



FH915

Features Guide

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FH915 FEATURES GUIDE

Please use this Features Guide to get familiar and have a good understanding with yours FH915 OEM modem (below the Modem).

See FH915 User Manual for full description and service operation details at ArWest website www.arwestcom.com.

FH915 is a multi functional, compact, reliable Spread Spectrum Radio Transceiver.

The following steps summarize the procedure of FH915 installing:

- The easiest way to access the FH915 OEM board is to use the Evaluation Kit (p / n 99-571010-01). The FH915 connected directly to Evaluation Kit (p/n 99-571010-01) by its 16-Lead Header Connector, ECS Corp.
- A standard Null-Modem cable (included in Kit) with DB-9 Female connectors on both ends may be used to connect PC COM_X port with Serial port on adapter.

Additionally, you may need to install on your computer a software like JNSTerm.exe or Hyper Terminal and ModemVU – Windows based Unit Configuration and Maintenance Software Application running on a IBM PC compatible computer.

Connect to FH915 modem at 115200/8/N/1/HW.

1. Connect adapter to the computer's serial port PC, then power it using Power Supply 9.0 ... 20.0 VDC.
2. A greeting string from serial port appears on the screen of the JNSTerm.exe or Hyper Terminal: "Javad GNSS. Real Time Firmware Version 3.1.15, Mar 27 2013"

Modem status is defined by configuration file. Modem is in the data mode and ready to receive or transmit the data. The received data can be obtained through a serial port RS232. Data transfer can also be served through a serial port RS232. The full description of the commands which control the routing of the data stream is presented in the user manual.

The built-in user-friendly Command Line Interface (CLI) allows user to perform a full configuration of the unit and read the statistics and alarm status. It is the most powerful tool to configure the unit. It makes changes to all possible settings that system will not be able to determine automatically.

1. Command mode

On power-up the radio modem is in data-mode. To switch to command mode send to the port the Escape-Sequence `+++`. All bytes that come into the port after this command the modem will recognize as a command sequence.

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Info

Default configuration

The modem automatically returns to data mode, if the next command won't be sent to the port within 45 seconds. To return to data mode from command mode use command `datamode\n`.

2. Info

If you give the command `info\n`, the Modem answers:

FH915 Land Mobile Radio, Javad GNSS.

```
Product ID =41
S/N =BT001
Hardware =2
Firmware =3.1.14
BootLoader =4.03
MstrDev =0
@00
```

Where:

Product ID =41 – the FH915 board product identification number;

S/N =BT001 - the serial number assigned to the FH915 board at the factory;

Hardware =2 - the revision number of the modem board;

Firmware =3.1.14 - Version of FW FH915 board;

BootLoader =4.03 - Version of the Bootloader;

MstrDev =0 - Code of the device, which uses a modem FH915 board;

0 - the FH915 is OEM board.

3. The default settings

3.1. Default configuration

Modem status is determined by the configuration file, which stores user's settings. The factory settings are stored in the default configuration file. At any time you can return the modem to the default configuration file by sending two commands `Cfg2df1t\n` and `boot\n`.

It is convenient to start the acquaintance with the modem with the default settings.

The current status of the modem can be called by using commands `state\n`, `link\n`, and others.

3.2. state

If you issue the command `state\n`, the modem answers:

```
Region =1
Tx =915000000
Rx =915000000
T=43.50
@00
```

Where

Region =1 - the region code; 0 – EUR; 1 – USA; 2 – AUS; 3 – SPC.

Note: The region code specifies the frequency range, the signal structure, so that many modem settings are related to the choice of the region.

Tx =915000000 – the preset value of the transmitter frequency in Hz.

Rx =915000000 – the preset value of the receiver frequency in Hz.

T=43.50 – Temperature on the FH915 board near the power amplifier.

3.3. link

The Modem settings can be accessed using the `link\n`.

If you issue the command `link\n`, the Modem answers:

```
MOD =5
PWRB =15
FHOP =0 0
TRFC =1
SCRAM =1
FEC =1
DCRC =0
DLNG =0
DSRV =0
LBT =1
@00
```

Programmable parameters and their meaning:

MOD =5 – the modulation type code;

PWRB =15 - programmable output transmitter power;

Parameter PWRB can be read by command `link pwr\n`.

