



A^{RF53} Data modem



User Guide

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About this document

This guide describes the A^{RF53} devices, their options and accessories.

Compliance to FCC US/CAN

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures :

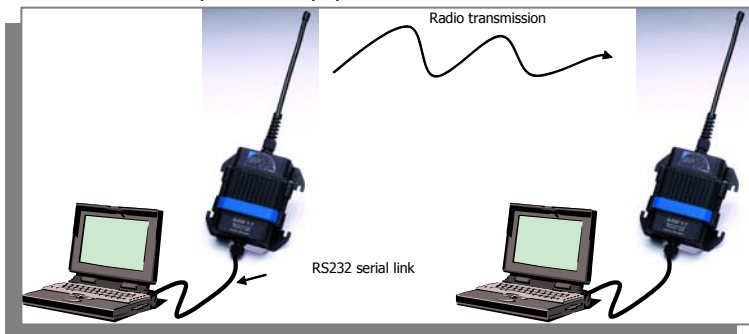
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY ADEUNIS RF COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

RF Exposure Warning: During operation, the user may keep a minimum separation distance of 20 cm with the RF devices.

Overview

The modem converts data from a serial link into a radio frame to be sent to a similar piece of equipment.

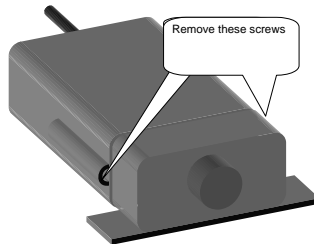


The operating parameters of these modems (serial link, radio management...) can be updated through commands on the serial link.

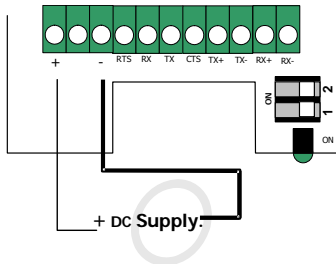
The products are available either in card version to be integrated in an assembly or as an IP65 chip. In the IP65 case, the products are fixed with the fixing lugs onto the top (antenna) and bottom (stuffing box) of the casing (4 screws not provided).

Product Power supply

To perform wiring of these products, the bottom part of the housing (part with stuffing box) has to be opened by unscrewing the two stainless steel screws on each side.



The ARF53 range products are supplied from a DC voltage source. This voltage source must be 4,5V minimum and must not exceed 36 Vdc. Green LED is ON when powered.



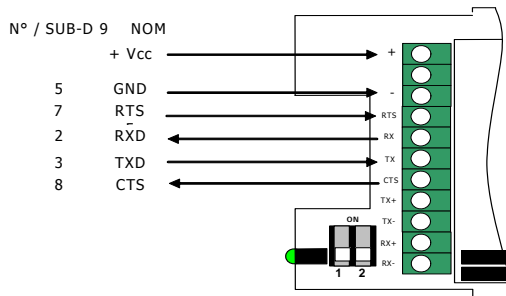
EASY CHECK

Green LED is ON when modem is powered.

Serial link wiring

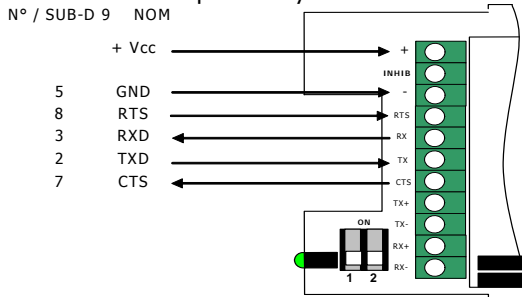
MODEM / DTE RS232

This is for example the case of a modem connected to a PC. RTS and CTS are required only if flow control is used.



DCE RS232

This is for example the case of a modem connected to a measuring device. RTS and CTS are required only if flow control is used.

