CANOpen System
Installation manual rev. 3.0

Technical characteristics

SUPPLY VOLTAGE:	24 V⎓ ± 10 %
WORKING TEMPERATURE:	0 ÷ 50 °C
PERCENTAGE OF HUMIDITY:	30 ÷ 90 % @ 25 °C
	30 ÷ 50 % @ 50 °C
MAXIMUM CONSUMPTION:	1300 mA continui
	1600 mA di spunto
CONFORMS TO:	EN 61131-2
	EN 61000-6-1
	EN 61000-6-3
PROTECTION LEVEL:	IP65
MAX. NUMBER OF EXPANSIONS:	15
MAX. NUMBER OF SOLENOIDS:	32
MAX. LENGTH CONNECTIONS (worse case):	50 m

Functioning

The system is designed to operate solenoid valves according to the signals received from an external bus and to provide the diagnostic information to the system and the external bus.

The system consists of an Initial Module (slave CANOpen device) which communicates with a Master CANOpen by means of a bus up to 1 Mb/s (setting of the speed by means of software) to which it is possible to connect up to 15 sequential "expansion" modules by means of an internal fieldbus.

The supply of the expansion modules activation signals of the solenoids come from the Initial Module which has an external power supply and is therefore able to communicate by means of a serial RS232 for the configuration of the system. It is also possible to connect digital input modules which communicate with the initial module through the same internal fieldbus. The input module has an external power supply. The system is able to handle up to maximum 48 inputs, (3 input modules, each containing 16 digital inputs). In the following diagrams the main connections and the details of the different connections are shown. For cabling of the internal fieldbus use the wired cable supplied by CAMOZZI.