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The default settings

link

The set output transmitter power use the command `link pwr D\n`, $D = 7, 8, \dots, 30$ – output power in dBm.

`FHOP = 0 0` - selected transmitter and receiver frequency hopping sequences. The first parameter specifies the frequency sequence selected for the transmitter, the second - for the receiver.

Command to read the parameters – `link fhop\n`.

Command to set both parameters – `link fhop D\n`.

$D = 0, 1, \dots, 9$ – for Region 1;

$D = 10, 11, \dots, 19$ – for Region 2.

In the region 0 the frequency hopping is not used.

Command to set the frequency sequence of the transmitter – `link fhtx D\n`.

Command to set the frequencies sequence of the receiver – `link fhrx D\n`.

`TRFC = 1` – the mode of the subpackage transmission at two different frequencies with a choice of the best subpackage at the reception.

The command to read parameter – `trfc\n`.

The command to set parameter – `trfc D\n`.

$D = 0$ – subpackets transmitted without repetition.

$D = 1$ – subpackets transmitted at two different frequencies with a choice of the best subpackage at the reception.

$D = 2$ – subpackets are transmitted only on the even frequencies. Odd frequencies reserved for data reception.

`TRFC = 2` - "transparent mode" - in this mode two modems can implement a "full duplex" - duplex transmission mode in which data transfer can be maintained "simultaneously" with the reception of data.

`SCRAM = 1` - data scrambling.

The command to read parameter is `link scram\n`.

Command to set – `link scram D\n`.

$D = 0$ - data without scrambling;

$D = 1$ - the standard scrambling;

$D = 2$ - used scrambling, defined by the user.

`FEC = 1` - data encoding.

The command to read parameter is `link fec\n`.

Command to set – `link fec D\n`.

$D = 0$ - data is transmitted without encoding;

$D = 1$ - data is encoded standard convolution code with $R = 1/2$.

DCRC = 1 - manage the output of the received data to the port.

The command to read parameter is `dcrc\n`.

Command to set – `dcrc D\n`.

D = 0 - received data are distributed to the port, regardless of the received data CRC.

D = 1 - data are distributed to the port only if the CRC is correct.

DLNG = 1 - used validation the receipted parameter length subpackage data

The command to read parameter is `dlng\n`.

Command to set – `dlng D\n`.

D = 0 - validation of the receipted parameter length subpackage data is not used.

D = 1 - validation of the parameter is used.

DSRV = 1 - a number of receiver parameters passed to the receiver through the channel.

The command to read parameter is `dsvr\n`.

Command to set – `dsvr D\n`.

D = 0 - the receiver's parameters are set from the configuration file.

D = 1 - a number of the receiver parameters are set from service data passed to the receiver through the channel.

LBT = 1 - Listen Before Talk. The channel occupancy is verified before subpackage transmitting. If the channel was occupied at the previous slot, the current slot is not used for data transmission.

The command to read parameter is `lbt\n`.

Command to set – `lbt D\n`.

D = 0 - Listen Before Talk mode is turned off.

D = 1 - Listen Before Talk mode is enabled.

To save the settings in the configuration file, you must issue the command `save\n`.

4. Additional settings

Parameter PMP - provides the addressed data transfer as well as the ability to transfer commands. If parameter PMP is not zero, then its value is displayed in the response to the command `link\n`.

For example, the response to the command `link\n` when PMP =3:

```
MOD =5
PWRB =15
FHOP =0 0
TRFC =1
PMP =3, 44 123 091 123
```

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Additional settings

link

```
SCRAM =1
FEC =1
DCRC =0
DLNG =0
DSRV =0
LBT =1
@00
```

The first parameter in the string `PMP =3, 44 123 091 123` represent PMP value.

The command to read parameter PMP is `link pmp\n`.

Command to set – `link pmp D\n`.

`PMP = 0` – Any transmits, any receives. At the receiver side neither the source nor the recipient is validated.