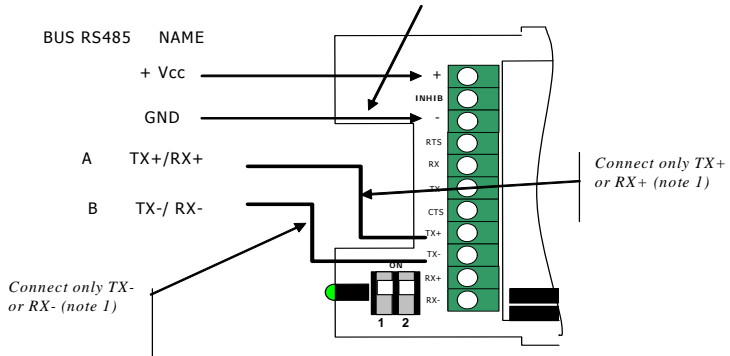


EASY CHECK

Serial link activity will make the green LED flashing, whatever the selected data rate is right or wrong.

RS485 wiring

The RS485 bus wiring needs only two wires (TX+ is connected to RX+ and TX- is connected to RX- on the PCB)



Note 1:

- TX- is connected to RX- on the PCB
- TX+ is connected to RX+ on the PCB

Figure 1: RS485 wiring

In order to activate the RS485 management the SW1.1 switch MUST be ON and the S215 value MUST be 1 (see the following table).

WARNING

the SW1.1 switch is read only at the power-up. Changing the SW1.1 switch when the modem is already running will not be taken in account.

S215 values	SW1.1	Note
1	ON	RS485 control lines management
1	OFF	RS232 configuration
0	ignoré	RS232 configuration

Table 1: R485/232 configuration settings

By default the DE and RE lines are asserted LOW, allowing receiving character from the RS485 differential bus. The DE and RE lines are asserted HIGH only when one or several characters have to be transmitted over the RS485 differential bus: when a radio frame is demodulated, the lines are asserted HIGH and then the data extracted from the radio frame are sent to the module TXD line and therefore to the RS485 differential bus. When the last character has been transmitted over the RS485 differential bus, the lines are asserted LOW.

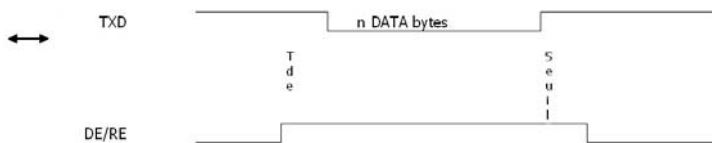


Figure 2 : DE/RE timing when data are sent over the serial link

Threshold: minimum = 1 μ s

Tde: set according to the S219 register value (see table hereafter)

S219	0	1	2	3	4	5	10	20	40	60	80
Tde min	15 μ s	35 μ s	65 μ s	135 μ s	150 μ s	190 μ s	330 μ s	600 μ s	1,1 ms	1,7 ms	2,3 ms

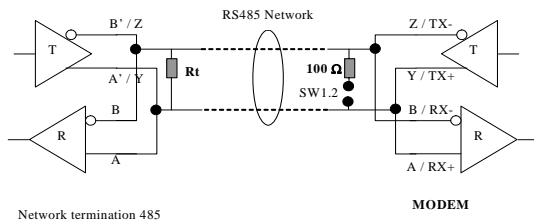
In command mode, a reply is sent back (on the TXD line) according to the following DE/RE timing:

The RS485 link needs to be adapted (each side). The modem includes a 100 Ω termination resistor:

SW1.2 = ON, the resistor is connected between A and B (respectively RX+ and RX-)

SW1.2 = OFF, the resistor is not connected between A and B.

If the modem is ending the RS485 bus, SW1.1 must be ON.

**EASY CHECK**

Serial link activity will make the green LED flashing, whatever the selected data rate is right or wrong.

Radio communication

This modem has 50 channels over the 902-928 MHz Band used through FHSS transmission. Hopping is possible over the whole range but also selectable over up or down sub-bands. These modes can be selected using AT commands.