Initial module

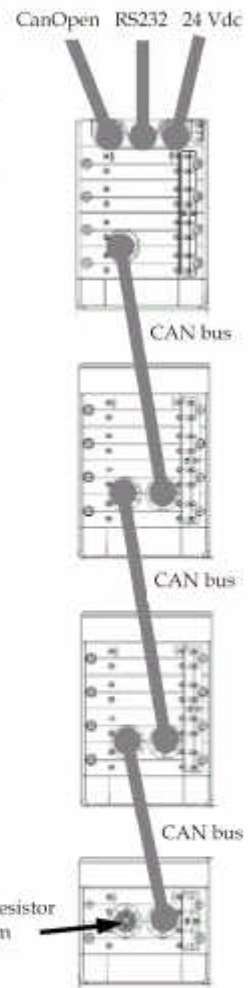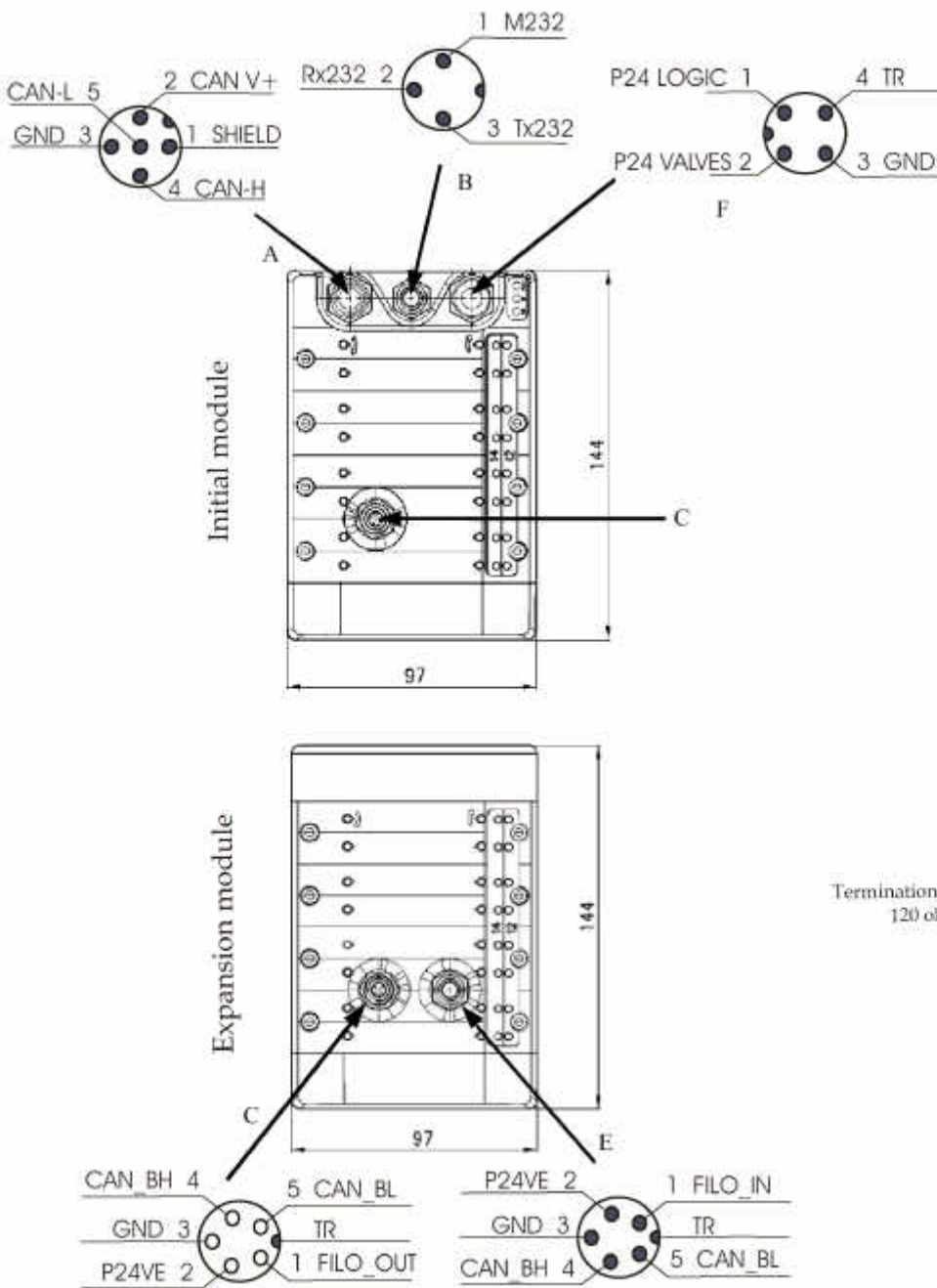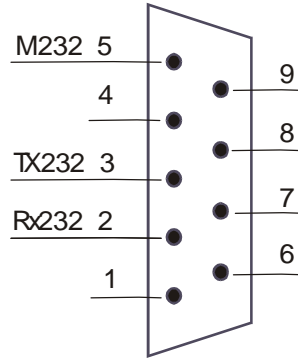The initial module has the following funtions:

- Is supplied by a source of 24 Vdc with ground connection for the solenoids;
- Is supplied by a source of 24 Vdc with ground connection for electronics;
- 24Vdc supply from the bus for the electronics of the CANOpen interface;
- Communicates by means of CANOpen with the Master CANOpen;
- Communicates by means of RS 232 with an external PC to configure the system;
- Communicates by means of the subserial (CAN bus) with the expansion modules and supplies them

Expansion module

The expansion module (2, 4 and 8 positions) has the following functions:

- Is supplied by the Initial Module;
- Communicates by means of the internal fieldbus with the Initial Module and the eventual following expansions;

Connessione seriale
lato PC

M232 5
4
TX232 3
Rx232 2
1
9
8
7
6

CAN-L 5   2 CAN V+
GND 3   1 SHIELD
4 CAN-H
A

Rx232 2   1 M232
3 Tx232
B

P24 LOGIC 1   4 TR
P24 VALVES 2   3 GND
F

Initial module

144

97

C

CanOpen RS232 24 Vdc

CAN bus

CAN bus

CAN bus

Termination resistor
120 ohm

Example, system

Expansion module

144

97

C

E

CAN_BH 4   5 CAN_BL
GND 3   TR
P24VE 2   1 FILO_OUT

P24VE 2   1 FILO_IN
GND 3   TR
CAN_BH 4   5 CAN_BL

CONNECTOR A

PIN 1 (SHIELD): ground. You have to connect this pin to the screen of the CANOpen wire.
PIN 2 (V+):   Positive supply voltage of the CANOpen bus (24V).
PIN 3 (GND):   Reference (0V) of the voltage on pin 2.
PIN 4 (CANH): CANH line of the CANOpen bus.
PIN 5 (CANL): CANL line of the CANOpen bus.

