Application note for the HW-RFR900T UHF RFID reader System

1. Introduction

The HW-RFR900T UHF RFID reader development kit supports the **EPC generation 2** standards. The sample kit is to show the features of the HW-RFR900T UHF RFID reader.

The system comprises of two boards: the UHF board and the JIG board. On the UHF board the main components are the AS3990 UHF RFID chip, MCU chip, external RF power amplifier, coupler, external VCO, and TCXO. On the JIG board the components are RS-232 driver chip, RS-232 port and 5pi DC-JACK. The two boards are connected 4wires cable.

The demonstration board can operate by graphic user interface (GUI) when connected to a RS-232 port. All mandatory commands and some optional commands for the EPC generation2 standard are supported.

For development purposes the JIG board can be removed and the host system can directly access the UHF board using a 4 pin connector. The operational RF part can be used to develop customized software that will control the RFID reader. A description of the interface can be found in the chapter of technical description.

1.1. *Getting started*

1.1.1. System assembly

- Use a 50 Ohm coaxial cable to connect the U.FL connector on the reader board
- Use DC power supply or a stabilized laboratory power supply with current rating of at least 1000 mA at output voltage with a voltage setting of 5 Vdc for supply the JIG board. Use RS-232 cable to connect PC and the JIG board.

1.1.2. Stand-alone operation

When power is supplied to the board, Reader automatically starts stand-alone operation. In this operation Reader continuously searches transponders in antenna field.

1.1.3. Operation of the board PC based with graphic user interface control

You have to set the RS-232 port properties first. In the Windows Start menu, open Control Panel/System/Hardware/Device Manager/Ports. Double click on the COM port and open the 'Port Settings' tab, choose 115200 bits/s, 8 Data bits, No parity, 1 Stop bit, No Flow control. In case the COM port is assigned a very high number (above 6) use Advanced options to assign it a lower number.

Once this is complete you can connect reader board to a PC with the RS-232 cable and start GUI program. The GUI should automatically detect the COM port number that the board is attached to. If it is different from the one that you have manually selected, please select the COM port that you used in the settings.

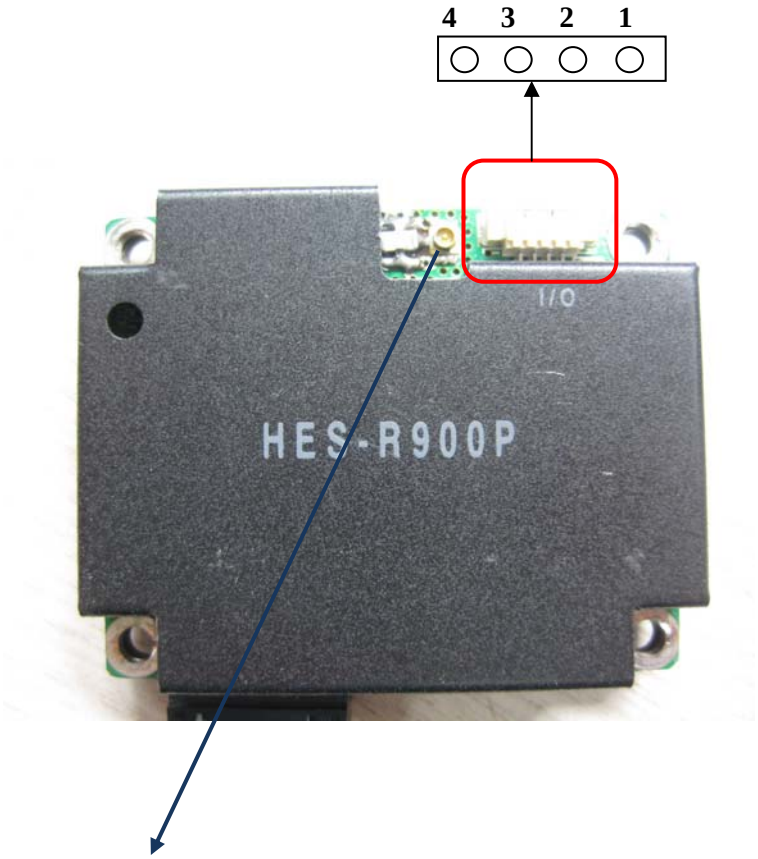
2. Specifications

2.1. *RFID board*

Parameter		Measurements	Remark
Frequency range		910.2MHz ~ 920MHz	UHF RFID ISM BAND
Output power		27dBm	MAX / total
Output PWR variation		15dBm ~ 27dBm	
Current	Scan mode	Under 1000 mA	Max power
		-	20dBm
		-	12dBm
	Idle mode	Under 250 mA	-
Output PWR resolution		-	Adjustable in GUI
RF port Impedance		50ohm	SMA or H.FL connector
Modulation		ASK	
Spectrum Mask		29.6dBch, 30.1dBch	fc +200kHz,-200kHz
		59.6dBch, 60.1dBch	fc +400kHz,-400kHz
		69.5dBch, 70.3dBch	fc +600kHz,-600kHz
		73.7dBch, 73.8dBch	fc +800kHz,-800kHz
ASK Envelope	Rise Time	7.09us	tr
	Fall Time	7.20us	tf
	Ripple	0.0214	Mh-Ml
	Pulsewidth	0.125	PW
	Depth	96.64%	Dep
Interface		RS-232	
Supply Voltage		5±0.5 Vdc	

2.2. *Pin Description*

Pin No.	Pin Name	Pin Function	Remark
1	Vcc	DC Input	+5V
2	GND	GND	
3	URX	UART RX PORT	
4	UTX	UART TX PORT	



Ant port : connect rf cable to reader module and ANT

2.3 Installation

Installation requires special training and must be done by a professional installer only.

