Altivar 12

Variable speed drives
for asynchronous motors

Modbus Communication Manual

06/2012

Schneider Electric

Contents

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result** in property damage.

PLEASE NOTE
The word "drive" as used in this manual refers to the controller portion of the adjustable speed drive as defined by NEC.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Before you begin

Read and understand these instructions before performing any procedure with this drive.

⚡ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Read and understand this manual before installing or operating the Altivar 12 drive. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- The user is responsible for compliance with all international and national electrical code requirements with respect to grounding of all equipment.
- Many parts of this drive, including the printed circuit boards, operate at the line voltage. DO NOT TOUCH. Use only electrically insulated tools.
- DO NOT touch unshielded components or terminal strip screw connections with voltage present.
- DO NOT short across terminals PA/+ and PC/– or across the DC bus capacitors.
- Before servicing the drive:
    - Disconnect all power, including external control power that may be present.
    - Place a "DO NOT TURN ON" label on all power disconnects.
    - Lock all power disconnects in the open position.
    - WAIT 15 MINUTES to allow the DC bus capacitors to discharge. Then follow the "Bus Voltage Measurement Procedure" (see User manual) to verify that the DC voltage is less than 42 V. The drive LEDs are not indicators of the absence of DC bus voltage.
- Install and close all covers before applying power or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

- Read and understand this manual before installing or operating the Altivar 12 drive.
- Any changes made to the parameter settings must be performed by qualified personnel.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

DAMAGED DRIVE EQUIPMENT

Do not operate or install any drive or drive accessory that appears damaged.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure.
  Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.[a]

Failure to follow these instructions can result in death, serious injury, or equipment damage.

a. For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems."

Documentation structure

The following Altivar 12 technical documents are available on the Schneider Electric website (www.schneider-electric.com) as well as on DVD-ROM (reference VW3A8200).

ATV12 Quick Start Guide (S1A56146)

The Quick Start describes how to wire and configure the drive to start motor quickly and simply for simple applications.
This document is delivered with the drive with an Annex (S1A58684) for Short Circuit Current Ratings (SCCR) and branch circuit protection.

ATV12 User manual (BBV28581)

This manual describes how to install, program and operate the drive.

ATV12 Modbus Communication manual (BBV28590)

This manual describes the assembly, connection to the bus or network, signaling, diagnostics, and configuration of the communication-specific parameters via the 7 segment LED display.
It also describes the communication services of the Modbus protocol.
This manual includes all Modbus addresses. It explains the operating mode specific to communication (state chart).

ATV12P Installation manual (BBV28587)

This manual describes how to install the drive ATV12 baseplate following the conditions of acceptability.

ATV12 Parameters description file

All the parameters are grouped together in an Excel file available on the Schneider Electric website (www.schneider-electric.com), with the following data:
• Code
• Name
• Modbus Addresses
• Category
• Read/write access
• Type: signed numerical, unsigned numerical, etc.
• Unit
• Factory setting
• Minimum value
• Maximum value
• Display on the 7-segment integrated display terminal
• Relevant menu
This file offers the option of sorting and arranging the data according to any criterion chosen by the user.

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION
• Read and understand this manual before installing or operating the Altivar 12 drive.
• Any changes made to the parameter settings must be performed by qualified personnel.
• The excel file does not describe the behaviour of the parameters. Before any modification, refer to the ATV12 User Manual.

Failure to follow these instructions will result in death or serious injury.

Presentation

The Modbus socket on the Altivar 12 can be used for the following functions:

• Configuration
• Settings
• Control
• Monitoring

The ATV12 drive supports:
• The 2-wire RS485 physical layer
• The RTU transmission mode
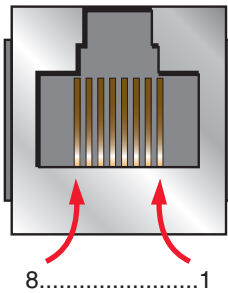
Connection to RS485 bus

Connection to ATV12

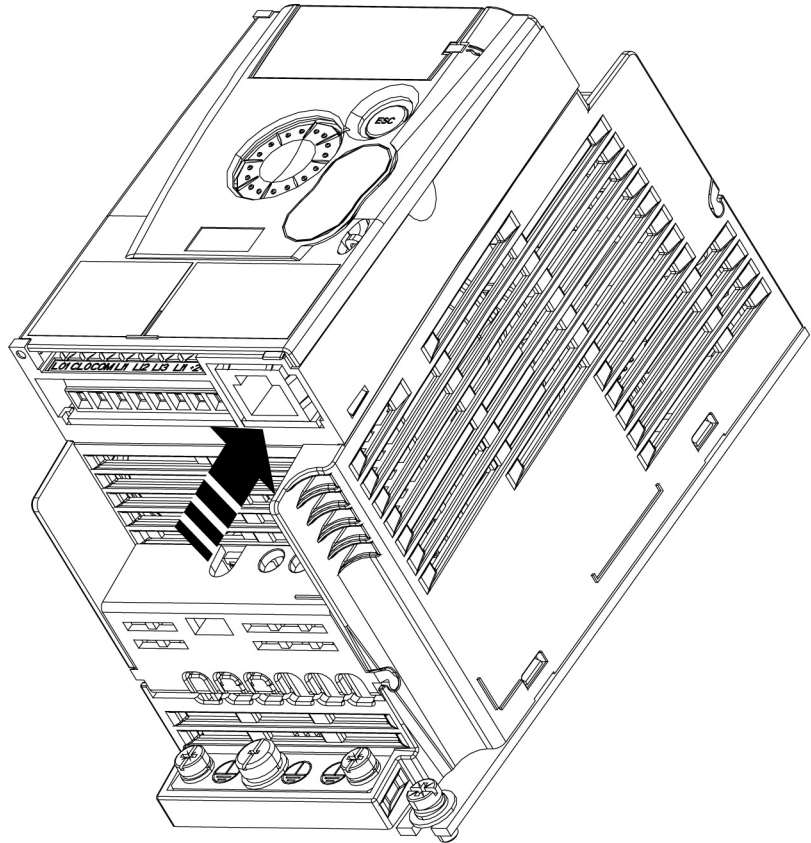Connection accessories should be ordered separately (please consult our catalogues).

Connect the RJ45 cable connector to the ATV12 connector.

