

**Chapter 11**

**Intelligent MODBUS Coupler  
07 KP 53**

# Intelligent MODBUS Coupler 07 KP 53

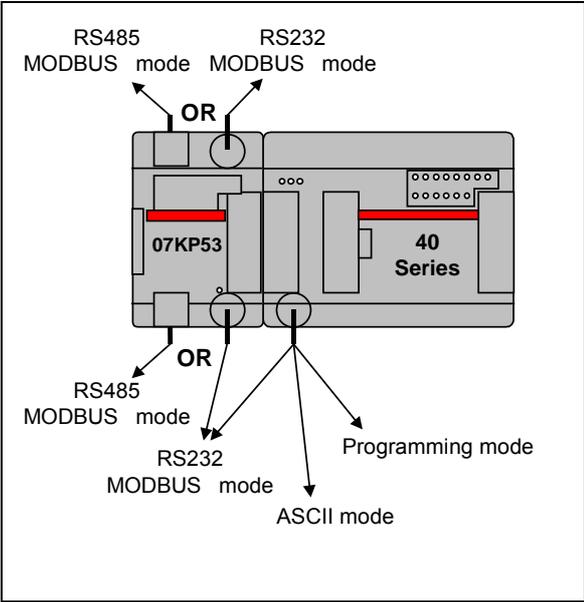


Figure: Communication protocols with the 40 series + 07KP53

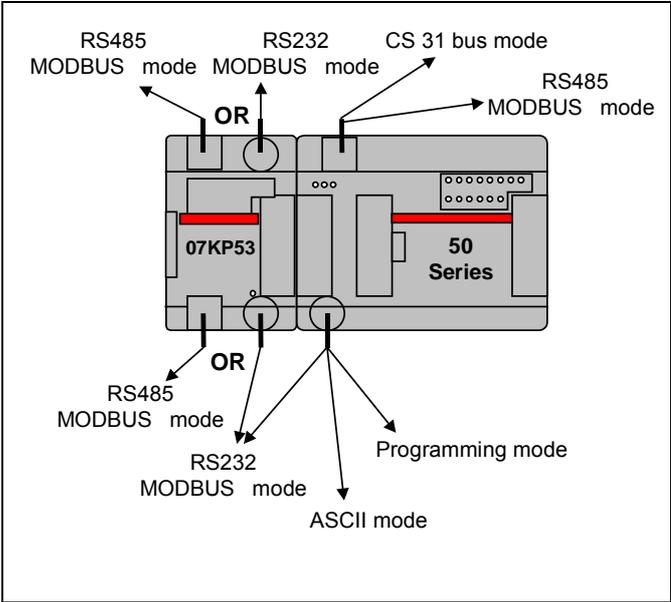


Figure: Communication protocols with the 50 series + 07KP53

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

This chapter presents, in particular, the module of communication 07KP53 which allows to spread the possibilities of communication of 40 & 50 series.

07KP53 is an intelligent coupler with two independent MODBUS protocol communication ports, master or slave mode on RS232 or RS485 interfaces.

The exchange communication between central unit and coupler can be completely independent of cycle time of the central unit.

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## 1. Network communication with the MODBUS interface

### 1.1. Protocol presentation

The MODBUS protocol, which is known world-wide, incorporated in MODBUS coupler 07KP53 is the **MODICON MODBUS RTU** protocol.

Numerous automation devices, such as PLCs, displays, variable speed drives or monitoring systems possess a standard, or optional, MODBUS RTU interface and can therefore easily communicate with the 40 or 50 series central units via MODBUS coupler 07KP53.

#### On series 50:

The association with a MODBUS coupler 07KP53 is possible starting from software **version 3.2**

Designation of products	Index of version
07 KR 51 - 24 V d.c.	From Q32
07 KR 51 - 120/230 V a.c.	From Q32
07 KT 51 - 24 V d.c.	From P32

#### On series 40:

The association with a MODBUS coupler 07KP53 is possible starting from software **version 3.2**

Designation of products	Index of version
07 CR 41 - 24 V d.c.	From M32
07 CR 41 - 120/230 V a.c.	From M32
07 CT 41 - 24 V d.c.	From L32
07 CR 42 - 24 V d.c.	From A32
07 CR 42 - 120/230 V a.c.	From A32
07 CT 42 - 24 V d.c.	From A32

How to verify which version you have ?

You can find this information on the label, on the left side of the 40 & 50 series central units.

