



mod. IO-MB/AI-08TC

M.U. IO-MB/AI-08TC-3/09.02
Cod. J30-478-1AAI-08TC E

User manual

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APPLICABLE STANDARDS

The AI-08TC module is suited for the Modbus-IDA Organization protocol [1] and implements a subset of it, as explained in the text.
MODBUS is a registered trademark of Schneider Automation Inc.

Characteristics

Technical data

| | |
|-------------------------|---------------------|
| Accuracy at 25°C | ±0.1% FS |
| Temperature coefficient | 0.005% FS/K |
| Input impedance | mV > 100MΩ |
| Digital resolution | 16 bit |
| Input ranges | 0...100 mV |
| | 0...1000 mV |
| | -100...+100 mV |
| Type of TC | -1000...+1000 mV |
| | J, K, L, N, R, S, T |
| Conversion time | 50 ms |
| Overvoltage protection | 30 V |
| CMRR | > 100 dB |

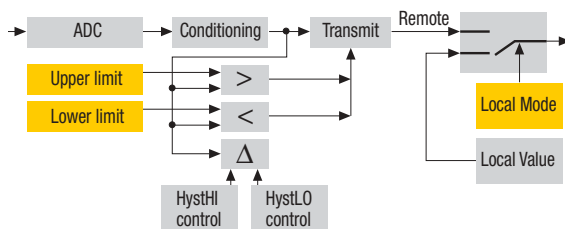
General

| | | |
|---------------------------------|--|------------------|
| 3 way isolation (see last page) | Channel to channel to logic: no isolation (channels-logic) to serial bus to power supply: 800 Vp | |
| Power supply | 24 Vdc; -15...+25% | Consumption: 3 W |
| Dimensions | L: 76; H: 110; W: 65; | |
| Weight: | 220g | |
| Safety regulations EN61010-1 | Isolation class II (50 Vrms), Installation category II | |
| CE marking | EN61131-2 | |

Environment

| | Operating | Storage |
|---------------------|--|---|
| Temperature | -10...+65°C | -40...+85°C |
| Relative Humidity | 5...95% non condensing Appropriate measures must be taken against humidity >85% | 5...95% non condensing For a short period, slight condensation may appear on the housing |
| Mounting | Vertical, free air | |
| Protection | IP20 | |
| Vibrations (3 axes) | 10...57Hz 0.0375mm, 57...150Hz 0.5g | |
| Shock (3 axes) | 15g, 11ms half sine | |

Functional Block Diagram



The analogue input function block describes, for each input channel, how field values are transmitted. Every time one of the limit conditions is reached it is reported to the appropriate register.

MODBUS I/O Module

8 Thermocouple Analogue Inputs

mod. IO-MB/AI-08TC



8 analogue inputs configurable for:

- Thermocouple
- mV linear inputs



WARNING

The product described in this manual should only be installed, operated and maintained by qualified application programmers and software engineers who are familiar with automation safety concepts and applicable national standards.

Function Codes used by the module

| | | | | Functions | (hex) |
|-------------|-------------|------------------------------|-----------------------|------------------------|-------|
| Data access | Bit access | Physical Digital Inputs | Read Inputs status | 02 | 02 |
| | | Internal Bits Or | Read Coil status | 01 | 01 |
| | | Physical Digital output | Write Single Coil | 05 | 05 |
| | Word access | Physical Input Registers | Read Input Register | 04 | 04 |
| | | | Internal Registers | Read Holding Registers | 03 |
| | | Or Physical Output Registers | Write Single Register | 06 | 06 |
| Diagnostics | | Write Multiple Registers | 16 | 10 | |
| | | Read Exception status | 07 | 07 | |
| | | Diagnostics | 08 | 08 | |

The function codes provided for all the modules are a subset of the "Public Function Codes", validated by the Modbus-IDA Organization.

Function 01 and Function 02 can be used to read both digital output and digital input.
Function 03 and Function 04 can be used to read both output and input registers.