Pin out of the ATV12 RJ45 Connector

View from underneath

8........................1

Pin	Signal
1	-
2	-
3	-
4	D1 (1)
5	D0 (1)
6	-
7	VP (2)
8	Common (1)

(1) Modbus signals
(2) Supply for RS232 / RS485 converter or a remote terminal

Protection against interference

• Use the Schneider Electric cable with 2 pairs of shielded twisted conductors (reference: TSXCSA100, TSXCSA200, TSXCSA500).
• Keep the Modbus cable separated from the power cables (30 cm (11.8 in.) minimum).
• Make any crossovers of the Modbus cable and the power cables at right-angles, if necessary.

For more information, please refer to the TSX DG KBL E manual: "Electromagnetic compatibility of industrial networks and fieldbuses".

RS485 bus schematic

The RS485 standard allows variants of different characteristics:
• polarisation
• line terminator
• distribution of a reference potential
• number of slaves
• length of bus

The new Modbus specification published on the Modbus.org site in 2002 contains precise details of all these characteristics. They are also summarised in Standard schematic section. The new Schneider Electric devices conform to this specification.

Configuration of the Modbus serial port

Communication Menu Structure

The communication parameters are part of the COM- submenu.
This menu is accessible as follows:
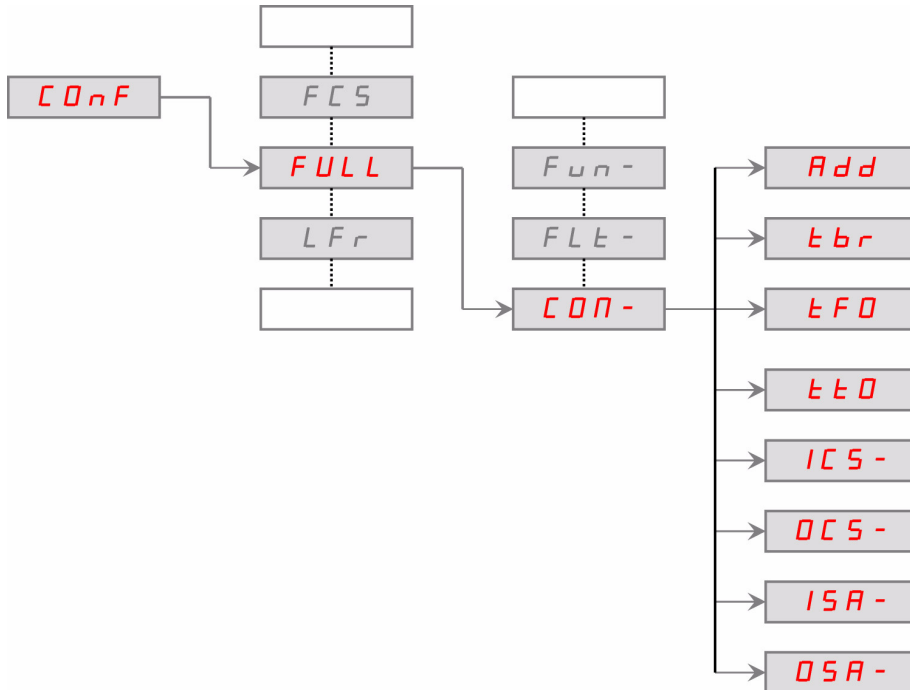
Communication configuration - Parameters decription

Parameter description	Range or listed values	default	Possible Value	Modbus address
MODBUS address of the drive *Add*	1 to 247 0 : OFF (broadcast only)	OFF	*OFF* *1... 247*	16#1771 = 06001
MODBUS baud rate *tbr*	4,8 kbps 9,6 kbps 19,2 kbps 38.4 kbps	19,2 kbps	*4. 8* *9. 6* *19. 2* *38. 4*	16#1773 = 06003
MODBUS format *tFO*	8O1: 8 bits, odd parity, 1 stop bit. 8E1: 8 bits, even parity, 1 stop bit. 8N1, 8 bits, no parity, 1 stop bit 8N2: 8 bits, no parity, 2 stop bits.	8E1	*8o1* *8E1* *8n1* *8n2*	16#1774 = 06004
MODBUS Time out *ttO*	Adjustable from 0.1 to 30s	10,0 s	*0. 1. . . . 30*	16#1775 = 06005
ICS - *OCS -* *ISA -* *OSA -*	Communication scanner submenus :Detailed in the next chapter			

The behaviour of the ATV12 when a time-out occurs is defined by the *SLL* parameter, this parameter can be found in the menu *FLt -*
(see User Manual).

⚠ WARNING

LOSS OF CONTROL
If Modbus fault management (SLL) = fault ignore (n0), communication control will be inhibited. For safety reasons, inhibition of communication fault should only be used for adjustment or special applications purpose.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

IO Scanner configuration parameters

Integrated communication scanner

The communication scanner is useful when used in combination by the Modbus client device with the function "Read/Write Multiple registers" : 23 (0x17), which provides in a single telegram a read multiple registers and a write multiple registers. The detail of the function 23 is described in the supported Modbus functions

Local configuration of the communication scanner

The communication scanner is accessible via the following menus : *C O N -* and *I C S - O C S -* submenus.
The 4 output variables and the 4 input variables are assigned by means of parameters *n C A 1* to *n C A 4* and *n M A 1* to *n M A 4*. An *n C A* or *n M A* parameter with a value of zero indicates that the parameter is not active. These 8 parameters are described in the table.

NCA or NMA defines the addresses. All these parameters are Modbus eligible addresses.

Submenu	On the local HMI, it is parameter description	Factory setting parameter	Modbus address
I C S -	NMA1 (*n M A 1*) Source drive address of the 1st input word	Address of ETA=3201 16#0C81	NMA1 address 16#319D = 12701
	NMA2 (*n M A 2*) Source drive address of the 2nd input word	Address of RFRD=8604 16#219C	NMA2 address 16#319E = 12702
	NMA3 (*n M A 3*) Source drive address of the 3rd input word	0	NMA3 address 16#319F = 12703
	NMA4 (*n M A 4*) Source drive address of the 4th input word	0	NMA4 address 16#31A0 = 12704
O C S -	NCA1 (*n C A 1*) Destination drive address of the 1st output word	Address of CMD=8501 16#2135	NCA1 address 16#31B1 = 12721
	NCA2 (*n C A 2*) Destination drive address of the 2nd output word	Address of LFRD=8602 16#219A	NCA2 address 16#31B2 = 12722
	NCA3 (*n C A 3*) Destination drive address of the 3rd output word	0	NCA3 address 16#31B3 = 12723
	NCA4 (*n C A 4*) Destination drive address of the 4th output word	0	NCA3 address 16#31B4 = 12724

Monitoring the communication scanner

It is also possible to monitor the parameters value that have been configured in the communication scanner. This monitored values are accessible via the following menus : *C O N -* and *I S A - O S A -* submenu.

