USER GUIDE

ARM-SE

A.R.M. ®(Advanced Radio Modem)

– Serial and Ethernet –

Table of contents

CE CONFORMITY DECLARATION

Manufacturer's name: **ATIM SARL**
Person responsible: Francis Raimbert, manager
Manufacturer's address: Les Guillets - 38250 Villard de Lans - France

Declares that this product:

Product name: A.R.M. (Advanced Radio Modem) range
Model reference number: ARM-SE/ARM-D/ARM-X (versions 433MHz/10mW, 868MHz/500mW)
Use: Transmission of digital, on-off and analogue data.

Complies with the essential requirements of article 3 of the R&TTE directive 1999/5/EC when used under the conditions specified in the user guide and the following standards:

1. **SAFETY** (Article 3.1a of directive 1999/5/EC)
   Standard(s) NF EN60950 Ed. 2000
   (health) Recommendation 519 (July 1999)

2. **EMC** (Article 3.1b of directive 1999/5/EC)
   Standard(s) EN 301 489-3 v1.4.1

3. **Use of radio frequency spectrum** (Article 3.2 of directive 1999/5/EC)
   Standard(s) ETSI EN300 220-3 v1.1.1

Villard de Lans, 10.01.2005

Francis RAIMBERT, gérant.

1 PRESENTATION

We have drawn on our considerable involvement in the field and our experience of more than ten years in the world of digital radio communications, to design our A.R.M. range of licence-free ISM band radio modems. They are the embodiment of all our know-how and the wide-ranging demands of a broad spectrum of users.

This guide contains all the information you will need to get these ARM radio modems working quickly. ATIM reserves the right to change the product characteristics and information contained in this guide without prior notice.

For technical support, talk to your specialist retailer.

1.1 GENERAL

The aim of a radio modem is to replace a hardwired link by establishing HF (High Frequency) communications between 2 or more remote points.

The A.R.M. radio modem is designed to meet tremendous demand in this area and offers excellent performance. It remains open to numerous extension and configuration options as well as offering a choice of which frequency band to use.

The A.R.M. can be used in many situations, such as remote control, monitoring, telemetry, data transfer etc.. It can be used anywhere where hardwiring is tricky or expensive (dams, isolated weather stations, ski pistes etc.), as well as in mobile applications (vehicles, conveyors, swing bridges, cranes, robotics etc.).

Its versatility means that it is capable either of sending information from one place to another, or of managing different types of input and output over large distances. Its modular nature means that standard input-output modules or even special modules can be added on request.

1.2 AVAILABLE VERSIONS:

- **ARM-D** "**D**igital" radio modem: 2 on-off in and out
- **ARM-DA** "**D**igital + **A**nalogue" radio modem: as above + 1 ana. in and 1 4-20 mA out
- **ARM-SE** "**S**erial + **E**thernet" radio modem: RS232, RS485, RJ45 interface
- **ARM-CS** "**C**ompact **S**erial" radio modem: IP65, RS232/RS422/RS485

Extension modules (requires ARM-SE base radio modem):

- **ARM-X8800** Extension module: 8 on-off in and out
- **ARM-X4440/I** Extension module: 4 on-off in and out, 4 analogue 4/20 mA in
- **ARM-X4440/U** Extension module: 4 on-off in and out, 4 analogue 0/10 V in
- **ARM-X4404/I** Extension module: 4 on-off in and out, 4 analogue 4/20 mA out
- **ARM-X4404/U** Extension module: 4 on-off in and out, 4 analogue 0/10 V out

(PT100 version and thermocouples available soon)

1.3 REGULATORY ASPECTS

Modems in the ARM range come under the heading of radiocommunications over ISM (Industrial, Scientific, Medical) bands, which can be used freely (free of charge and unlicensed) for industrial, scientific and medical applications.

As a result of this, regulation has been introduced at both the national and global level with the aim of controlling problems caused by interference and frequency band saturation.

At the national level, the legislation is provided by both the ANFR (Agence Nationale des Fréquences) and the ART (Autority of Télécommunications' Regulation).

The ANFR, created in 1996, draws up and issues the national frequency band distribution table, drawing on radiocommunications regulations drawn up under the UIT.

In the field of civil applications, conditions of use are set by the ART, which carries out the necessary planning and decides how frequencies are to be awarded. This planning consists of breaking the country down into regions, in which a further breakdown of the bands is done. Next, dedicated radiocommunications services are defined, along with the list of operators. There are distinct categories, including ministries (Defence, Research, Interior), the ART and the CSA.

Figure 1 shows the authorised power distribution for regulated bands in the 868 MHz range.

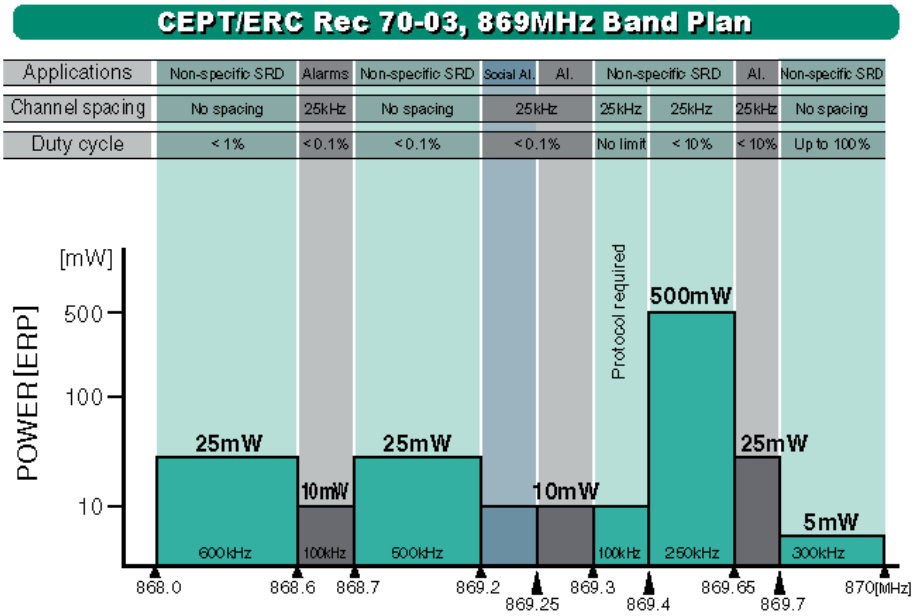


Figure 1: Power distribution in the 868MHz range.

Thus the transmission power of a radio transmitter, antenna gain included, is limited by these values.

1.4 OPERATING PRINCIPLE:

Whilst being very easy to use, the ARM-SE is fully configurable via its embedded Web pages or by means of "AT" commands (a single terminal is all you need).

Users themselves can set up the mode in which they wish to work. There is a choice between Serial mode, Ethernet mode or Gateway mode (in no cases is the modem able to establish radio links across more than one mode (**one single source of information**) at any one time). All of these options are integrated as standard into the standard version of the A.R.M. internal software.

Figure 2 shows the principles and possibilities of modem operation.

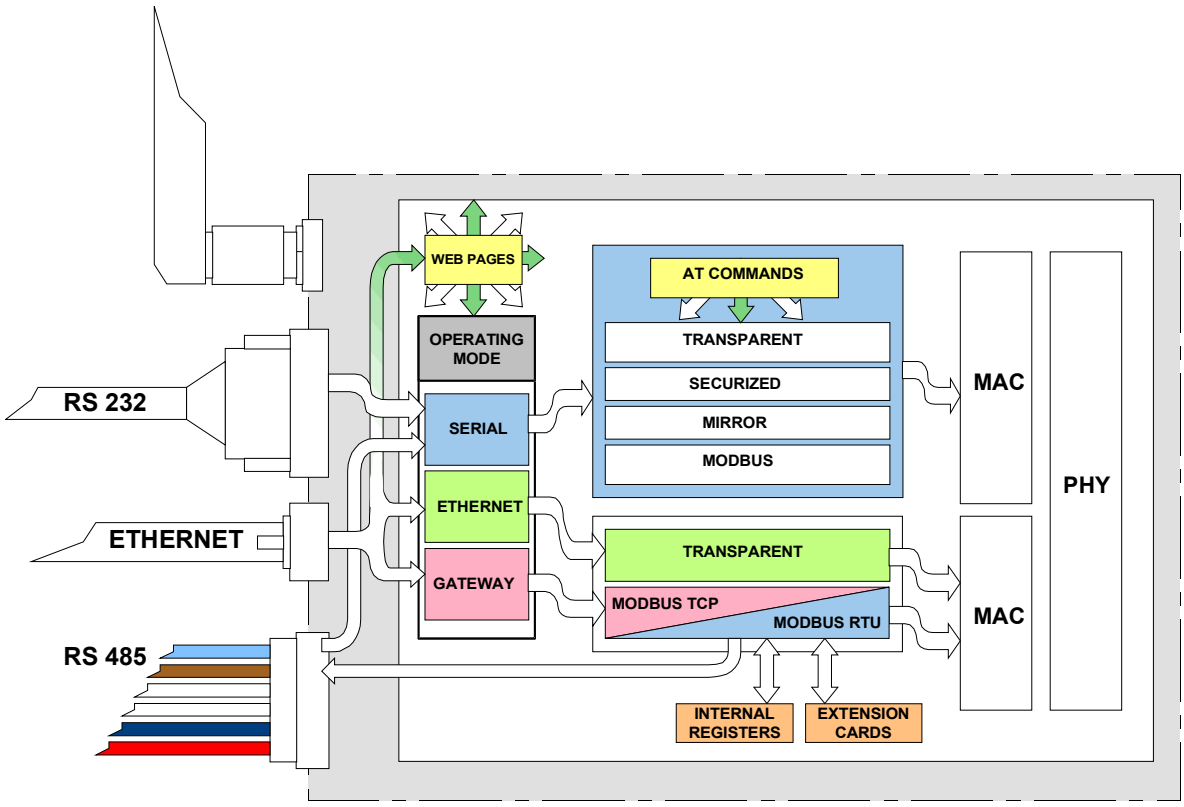


Figure 2: ARM-SE organisation chart.

Transparent mode is the default mode, for which no adjustment is needed. It reproduces as faithfully as possible the data stream sent over a hardwired link. This mode is suited to most cases where a user protocol already exists on the connected equipment.

1.5 GENERAL CHARACTERISTICS:

- Ethernet and serial link management (1 Kb memory buffer)
- Half-duplex radio transfer
- 868 MHz/ 433 MHz frequency according to radio card
- 38.4kbps, 19.2kbps and 9.6kbps radio transfer rate (868 MHz version)
- RS232 RS485 serial link transfer rate: 1200 bps to 115000 bps
- Radio output 10 mW at 433 MHz or 5, 25, 500 mW at 868 MHz
- Ethernet, serial, gateway operating modes
- Configuration via Web page and AT commands
- Simple repeater mode
- Router and repeater mode
- Error correction code
- LBT (Listen Before Talk) radio control

1.6 TECHNICAL CHARACTERISTICS:

RADIO MODULE:

- Frequency band: 868 – 870 MHz
- Transfer rate: 38.4kbps, 19.2kbps and 9.6kbps
- Number of channels: 16 @ 19200bps
- Channel spacing: 50 kHz
- Modulation type: FSK
- Frequency stability: ±2 kHz
- Output: 5 mW, 25 mW, 500 mW according to radio channel
- Output stability: -2/+1dBm
- Receiver sensitivity: -107 dBm (19k2), -110 dBm (9k6)
- Adjacent channel selectivity: -40 dBm (Channel spacing 50 kHz)
- Antenna connector: SMA

CONNECTION INTERFACES:

- Ethernet interface: Isolated 10 Base-T RJ45 connector
- RS232 interface: 9-pin D-sub female
- RS485 interface: Terminal block connector
- Serial link transfer rate: 1200 bps to 115000 bps
- MOS watchdog output +10 V to + 30 V DC

VARIOUS:

- Ethernet buffer: 8 Kb shared
- Flash memory for Web page storage: 128 kb or 4 Mb (according to version).
- Power supply: +10 V to +30 V DC
- Max consumption: 150 mA (receiving) 400 mA (sending)
- Operating temperature: -20 / +55°C
- Aluminium casing: 105*105*31 mm (Excluding antenna)
- Weight: 300 g

DELAY TIMES:

- Modem wake-up time: 180 ms
- Rx/Tx and Tx/Rx turnaround time: 2.4 ms
- RS232 Rx/Tx and Tx/Rx times: 0 ms
- RS485 Rx/Tx and Tx/Rx times: <1 ms
- Transmission delay in Transparent Serial mode: 5.6 ms
- Ping time through Ethernet connection by ARM-SE:
  - ~80 ms without RTS/CTS
  - ~118 ms with RTS/CTS (securized mode)

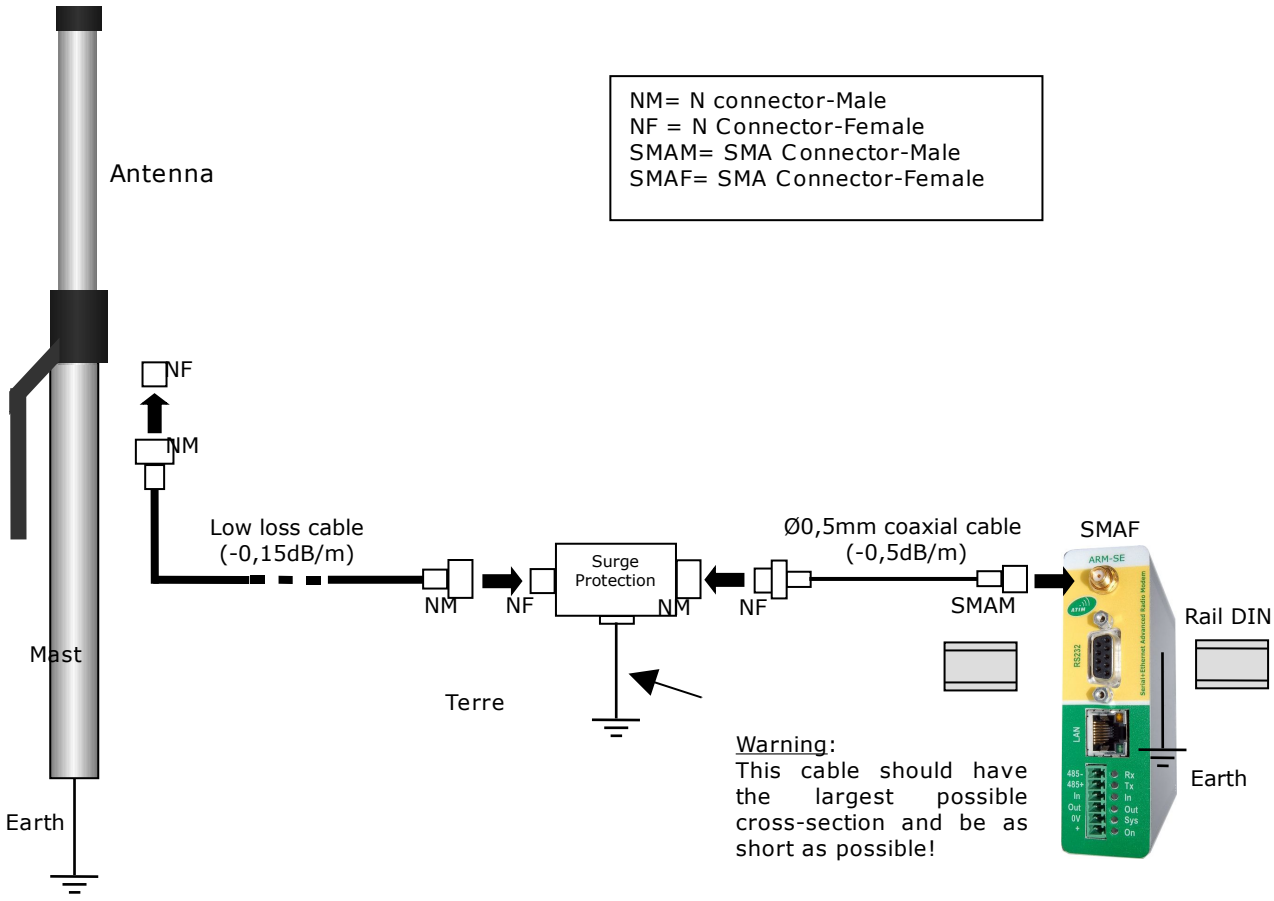
LED INDICATORS:

- **ON** LED: The modem is powered and running
- **SYS** LED: Modem malfunction
- **OUT** LED: Output logic status
- **IN** LED: Input logic status
- **Tx** LED: Modem in radio transmission
- **Rx** LED: Modem in radio reception

2 INSTALLATION

During installation, please observe the following instructions:

- Do not connect the modem to a 110 V or 220 V mains power supply!
- The power supply for ARM radio modems must be in the range 10 – 30 V DC (min and max values).
- For safety, the connection to the power supply must be made with the power off. Check that the power supply to the module is turned off before working on it.
- Do not use the radio box outside; it is not watertight and is designed for fitting inside a protective case or an electrical cabinet (optional on request).
- Before connecting or disconnecting the antenna, make sure that you have earthed yourself to discharge any static electricity, as the antenna input is very sensitive.
- Connect the DIN Rail mounting to the earth so that the radio box is earthed. If a mast-mounted external antenna is used, this must also be earthed and a lightning arrester fitted if appropriate (see diagram below)
- Observe current standards by using only the recommended cables and antennae; this will ensure you do not exceed the authorised effective radiated power (ERP). Use of coaxial cable (RG58 -1dB/m) is not recommended (high loss).



The use of a type RG58 (-1 dB/m) coaxial cable is not recommend (high loss).

2.1 ANTENNA

Choosing the wrong antenna can have a considerable effect on the quality of the radio link. It is important to use a suitable antenna and, if necessary, a low loss cable so that it can be position in an area free from obstructions.

Table 1 shows the antenna which are available to order:

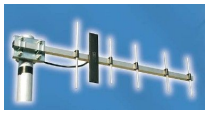
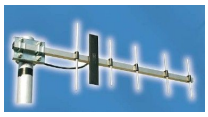
ANT868-14S3.8		¼ wave roof antenna with 3.80 m cable + SMAM connector (Length 0.5, 1 or 3.80 m)
ANT868-12FSC		½ wave elbow joint SMA whip antenna (directly mounted on A.R.M.)
ANT868-12S3.8		½ wave roof antenna with length 3,80m cable + SMAM connector
ANT868-BZ		"Bazooka" 4.15 dBi omnidirectional antenna for mast fitting (with fitting bracket), female N connector
ANT868-Y12		8-element 11,5 dBi directional Yagi antenna, female N connector (Warning: observe applicable regulations!)
ANT868-Y15		8-element 15 dBi directional Yagi antenna, female N connector (Warning: observe applicable regulations!)

Table 1

2.1.1 Fitting to a box or cabinet:

A.R.M. radio modems can be supplied with a ½ wave elbow joint whip antenna such that the antenna can be mounted vertically to the modem itself.

This antenna is useful if the A.R.M. is fitted in a plastic box. In this case, the antenna does not need to be set against a metal plate (backplate for example). ½ wave antennae require no ground-plan and can therefore be fitted directly to a non-metallic surface.

If the radio modem is fitted in a metallic cabinet or box, you can use antenna ANT868-14S – ¼ wave roof antenna – with cable and SMA connector.

The antenna must be mounted vertically (upwards or downwards, depending on area to be covered). For optimal results, it is recommended to place it high up and away from any metallic obstacles within a radius of 1 metre if possible (see figure 3).