Diagnostics

MODBUS Exception Responses:

| Code | Name | Meaning |
|------|----------------------------|---|
| 01 | ILLEGAL FUNCTION | The function code received in the query is not an allowable action for the server (or slave) |
| 02 | ILLEGAL DATA ADDRESS | The data address received in the query is not an allowable address for the server (or slave). |
| 03 | ILLEGAL DATA VALUE | A value contained in the query data field is not an allowable value for server (or slave) |
| 07 | NEGATIVE ACKNOWLEDGE - NAK | The server (or slave) is in the wrong state to process a request of this type or an attempt to write to a read only address has been made |

Code 07 has not been provided by Modbus.org Protocol. Use it for ASCON products compatibility only.

Function Code 07: Read Exception Status:

| bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|---|---|---|---|---|---|---|---|
| status | 0 | 0 | 0 | X | X | X | X | X |

Digital Input writing attempted (1) → bit 4
Local Value state (1) → bit 1
Dummy Data Field (0 fill) (1) → bit 3
Invalid Input Data (1) → bit 0
Output Data Valid (1) → bit 2

Function Code 08: Diagnostics

The only supported sub code is 0 – Return Query Data

MODBUS Address Map organisation

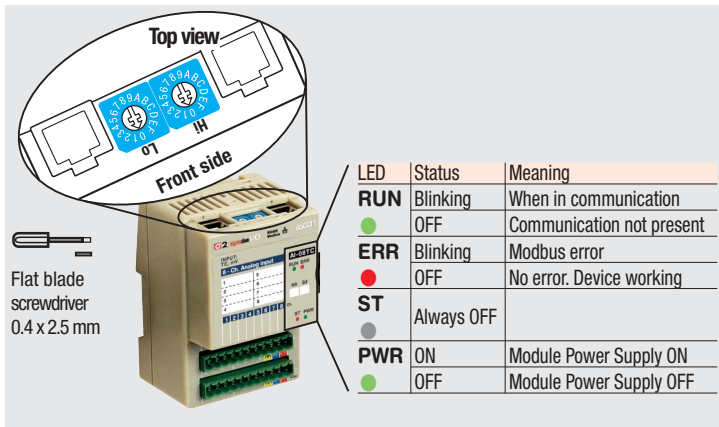
| Data Type | Address Range | Sub range | Data sub type |
|-------------|---------------|-------------|---------------------------------|
| Digital I/O | 1 - 400 | 1 - 100 | Physical Digital I/O |
| | | 101 - 200 | Digital I/O Extension |
| | | 20 - 300 | Alarms |
| | | 301 - 400 | Status variables |
| Registers | 1 - 1200 | 1 - 120 | Field/Process I/O Data |
| | | 121 - 200 | Device Id/Info Area |
| | | 201 - 300 | Field/Process I/O Extension |
| | | 301 - 400 | Non retentive Device Management |
| | | 401 - 800 | Retentive Device Management |
| | | 801 - 1000 | Configuration Data |
| | | 1001 - 1050 | Diagnostics |
| | | 1101 - 1200 | Reserved registers |

Writing and reading data length limits:

| | |
|--|----------|
| Number of Digital Outputs to be written in a single message | Max. 128 |
| Number of Digital I/O to be read in a single message | Max. 160 |
| Number of Output Registers to be written in a single message | Max. 16 |
| Number of I/O Registers to be read in a single message | Max. 125 |

Hardware Set-up

Hexadecimal rotary switches, service and I/O LEDs



Baud Rate and Node ID configuration

Baud Rate

| Lo switch | Baud rate bps |
|-----------|---------------|
| 0 | 300 |
| 1 | 1200 |
| 2 | 2400 |
| 3 | 4800 |
| 4 | 9600 |
| 5 | 19200 |