The 4 output variable values and the 4 input variable values are located into parameters *n C 1* to *n C 4* and *n M 1* to *n M 4*.

Submenu	On the local HMI, it is parameter description	Factory setting parameter	Modbus address
I S A -	NM1 (*n M 1*) Source drive value of the 1st input word	ETA value	NM1 address 16#31C5 = 12741
	NM2 (*n M 2*) Source drive value of the 2nd input word	RFRD value	NM2 address 16#31C6 = 12742
	NM3 (*n M 3*) Source drive value of the 3rd input word	0	NM3 address 16#31C7 = 12743
	NM4 (*n M 4*) Source drive value of the 4th input word	0	NM4 address 16#31C8 = 12744
O S A -	NC1 (*n C 1*) Destination drive value of the 1st input word	CMD value	NC1 address 16#31D9 = 12761
	NC2 (*n C 2*) Destination drive value of the 2nd input word	LFRD value	NC2 address 16#31DA = 12762
	NC3 (*n C 3*) Destination drive value of the 3rd input word	0	NC3 address 16#31DB = 12763
	NC4 (*n C 4*) Destination drive value of the 4th input word	0	NC4 address 16#31DC = 12764

IO Scanner configuration parameters

Configuration example

In this example the communication scanner is configured as follow, *nCA1*, *nCA2*, *nMA1*, *nMA2* are used with their default values. *nCA3* is configured with the address of *CM1* (Modbus 8504 16#2138). *nMA3* is is configured with the address of *Et1* (Modbus 3206 16#0C86).

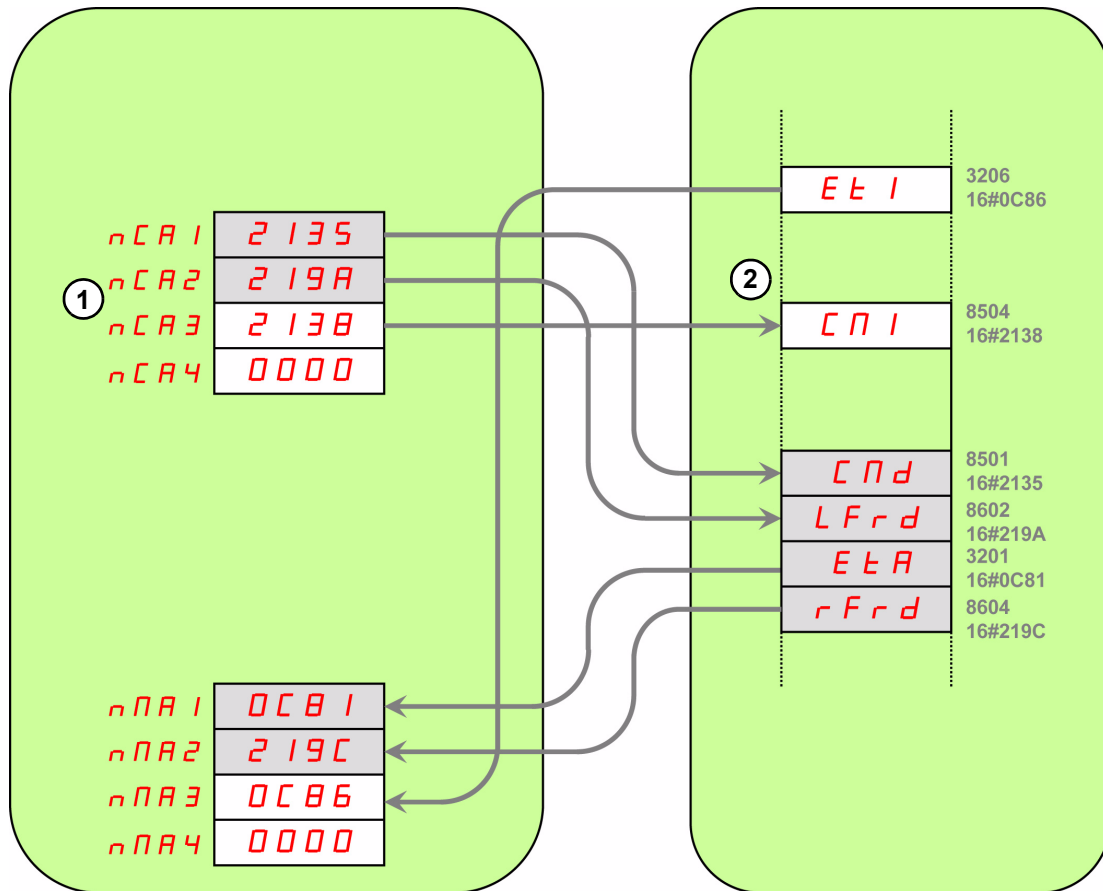**How to read the diagram below**

Example for *nCA3*:
nCA3 ① contain the logical address (*2138*) of *CM1* ②

Communication scanner
- menu *COn-*
- submenu *COn-*, *OCS-*

The required telegram to perform the exchange is the Modbus function 23, Obviously a sequence of requests based on Modbus functions 03 and 16 is also possible.
(See also the chapters Modbus Functions and Altivar 12 and M340).

Modbus Functions

Modbus Protocol

The transmission mode used is RTU mode. The frame contains no message header byte, nor end of message bytes.
It is defined as follows:

Slave address	Request code	Data	CRC16
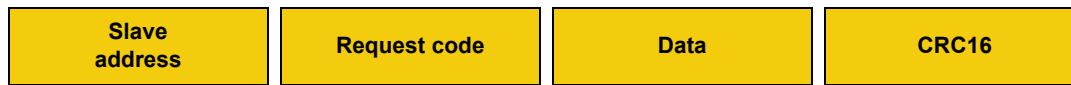
The data is transmitted in binary code.
CRC16: cyclical redundancy check.
The end of the frame is detected on a silence greater than or equal to 3 characters.

Principle

The Modbus protocol is a master-slave protocol.