Transceiver location typically has a significant impact on the instrument's performance. In general, higher placement of the antenna ensures a better communication link. Additionally, the transceiver should be placed away from computers, telephones, answering machines, and other similar equipment. Placement of the external antenna is critical to a solid data link. Other antennas in close proximity are a potential source of interference. It is also possible that slight adjustments in antenna placement will solve noise problems.

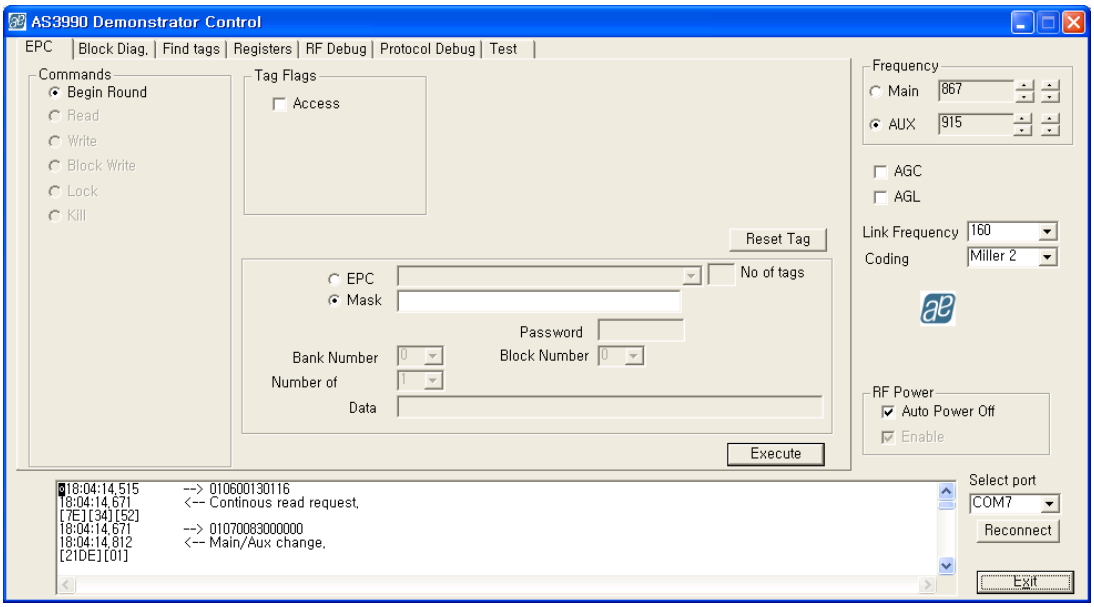
Approved antennas include the Mac technologies Inc MPAC45SF915P-TA Ceramic Patch antenna. (antenna connector : U.FL)

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operate in conjunction with any other antenna or transmitter.

Note Power output of the radio system, including cable loss, the antenna gain, and insertion loss, should not exceed 22 dB EIRP.

Graphic User Interface

2.3. *Main Window*

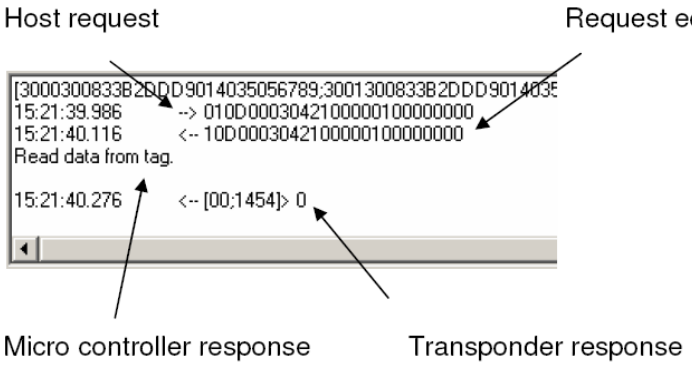


Most of the GUI window is used for tabs which allow user to perform different tasks

- ***EPC*** tab is used to execute EPC operations on transponders;
- ***Block Diag.*** tab is used to set properties of individual blocks of AS3990;
- ***Find Tags*** tab is used to continuously scans for transponders in its RF field and displays their respective EPC values;
- ***Registers*** tab is used to observe and change values in registers of AS3990 reader IC;
- ***RF debug*** tab is used to check FR properties of the board, antenna, and environment;
- ***Test*** is used to send Host-Reader commands to the Reader.