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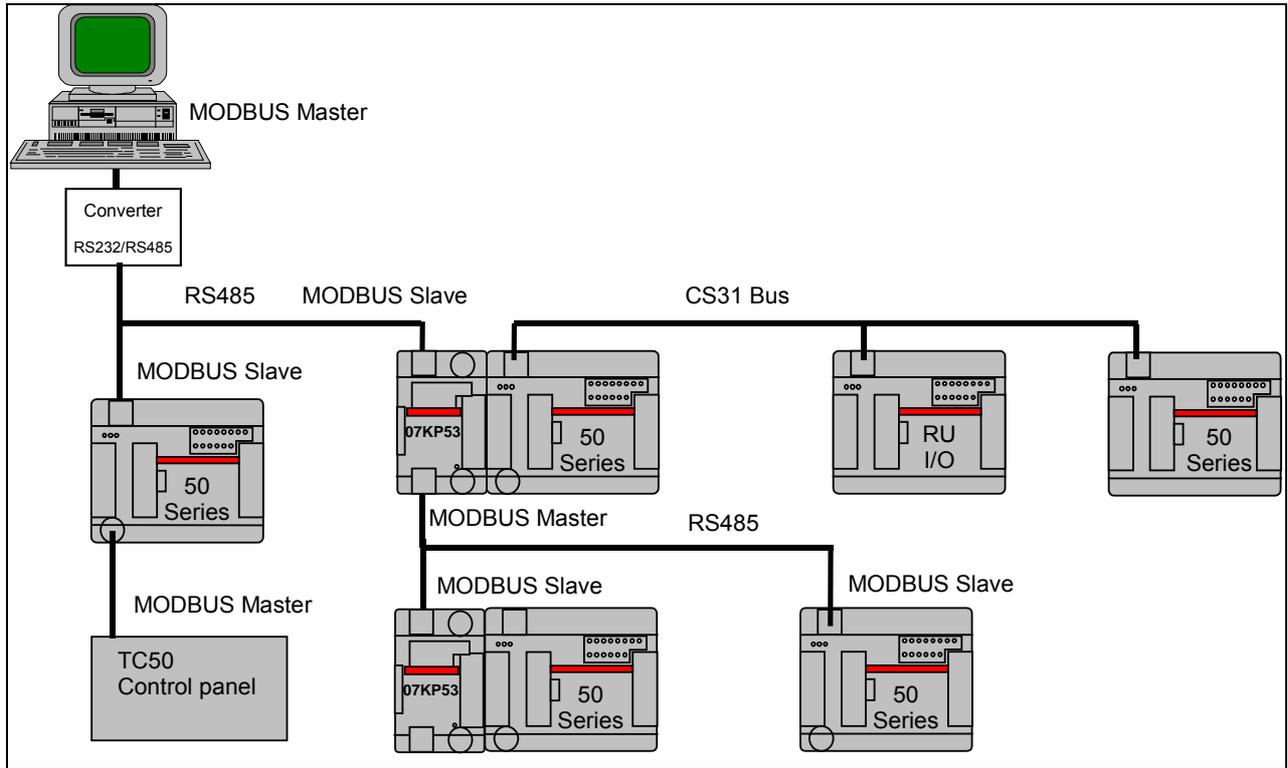


Figure: Network connection between Central units 50 series.