Master

Slave i   Slave j   Slave k

Direct slave-to-slave communications are not possible.
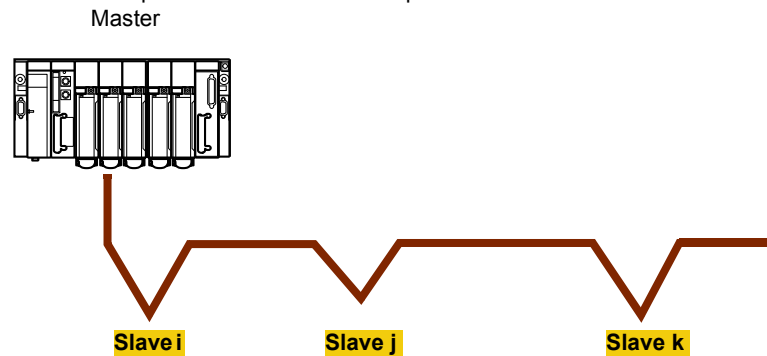
Only one device can transmit on the line at any time.
The master manages the exchanges and only it can take the initiative.
It interrogates each of the slaves in succession.
No slave can send a message unless it is invited to do so.
The master repeats the question when there is an incorrect exchange, and declares the interrogated slave absent if no response is received within a given time period.
If a slave does not understand a message, it sends an exception response to the master. The master may or may not repeat the request.

For slave-to-slave communication, the application software must therefore be designed to interrogate a slave and send back data received to the other slave.

Two types of dialogue are possible between master and slaves:
• the master sends a request to a slave and waits for its response
• the master sends a request to all slaves without waiting for a response (broadcasting principle)

Addresses

• The drive Modbus address can be configured from 1 to 247.
• Address 0 coded in a request sent by the master is reserved for broadcasting. ATV12 drives take account of the request, but do not respond to it.

Supported Modbus functions

The Altivar 12 supports the following Modbus functions.

Function name	Code	Description	Remarks
Read holding registers	03 16#03	Read N output words	Max PDU length : 63 words
Write one output word	06 16#06	Write one output word	
Write multiple registers	16 16#10	Write N output word	Max PDU length : 61 words
Read/write Multiple registers	23 16#17	Read/write multiple registers	Max PDU length : 4 words (W), 4 words (R)
(Sub-function) Read device Identification	43/14 16#2B 16#OE	Encapsulated interface transport / Read device identification	

Modbus Functions

The following paragraphs describes each supported function.

Read Holding registers

Request

Function code	1 Byte	**0x03**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 63 (0x 3F)

Response

Function code	1 Byte	**0x03**
Byte count	1 Byte	2 x N*
Register value	N* x 2 Bytes	

*N: Quantity of Registers

Error

Error code	1 Byte	**0x83**
Exception code	1 Byte	01 or 02 or 03 or 04 (see details on page 16)

Example

Note: Hi = high order byte, Lo = low order byte.

This function can be used to read all ATV12 words, both input words and output words.

Request

Slave no.	03	No. of first word		Number of words		CRC16	
		Hi	Lo	Hi	Lo	Lo	Hi
1 byte	1 byte	2 bytes		2 bytes		2 bytes	

Response

Slave no.	03	Number of bytes read	First word value		-------	Last word value		CRC16	
			Hi	Lo		Hi	Lo	Lo	Hi
1 byte	1 byte	1 byte	2 bytes			2 bytes		2 bytes	

Example: read 4 words W3102 to W3105 (16#0C1E to 16#0C21) in slave 2, using function 3, where:

• SFr = Switching frequency = 4 kHz (W3102 = 16#0028)
• tFr = Maximum output frequency = 60 Hz (W3103 = 16#0258)
• HSP = High speed = 50 Hz (W3104 = 16#01F4)
• LSP = Low speed = 0 Hz (W3105 = 16#0000)

Request	02	03	0C1E	0004	276C			

Response	02	03	08	0028	0258	01F4	0000	52B0
Value of:				W3102	W3103	W3104	W3105	
Parameters:				SFr	tFr	HSP	LSP	

Modbus Functions

Write one output word

Request

Function code	1 Byte	**0x06**
Register Address	2 Bytes	0x0000 to 0xFFFF
Register value	2 Bytes	0x0000 to 0xFFFF

Response

Function code	1 Byte	**0x06**
Register Address	2 Bytes	0x0000 to 0xFFFF
Register value	2 Bytes	0x0000 to 0xFFFF

Error

Error code	1 Byte	**0x86**
Exception code	1 Byte	01 or 02 or 03 or 04 (see details on page 16)

Example

Request and response (the frame format is identical)

Slave no.	06	Word number		Value of word		CRC16	
		Hi	Lo	Hi	Lo	Lo	Hi
1 byte	1 byte	2 bytes		2 bytes		2 bytes	

Example: write value 16#000D in word W9001 (16#2329) in slave 2 (ACC = 13 s).

Request and response	02	06	2329	000D	9270

Read/write Multiple registers

Description	Length in byte	Value	Comment
Function code	1	16#17	
Read starting address	2	16#XXXX	Always Modbus address
Quantity to read	2	16#03	Contain number of holding registers to be read.
Write starting address	2	16#XXXX	Always Modbus address
Quantity to write	2	16#03	Contain number of holding registers to be written.
Write Byte count	1	16#06	The byte count specifies the number of bytes to follow in the field Write Register Value.
Write Registers Value	Nx2 Bytes (N: quantity to write)	16#XX XXXX XXXX XX	Value to be written respectively in NCA1 to NCA3, so the configured example: CMD, LFRD, CMI.

Example

Slave n°	Function Code	Read starting Address HI	Read starting Address LOW	Qty	Write starting Address HI	Write starting Address LOW	Qty	
1 byte	1 byte	1 byte	1 byte	2 byte	1 byte	1 byte	2 byte	

	Write byte count	Writing Value 1 HI	Value 1 Lo		Value 1 HI	Writing Value 1.. 2... 3...n ...	CRC16	
	1 byte	1 byte	1 byte		1 byte	1 byte	2 byte	

Modbus Functions

Read Device Identification

ID	Name / Description	Type
0x00	VendorName	ASCII String
0x01	ProductCode	ASCII String
0x02	MajorMinorRevision	ASCII String

Example
Default values to be detailed

Request

Slave no.	2B	Type of MEI 0E	ReadDeviceId 01	Object Id 00	CRC16	
					Lo	Hi
1 byte	1 byte	1 byte	1 byte	1 byte	2 bytes	

