number and types of inputs and outputs (physical data points) in the panels.

Specify which panels have to be autonomous (with their own process stations) and which only are remote I/O islands (with power part and I/O modules connected to a process station in another panel over the I/O bus).

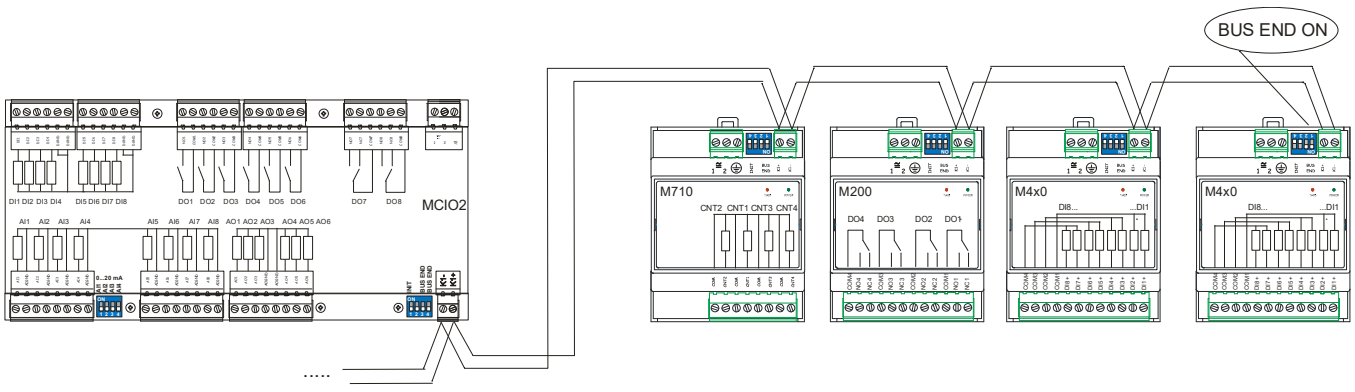
Remote I/O islands are used when:

- the I/O amount is so small that a separate process station is not worth it
- the panel is installed in a location where the control panel of the process station (touch screen or LCD display and buttons) would not be accessible.

A certain disadvantage is that the I/O bus is outside of the panel and may be subject to damage or EMC interference.

Based on the I/O amount and types in the panel, the I/O modules are selected and populated.

Usually, analogue inputs and outputs are covered by compact modules **RCIO**. Then, digital inputs and outputs are assigned, mostly using extra digital modules like **R220, R420** etc.



Example of connection of I/O modules to the bus incl. bus termination.

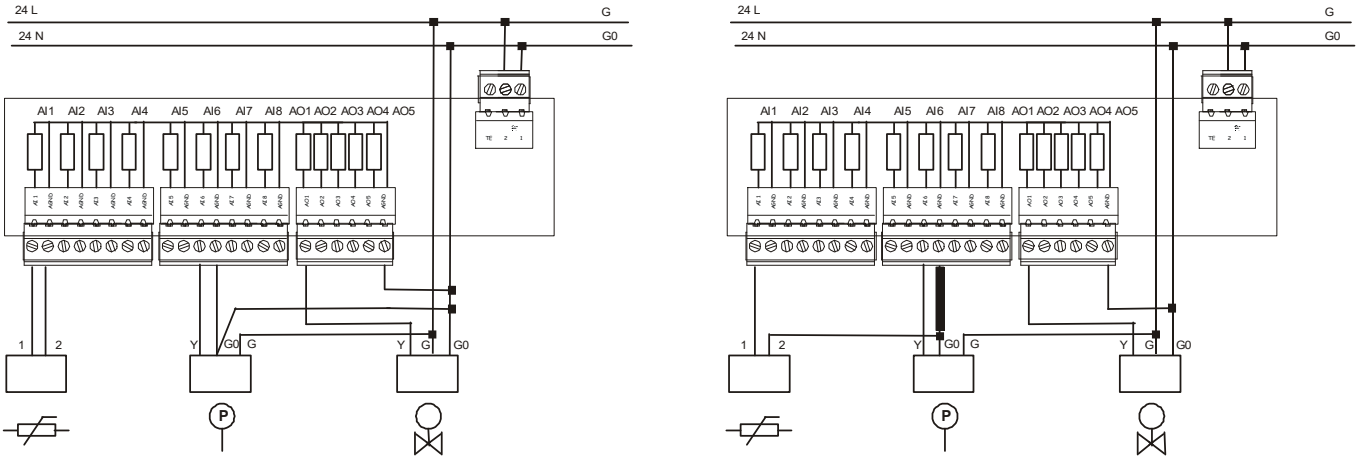
To control thermic valves or modulated electrical heaters by a pulse width signal (PWM), triac outputs shall be used: **R312** (8 triacs) or **RMIO**, which contains (among other I/Os) two solid state relays which have unlimited number of switching cycles. Both SoftPLC and Merbon function blocks provide conversion function from 0...100 % signal to PWM.

