L.R. Nelson Corporation
One Sprinkler Lane
Peoria, IL 61615

OEM Manual
8602 Radio Module

General Information

The 8602 module was designed for
point to point operation between a pair of modules, one designated as master and the other designated as slave. Point to multi-point is not supported.

Features

- The Radio module contains it's own shielding, alleviating the need for the final product that the module is used in from having to have it's own shielding.
- All operations of the radio portion of the unit are controlled by the on-board micro controller and thus transparent to the system integrator. All that is required is to issue serial commands.
- The power supplies to the RF portions of the radio are regulated on-board alleviating the need for strict power supply regulation to maintain compliance.
- The antenna is permanently attached to the unit, alleviating the need for additional labor installing an antenna.

L.R. Nelson Radio Transceiver

Radio Frequency	ISM 2.4 GHz
Frequency Range	2.455-2.467 GHz
Type	FHSS
Power Output	30mW
Receiver Sensitivity	-105dBm
Range LOS	1000ft/300m
Air Baud Rate	2400bps
Operating Temp	-23 to 65°C
Storage Temp	-29 to 80°C
Power Consumption (5V)	idle 40mA, Rx 110mA, Tx 170mA
Hardware Interface	TTL Serial, 9600b, 8 data, 1 stop, no parity
Software Interface	Nelson Serial Protocol

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Requirements for compliance

- The antenna must be kept intact to maintain compliance. Alternative antennae are not supported.
- The metal housing must be kept intact to maintain the module's shielding properties. The module must be kept unmodified as received except for straightening the antenna if it is received out-of-shape due to shipping.
- If the FCC ID tag is not visible when the module is installed, then the outside of the device into which the module is installed must display a label referring to the enclosed module. Wording such as "Contains Module FCC ID NYD8602" or "Contains FCC ID NYD8602" is sufficient. The external label must also contain the wording "This 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.
- The final product that the module is used in may be subject to other certifications not covered by the module certification such as computer accessories, etc.
- A power supply module is not supplied for the radio, therefore if it is powered by an AC source other than an EZ Pro controller, the product would be subject to testing for power-line conducted emissions.

EXPOSURE NOTICE

This device generates and radiates radio-frequency energy. In order to comply with FCC radio-frequency radiation exposure guidelines for an uncontrolled environment, this equipment has to be installed and operated while maintaining a minimum body to antenna distance of 2.5 cm."

- **Instructions must be provided to the OEM to place a statement, similar to the one above, in their manual. This statement is to inform the end users that this device does generate RF energy. The end user must be made aware of the potential exposure to RF energy.**

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Life Support Application

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. L.R. Nelson customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify L.R. Nelson for any damages resulting from such improper use or sale.

8602 Installation and Operation Tips

The 8602 Radio Module has been designed to provide the best performance possible in a wide variety of applications. The installation of the 8602 Radio Module can be of great impact on the actual performance of the radio system. The structural material of the building, the installation location in the building, local terrain, and local conditions can have a dramatic effect on the range of signal. The following tips can be very useful in gaining the best performance and range from the radio. Generally the user can expect range to be 1000 feet line of sight and 500 feet through wooden structures such as a home.

Installing an 8602 Radio Module

It is important to remember per the instructions to disconnect power to the device receiving the module before plugging in the 8602 Radio Module. Gently seat the 8602 into the connector on the interconnect board and install the two screws. Reconnect the AC power.

Radio Usage Guidelines

It is important to understand that at any particular installation we expect the performance of the radio will meet the needs of the user. The following are general guidelines.

- Outside on a pedestal, pole, or roof top will provide maximum range and performance.-**Best range**
- Mounted on an outside wall of the building. Depending on the type of structure the range on the opposite side of the building could be reduced.

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The signal must pass clear through the structure to get out the other side. –**Good range**

- Mounted on the inside of an exterior wall of a building. –**Reduced range**
- Mounted inside of a building with more than one wall to pass through before signal reaches outdoors. -**Further reduces range**
- Mounting higher is usually better than lower. It would be preferable to mount the controller above ground rather than in a basement.
- A larger building with more walls will effect range more than a small building with only a few walls.

Type of Structure

The construction material of the building can have an effect on range and performance. Wood and glass will reduce the signal. Any type of metal can greatly reduce or block the signal.

- Pedestal mount with no structure.-**Best range**
- In a residential setting the signal can be expected to pass through one to several wooden walls of a home and still generally reach to 500 feet.-**Good range**
- A brick home could reduce that range slightly-**Good range**
- A steel reinforced concrete building.-**Reduced range**
- A steel walled building**- Further Reduced range or a blocked signal**
- Performance in a small structure will usually be better than a large structure.

Local Terrain and Local Conditions

- Clear line of sight will give the best range.
- The presence of a hill or earthworks between the modules can reduce radio range.
- Walking into a low area or valley can reduce range.
- The presence of other structures or obstacles in the radio signal path can reduce range.

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- The presence of power lines or strong radio signal sources could reduce range
- Weather conditions can effect range. We have observed noticeable differences from one day to the next at the same location.

Troubleshooting

- Both units must have power for radio operation.
- Match ID Codes
- If an antenna is badly bent gently return the antenna back to its original shape.

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Technical Information

EZ Pro Controller and Command Communication Protocol Definition
Version 0.9
L.R. Nelson Corporation

This document describes the serial link protocol and packet formats used for the EZ Pro Radio system.

