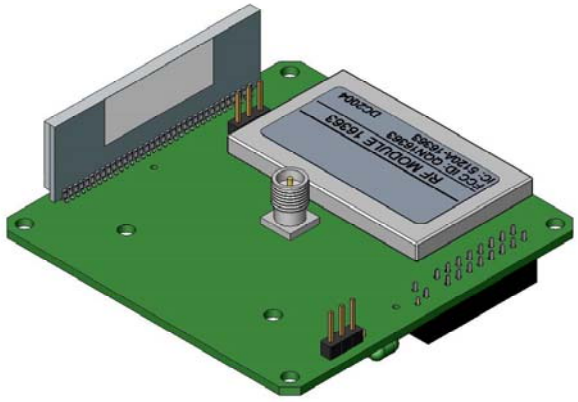
ACCUTECH / ADAPTIVE INSTRUMENTS CORP.

RF Module

Product Manual v1.0.0
For Adaptive Instruments RF Module part number WI-MODULE-915 (16363)



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Introduction

Accutech Wireless Instrumentation products utilize a wireless radio protocol to communicate between field units and base radios. Field units generally contain various types of sensors for measuring physical parameters such as pressure or temperature. Base radios accumulate the data from field units and serve as the link to control systems or data logging/collecting PCs.

The wireless radio protocol operates in the 900 MHz band assigned by the FCC as the Instrument, Scientific and Medical (ISM) band. By following the guidelines set forth by the FCC, in part 15 of their regulations, for products operating in the ISM band, Accutech has obtained FCC Equipment Authorization QQN16363 allowing users of this equipment to operate the devices without obtaining an FCC license covering radio operation for the site where the equipment is to be used. Operation without a site license is known as "license-free" operation and is enabled by the FCC Equipment Authorization label.

The wireless communications operate between 902 MHz and 928 MHz. The protocol employs several techniques to achieve secure, error-free communications. These techniques include:

- Frequency Hopping Spread-Spectrum (FHSS) techniques as dictated by the FCC to alter the wireless carrier frequency to suppress possible interference from other radio signals, while at the same time minimizing possible interference to other radio signal devices.
- Frequency Shift Keying (FSK) techniques to modulate data bits onto the underlying analog carrier frequency.
- A flexible Time Division Multiple Access (TDMA) technique to allow multiple field units to communicate with a base radio in a deterministic manner to guarantee timely transmission of process variable information and to allow higher bandwidth communications for sending/receiving of field unit configuration, diagnostic or other data.
- Multiple frequency hopping patterns to allow several radio networks to co-exist in a single radio cell without interfering with each other.
- Message synchronization bit stream to match the communication timing of field units to the base radio.
- Manufacturer Identification Code to ensure message security between a base radio and field units.
- Send-Receive Acknowledgement techniques where every communication initiated by the Base-Radio or by the Field-Unit is acknowledged by its intended receiver.

The following document details the interface to a field unit radio card, which allows an external microprocessor driven device to communicate on an Accutech radio network.

Specifications

WI-MODULE-915 OEM RF Module Specification	
Performance	
Transmit Power	20 mW
Range	Up to 3000’
Interface Data Rate	19,200 bps, 8 data bits, 1(even)parity, 1 stop
RF Data Rates	9600, 19200, 76800 bps
Receiver Sensitivity	-110 dBm typical
Power Requirements	
Receive Current	45 mA typical
Transmit Current	55 mA typical
Sleep Current	40 uA typical
General	
Frequency	902 – 927 Mhz
Spread Spectrum	FHSS (Frequency Hopping Spread Spectrum)
Modulation	FSK (Frequency Shift Key)
Physical Properties	
Module Size	2.7” X 2.7” X
Connector	20 Pin (0.100 dual row spacing)
Operating Temperature	-40°C - 85°C
Antenna Connection	
Connector	RPSMA (Reverse Polarity SMA)
Impedance	50 Ohms
Certifications	
FCC Part 15.247	WI-MODULE-915

System Architecture

The field unit radio card and attached external device fit into a larger system as illustrated below in Figure 1.