In case the valve island is the last slave node of the CANOpen line, it is necessary to insert a terminal resistance of 120 ohm connected to CANH e CANL signals. The terminal resistance has to be inserted externally to the last slave node (inside connector A or in the T-derivation)

While in case the valve island is in an intermediate point of the CANOpen line, a T-derivation has been realized (code CS-AA05EC) which allows to enter with the CANOpen line from on side (BUS IN), continue the line from the opposite side (BUS OUT) and bring the CANOpen line from the lower side up to connector A of the valve island Series Y (STUB).
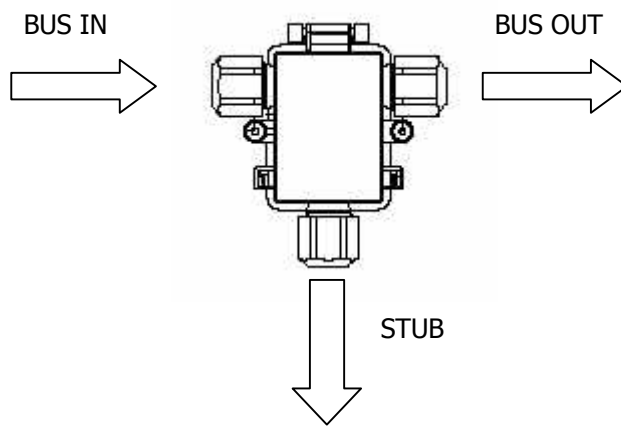
The T-derivation for the CANOpen line has to be positioned as close as possible to the valve island Series Y in order to limit the length of the stub.
In order to connect the valve island to the CANOpen network, it is necessary to use an M12 5 pole female connector (code CS-LF05HC for the straight connector and code CS-LR05HC for the 90° connector). In particular hard applications as regards inconveniences, it is advised to use metallic connectors.

Following you will find the example scheme of a CANOpen system with the two valve islands series Y, one mounted in an intermediate position and one at the end of the network.
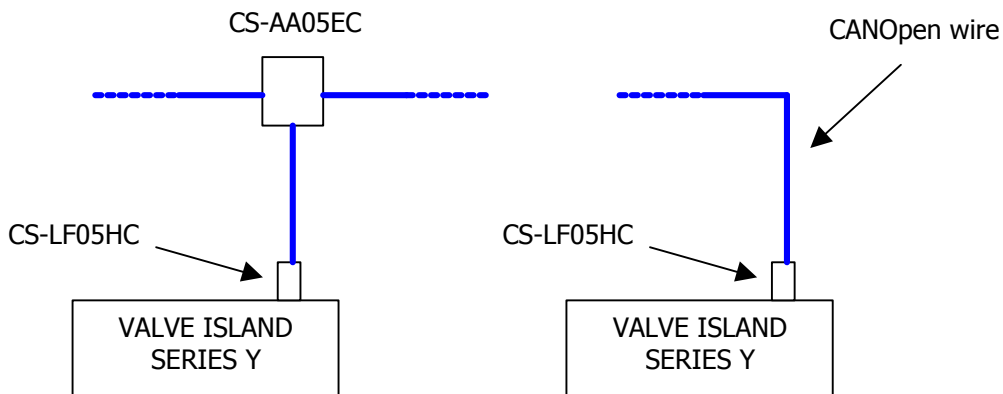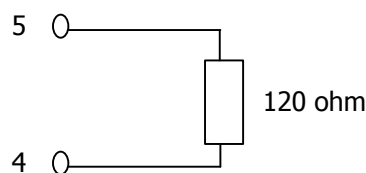

CONNECTOR F:

PIN 1 (P24 LOGIC):   supply for the part which handles the CANOpen communication inside the valve island. You have to connect the positive pole of the supply (24V) to this pin.