When `PMP > 0` received data contain proprietary service information:

`WHT` - a type of data;

`DST` - code of the recipient;

`SRC` - the data source code. By defaults `SRC` coincides with the last three symbols of the transmitter `SN`, but can be reprogrammed.

The configuration file contains the parameter `KNW` - the code of the certified data source;

`PMP = 1` - Any transmits to me only. The receiver compares the received code `DST` with its code `SRC`. If the received code `DST` coincides with the code `SRC` of the receiver, the received data are distributed to the port.

If the received code `DST` is not coincide with the code `SRC` of the receiver, the received data to the port are not provided.

`PMP = 2` – Certified Base transmit to any. The receiver compares the received code `SRC` and code `KNW`. If the received code `SRC` coincides with the code `KNW`, stored in the configuration file of the receiver, the received data are distributed to the port.

If the received code `SRC` is not coincide with the code `KNW`, then the received data to the port are not provided.

`RMR = 3` – Certified Base transmit to me only. The receiver compares the received codes: code `DST` with its code `SRC` and the code `SRC` with the code `KNW`.

If these codes match the received data are distributed to the port.

Other parameters of the string – `PMP =3, 44 123 091 123` - deciphered as follows:

`PMP = 3, WHT DST SRC KNW`

`WHT` – type of data: `WHT =44 (D)` – data; `WHT =43 (C)` – command.

If the modem transmits data (with `PMP > 0`) it indicates that its (091) data (44) are designated to modem which code `SRC =123`.

If the modem receives data (with `PMP = 3`) it compares own code `SRC =091` with code `DST` in the received signal, checks that the code `SRC` specified in the received signal matches the `KNW =123` stored in the configuration file. If both codes match the received data (44) are distributed to the port.

If these data are the command (43) then the command is executed.

It should be noted that the command is executed only if the `CRC =OK`, whatever you selected `DCRC =1` in the configuration file or not.

5. Using the modem as a repeater

Parameter `REP` allows using the modem as a data repeater. Retransmission of the data requires the time, because the transmitting modem uses a transfer mode only on even-numbered slots (`TRFC = 2`). The receiving modem operating as a repeater (`REP = 1`), must also be set `TRFC = 2`.

If parameter `REP` is not zero, then its value is displayed in a `link\n` response.

For example, below you can see the response to the command `link\n` for `REP = 1`: (`TRFC =2` is set before).

```
MOD =5
PWRB =15
FHOP =0 0a
TRFC =2
REP =1
SCRAM =1
FEC =1
DCRC =0
DLNG =0
DSRV =0
LBT =1
@00
```

The command to read parameter `REP` is `link rep\n`.

Command to set – `link rep D\n`.

`D = 1` - modem retransmits the received data.

While data transmitter (Base) uses only the even slots (even-numbered frequencies), the repeater must use the odd slots (odd-numbered frequencies), i.e. use the frequency sequence with single offset - sequence in which all frequencies shifted by one position in a circle.

Example:

All Rovers receive data at the frequency sequence `FHRX =0`.The Repeater transmit data at the frequency sequence `FHTX =0`.

The repeater receives the data from the Base at the frequency sequence with “single offset” `FHRX =0a`. The Base transmits data to the repeater using the frequency sequence with “single offset” `FHRX =0a`.

Base not produces an interference for Rovers, since the Base transmits data using `FHRX =0a`, but Rovers receive at `FHRX =0`.

Command to set the frequency sequence with single offset for the transmitter is `link fhtx Da\n`.

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Modem protection from interference. Exclusion of unwanted frequencies
link

Command to set the frequency sequence with single offset for the receiver is `link fhrx Da\n`.

6. Modem protection from interference. Exclusion of unwanted frequencies

If interference contains a big power at some frequency such frequency can be excluded from the use.

To eliminate unwanted frequency, for example, 908400000 Hz it must be added to the list of unwanted frequencies and stored in the configuration file. To do that use the command `nadd 908400000\n`. After this command modem answers:

```
1F 908400000
@00
```

where 1F - number of frequency in the sequence FHRX.