Wide Band transmission:

- 3 modes, FHSS over 25 or 50 channels
- 57,6 kbit/s radio rate
- channel spacing: 500 kHz
- Sensitivity : - 108 dBm
- Adjacent channel rejection: see chapter. **Erreur ! Source du renvoi introuvable.**

Narrow Band transmission:

- 3 modes, FHSS over 25 or 50 channels
- 10 kbit/s radio rate
- channel spacing: 500 kHz
- Sensitivity : - 112 dBm
- Adjacent channel rejection: see chapter. **Erreur ! Source du renvoi introuvable.**

This module is designed to operate according to FCC Part 15.247.

NOTE

when delivered this modem is set up in Narrow Band to optimize the range.

NOTE 1

The RF out power could be adjusted using AT commands (see register S231).

Radio channels & Sub-bands

The 50 channels are available according to the following table:

Channel S200	Frequency (MHz)		Channel S200	Frequency (MHz)
	Low Sub Band			High Sub Band
0	902.75		25	915.25
1	903.25		26	915.75
2	903.75		27	916.25
3	904.25		28	916.75
4	904.75		29	917.25
5	905.25		30	917.75
6	905.75		31	918.25
7	906.25		32	918.75
8	906.75		33	919.25
9	907.25		34	919.75
10	907.75		35	920.25
11	908.25		36	920.75
12	908.75		37	921.25
13	909.25		38	921.75
14	909.75		39	922.25
15	910.25		40	922.75
16	910.75		41	923.25
17	911.25		42	923.75
18	911.75		43	924.25
19	912.25		44	924.75
20	912.75		45	925.25
21	913.25		46	925.75
22	913.75		47	926.25
23	914.25		48	926.75
24	914.75		49	927.25

Figure 3: Channels & Sub bands

Channel selection

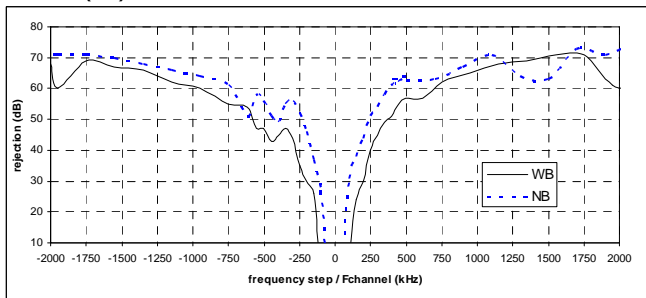
S220 = 2:	Frequency hopping over the whole 50 channels
S220 = 3:	Frequency hopping over the lower Sub Band
S220 = 4:	Frequency hopping over the higher Sub Band
ATS200? =	Viewing the hopping table (Channel numbers)

Air radio rate selection

S202 = 0:	10 kbps Narrowband
S202 = 1:	57.6 kbps Wideband (Default)

Channel rejection

The graph below shows the typical channels rejection in WideBand (WB) and NarrowBand (NB) modes.

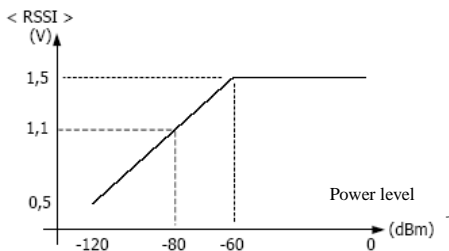


NOTES

Particular attention is required for product installation. In the case where several links must work in the same area (independently of the channel positions), the minimum distance between 2 products belonging to different radio links is 3 meters. Even with this precaution (depending of the product environment), channel rejection could be reduced.

RSSI reading

The RSSI (Received Strength Signal Indicator) gives an indication for the received power level on the first channel of the hopping table. It could be accessed with `ATS230?<cr>` command.



NOTE

The RSSI level is only an indication. Use this level with care due to the dispersion between components.

The schema above could be modified from one to another product. The operating temperature could also have an impact on these dispersions.

The RSSI level could also indicate the potential presence of any jammer in the used channel.

The RSSI is a necessary but not sufficient condition to get a correct reception.

Transceiver operating mode

Two operating modes are available:

- Command mode (usage of AT commands)
- Transceiver or normal mode (serial data are transmitted on radio link)

At power up the transceiver is in transceiver mode: it is able to send / receive data to / from the radio link according to its current parameter configuration.