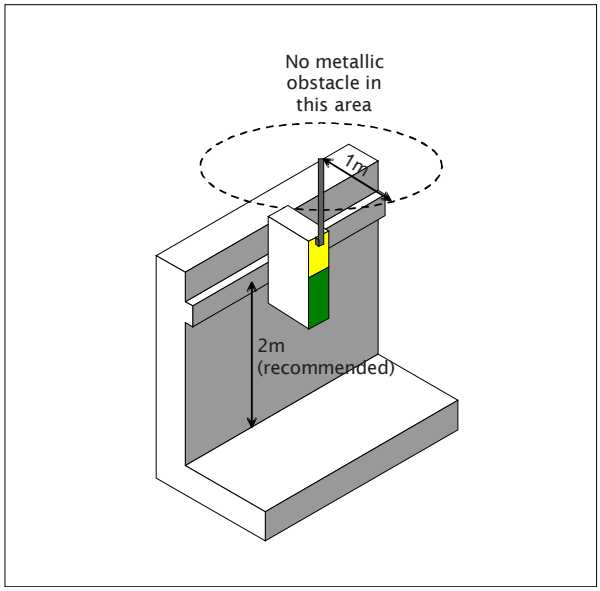


Figure 3: Modem placement.

2.1.2 Fitting an external antenna (on a mast):

In this case, you can use antenna ANT868-BZ with a CFP10 type cable (low loss, 10 mm diameter). With this type of cable, you can fit the antenna 10 or even 20 m or more away, according to the link budget (we can calculate this for you; you need to know the distance between the two or more points, the type of antenna and the length of cable required). Do not use just any coaxial cable or RG58 which, at this frequency, causes huge losses. See table 1 above.

In radio transmission, there is what is known as the "Fresnel zone", which forms an ellipse between the 2 antennae (see figure 4). The further you wish to send your transmissions, the higher the antennae need to be mounted (~ 1 m/km, i.e. 5 m high for 5 km range), so that any obstacle in this zone can be avoided. In a clear field with a direct line of sight, where antennae are installed according to these instructions, the range of A.R.M. radio modems can extend over several kilometres.

Figure 4: Fresnel Zone.

2.1.3 Spectrum occupancy

Before any installation, it is a good idea to make sure that the chosen radio channel is free using the "spectrum analyser" test from the Web pages test mode.

2.1.4 Radio channel selection

Radio channel selection is normally done using the thumb wheel on the back of the modem, or via software configuration. Since this can only be read at start-up, the power must be switched off, the radio channel selected and then the power restored when any changes are to be made.

The thumb wheel has 16 positions from 0 to F (hexadecimal), each of which corresponds to a different carrier frequency, spaced in 50 kHz steps and varying in power (see table 2).

To satisfy standards requirements, data sent from the user must observe an imposed transmission time (duty cycle) or adhere to the LBT (Listen Before Talk) protocol. These specific settings can be managed via the Web pages.

According to the radio channel selected, ARM modems can operate over distances of several kilometres.

The radio part is available in two versions:

- "Standard" radio datarate from 9,6kbps to 19,2Kbps.
- "High bandwidth" radio datarate from 19,2Kbps to 38,4 Kbps.

Table 2 and 3 provides the distances which can be attained in a free field.

CHANNEL	FREQUENCY (MHz)	STANDARD POWER	DUTY CYCLE	ACHIEVABLE RANGE
0	869,800	5mW	100%	<1km
1	868,075	25mW	1%	<2km
2	868,125			
3	868,175			
4	868,225			
5	868,275			
6	868,325			
7	868,375			
8	868,425			
9	868,475			
A (10)	868,525			
B (11)	869,850	5mW	100%	<1km
C (12)	869,900			
D (13)	869,475	500mW	10%	~5km
E (14)	869,525			
F (15)	869,575			

Table 2: Radio channel details for radio datarate <19,2Kbps.

CHANNEL	FREQUENCY (MHz)	STANDARD POWER	DUTY CYCLE	AVAILABLE RANGE
0	869,850	5mW	100%	~500m
1	868,075	25mW	1% 0,1%	~1km
2	868,750			
3	868,175			
4	868,850			
5	868,275			
6	868,950			
7	868,375			
8	869,050			
9	868,475			
A (10)	869,150			
B (11)	869,850	5mW	100%	~500m
C (12)				
D (13)	869,525	500mW	10%	<5km
E (14)				
F (15)				

Tableau 3: Radio channel details for radio datarate >19,2Kbps.

To enable ARM modules to talk to one another, you must assign the same channel number to each of them.

Comment: in cases where another transmitter which is not part of the same application is positioned close by, allow at least one free channel between the two: C2, C4 for example.

2.2 ARM-SE connections:

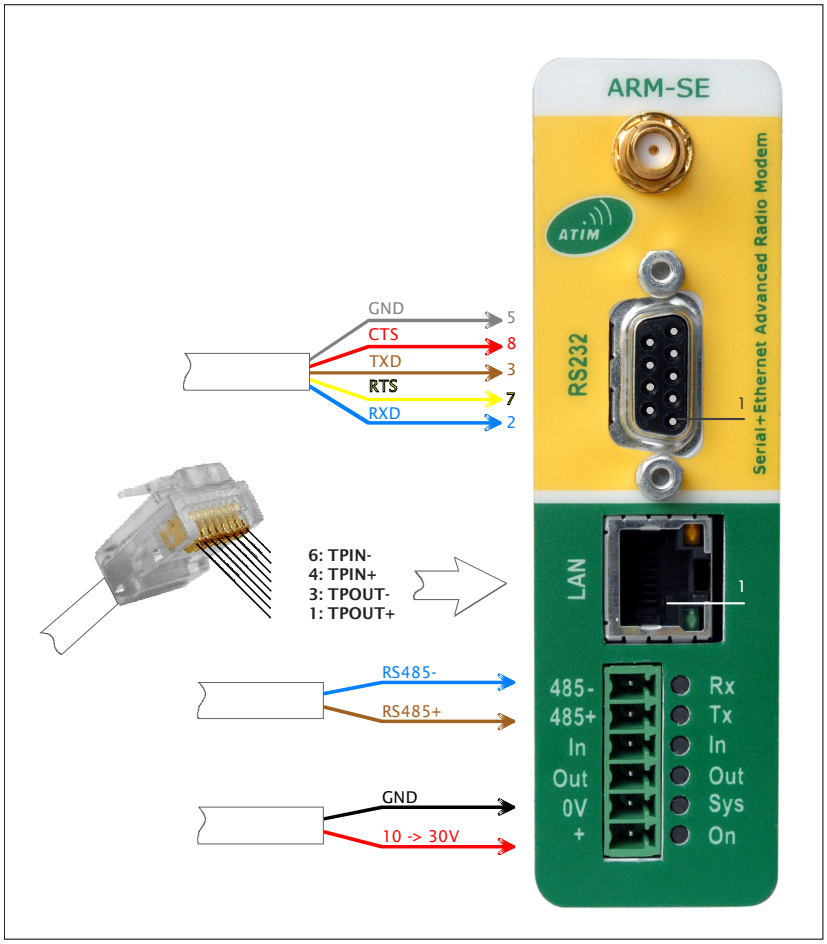


Figure 5: Diagram showing modem connections.

2.2.1 Power Supply

Connect your power supply to the 0 V and + terminals of the pluggable terminal block.

This must be rectified, filtered and between 10 and 30 V. Beware of 220 V supply blocks which are often of poor quality and may produce peaks of less than 10 V!

The 0 V (negative terminal) is connected to the terminal block and thus to ground via the DIN rail.

Consumption at 12 V is:

- ~ 130 mA receiving
- ~ 200 mA transmitting at 10 mW
- ~ 400 mA transmitting at 500 mW

2.2.2 Ethernet connection

The ARM-SE modem must be connected to the network via a CAT3 or CAT5 straight or crossover cable in accordance with the network peripheral to which it is connected.

On power-up the orange LED on the RJ45 connector should light up. If this is not the case, check your Ethernet lead is suitable.

2.2.3 RS232 Serial link

It is possible to configure the radio modem and also to communicate via this interface.

Warning:

Since the interface is of the DCE type, you must use a 9-pin male/female straight cable for connection to a PC. By default, selection of the RS485 or RS232 interface is done automatically, but for this a 9-pin cable must be used (Requires at least the 5 signals: Tx, Rx, Gnd, RTS, CTS). It is also possible to force the RS232 or RS485 mode (see register configuration). The RS232 cable must be shielded and we recommend a maximum length of 3 m; otherwise use RS485 and a converter.

1			Not used
2	RXD	Output	Data transmission / Host reception
3	TXD	Input	Data reception / Host transmission
4	DTR	Input	Radio and serial communication authorisation
5	GND	-	Ground
6	DSR	Output	Indicates radio modem status
7	RTS	Input	Request to send
8	CTS	Output	Clear to send
9			Not used

Table 4: Pin configuration for 9-pin D-Sub

Use of CTS RTS in memory full mode (Bit0 in register S27)

RTS: If Active (level 1 RS232) No authority to transmit the information over the serial link

CTS: Active (level 1 RS232) Indicates modem memory is full

Must be used if the serial link speed is higher than the radio streaming rate

Use of CTS RTS in radio mode (Bit2 in register S10)

RTS: If Active (level 1 RS232) Confirmation of radio reception

CTS: Inactive (level 0 RS232) Radio data reception signal

Use of DTR and DSR signals

These allow control of the modem communication state in transparent mode only. The DSR signal indicates if the modem is active. DTR input immediately halts radio communication and communication over the serial link (active in RS232 state 1).

Confirmation of this function by bit1 of register S10.

2.2.4 RS485 serial link

It is possible to configure the radio modem and also to communicate via this interface. The advantage of RS485 is that several devices can be added to a single 2-wire bus (A, B or + and - respectively). This bus is widely used in industrial applications because it is largely unaffected by external interference (differential link).

Warning:

By default, selection of the RS485 or RS232 interface is done automatically, but for this not should be connected to the RS232 (D-Sub disconnected). However, it is preferable to set RS232 or RS485 mode (see register S16).

The RS485 bus requires a termination resistance of 120 Ohms to be placed on each of the RS485 devices located at the end of the line (in the case of a long line or in an area of high interference). If the cable between your equipment and the ARM is short and in an area without interference, it is preferable not to add the terminating resistance to reduce power dissipation. It is also necessary for the line to be polarised on at least one of the devices connected to the bus.

To activate or deactivate the termination resistance and the pull-up, pull-down resistances, you must operate the dip switches on the back of the modem (See figure 6).

Desactivated ↔ Activated
4: Terminaison 120Ω
3: Pull-down 2.7K
2: Pull-up 2.7K
1: Test mode

Figure 6: Hardware configuration dip switches (rear of modem).

2.2.5 On / Off Input - Output

The ARM-SE is fitted with one logical input and output as standard.

The main function of the output is for use as an alarm (Watchdog) in the case of a break in radio communication between the 2 (or more) devices.

Illustration 7: Internal diagram of On/Off I/O.

3 CONFIGURATION

The modem has a basic configuration in its program memory. This configuration is copied into the protected memory which can be modified according to configuration changes made by the user. These modifications are possible either via the internal Web pages or via AT commands.

NB: For any configuration from the RS232 serial link it is necessary to activate "Serial" mode from the Web pages.

AT command emulation is set in the Web pages from the "Advanced Controls" page. See chapter 3.3 page 23.

Parameters set in this way can only take effect after confirming and re-starting the modem. From the Web pages, confirm the modifications by clicking on "Apply" then exit the application by clicking on "Exit and Save" to re-start the modem. The Web pages are straightforward and intuitive by design, and it is recommended to use them in most cases.

3.1 CONFIGURATION VIA THE EMBEDDED WEB PAGES

To gain access to modem configuration, the IP addresses of the modem and the PC must belong to the same class. The original ARM-SE address class is **192.168.0**; the work station wanting to access its configuration must therefore have a similar address class.

If this is not the case, configuration of these parameters can be completed from the Windows Control Panel, within the category **Network Connections** > **Local Network Connection** > **General** tab > **Properties** > **General** tab > **Internet Protocol (TCP/IP)** > **Properties** > **IP Address**.

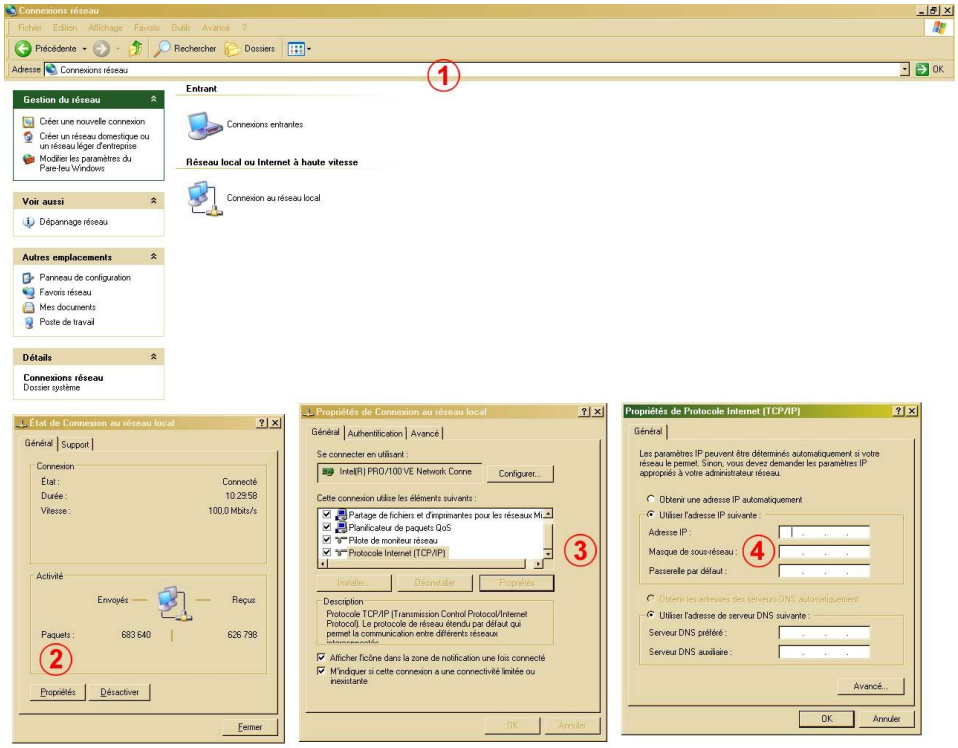


Figure 8: Configuration of TCP/IP parameters.

N.B.: Be careful when using PCs fitted with Wi-Fi controllers, as they may redirect Ethernet traffic over their media. To ensure better compatibility, it may be worth disabling this type of controller.

Most PCs are equipped with Firewalls working at a number of levels:

- Windows (see Control Panel > Firewall or Security Center)
- Anti-Virus software
- Access control software.

It is therefore essential to enable access to the modem through the Firewall(s).

The value of an embedded driver is that it requires no installation. However, for browser versions which are too old, or other than Internet Explorer, Mozilla or Opera, compatibility problems may arise.

To avoid this, it is important to keep your browser version up to date, along with FlashPlayer (http://www.adobe.com/fr/products/flashplayer/) for test mode animations.

3.1.1 Welcome page and password

The modem must be connected up to a PC by an Ethernet lead in accordance with its network connection (straight or crossover). From an Internet browser, access the modem welcome page at address **192.168.0.20**.

The default password is "**default**", which can be changed from the "Administration" tab.

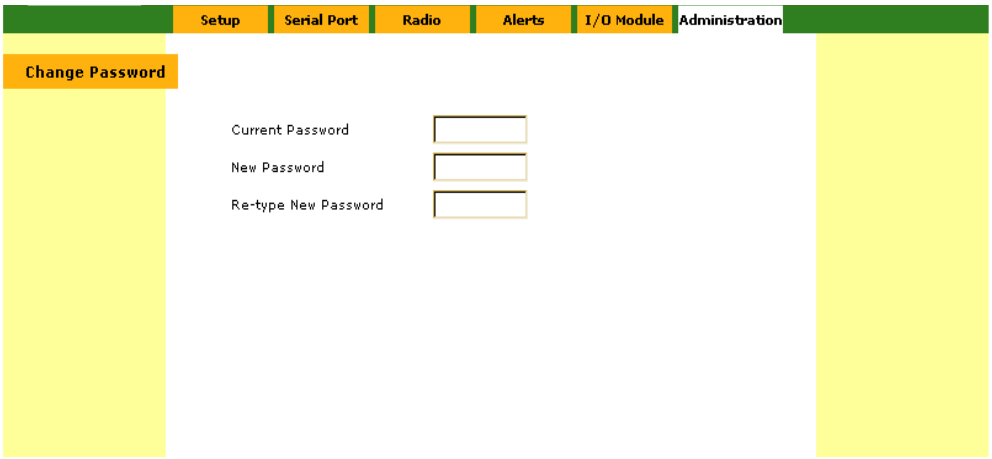


Figure 9: New password setting.

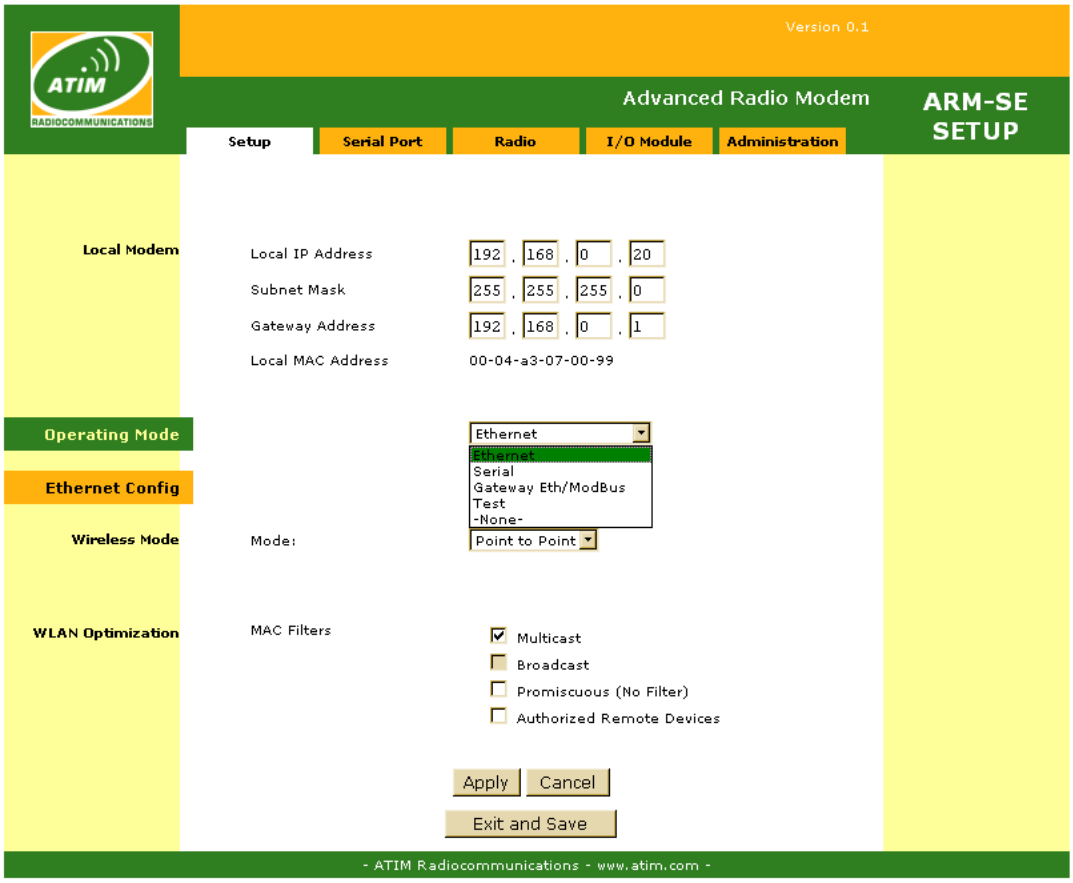


Figure 10: Operating mode selection.