PIN 2 (P24 VALVES):   supply for the operating of the solenoid valves mounted on the valve island. You have to connect the positive pole of the supply (24V) to this pin.

PIN 3 (GND):   voltage reference on the pins 1 and 2. You have to connect the negative pole of the supply (0V) to this pin.

PIN 4 (TR):   ground connection. Where present, you have to connect the ground reference of the machine to this pin. This connection is not indispensable for the function of the valve island, but it improves its performance.

If the user wants to handle the emergency phase of the machine, taking away the supply from the actuators, he has to connect two different supply lines to the pins 1 and 2 of the connector F. In the opposite case, it is possible to connect one supply line and create a short circuit pins 1 and 2 inside the free connector M12 4 pole female (code CS-LF04HB for the straight connector and code CS-LR04HB for the 90° connector). It is important that the user checks the total load connected to the supply of the machine, in order not no voltage drops are noted, which could compromise the correct functioning of the valve island.

TERMINAL RESISTANCE FOR THE CAN SUBSERIAL:
In the right figure on page 2, you can see an example of a system where 3 expansion modules are connected to an initial cover. On the female connector of the last expansion (connector D) a terminal resistance is connected according to the following scheme:

An M9 connector is available with this resistance integrated (code CS-FP05H0).

Installation and connection

To install the CANOpen system, take it out of the package and follow the operations detailed below, referring to the schemes on the previous page.

- Place the island equipped with the Initial Module in order to receive the power supply and the connection CANOpen from the Master CANOpen.
- Place the islands equipped with the Expansion Modules according to the requirements of the machine
- Connect the external bus, CANOpen, to connector **A** on the Initial Module.
- Connect the serial port RS 232 (if you think it is necessary to configure the system the first time) to connector **B** on the Initial Module.
- Connect the subserial (if the systems provides the presence of expansions) to connector **C** of the Initial Module.
- Connect the subsequent Expansion modules by means of the connectors **D** and **E** .
- Connect the terminal resistance (120 Ω) to connector **D** of the last connected expansion.
- Connect the supply wire (24 Vdc $\pm$ 10 %) to connector **F** of the Initial Module.

Once the connections are finished, it is possible to supply the valve island.

The initial module of the Series Y is provided with an internal non volatile memory on which the configuration of the valve island is memorized. If the configuration of the island is modified (for example with the adding of a coil), in order to make it effective, you will have to use the software "Hardware Configurator" (refer to the procedure manual) in order to memorize it on the initial module (identification procedure). If the modification is not memorized, the island will continue to act as if the modification never took place.

The identification procedure is started by means of the "Hardware Configurator" and requires that the supply is taken away from the valve island (both the logic and the power supply) and that then the island is reconnected to the supply. For a correct functioning of the identification procedure you must avoid to connect the power supply before having connected the logic supply (these can be connected at the same time). During this phase we advise to interrupt the air supply to the valve island as accidental activations of some coils could occur.

The procedure takes about 10 seconds and during this period the two red leds BF and DIA continue to blink, which indicates that the system is checking its configuration. When the blinking of the two red leds BF and DIA stops (in normal conditions the two leds DIA and BF are switched off), it means that the valve island is ready to communicate with the CanOpen master on the network. We advise to use the Hardware Configurator to make sure that all the components of the island have been identified correctly.

But if the valve island is supplied without having started the identification procedure, the power and the logic supply can be connected in any type of sequence.

If voltage is supplied to the logics only (pin 1 of connector F), the green led RUN switches on and the red led DIA switches on. When also connecting the power supply (pin 2 of the connector F), if there are no anomalies, the red led DIA switch off.

If voltage is supplied to the valves part only, pin 2 of connector F), all LED's remain switched OFF.
When connecting also to the logics (pin 1 of connector F), the green led RUN switch ON, and the sequence continue as described previously.

The master CANOpen which is present in the network starts
to interrogate the valve island in order to verify its functioning. If there are no anomalies, the red BF led starts flashing indicating the trasnfer of information on the network, while if the contrary is the case, it remains switched on. The most frequent causes of anomalies on the CANOpen network are the following:
-    interruption or erroneous cabling of the CANOpen network
-    CANOpen address of the valve island not correct (the address of the valve island should coincide with the one present in the configuration hardware saved on the master).