Response

Slave no.	2B	Type of MEI 0E	ReadDeviceId 01	Degree of conformity 02	-------
1 byte	1 byte	1 byte	1 byte	1 byte	

-------	Number of additional frames 00	Next object Id 00	Number of objects 03	-------
	1 byte	1 byte	1 byte	

-------	Id of object no. 1 00	Length of object no. 1 12	Value of object no. 1 "Schneider Electric"	-------
	1 byte	1 byte	18 bytes	

-------	Id of object no. 2 01	Length of object no. 2 0B	Value of object no. 2 "ATV12HU75M3"	-------
	1 byte	1 byte	11 bytes	

-------	Id of object no. 3 02	Length of object no. 3 04	Value of object no. 3 "0201"	-------
	1 byte	1 byte	4 bytes	

-------	CRC16	
	Lo	Hi
	1 byte	1 byte

The total response size equals 49 bytes

The three objects contained in the response correspond to the following objects:

- Object no. 1: Manufacturer name (always "Schneider Electric", ie. 18 bytes).
- Object no. 2: Device reference (ASCII string; *for example:* "ATV12HU75M3", ie. 11 bytes).
- Object no. 3: Device version, in "MMmm" format where "MM" represents the determinant and "mm" the subdeterminant (4-bytes ASCII string; *for example:* "0201" for version 2.1).

Note: The response to function 43 may be negative; in this case, the response located at the top of the next page is sent by the Altivar 12 rather than the response described above.

Modbus Functions

Error management

Exception responses

An exception response is returned by a slave when it is unable to perform the request which is addressed to it.

Format of an exception response:

Slave no.	Response code	Error code	CRC16	
			Lo	Hi
1 byte	1 byte	1 byte	2 bytes	

Response code: request function code + 16#80.

Error code:
1 = The function requested is not recognized by the slave
2 = The bit or word addresses indicated in the request do not exist in the slave
3 = The bit or word values indicated in the request are not permissible in the slave
4 = The slave has started to execute the request but cannot continue to process it completely

CRC16 calculation

The CRC16 is calculated on all the message bytes by applying the following method:

Initialize the CRC (16-bit register) to 16#FFFF.

Enter the first to the last byte of the message:

CRC	XOR	<byte> —> CRC
Enter	8 times	
	Move the CRC one bit to the right	
	If the output bit = 1, enter CRC XOR 16#A001—> CRC	
End enter		

End enter

The CRC obtained will be transmitted with the low order bytes sent first, followed by the high order ones (unlike the other data contained in Modbus frames).
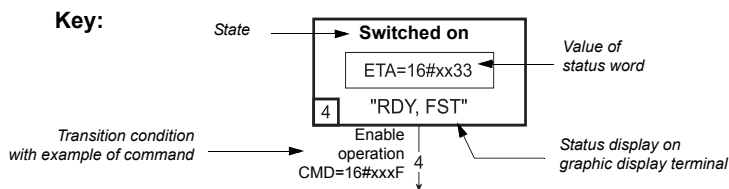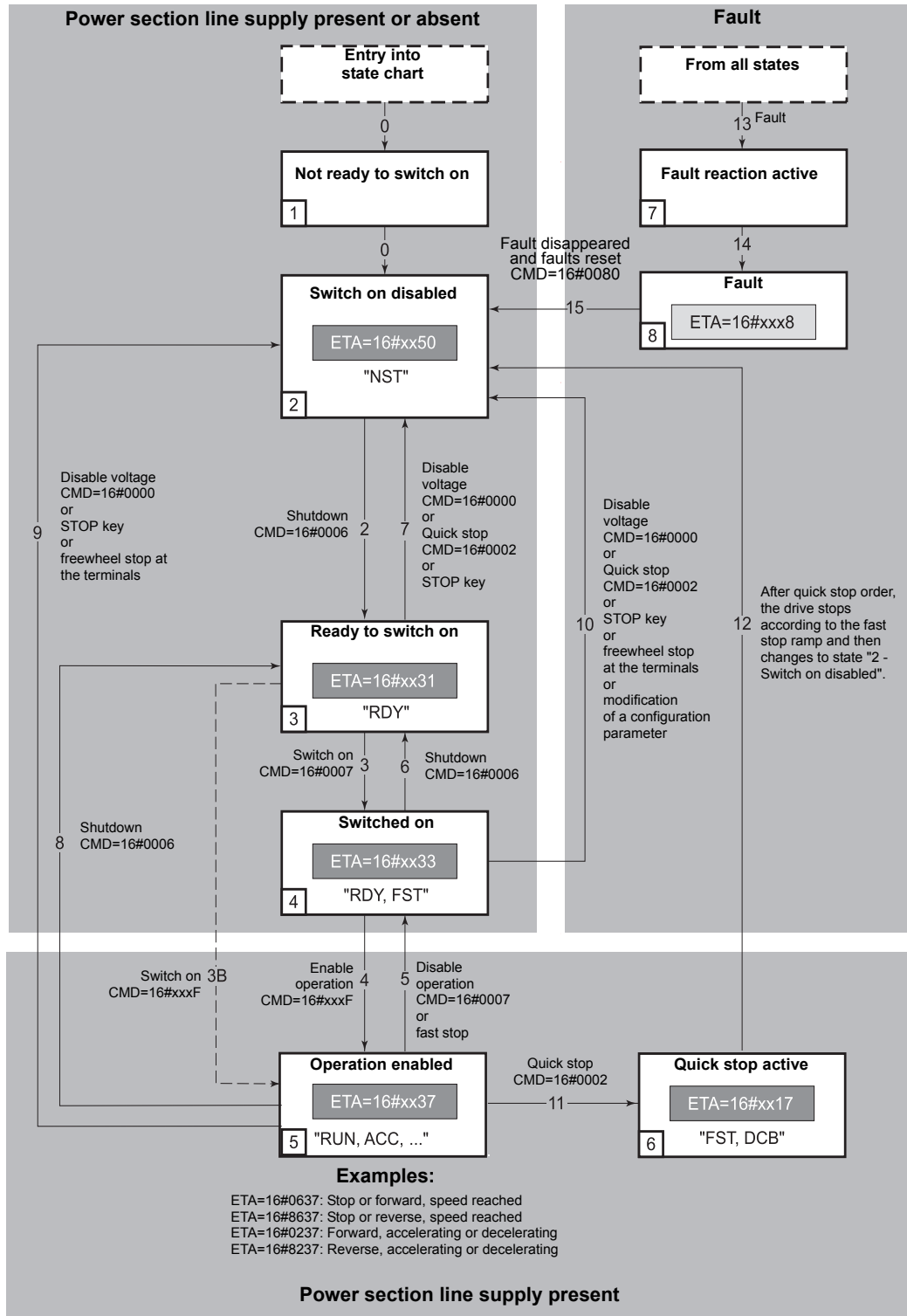
XOR = exclusive OR.