Node ID

| Hi switch | Lo switch | Valid ID Node |
|-----------|-----------|--------------------|
| 0 | 1 | 1 (address 1) |
| 0 | 2 | 2 (address 2) |
| ↓ | ↓ | ↓ |
| F | 7 | 0xF7 (address 247) |

Common parameters

Out of range warnings for Field Values

| Digital Inputs | Name | Access | Notes |
|----------------|--------------|--------|-----------------------|
| 301 | OutOfRange-1 | R | Out of Range Warnings |
| ... | ... | R | |
| 308 | OutOfRange-8 | R | |

Common Digitals

| Digital outputs | Name | Access | Notes |
|-----------------|---------|--------|----------------------------|
| 397 | Parity | R/W | 0: Disabled; 1: Enabled |
| 398 | EvenOdd | R/W | 0: Even; 1: Odd |

Common Registers

| Output Registers | Name | Access | Notes | | | | | | |
|------------------|-------------------|--------------|--|------|------|------|------|------|------|
| 398 | Ch_LO | R/W | Channel Number 8-1 enable for ModuleCom (see reg. 399) | | | | | | |
| bit | bit 15...8 | bit 7 | bit 0 | | | | | | |
| Channel | X...X | Ch 8 | Ch 7 | Ch 6 | Ch 5 | Ch 4 | Ch 3 | Ch 2 | Ch 1 |

| Output Registers | Name | Access | Notes |
|------------------|-----------|--------|-------------------------|
| 399 | ModuleCom | R/W | Module Command Register |

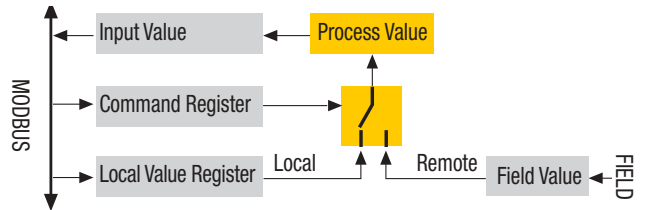
Commands:

| | |
|--------------------------|--|
| 0x0 | Normal State (all channels) |
| 0x4C42 (ASCII code "LB") | Local Value State (only for enabled channels see reg. 398) |

How Local Value Command works (valid for Channel Number Bit = 1)

| Output Registers | Name | Access | Notes |
|------------------|------------|--------|------------------------------------|
| 921 | ColdJunAct | R/W | Cold Junction Activation (0 = OFF) |

| Input Registers | Name | Access | Notes |
|-----------------|------------|--------|---------------------------------------|
| 922 | ColdJunVal | R | Cold Junction Value (1 decimal point) |



| Output Registers | Name | Access | Notes |
|------------------|----------|--------|-------------------------------|
| 400 | StackCom | R/W | Modbus Stack Command Register |

Commands:

| | |
|--------------------------|--|
| 0x0 | Normal State |
| 0x5354 (ASCII code "ST") | Store Configuration in non volatile memory |
| 0x5253 (ASCII code "RS") | Restore default configuration values |
| 0x5254 (ASCII code "RT") | RESET (Cold Start) |

| Output Registers | Name | Access | Notes |
|------------------|-------|--------|-----------------------|
| 801 | NodeA | R/W | Node Address Register |
| 802 | BaudR | R/W | Baud Rate Register |

| Baud Rate | Register Value | Node Address | Register Value |
|-----------|----------------|-------------------|----------------|
| 300 | 0 | 0 reserved | 0 |
| 1200 | 1 | 1 | 1 |
| 2400 | 2 | ... | ... |
| 4800 | 3 | ... | ... |
| 9600 | 4 | 247 | 0xF7 |
| 19200 | 5 | 248..256 reserved | 0xF8...0xFF |

Procedure for Node Address and Baud Rate configuration

The HI and LO hexadecimal rotary switches set the module's Baud Rate and MODBUS Node Address. To configure the module, follow the procedure:

- 1 Turn the Power OFF
- 2 Set the HI and LO switches to "F"
- 3 Turn the Power ON
- 4 Select the desired Baud Rate value by setting the LO switch following the table (e.g. "4" for 9600 bps)
- 5 Shift the HI switch to "E" (all the module service LEDs should flash)
- 6 Turn the Power OFF. Now configure Node ID
- 7 Set the HI and LO switches to the desired valid Node ID following the table
- 8 Turn the Power ON.