When the valve island indicates any anomaly through the BF led, also on the PLC there is a led which turns switched on to indicate the error and normally the master enters in a STOP state. Usually the user has the possibility to manage through the software this situation and to avoid that the master goes into the STOP state: in this way the program charged in the memory of the master could function either way, also if the valve island does not receive any command and does not send any diagnostics information.

When putting the master in the RUN state, while no anomalies are indicated in the CANOpen network, the execution of the program charged in the memory starts. In case of correct message transfer (communication) CANOpen, the BF led flashing red.

During this phase there are two conditions which could cause communication problems with the PLC:
-    interruption of the CANOpen network
-    interruption of the logic supply

In both cases the master indicates the state of the BF (and usually enters in the STOP mode), while the valve island indicates the anomaly only in the first case (in the second case, the valve island switches off completely and to restore the functioning correctly, you should also remove the power supply to the solenoids, pin 2 of connector F).

N.B. when the master enters in a STOP mode, the program do not restart automatically after having eliminated the cause of an error. It is necessary to restart the whole system. Furthermore, when the master enter in STOP mode, all the outlets connected to it are deactivated and consequently also all the solenoids are deactivated, except those which have the RELAX function activated. These will be activated instead, (for further information regarding RELAX see the manual "Series Y Hardware Configurator).

If the master indicates a BF situation without entering in STOP mode, it normally restarts automatically when eliminate the cause of the error.

With the master in the RUN state, if the valves' supply is interrupted (pin 1 of connector F), keeping the logic one connected, there is no BF signal neither on the master nor on the valves' island: The CANOpen network is active. The anomaly is signaled by the valves' island with the flashing of the red led DIA and with the flashing of the green led RUN. Furthermore the diagnostic of the valves' island signals all the coils if interrupted. The user must decide how to handle this situation through the software saved in the master (he may decide, for example, to block the program, to stop the functioning of a machine's part or to continue regularly the cycle). Through the re-connection of the valves' supply, the island start immediately it's normal. When the power voltage is reconnected, the island's diagnostic indicate immediately as OK the coils of Initial Module, instead the coils of eventual expansions are indicate as interrupted for some seconds and after they are indicated as OK. If on a module (initial or expansion) a coil was indicated as interrupted before of coils voltage interruption, the other coils will not indicated as interrupted and the interrupted coils indication are sustained also when the coils voltage are reconnecting.

With the master in the RUN state, if the cable which connects the initial module with the different expansions is interrupted, the led DIA lights up and the diagnostic of the valves' island signals all the coils, which are present on the disconnected expansions, as interrupted, while both the initial module and the still connected expansions keep working regularly. Also in this case the user must decide how to handle this situation through the software saved in the master. Once the problems which caused the connection interruption have been solved, the error's signal through the led DIA disappeared and the diagnostic signals that the coils work regularly: therefore the valves' island start again working properly. The same situation occurs in case the system registers a supply tension lower than 19,5V on any of the present expansions.

With the master in the RUN state, if the valves' supply is interrupted (pin 2 of the connector F), the logic's one is connected and the valve's island structure is modified (for example by the disconnection of the cable which connects one of the eventually present expansions), the island signals the presence of an anomalous situation, even if the valves' supply is re-connected: the red led DIA keeps flashing and the diagnostic of the valves' island signals that all the coils are interrupted. Also in this case the user must decide how to handle this situation through the software saved in the master

We strongly advise against connecting a new expansion to the valve island and to start the island without carrying out an identification procedure before. In fact, in this case the expansion already memorized an address inside, but which, being random, could coincide with the one of an already existing expansion on the island: at this point the two expansions would receive the same activation commands for the coils. The identification procedure allows to assign a univocal address to all connected expansions.