The modules may be placed on the bus with any combinations and any order. It is not necessary for the control loops to be within one module. However, this may make commissioning more comfortable and easy to overview.

The last module on the bus should be marked as “BUS END ON“. The other end of the bus is usually terminated at the process station or **R012** converter.

6.1 Analogue inputs and outputs

At all Domat modules, analogue inputs are separated from all the other parts of the module. However, a set of basic rules should be kept:



Analogue grounds connection: left: correct, right: incorrect – the bold part of the conductor carries a voltage caused by the powering current of the active pressure sensor. The voltage brings a measuring error to the passive temperature sensor input.

- resistance (passive) sensors should be connected directly to the module input terminals AIx, AIGND or AIC. In case of incorrect grounding, the voltage drop at the active input peripherials wiring may influence the passive temperature sensors. The sensors then show values up to 10 – 20 K higher than the real temperature.
- the same is for analogue output grounds (AOGND, AOC). A typical effect of this problem is that if a valve is opened, the measured temperature seems to be rising. At the commissioning phase, when the sensors are connected as the last part of the system, and valves are closed at the same time, this problem may not be identified.

The analogue inputs are resistant to voltage up to 24 V AC even if set as passive sensor inputs (**R560**, **RCIO, RXIO)**. This does not apply if they are switched or jumpered as 4..20 mA (the internal 125 Ohm resistor may be damaged by the excessive heat caused by the flowing current).

6.2 Digital inputs and outputs

Digital, or binary, inputs and outputs are connected in groups with a common terminal. The older modules, **M400** and **M410,** have common terminal in pairs, the ground terminal at other **M...** modules is common for all 8 inputs. The **R420** has common ground for all 16 inputs, the **R430** for 16 and 8 inputs separately. Usually, however, all inputs are powered by the same potential, so the input ground is also common for all inputs: G0. The inputs must be powered by 24 V AC, potential-free inputs for dry contacts are only at room units and controllers **UI...** / **UC...** / **FC...** and **mark150**, **mark150/485,** see the respective data sheets.

All inputs are separated by optotransistors. It is possible to power them from the same source which is used as power supply for the modules. The maximum admissible voltage at the input is 50 V.

Beware the correct polarity when using DC voltage at the inputs: the input must be positive, COM or DGND must be negative.

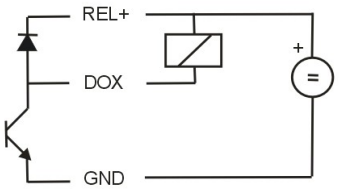
Digital output modules are equipped with following components:

R220, **R320**, **RXIO, RMIO**, **M200**, **M210**, **M215**, **MCIO2**, **MXIO, MMIO**: mechanical relays 230V / 5A, NO or changeover contacts – see data sheets of the modules.

RMIO, MMIO, **UI...**: solid state relays (SSR), zero-switching, for DC or AC load. Maximum admissible current is 0.4 A, which is OK for a contactor or up to 2 thermic valves for radiators or fan-coil units.

The main advantage of a SSR is that it is noiseless and has no limitation regarding switching cycles. These outputs are thus suitable for pulse-width modulated signals (PWM), also known as quasi-analogue control. This is how the thermic valves or power semiconductor relays are controlled.

R320, R330, M300, **M320**: transistor with open collector. A semiconductor element is used to switch an external relay or contactor, or an indication element such as a LED or small bulb. Recommended circuitry must be used:



Digital output with an open-collector transistor

The diode, which is on the PCB of the output module, protects the transistor from voltge peaks which originate at the contactor relay at the moment of disconnection. The power voltage is 24 V DC, this voltage must be available in the panel, preferably from an industry switched power supply.

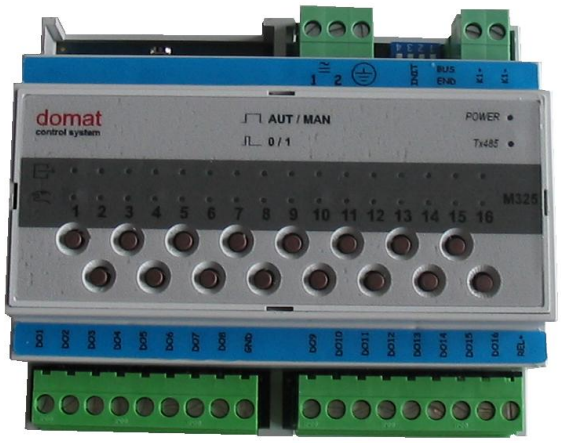
Digital inputs and outputs states are indicated by LEDs at the front panels of the modules.