Alternatively, at step 7 set the value 00h (default value). Then, at the next Power ON, the last valid stored value will be resumed as Node ID. The default values are: Baud Rate = 9600 bps, Node ID = 247.

Module Identity Registers

| Output Registers | Name | Access | Notes |
|------------------|-------------|--------|-----------------------|
| 121 | ManuCode | R | Manufacturer Code |
| 122 | ProdCode-1 | R | Product Code # 1 |
| 123 | ProdCode-2 | R | Product Code # 2 |
| 124 | RelCode-1 | R | Hardware Release Code |
| 125 | RelCode-2 | R | Software Release Code |
| 126 | SpecialCode | R | Special Product Code |
| 127 | ProdCode-3 | R | Product Code # 3 |

User defined Registers

| Output Registers | Name | Access | Notes |
|------------------|--------|--------|--|
| 189 | Usr#1 | R/W | User Defined Register # 1 (retentive) |
| 190 | Usr#2 | R/W | User Defined Register # 2 (retentive) |
| ... | ... | ... | ... |
| 198 | Usr#10 | R/W | User Defined Register # 10 (retentive) |

Module parameters

Input type selection

| Output Register | Name | Access | Notes |
|-----------------|----------|--------|--|
| 473 | Sel°C/°F | R/W | °C, ° F selector: Value 0 for °C, value 1 for °F. Default 0 |

| Output Registers | Name | Access | Notes |
|------------------|------------|--------|--|
| 821 | BurnOutV-1 | R/W | In case of sensor break, the T/C input value becomes one of those inserted in the table that follows |
| ... | ... | R/W | |
| 828 | BurnOutV-8 | R/W | |

BurnOut selection codes

| Type | Register Value | Note |
|----------|----------------|--------------------|
| Standard | 0 | Hardware dependent |
| Low | 1 | Low range |
| High | 2 | High range |

| Output Registers | Name | Access | Notes |
|------------------|------------|--------|---------------------|
| 811 | InTypeCh-1 | R/W | See selection codes |
| ... | ... | R/W | |
| 818 | InTypeCh-8 | R/W | |

Selection codes

| Type | | Register Value | Range °C | | Range °F | |
|------|---------------|----------------|----------|--------|----------|--------|
| TC | J | 1 | -200.0 | 1200.0 | -328.0 | 2192.0 |
| TC | K | 2 | -200.0 | 1372.0 | -328.0 | 2501.6 |
| TC | L | 3 | -200.0 | 600.0 | -328.0 | 1112.0 |
| TC | N | 4 | 0.0 | 1300.0 | 32.0 | 2372.0 |
| TC | R | 5 | 0.0 | 1600.0 | 32.0 | 2912.0 |
| TC | S | 6 | 0.0 | 1760.0 | 32.0 | 3200.0 |
| TC | T | 7 | -200.0 | 400.0 | -328.0 | 752.0 |
| mV | 0.00...100.00 | 8 | | | | |
| mV | 0.0...1000.0 | 9 | | | | |
| mV | ±100.00 | 10 | | | | |
| mV | ±1000.0 | 11 | | | | |

Alarm High warnings for PV

| Digital Inputs | Name | Access | Notes |
|----------------|-----------|--------|-------|
| 201 | AlarmHI-1 | R | |
| ... | ... | R | |
| 208 | AlarmHI-8 | R | |