Command mode

The command mode is used to read and update the modem configuration registers using AT command.

NOTE

The AT command can be locked using ATPWD command.

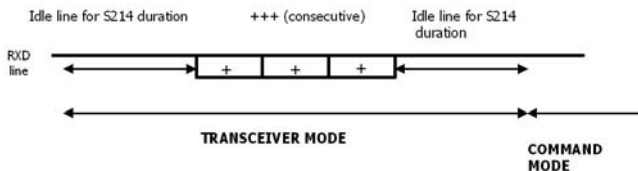
In command mode, the radio is inhibited (reception and transmission), excepted when using test command.

Entering command mode: issues on the serial link a +++ sequence. The sequence of 3 consecutive + characters is accepted only if no character have been seen before and after the +++ sequence. Register (S214) defines the silence duration.

TIPS 1

if you are using a terminal (such as Hyperterm), you have to send the +++ sequence using a text file (first create a text file containing only the +++ characters, and then use in Hyperterm the command "Send text file" in the "Transfer menu")

TIPS 2



Exiting command mode (return back in transceiver mode): send the serial command

ATO <cr>

EASY CHECK

When receiving a right command, modem will answer:

`O`<cr> (ASCII character 0x4F) for accepted command (or OK command)

`E`<cr> for error

Specific string when specified

Transceiver mode

The transceiver mode used a secured addressed protocol.

The communication is always half-duplex. The radio transmission is processed prior to the radio reception. When the transceiver is sending a radio packet, it is not able to decode any incoming radio packet.

If no data are sent on the serial link, the modem is waiting for radio reception. Each radio packet sent by another modem is received and the validated data extracted from the radio packet are sent on the serial link.

All the data received on the serial link are encapsulated in a radio packet.

In transmission mode, data received on the serial link are sent on the radio link with the following format:

<Preamble><synchro><packet header> DATA <CRC><postamble>.

Preamble, synchronisation and postamble are used for the radio reception.

The packet header contains the following fields : packet length, number of retries and packet number, target address.

The CRC follows the data and check the integrity of the radio packet.

The Target Address field is set up with S256 register. The Target Address value 0000 is a broadcast address.

In reception mode: The <Target Address> field of the radio packet is checked (if different of 0000) with the reception address (S252).

If the radio packet address matches the transceiver reception address (S252), DATA (and only DATA) are transmitted on the serial link

Otherwise received data are silently discarded.

Transceiver state machine

When operating in transceiver mode the 'RF transmission' state machine is:

Idle state of the transceiver: by default the transceiver is waiting for incoming data on the RS232 link and for incoming radio packet on the radio link.

Processing incoming RS232 data: the incoming RS232 data are internally buffered. The buffered data are encapsulated in a radio packet and transmitted.

Processing incoming radio frame: the valid data are extracted from the incoming radio packet and internally buffered. The buffered data are sent on the fly to the RS232 module output.

AT Commands

Description

AT commands are interpreted only when the transceiver is in Command mode. Command : are used to read and update the modem parameters
A command starts with the 2 ASCII 'AT' characters. 'AT' means 'Attention' follow with one or several characters or other data.
Each command is ended with <cr> (carriage return).
In the same command, the time between 2 characters must be less than 10s.

EASY CHECK:

When receiving a right command, modem will answer:

'O'<cr> (ASCII character 0x4F) for accepted command (or OK command)

'E'<cr> for error

Specific string when specified

Set of commands

Commands	Description
<i>Operating mode selection</i>	
ATO	Return back to transceiver mode.
<silence>+++<silence>	Command mode activation. The +++ sequence must be preceded and followed by a calibrated silence (no other character)
<i>Registers management</i>	