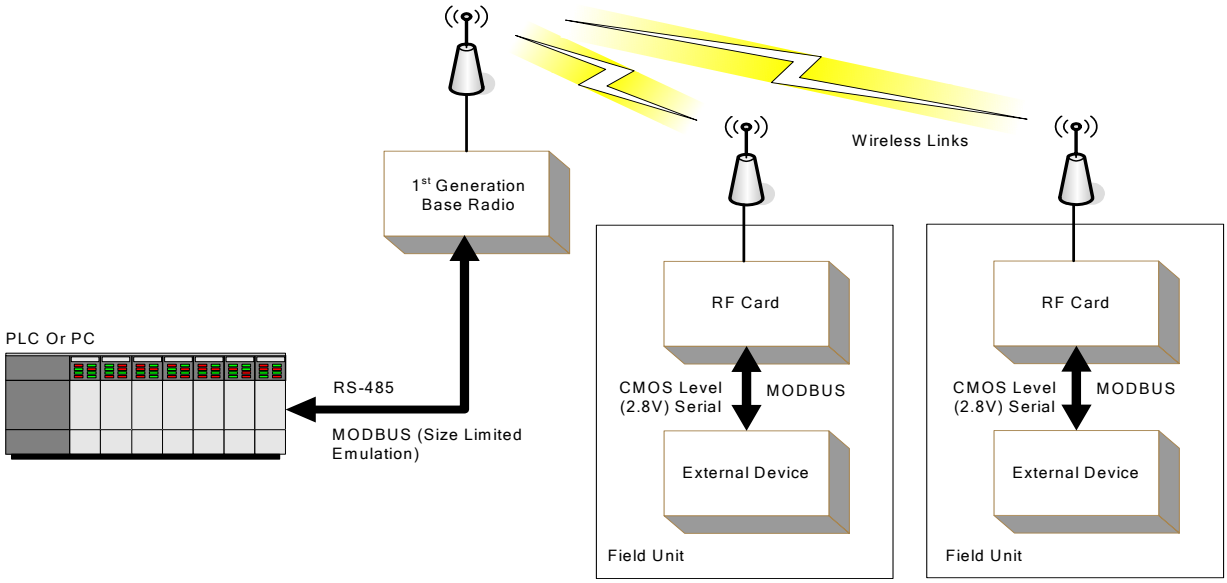


Figure 1: Present 1st Generation System Architecture

Multiple field units can communicate with a single base radio, transmitting measurement and diagnostic information and allowing configuration settings to be both read and written. Data from the field unit can be accessed via the base radio through a MODBUS/RS-485 connection. Due to limited memory resources in the current generation base radio, the MODBUS emulation of an external device is limited in the number of pieces of data available. The system will be functionally complete however including full read/write access to configuration settings and diagnostic information on the external device. A second-generation base radio is currently being developed by Accutech and will be available in the near future. The major difference between the current product offering and the new base radio will be the use of a more powerful microprocessor with greater memory resources and the addition of a 10/100 MBit Ethernet port. With this hardware configuration, a full MODBUS emulation of an external device attached to a field unit radio card will be possible both on a RS-485 serial interface as well as a MODBUS TCP/IP interface. Additionally, a TCP/IP based version of a proprietary Accutech protocol called Device Management & Monitoring Protocols (DMMP) will be available, which will allow the system to be interfaced with an OPC server/client operating on a PC.

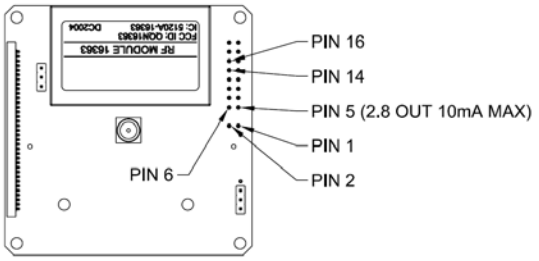
Radio Card Electrical Interface

Accutech's field unit radio card may be interfaced through a dual row, 20-pin female header socket with 0.1 inch spacing between connections. Pins 14 and 16 are used for asynchronous serial communications between the microcontroller located on the radio card and an external device. Serial communications is full duplex at CMOS levels (2.8 volts). Table 1 shown below lists pins on the interface connector to the radio card. Note that pins marked, as No Connection must not be electrically connected on the external device.