6.3 Outputs with manual override

The **M215** and **M325** modules **are not supplied anymore. Do not use them in new projects. This part is for information only.**

These modules feature manual override buttons at the front panel. Every output may be overriden to ON or OFF separately. A long push (> 1.5 s) of the button switches from automatic (controlled over the bus) mode to manual mode, which is indocated by the yellow LED (symbol of a hand). Short pushes (< 1 s) in the manual mode toggle between ON and OFF. The state is indicated by a green LED (digital output symbol). Another long push switches back to automatic mode, the yellog LED goes off and the output is controlled by the commands over the bus (from the process station)

Manual mode and manual output state are saved in EEPROM and are kept even after power outage.



M325 module with buttons and LEDs for manual override

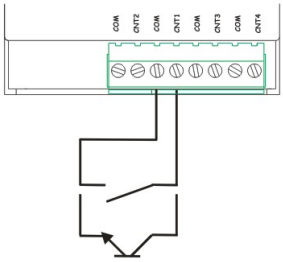
The output states (auto/man, off/on) are available as Modbus registers and can be read by the process station to be e.g. displayed in the SCADA or indicated as an alarm. It is **not possible** to switch the outputs to manual or auto over the bus (which would not make sense for the manual functionality). To control the outputs directly from SCADA (and to override the process logic in the PLC) there are other SoftPLC functions, however, the manual override directly at the I/O module is that of the highest priority.

6.4 Counting inputs

The **R710** (4 counting inputs) and **M700, M710** (not supplied anymore – two and four counting inputs respectively) modules have fast pulse counting inputs for potential-free contacts with maximum input frequency 50 Hz. Minimum ON time is 10 ms. The module provides 12 V DC at the CNTx terminals, which should be brought back through the counting contact to the COM terminal.

The module has an internal battery which backups the counter, so that the counted values are retained even when the power is off.

Some of the meters (pulse modules of gas meters, electrical meters etc.) do not have reed relays, and use open collector transistors together with protecting resistors. For correct functionality they need slightly higher operating voltage, typically 24 V DC. The M710 may be supplied with a 24 V DC/DC converter. Please note it in the project and when ordering, e.g. „R710 (24V contact)“.



Connection of a counting input

The modules also contain auxiliary variables for peak shaving function (E-Max). It is possible to read cumulated value for the last 15 minutes, cumulated value for the current 15 minutes, and running time of the measuring interval (typically 0...900 s). These variables are used in the Merbon or SoftPLC E-Max function block. CNT1 must be connected to the energy meter pulse output, CNT2 to the 15 min. synchronisation output.

If there are M-Bus communicative meters in the system, it is advisable to use pulse to M-Bus converters (Relay PadPuls, Siemens AEW...) rather than R710. The converters are then integrated together with the regular M-Bus meters over a M-Bus converter **R095** or **R096**. For the E-Max functionality, R710 is necessary because of its short response time and internal variables.

If the I/O modules have been assigned to the buses, the next step is to specify the system topology.

7 System topology

The main point is to know how the system should be operated:

- a) occassionally, over keyboard and LCD display in a closed panel
- b) on a regular basis, over keyboard and LCD display in the panel door
- c) comfortably, using a touch screen terminal in the panel door
- d) over a touch screen terminal located where the operator is (apart from the panel with I/O modules)
- e) over a web interface of the process station

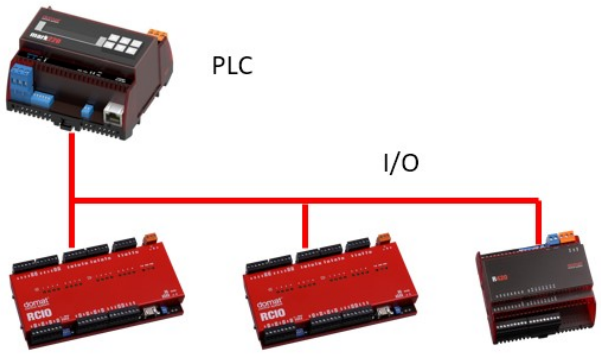
- f) using touch screen terminal for local control, and web interface for remote control
- g) using a management station on a separate PC (visualisation, SCADA)
- h) same as above, but the web access should be available over the Internet
- i) one of the above, together with mobile application and remote access
- etc. ...