Programming

Format of the data

The outlets coming from the Master CANOpen (PDO1Tx) and directed to the Initial Module can be formed by max. 4 bytes disposed as follows:

Byte 0								Byte 1								Byte 2								Byte 3							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	23	22	21	20	19	18	17	16	31	30	29	28	27	26	25	24

N. coils (left of row)

For example: bit 0 of byte 0 corresponds with the outlet 0
bit 2 of byte 1 corresponds with the outlet 10
bit 7 of byte 3 corresponds with the outlet 31

The diagnostic inlets for the Master CANOpen (PDO1Rx diagnosis of the system generated by the Initial Module) can be formed by a maximum of 8 bytes disposed as follows:

Byte 0								Byte 1								Byte 2								Byte 3							
3	3	2	2	1	1	0	0	7	7	6	6	5	5	4	4	11	11	10	10	9	9	8	8	15	15	14	14	13	13	12	12

N. coils (left of row)

Byte 4								Byte 5								Byte 6								Byte 7							
19	19	18	18	17	17	16	16	23	23	22	22	21	21	20	20	27	27	26	26	25	25	24	24	31	31	30	30	29	29	28	28

N. coils (left of row)

For example: bits 0 and 1 of byte 0 are the diagnosis of the coil with index 0
bits 2 and 3 of byte 0 are the diagnosis of the coil with index 1
bits 6 and 7 of byte 7 are the diagnosis of the coil with index 31

The significance of these diagnosis bits relative to a coil are as follows:

0 0   correct functioning
1 0   solenoid interrupted
0 1   solenoid in short circuit

The inlets for the Master CANOpen (PDO2Rx state of digital inputs; data generated from the Initial Module) can be formed by a maximum of 8 bytes disposed as follows:

Byte 0								Byte 1								Byte 2								Byte 3							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	23	22	21	20	19	18	17	16	31	30	29	28	27	26	25	24

Byte 4								Byte 5							
39	38	37	36	35	34	33	32	47	46	45	44	43	42	41	40

Byte 6								Byte 7							
55	54	53	52	51	50	49	48	63	62	61	60	59	58	57	56

The first six bytes assume the value for the state of the digital inputs.
For example: bit 0 of byte 0 corresponds to the state of the digital input 0
bit 2 of byte 1 corresponds to the state of the digital input 10
bit 7 of byte 3 corresponds to the state of the digital input 31

The significance of these bits are as follows:
0 input circuit open (not activated)
1 input circuit closed, (activated)

The seventh byte (byte 6) is not used while the first six bits of the last byte (byte 7) indicates the state of the whole circuit module.

For example: bit 0 of byte 7 correspond to the state of the first input module.

bit 2 of byte 7 correspond to the state of the third input module.
(bit 6 and 7 of byte 7 are not used)

The significance of these bits are as follows:

0   the module is functioning OK
1   the module does not communicate

The system supports Node Guarding.

File EDS

The ESD file, relative to the Initial Module, CANOpen, is supplied by the system (name SERIEY-CANOPEN.EDS), and needs to be installed on the Master CANOpen and allows to:
o   configure the communication between Master and Slave;
o   carry out PDO mapping based on the number of PDORx to handle:
     o   PDO1Tx + PDO1 Rx in case the system does not include digital input modules.
     o   PDO1Tx + PDO1Rx + PDO2RX in case the system also includes digital input modules.

Indications

LED	COLOUR	SIGNIFICANCE LED SWITCHED ON
RUN [1]	Green	Power supply present on the logics part of the Initial Module.
BF [1,2]	Red	Flashing: in comunication with the master, messages in transit ON: communication error with master CANOpen OFF: The module comunicates correctly but there are no messages in transit.
DIA [1,2]	Red	ON: Communication error on the internal fieldbus or anomaly of the expansions or of the solenoids. OFF: The outputs are functioning OK.
12/14	Yellow	Corresponding solenoid supplied

[1] The leds RUN, BF and DIA are only present on the Initial Module
[2] The flashing led's BF and DIA indicate that the system is proceeding with the initial recognition.