Alarm Low warnings for PV

| Digital Inputs | Name | Access | Notes |
|----------------|-----------|--------|-------|
| 209 | AlarmLO-1 | R | |
| ... | ... | R | |
| 216 | AlarmLO-8 | R | |

Linearised measurements readings

| Input Registers | Name | Access | Notes |
|-----------------|------|--------|-------|
| 1 | PV-1 | R | |
| ... | ... | R | |
| 8 | PV-8 | R | |

Local Values

| Output Registers | Name | Access | Notes |
|------------------|---------|--------|---|
| 301 | LocalV1 | R/W | While in Local Value state the module transfers the value of the registers into the PV registers. |
| ... | ... | R/W | |
| 308 | LocalV8 | R/W | |

Decimal points

| Input Registers | Name | Access | Notes |
|-----------------|--------------|--------|------------------------|
| 417 | DecPointCh-1 | R | Decimal point position |
| ... | ... | R | |
| 424 | DecPointCh-8 | R | |

High and Low Alarm Thresholds for PV

HI Threshold

| Output Registers | Name | Access | Notes |
|------------------|----------|--------|-----------------------|
| 425 | ThreHI-1 | R/W | High alarm thresholds |
| ... | ... | R/W | |
| 432 | ThreHI-8 | R/W | |

LO Threshold

| Output Registers | Name | Access | Notes |
|------------------|----------|--------|----------------------|
| 433 | ThreLO-1 | R/W | Low alarm thresholds |
| ... | ... | R/W | |
| 440 | ThreLO-8 | R/W | |

Hysteresis (0.1% FS)

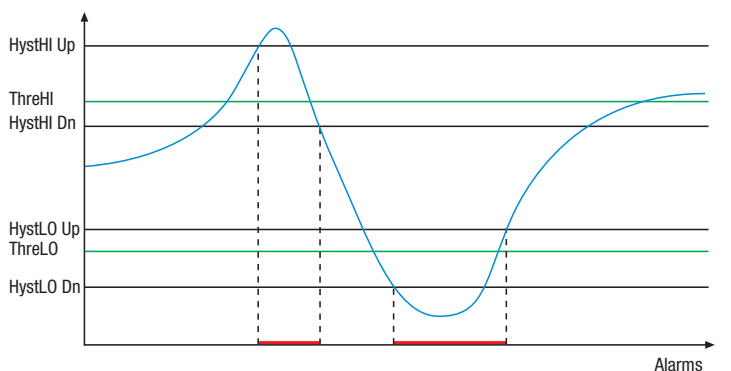
| Output Registers | Name | Access | Notes |
|------------------|-------------|--------|-------------------------------|
| 441 | HystHI Up-1 | R/W | High hysteresys UP thresholds |
| ... | ... | R/W | |
| 448 | HystHI Up-8 | R/W | |

| Output Registers | Name | Access | Notes |
|------------------|-------------|--------|---------------------------------|
| 449 | HystHI Dn-1 | R/W | High hysteresys DOWN thresholds |
| ... | ... | R/W | |
| 456 | HystHI Dn-8 | R/W | |

| Output Registers | Name | Access | Notes |
|------------------|-------------|--------|------------------------------|
| 457 | HystLO Up-1 | R/W | Low hysteresys UP thresholds |
| ... | ... | R/W | |
| 464 | HystLO Up-8 | R/W | |

| Output Registers | Name | Access | Notes |
|------------------|-------------|--------|--------------------------------|
| 465 | HystLO Dn-1 | R/W | Low hysteresys DOWN thresholds |
| ... | ... | R/W | |
| 472 | HystLO Dn-8 | R/W | |