ATSn?	Displays the Sn register content where n represents the register number. The response has the following format: Sn=y<cr><lf>
ATSn=m	Sets the Sn register value with 'm'. n represents the register number..
AT&W	Saves the new register configuration in EEPROM. Each time you switch on the modem, the EEPROM configuration will be loaded in the modem registers.
AT/S	Displays all register values. The response has the following format: Sxxx=y<cr><lf> for each register.
AT/V	Software version display. The response has the following format: Adeunis RF Versatile Modem II 915 MHz 500mW Vxx.yy<cr><lf>
ATR	Restore the register default values Be careful: When restoring USB DC supplied modem regs, S231 - RF power will become "3" which is incompatible with USB power supply.
ATPWD=m	m = pin code (register S205) : unlock all AT commands. m = 0000 : set registers to default value and unlock all AT commands.
<i>Test modes</i>	
ATT1	Pure Carrier (data=0) transmission using current channel. The output of this mode is achieved by reception of any character on the serial link.
ATT2	Pure Carrier (data=1) transmission using current channel. The output of this mode is achieved by reception of any character on the serial link.
ATT3-ATT6	Modulation using current channel. The output of this mode is achieved by reception of any character on the serial link. ATT3: 0.9 KHz modulation ATT4: 3.6 KHz modulation ATT5: 14.4 KHz modulation (Wide Band channel only) ATT6: 28.8 KHz modulation (Wide Band channel only)

Register description

The register value could be updated using the ATSn=m<cr> command and displayed using ATSn?<cr> command.

At power-up, the previous transceiver configuration is restored from E2PROM (non volatile) to RAM. The registers are located in RAM registers, any modification is performed on RAM registers: To save current register configurations, it is necessary to use the AT&W<cr> command. If not, the updated parameters are lost in case of power shortage.

The registers are shared in 2 types: read only (R) or read/write (R/W)

It is mandatory that the Master modem and the Slave modem have exactly the same registers configuration in term of : hopping table (S200), start channel (S201), channel type (S202), serial parameters (S210, S211, S212, S213), handshake (S216), protocol (S220) and packet retries (S221).

It is recommended to have the same RF OUT level (S231).

Type	Register	Function	Description	Default value	Note
<i>Radio management</i>					
R/W	S200	Hopping table	Hopping table	Default table	4
R/W	S201	Start channel	Start channel number for hopping table	0	
R/W	S202	Channel type	Channel type configuration 0 : Narrow band (10 kbps) 1 : Wide band (57.6 kbps)	1	2
When leaving factory, this modem is set up in Narrow Band to optimize the range					
R	S230	RSSI level	Displays the reception level of the latest received message. Response: S230=-xxx dBm<cr><lf> with xxx decimal value The RSSI values range from -115 up to -60 dBm.	None	

Type	Register	Function	Description	Default value	Note
R/W	S231	RF OUT level	Adjusts the RF out level 0 => 20 dBm (100 mW) 1 => 23 dBm (200 mW) 2 => 24,5 dBm (<450 mA for USB power supply) 3 => 27 dBm (500 mW – Not for USB power supply)	3	
<i>Serial link</i>					
R/W	S210	Baudrate	Serial link rate in bits/s '1': 1 200 '2': 2 400 '3': 4 800 '4': 9 600 '5': 19 200 '6': 38 400 '7': 57 600	4	1,2,3
R/W	S211	Data length	'7' : 7 bits '8' : 8 bits	8	2,3
R/W	S212	Parity	'1' : none '2' : even '3' : odd	1	2,3
R/W	S213	Stop bits	'1' : 1 stop bit '2' : 2 stop bits	1	2,3
R/W	S214	Command timeout	Time out duration for detecting the +++ pattern, unit 10ms. From 1(10ms) up to 100 (1s).	8	1
R/W	S215	Interface type	'0' : RS232 only '1' : RS232 or RS485 (managed DE/RE lines) (RS485 if pin 6 tied to ground)	1	
R/W	S216	Handshake	'0' : hardware RTS mandatory if packet retries register S221 = 1 or 2. '2' : none	2	2