To exclude other unwanted frequency, for example, 925000000 Hz add it to the list by command `nadd 925000000\n`. The modem responds:

```
72 925000000
@00
```

To view a saved list of unwanted frequencies use the command `n1st\n`. The modem responds:

```
1F 908400000
72 925000000
@00
```

To store the unwanted frequencies in the configuration file you would issue the command `save\n`.

Lists of unwanted frequencies should be the same at the transmitting and receiving sides.

When you have a list of unwanted frequencies the selected frequency sequence is modified so that the frequencies specified in the list are not used for the transmission or for the reception.

Saved list of unwanted frequencies is applied when the modem have Reset or Power on or when issued the command `nap1\n`.

This feature allowed excluding those frequencies with interference.

To remove some frequency from the list of unwanted frequencies use the command, for example, `ndel 1F\n`. This command removes from the list 1F frequency 908400000 Hz.

7. Regional features of the modem FH915

Region code can be read by command `rgn\n`.

Region code is changed by command `rgn D\n`.

- D = 0 - Region EUR.
- D = 1 - Region USA.
- D = 2 - Region AUS.
- D = 3 - Region SPC (Special).

To save the Region code in the configuration file, issue the command `save\n`.

7.1. Region 0

The range of frequencies used: 868.0 ... 870.0 MHz.

Operating frequencies are placed in increments of 25.0, 12.5, 6.25 kHz.

Maximum power is used depends on the selected frequency.

7.2. Region 1

The range of frequencies used: 902.0 ... 928.0 MHz.

Working frequency of modem is changing stepwise as pseudo random sequence. Only a 128 frequencies are in use: $f = 902\,200\,000 + n * 200$, $n = 0,1, \dots, 127$.

The modem works on a separate frequency a short time - 1/16 sec.

The frequency sequence is user-selectable of 10, stored in the modem memory.

The frequency sequence for the transmitter (FHTX D) and the frequency sequence for the receiver (FHRX d) can be selected independently.

Data supplied to the transfer, are divided into subpackets. Each subpacket transmitted on a separate frequency.

7.3. Region 2

The range of frequencies used: 915.0 ... 928.0 MHz.

Working frequency of modem is changing stepwise as pseudo random sequence. Only a 64 frequencies are in use: $f = 915\,200\,000 + n * 200$, $n = 0,1, \dots, 63$.

The modem works on a separate frequency a short time - 1/16 sec.

The frequency sequence is user-selectable of 10, stored in the modem memory.

The frequency sequence for the transmitter (FHTX D) and the frequency sequence for the receiver (FHRX d) can be selected independently.

Data supplied to the transfer, are divided into subpackets. Each subpacket transmitted on a separate frequency.

7.4. Region 3

The range of frequencies used: 902.0 ... 928.0 MHz.

Operating frequencies are placed in increments of 25.0, 12.5, 6.25 kHz.

8. Modem and Channel Diagnostics

8.1. Estimation of the reception quality “On the Fly”

At short-term transfer of a modem that receives data in command mode (send to port `+++`) received data comes in the buffer and are issued at the port after the return to data mode (send to port `datamode\n`).

The data buffer allows interrupt about 2 seconds without data stream destruction (at default settings). During this time, the modem can perform multiple commands. For example, it is possible to issue a command `rss\n` and get the number of the received subpackages, the number of the received “corrupted” subpackages, and get RSSI value for the last received subpackage.

After response the command `rss\n` clears both counters of the received subpackages and the “corrupted” subpackages.

Algorithm to obtain “On the Fly” the response to the command `rss\n` during the reception:

- Send to the port `+++`.
- At the end of the received data stream detect response to the `+++`- command `@00\r\n`. This response does not have to come to the recipient.
- Send to the port the command `rss\n` and decode the response, which came in the form, for example: `01 0055 -78.5` - where the first two hexadecimal digits `01` indicate the number of the bad subpackages; next field containing four hexadecimal digits `0055` indicates the number of the received subpackages; `-78.5` last field - the RSSI value of the last received subpackage (in dBm).
- Go to the data mode. Send to the port command `datamode\n`. This command will restore the issuing of the received data to the port. First of all are issued the detainees data.