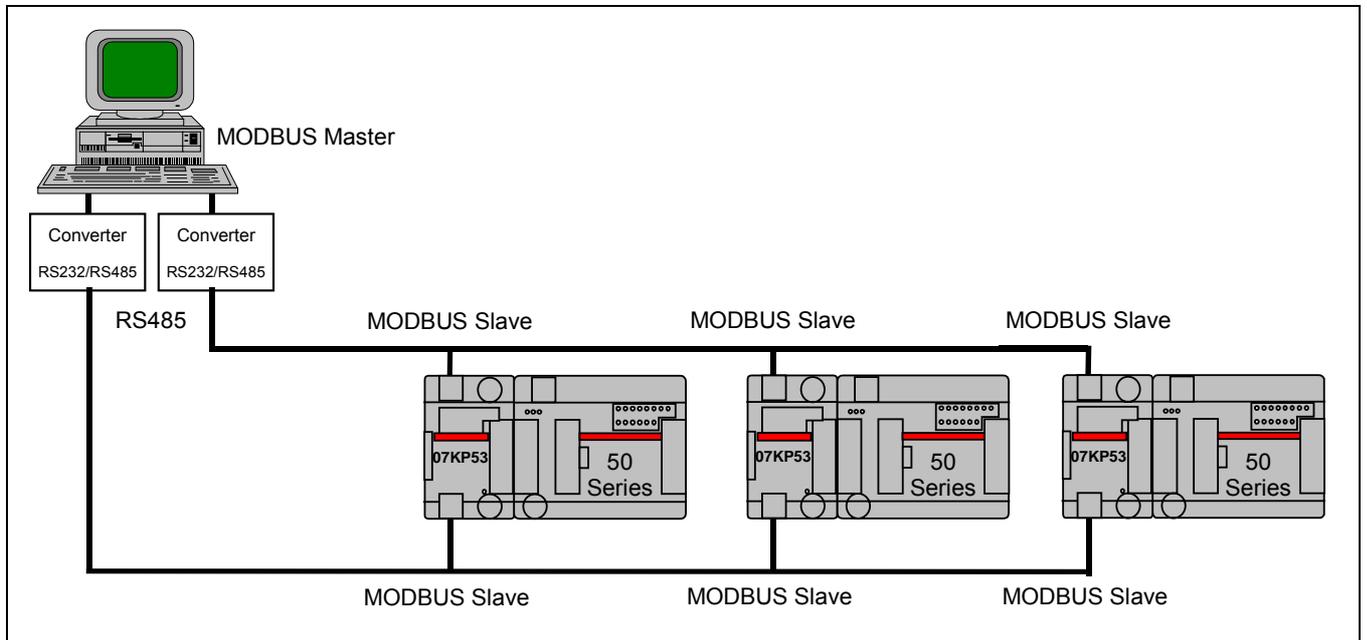


Figure: Network using configuration with redundancy.

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## 1.2. Configuration example:

- **Example of network connection between coupler 07 KP 53 and central units :**
- **Example of network using configuration with redundancy of data's between Supervisor and different central units :**

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

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

Thus the intelligent 07 KP 53 MODBUS coupler connects on the 40/50 series central units provide two additional communication ports COM3 and COM4, whose can be configure in master or slave modes without restriction. Possibility also to use them with RS232 or RS485 communication supports.

Not necessary to use an external power supply to use the MODBUS coupler 07 KP 53, all power supplies necessary for the coupler (5 V d.c. and 24 V d.c. ) are provide by the central unit on which it is connect.

The intelligent 07 KP 53 MODBUS coupler can use two different communication system, synchronous and asynchronous mode, but the coupler can be also used them in same time, independently.

### **Synchronous mode:**

When the coupler is configured in this mode, its central unit receives and sends MODBUS frames without modification, in this case, the coupler provides just two communication ports moreover for the central unit. This is not the fastest solution for communication, the treatment is realised after each program cycle time of central unit.

### **Asynchronous mode:**

When the coupler is configured in this mode, it works like "concentrator", it generates the sequence to link all the MODBUS requests, configured inside its requests table, and it builds also one results table that can be read from central unit, or one supervisor with only one request.

The response of requests of the different slaves can be realized in only one request, in this case, is faster than with the synchronous mode, the asynchronous mode can be used with master or slave modes.

In master mode: the configuration table is only realized by the central unit of the coupler.

In slave mode: the communication table is realized by central unit or directly by one supervisor.

# Intelligent MODBUS Coupler 07 KP 53

## 2. References

Products	Description	References
<b>Coupler</b> 07 KP 53	Intelligent coupler is an interface module with 2 serial MODBUS RTU interfaces (RS232 and RS485) slave / master. The communication coupler allows external units to be connected to the Advant Controller 31 (40 and 50 series) using the MODBUS RTU protocol. Power supply provides by Central unit.	1SBP260162R1001

## 3. General operating conditions

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

<b>Ambient conditions</b> - Temperature: operation:           horizontal           0°C to + 55°C vertical               0°C to + 40°C storage               - 40°C to + 75°C transport             - 25°C to + 75°C  - Humidity: annual average       DIN 40040 class F without condensation ≤ 75% up to 30 days per year   85% occasionally           95%  - Atmospheric pressure: operation             DIN 40050 ≥ 80 hPA (≤ 2000 m) storage                ≥ 600 hPA (≤ 3500 m)	
<b>Mechanical data</b> - Protection index       IP20 - Unit                     UL V2 - Vibration stress        IEC 60068-2-6 test Fc - Shock stress            IEC 60068-2-27 test Ea	
<b>Mountings</b> - DIN rail                35 mm - Screw fittings         4 mm diameter screw (M4)	
<b>Weight</b>	220 g

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## 4. Technical specifications of 07 KP 53 MODBUS coupler

<b>Support situation</b>	Upper side (Com3)	Lower side (Com4)
<b>Communication connections</b>	Min-Din 8 used in RS232 and 5.08mm step size connectors in RS485	
<b>Power supply</b>	Provide by its central unit	
<b>Protocol</b>	MODICON MODBUS RTU (master / slave)	
<b>Mode</b>	half-duplex on RS485 and Full-duplex on RS232	
<b>Number of connection points</b>	1 single master max. 1 slave with RS232 interface max. 128 slaves with build-in RS485 interface max. 255 slaves with repeaters	
<b>Transmission control</b>	CRC 16	
<b>Communication diagnosis</b>	By LED's on the front face	
<b>Bus configuration</b>	By dip switches on the left side	
<b>Communication system</b>	Synchronous / Asynchronous modes	
<b>Speed</b>	up to 115 200 Bauds	
<b>Maximum length</b>	on RS485: 600 m at 115200 Bauds 1 200 m at 19 200 Bauds	