On the welcome page ("Setup" tab) before "Operating Mode" is a list of operating modes mentioned in chapter 1.4 which determine the source of information transmitted by radio. From this there follow the various settings which can be configured, which helps the user to modify the settings which will be useful and suitable for their situation.

3.2 CONFIGURATION BY HAYES COMMANDS (AT)

In this mode you have access to the full modem configuration. The configuration memory is divided into 3 pages; to access each page you must change the value of register S99 (by default you will access memory page 0). The AT frame must be sent to the ARM in programmed UART format (by default: 19200 bps, 8 bits, no parity, 1 or 2 stop bits).

To access this mode you must send the ASCII access codes over the RS232 or 485 serial link: +++

Comment: frame format: <Delay 50 ms>+++

Any other ASCII code apart from the 2 ASCII codes LF (0x0A) and CR (0x0D) during the 50 ms period cancels the command.

→ If you can no longer remember the previously saved format, it is possible to return to the default UART configuration by changing to test mode 12 (see Test Mode chapter page 48).

Example 1: (see table of AT commands in annex)

+++	'Change to command mode
ARM VERSION …	'Modem response
ATS55	'Read S55 (Paging code)
Value=$50	'Modem response

Example 2:

+++	'Change to command mode
ARM VERSION …	'Modem response
ATS99=01	'Change to memory page 1
Value=$01	'Modem response
ATS55	'Read S55 (Paging code)
Value=$51	'Modem response
AT&W	'Write to EEPROM
ATR	'Reset modem

Warning: with AT commands access to all configuration registers is possible. Thus any input error may cause modem malfunction; in this case you must return to the factory settings via test mode D.

3.3 Advanced controls

A section of advanced configuration controls is accessible by entering the "**advanced**" password at the welcome screen.

When an ARM-SE is communicating with other modems in the ARM range, it is possible to download the configuration from these and modify it remotely. Then all that you need to do is to select the type of remote ARM module to be configured and to enter its MAC address, then click on "Get Config", which opens an "AT Commands" type registry settings window (See Annex A - AT Commands -)

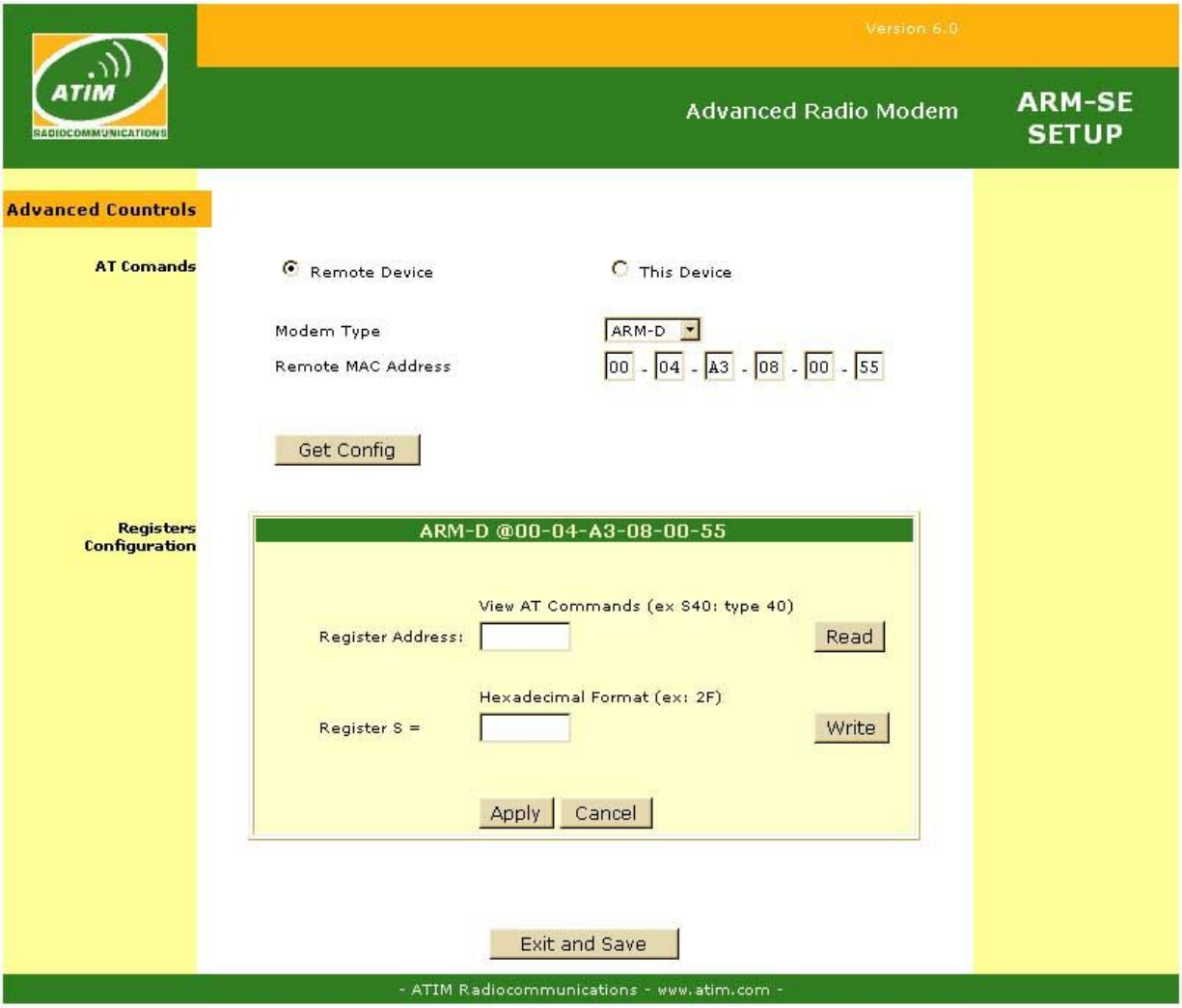


Figure 11: Web page for advanced and remote controls.

"Reading" from the register address (e.g. 60 for ATS60) reveals its value which can then be modified by "Writing" in hexadecimal format.

When writing takes place, the downloading of new parameters to the remote modem only takes place after confirmation with "Apply". A confirmation message then appears if remote configuration has been successful.

4 OPERATING MODES

4.1 ETHERNET MODE

By definition, Internet is derived from a family of heterogeneous interconnection protocols. This means that the protocols managing the application are independent of the physical medium used by the communication.

The ARM-SE thus operates in a transparent manner at the low layer level, and simply repeats the information as sent out by the NIC[s] (network cards) during communication.

The reliability of communications between two ARM-SE[s] is guaranteed by the acknowledgement of messages and, according to configuration, by the RTS/CTS (Request To Send/Clear To Send) radio channel access mechanism.

In applications which are demanding in terms of response times, ARM-SE communication can put a brake on dialogue, given the radio data rate which is much lower than the rate theoretically achievable over a 10 Base-T network. Therefore any communication not based on a flow management protocol (typically TCP) exposes transmission to flow congestion and data overrun on the link.

4.1.1 Link performance and flow optimisation

When the user chooses the Ethernet operating mode, priority may be given to the speed (without RTS/CTS) or security (with RTS/CTS) of the radio communication from the “Radio” tab under the “Focus on:” setting.

NB: This adjustment is only possible in P2P mode after confirming the operating mode by clicking on “Apply”. If response times are not critical, it is recommended to keep RTS/CTS mode (default “Security” mode).

To optimise radio data flows, it is essential to know the type of traffic on the network and what is to be transmitted over the radio channel. To satisfy this, it is possible to set up MAC address filters (see illustration 18) or to create a specific subnet for radio communications (see page 24).

A traffic analyser (such as Ethereal or Wireshark) could be of use, but simple knowledge of the network configuration is sufficient.

4.1.2 Radio subnet address classes

The ARM-SE transmits ethernet frames from devices belonging to its IP address class over radio. It is therefore possible to set up a subnet operating on the same radio channel by using the mask provided for this purpose. By default the subnet mask is 255.255.255.0.

Figure 12 shows an installation using different subnets to create different zones (thus avoiding simultaneous frame transmission).

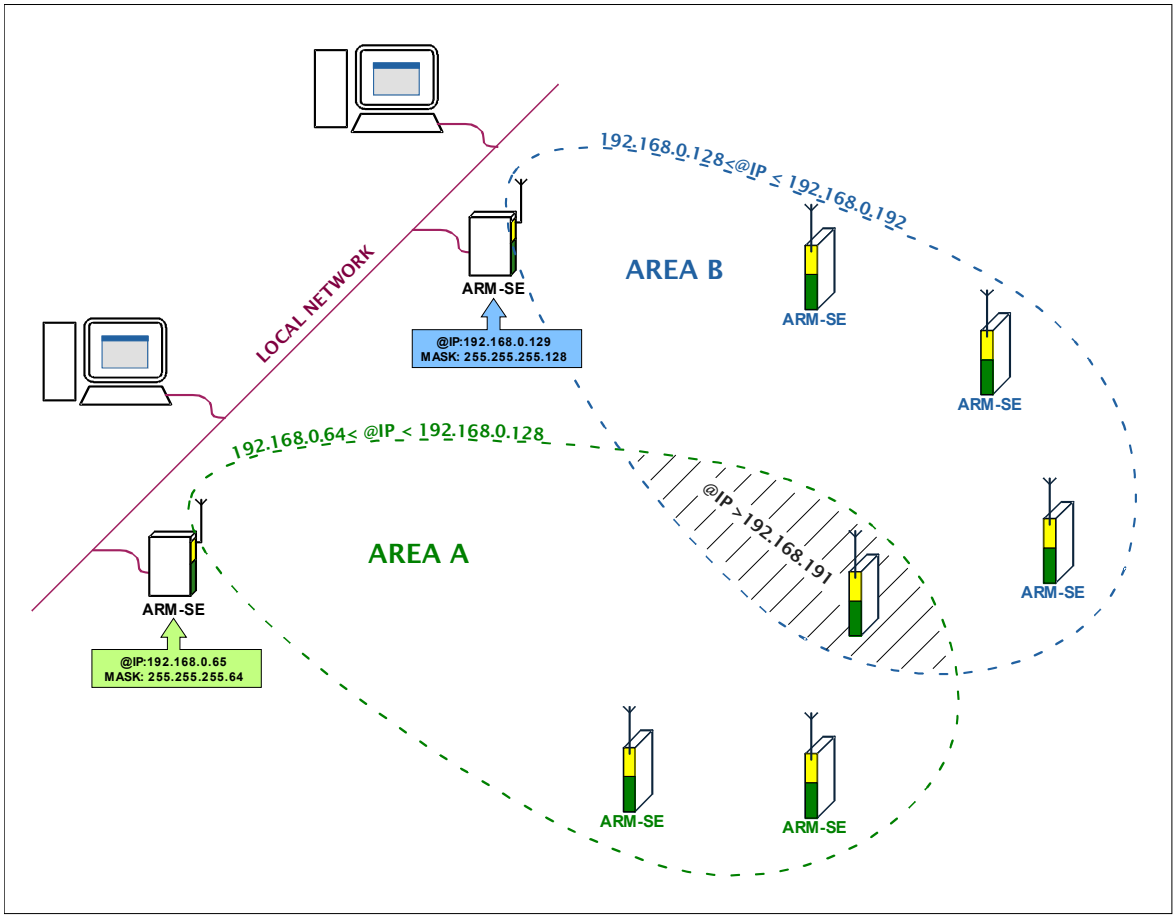


Figure 12: Radio subnet.

N.B.: As the ARM-SE has no router function, interconnection of different networks requires the user to modify the mask value.

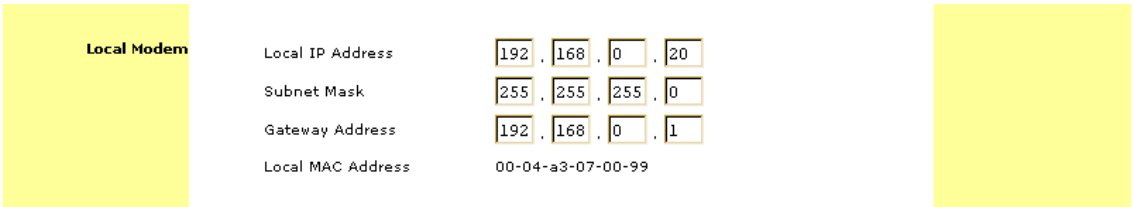


Figure 13: Subnet mask and network address.

4.1.3 Point to point mode (P2P):

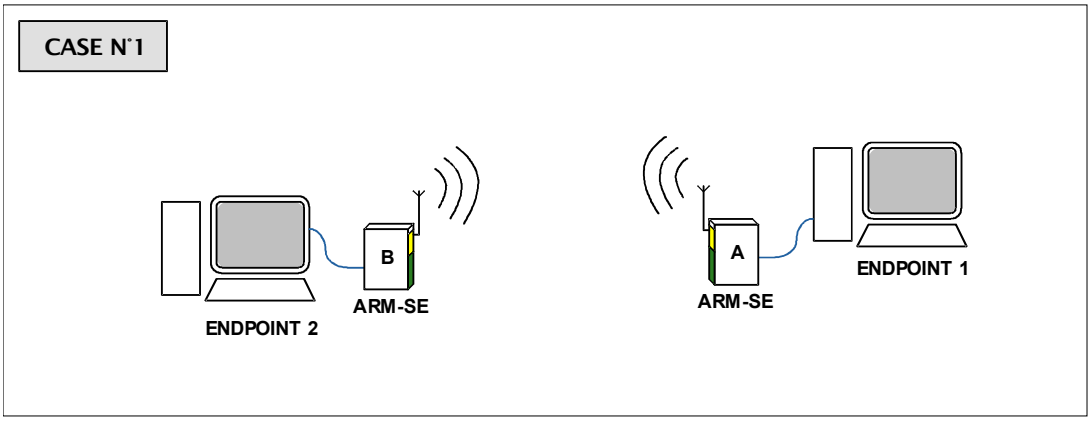


Figure 14: Case n°1 in Point to Point.

The default configuration of ARM-SE[s] matches the situation shown in figure 14. This is a simple situation where ARM-SE[s] provide communication from one endpoint to another.

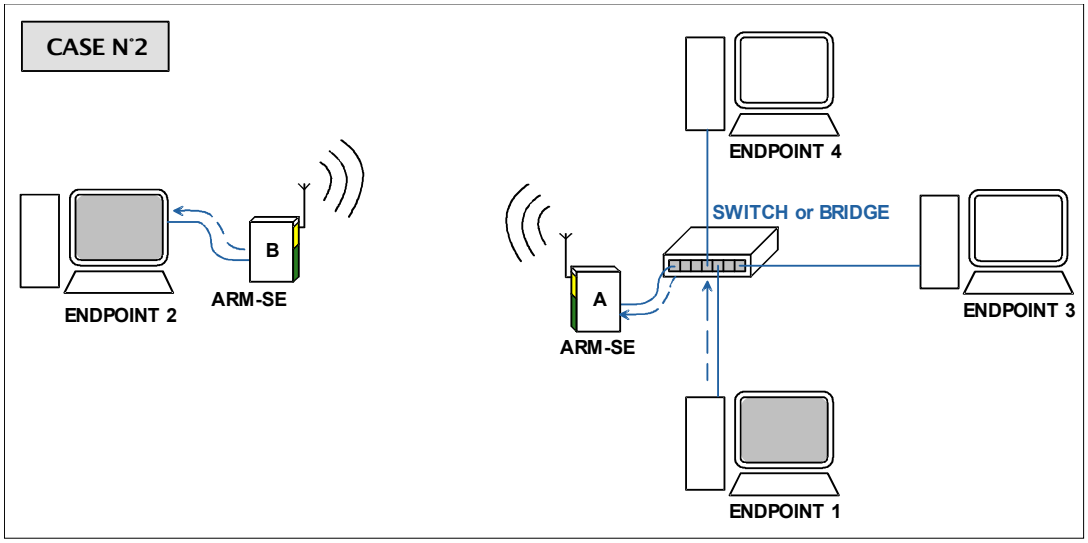


Figure 15: Switched or Bridged Point-to-Point mode.

The situation where a point is connected to a switch or bridge is no different from case n° 1. These can separate out the physical addresses of the equipment connected to them, thus keeping the radio channel restricted to just those endpoints using it (endpoints 1 and 2 in figure 15).

For cases n°1 and 2, figure 16 shows the appropriate configuration.

The “Promiscuous” setting means that no address filter is applied

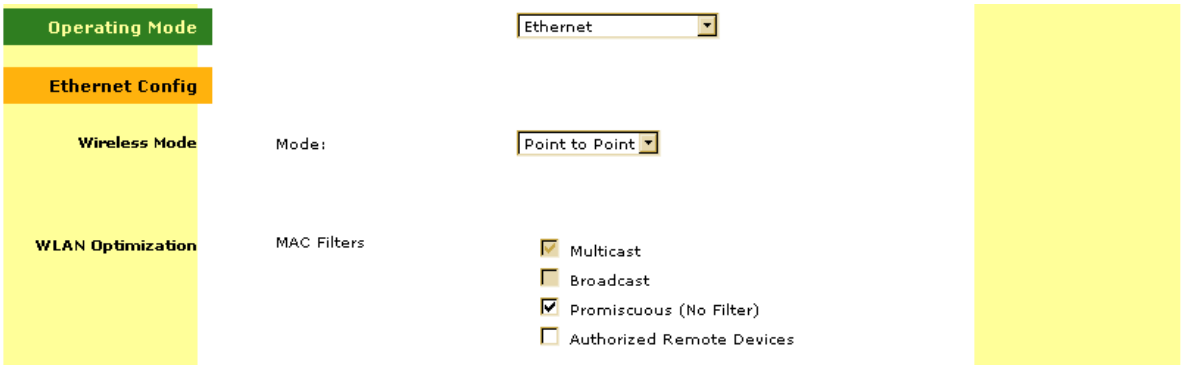


Figure 16: Settings for cases N°1 and 2 in P2P.