We can see that there is a lot of possible topologies.

All specifications listed below do NOT contain peripherials (sensors, valves etc.).

7.1 Autonomous system (without networking) (a)

There is only a process station with local HMI connected to the I/O bus at the most simple topologies.



PLC and I/O modules over a RS485 bus

Specification:

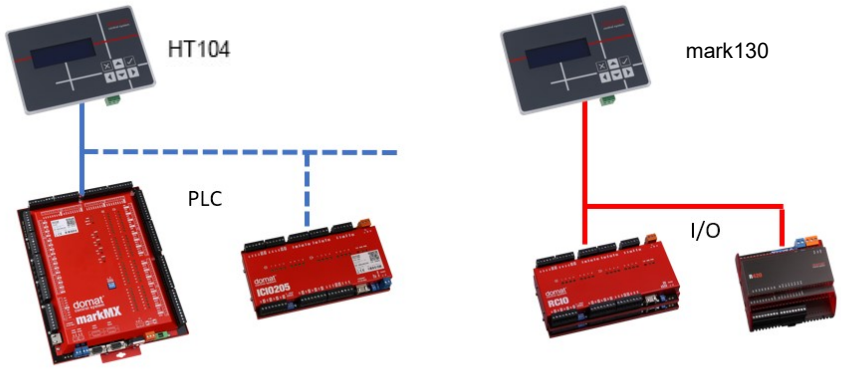
mark220LX	PLC – a Merbon process station
R...	I/O modules – according to the plant I/O mix

The bus is connected directly at the RS485 interface (terminals K+, K-) of the process station. There is nothing else connected to the PLC apart from 24 V power supply. The PLC is operated using LCD display and a 6-button keyboard. The Ethernet interface is only used for commissioning and service.

7.2 Autonomous system, local display on the panel door (b)

When operating the system from the outside of the panel door, the operator needs no qualification for work inside of the panel. The plant is operated with panel door closed. The PLC may have no display, comapct types are usually used (**IMIO105, ICIO205, markMX).** The terminal is connected using a cross Ethernet cable. However, mostly an active network element (industrial switch) is used, so that a service PC can be connected to the **HT104** (or its predecessor HT102) terminal and the PLC. A single terminal is able to operate up to 4 PLCs. The terminal may be also located outside of the panel, being connected to the PLC over the technological network.

It is also possible to use a panel-mounted PLC (**mark130**) and attach the I/O modules over the RS485 bus. Do not exceed the maximum datapoint amount that a PLC is able to host. Unlike with the HT104 solution, there are only variables from this PLC available on its display.



Two topologies with an LCD panel on the cabinet, left: HT102/HT104 terminal, right: PLC, mark130

Specification (topology on the left):

HT102/HT104	terminal for Merbon PLCs
markMX	compact PLC, 88 I/O
ICIO205	more PLCs if necessary

Specification (topology on the right):

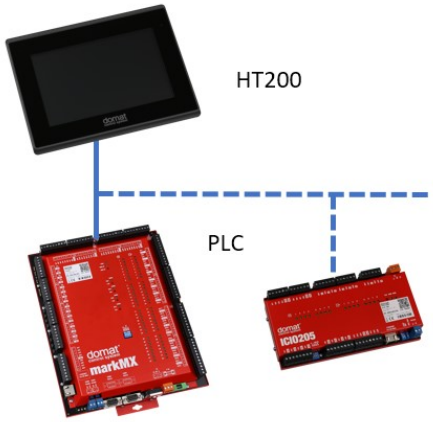
mark130	Merbon PLC
RCIO	I/O module, 30 I/O
R...	more I/O modules if necessary

7.3 Process station, terminal with touch screen (c, d)

For a more comfortable operation with a touch screen and both text and graphic menu, use **HT200**, the graphic terminal. The topology is the same as that with HT104. There may be up to 10 PLCs connected to the terminal, installed anywhere in the network, i.e. also in other cabinets. The graphic terminal may be located where the operator is, e.g. at the reception desk.