ATV12 state machine

Status chart based on IEC 61800-7*

The state machine below describes the interaction between the drive's state machine, monitored by the status word (ETA) parameter, and the Command Word (CMD). CiA® and CANopen® are registered Community Trademarks of CAN in Automation e.V.
*:Since 2007, CiA402 profile is part of the IEC standard 61800-7. Therefore DriveCom or CiA402 terminology is no more used.

Power section line supply present or absent

Entry into state chart

0

Not ready to switch on
1

0

Switch on disabled
ETA=16#xx50
"NST"
2

Fault

From all states

13 Fault

Fault reaction active
7

14

Fault
ETA=16#xxx8
8

15

Fault disappeared and faults reset CMD=16#0080

Disable voltage CMD=16#0000 or STOP key or freewheel stop at the terminals
9

Shutdown CMD=16#0006
2

7 Disable voltage CMD=16#0000 or Quick stop CMD=16#0002 or STOP key

Disable voltage CMD=16#0000 or Quick stop CMD=16#0002 or STOP key or freewheel stop at the terminals or modification of a configuration parameter
10

After quick stop order, the drive stops according to the fast stop ramp and then changes to state "2 - Switch on disabled".
12

Ready to switch on
ETA=16#xx31
"RDY"
3

Switch on CMD=16#0007
3

6 Shutdown CMD=16#0006

Shutdown CMD=16#0006
8

Switched on
ETA=16#xx33
"RDY, FST"
4

Switch on 3B CMD=16#xxxF

Enable operation CMD=16#xxxF
4

5 Disable operation CMD=16#0007 or fast stop

Operation enabled
ETA=16#xx37
"RUN, ACC, ..."
5

Quick stop CMD=16#0002
11

Quick stop active
ETA=16#xx17
"FST, DCB"
6

Examples:

ETA=16#0637: Stop or forward, speed reached
ETA=16#8637: Stop or reverse, speed reached
ETA=16#0237: Forward, accelerating or decelerating
ETA=16#8237: Reverse, accelerating or decelerating

Power section line supply present

Key:

State

Switched on
ETA=16#xx33
"RDY, FST"
4

Value of status word

Status display on graphic display terminal

Transition condition with example of command

Enable operation CMD=16#xxxF
4

ATV12 state machine

State machine description

The Altivar control process using the communication bus follows IEC 61800-7 profile status chart compatible with the DRIVECOM standard. Each state represents an aspect of the internal behaviour of the drive.

This chart evolves according to whether the control word is sent (CMD W8501) or an event occurs (example: lock following malfunction). The drive status can be identified by the value of the status word (ETA W3201).

Not ready to switch on (Initialization):

Communication is being initialized.
Transient state invisible to the communication bus.

Switch on disabled (Configuration):

Initialization of the drive is complete.
The configuration and adjustment parameters can be modified. The drive is locked.

Ready to switch on and Switched on (Drive initialized):

The drive is locked.
The power stage of the drive is ready to operate, but voltage has not yet been applied to the output.
The configuration and adjustment parameters can be modified, but modifying a configuration parameter returns the drive to the "Switch on disabled" state.

Operation enabled (Operational):

The drive is unlocked and voltage can be applied to the motor terminals.
Auto-tuning (tUn) requires an injection of current. The drive must therefore be in this state to perform this command.
The adjustment parameters can be modified even if a run command or a DC injection current is present. However, a configuration parameter can only be modified if the motor is stopped, and this returns the drive to the "Switch on disabled" state.

Quick stop active (Emergency stop active):

Fast stop
Restarting is only possible after the drive has changed to the "Switch on disabled" state.

Malfunction reaction active (Reaction on fault):

Transient state during which the drive performs an action appropriate to the type of fault detection.

Malfunction (Fault):

The drive is locked.

Summary

State	Power supplied to motor	Modification of configuration parameters
1 - Not ready to switch on	No	Yes
2 - Switch on disabled	No	Yes
3 - Ready to switch on	No	Yes
4 - Switched on	No	Yes, return to "2 - Switch on disabled" state
5 - Operation enabled	Yes, except at zero reference or "halt"	No
6 - Quick stop active	Yes, during fast stop	No
7 - Fault reaction active	Depends on fault managment configuration	-
8 - Fault	No	Yes

ATV12 state machine

Command word description CMD - 8501

bit 7	bit 6	bit 5	bit 4
0 to 1 transition : Fault reset	Reserved (=0)	Reserved (=0)	0:Free wheel staying in "Operation Enabled"

bit 3	bit 2	bit 1	bit 0
Enable operation Drivecom state activation	Quick stop Drivecom state activation (bit active at 0)	Switch on disabled. Drivecom state activation (bit active at 0)	Switch on

bit 15	bit 14	bit 13	bit 12
Reserved	Not assignable	Reserved	Reserved

bit 11	bit 10	bit 9	bit 8
Direction of rotation asked 0: Forward 1: Reverse	Reserved (=0)	Reserved (=0)	0: RUN asked
			1: STOP asked

Command	Transition address	Final state	bit 7 Fault reset	bit 3 Enable operation	bit 2 Quick stop	bit 1 Switch on disabled	bit 0 Switch on	Example value
Shutdown	2, 6, 8	3 - Ready to switch on	x	x	1	1	0	16#0006
Switch on	3	4 - Switched on	x	x	1	1	1	16#0007
Enable operation	4	5 - Operation enabled	x	1	1	1	1	16#000F
Disable operation	5	4 - Switched on	x	0	1	1	1	16#0007
Disable voltage	7, 9, 10, 12	2 - Switch on disabled	x	x	x	0	x	16#0000
Quick stop	11	6 - Quick stop active	x	x	0	1	x	16#0002
	7, 10	2 - Switch on disabled						
Fault reset	15	2 - Switch on disabled	0 ○ 1	x	x	x	x	16#0080

x: Value is of no significance for this command.
0 ○ 1: Command on rising edge.