8.2. RSSI distribution in frequency

Modem receiver estimates RSSI on accepted subpackages. The RSSI of the last received packet is stored in the modem, and you can read it by command `rss\n`.

```
RSSI=-85.3 dBm
```

```
@00
```

In region 1 subpackets transmitted at different frequencies, a condition of which may vary considerably.

Radio modem stores the last RSSI values for each particular frequency on which a subpacket was received. An array of the last RSSI for 128 possible frequencies can be read by command `rssm\n`.

```

913000000 -58.9
909000000 -58.4
906200000 -58.4
. . .
. . .
919000000 -60.0
905600000 -58.7
910600000 -58.7
917400000 -60.0
925400000 -60.8
925800000 -140.7
@00
    
```

This array shows the distribution of the received signal power in range.

The command `rssc\n` sets all cells of the RSSI array to default value `-140.7`.

8.3. The distribution of noise and interference on frequencies

To get the power of noise and interference for 128 frequencies from `902200000` to `927600000`, use the command `nscn 10\n`.

```

902200000 -113.4
902400000 -114.3
902600000 -115.5
902800000 -116.3
. . .
. . .
926400000 -101.7
926600000 -100.2
926800000 -99.7
927000000 -100.2
927200000 -100.2
927400000 -100.4
927600000 -99.3

-112.2
-102.2
    
```

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```
908400000 -76.3
926400000 -101.7
926600000 -100.2
926800000 -99.7
927400000 -100.4
927600000 -99.3
```

This array shows the distribution of the power of noise and interference for the frequencies used in the modem.

-112.2 - Shows the average noise power (dBm).

-102.2 - The threshold set at 10 dB above the average level.

The following list specified the frequencies on which the noise and interference power exceed this threshold.

8.4. Scanner

The modem allows you to scan a specified range of frequencies. At the command

`scan 850000000 970000000 50000` modem will scan the frequency range from 850000000 to 970000000 Hz increments 50000 Hz. The result of the measurement of the noise and interference power at each frequency is outputted as:

```
850000001 -126.7
850500001 -126.2
851000001 -126.5
851500001 -126.2
852000001 -126.4
852500001 -126.7
853000001 -126.7
853500001 -127.1
854000001 -126.9
...
```

LSB frequency in is 1, 0, 2, indicating the status of the modem AGC: 1 = 01, 0 = 00, 2 = 10

- in code form means:

01 - ATT off, LNA is on

00 - ATT off, LNA off

10 - ATT is on, LNA off

Scanner is running non-stop, walking the specified frequency range circle-wise. Scanner stops by command `scns`.

After using the scanner is desirable to apply the command `boot`, which resets the modem.

8.5. BER measurement

To measure the received signal power and survey the status of the receiver you can use the command `berr 180\n`. When applying this command receiver outputs to port instead data the coded string, characterizing the receiver state:

```
0 F501 0028 1 65 0 -57.3
0 F501 0028 0 66 0 -57.1
0 F501 0028 0 67 0 -56.8
...
```

This line contains seven fields.

First field - 0 or 1 - describes the result of the received subpacket CRC. If CRC is OK, the first character is 0, else 1.

Contents of the second field depends on the first character. If the first character is 0, the second field - F501 - represented in binary code is interpreted as follows.

Left three bits (15,14,13) are always 111.

Bit₁₂ - represents DSRV.

DSRV = 1. The receiver is configured by parameters that are stored in the configuration file. Bit₁₂ = 1.

DSRV = 0. The receiver is configured by parameters that are transmitted over the air. Bit₁₂ = 0.

Bit₁₁ = 0 - reserved.

Bit₁₀ - represents FEC code.

Bit₉, bit₈ - represent SCRAM code.

Bit₇ = 0 - reserved.

Bit₆, bit₅, bit₄ - represent PMP code.

Bit₃ = 0 - reserved.

Bit₂, bit₁, bit₀ - represent TRFC code.

If the first character is 1 and FEC=0, the second field represents the number of errors in the received packet. For correct calculation of the error number transmitter should transmit the standard data packet with FEC = 0.

Transmitter will transmit the Standard data packet every possible for transmission slot after the command `bert 17A\n`.

Transmitter will transmit the Standard data packet every second after the command `bers 17A\n`.

When FEC = 1 this field not used.

The third field (0028 hex) indicates the packet length in bytes.

The fourth field is (1, 0, 2) indicates the status of the receiver AGC.

1 = 01, 0 = 00, 2 = 10 - in code form means:

01 - ATT off, LNA is on

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Modem features programming in the region 0

00 - ATT off, LNA off

10 - ATT is on, LNA off

The fifth field (65 hex) – current number of frequency in the transmitted signal.

The sixth field (0 or 1) - the result CRC4, calculated for service information.

0 - CRC4 = OK;

1 - CRC4 = BAD;

Seventh field (-57.3) - RSSI dBm.

8.6. Modem features programming in the region 0

Set Region 0.

Put the modem to command mode and issue to port commands `rgn 0\n`, `save\n`.

For a command `state\n` modem responds:

```
Region = 0
Tx = 869000000
Rx = 869000000
T = 45.50
@ 00
```

By default, the transmitter and receiver of the modem tuned to 869000000 Hz.

To configure the modem receiver to a different frequency, use the command:

`map fddddddd\n`, where `dddddddd` - frequency in Hz.

To configure the modem transmitter to a different frequency, use the command:

`map ftx dddddddd\n`, where `dddddddd` - frequency in Hz.

The transmitter and receiver can operate at different frequencies. It is important only to match the Base transmitter frequency and the Rover receiver frequency.

Modem settings can be accessed using the command `link\n`.

Put the modem to command mode and issue the command `link\n`. The modem responds:

```
MOD =5
PWRB =15 Crnt =14
SCRAM =1
FEC =1
SPACE =0
DCRC =0
DLNG =0
DSRV =0
LBT =1
@00
```


Note that the response to the command `link\n` in the Region 0 is different from the corresponding answer in the Region 1.

In the region 0 the permissible maximum power depends on the transmitter frequency. For the frequency 869000000 Hz power shall not exceed 14 dBm. Although set in the configuration file transmitter power, equal to 15 dBm, the transmission will be limited by the permissible value `Crnt = 14 dBm`.

`SPACE` - defines the channel space.

The command to read parameter is `link space\n`.

Command to set – `link space D\n`.

`D = 0` – channel space 25 kHz.

`D = 1` - channel space 12.5 kHz.

`D = 2` - channel space 6.25 kHz.

The transition from command mode to data mode is executed by command `datamod\n`.

While the modem is in command mode, the receiver receives the data and stored it into the buffer. This makes it possible to interrogate the state of the modem without any loss of received data.

When you leave the command mode the received and buffered data are issued to the port. If you need to clean the data buffer before switching to data mode, you have to use the command `datamod\n`.

9. Test signals forming

The modem can form several different test signals.

If you give the command `tstsgl 1\n`, the modem generates an unmodulated signal at the frequency, installed using the command `map ftx dddddddd\n`, where `dddddddd` - the carrier frequency in Hz.

The output power is determined by the `D` dBm, if was set by the command `link pwrB D\n`.

The test signal will shut down by the command – `tstsgl 0\n`.

If you give the command `tstsgl 3\n`, the modem generates a continuous GMSK signal modulated by pseudo-random sequence of binary digits, the length of which is equal to 511.

If you give the command `tstsgl 5\n`, the modem generates a continuous GMSK signal modulated by a periodic sequence of bytes `0x00, 0xFF, 0x00, 0xFF...`

If you give the command `tstsgl 6\n`, the modem generates a continuous GMSK signal modulated by a periodic sequence of bytes `0x00, 0xFF, 0x00, 0xFF ...`

If you give the command `tstsgl 7\n`, the modem generates a continuous GMSK signal modulated by a periodic sequence of binary symbols of the form `111 ... 11`.

Before to switch from one test to another the previous test signal must be shut down by the command `tstsgl 0\n`, and then switch to the other test.



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