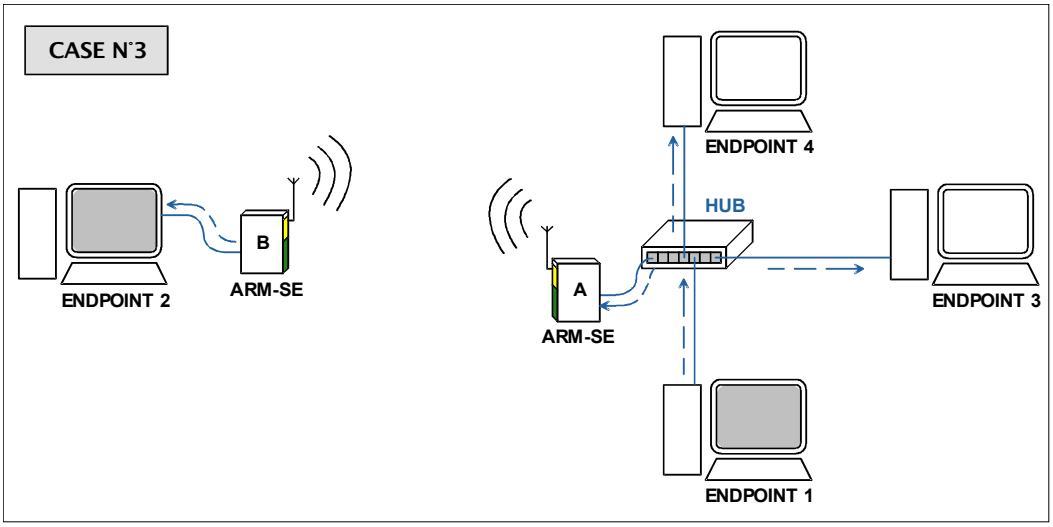


Figure 17: Mode Point à Point via Hub.

In the case of a network connected through a Hub, all frames entering the Hub are repeated to each port. In the case of figure 17, if endpoints 3 and 4 communicate with one another, their messages will also be sent to endpoint 1 and endpoint 2, adding unnecessary traffic to the radio channel.

This problem can be overcome by using the ARM-SE table of MAC (physical) addresses, which defines which destination addresses are authorised to use the radio channel. In this example, simply configure the table for modem A with the address of endpoint 2 and possibly that of modem B.

For case N°3 figure 18 shows the appropriate configuration to follow.

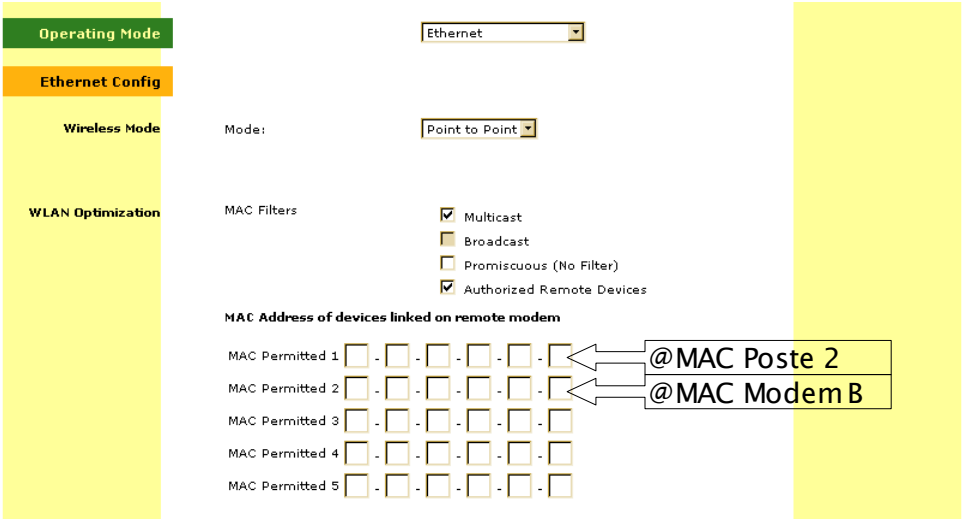


Figure 18: Settings associated with case N°3.

4.1.4 Point to Multipoint Mode

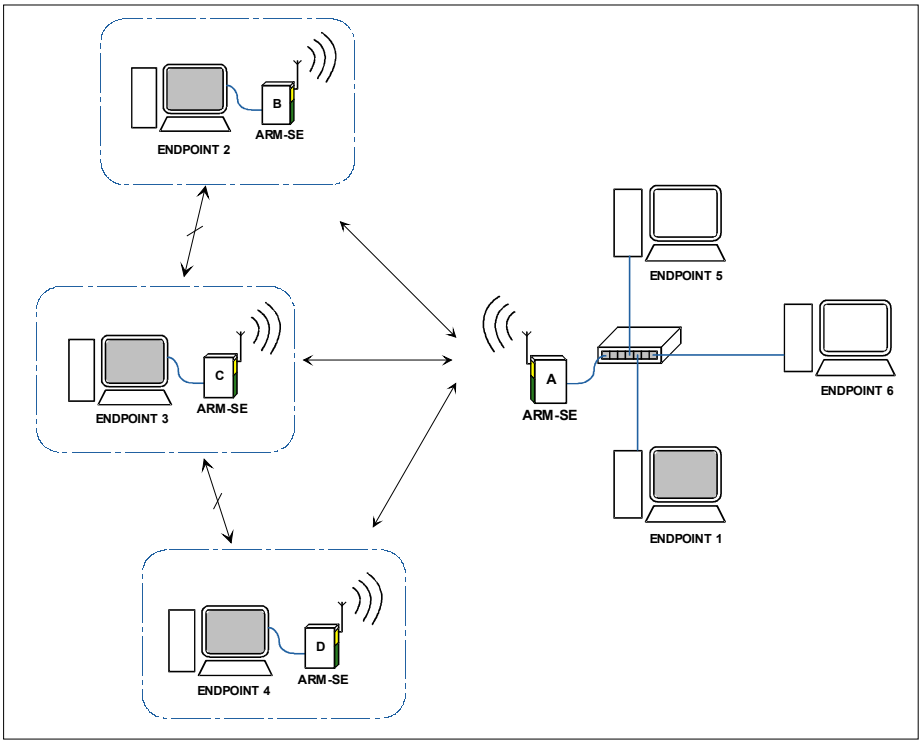


Figure 19: Point to Multipoint

In this "star" type configuration, the access point may interrogate each of the endpoints connected to each of the client configured modems.

<u>Comment:</u> In this type of configuration, it is important to assign a different IP address to each ARM-SE modem.

Client configured modems cannot communicate with one another and response times depend upon each one's channel occupation. In addition, the rules mentioned in cases N°1, 2 and 3 are valid for each of the endpoints (client or access point).

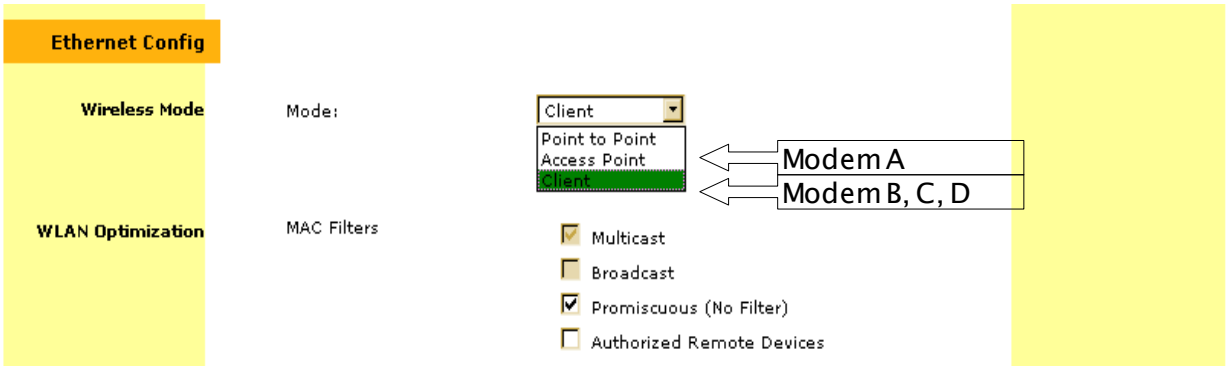


Figure 20: Point-to-Multipoint mode settings.

4.2 SERIAL MODE

4.2.1 Transparent Mode

In this mode, only the physical data layer is managed. Each byte entering the transmitting module is copied on to the receiving module and no error checking is performed. It is possible to establish a point-to-point or point-to-multipoint link. A communication protocol must already be present on the equipment connected to the modems (typical example: PLC[s] which already have Modbus, Unitelway or other protocol installed).

It should be noted that with this mode, since radio is not a 100% reliable medium, data may occasionally arrive with errors and must therefore be repeated if necessary.

Radio frame format:

- Bit synchronisation (N bit synchronisation)
- Preamble Code
- Message (x bytes)

[Preamble] [Preamble Code] [Raw data] [End Sequence]
48 16 8 x n 6

(n: number of bytes in incoming frame)
(bit time=52 µs at 19200 b/s, bit time=104 µs at 9600 b/s)

The radio modem switches to transmission from receiving the first incoming byte over its serial link (+ any ***"Delay before emission" (by Web pages)*** of 3 ms or as set ***(register S28 by AT commands)*** corresponding to the time for these n bytes at the serial link transmission rate. E.g.: 1 ms for 2 bytes at 19200 bps).

This delay is reset to zero each time a byte is received over the serial link. There must be a period of silence corresponding to the time for these "n bytes" to be able to start transmission.

Transmission continues just as long as the serial link reception buffer is not empty. When the last byte is sent from the buffer memory, a count begins allowing transmission to continue for n blocks of 312 µs corresponding to n packets of 6 stop bits. This time can be adjusted via the **"Number of stop frames after Ex" (register S29)** value or by a fixed time of 3 ms via the Web pages under the ***"Wait end of transmission"*** setting. The counter is reset with each new piece of data transmitted. This value must be identical on each of the connected ARM[s]. At the end of the message, the modem remains in transmission for the preset time.

The modem has a 1024 byte buffer memory. If the speed of the serial link is equal to the radio speed, then the data are sent directly. If the speed of the serial link is less than the radio data rate, then the use of the delay after transmission allows the modem to avoid returning to reception mode and to waste time (Tx/Rx/Tx switching time).

When the serial link speed is greater than the modem, the modem can store up to 1024 bytes in a buffer and thus delay transmission. If the buffer memory is full, the modem takes no account of the data from the serial link which are lost. To prevent this type of behaviour it is recommended to use control signals (CTS – RTS). In this flow management mode, RTS is activated when the number of bytes in the serial link reception buffer memory reaches 1000.

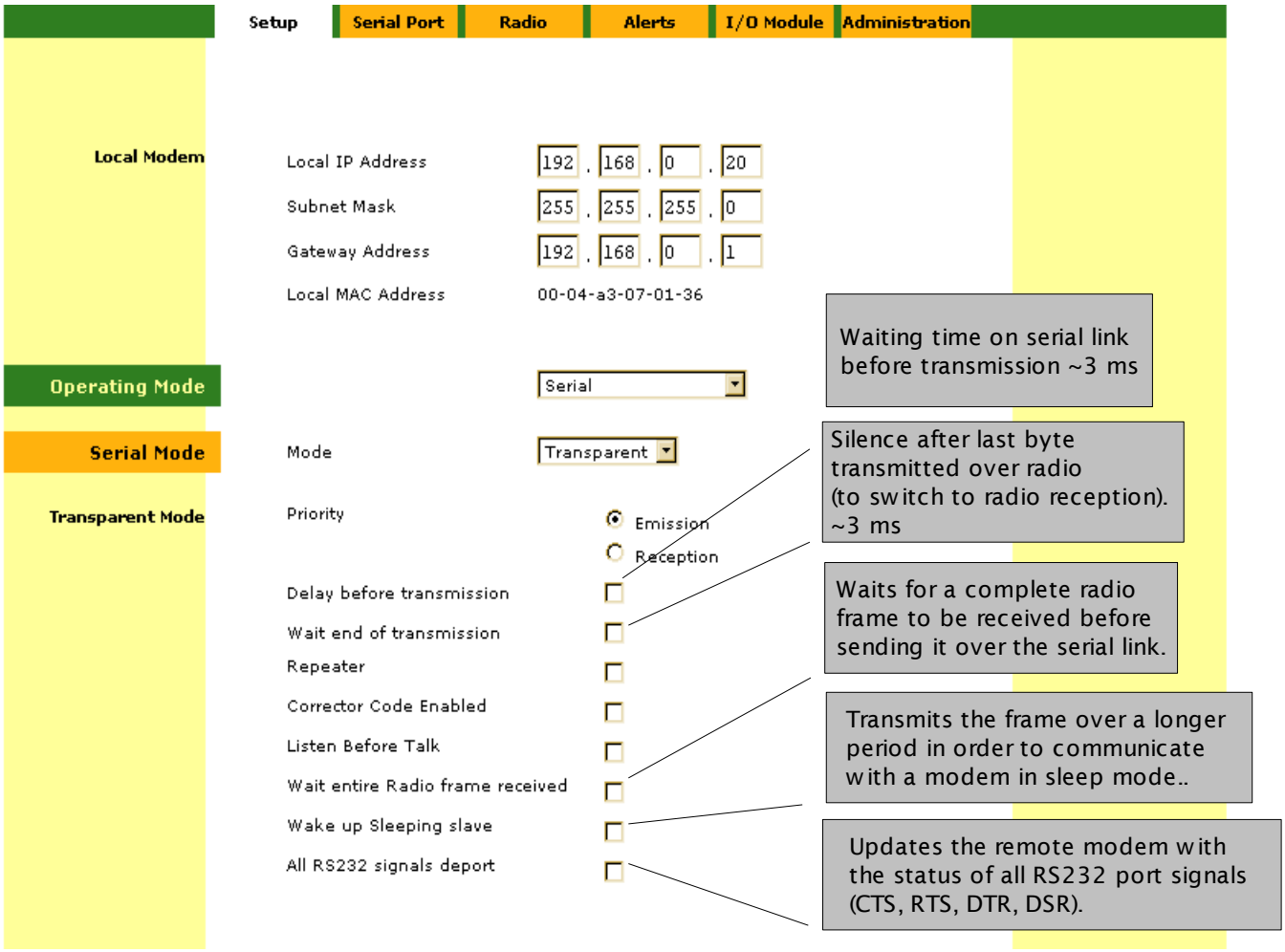


Figure 21: Settings for Serial-Transparent mode.

Comment:

In transparent mode, it is important to consider the transmission delay and end of transmission waiting times. This can enable radio frame "hole" phenomena to be avoided. For example, for a serial link rate of 2400 bps, where delays are not used, the modem sends each byte separately in each radio frame.

Case where no delays used:

TRANSMITTING MODEM

- Serial link < ---Message--- >
- Radio link < tr > <tp>< ---Message --- >

RECEIVING MODEM

- Radio link <tp>< ---Message --- >
- Serial link < ---Message --- >

t0: delay time before transmission

tr: radio response time

tp: preamble time

Case using delay before transmission:

TRANSMITTING MODEM

- Serial link < ---Message--- >
- Radio link < t0 > <tp>< ---Message --- >

RECEIVING MODEM

- Radio link <tp>< ---Message --- >
- Serial link < ---Message --- >

t0: delay time before transmission

tr: radio response time

tp: preamble time

Case using end of transmission waiting time:

TRANSMITTING MODEM

- Serial link < -Mes1- > < ti> < -Mes2- > --
- Radio link < tr > <tp>< -Mes1- >< ta> < -Mes2- >< ta>

RECEIVING MODEM

- Radio link <tp>< -Mes1- >< ta> < -Mes2- >< ta>
- Serial link < -Mes1- > < ti> < -Mes2- >

tr: radio response time ti: inter-character time

tp: preamble time ta: transmission end time

Serial link speed	Inter-character time	Radio speed selection	Delay before transmission	Transmission delay
> 19200b/s	0 ou >0	19200b/s	0	0
19200b/s	0	19200b/s	0	0
19200b/s	> 0 à <2 caractères	19200b/s	0	4
19200b/s	>= 2 caractères	19200b/s	>=2	0
9600b/s	0	9600b/s	0	0
9600b/s	> 0 à <2 caractères	9600b/s	0	4
9600b/s	>=2 caractères	9600b/s	>=2	0
4800b/s	0	9600b/s	0	8
4800b/s	>0 caractère	9600b/s	>=2	0
2400b/s	0 ou >0 caractère	9600b/s	>=2	0
1200b/s	0 ou >0	9600b/s	>=2	0

Table 5: Transmission delays

Table 5 above corresponds to the recommended values; it is possible to use other configurations according to different situations.

Repeater option:

In transparent mode, the repeater is simple and only stores the received frame (max 1024 bytes) and retransmits it in the same form once reception is complete.

- Repeater mode option with data return over serial link (Bit5 of register S00)
- Repeater mode option without data return over serial link (Bit4 of register S00)

In this mode, it is essential to implement the delay before transmission or to set value 2 in delay before transmission. All other functions can be deactivated.

It is possible to have a single modem configured to simple repeater in a network.

Transmission priority: (Bit 2 of register S04 to 0)

On receiving data over the serial link, the modem interrupts radio reception and changes to radio transmission to relay the message.

Reception priority: (Bit 2 of register S04 to 1)

On receiving data over the serial link, the modem stores the data if a radio message is being sent. At the end of receiving the message, it transmits the stored data by radio.

Channel busy detection before transmission: (Bit 0 of register S08 to 1)

On receiving data over the serial link, the modem listens to the radio transmission channel. During the listening period the data are stored.

If the channel is free for 5 ms the modem changes to transmission.

Otherwise the modem waits for the channel to be free for a period of 5 ms + a random value from 5 to 64 ms.

After transmitting the data, the modem can only repeat a transmission for a set time of 100 ms.

The carrier detection threshold is -91 dBm.

The value of Bit4 and 5 of register S08 = 10 (Carrier detection threshold)

Transmission OFF delay after transmission: (Page 1) S12 default value $66

Random value delay: (Page 1) S13

In this mode do not use delay before transmission.

Error correction code: (Bit 7 of register S02 to 1)

The coding used is an interlaced HAMMING code. The coding is automatically managed on receiving data over a serial link. The coding must be valid on modems in dialogue with one another. Be aware that confirming this function will double transmission times.

Transmission forcing transparent mode code: (Register S00 equal to 0A)

In this mode the modem remains always in radio transmission (The radio power is cut if no communication is in progress). However the RS485 link remains constantly in reception.

This mode is used to allow full duplex with 4 modems.

To access AT command programming mode, you must use the RS232 connection.

Reception forcing transparent mode code: (Register S00 equal to 09)

In this mode the modem remains always in radio reception. However the RS485 link remains constantly in transmission.

This mode is used to allow full duplex with 4 modems.

To access AT command programming mode, you must use the RS232 connection.

Registers used in AT command mode:

- Register S00: =00 => Transparent Mode
- Register S28: Transmission delay time
- Register S29: End of transmission waiting time

4.2.2 Securized Mode

In securized mode, as the name suggests, the radio modem manages communication as well as communication errors. A master modem can manage several slaves. Hence the communication time is extended compared with transparent mode.

Radio frame format:

[@Location] [@Destination] [@Repeater] [Control] [Length] [Data] [CRC16]

@ Local:	16-bit local address
@ Destination:	16-bit destination address
@ Repeater:	16-bit repeater address (optional according to S00 flags, bits 4 and 5)
Control:	Control byte: Number of repetitions, repeater mode etc..
Length:	Length of incoming message [Data] from 1 to 250 (8 bits)
Data:	User message (serial link message for transmission)
CRC16:	16-bit cyclic redundancy code

Securized mode includes 2 operating possibilities:

- Point-to-Point dialogue
- Dialogue with external address

4.2.2.1 Point-to-Point Dialogue

This dialogue allows radio communication between two devices to be secured.

The modem is preconfigured in the factory for error management. Simply supply the local and destination address for each modem (Address limited to 1 byte).

4.2.2.2 Dialogue with external address

In this case, the user must include at the start of the message 1 or 2 bytes corresponding to the destination address, which authorises multipoint operation.

Confirmation of this dialogue is by Bit0 of register S05.