The MODBUS frames transmitted by the master contain the following information:

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

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

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

Function codes		Description	
In hexadecimal	In decimal		
01 or 02	01 or 02	Read n bits	Only in synchronous mode  Only in synchronous mode
03 or 04	03 or 04	Read n words	
07	07	Fast reading of 8 bits	
08	08	Diagnosis / initialization	
0F	15	Write n bits	
10	16	Write n words	

The codes generated on error are:

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

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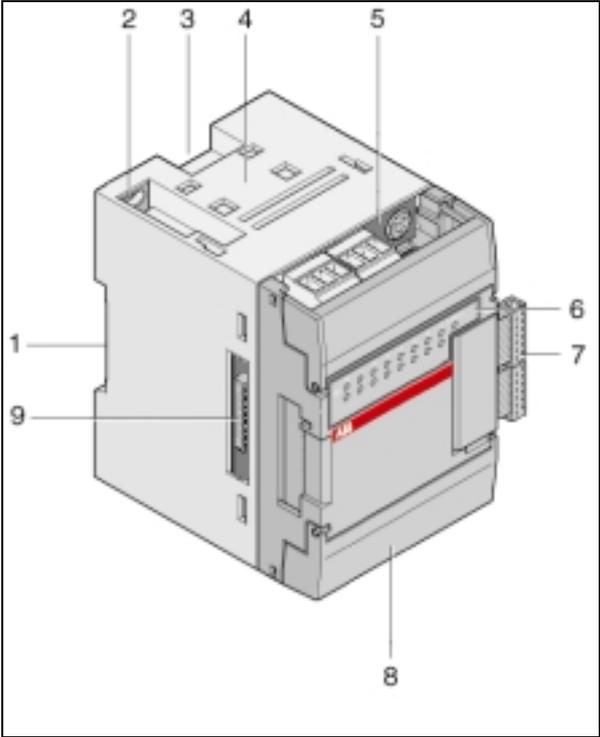


Figure: 07KP53 MODBUS coupler

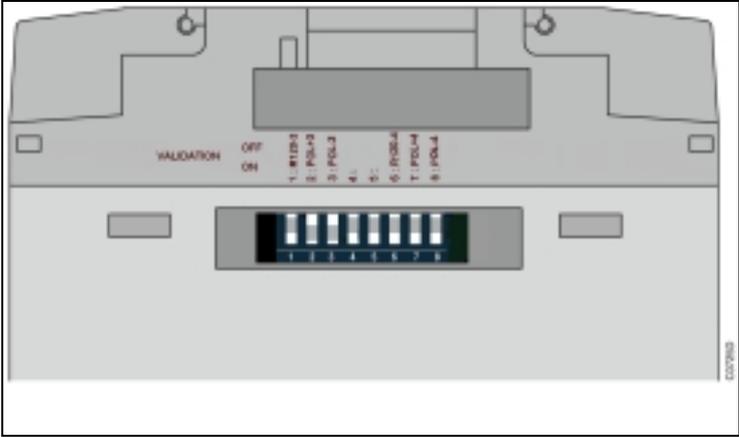


Figure: Dip switches configuration on 07KP53

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## 5. Description of 07KP53 MODBUS coupler

### 5.1. The front (see figure )

- 1 - Location for the DIN rail
- 2 - Plate fixture with unit earthing
- 3 - Lock for DIN rail mounting
- 4 - Location for external dual connector
- 5 - Location for COM3 (Min-Din 8 used in RS232 and 5.08mm step size connectors in RS485)
- 6 - Status Visualization area of communication (COM3 –COM4)
- 7 - Connectors for connection to the central unit
- 8 - Location for COM3 (Min-Din 8 used in RS232 and 5.08mm step size connectors in RS485)
- 9 - Location of the switches to configure the polarity and end resistance of bus

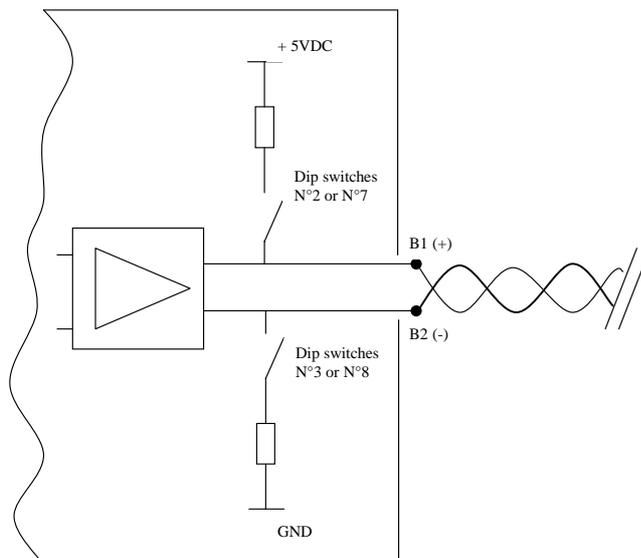
### 5.2. Dip Switches configuration (see figure )

Dip switches on the left side of the coupler are used to set polarity of bus (used only in master mode) and to add internally an end bus resistance (120Ω).