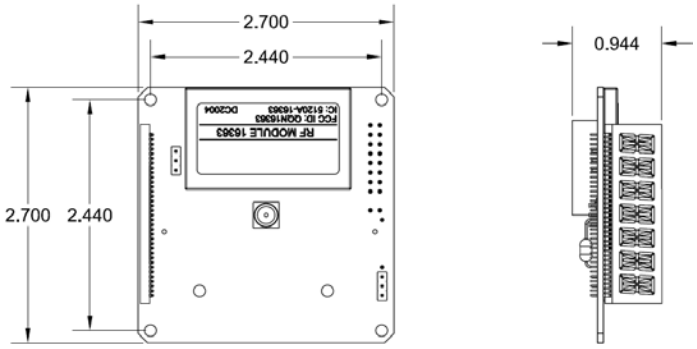
The radio card may be operated from either an on-board battery or when available, from 3.0 to 5.0 volts power supplied by the external device through Pin 1. Note that if an on-board battery is in use, the external device cannot connect to Pin 1.

Pin Number	Description
1	+3.6 Volts (Battery or External 3.0 To 5.0 Volt Supply)
2	Ground
3	No Connection
4	No Connection
5	+2.8 Volts (Regulated Output From Radio Card, 10 mA Maximum Output Current)
6	Ground
7	No Connection
8	No Connection
9	No Connection
10	No Connection
11	No Connection
12	No Connection
13	No Connection
14	Radio Card Transmit Line/External Device Receive Line – CMOS Level (2.8 volts)
15	No Connection
16	Radio Card Receive Line/External Device Transmit Line - CMOS Level (2.8 volts)
17	No Connection
18	No Connection
19	No Connection
20	No Connection

Table 1: Radio Card Electrical Interface



Radio Card Mechanical Drawings



Radio Card Communications Interface

Accutech's field unit radio card uses the MODBUS communications protocol to communicate with an external device. The radio card operates in MODBUS Master Mode using RTU (Remote Terminal Unit) transmission mode as specified by MODBUS-IDA.org in the "MODBUS Application Protocol Specification V1.1A" and "MODBUS over Serial Line Specification & Implementation Guide V1.0" documents. The radio card conforms to these specifications with the following exceptions/limitations.

- The communications parameters of the radio card are fixed at 19200 baud, 8 data bits, 1 (even) parity bit, and 1 stop bit.
- The physical layer is a CMOS (2.8 volts) full duplex serial link instead of a multi-drop EIA/TIA-485 line. Despite the full duplex physical layer, the card conforms to the standard master/slave response half duplex format.
- Since the communications physical layer is not multi-drop, only two devices may be present on the network – the Modbus master (i.e. the RF radio card) and the external interfacing device acting as a MODBUS slave device.
- The external interfacing device must use MODBUS slave address 1.
- The external interfacing device must map its MODBUS registers in a specified manner to guarantee operation with the radio card and to minimize variations in the radio card's firmware.

The external interfacing device is **REQUIRED** to implement the following Modbus function codes.

Function Code	Description
1 (0x01)	Read Coils
3 (0x03)	Read Holding Registers
5 (0x05)	Write Single Coil
6 (0x06)	Write Single Register
15 (0x0F)	Write Multiple Coils
16 (0x10)	Write Multiple Registers
17 (0x11)	Report Slave ID

Table 2: Required Slave Function Codes

The external device may **OPTIONALLY** implement the following function codes.

Function Code	Description
8 (0x08)	Diagnostics
11 (0x0B)	Get Comm Event Counter
12 (0x0C)	Get Comm Event Log
20 / 6 (0x14 / 0x06)	Read File Record
21 / 6 (0x15 / 0x06)	Write File Record

Table 3: Optional Slave Function Codes

Function codes 20 and 21 can be customized to be application specific and may be used for features such as firmware uploads to the external device or reading/writing binary data such as calibration tables.

Three types of register data may be accessed by the radio card on the external device with the Read Holding Registers, Write Single Register, and Write Multiple Registers commands. The data includes:

- Primary measurement data from the external device.
- Secondary measurement/diagnostic data from the external device.
- User configuration data for both the radio card and the external device.

Additionally, a number of MODBUS coils are available and may be read/written using the Read Coils, Write Single Coil, and Write Multiple Coils commands.

Primary measurement data is as the name implies, the main information generated by the external device. This data is sent in a deterministic manner across the radio network and is guaranteed to be received by the base radio in a timely manner.

Secondary measurement/diagnostic data is less time critical information generated by the external device. This data will be monitored by the radio card's microcontroller, which will look for a change in value. If any of the data changes, the new value will be transmitted across the radio network link as soon as network bandwidth is available. Secondary measurement data includes a user-defined number of coils, which like the register-based data will be monitored by the radio card looking for changes in values.