Alarm HI and LO generator



MODBUS Map summary (with default values)

| Modbus address | Module digital I/O | Name | Access | Description | default (hex) |
|----------------|--------------------|--------------|--------|---------------------------------------|---------------|
| 200 | 201 | AlarmHI-1 | R | | |
| ... | ... | ... | R | | |
| 207 | 208 | AlarmHI-8 | R | | |
| 208 | 209 | AlarmLO-1 | R | | |
| ... | ... | ... | R | | |
| 215 | 216 | AlarmLO-8 | R | | |
| 300 | 301 | OutOfRange-1 | R | | |
| ... | ... | ... | R | | |
| 307 | 308 | OutOfRange-8 | R | | |
| 396 | 397 | Parity | R/W | 0: Parity Disabled; 1: Parity Enabled | 0 |
| 397 | 398 | EvenOdd | R/W | 0: Parity Even; 1: Parity Odd | 0 |

| Modbus address | Module registers | Name | Access | Description | default (hex) |
|----------------|------------------|--------------|--------|-------------------------------|---------------|
| 0 | 1 | PV-1 | R | Field Value # 1 | |
| ... | ... | ... | R | ... | |
| 7 | 8 | PV-8 | R | Field Value # 8 | |
| 120 | 121 | ManuCode | R | Manufacturer Code | 0258 |
| 121 | 122 | ProdCode-1 | R | Product Code # 1 | 3038 |
| 122 | 123 | ProdCode-2 | R | Product Code # 2 | 5443 |
| 123 | 124 | RelCode-1 | R | Hardware Release Code | |
| 124 | 125 | RelCode-2 | R | Software Release Code | |
| 125 | 126 | SpecialCode | R | Special Product Code | |
| 126 | 127 | ProdCode-3 | R | Product Code # 3 | 4149 |
| 188 | 189 | Usr#1 | R/W | User Defined Register # 1 | FFFF |
| 189 | 190 | Usr#2 | R/W | User Defined Register # 2 | FFFF |
| ... | ... | Usr#n | R/W | User Defined Register # n | FFFF |
| 197 | 198 | Usr#10 | R/W | User Defined Register # 10 | FFFF |
| 300 | 301 | LocalV1 | R/W | Local Value # 1 | 0000 |
| ... | ... | ... | R/W | ... | 0000 |
| 307 | 308 | LocalV8 | R/W | Local Value # 8 | 0000 |
| 397 | 398 | Ch_LO | R/W | Channel Number 8-1 selection | 0000 |
| 398 | 399 | ModuleCom | R/W | Module Command Register | 0000 |
| 399 | 400 | StackCom | R/W | Modbus Stack Command Register | 0000 |
| 416 | 417 | DecPointCh-1 | R | Number of decimal digits Ch 1 | 0000 |

| | | | | | |
|-----|-----|--------------|-----|---------------------------------|------|
| ... | ... | ... | R | ... | 0000 |
| 423 | 424 | DecPointCh-8 | R | Number of decimal digits Ch 8 | 0000 |
| 424 | 425 | ThreHI-1 | R/W | Hi threshold # 1 | 7FFF |
| ... | ... | ... | R/W | ... | 7FFF |
| 431 | 432 | ThreHI-8 | R/W | Hi threshold # 8 | 7FFF |
| 432 | 433 | ThreLO-1 | R/W | LO threshold # 1 | 8000 |
| ... | ... | ... | R/W | ... | 8000 |
| 439 | 440 | ThreLO-8 | R/W | LO threshold # 8 | 8000 |
| 440 | 441 | HystHI Up-1 | R/W | HI threshold Upper Hysteresis 1 | 0000 |
| ... | ... | ... | R/W | ... | 0000 |
| 447 | 448 | HystHI Up-8 | R/W | HI threshold Upper Hysteresis 8 | 0000 |
| 448 | 449 | HystHI Dn-1 | R/W | HI threshold Lower Hysteresis 1 | 0000 |
| ... | ... | ... | R/W | ... | 0000 |
| 455 | 456 | HystHI Dn-8 | R/W | HI threshold Lower Hysteresis 8 | 0000 |
| 456 | 457 | HystLO Up-1 | R/W | LO threshold Upper Hysteresis 1 | 0000 |
| ... | ... | ... | R/W | ... | 0000 |
| 463 | 464 | HystLO Up-8 | R/W | LO threshold Upper Hysteresis 8 | 0000 |
| 464 | 465 | HystLO Dn-1 | R/W | LO threshold Lower Hysteresis 1 | 0000 |
| ... | ... | ... | R/W | ... | 0000 |
| 471 | 472 | HystLO Dn-8 | R/W | LO threshold Lower Hysteresis 8 | 0000 |
| 472 | 473 | Sel°C/°F | R/W | °C, °F selector | 0000 |
| 800 | 801 | NodeA | R/W | Node Address Register | 00F7 |
| 801 | 802 | BaudR | R/W | Baud Rate Register | 0004 |