Diagnostics

SIGNALLING	OPERATIONS TO CARRY OUT
LED RUN switched off	☞ Verify the presence of power supply on the logics part of the initial module.
LED RUN flashing	☞ Verify the presence of power supply on the solenoid part of the initial module.
LED BF switched on	☞ Verify CANOpen connection ☞ Verify CANOpen Master – Slave configuration
LED DIA switched on	☞ Verify Initial Module – Expansions connections ☞ Verify state of solenoids and Expansions by means of serial

In case of a defect solenoid, the system points out the anomaly and:
o   Deactivates the faulty solenoid;
o   Blocks any signal directed to the faulty solenoid;
o   activates the LED **DIA**;
    sets up the corresponding bits in the outlet (inlet to Master CANOpen) to the faulty solenoid.
The user should decide how to manage this situation through the software, which is memorised in the master.

Research of defects

PROBLEM	LED RUN	LED BF	LED DIA	OPERATIONS TO CARRY OUT
Power supply on the logics part absent	OFF	OFF	OFF	Check the presence of supply
Power supply on the solenoid part absent	LAMP	OFF	OFF	Check the presence of supply
Supply less than the specifications	ON	OFF	ON	Check the supply voltage
Disconnection CANOpen connection	ON	ON	OFF	Chek the CANOpen connection
Disconnection subserial connection	ON	OFF	ON	Check connections Initial Module – Expansions
Length of expansion connections superior to the length allowed	ON	OFF	ON	Check the length of the connections Initial Module – Expansions
Wrong communication configuration CANOpen	ON	ON	OFF	Check configuration CANOpen Master - Slave
Internal defect of the electric cover	OFF	OFF	OFF	Check the presence of supply
Internal defect of the electric cover	ON	ON	OFF	Contact assistance
Solenoid defect	ON	OFF	ON	Check the state of the solenoids by means of the hardware configurator program
Expansion defect	ON	OFF	ON	Check the state of the expansions by means of the hardware configurator program

In case of absence of electrical supply it is possible to operate manually on each single valve by means of the corresponding manual override **G** (mechanical movement is guaranteed only in presence of compressed air).

Accessories

CS-LF04HB	CONNECTOR M12 4 POLE FEMALE (FOR SUPPLY)
CS-LR04HB	CONNECTOR M12 4 POLE FEMALE 90° (FOR SUPPLY)
CS-LF05HC	CONNECTOR M12 5 POLE FEMALE (FOR CANOPEN)
CS-LR05HC	CONNECTOR M12 5 POLE FEMALE 90° (FOR CANOPEN)
CS-FZ03AD-C500	CONNECTOR M9 3 POLE FEM+ SUB-D PLUG+CABLE 5 mt. (FOR PROGRAMMING)
CS-FW05HE-D025	CABLE WITH TWO CONNECTORS M9 5 POLE MALE + FEMALE 25 cm.(FOR EXPANS.)
CS-FW05HE-D100	CABLE WITH TWO CONNECTORS M9 5 POLE MALE + FEMALE 1mt.(FOR EXPANS.)
CS-FW05HE-D250	CAVO CON DUE CONNETTORI M9 5 POLE MALE + FEMALE 2.5 mt.(FOR EXPANS.)
CS-FW05HE-D500	CAVO CON DUE CONNETTORI M9 5 POLE MALE + FEMALE 5 mt.(FOR EXPANS.)
CS-FW05HE-DA00	CAVO CON DUE CONNETTORI M9 5 POLE MALE + FEMALE 10 mt.(FOR EXPANS.)
CS-FP05H0	CONNECTORS M9 5 POLE MALE+TERMINAL RESISTANCE (FOR EXPANS.)
CS-AA05EC	CANOPEN DATA LINE TEE

GLOSSARY

IP65	Total protection against dust. Protected against low pressure jets if water from all directions.
CANOpen	**(Controller Area Network**) serial flexible data communication system at high speed (up to 1000Kbit/sec) for the industrial automation. Its primary application area ca be attributed to the field's level. There are different kinds of communication: Client/server model, producer/user and master/slave model.
MASTER	It is the device which inside a CANOpen net has to control the data flow. There may be more CANOpen on the same net
SLAVE	Device which communicates inside the CANOpen net and replies to the master' s requests or generates messages in asynchronous modality. The slaves' priority is connected to their address.
NODE	Master or slave device connected to a CANOpen network. In a CANOpen network there may be up to 128 nodes.
FIELDBUS	Communication system which foresees the data coding in a sequence of 0 and 1 and the use of an unique transmission means. It is necessary that all the connected devices can code and decode the information.
FILE EDS	Word file which contains all the information required by the Master to communicate correctly with the slave and some information connected with the producer. This file is supplied by the slave's producer.