- Log Window

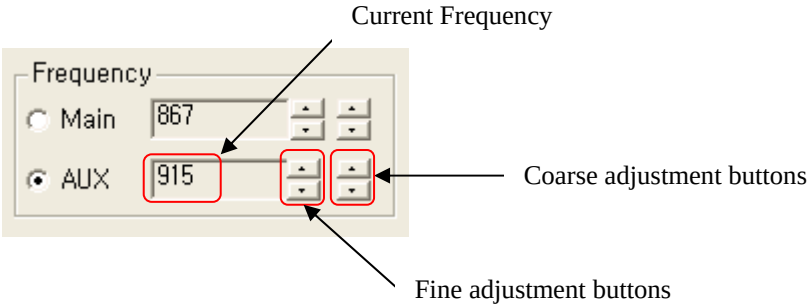
  The log window is used to display all the messages and data sent to and from the reader board. This information is also stored in the rfid-reader.log file which can be opened with a text editor (Notepad).



  The relevant information returned by the Reader (transponder response, register content) is always in brackets to distinguish it from other data in host-to-reader data exchange.

- Frequency selection

  Frequency selection field and four buttons on the right side of the GUI window allow user to select operation frequency. The two buttons on the left change frequency in 200 kHz.



- Control buttons

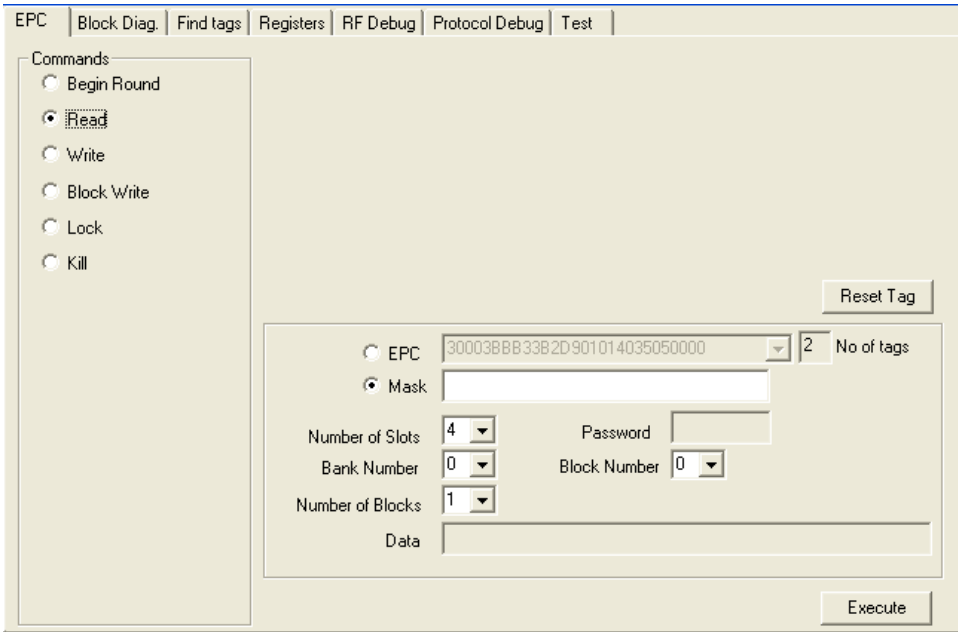
  The following buttons change operation of the Reader:

  ✓ **AGC** – Automatic Gain Control setting
  ✓ **AGL** – Automatic Gain Leveling setting
  ✓ **Enable RF Power** – turn on / off RF power

- COM port

  If automatic port selection fails upon GUI initialization you can select the port and try to execute the “Inventory Round” operation in the EPC tab. In case the Reader will be reset (or removes power during RF debug tab measurement) Reconnect button should be used to reestablish connection.

2.4. *EPC Tab*



When this tab is activated only Inventory Round operation is enabled. You have to click Execute to run this operation and inventory the transponders before you can Execute other operations. When operations other then Inventory Round are selected modification of appropriate text entry and selection controls is enabled.

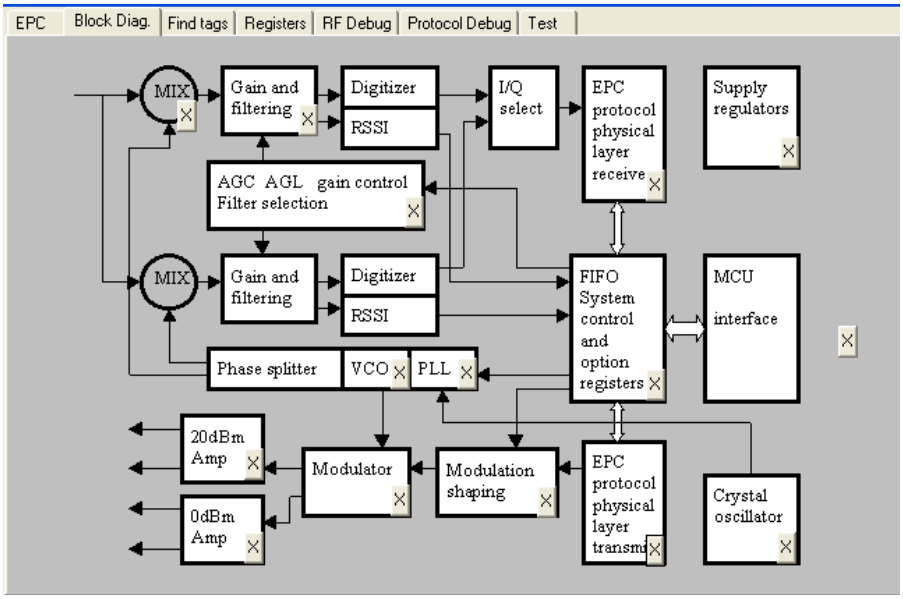
- ID mask

The mask can consist of arbitrary number of characters up to full EPC length (often 28 hexadecimal characters). Reader GUI currently enables modification of mask in 4 bit units (1 hexadecimal character). Mask offset is achieved by preceding the mask by non-xadecimal characters (1 character = 4 bits).