Configuration data includes settings for both the radio card and the external device. Unlike the primary and secondary measurement data, this data may be read from or written to by the radio card to allow settings to be changed from a distance over the radio link. The operation of the radio card may be configured by the external device, avoiding the need to access the radio card through its normal pushbutton/LCD display user interface.

Table 4 describes the global register map that is **REQUIRED** to be implemented in the external device's MODBUS slave implementation. Details on each address are given later in this document in both text and additional tables. All addresses are shown in Modicon address format. To convert an address to a register number, subtract 40001. Also note that certain address ranges are reserved in case additional functionality is added to the radio card interface in the future. The set of features described in this document will always be present although may be a subset of functionality in future implementations.

Starting Address	Ending Address	Description
40001	40099	Radio Card Configuration Registers
40100	40199	External Device Primary Measurements Registers
40200	40499	External Device Secondary Measurements Registers
40500	44999	External Device Configuration Registers

Table 4: Register Map Overview

Radio Card Configuration Registers

The operation of the radio card may be controlled by the external device through the settings in a number of configuration registers. The radio card will periodically read the value of these registers from the slave and set its own internal configuration accordingly. Table 5 shows the **REQUIRED** mapping scheme on the external device for these configuration registers.

Register Address	Description	Radio Card Access Rights	Register Type
40001	Radio Card Channel Configuration	Read Only	16-Bit Unsigned Integer
40002	Radio Card Baud Rate Configuration	Read Only	16-Bit Unsigned Integer
40003	Radio Card Network ID Configuration	Read Only	16-Bit Unsigned Integer
40004 – 40099	Reserved For Future Use	----------	----------

Table 5: Radio Card Configuration Register Map

Register 40001, Radio Card Channel Configuration, controls the RF hopping sequence/channel that is in use by the radio card. This setting must match the setting in use on the base radio with which the device is communicating. Valid values for this register are shown below in Table 6.

Value	Channel
0	RF communications disabled/OFF
1	RF Channel 1
2	RF Channel 2
3	RF Channel 3
4	RF Channel 4
5	RF Channel 5
6	RF Channel 6
7	RF Channel 7
8	RF Channel 8
9	RF Channel 9
10	RF Channel 10
11	RF Channel 11
12	RF Channel 12
13	RF Channel 13
14	RF Channel 14
15	RF Channel 15
16	RF Channel 16

Table 6: Radio Card RF Channel Configuration Register

Register 40002, Radio Card Baud Rate Configuration, controls the RF baud rate that is in use by the radio card. Once again, this setting must match the setting on the base radio with which the device is communicating. Valid values for this register are shown Table 7.

Value	RF Baud Rate
0	4800 Baud
1	19200 Baud
2	76800 Baud

Table 7: Radio Card RF Baud Rate Configuration Register

Register 40003, Radio Card Network ID Configuration, controls the RF network address that is in use by the radio card. Valid values are 0 to 50 with a value of 0 disabling the device. The setting must be unique for the RF network on which the radio card is communicating and must not be duplicated by any other field unit communicating on the same RF channel.

Note that registers 40001, 40002, and 40003 may only be set by the external device and the radio card only has read access rights for these registers. If these registers are not set to valid values by the external device, the radio card will not function properly and will not establish a communications link with a base radio. For further details of the configuration of these registers, please consult Accutech user manuals for the base radio and field units.

Primary Measurement Registers

Table 8 illustrates the **REQUIRED** mapping scheme on the external MODBUS slave device for the primary measurement data registers.

Register Address	Description	Radio Card Access Rights	Register Type
40100	Number Of Primary Measurements	Read Only	16-Bit Unsigned Integer
40101	Primary Measurement Polling Rate	Read Only	16-Bit Unsigned Integer
40102	External Device Type	Read Only	16-Bit Unsigned Integer
40103	External Device Status	Read Only	16-Bit Unsigned Integer
40104-40109	Reserved For Future Use	----------	----------
40110	Primary Measurement Value 1	Read Only	Variable
40111			
40112	Primary Measurement Value 2	Read Only	Variable
40113			
40114	Primary Measurement Value 3	Read Only	Variable
40115			
40116-40199	Reserved For Future Use	----------	----------

Table 8: External Device Primary Measurement Register Map

Register 40100 configures the number of primary measurements in use by the external device. Valid values are 0 through 3. If set to 0, the radio card will only read the value of registers 40102 and 40103, the External Device Type and the External Device Status. If set to 1, the radio card will not only read the value of register 40102/40103 but will also read registers 40110/40111, Primary Measurement Value 1. If set to a value of 2, the radio card will additionally read registers 40112/40113, Primary Measurement Value 2, etc.