ATV12 state machine

Status word description ETA - 3201

bit 7	bit 6	bit 5	bit 4
Reserved (always 0)	Switch on disabled	Quick stop (bit active at 0)	Voltage enabled (bit always on)

bit 3	bit 2	bit 1	bit 0
Fault detection	Operation enabled	Switched on	Ready to switch on

bit 15	bit 14	bit 13	bit 12
0: Motor rotation in forward direction (or stopped)	Stop via STOP key	Reserved (=0)	Reserved (=0)

bit 11	bit 10	bit 9	bit 8
Reference exceeded (< LSP or > HSP)	Reference reached (steady state)	Local mode (bit active at 0)	Reserved (=0)

Status	bit 6 Switch on disabled	bit 5 Quick stop	bit 4 Voltage enabled	bit 3 Fault detection	bit 2 Operation enabled	bit 1 Switched on	bit 0 Ready to switch on	ETA masked by 16#006F (1)
1 -Not ready to switch on	0	x	x	0	0	0	0	-
2 - Switch on disabled	1	x	x	0	0	0	0	16#0050
3 - Ready to switch on	0	1	x	0	0	0	1	16#0031
4 - Switched on	0	1	1	0	0	1	1	16#0033
5 - Operation enabled	0	1	1	0	1	1	1	16#0037
6 - Quick stop active	0	0	1	0	1	1	1	16#0017
7 - Fault reaction active	0	x	x	1	1	1	1	-
8 - Fault	0	x	x	1	0	0	0	16#0018 (2) or 16#0038

x: In this state, the value of the bit can be 0 or 1.
(1) This mask can be used by the PLC program to test the chart state.
(2) Fault following state "6 - Quick stop active".

Application example

Connecting an ATV12 to a M340 PLC

Here is an example of an application that shows how to control an ATV12 from a M340 PLC equipped with a Modbus master serial port.
The program provides a control of the drive from an operator screen designed under Unity.
The example illustrates also the previous chapter

Configuration of the Modbus Master

The default settings of the serial port used as a Modbus master are compliant with the default settings of the ATV12.
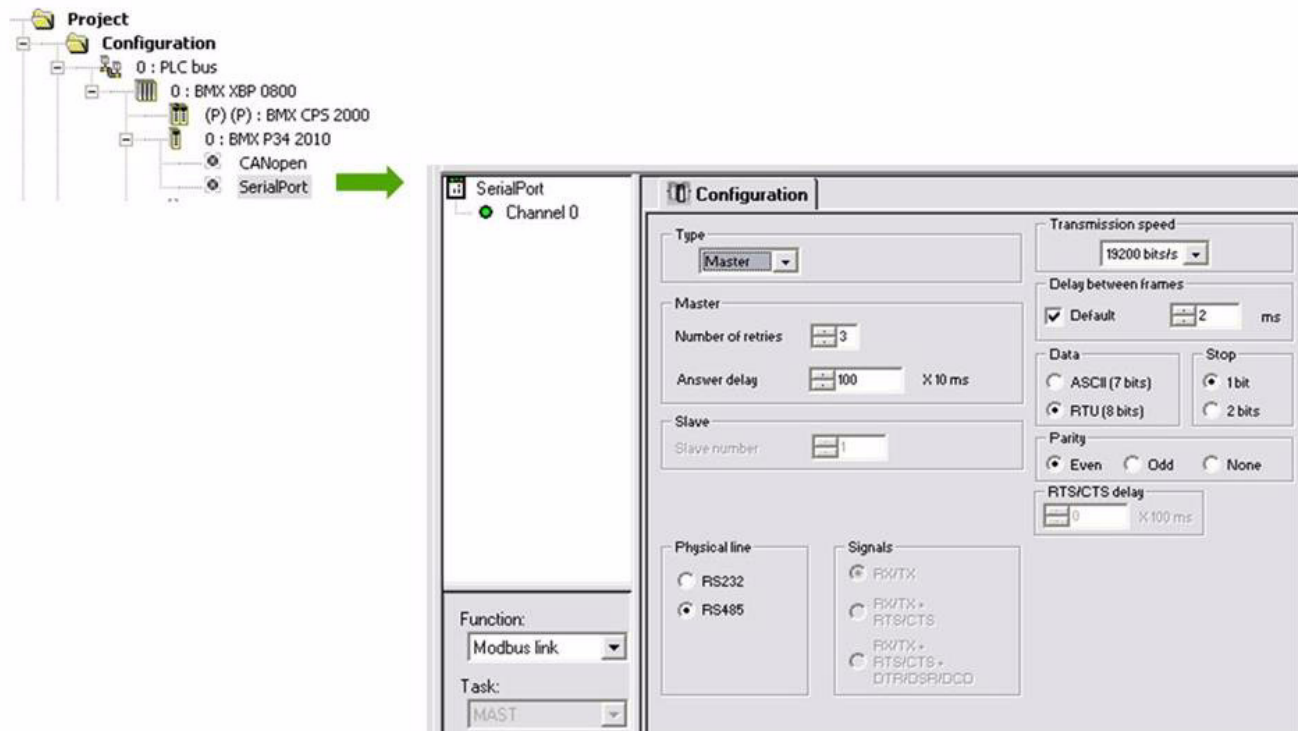
Application example

Initialization

The communication is based on the READ_VAR , WRITE_VAR functions. During the first execution of the MAST task you can initialize the data structures used by these two functions. Devicepath describes the path to the device including its slave address. ReadVarMgt and WriteVarMgt are arrays used respectively by READ_VAR and WRITE_VAR. Only the 3rd element of these arrays is modifiable by the user: To define the time out duration of the requests

```
(* data initialization *)

(* Communication path to Modbus slave device at @ 3     *)
(* The device path can be modified later by the app.    *)
(* MSB of DevicePath[3] contains the device address     *)
DevicePath := ADDM ('0.0.0.3');
(* Time out duration   *)
ReadVarMGT[2]:=50;
WriteVarMGT[2]:=50;
```

Data structure declaration :

DevicePath	ADDM_TYPE	%MW50
DevicePath[0]	INT	%MW50
DevicePath[1]	INT	%MW51
DevicePath[2]	INT	%MW52
DevicePath[3]	INT	%MW53
DevicePath[4]	INT	%MW54
DevicePath[5]	INT	%MW55
DevicePath[6]	INT	%MW56
DevicePath[7]	INT	%MW57

ReadVarMGT	MBMgtTable	%MW40
ReadVarMGT[0]	INT	%MW40
ReadVarMGT[1]	INT	%MW41
ReadVarMGT[2]	INT	%MW42
ReadVarMGT[3]	INT	%MW43

Application example

Cyclical exchanges

In the example below the application manages 2 requests:
• "A read request of 4 words starting at Modbus address 12741 (NM1) - Modbus function #3
• "A write request of 4 words starting at Modbus address 12761 (NC1) - Modbus function #16

Requests are executed only each N x FAST task to avoid too much activity on the serial line.
The device can be modified (polling several devices) by writing in DevicePath[3].