- Changing EPC number

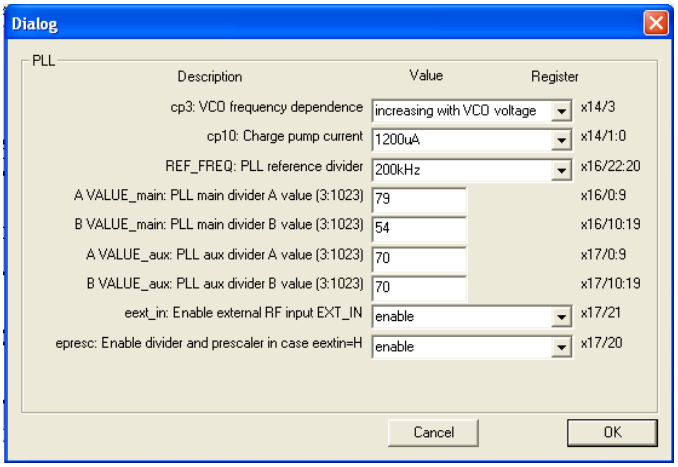
Transponders read their ID from non-volatile memory when they gather sufficient RF field from the reader side. it is possible to change EPC number by writing to bank 1 of the transponders memory. Once the number is changed transponder did not respond to further commands until the TAG is removed from the RF field and inserted again. This can be achieved by switching RF field off and on or clicking **Reset Tag** button.

2.5. *Block Diagram Tab*

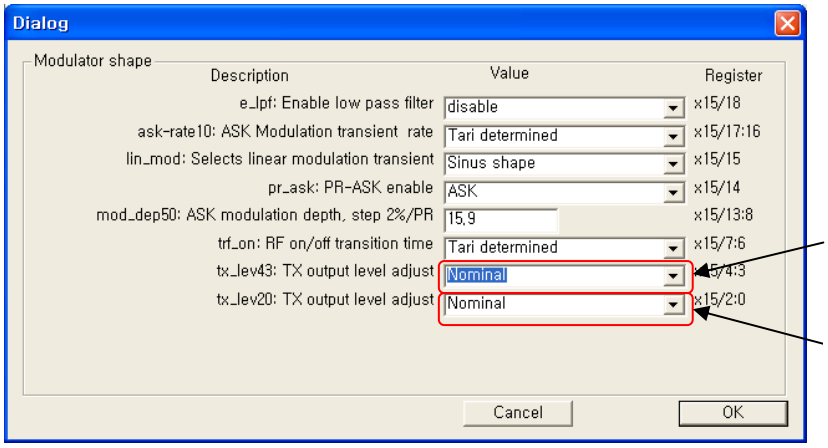


A block diagram of the circuit is presented to give a convenient possibility to change registers and modify properties of circuit blocks by clicking the **X** button in the lower right corner of some blocks. A new dialog box is opened where you can modify values of registers by entering new values in the text entry controls or selecting appropriate values from selection controls.

All values shown in the controls are read from AS3990 registers when the dialog box is opened. Writing to the registers is executed upon clicking the OK button. You will be not asked for confirmation. There is no undo. Some combinations of register values can severely degrade operation of the Reader. You can restore default values in ***Registers*** tab clicking **Set Defaults** button.

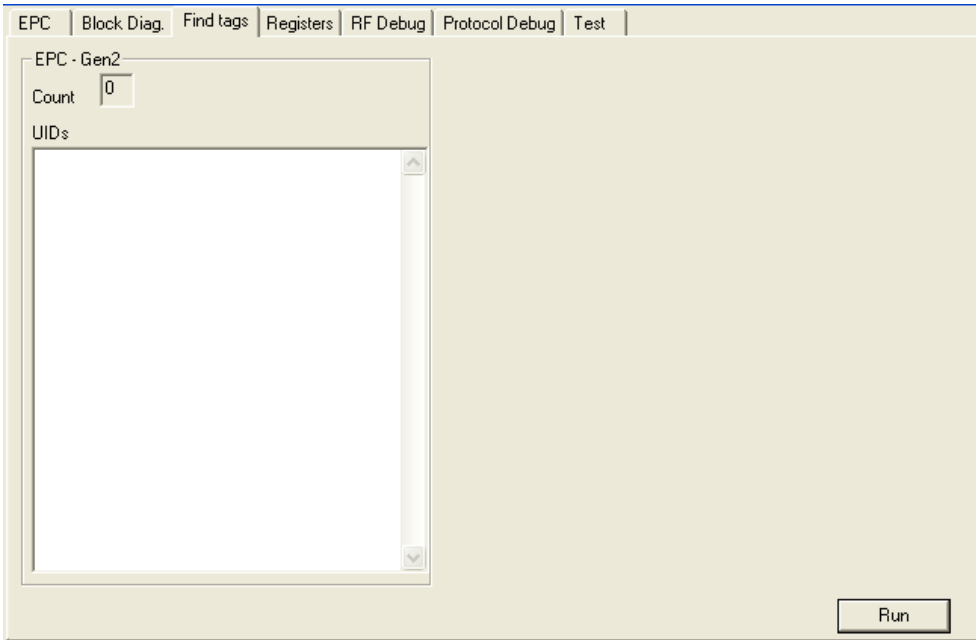


The ***Block Diagram*** tab enables modification of majority of registers. All register values maybe modified in the ***Registers*** Tab.