Bit5 of register S05 allows selection of the address using 8 or 16 bits (8 bits by default).

Bit6 of register S05 allows the radio frame destination address to be sent at the start of the serial link frame.

Important comments:

Each modem can be a repeater by the radio frame can only be repeated once per repeater modem.

The configuration must be identical over all modems used in a single application, except for the local and destination addresses.

In configuration with a repeater, register S22 (Number of retransmissions) must be equal to 0 and the value of register 21 (ACK frame wait time) must be doubled.

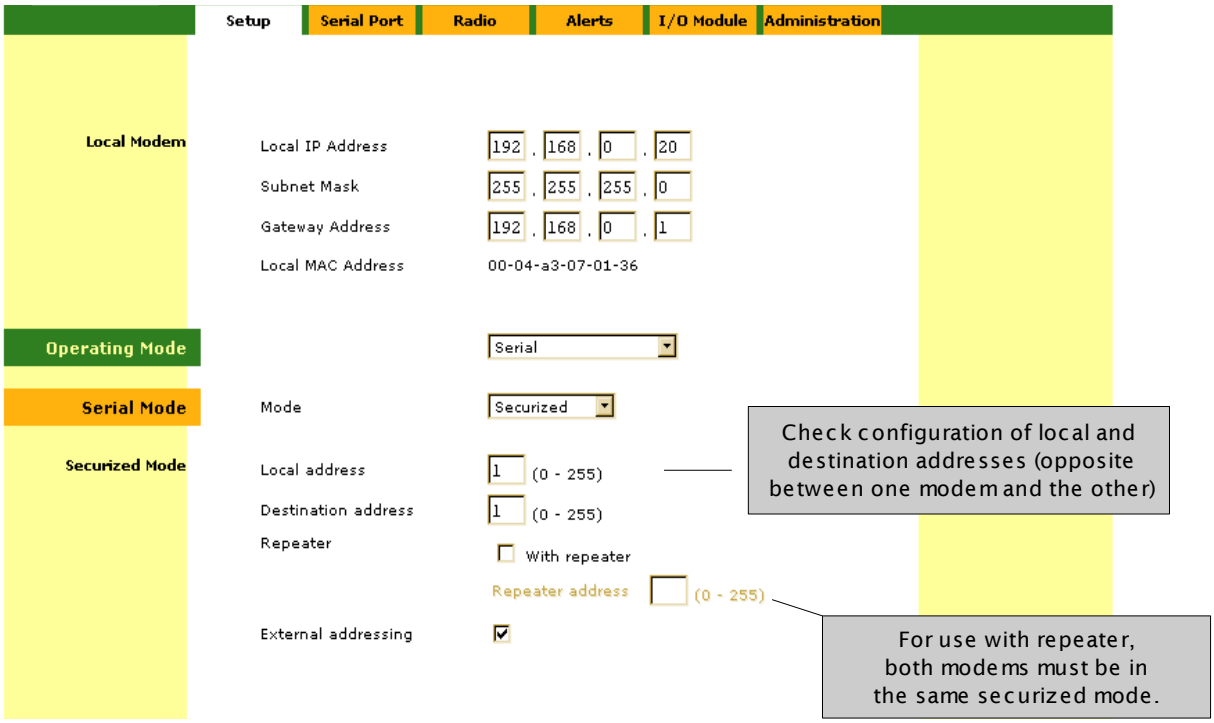


Figure 22: Serial-Securized Mode configuration.

Registers used in AT Command mode:

- Register S00: =01 -> Securized Mode
- Register S05: Securized Mode function selection)
- Register S16: Destination address (Used for 8 or 16 bit addressing)
- Register S17: Destination address (Used for 16-bit addressing)
- Register S18: Local address
- Register S21: Repeater address (Used for 8 or 16-bit addressing)
- Register S22: Repeater address (Used for 16-bit addressing)
- Register S28: Transmission delay time (Default value 2)
- Register S32: Radio frame acknowledge waiting time (0A by default)
- Register S33: Number of frame repetitions in case of error (3 by default)

4.3 MODBUS TCP/MODBUS RTU GATEWAY MODE

The ARM-SE manages the ModBus protocol over several media types:

- Ethernet connection
- RS485 or RS232 serial link
- Radio link

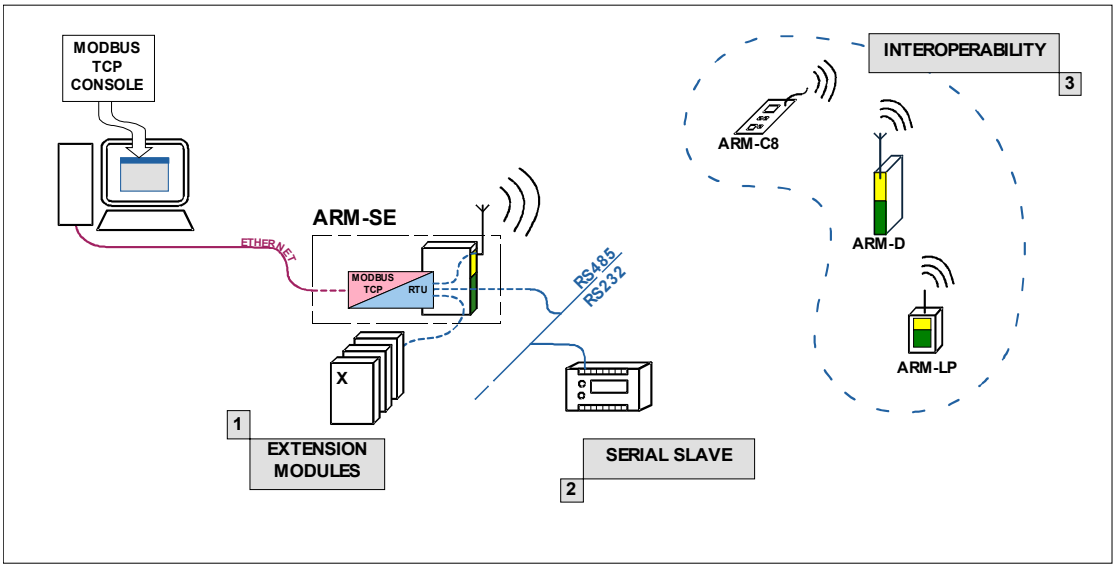


Figure 23: Modbus RTU targets.

For the purposes of making these modes of communication mutually compatible from an Ethernet connection, the ARM-SE incorporates a ModBus TCP/ModBus RTU gateway. The ARM-SE is then seen as a server being interrogated by a ModBus TCP client application. In order to keep memory and performance as high as possible, the user is requested to specify the number of client applications connecting to the ModBus TCP server. If a single endpoint interrogates it, simply select "1" from the "Max Connected Clients" list. (parameter 2 in figure 25).

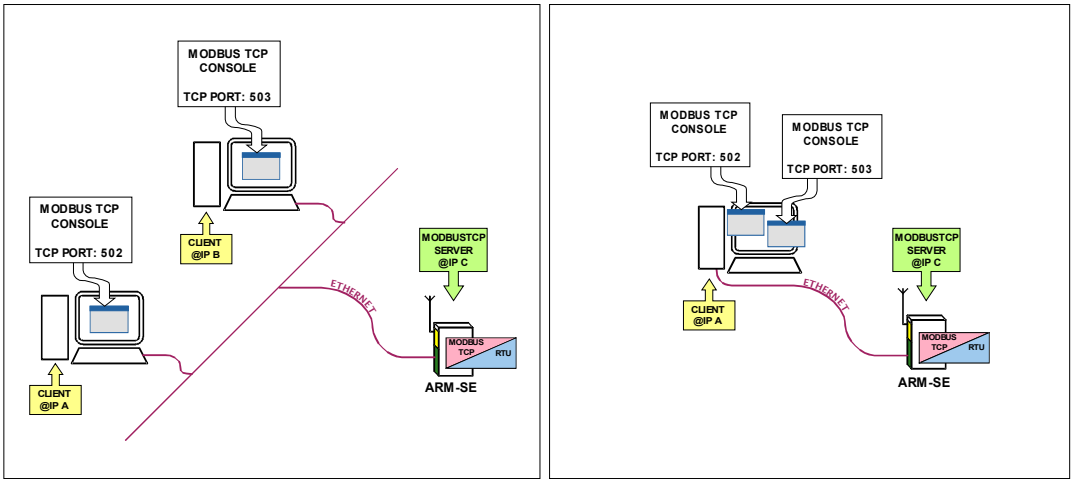


Figure 24: Clients and clients applications in ModBusTCP.

In MODBUS TCP/MODBUS RTU gateway mode, the modem continue to send ethernet frames by radio the frames received on the ethernet port (see why in 4.3.4 Remote ModBusTCP Server). To use the ARM-SE in Server ModBusTCP only, Ethernet frames sending can be desactivated (see parameter 1 figure 25).

The aim of the server (gateway) is to decapsulate the ModBus RTU message contained in an Ethernet ModBus TCP frame. Once decapsulated, the ModBus RTU message is sent to different possible targets (target 1, 2, ou 3 in figure 23 and parameters 3 in figure 25).

The TCP port used by the client must be the same than the port on server side which allow to reach the wished target (see parameter 4 in figure 25). Clients or clients applications are reduced to number of two and must take a different TCP port (which doesn't exclude the interrogation of several ModBusRTU slaves with the same port. See figure 24).

If the target does not respond within a predefined time (see parameter 5 in figure 25), the server sends back a type 11 ModBus exception (cannot communicate with target).

NB: This parameters must match on client side (ModBus TCP console).

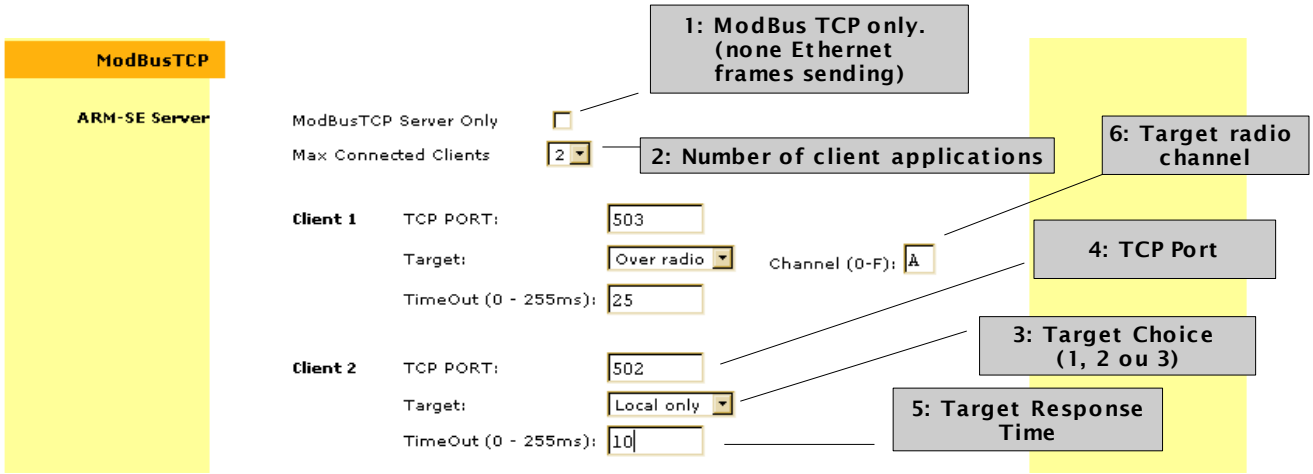


Figure 25: Configuration Serveur ModBusTCP.

4.3.1 Local Target

If the modem is accompanied by extension modules, it is possible to interrogate the status of their inputs/outputs or to look up a list of internal registers specific to the modem (counters, variables, IN and OUT status etc.) from the ModBus console. To find the table of ModBus addresses, see annex B.

4.3.2 Target over serial link

In this mode, the target is connected to the modem's serial link. It is then necessary to specify the type of link (RS485 - RS232 and their parameters) from the "Serial Port" tab of the Web pages.

It's not possible to use a differents serial configuration for each client (configuration of one of serial target port will be the same for both).

4.3.3 Remote target over radio modem

This mode makes it possible to make other modems in the ARM range compatible with the ARM-SE. According to their operating modes it is possible to interrogate them remotely and to access all their functionalities. Remote ARMs can work on another radio channel (paramete 6 figure 25) but must be configured to ModBus mode and have the same radio characteristics (channel number, preamble code activated and radio encryption or not) as the ARM-SE interrogating them.

Figure 26 illustrates this mode.

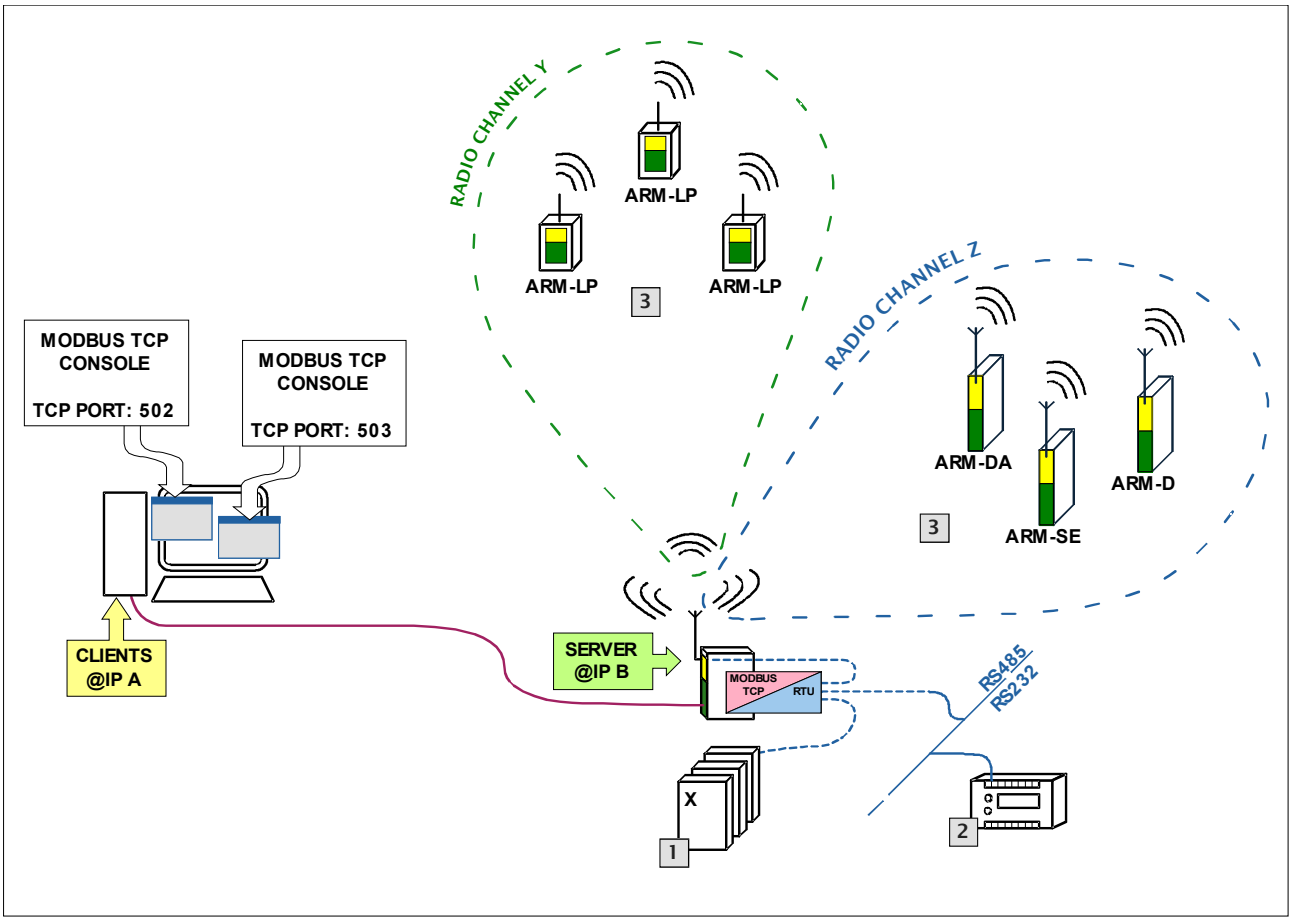


Figure 26: Example of use

4.3.4 Remote Server

It is also possible to access a remote ARM-SE by radio by configuring the ARM-SE connected to the ModBus TCP console to Ethernet mode (transparent mode) or in authorizing ethernet frames sending (parameter 1 in figure 21) and to interrogate the server on the remote modem from the console. The example below illustrates this configuration type.

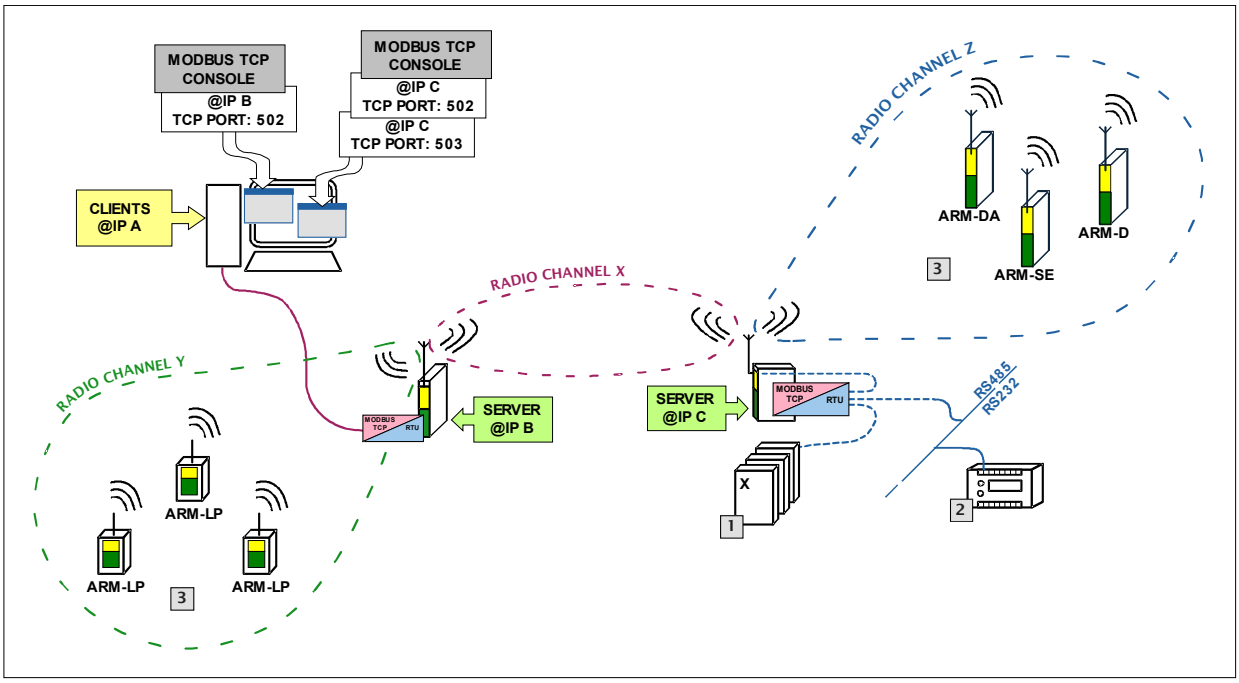


Figure 27: Exemple d'application avec Passerelle Distante.