Specification:

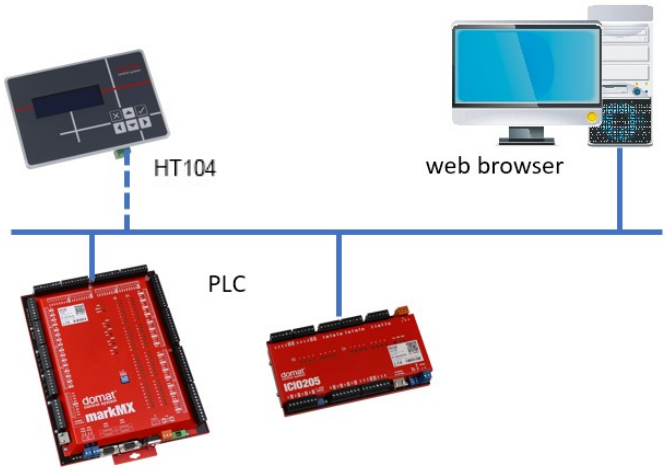
HT200	graphic terminal for Merbon PLCs
markMX	compact PLC, 88 I/O
ICIO205	more PLCs if necessary



Terminal with touch screen for up to 10 PLCs

7.4 Access over a web interface of the PLC (e)

All previously listed topologies possess this functionality, it is only necessary to configure the process station so as to fit into the local network, and design the graphic web pages in the same way as the touch screen panels for terminals. There may be terminals and other clients connected to PLCs at the same time, just note that the maximum number of client connections is not exceeded, see above. The web interface is available in Mini-PLCs, too).



Example of web browser integration

The web pages are stored in the PLCs.

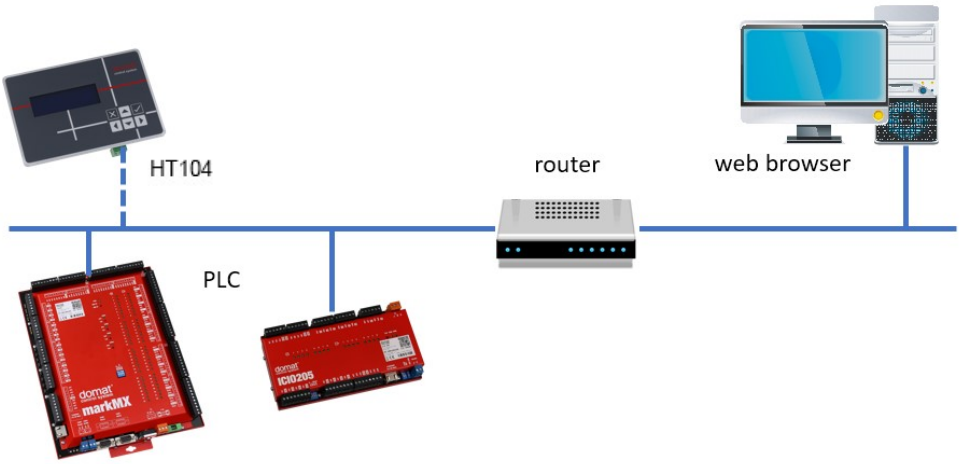
The specification remains unchanged, there are no licences nor hardware modules required for web access to the process stations.

7.5 Remote web access (f)

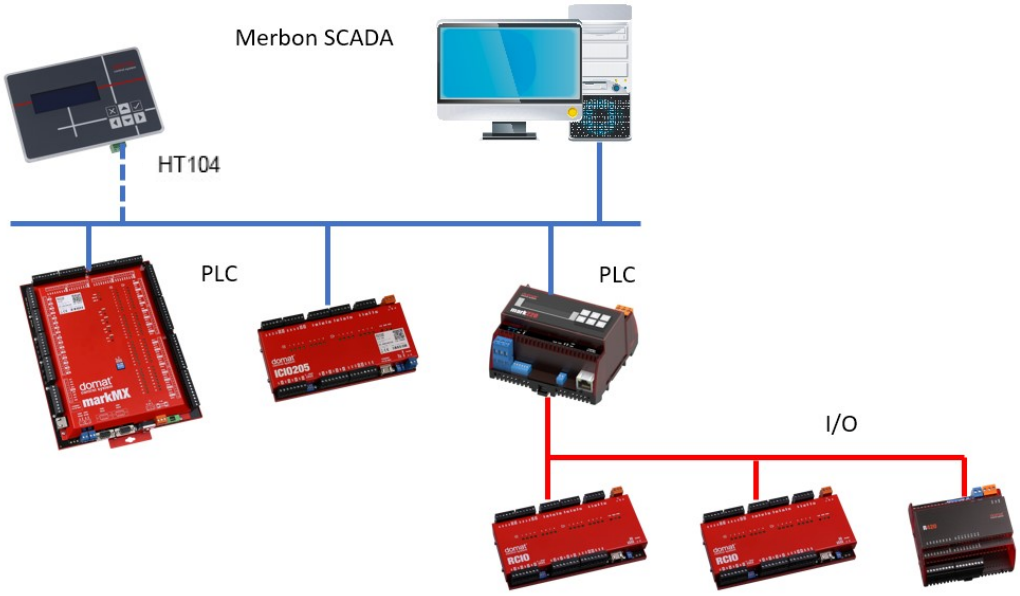
There is a router between the technological network and the web browser. The router connects the process station(s) to the network where the web browser resides.