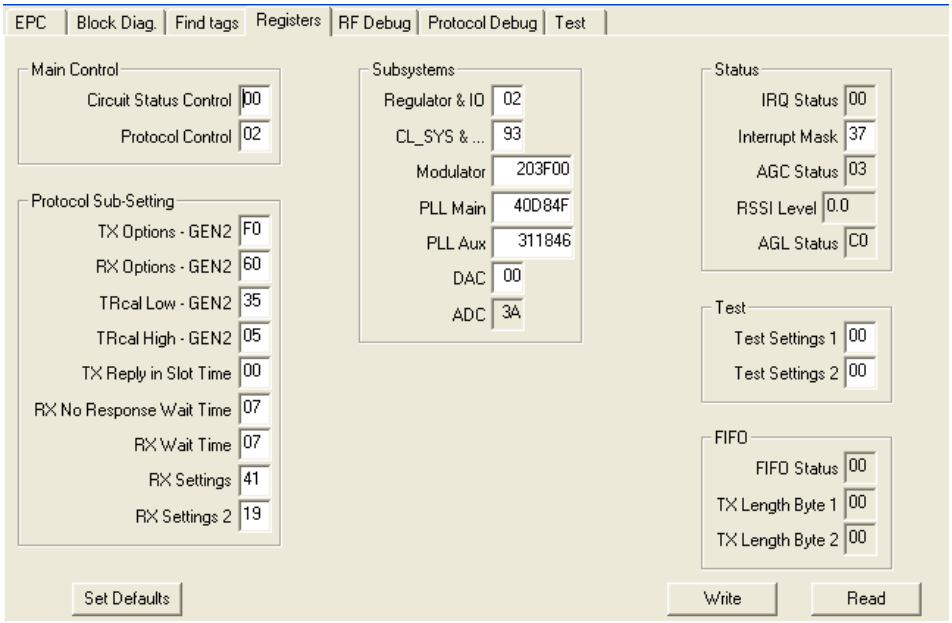
Be able to modified RF output Power of RFID board where Dialog window when click the Modulation shaping button.

2.6. *Find Tags Tab*



By changing into this tab, the active Reader is trying to identify all tags or labels in the RF field. The EPC numbers of the tags will be shown. This operation can be stopped and restarted with the **Stop** / **Run** button. No Reader to PC communication is echoed to the log window but it is still written to the log file (rfid-reader.log).

2.7. *Registers Tab*



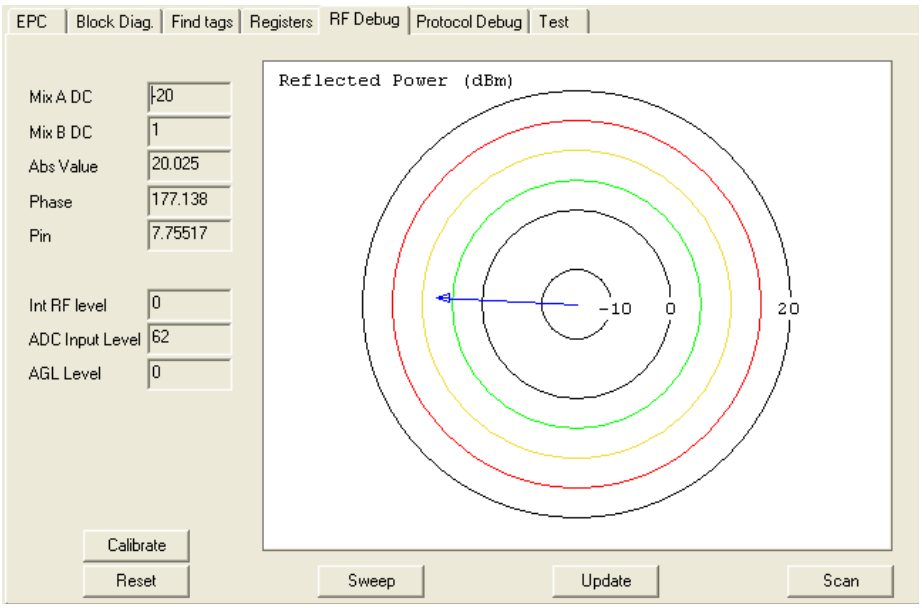
The content of the registers in AS3990 can be read and written in the ***Registers*** tab. Do not alter the register content unless you are familiar with the functions described in the AS3990 specifications. If you change the content by mistake, press the **Set Defaults** button. The register values are updated automatically every time the user enters the Registers tab or when the Special functions on the Main Window are changed.

2.8. *RF Debug Tab*

The transmission wave propagates from power amplifier through directional device (circulator), and coax cable, and is transmitted by an antenna. Leakage or reflections on this path increase reflected (transmission) power level of the un-modulated carrier at the receiver input. (self jamming) High level of reflected power affects the receiver operation.