The example in figure 27 involves interrogating the ARM-LP via ARM-SE @IP B letting pass ethernet traffic by radio (parameter 1 in figure 25 desactivated) to communicate with ARM-SE @IP C and reach ModBusRTU targets. The targets accessed by the local server or remote server are those in the points made above.

4.3.5 Multipoint Servers

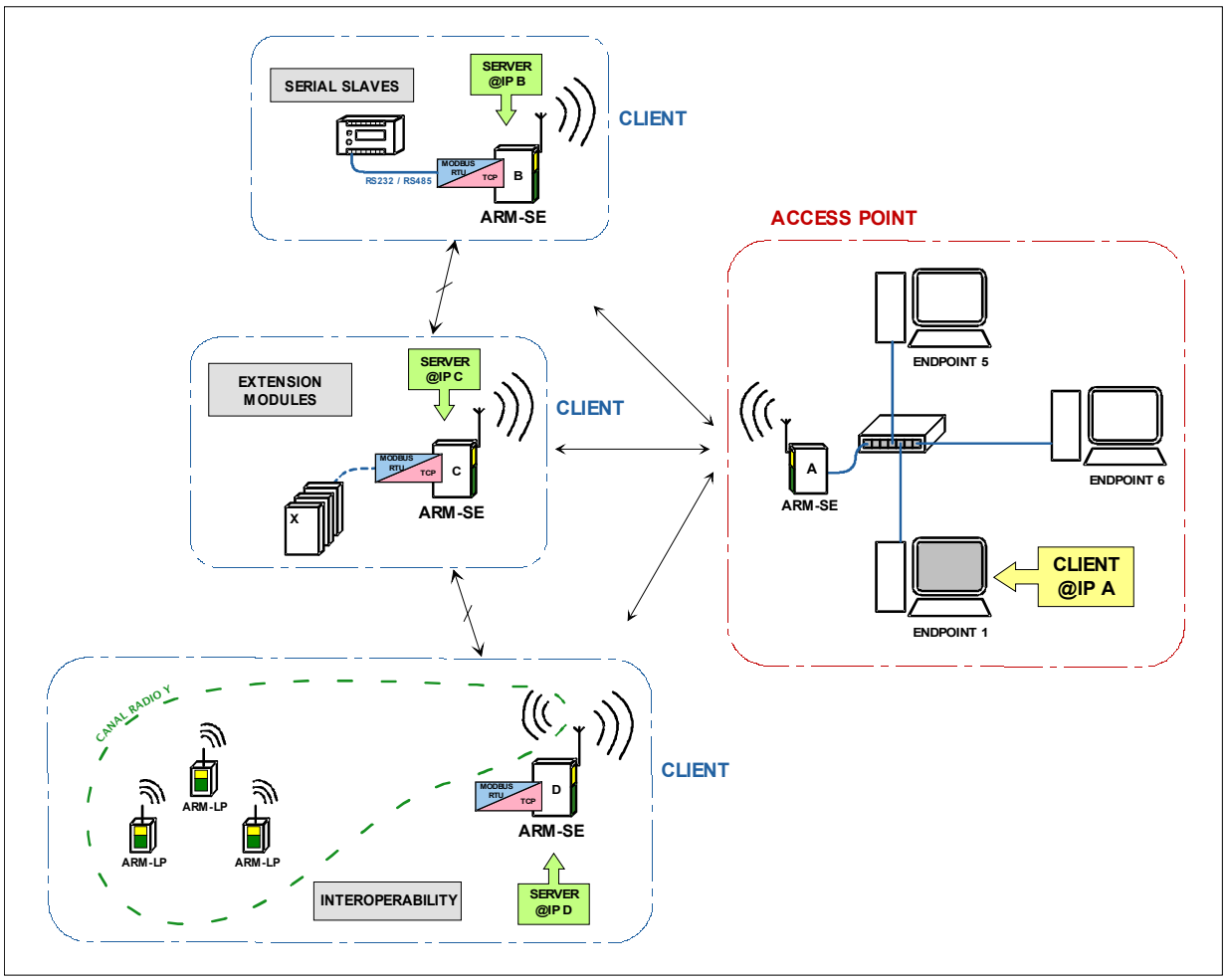


Figure 28: radio network with several ModBusTCP servers.

Like the star type configuration described in paragraph 4.1.3, it is possible to poll several ModBusTCP servers in point-to-multipoint mode from an access point.

N.B.: Be careful not to confuse the notion of radio network client (polled by the access point) with that of the client application, associated with the ModBusTCP server.

Figure 29 shows the configuration for this operating mode which is similar to that described in paragraph 4.1.3 (simple Ethernet mode configuration).

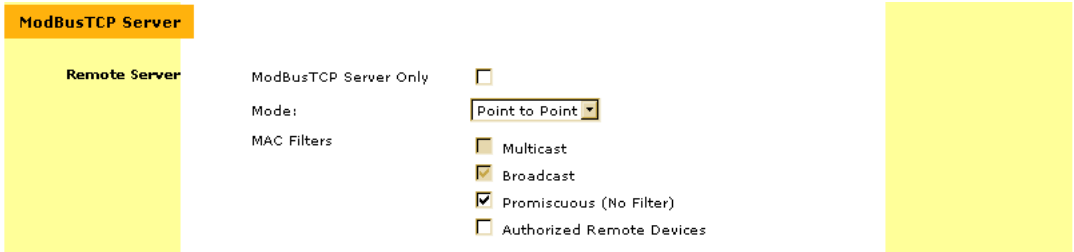


Figure 29: Radio Network configuration

4.3.6 Exceptions

Exceptions are returned by the server to the client when the request has not reached its target or when it has not answered before a particular timeout. The ARM-SE ModBusTCP, just like the ModBus RTU targets, will transmit certain exception types, making it possible to identify the origin of the problem. The illustration shows requests from the server side and from the target side, and table 6 lists the exception types returned by the server in the case of a communication error.

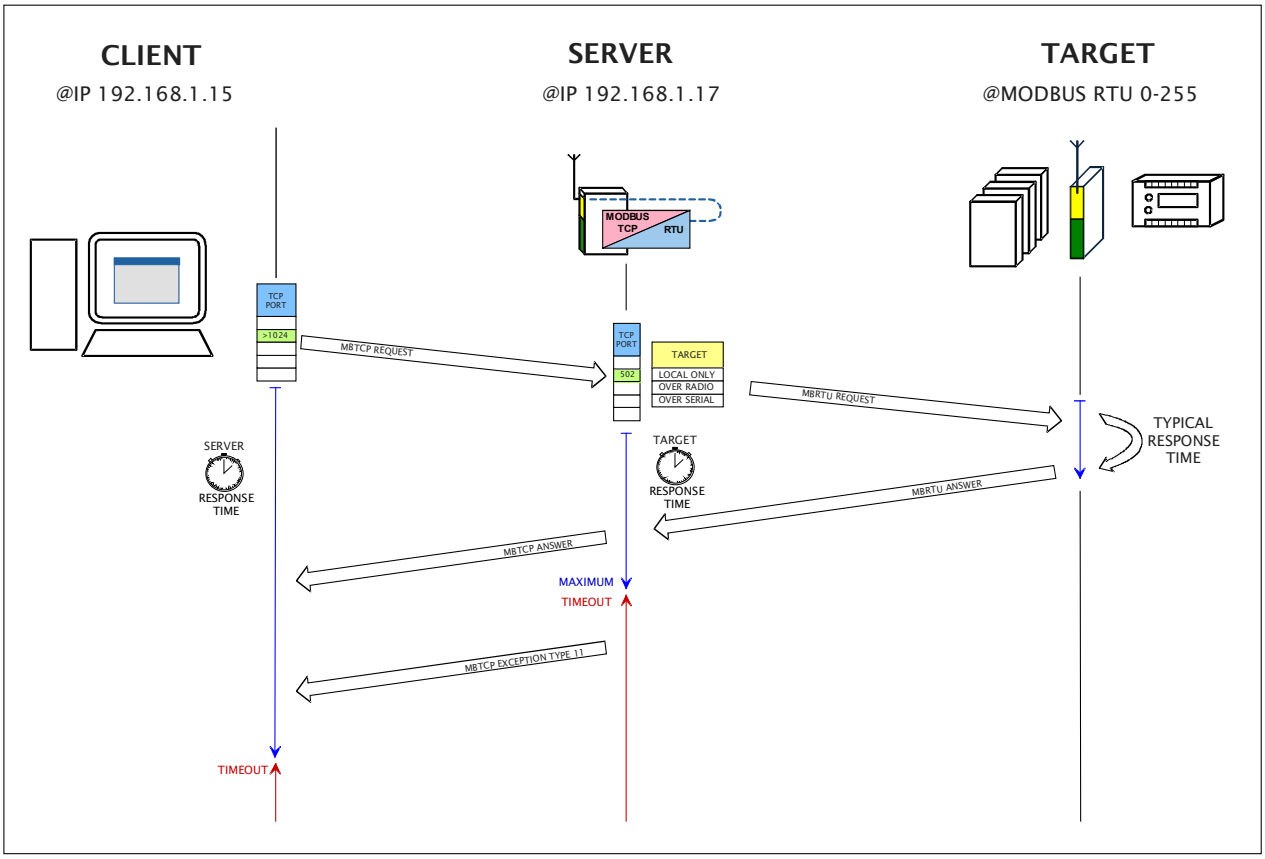


Figure 30: ModBus TCP/ModBus RTU exchanges

MODBUS EXCEPTION	TYPE	DESCRIPTION	SOLUTION
SERVER FAILURE	4	Due to excessive bandwidth, the server is unable to decapsulate the message.	Reduce the number of requests or clients.
ACKNOWLEDGE REQUEST	5	The message has been decapsulated, but the target is asking for time to process the message.	Use a different radio channel (pending release) or increase the maximum target response timeout (parameter 5, figure 21)
SERVER BUSY	6	The server is busy	Exit configuration of the modem by web pages (Exit and Save).
GATEWAY TARGET FAILED	11	The target is not responding.	Check the settings for the target and the settings set out in the previous paragraphs.

Table 6: Exceptions returned by the ModBusTCP server.

4.4 RADIO CONFIGURATION

General information about the radio channels used are given in paragraph 2.1.4 on page 13.

4.4.1 Remember

For FSK type modulation with limited transmission power, ambient noise contained in the system bandwidth forces the receiver to adjust its sensitivity and thus defines the maximum range of the message[1].

The radio data rate thus limits the range and forces the user to choose a radio data rate suited to their system's information rate. The values in table 2 page 13 give the radio ranges for a 19200 bps configuration. Tables 7, 8, 9 rely on the values for an ARM-based link budget and enable calculation of the transmission or non-transmission of information according to the following formula:

$$Transmission\ Power + Antenna\ Gain + Attenuation\ by\ medium > Receiver\ Sensitivity$$

Ideally, the supposed medium is air, in an interference-free environment located within the Fresnel zone.

TRANSMISSION POWER	
5mW	7dBm
25mW	14dBm
500mW	27dBm

Table 7

ATTENUATION BY AIR	
0,5km	-81dBm
1km	-91dBm
2km	-97dBm
3km	-101dBm
4km	-103dBm
5km	-105dBm
6km	-107dBm
7km	-108dBm

Table 8

RECEIVER SENSITIVITY	
4800Bauds	-112dBm
9600Bauds	-110dBm
19200Bauds	-107dBm
38400Bauds	-104dBm
76800Bauds	-101dBm

Table 9

1 $C = B \cdot \log\left[2\pi e \frac{(P + N)}{N}\right]$ Shannon's theorem

C : Channel capacity in Bauds N : Noise power
P : Transmission power B : Bandwidth

Figure 31 illustrates the manner in which these properties are configured using Web pages.

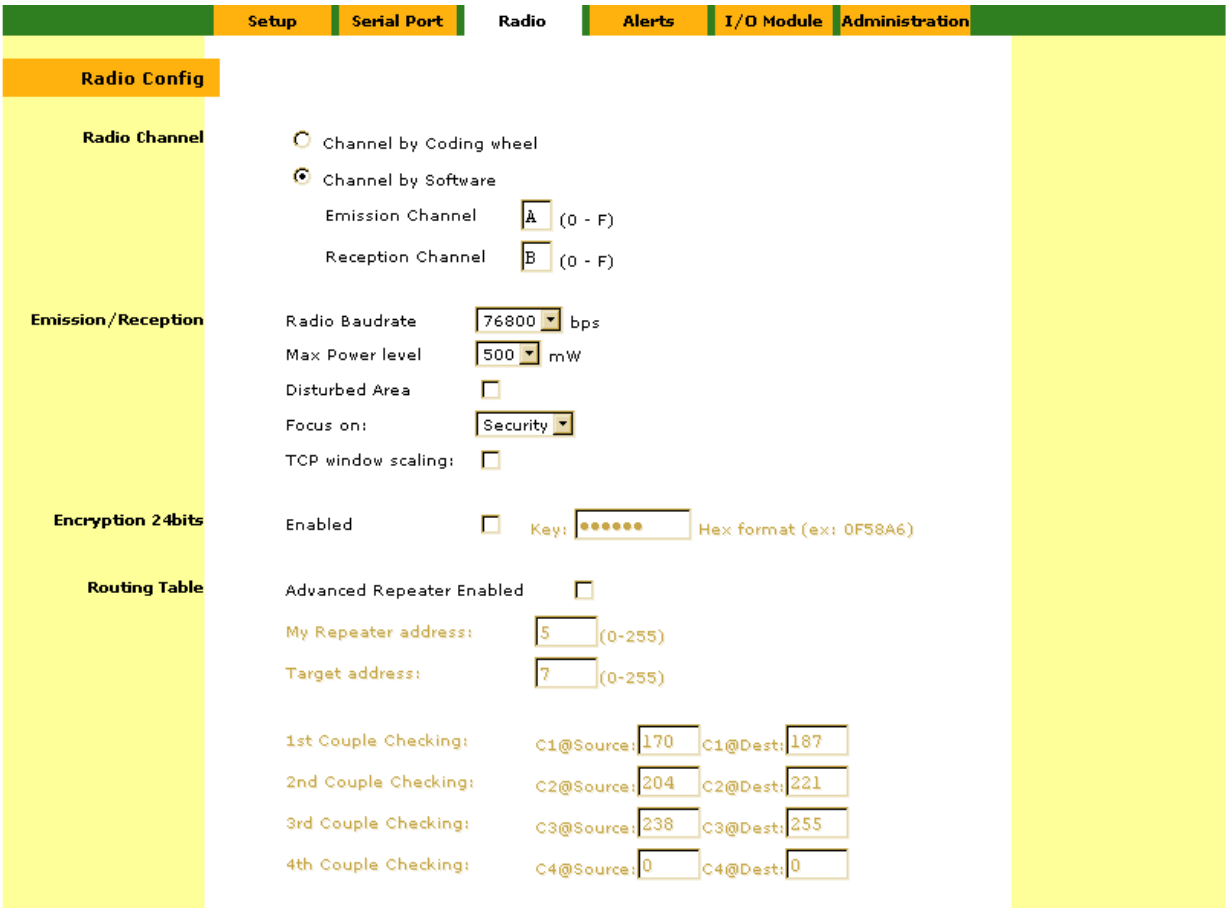


Figure 31: Web page for radio configuration

4.4.2 Choice of transmission – reception channel

When the thumb wheel is used for a purpose other than selecting a radio channel frequency (choice of a test mode for example), attribution of a channel for the transmission and/or[2] reception is possible by software configuration. Once selected, the marking of the thumb wheel is no longer linked to the desired radio channel.

2 Special case of a modem working on two different frequency bands for transmission and reception.

4.4.3 Transmission and reception configuration

- ✔ The radio data rate should be configured according to the desired throughput capacity.
- ✔ The maximum power level only allows the power to be reduced and thus respects the standard values for each channel.
- ✔ The "Disturbed Area" box allows the receiver gain to be reduced in an area of high interference[3].
- ✔ The "Focus On" parameter only appears in "Ethernet" operating mode. It allows emphasis to be placed on either information transfer security (RTS/CTS type short message exchange when sending) or transmission speed (without RTS/CTS). The actual difference in throughput between this two modes is in the order of 30%.
- ✔ The "TCP window scaling" parameter, in Ethernet mode and for communications by TCP protocol, enables the modem buffer size to be considered, rather than the transmitting station buffer size. This parameter may be restrictive in the case of applications managing an additional level of secure encapsulation (e.g. SSL, TLS, etc.).

4.4.4 Radio Encryption

Encryption is intended to make exchanges between two modems secure by encoding the radio frame using a 24-bit rotating key system. The key value for entry is in hexadecimal format (4 digits from 0 to F) and must be the same on each of the modems in communication. Key value "000000" does not encode the frame and automatically deactivates this mode.

4.4.5 Routing Table

This function only appears in "Serial"[4] operation in transparent mode, ModBus mode and mirror mode. It allows information to be sent via repeater modems and according to an address table.

Each modem includes:

- a local address: Modem address on 1 byte
- a destination address: Address of the modem which should receive the message
- 4 pairs of addresses, each comprising:
    - Address of sending modem
    - Address of destination modem

3 High interference: High noise level or interference made by another device or when radio channel is close to used channel.

4 In Serial mode, data packet's size is smaller than ethernet frame's size and allow more propagation delays.

The transmitting modem adds its local address and destination address to the radio frame. Modems receiving the radio frame compare the 2 addresses added to the pairs of configured addresses. If the additional addresses are identical to a configured pair of addresses, the message is recognised by the modem; otherwise the modem does not recognise the radio frame. The modem recognising the message compares the destination address for the message with its local address. If they are identical the message is sent over the serial link; otherwise, the modem returns the message by radio, exchanging the message's local address with its own local address.

Figure 32 shows the operation principle of a modem with repeater and addressing.