Type	Register	Function	Description	Default value	Note
R/W	S219	RS485 delay	Delay between DE activation and the first RS485 transmitted byte From 0 up to 160	3	
<i>Protocol</i>					
R/W	S220	Protocol	'2'= hopping all the band '3'= hopping low band '4'= hopping high band	2	
R/W	S221	Packet retries	Number of radio packet retries From 0 up to 2. It is mandatory to set S216 to 0 (hardware RTS) if S221 = 1 or 2.	0	
R/W	S252	Reception address	From 0 up to FFFF Used in addressed protocol only, for filtering incoming frame	0000	
R/W	S256	Transmission address	From 0 up to FFFF Used in addressed protocol only, added to out coming frame	0000	
<i>Miscellaneous</i>					
R/W	S205	Pin code	Pin code value Value 0000 is not allowed	1111	
R/W	S207	Pin code activation	0 pin code disabled 1 pin code enabled	0	

NOTE 1

when a serial speed change is requested, the S214 register value can be automatically set to a value greater or equal than the duration of three characters in the requested speed.

NOTE 2

If the radio rate is equal to the serial baudrate, the radio packet is longer than the serial frame, due to radio protocol overhead. If the current radio rate is 10 kbit/s (Narrow band), a serial baudrate of 4800 bauds can be used

without flow control, while using a serial baudrate greater or equal to 9600 bauds will produce data overrun.

We recommend to use RTS handshake (S216=0) for serial baudrate greater or equal to the radio rate in order to avoid FIFO buffer overlap.

For example with serial baudrate greater or equal to 9600 bauds for Narrow band (radio rate 10 kbits/s) and serial baudrate equal to 57600 bauds for Wide band (radio rate 57600 kbits/s).

NOTE 3

when changing the serial link configuration (rate, parity, stop bit...), the answer is done using the old serial link format, the next command must be sent using the new serial format.

For avoiding character lost, you should:

- use the flow control (S216=0),
- or use a serial rate lower to the radio rate,
- or limit the size of serial data to one radio packet.

NOTE 4

(S200 register) see chapter channel selection **Erreur ! Source du renvoi introuvable.** and chapter radio channels & sub bands.

Specifications

General technical characteristics

902/928 MHz version

Operating temperature	-30 to +70 °C
Power supply	4,5 to 36 Volts (integrated regulator)
Size	145x100x40 mm
Number of channels	50 FHSS channels
Modulation	FSK
Packaging	IP65 Box with integrated or external antenna

Transmitter

Programmable Frequencies	902,75 to 927,25 MHz through 500 kHz steps
Programmable Radiated RF power	Up to 27 dBm (500 mW).
Tx / Rx consumption	3,2 W / 0,27 W

Receiver

Receiver Sensitivity	Down to -112 dBm for BER 10-3
Radio data rate	from 10000 or 57600 bps
RSSI	available through AT commands

Protocol

Serial data rate	from 1200 to 57600 bauds (programmable through AT commands)
Serial ports	TxD, RxD, RTS, CTS. Standard configuration: RS232 port. The RS485 configuration is performed through AT commands
Setup and configuration	through Hayes commands
Modes	Transparent or Addressed mode, full custom firmware on demand
Embedded protocol	ADEUNIS-RF enhanced and versatile RF communications manager
Embedded profiles	Multimode modem
Standards compliance	FCC Part 15.247 (fully certified modem)
Range	up to 6 Km

References

ARF7474C : Modem RS232/RS485 – IP65 box

ARF7474E : Modem RS232/485- IP65 box with external antenna(*)

ARF7474G : Modem USB – IP65 box

ARF7474J : Modem USB –IP65 box with external antenna(*)

Glossary

TBD	To Be Defined
NC	Not Connected
NU	Not Used
FHSS	Frequency Hopping Spread Spectrum
FIFO	First In First Out
WB	Wide Band
NB	Narrow Band

ANNEX : Firmware updates

Firmware	Updates
V2.02	Pin code added
V1.0	Original version

Firmware	Updates
V6.0	Pin code added (LMN)
V4.0	NB configuration when leaving factory
V3.0	RF power update + "EASY CHECK" assertions + Power Mgt suppress
V2.0	Commands update
V1.0	Original version