Dip switch N°1	Position	ON	End resistance for COM3
Dip switch N°2	Position	ON	Polarization bus + COM3
Dip switch N°3	Position	ON	Polarization bus - COM3
Dip switch N°4	Not used		
Dip switch N°5	Not used		
Dip switch N°6	Position	ON	End resistance for COM4
Dip switch N°7	Position	ON	Polarization bus + COM4
Dip switch N°8	Position	ON	Polarization bus – COM4

#### **Warning:**

- The polarization of bus should be used only when the 07KP53 MODBUS coupler is configure in Master mode.
- The dip switches N°2 and N°3 for COM3 and the dip switches N°7 and N°8 for COM4 works by couple.



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# Intelligent MODBUS Coupler 07 KP 53

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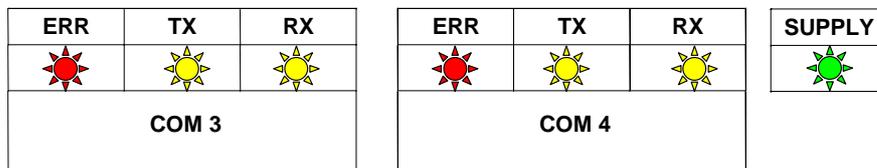
## 1.3. Led displays for status

Led displays on the front face allow to indicate and to control information about communication and status of 07KP53.

There are two groups of led displays, one for COM3 and another for COM4.

The 07KP53 executes a complete series of auto tests and configuration at each start-up. During power On, all Led displays flash and the 07KP53 (by default setting in slave mode) detects automatically the speed and the polarity of bus.

And also after during power On, the two error led displays stay at On as long as any communication between central unit and the coupler. This status allows to verify for instance, that the configuration of coupler is ready. This status allows also to identify, if the central unit have a correct software version to manage a coupler 07KP53. (see paragraph 1.1)



**SUPPLY** Green Led Indicates presence of supply voltage 5 V d.c. on 07KP53 (provides by CPU)

**ERR** Red Led Indicates error of communication :

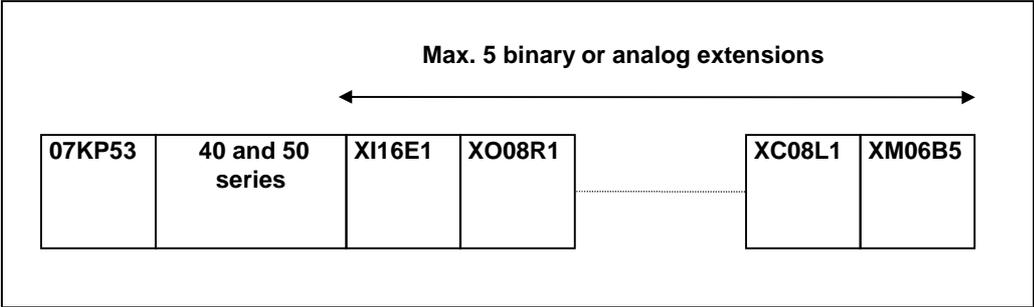
- bad frame received in slave mode
- bad answer from slave in master mode
- time out error in master mode

During the automatic detection of speed and polarity, the ERR Led display flashes

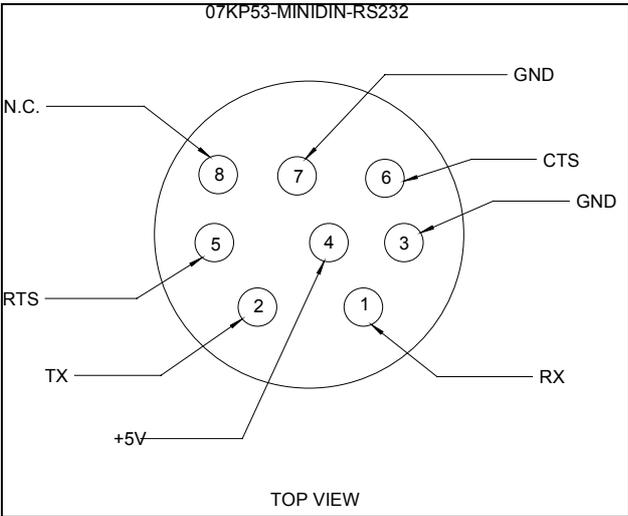
**TX** Yellow Led Lights On during data transmission.