Register 40101, the Primary Measurement Polling Rate, configures the rate in seconds at which the radio card will poll the external device for its primary measurement data. Valid values for this register are 1 through 60.

Register 40102, the External Device Type, specifies the type of external device interfaced to the field unit radio card. Valid values are 0 to 255.

Register 40103 indicates the current status of the external device. This is a bitfield variable with additive values possible. For example, if a system error and an active alarm condition exist in the external device, the value of this register should be 18 (16 + 2). The specific meaning of each bit in the register are shown below in Table 9.

Value	Status
0	No errors/warnings.
2	Alarm active.
4	Measurement/sensor error.
8	Measurement overrange.
16	System error.
32-128	Reserved for future use.

Table 9: External Device Status

Primary measurement data occupies two MODBUS registers may be a number of different data types including 32-bit IEEE floating point numbers, bit fields, integers, or any other data type as defined by the external device and application. The radio card may only read primary measurement data. The radio card will transmit one primary measurement value plus the External Device Type and Status per radio transmission. The measurement values will be sent in a round-robin manner. If the external device uses three primary measurement values, Primary Measurement Value 1 will be sent first, then the Primary Measurement Value 2, and lastly Primary Measurement Value 3 before the Primary Measurement Value 1 is sent again.

Secondary Measurement Registers

Table 10 shows the **REQUIRED** mapping scheme on the external MODBUS slave device for the secondary measurement data registers.

Register Address	Description	Radio Card Access Rights	Register Type
40200	Number Of Secondary Measurements	Read Only	16-Bit Unsigned Integer
40201	Number Of Coils	Read Only	16-Bit Unsigned Integer
40202	Secondary Measurements Polling Rate	Read Only	16-Bit Unsigned Integer
40203-40209	Reserved For Future Use	----------	----------
40210	Secondary Measurement 1 Data Size	Read Only	16-Bit Unsigned Integer
40211	Secondary Measurement 1 Value	Read Only	Variable
40212	Secondary Measurement 1 Value (If Applicable)		
40213-40219	Reserved For Future Use	----------	----------
40220	Secondary Measurement 2 Data Size	Read Only	16-Bit Unsigned Integer
40221	Secondary Measurement 2 Value	Read Only	Variable
40222	Secondary Measurement 2 Value (If Applicable)		
40223-40229	Reserved For Future Use	----------	----------
40230	Secondary Measurement 3 Data Size	Read Only	16-Bit Unsigned Integer
40231	Secondary Measurement 3 Value	Read Only	Variable
40232	Secondary Measurement 3 Value (If Applicable)		
40233-40239	Reserved For Future Use	----------	----------
…	…	…	…
40460	Secondary Measurement 25 Data Size	Read Only	16-Bit Unsigned Integer
40461	Secondary Measurement 25 Value	Read Only	Variable
40462	Secondary Measurement 25 Value (If Applicable)		
40463-40499	Reserved For Future Use	----------	----------

Table 10: External Device Secondary Measurement Register Map

Register 40200 configures the number of secondary measurements in use by the external device. Valid values are 0 through 25.

Register 40201 configures the number of coils that are in use in addition to the register based secondary measurement data. Valid values are 0 through 64.

Register 40202 configures the rate in seconds at which the radio card will poll the external device for its secondary measurement data as defined by Register 40200, Number Of Secondary Measurements. Valid values are 1 through 60.

Secondary measurement values are offset from each other by 10 addresses with the first value mapped to address 40211. To allow flexibility for the external device, secondary data may any data type occupying 1 or 2 MODBUS registers including 32-bit IEEE floating point numbers, bit fields, integers, or any other data type as defined by the external device and application. Each secondary measurement value has a data size register associated with it to indicate to the radio card the length in number of MODBUS registers of the data. As shown in Table 11, valid values of the Secondary Measurement Data Size are 1 or 2.

Value	Data Size
1	1 MODBUS register of data
2	2 MODBUS registers of data

Table 11: Register Data Size

The secondary data values are read by the radio card at a rate set by register 40201, the Secondary Measurements Polling Rate. The radio will keep track of the current value of the numbers of registers of secondary data (as specified by Register 40200 and the Secondary Measurement Data Size register for each value) looking for a change in value. If a value changes, the new value will be transmitted across the radio link as soon as possible. Unlike primary measurement data which is transmitted in a deterministic manner, bandwidth for secondary data transmissions must be requested from the base radio and due to the limited bandwidth of the radio network, may not be immediately available depending upon the loading of the network with similar requests from other field units.