This configuration requires close cooperation with the network administrator or connection provider. The specification will be enhanced by a router or other network components. Contact the network administrator for details.

The control system specification remains unchanged, there are no licences nor hardware modules required for web access to the process stations.



7.6 SCADA on a dedicated workstation (g)



Management station for local SCADA

There is a Merbon SCADA software with licence according to the number of data points used. The application consists of the server part and client workstations. Merbon SCADA server requires Windows 8.1, Windows 10, Windows Server 2012 R2, or Windows Server 2016, and uses Microsoft IIS as a web server.

The server communicates with PLCs. It reads measured and calculated values, and writes changed setpoints, time schedulers etc. The data are provided to users as schemas with floor plans, technology schemas, tables etc., which are filled by the communicated values. Clients use web browsers, which strongly simplifies maintenance, licensing, and user work-place management. Licences are issued in three sizes:

- for 5 000 data points (**Merbon SCADA 5 000**)
- for 50 000 data points (**Merbon SCADA 50 000**)
- for unlimited number of data points (**Merbon SCADA unlimited**).

Note that for licensing purposes the data points are counted as **software data points**, which means not only hardware I/Os, but all variables that are communicated to the SCADA. The amount of software data points is usually 3 – 3.5× higher than that of the physical I/Os. Apart from inputs and outputs, also time schedulers, setpoints, heating curve parameters etc. are brought to SCADA. An integrated room controller (**UC102, UC300, FCR010, FCR013** and others) takes about 20 data points..

If the total amount of data points in all projects exceeds the licensed amout of data points, Merbon SCADA has a limited functionality. The licence can be extended for the price difference between the old and new licences. The number of web clients which access the server at a time is not limited.

This visualisation is suitable for middle-sized and large objects and where trend data and logs shall be saved permanently. For local operation, terminals (**HT104, HT200**) are usually installed at the cabinets.

At large projects (exceeding 15 000 software data points) it is recommended to install also an external database for trend data storage, **Merbon DB.** The database speed up the system response significantly and provides a safe way of data storage together with other func-

tions, like access to the trend data for third-party programs over an application interface (API).

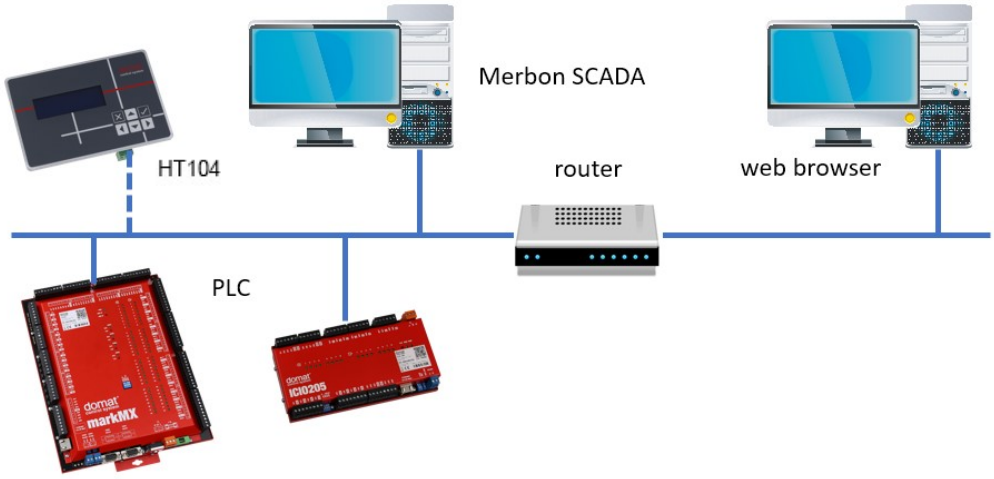
Merbon DB is licensed according to the software data points (data rows): there is 40 000 data points in the basic licence, more data points can be added in batches of 10 000 data points. The database may be installed on the same PC as the SCADA server or on a different machine – according to the required load distribution and overall network topology.

Specification:

Merbon SCADA...	licence according to the number of software data points
markMX, ICIO205...	PLC as required
PC	min. 8 GB RAM, 200 GB HDD, processor Core i3/i5 or similar
switch	active network device to connect the PLCs and PC, e.g.by Moxa.