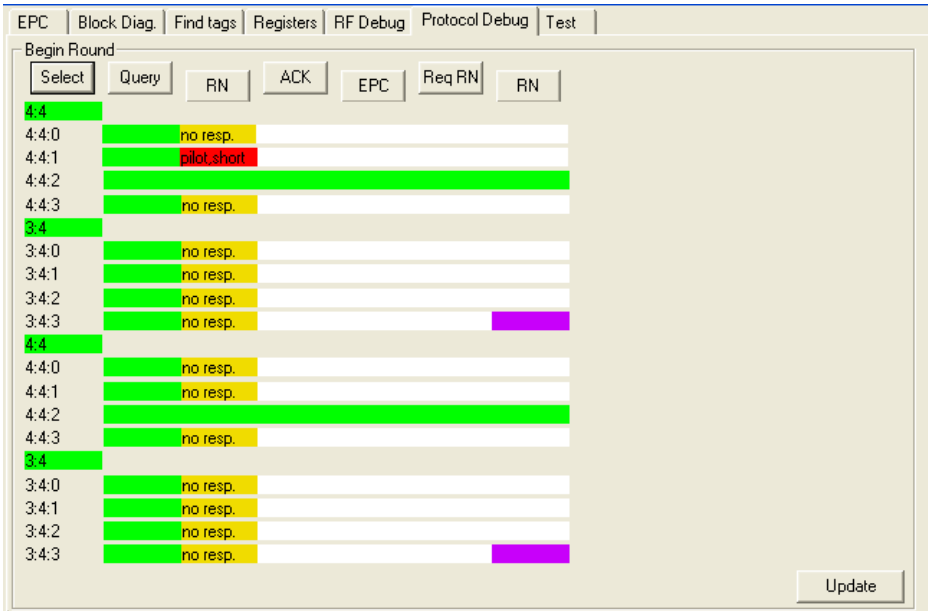
To check the reflected power level we have integrated a diagnostic system in the AS3990 which observes the amplitude and phase of the down converted received carrier. The result can be converted by DAC and read by the MCU (see device specification for details).

In the RF debug tab the amplitude and phase of the received carrier (reflected power) is shown graphically. The acceptable levels are marked by green and yellow marks. On the left side you can also observe the two values coming directly from the ADC conversion, their absolute value, phase and approximate reflected power calculated to dBm.



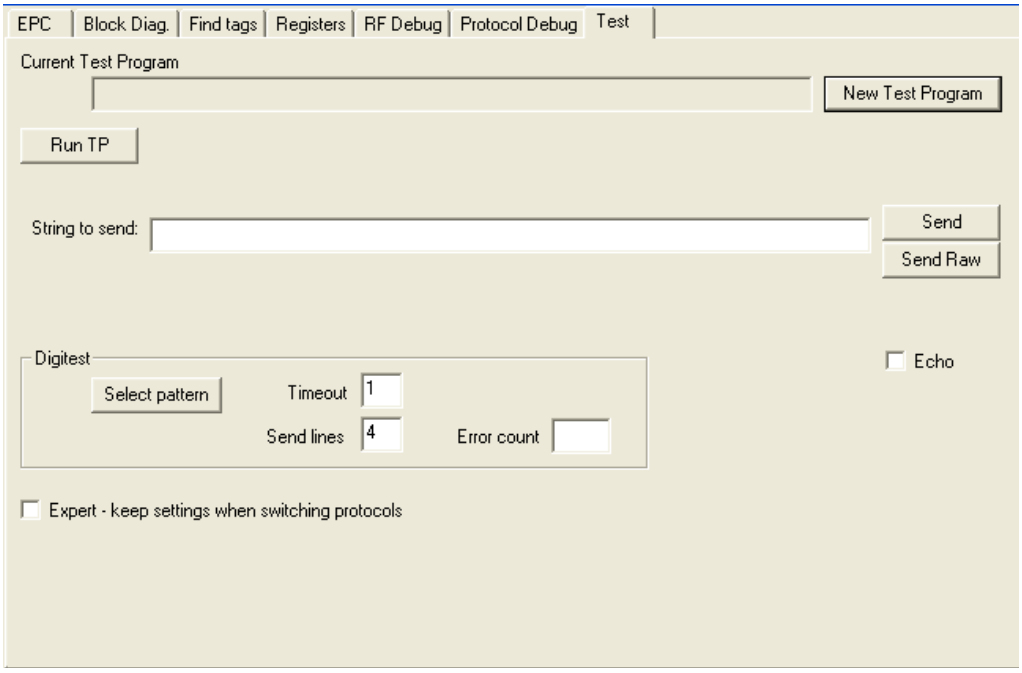
Update soft key is used update the readout on selected frequency. Scan soft key is used for continuously update. Sweep key is used to show results in a frequency domain using a wide frequency sweep. It is also possible to store the response shape by pressing calibrate key and in next sweep observe only the difference between actual reflectivity and the stored previous one.