**RX** Yellow Led Lights On during data reception.

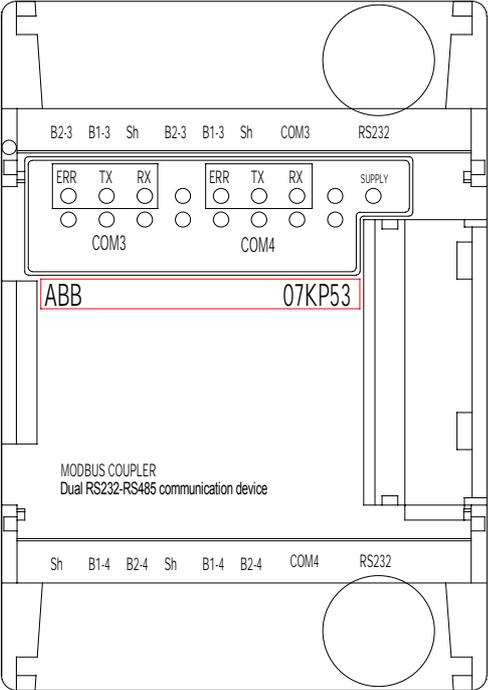
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**Figure : 07KP53 + central unit with extensions**



**Figure : Pin assignment of the RS232 interfaces COM3 and COM4**



**Figure : 07KP53 MODBUS coupler**

# Intelligent MODBUS Coupler 07 KP 53

## 1.4. Installation and cabling

The 07KP53 is powered with 5 V by the central unit. The connection between the 07KP53 and the central unit is effected with the two cables situated on the left side of the coupler. Precondition for connect them together, it is necessary to remove the EMC plastic adhesive.

**Warning:** The 07KP53 must be connected or disconnected without power supply on central unit.

When the 40 and 50 series are used with a 07KP53 MODBUS coupler, it is possible to increase the number of inputs / outputs by adding up to only 5 local extension units, instead of 6 without coupler. (see figure: )

The 07 KP 53 MODBUS coupler connects on the 40/50 series central units provide two additional communication ports COM3 and COM4, these ports could be used with RS232 (point to point) or RS485 (network) communication supports.

The top of product corresponds to the **COM3** communication port

The bottom of product corresponds to the **COM4** communication port

- **With RS232** Min Din 8 connector is used for RS232 connection, the different cables available can be used (07SK50, 07SK51, 07SK52, 07SK53) (see figure: )

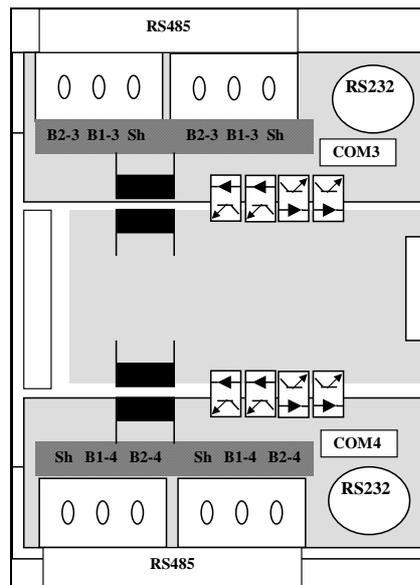
- **With RS485** 2 groups of connectors are available to use and make a easy cabling of network RS485 connection. These connections are effected through removable terminal blocks with an acceptable wire section equal to 2.5 mm<sup>2</sup> and the tightening torque, for reference, is equal to 0.5 Nm. (see figure: )

MODBUS network must be connected with shielded twisted pair.

Use a AWG 24 (0.22 mm<sup>2</sup>) to AWG 18 (0.18 mm<sup>2</sup>) twisted pair.

Shielding (preferably braided) on terminal Sh and earth connected at the master level (cable < 1 m)

## 1.5. Electrical isolation



The signals of the interfaces COM3 and COM4 are electrically isolated from each other and also from the internal electronics of the product.

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## 1.6. Software introduction

The intelligent 07KP53 MODBUS coupler connects on the 40/50 series central units provide two additional communication ports COM3 and COM4, whose can be configure in master or slave modes without restriction. Possibility also to use them with RS232 or RS485 communication supports.

The intelligent 07 KP 53 MODBUS coupler can use two different communication system, synchronous and asynchronous mode, the coupler can be also used them in same time, independently.

### 1.6.1. Communication port configuration

#### - Factory default settings:

The interfaces of the 07KP53 units have a default MODBUS configuration with the following parameters:

In slave mode, the coupler is able to adjust the speed and the polarity of bus automatically.