External Device Configuration Registers

Table 12 shows the **REQUIRED** mapping scheme for the external device configuration settings.

Register Address	Description	Radio Card Access Rights	Register Type
40500	Number Of Configuration Settings	Read Only	16-Bit Unsigned Integer
40501	Configuration Setting Change	Read/Write	16-Bit Unsigned Integer
40502-40509	Reserved For Future Use	----------	----------
40510	Configuration Setting 1 Data Size	Read Only	16-Bit Unsigned Integer
40511	Configuration Setting 1 Read/Write Access Type	Read Only	16-Bit Unsigned Integer
40512	Configuration Setting 1 Value	Read/Write	Variable
40513	Configuration Setting 1 Value (If Applicable)		
40514-40519	Reserved For Future Use	----------	----------
40520	Configuration Setting 2 Data Size	Read Only	16-Bit Unsigned Integer
40521	Configuration Setting 2 Read/Write Access Type	Read Only	16-Bit Unsigned Integer
40522	Configuration Setting 2 Value	Read/Write	Variable
40523	Configuration Setting 2 Value (If Applicable)		
40524-40529	Reserved For Future Use	----------	----------
40530	Configuration Setting 3 Data Size	Read Only	16-Bit Unsigned Integer
40531	Configuration Setting 3 Read/Write Access Type	Read Only	16-Bit Unsigned Integer
40532	Configuration Setting 3 Value	Read/Write	Variable
40533	Configuration Setting 3 Value (If Applicable)		
40534-40539	Reserved For Future Use	----------	----------
…	…	…	…
45000	Configuration Setting 500 Data Size	Read Only	16-Bit Unsigned Integer
45001	Configuration Setting 500 Read/Write Access Type	Read Only	16-Bit Unsigned Integer
45002	Configuration Setting 500 Value	Read/Write	Variable
45003	Configuration Setting 500 Value (If Applicable)		
45004-45009	Reserved For Future Use	----------	----------

Table 12: External Device Configuration Register Map

Register 40500 configures the number of configuration settings in use by the external device. Valid values are 0 through 500.

Register 40501 is used by the external device to indicate to the radio card that one of the configuration settings has changed locally. A value of 0 indicates that there has been no change and a value of 1 indicates that there has been a change since the radio card has last read the configuration data. The radio card has read/write privileges with this register to allow it to clear the value back to 0 after the new configuration settings have been read.

Like secondary measurement values, configuration settings are offset from each other by 10 addresses with the first value mapped to address 40512. Also like secondary data values, configuration data may be any data type occupying 1 or 2 MODBUS registers as specified in the associated Configuration Setting Data Size register including 32-bit IEEE floating point numbers, bit fields, integers, or any other data type as defined by the external device and application. Configuration settings have an additional MODBUS register associated with each parameter to indicate the read/write access rights of the radio card for each configuration setting. A value of 0 indicates the radio card may only read the configuration setting while a value of 1 indicates that the radio card has both read and write access rights.

Value	Access Type
0	Read Only
1	Read/Write

Table 13: Configuration Data Access Types

Due to the limited bandwidth of the radio network, configuration settings will be transmitted over the radio link upon power up, if a value has been changed, or if a device connected to the base radio on the other side of the radio link requests the current value of a configuration setting.

Base Radio MODBUS Mapping

Once data from an external device attached to a field unit radio card is transmitted across the wireless network to the base radio, it is available for use by an external MODBUS master such as a PLC or PC. The base radio operates in MODBUS Slave Mode using RTU (Remote Terminal Unit) transmission mode as specified by MODBUS-IDA.org in the "MODBUS Application Protocol Specification V1.1A" and "MODBUS over Serial Line Specification & Implementation Guide V1.0" documents. More details concerning the MODBUS implementation of the base radio may be found in Accutech's Wireless Base Radio User Manual.

For use with the field unit radio cards/external interfacing devices described in this document, a new MODBUS register mapping is used. The mapping is shown below in Table 14.