2.9. *Protocol Debug Tab*



This tab is used to debug the EPC protocol using graphics. Details of communication required to execute one EPC operations Inventory *Round*, *Read*, and *Write* are shown. Rounds with slots and all EPC commands of communication are shown in color codes. Green color is used to show normal operation, yellow is used to show slots with no response and red is used to show unexpected slot termination. The meaning of the interrupt or error code returned by AS3990 is shown in the red area. Rounds are repeated at least twice to find all the transponders. When reader finds a round with all empty slots it assumes that all tags are inventoried. This is marked in magenta at the end of the line.

2.10. *Test Tab*



All Host to Reader commands that are described in the enclosed Interface description can be manually send in the Test tab using a string and the Send button. you simply has to fill the 'Command + parameters' field as shown. All other fields in the protocol are automatically generated by the program when **Send** button is pressed:

SOF (0x01)	Number of bytes	Number of bytes2	Command + Parameters

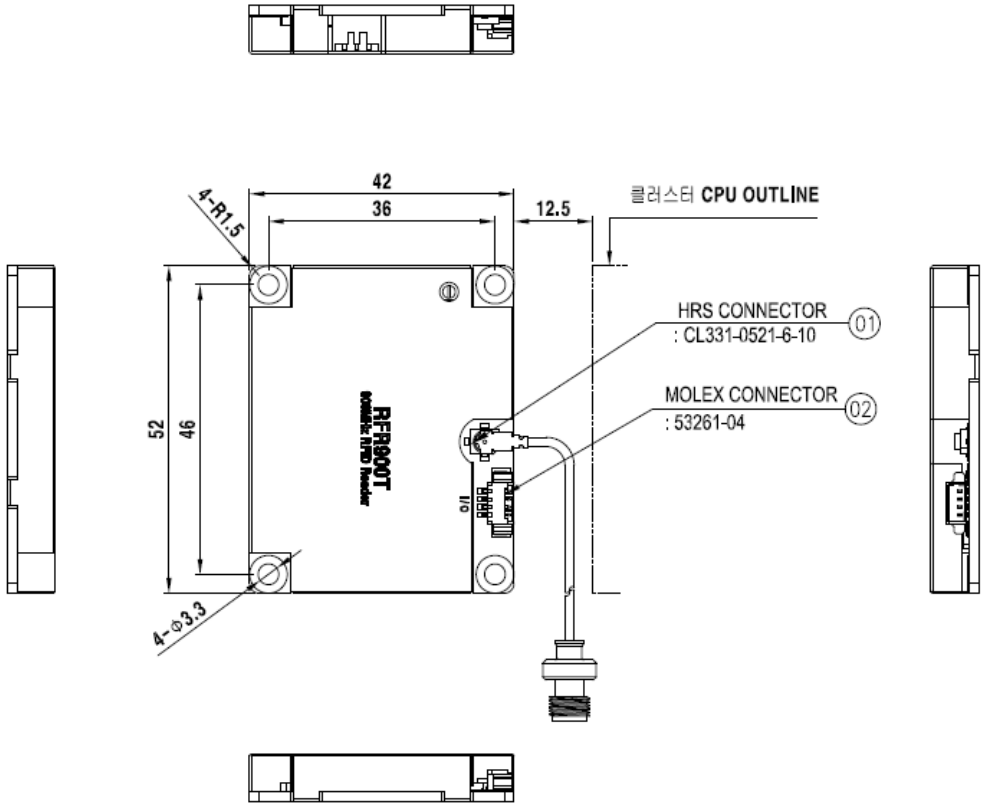
The same text can be send without the header with the **Send Raw** button. Check **Host to Reader Board Protocol** for the list of available Host-Reader commands.

- Test programs

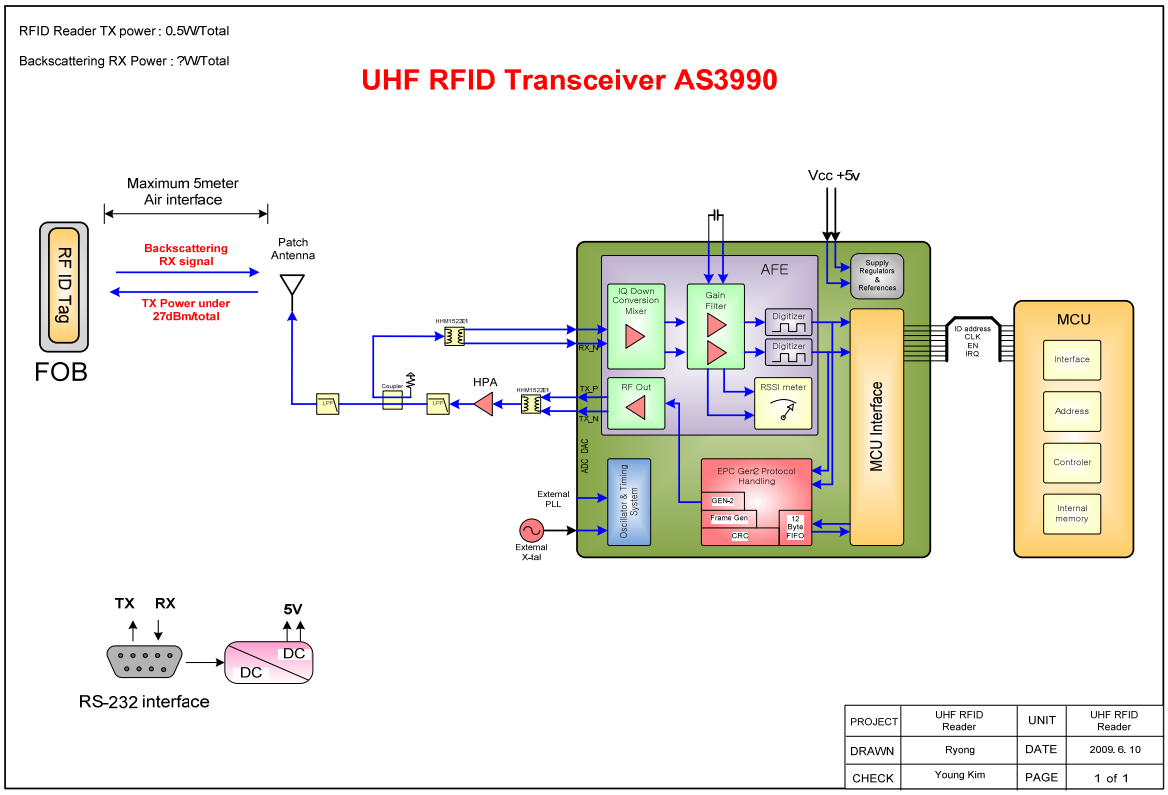
You can also write a number of Host-Reader commands that should be executed in succession in a test file. Verification of return values, loops and user interaction are also supported. Please, check syntax and samples of test programs on your CDROM.