	COM3	COM4
- Mode:	MODBUS slave 99	MODBUS slave 99
- Transmission speed :	19 200 Baud	19 200 Baud
- Number of stop bits :	1 in reception 2 in transmission	1 in reception 2 in transmission
- Number of data bits :	8	8
- Parity :	None	None

#### - Communication speed parameters:

The following table gives a corresponding between baud rate and code use for configuration of speed of COM3 and COM4.

Data transmission speed ( Baud )	Baud rate code	Cable maximum length ( meter )
2400	2400	1200
4800	4800	1200
9600	9600	1200
19200	19200	1200
33600	44	1000
38400	38	1000
57600	25	800
75000	19	800
76800	18	800
115200	12	600

In slave mode is not necessary to configure the speed, the speed is automatically detected by the coupler, and when the speed is correctly detected, the measure is written directly to the second parameter inside configuration table.

In slave mode ,it can be interesting to write the value, if it is known, in order to reduce the time of initialization of network.

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## 1.6.2. Configuration of coupler operation:

The two ports of communication are seen by the central unit as two slaves MODBUS with address 256 for COM3 and 257 for COM4. The MODBUS addresses 1 to 255 are reserved for an external MODBUS network.

The programming of different areas (configuration and requests) of coupler is realised by the function block MODMASTK with AC31GRAF programming software or by function block MODMASTW with 907AC1131 programming software.

Independently of coupler mode (synchronous or asynchronous modes) it is necessary to configure the communication port for COM3 or COM4.

After that if the coupler is used in Asynchronous mode, always realised by the function block MODMASTK with AC31GRAF programming software or by function block MODMASTW with 907AC1131 programming software, it will be possible to configure the table of requests.

The 07KP53 is configured at the MODBUS address 99 (default settings) that it can be change by writing in the table of configuration.

	COM3	COM4
Factory default setting	1199	1199
Slave MODBUS address to load configuration	256	257
Value to configure the coupler in MODBUS Master	1100	1100
Value to configure the coupler in MODBUS Slave N° XX	1100 + XX	1100 + XX

The different tables (configuration and requests) are accessible via the MODBUS addresses described inside the following table:

Tables		MODBUS addresses	
		In decimal	In hexadecimal
Table of configuration of port COM3 Length = 244 Words	Begin	30000	7530
	End	30243	7623
Table of configuration of port COM4 Length = 244 Words	Begin	30244	7624
	End	30487	7717
Table of result of requests on COM3 Length = 256 Words	Begin	31000	7918
	End	31255	7A17
Table of result of requests on COM4 Length = 256 Words	Begin	31256	7A18
	End	31511	7B17

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## - Description of parameters of configuration:

Inside the configuration table ,we can found two different areas for each communication ports COM3 and COM4:

A common area is used independelly of communication system (synchronous or asynchronous) to configure the communication parameters of ports COM3 and COM4.

This area contains 4 words used in slave mode or master mode.

Configuration area for communication port		Explanation of parameters
First word	Master / slave	Value = 1100 the coupler is MODBUS master Value = 1100 +XX, the coupler is MODBUS slave N°XX
Second word	Speed	Value = code corresponding at the speed for communication (see paragraph 5.6.1 Communication speed) In slave mode: the coupler detects it automatically
Third word	RTS delay	Value in ms, corresponds to the delay between rising edge of RTS signal and the transmission of first character.
Fourth word	Time out	Value in ms, corresponds to the delay beyond which an error is announced by the indicators (Led displays and status word) In master Mode: Max delay between request and the slave answer

And an area only uses when the communication system is asynchronous, to configure the table of requests, size of this area depends of number of requests:

Each communication ports (COM3 or COM4) have 60 areas of 4 words following:

Configuration area for asynchronous mode		Explanation of parameters
Fifth word	Slave nb. 1 <sup>st</sup> request	Corresponds to slave MODBUS address of the first request.
Sixth word	MODBUS function	Corresponds to MODBUS function code of the first request. (see paragraph 4 Technical specifications), except codes 7 and 8
Seventh word	Data address	Corresponds to the MODBUS address of data of the first slave where the data must be written or read.
Eighth word	Number of data	Corresponds to the number of data of the first request. The limit by request in word format is 120 words writing or reading.
----	----	----
----	----	----
----	----	----
----	----	----
241 <sup>th</sup> word	Slave nb. 60 <sup>th</sup> request	Corresponds to slave MODBUS address of the sixtieth request.
242 <sup>th</sup> word	MODBUS function	Corresponds to MODBUS function code of the sixtieth request
243 <sup>th</sup> word	Data address	Corresponds to the MODBUS address of data of the sixtieth slave where the data must be written or read.
244 <sup>th</sup> word	Number of data	Corresponds to the number of data of the sixtieth request.