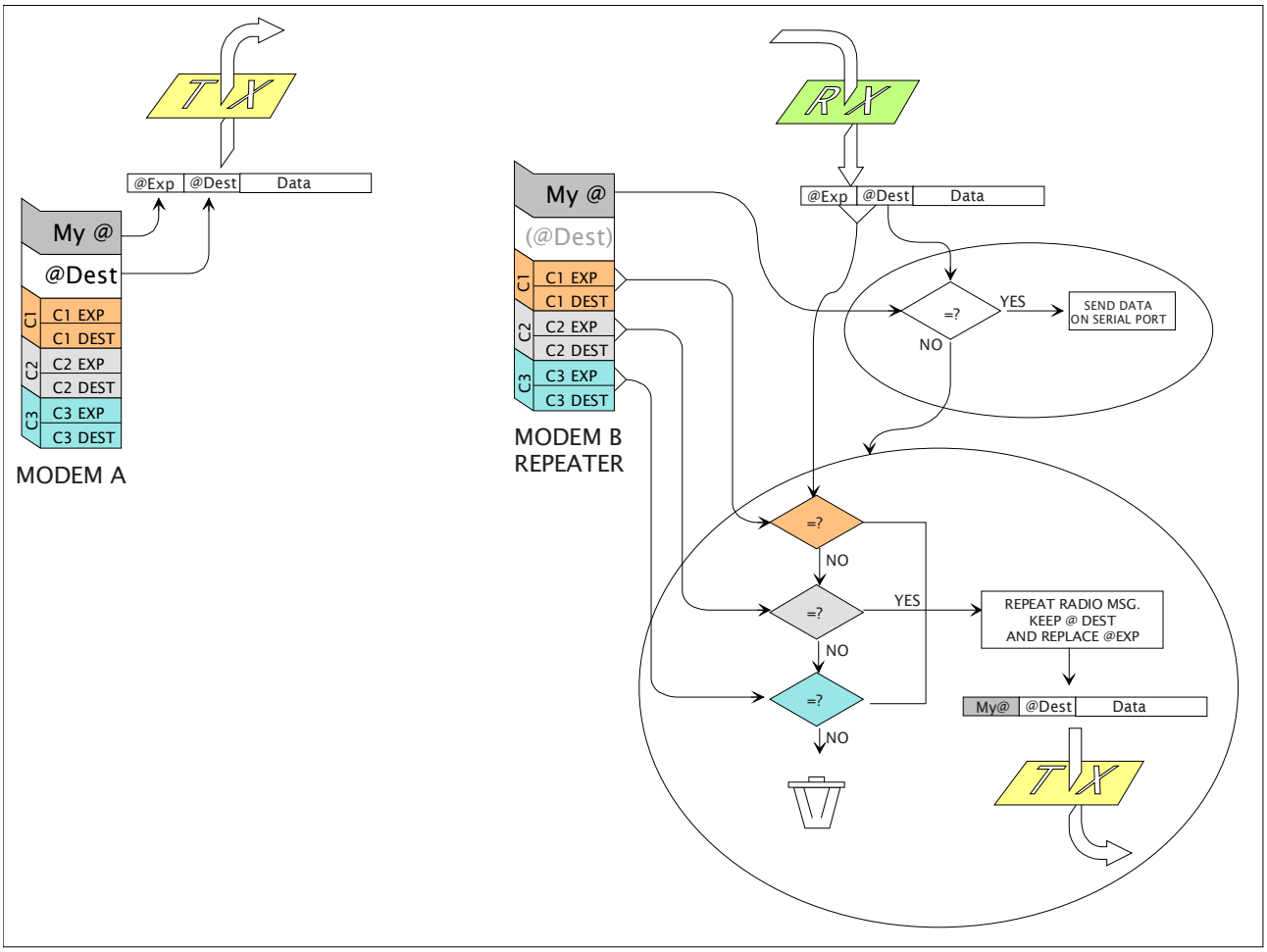


Figure 32: Operating principle of routing table

Figure 33 shows an actual situation where repeaters are used with a routing table:

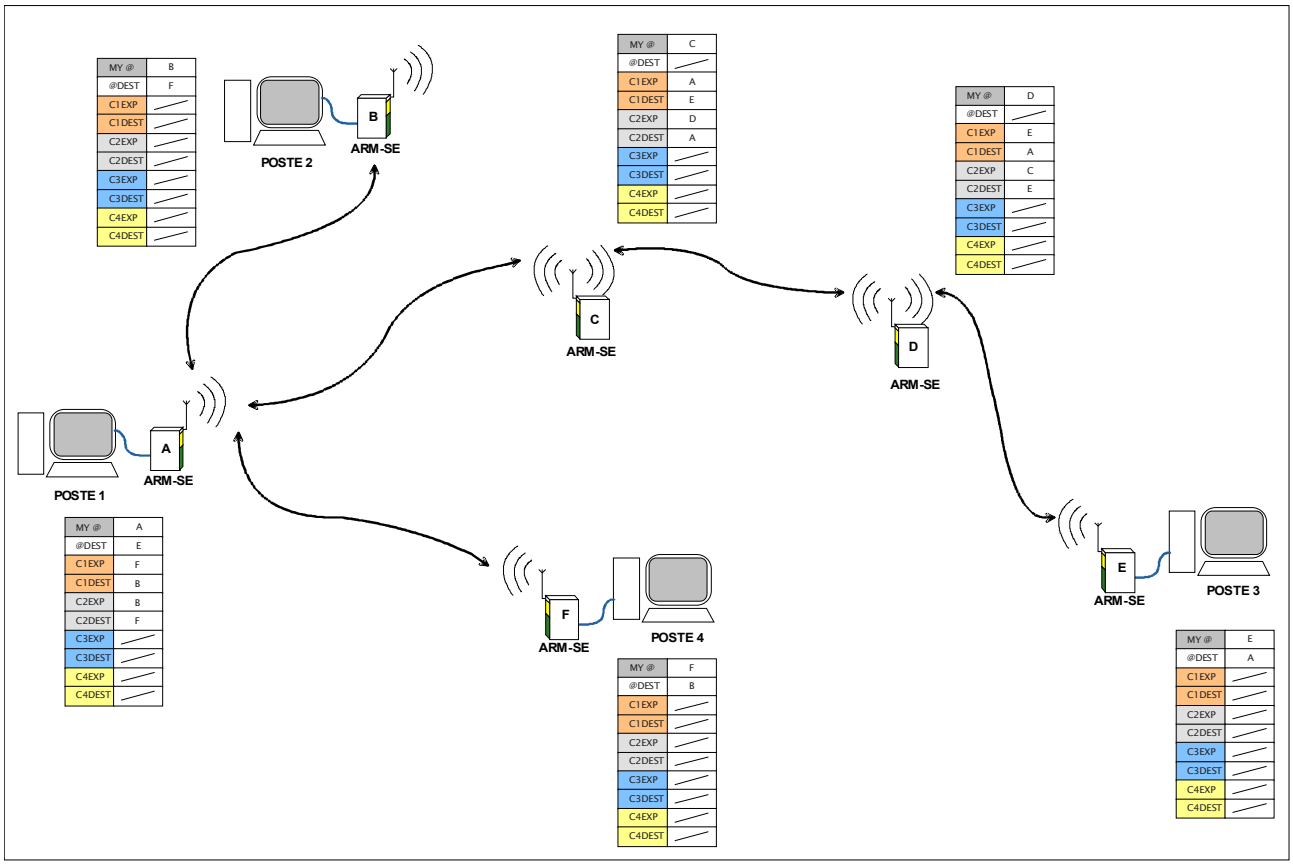


Figure 33: Repeater modems and routing

Registers used in AT Command mode:

- Register S00 Mode confirmation Bit6
- Register S90 local address
- Register S91 destination address
- Register S92: Sender modem address 1
- Register S93: Destination modem address 1
- Register S94: Sender modem address 2
- Register S95: Destination modem address 2
- Register S96: Sender modem address 3
- Register S97: Destination modem address 4

4.5 TEST MODE

The test mode can be activated either via Web pages (requires Flash Player v8 or later), or by "AT" command, or by test jumper (Dip switch 1 to ON and thumb wheel to function code).

4.5.1 Test Mode via Web pages

The Web pages allow the modem to be set to the following test modes:

- "Ping-pong" mode: Allows the quality of communication with the remote modem to be determined. The information shows the quality of the signal and integrity of the messages transmitted from one end to the other
- "Spectrum analyser" mode: Allows ARM-SE spectrum occupancy to be measured.
- "Pure carrier transmission" mode: The modem changes to transmitting a carrier signal without modulation for 30 seconds.

Figure 34: Spectrum Analyser

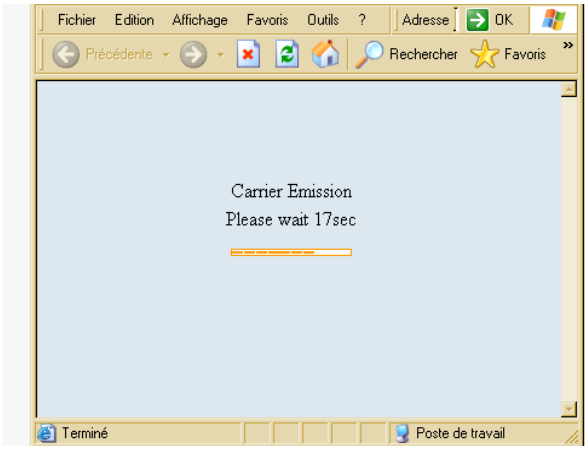


Figure 35: Unmodulated carrier emission

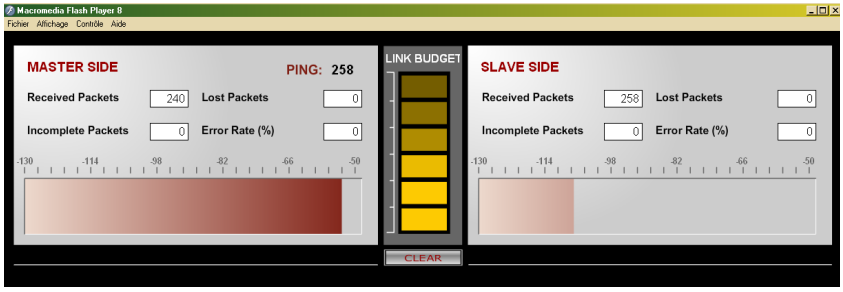


Figure 36: Ping-Pong Test

4.5.2 Test mode by Dip Switch

In test mode by dip switch, the choice of transmission channel is not made using the thumb wheel, but is set in the configuration registers. By default, the test channel is E (869.525 MHz / 500 mW). There is no need to reprogram it each time.

Test 0 (Thumb wheel = 0)	Power LED flashing
Test 1	Looping inputs to outputs
Test 2	Read and send EEPROM configuration over RS232
Test 3	Carrier signal transmission
Test 4	Transmission of numbered frames of 504 ASCII characters every 200 ms
Test 5	Do not use
Test 6	Read RSSI send value over RS232 Bit2 register S49 = 16 channel value (bit=0) Bit2 register S49 = 1 channel value (register3) (bit=1)
Test 7	PING PONG Master Transmission of 250 characters wait to receive 250 characters in response Send number of characters received over RS232
Test 8	PING PONG Slave Await reception of 250 characters then send 250 characters Send number of characters received over RS232 From ARM version 4.0: If reception of 250 good characters: Rx LED flashing (Green) If reception of 1 to 249 char. only: Rx and Sys LEDs flashing If reception of 0 good characters: Sys LED flashing (Red) If no frame received: Rx and Sys LEDs off
Test 9	Do not use
Test A	Do not use
Test B	Bootloader mode
Test C	Serial link parameter reconfiguration: 19200/8/N/1 mode RS232 forced, forcing transparent mode
Test D	Reprogram EEPROM with factory default values
Test E, F	Do not use

Tableau 10: Test Functions (Dip switch 1 down):

5 Watchdog and e-mail alerts:

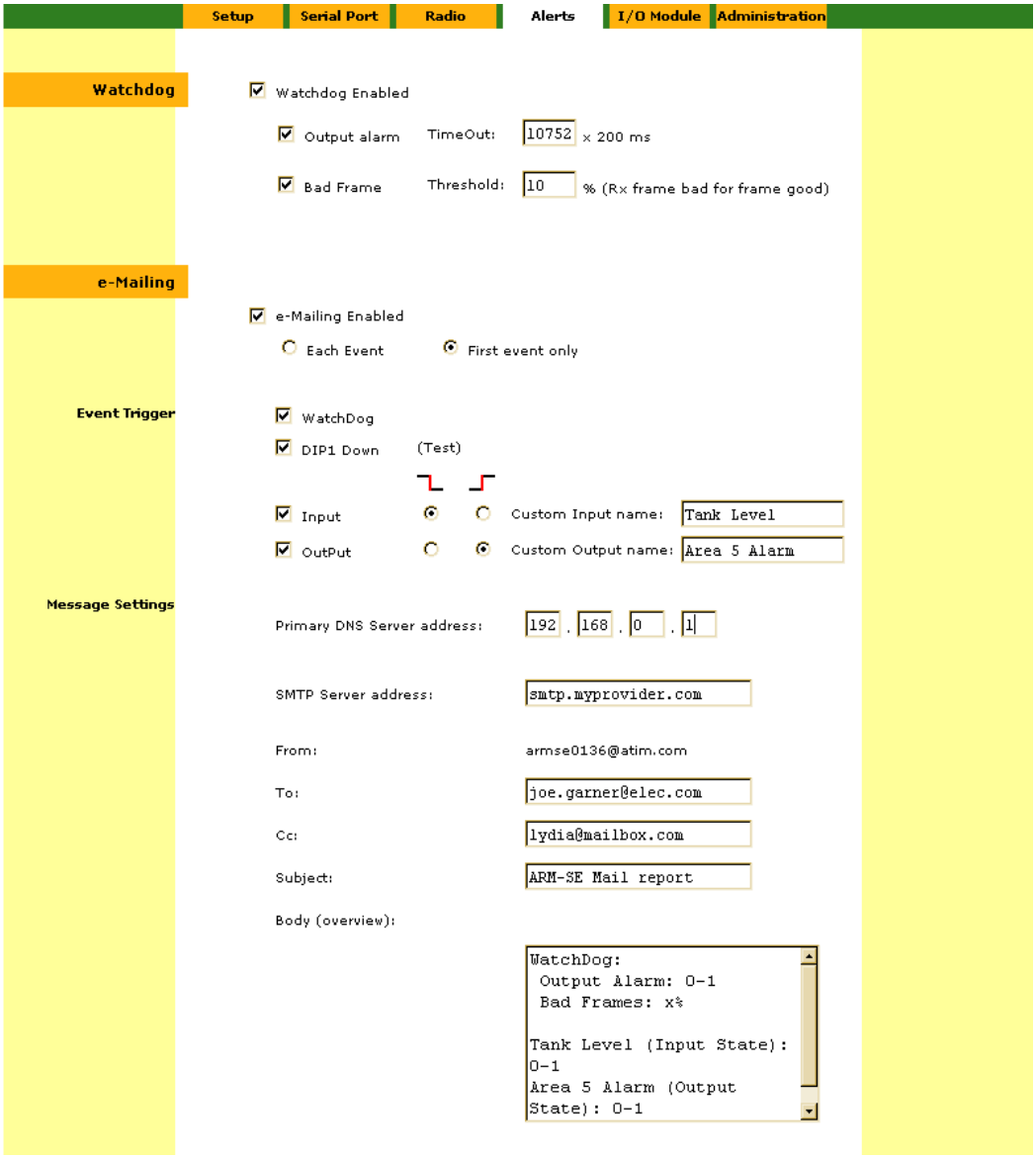


Figure 37: Alerts by watchdog and e-mail.

When the watchdog is enabled, this makes it possible to check the non-reception of a radio frame over a given period of time (timeout) and/or the non-conformity of the message if bad frames exceed a certain percentage of the total frames received. In these cases, modem “Out” is enabled.

When the “e-mailing enabled” box is checked, the modem connects to the outgoing mail server (SMTP) and sends an e-mail with information about the status of a number of parameters. The “Each Event” setting results in an e-mail being sent with every trigger events, whereas “First event only) only sends one single e-mail after the modem has been turned on.

The events which result in e-mail being sent can be selected under “Event Trigger”. These may be:

- from the watchdog (explained above)
- from key 1 of the DIP Switch to the rear of the modem
- from the status (front edge or back edge) of the modem input or output

These settings, along with their status, shall be repeated in the message body and the input or output may be renamed according to user assignment using the button “Owner I/O ID”.

The SMTP server address must be provided (e.g.: smtp.myprov.com) as well as the DNS server address for address resolution by the modem. There is a limit of two e-mail addresses (fields To: and Cc:) and must not exceed 47 characters.

- The message subject is also settable, and cannot exceed 47 characters.

Registers used in AT Command mode:

- Register S52 (LSB) - S53 (MSB): 5s by default (time base: 200 ms)
- Register S02- Bit3: Watchdog alarm confirmation
- Register S01- Bit6: Mother card OUT deactivated (0) if timeout end alarm.

6 UPDATING ARM-SE FIRMWARE:

To keep the ARM-SE firmware (internal software) up to date, the modems include a BootLoader program which enables the main program to be reinstalled.

From the source program file (.HEX format file sent on request) and the LIA Loader Utility software, reinstallation is via the modem's Ethernet connection.

This operation is only permitted under certain conditions and according to the following procedure:

This operation is only permitted under certain conditions and according to the following procedure:

1. Set the thumb wheel located at the rear of the modem to B and set key 1 of the dip switch located below to the down position.
2. Turn on the power. After a few seconds the power LED will flash.
3. Run the LIA Loader Utility application

   NB: In this mode the computer and modem do not need to belong to the same IP address class. The modem's IP address is called Multicast.
4. Click on "Locate LIA". Stage 1 (*LIA Status: 0408*) in figure 38 shows that the modem has been located.
5. In the drop-down list, under "Configure LIA", check that "LIA ID" matches the previously located target.
6. Click on "Capture Target". Stage 2 (*LIA Status: 4408*) in figure 38 shows that the target is captured and the modem's Rx LED lights up.

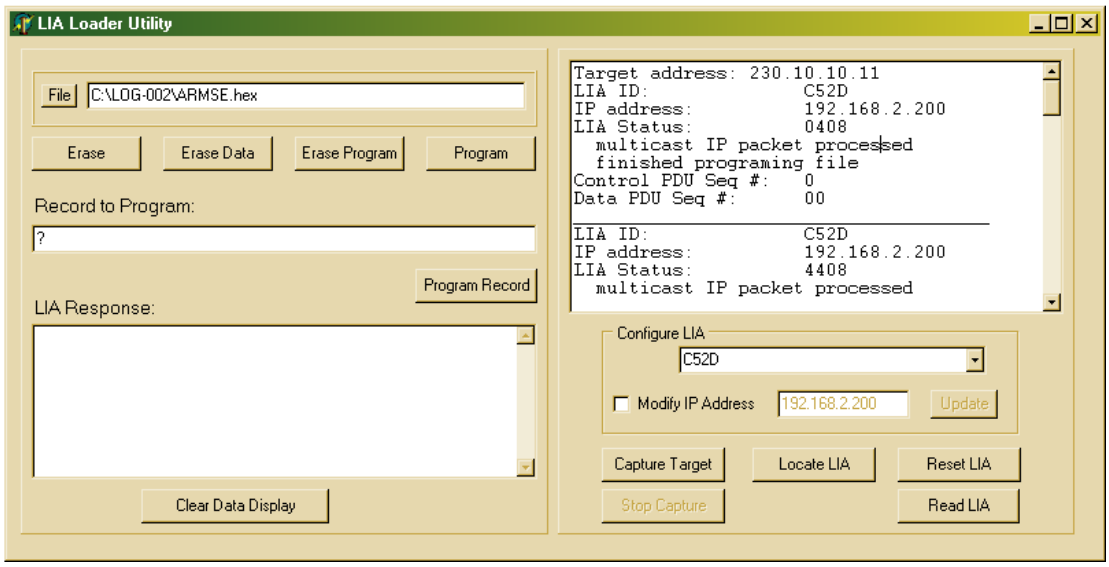


Illustration 38: Target location and capture.

7. Click on "File" and open the .HEX file.
8. Click on "Program". The .hex file is downloaded to the modem and the Rx LED flashes.
9. Download completes and the modem sends the "Programming Complete" message shown in figure 39.