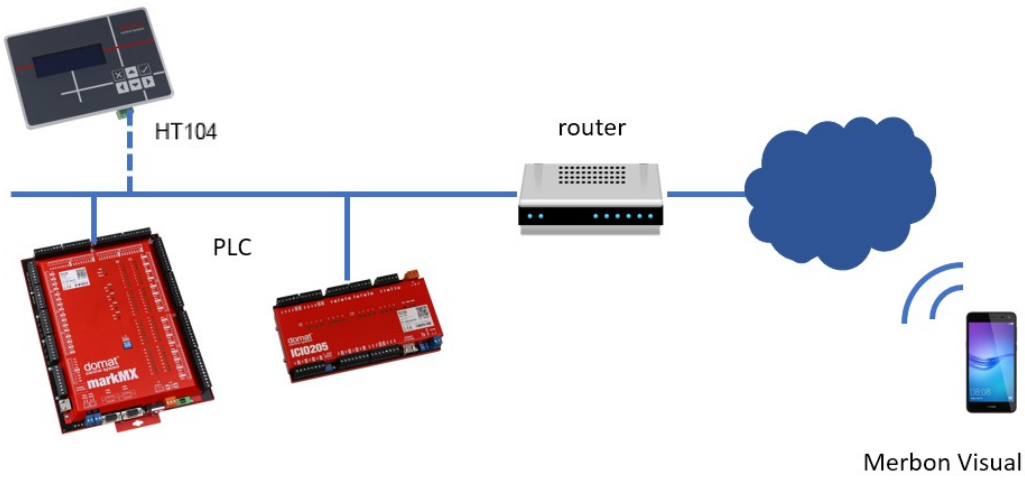
7.7 Supervisory system with remote access over the Internet (h)

The control system topology is same as in the previous example, the only difference is that the PC with web client is connected over the router. As the SCADA server is accessed over the Internet, network security should be highly considered.



The solution requires coordination with the customer's IT department or with the connectivity provider. There will be an extra router in the specification, please contact the IT staff or Internet provider.

7.8 Operation over a mobile application (i)



Access over the Merbon Visual app

The Merbon Visual app for OS Android and iOS (Apple) is free for download at Google Play and App Store. After installation, the menu or graphic definition, set up by the commissioning engineer, is opened. The app then connects to the PLC over SSCP protocol. In the app it is possible to read and set values in the same way as over the HT104 or HT200 terminals.

When connecting over the Internet, the PLC(s) must have a public IP address. COntact the Internet provider for more details. The mobile device where Merbon Visual is installed must have access to the Internet.

For more complex topologies, information about licensing etc. please contact the Domat Control System technical support.

8 Other network and communication components

This hardware connects the process stations between each other, to the management station, and to the communication interfaces (routers) to the Internet over their network interfaces.

8.1 Switch

The main element for interconnectiong of the process stations and connecting them to the management station. Any commercially available 10/100 Mbit/s Ethernet switch is OK, in a more demanding environment it is recommended to use a industry-grade switch, such as MOXA, EDS range.

Remember to install a 230 V network socket to power the switch in the panel where the switch shall be located.

8.2 Wireless access point

When planning a wireless access, two main aspects must be considered:

- signal range
- network security.

WiFi (802.11) network elements communicate over 2.4 or 5 GHz and for a robust link, direct visibility between the receiver and the transmitter is required. It is very difficult to plan the signal propagation in buildings, expensive measurements are necessary at most of the sites. The signal is attenuated by concrete constructions with steel reinforcing, it propagates better through plaster boards.

The main security rule is to limit the signal availability to controllable places only. Use MAC filtration, and other up-to-date security technologies where available. In general, it is recommended to avoid WiFi access completely, as the link quality may degrade in time (due to electromagnetic interference, relocation of walls, furniture and machines etc.) and the arising problems may complicate both the warranty and after-warranty service.

8.3 Router

A router links the technological network to the customer network or the Internet, if such link is required. The router is configured by a network administrator or according to the specification of the Internet provider.

We recommend to use any available type which meets all technical and security requirements. Contact your network administrator or Domat Control System technical support for details.

8.4 GSM modem

A modem connects to the RS232 port of a process station or management station, according to the topology and uptime requirements. It is used for alarm and event messaging to mobile phones.

We recommend using GSM modems with Cinterion modules (supplied e.g. by SEA Praha), other modems will be tested on demand.

9 Third party system integration

In building technologies, integration of 3rd party systems, such as chillers, lighting, lifts etc. into the building control system is considered as standard.

Domat provides a broad range of software drivers which help to complete this task.

When specifying and designing integrated systems, it is necessary to get in touch with the 3rd party supplier so that it is possible to specify which functions are available and at what costs.