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## - Data area and request limits:

As seen, in the previous paragraph, the internal memory of coupler (table of configuration of requests) allows to configure a list of 60 requests for each communication ports COM3 and COM4. But as for each request, the length is limited to 120 words and that the size of result table is 256 words for each port, it is possible to determine the two extreme configurations with an equal repartition between the requests:

- 60 requests of 4 words each
- 2 requests of 120 words each

## 1.6.3. Status information area

### - Status of communication for each request:

A area with length of 4 words is available in master or slave mode to control the correct operation of the requests.

- In master mode, one bit is affected to each requests. This bit is set at 1 when the request don't receive an answer after the time defined in the word "*Time out*" inside configuration table. The first request set the less significant bit of the word of the table.

The different tables of status are accessible via the MODBUS addresses described inside the following table:

Tables		MODBUS addresses	
		In decimal	In hexadecimal
Counter in ms which allows to configure the time of switch On the Led displays in order to verify them. ( by multiple of 10ms) Length = 1 Word	Begin	30990	790E
	End	30990	790E
Communication information on port COM3, counter of errors, and type of errors...etc... Length = 3 Words	Begin	30991	790F
	End	30993	7911
Communication information on port COM4, counter of errors, and type of errors...etc... Length = 3 Words	Begin	30994	7912
	End	30996	7914
Management of slave failure and initialization commands for COM3 and COM4 Length = 3 Words	Begin	30997	7915
	End	30999	7917
Status of requests on COM3, 1 bit per request Length = 60 bits	Begin	32000	7D00
	End	32059	7D3B
Status of requests on COM4, 1 bit per request Length = 60 bits	Begin	32064	7D40
	End	32123	7D7B
Information about soft and hard versions of coupler Length = 5 Words	Begin	33000	80E8
	End	33004	80EC

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## 1.7. List of cross references for the 40 and 50 central units

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

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

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

- MODBUS addressing method :

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

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

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

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

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

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

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

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

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Variable types	Variables	MODBUS addresses in hexadecimal	MODBUS addresses in decimal
Binary inputs	I 00.00	0000	0000
	I 00.01	0001	0001
	...	...	...
	I 00.15	000F	0015
	I 01.00	0010	0016
	...	...	...
	I 61.15	03DF	0991
	I 62.00	03E0	0992
Binary outputs	O 00.00	1000	4096
	O 00.01	1001	4097
	...	...	...
	O 00.15	100F	4111
	O 01.00	1010	4112
	...	...	...
	O 61.15	13DF	5087
	O 62.00	13E0	5088
Internal bits	M 000.00	2000	8192
	M 000.01	2001	8193
	...	...	...
	M 000.15	200F	8207
	M 001.00	2010	8208
	...	...	...
	M 099.15	263F	9791
	M 230.00	2E60	11872
	...	...	...
	M 254.15	2FEF	12271
	M 255.00	2FF0	12272
...	...	...	
M 255.15	2FFF	12287	
Steps	S 00.00	3000	12288
	S 00.01	3001	12289
	...	...	...
	S 00.15	300F	12303
	S 01.00	3010	12304
	...	...	...
S125.15	37DF	14303	

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Variable types	Variables	MODBUS addresses in hexadecimal	MODBUS addresses in decimal
Analog inputs	IW 00.00	0000	0000
	IW 00.01	0001	0001
	...	...	...
	IW 00.15	000F	0015
	IW 01.00	0010	0016
	...	...	...
	IW 62.15	03EF	1007
Analog outputs	OW 00.00	1000	4096
	OW 00.01	1001	4097
	...	...	...
	OW 00.15	100F	4111
	OW 01.00	1010	4112
	...	...	...
	OW 62.15	13EF	5103
Internal words	OW 63.00	13F0	5104
	...	...	...
	OW 68.15	144F	5199
	MW 000.00	2000	8192
	MW 000.01	2001	8193
	...	...	...
	MW 000.15	200F	8207
	MW 001.00	2010	8208
	...	...	...
	MW 099.15	263F	9791
Internal double words	MW 230.00	2E60	11872
	...	...	...
	MW 254.15	2FEF	12271
	MW 255.00	2FF0	12272
	...	...	...
	MW 255.15	2FFF	12287
	MD 00.00	4000	16384
MD 00.01	4002	16386	
...	...	...	
MD 00.15	401E	16414	
MD 01.00	4020	16416	
...	...	...	
MD 07.15	40FE	16638	
Indirect word constants	KW 00.00	3000	12288
	KW 00.01	3001	12289
	...	...	...
	KW 00.15	300F	12303
	KW 01.00	3010	12304
...	...	...	
KW 31.15	31FF	12799	
Indirect double word constants	KD 00.00	5000	20480
	KD 00.01	5002	20482
	...	...	...
	KD 00.15	501E	20510
	KD 01.00	5020	20512
...	...	...	
KD 07.15	50FE	20734	