Base Radio Register Address	Description	External Access Rights	Register Type
40001	External Device Type	Read Only	16-Bit Unsigned Integer
40002	External Device Status	Read Only	16-Bit Unsigned Integer
40003-40099	Reserved For Future Use	----------	----------
40100	Primary Measurement Value 1	Read Only	Variable
40101			
40102	Primary Measurement Value 2	Read Only	Variable
40103			
40104	Primary Measurement Value 3	Read Only	Variable
40105			
40106-40199	Reserved For Future Use	----------	----------
40200	Secondary Measurement 1 Value	Read Only	Variable
40201	Secondary Measurement 1 Value (If Applicable)		
40202-40209	Reserved For Future Use	----------	----------
40210	Secondary Measurement 2 Value	Read Only	Variable
40211	Secondary Measurement 2 Value (If Applicable)		
40212-40219	Reserved For Future Use	----------	----------
…	…	…	…
40440	Secondary Measurement 25 Value	Read Only	Variable
40441	Secondary Measurement 25 Value (If Applicable)		
40442-40499	Reserved For Future Use	----------	----------
40500	Configuration Setting 1 Value	Read/Write	Variable
40501	Configuration Setting 1 Value (If Applicable)		
40502-40509	Reserved For Future Use	----------	----------
40510	Configuration Setting 2 Value	Read/Write	Variable
40511	Configuration Setting 2 Value (If Applicable)		
40512-40519	Reserved For Future Use	----------	----------
…	…	…	…
44990	Configuration Setting 500 Value	Read/Write	Variable
44991	Configuration Setting 500 Value (If Applicable)		

44992-44999	Reserved For Future Use	----------	----------

Table 14: Base Radio MODBUS Mapping For A Single Field Unit

The table shown above corresponds to the mapping for a single field unit. In this implementation, data for each field unit present in the system is associated with a single MODBUS slave address/device ID. Although all the data is physically located on the base radio, a number of "virtual" MODBUS slave are created and the base radio will respond to messages for a number of MODBUS slave addresses. This behavior is identical to the device ID mapping mode (DEVMODE) described in Accutech's Wireless Base Radio User Manual, which should be consulted for further information.

Appendix A: Agency Certifications

FCC Certification

The WI-MODULE-915 Module complies with Part 15 of the FCC rules and regulations. Compliance with labeling requirements, FCC notices and antenna regulations is required.

Labeling Requirements

In order to inherit Adaptive Instruments Corp. FCC Certification, OEM's and integrators are required to publish the test shown in Figure A-01 on the final product and within the final product operation manual.

WARNING	The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown in the figure below.

Contains FCC ID: QQN16363
The enclosed device complies with Part 15 of the 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.

Figure A.1 Required FCC Label for OEM products containing the WI-MODULE-915 OEM RF MODULE

FCC Notices

Adherence to the following is required:

IMPORTANT: The WI-MODULE-915 modules have been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by Adaptive Instruments Corp. could void the user's authority to operate the equipment.

IMPORTANT: OEM's must test their final product to comply with unintentional radiators (FCC section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

IMPORTANT: The WI-MODULE-915 RF Modules have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

NOTE:

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 receiving module.

- Connect the equipment into an outlet on a circuit different from that to which the receiving module is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Antenna Warning

WARNING: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in Table ## of Appendix A. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the table must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).

FCC-Approved Antennas (900 MHz)

RF Exposure

(This statement must be included as a CAUTION statement in OEM product manuals.)

WARNING: This equipment is approved only for base station transmitting devices. 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 operating in conjunction with any other antenna or transmitter.

To fulfill FCC Certification requirements:

1. **Integrator must ensure required test [Figure A.1] is clearly placed on the outside of the final product.**
2. **WI-MODULE-915 may be used only with Approved Antennas that have been tested with this module. [Refer to Table A.1 – A.2]**

Part Number	Type	Connector	Gain	Application
16529	¼ Wave Whip	RPSMA		Fixed / Mobil
SSA16597	½ Wave Whip	RPSMA		Fixed / Mobil

Table A.1 Approved Antennas All RF Baud Rates

Part Number	Type	Connector	Gain	Application
17151(Y8963)	3 – Element Yagi	RPTNC	6 dBd	Fixed
(Y8966)	6 – Element Yagi	RPTNC	9 dBd	Fixed
(FG9023)	Fiberglass Base Station	RPTNC	3 dBd	Fixed
17152(FG9026)	Fiberglass Base Station	RPTNC	6 dBd	Fixed

Table A.2 Approved Antennas RF Baud Rates 19200 and 76800 bps