Cyclical communication

```
(* Modbus Requests are sent only each:
( ModbusRequestPeriod X FAST period X n) *)
if ModbusRequestPeriod >25 then
(* Read request to ATV12 : Modbus function 3 *)
IF not ReadVarBusy then
READ_VAR(DevicePath, '%MW' , 12741, 4, ReadVarMGT, %MW124:4);
(*Devicepath is initialized during Init_Sequence *)
END_IF;

(* Write request to ATV12 : Modbus function 16 *)
IF not WriteVarBusy then
WRITE_VAR(DevicePath, '%MW' , 12761, 4, %MW120:4, WriteVarMGT);

END_IF;
ModbusRequestPeriod:=0;
END_IF;
```

The key data are highlighted: address and lengh in the device source and destination of the data in the PLC.
The time out can be managed by the application in a separate way by testing the activity of the 2 bits: ReadVarBusy and WriteVarBusy

Overview of the communication tables:

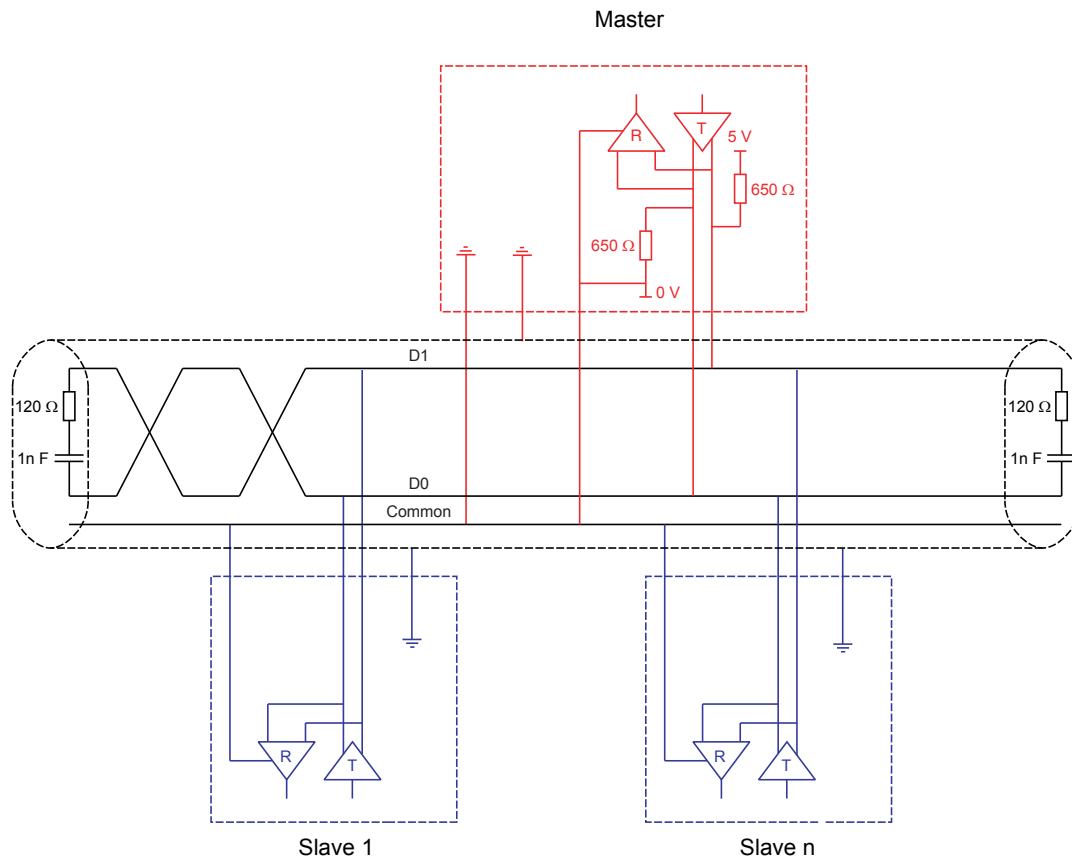| Name	Type	Address	Value	Comment
⊟ ■ ATV12_NC	ATV12IOSCAN	%MW120		ATV12 com scanner IN (PLC > ATV)
● ATV12_NC[0]	INT	%MW120		default : ATV 12 CMD Control Word
● ATV12_NC[1]	INT	%MW121		default : ATV12 LFRD Frequency reference
● ATV12_NC[2]	INT	%MW122		
● ATV12_NC[3]	INT	%MW123		
⊟ ■ ATV12_NM	ATV12IOSCAN	%MW124		ATV12 COM scanner OUT (ATV > PLC)
● ATV12_NM[0]	INT	%MW124		default : ATV 12 ETA (status word)
● ATV12_NM[1]	INT	%MW125		default : ATV 12 RFRD Output speed
● ATV12_NM[2]	INT	%MW126		
● ATV12_NM[3]	INT	%MW127		

Connection to RS485 bus

Standard schematic

The standard schematic corresponds to the Modbus specification published on the Modbus.org site in 2002 (Modbus_over_serial_line_V1.pdf, Nov 2002) and in particular to the schematic of the 2-wire multidrop serial bus.

The ATV12 drive follows this specification.

Schematic diagram:

Type of trunk cable	Shielded cable with 1 twisted pair and at least a 3rd conductor
Maximum length of bus	1000 m at 19200 bps with the Schneider Electric TSX CSA●●● cable
Maximum number of stations (without repeater)	32 stations, ie. 31 slaves
Maximum length of tap links	• 20 m for one tap link • 40 m divided by the number of tap links on a multiple junction box
Bus polarisation	• One 450 to 650 Ω pulldown resistor at 5 V (650 Ω recommended) • One 450 to 650 Ω pulldown resistor at the Common (650 Ω recommended) This polarisation is recommended for the master.
Line terminator	One 120 Ω 0.25 W resistor in series with a 1nF 10 V capacitor
Common polarity	Yes (Common), connected to the protective ground at one or more points on the bus