The first thing is: **Will the 3rd party system be integrated into a process station, or into a management station?**

9.1 Integration into process stations

There must be a communication interface free in the process station. Typically, it is a serial port. In some cases, a RS232/RS485 converter (e.g. **R012**) must be used. If a PC-based process station (e.g. **IPCT.1**) has no free serial port available, it may be created using a terminal server (**R020**, **R031**), which creates a virtual serial port available over the Ethernet network. If there are standard protocols used, a Modbus RTU/TCP router, or **R025** (RS232), **R035** (RS485) is a good solution.

The process station must provide the necessary communication protocol (driver). In SoftPLC, there are more than 60 protocols available at the **IPLC5..** and Windows runtime. The Merbon PLCs now contain drivers for Modbus RTU, Modbus TCP, M-Bus and IEC 62056-21. However, there are third party devices which use a specific protocol. Merbon IDE allows writing of customized drivers in the ST language, which brings more flexibility and independence for the engineers.

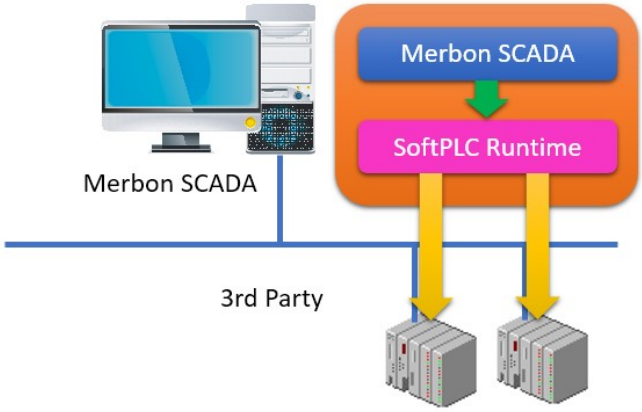
The drivers in Merbon IDE can be divided into following groups:

- **Native drivers** supported in Merbon IDE: They are part of the IDE and are configured by adding a communication channel and defining the required driver from the list. Driver properties, such as baudrate and addresses, are set in the property grid. Native drivers are fully supported by Domat, and their updates are part of the new Merbon IDE releases. The drivers source codes are part of Merbon IDE source codes and are not available to the public.
- **ST drivers** written by Domat on demand: if a customer needs to develop a new driver, there is the protocol description available, and the development is technically feasible, Domat can write the driver in ST language as a paid service. The customer gets a complete, fully commented source code which is fully at his disposal. The invoiced sum does not fully cover the development costs, and therefore the source code is a property of Domat Control System. Domat may decide to make the driver available to the public, including its source codes (or part of it), at the web forum, so that also other Merbon IDE users may take advantage of it. Domat is not responsible for keeping the driver updated nor for a full functionality of the published code, as third-party systems may be subject to updates, and Domat is not able to follow these changes and keep the drivers up to date continuously.
- **ST drivers written by customer**: The code is sole property of the customer, who decides if the code will be available to public or not; if it will be published for free or on a paid basis, and if so, if on his web pages, on the Domat forum, or anywhere

else; if any support will be provided for the code, and if so, if the support shall be paid or free of charge, etc. The same rules as for an ordinary application program apply.

9.2 Integration into SCADA

As Merbon SCADA provides a SoftPLC Runtime driver, third party integration directly into SCADA follows over the SoftPLC Runtime running on the same PC as Merbon SCADA or on another PC in the network. The integration layer is separated from the SCADA and can be configured autonomously. The SoftPLC Runtime must be licensed separately (in the price list as **RC-SoftPLC**).



Topology for third-party integration into Merbon SCADA

The PC must have all necessary communication ports. If the integration follows over the Ethernet, no other hardware is necessary. If serial ports (RS232, RS485) are required, a more suitable solution is using **IPLC510** (which contains 2× RS232 ports and 2× RS485 ports) rather than the SoftPLC Runtime..

9.3 Available protocols

All drivers are contained in the corresponding license (SoftPLC or Merbon).

The current list of supported protocols can be found at https://domat-int.com/en/downloads/technical-documentation.

9.4 Rules for successfull integration

When integrating a 3rd party device, the required data volume and character must be considered.

For several analogue / binary data points it is mostly good enough to use hardware connection with I/O modules.

At applications with dozens or hundreds datapoints and special signal types, such as discrete and cumulative values (error numbers, energy metering), it is better to use data integration. However, the 3rd party data protocol must be available, together with a list of values and their addresses and meaning. If planning to use already implemented drivers, check the version or variant of the protocol, such as Modbus ASCII / RTU, master / slave role, etc).

Before final design, a consultation with a Domat Control System representative is advisable. A properly designed project and clear tasks for all parties prevent unwanted extra costs and time delays during commissioning.