| | | | | | |
|-----|-----|------------|-----|---------------------------------------|------|
| 810 | 811 | InTypeCh-1 | R/W | Channel 1 Input type | 0001 |
| ... | ... | ... | R/W | ... | 0001 |
| 817 | 818 | InTypeCh-8 | R/W | Channel 8 Input type | 0001 |
| 820 | 821 | BurnOutV-1 | R/W | Type of Burnout Value 1 | 0000 |
| ... | ... | ... | R/W | ... | 0000 |
| 827 | 828 | BurnOutV-8 | R/W | Type of Burnout Value 8 | 0000 |
| 920 | 921 | ColdJunAct | R/W | Cold Junction Activation (0=OFF) | 0001 |
| 921 | 922 | ColdJunVal | R | Cold Junction Value (1 decimal point) | 0000 |

WARNING

The data written at retentive and configuration registers are stored in EEPROM (see "Address Map organisation" paragraph for details). This type of memory has a limited number of writing cycles. Also if this number is very high (about 100000 cycles), this limit can be easily reached if the storing process is forced through a serial communications line. Please check that the storing procedure of these registers is not performed automatically.

Parameter Store/Restore

This module allows parameters to be saved in a non volatile memory. In order to avoid storing configuration data parameters (registers 801...1000) by mistake, storage is only executed when a specific signature is written to the appropriate register. The signature is "ST".

Similarly, the default values of parameters are restored. On receipt of the correct signature in the appropriate register, the device restores the default parameters. The signature is "RS".

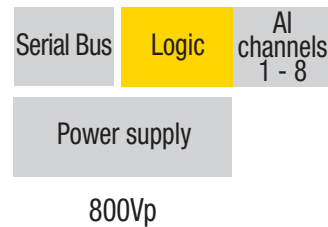
The new configuration becomes active after a reset, i.e. after a "Power Down" or a reset command (signature "RT"). See Register 400.

es. Node address change by serial communications:

1. Write the new address in register 801 (NodeA). - Write value.
2. Write 0x5354 (ASCII code "ST") to register 400. - Store value.
3. Write 0x5254 (ASCII code "RT") to register 400. - Cold reset.

The retentive device management data (registers 401... 800) are immediately valid after writing. To maintain the values after a power OFF/ON cycle, the command Store ("ST") must be executed.

Three way isolation diagram



Reference documents

The user should refer to the following list of documents:

[1] MODBUS.ORG: MODBUS Application Protocol Specification V1.1a, June 2004

Accessories, Spare Parts and Warranty

Power Supply 45W 24Vdc 2A
Power Supply 120W 24Vdc 5A
Additional Terminal Block 2x11
Female Plug 11 Screw clamp
Female Plug 11 Spring clamp
RJ45 terminated cable 14cm
RJ45 terminated cable 22cm
Termination Adapter

AP-S2/AL-DR45-24
AP-S2/AL-DR120-24
AP-S2/TB-211-1
AP-S2/SPINA-V11
AP-S2/SPINA-M11
AP-S2/LOCAL-BUS76
AP-S2/LOCAL-BUS152
AP-S2/TERM-CAN

Warranty: 3 years excluding defects due to improper use