CANOPEN – CONFIGURATION

GENERAL NOTES

Each CanOpen slave receives and transfers on the network, packages of data called PDO. Each slave can receive or transfer multiple PDO:s (each PDO can contain up to 8 byte of data).
For example, the initial module of the Series Y receives a PDO which contains the information for the valves' starting (PDO1 rx) and transmits two PDO, one containing the island's coils diagnostic (PDO1 tx) and the other containing the values of the digital inlets which may be connected (PDO2 tx). Furthermore it guarantees other kinds of packages foreseen by the protocol (ex. SDO).
To each PDO which runs on the net, an identification code is given (COB-ID), it indicates the kind of message and who has transmitted it. In particular, it is added to the value which indicates the kind of message, also the address value of the node which has transmitted the same message: for example, the PDO1 tx of the node slave 4 will have a COB-ID = 0x180 + 4 = 0x184. The association between the PDO and the related COB-ID can be found in the EDS file (the COB-ID can anyway make the calculation using the specific tables).
The list of the PDO handled by each slave can be found in the related EDS file and the group of the handled PDO and their structure make part of the module's object dictionary.
To each element of the dictionary an address is connected.
For the slave and the master the association between the addresses and the different kinds of objects is fixed and determined by the CANOpen specification.
The PDO mapping objects' content must be set. For the slave, it is defined in the EDS file, for the master it is sometimes automatically generated by the master (if it makes a net scan), while in other cases it must be calculated using the required tables and manually formulated in its parameters.
Especially, the reception PDO occupy the objects' dictionary addresses starting from 1400h an up (PDO1 -> 1400h; PDO2 -> 1401h; …), the transmission ones occupy the objects' dictionary addresses starting from 1800h and up (PDO1 -> 1800h; PDO2 -> 1801h; …).
Of course, if one slave transmits a determined PDO, the master must be configured for receiving it and vice versa, if one slave receives a determined PDO, the master must be configured for transmitting it.

CONFIGURATION EXAMPLE

Reference table (conform CANOpen specifics)

OBJECT	COB-ID	OBJECTS' DICTIONARY ADDRESSES
PDO1 tx	0x180 + NODEID	1800h
PDO2 tx	0x280 + NODEID	1801h
PDO3 tx	0x380 + NODEID	1802h
PDO4 tx	0x480 + NODEID	1803h
…		
PDO7 tx	0x780 + NODEID	1806h
….		
PDO1 rx	0x200 + NODEID	1400h
PDO2 rx	0x300 + NODEID	1401h
PDO3 rx	0x400 + NODEID	1402h
PDO4 rx	0x500 + NODEID	1403h
….		
PDO7 rx	0x800 + NODEID	1406h
….		

System with two slave nodes Series Y.

NODE 1 address 4

OBJECT	COB-ID	OBJECTS' DICTIONARY ADDRESSES
PDO1 rx	0x204	1400h
PDO1 tx	0x184	1800h
PDO2 tx	0x284	1801h

NODE 2 address 6

OBJECT	COB-ID	OBJECTS' DICTIONARY ADDRESSES
PDO1 rx	0x206	1400h
PDO1 tx	0x186	1800h
PDO2 tx	0x286	1801h

The Master should 6 PDO (3 for each slave).

OBJECT	COB-ID	OBJECTS' DICTIONARY ADDRESSES
PDO1 tx	0x204	1800h
PDO1 rx	0x184	1400h
PDO2 rx	0x284	1401h
PDO2 tx	0x206	1801h
PDO3 rx	0x186	1402h
PDO4 rx	0x286	1403h

NB: in the construction of the table above it is not necessary to follow a specific order in listing the PDO's. The COB-ID of the Master objects is the one calculated for the relative PDO slave.