3. Hardware Description

3.1. *DIMENSIONS*



3.2. *Block Diagram*



4. Channel List

CHANNEL NO	FREQUENCY	CHANNEL NO	FREQUENCY	CHANNEL NO	FREQUENCY
1	910.2 MHz	21	914.2 MHz	41	918.2 MHz
2	910.4 MHz	22	914.4 MHz	42	918.4 MHz
3	910.6 MHz	23	914.6 MHz	43	918.6 MHz
4	910.8 MHz	24	914.8 MHz	44	918.8 MHz
5	911.0 MHz	25	915.0 MHz	45	919.0 MHz
6	911.2 MHz	26	915.2 MHz	46	919.2 MHz
7	911.4 MHz	27	915.4 MHz	47	919.4 MHz
8	911.6 MHz	28	915.6 MHz	48	919.6 MHz
9	911.8 MHz	29	915.8 MHz	49	919.8 MHz
10	912.0MHz	30	916.0 MHz	50	920.0 MHz
11	912.2 MHz	31	916.2 MHz		
12	912.4 MHz	32	916.4 MHz		
13	912.6 MHz	33	916.6 MHz		
14	912.8 MHz	34	916.8 MHz		
15	913.0 MHz	35	917.0 MHz		
16	913.2 MHz	36	917.2 MHz		
17	913.4 MHz	37	917.4 MHz		
18	913.6MHz	38	917.6MHz		
19	913.8MHz	39	917.8 MHz		
20	914.0 MHz	40	918.0 MHz		

Hopping Table

35	**14**	**34**	**41**	**2**	**28**	**11**	**45**	**13**	**37**
25	**43**	**10**	**36**	**1**	**44**	**15**	**42**	**17**	**29**
21	**18**	**30**	**7**	**46**	**8**	**31**	**20**	**5**	**12**
47	**4**	**39**	**32**	**16**	**23**	**33**	**24**	**38**	**26**
19	**48**	**9**	**27**	**22**	**40**	**3**	**50**	**49**	**6**

Cautions

Modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC compliance Information

This device complies with part 15 of FCC Rules. Operation is subject to the following two conditions: 1. This device may not cause harmful interference, and 2. This device must accept any interference received. Including interference that may cause undesired operation.

Information to User

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.

FCC WARNING:

This equipment may generate or use radio frequency energy. Changes or modifications to this equipment may cause harmful interference unless the modifications are expressly approved in the instruction manual. The user could lose the authority to operate this equipment if an unauthorized change or modification is made.

Note Whenever any Hiwave module is placed inside an enclosure, a label must be placed on the outside of that enclosure which includes the module's
FCC ID.

FCC RF EXPOSURE:
The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the user.

This device has been designed to operate with the antennas listed below, and having a maximum gain of -0.87 dBi.
Antennas not included in this list or having a gain greater than -0.87 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.
- Patch Antenna with a gain of -0.87 dBi or less

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

FCC Guidelines for Devices Containing a Transmitter Module

The following is an extract from FCC PART 15 UNLICENSED MODULAR TRANSMITTER APPROVAL, DA 00-1407, Released: June 26, 2000, Section 6 describing labeling requirements for devices containing a modular transmitter.

> Section 6. The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: XYZMODEL1” or “Contains FCC ID: XYZMODEL1.” Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement.

In the latter case, a copy of these instructions must be included in the application for equipment authorization."

Sample Label for host equipment containing HW-RFR900T

Contains Transmitter Module FCC ID: XWPHW-RFR900T

Model : HW-RFR900T
FCC ID:XWPHW-RFR900T
HIWAVE,Inc **Made in Korea**

This device complies with part of the FCC Rules.
Operation is subject to the following two conditions:
(1)This device may not cause harmful interference,and
(2)This deivcemust accept any interference received,