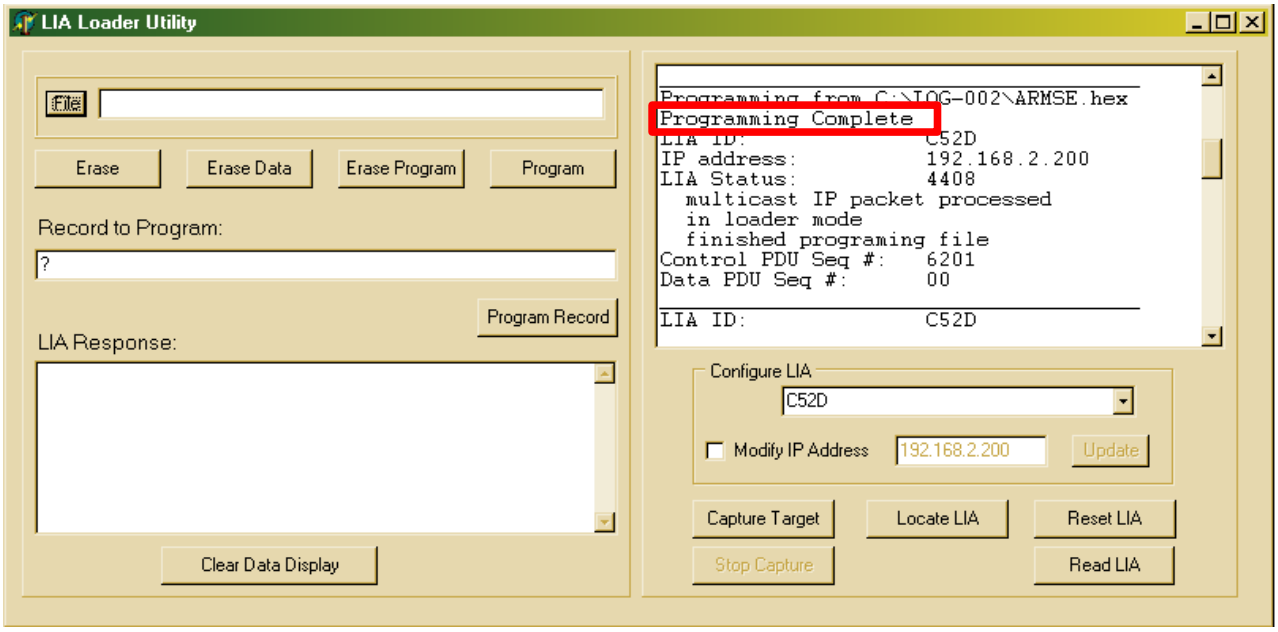


Figure 39: Programming complete

10. Remove the conditions set in stage 1 then re-start the modem by clicking on “Reset LIA”.

Important: When the modem is updated, it automatically returns to the factory settings. It is then necessary to readjust the settings via its Web pages.

ANNEX A – TABLE OF AT COMMANDS –

Command	Function
AT	Prefix required for all “Hayes” commands
O	Change to communication mode (transparent)
&W	Write to EEPROM registers (Apply only if the content has been modified)
&F	Restore default settings and reboot EEPROM.
In	n=0 Boot version n=1 Software version n=2 Card address ID n=3 country code + application code
+++	Return to “Hayes” mode
ATR	Reset
ATDxx	Dial mode (in securized mode) calls remote modem xx (1 – 99)
&T0	Exit test mode
&Tx	Change to test functions x= 1 to 12
Sxx?	Reading register x returns a hexadecimal value (? optional)
Sxx=nn	Write to register xx , nn hexadecimal value

*NOTES: Each command line must end with a “CR” (Carriage Return”)

Hayes commands must be sent to the ARM in the stored UART format (By default: 19200 bps, 8 bits, no parity, 1 or 2 stop bits).

If you have forgotten the last format stored in the ARM, it is possible to return to the default factory settings by using test mode “12” (see paragraph on test mode).

TABLE OF ARM-SE MODEM CONFIGURATION REGISTERS:

Register values are given in hexadecimal format: $xx

No	Register use
S00	Application Register 1: see details
S01	Application Register 2: see details
S02	Application Register 3: see details
S03	Application Register 4: see details
S04	Transparent Mode Application Register: see details
S05	Securized Mode Application Register: see details
S06	ModBus Mode Application Register: see details
S07	Mirror Mode Application Register: see details
S08	Radio Application Register 1: see details
S09	Radio Application Register 2: see details
S10	Serial Link Application Register: see details
S11	Test Mode Application Register: see details
S12	ARM-SE Application Register: see details
S13	Transmission Channel Number: $00 to $0F
S14	Reception channel number: $00 to $0F
S15	Transmission power selection
S16	Securized Mode: Destination address
S17	Do not use: Must equal $00
S18	MODBUS Mode and Securized Mode Local address
S19	Mirror mode: Local address
S20	Mirror Mode: Destination address
S21	Securized Mode: Repeater address
S22	Do not use: Must equal $00
S23	Serial link transmission speed $00=1200; $01=2400; $02=4800; $03=9600; $04=19200; $05=38400; $06=76800; $07=115200
S24	Number of serial link data bits: $07 or $08
S25	Serial link parity: $00 no parity $01 odd parity $03 even parity

S26	Serial link Stop Bit number = 1
S27	Serial link flow control: bit0: = 0 no control; = 1 CTS/RTS Bit6 (manual control): = 0 RS232; =1 RS485 Bit7: = 1 confirmation of serial link manual control
S28	Radio transmission delay time Waiting time automatically set in serial link Baud Rate Restarts each time a byte is received via the serial link
S29	Transmission end wait time Waiting time corresponding to number of stop bits sent (Time base: 312 µs at 19200 b/s) Restarts each time a byte is received via the serial link
S30	Do not use
S31	Do not use
S32	Securized Mode: Frame ACK waiting time Time base: 10 ms Default value: $0A
S33	Securized Mode: Select number of consecutive retransmissions of radio frame if error detected. $03
S34	Do not use
S35	Do not use
S36	Do not use
S37	Do not use
S38	Do not use
S39	Do not use
S40	Do not use
S41	Do not use
S42	RSSI threshold for radio reception control by SYS LED
S43	Do not use
S44	Do not use
S45	Radio Code 1 for radio frame encoding
S46	Radio Code 2 for radio frame encoding
S47	Radio Code 3 for radio frame encoding
S48	Preamble Code
S49	Do not use
S50	Do not use
S51	Do not use
S52	Do not use
S53	Securized Mode: ASCII ACK code returned on RS232

S54	Securized Mode: ASCII NACK code returned on RS232
S55	Do not use
S56	Test Mode: Control register
S57	Test Mode: Transmission delay
S58	Test Mode: Transmission delay
S59	Alarm: Delay to allow non-detection of radio reception (tb: 200 ms) (LSB)
S60	Alarm: Delay to allow non-detection of radio reception (tb: 200 ms) (MSB)
S61	Do not use
S62	Do not use
S63	Do not use
S64	Do not use
S65	Do not use
S66	Do not use
S67	Do not use
S68	Do not use
S69	Do not use
S70	Do not use
S71	Do not use
S72	Do not use
S73	Do not use
S74	Do not use
S75	Do not use
S76	Do not use
S77	Do not use
S78	Do not use
S79	Do not use
S80	Do not use
S82	Do not use
S83	Do not use
S84	Do not use
S85	Do not use
S86	Do not use
S87	Do not use
S88	Do not use

S89	Do not use
S90	Local Repeater Address
S91	Destination Repeater Address
S92	Repeater Address 1: Receiver address
S93	Repeater Address 1: Destination address
S94	Repeater Address 2: Receiver address
S95	Repeater Address 2: Destination address
S96	Repeater Address 3: Receiver address
S97	Repeater Address 3: Destination address
S98	Do not use
S99	Paging register
S00	PAGE 1: Do not use
S01	PAGE 1: Do not use
S02	PAGE 1: Do not use
S03	PAGE 1: Do not use
S04	PAGE 1: Do not use
S05	PAGE 1: Do not use
S06	PAGE 1: Do not use
S07	PAGE 1: Do not use
S08	PAGE 1: Do not use
S09	PAGE 1: Test function delay (LSB) (tb:10 ms)
S10	PAGE 1: Test function delay (MSB) (tb:10 ms)

Application Register 1: S00

b0 – b3:

0 Transparent Mode

1 Securized Mode

2 ModBus Mode

3 Single master Mirror Mode

4 Multiple master Mirror Mode

5 Slave Mirror Mode

6 Slave Mirror Mode

7 Programming Mode

8 Do not use

9 Permanent radio reception Forcing Transparent Mode

A Permanent radio transmission Forcing Transparent Mode

b4: Repeater mode

b5: Repeater mode with data return over serial link

b6: Repeater mode with Addressing and routing

b7: Do not use

Application Register 2: S01

b0: Do not use

b1: Do not use

b2: Do not use

b3: Do not use.

b4: Do not use

b5: Do not use

b6: Alarm: Confirm ARM-SE card output if watchdog triggered

b7: Do not use

Application Register 3: S02 (Formerly register S34 on ARM-S)

b0: =1 Do not change

b1: Alarm: Permit Reset on second alarm trigger.

b2: Configuration Mode: Register configuration for ARM-SE (1) or ARM-S (0)

b3: Alarm: Watchdog authorisation

b4: Radio: Frequency selection by thumb wheel (0) or by register (1)

b5: Do not use

b6: Alarm: Modem factory reconfiguration authorisation

b7: Radio: Hamming Code error control function authorisation

Application Register 4: S03

b0: Do not use

b1: Do not use

b2: Do not use

b3: Do not use

b4: Alarm: Alarm output status inverted by default

b5: Do not use

b6: Do not use

b7: Radio: Radio preamble length selection by internal register

Transparent Mode Application Register: S04

b0: Do not use

b1: Do not use

b2: Transmit priority (0) receive priority (1)

b3: Do not use

b4: Do not use

b5: Do not use

b6: Do not use

b7: Do not use

Securized Mode Application Register: S05

b0: External address mode selection

b1: Do not use

b2: Do not use

b3: Authorise to return predefined ASCII code over serial link following radio frame return

b4: Authorise to stop return of radio frame for error management

b5: External addressing on bytes (0) or Word (1)

b6: External addressing: return destination address over serial link

b7: Do not use

ModBus Mode Application Register: S06

b0 - b7: Do not use

Mirror Mode Application Register: S07

b0 to b7: Do not use

RADIO Application Register 1: S08

b0: Channel busy before transmission detection function

b1: Do not use

b2: Reception sensitivity attenuation (Around -8 dB)

b3: Do not use

b4: Carrier signal present detection threshold

b5: Carrier signal present detection threshold

b6: Do not use

b7: Do not use

Carrier signal present detection threshold:

At 19200 b/s: 00 = -107 dBm; 01 = -91 dBm; 02 = -72 dBm

At 9600 b/s: 00 = -104 dBm; 01 = -95 dBm; 02 = -77 dBm

RADIO Application Register 2: S09

b0: RSSI function selection function

b1: Preamble code confirmation

b2: Reception attenuation -2 dB

b3: Radio frame 24-bit encoding confirmation

b4: Radio Configuration

b5: Radio Configuration

b6: Radio frequency configuration

b7: Radio frequency configuration

Radio Configuration

00: 868 MHz 19200 baud

01: 868 MHz 9600 baud

Radio frequency

00: 868 MHz

Serial Link Application Register: S10

b0: Do not use

b1: DTR Signal Control function

b2: RTS and CTS signal control function for radio transmission

b3 - b7: Do not use

DSR Signal Control function over serial link:

- 0: Indicates modem availability in Transparent mode (Active at 0 (RS232 level))
- 1: Constantly indicates occupation status of radio channel (Active at 1 (RS232 level))

DTR Signal Control function over serial link:

- Permits modem radio communication (Active at 1 (RS232 level))

RTS and CTS signal control for radio transmission

- RTS input allows confirmation of radio reception (Reception confirmed level 1 RS232)
- The CTS output is active during radio reception

Test Mode Application Register: S11

b0 - b7: Do not use

ARM-SE Application register: S12

b0: Ethernet mode

b1: serial mode

b2: Do not use

b3: Test mode

b4: Do not use

b5: Do not use

b6: Do not use

b7: Do not use

Warning:

Any modification to configuration parameters (in AT mode) leads to a modification of the program currently running. If inconsistent data are stored, malfunctions may be experienced. It is therefore preferable to use the ARM-MANAGER utility if possible, which avoids this kind of conflict.

ANNEX B – MODBUS ADDRESSES –

Note 1: Read-Write across several registers

Values are given in hexadecimal format.

ModBus address	Card Position or Not Used (n.u.)	Designation	Read Function	Write Function	Note 1
$0000	Mainboard	Logical input	x		No
$0001 - $000F	n.u.				
$0010	Mainboard	Logical output	x	x	No
$0011 - $001F	n.u.				
$0020	Mainboard	Analogue Input	x		No
$0021 - $002F	n.u.				
$0030	Mainboard	Analogue Output	x	x	No
$0031 - $003F	n.u.				
$0040 - $0041	Mainboard	Counter	x	x	No
$0042 - $0043	ARM-D	Counter	x	x	No
$0042 ($0044) - $004F	n.u.				
$0050	Mainboard	Clear buffer address $600-$6FF Write code $A7B5		x	No
$0051 - $009F	n.u.				
$00A4 - $00F5	Mainboard	EEPROM register System Configuration	x	x	No
$00F6 - $00FE	n.u.				
$00FF	Mainboard	Reset Modem Data=$A7B5 (-22603)			
$0100	Extension card 1	Logical input	x		No
$0101 - $010F	n.u.				
$0110	Extension card 1	Logical output	x	x	No
$0111 - $011F	n.u.				
$0120 - $012F	Extension card 1	Analogue Input	x		No
$0130 - $013F	Extension card 1	Analogue Output	x	x	No
$0140 - $0143	n.u.				
$0144 - $017F	n.u.				
$0180 - $01FF	Extension card 1	EEPROM Register Extension Card Configuration	x	x	No
$0200	Extension card 2	Logical input	x		No
$0201 - $020F	n.u.				

$0210	Extension card 2	Logical output	x	x	No
$0211 - $021F	n.u.				
$0220 - $022F	Extension card 2	Analogue Input	x		No
$0230 - $023F	Extension card 2	Analogue Output	x	x	No
$0240 - $0243	n.u.	16-bit counter	x	x	No
$0244 - $027F	n.u.				
$0280 - $02FF	Extension card 3	EEPROM Register Extension Card Configuration	x	x	No
$0300	Extension card 3	Logical input	x		No
$0301 - $030F	n.u.				
$0310	Extension card 3	Logical output	x	x	No
$0311 - $031F	n.u.				
$0320 - $032F	Extension card 3	Analogue Input	x		No
$0330 - $033F	Extension card 3	Analogue Output	x	x	No
$0340 - $034F	n.u.	16-bit counter	x	x	No
$0360 - $037F	n.u.				
$0380 - $03FF	Extension card 4	EEPROM Register Extension Card Configuration	x	x	No
$0400	Extension card 4	Logical input	x		No
$0401 - $040F	n.u.				
$0410	Extension card 4	Logical output	x	x	No
$0411 - $041F	n.u.				
$0420 - $042F	Extension card 4	Analogue Input	x		No
$0430 - $043F	Extension card 4	Analogue Output	x	x	No
$0440 - $044F	n.u.	16-bit counter	x	x	No
$0460 - $047F	n.u.				
$0480 - $04FF	Extension card 4	EEPROM Register Extension Card Configuration	x	x	No
$0500	Extension card 1	Control register	x	x	Yes
$0501	Extension card 2	Control register	x	x	Yes
$0502	Extension card 3	Control register	x	x	Yes
$0503	Extension card 4	Control register	x	x	Yes
$0504	Extension card 1	Filtered Logical Inputs	x	x	Yes
$0505	Extension card 2	Filtered Logical Inputs	x	x	Yes

$0506	Extension card 3	Filtered Logical Inputs	x	x	Yes
$0507	Extension card 4	Filtered Logical Inputs	x	x	Yes
$0508	Extension card 1	Stored Logical Inputs	x	x	Yes
$0509	Extension card 2	Stored Logical Inputs	x	x	Yes
$050A	Extension card 3	Stored Logical Inputs	x	x	Yes
$050B	Extension card 4	Stored Logical Inputs	x	x	Yes
$050C	Extension card 1	Logical outputs	x	x	Yes
$050D	Extension card 2	Logical outputs	x	x	Yes
$050E	Extension card 3	Logical outputs	x	x	Yes
$050F	Extension card 4	Logical outputs	x	x	Yes
$0510	Extension card 1	Logical Outputs Command to 1	x	x	Yes
$0511	Extension card 2	Logical Outputs Command to 1	x	x	Yes
$0512	Extension card 3	Logical Outputs Command to 1	x	x	Yes
$0513	Extension card 4	Logical Outputs Command to 1	x	x	Yes
$0514	Extension card 1	Logical Outputs Command to 0	x	x	Yes
$0515	Extension card 2	Logical Outputs Command to 0	x	x	Yes
$0516	Extension card 3	Logical Outputs Command to 0	x	x	Yes
$0517	Extension card 4	Logical Outputs Command to 0	x	x	Yes
$0518	Extension card 1	Logical Outputs Flashing	x	x	Yes
$0519	Extension card 2	Logical Outputs Flashing	x	x	Yes
$051A	Extension card 3	Logical Outputs Flashing	x	x	Yes
$051B	Extension card 4	Logical Outputs Flashing	x	x	Yes
$051C - $051F	Extension card 1	Analogue Input Output 1 to 4	x	x	Yes
$0520 - $0523	Extension card 2	Analogue Input Output 1 to 4	x	x	Yes
$0524 - $0527	Extension card 3	Analogue Input Output 1 to 4	x	x	Yes
$0528 - $052B	Extension card 4	Analogue Input Output 1 to 4	x	x	Yes
$052C - $0533	Extension card 1	32-bit counter logical inputs 1 to 4	x	x	Yes

$0534 - $053B	Extension card 1	32-bit counter logical inputs 5 to 8	x	x	Yes
$052C - $0533	Extension card 1	32-bit counter logical inputs 1 to 4	x	x	Yes
$0534 - $053B	Extension card 1	32-bit counter logical inputs 5 to 8	x	x	Yes
$052C - $0533	Extension card 1	32-bit counter logical inputs 1 to 4	x	x	Yes
$0534 - $053B	Extension card 1	32-bit counter logical inputs 5 to 8	x	x	Yes
$052C - $0533	Extension card 1	32-bit counter logical inputs 1 to 4	x	x	Yes
$0534 - $053B	Extension card 1	32-bit counter logical inputs 5 to 8	x	x	Yes
$0600 - $0607	Extension card 1	Filtered Logical Inputs	x	x	Yes
$0608 - $060F	Extension card 2	Filtered Logical Inputs	x	x	Yes
$0610 - $0617	Extension card 3	Filtered Logical Inputs	x	x	Yes
$0618 - $061F	Extension card 4	Filtered Logical Inputs	x	x	Yes
$0620 - $0627	Extension card 1	Logical outputs	x	x	Yes
$0620 - $0627	Extension card 2	Logical outputs	x	x	Yes
$0620 - $0627	Extension card 3	Logical outputs	x	x	Yes
$0620 - $0627	Extension card 4	Logical outputs	x	x	Yes
$0600 - $63F	16-bit register for each logical input of extension cards				
Control register					
b0	MGREG1	R/W	Delete stored entry		
b1	MGREG1	R/W	Clear input 1 counter		
b2	MGREG1	R/W	Clear input 2 counter		
b3	MGREG1	R/W	Clear input 3 counter		
b4	MGREG1	R/W	Clear input 4 counter		
b5	MGREG1	R/W			
b6	MGREG1	R/W			
b7	MGREG1	R/W			

b8	MGREG2	R	Counter running			
b9	MGREG2	R	Flash LED running			
b10	MGREG2	R	Time-Out ON			
b11	MGREG2	R	Input 1 analogue threshold ON			
b12	MGREG2	R	Input 2 analogue threshold ON			
B13	MGREG2	R	Input 3 analogue threshold ON			
b14	MGREG2	R	Input 4 analogue threshold ON			
b15	MGREG2	R	Specific function flag			