SYSTEM DESCRIPTION

The system is made up of two entities that require data communications over an ISM band 2.4GHz FHSS (frequency hopping spread-spectrum) radio system. In our case each entity of the system is a remote device and an irrigation controller but can be extended to any system with serial communication capabilities. The EZ Pro radio system is comprised of the EZ Pro Command (Remote) and the EZ Pro Controller (Base.) See figure below.

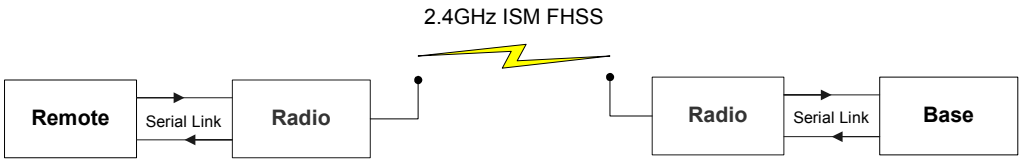

Figure 1

To initiate a communications link between the remote device and base (such as irrigation controller), the radios must first be initialized with an ID set; source and destination. A matching ID set must be set on both ends in order for a connection to take place. The ID set instructs each end of the system, the permission to speak with only to the destination device.

In order for communication to take place, a connection must be established between the two radio modules following a specific connection protocol. Once a connection is made, a data pipe is created between the remote and base units. Data transmitted by either side is packetized by the radio for RF transmission. In order to stop data transmission, a "disconnect" packet is sent by one of the two

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hosts, thus breaking the connection.
Each application side is responsible for
time-out triggers in the case of connection packet failing to reach its destination.

There are essentially two layers in the protocol stack to define operation from end-end. They are: physical layer and the data-link layer (Nelson Protocol.)

1. PHY Layer, describes the RF layer, frame format and timing information
2. DL Layer describes the TTL frame protocol between the radio module and the host.

The first section describes the data link layer (DLL) which internally has been defined as the Nelson protocol. Following this is a technical description of the RF layer dictated by the Nelson 8602 radio design.

DATA-LINK LAYER (DLL or Nelson Protocol)

All packets, whether they are local or pass-through, are formatted as shown in Figure 2. Local packets are for communication between the host and the radio module for configuration. Pass-through packets are sent from end-end once a connection is established.

CMD 1-byte	SIZE 1-byte	!SIZE 1-byte	DATA SIZE-bytes	CHK 1-byte

Figure 2: Packet Format – Pass through and local

Packet format decoding is described below. SIZE dictates the DATA payload size whereby !SIZE is the binary inversion of SIZE. CHK is the modulo 256 checksum of all bytes preceding it. Using the SIZE value and the CHK byte for verification allows for frame delimiting.

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LOCALIZED PACKETS

Local packets are packets sent between the remote/base device and the radio modules. These are used to setup the radio for a connection or to determine radio link diagnostics. All localized packets are in the format shown in Figure 2.

To Radio Module, CMD Bytes:

0x80 – Slave connect, sends 2 DATA words, low order byte first, (SRC word, a DEST word.) Places the radio into a slave connect state based on the hop group selected by the defined ID set (SRC and DEST.) SRC is the slave ID and DEST is the master ID. Once executed, the radio sends out a packet containing the ID set and the next channel of operation. It then waits for a reply from the master radio. If a reply is received without error, a connection state is set within the slave radio and data transmission can begin between the master and slave hosts.

Pin 3 on the connector must be pulled low for this command to be accepted and executed. Otherwise, it is ignored.

Slave radio acknowledges command with a Slave Connect Acknowledgement message (0x80). This message is ignored when radio-state is Test Mode. When sent during a connection, this command results in the connection being dropped and a new acquisition sequence started.

0x81 – Master dwell, sends 2 DATA words, low order byte first, (SRC word, a DEST word) from base
0x82 – Sleep, (Remote) commands the radio to power down
0x83 – Status request
0x84 – Software version request
0x85 – Test Mode, Enable/Disable - sends 5 DATA bytes
0x86 – Homeowner ID - sends 1 DATA byte (homeowner id - 0 to 63)
0x87 – Test Mode, Set skip - sends 3 DATA bytes ('S', 'K', n= #of packets to skip)
0x88 – Reserved
…

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0x8F – Reserved

From Radio Module CMD Bytes:

0x80 – Slave connect acknowledgement
0x81 – Master dwell acknowledgement
0x82 – Sleep acknowledgemen83h – Sends 1 DATA byte channel quality, 1 DATA byte indicating is the radio is IDLE-ing or CONNECTED.
0x84 – Software version - sends a 6 bytes packet of the format 'EZn.nn'
0x85 – No response
0x86 – Homeowner ID acknowledgement
0x87 – No response
0x88 – Reserved
…
0x8F – Reserved

PASS THROUGH PACKETS

Once a connection is made between the two radios, certain CMD codes allow the packets to be passed through from the remote to the base system. Examples are shown below using the Nelson protocol for irrigation.

From the Remote to Base, CMD Bytes:
0x01 – Buttons, sends two DATA bytes.
0x03 – Disconnect Request

***From the Remote to Base, CMD Bytes*:**
0x01 – Buttons response, sends eighteen DATA bytes (16 LCD display bytes, 2 Status bytes)

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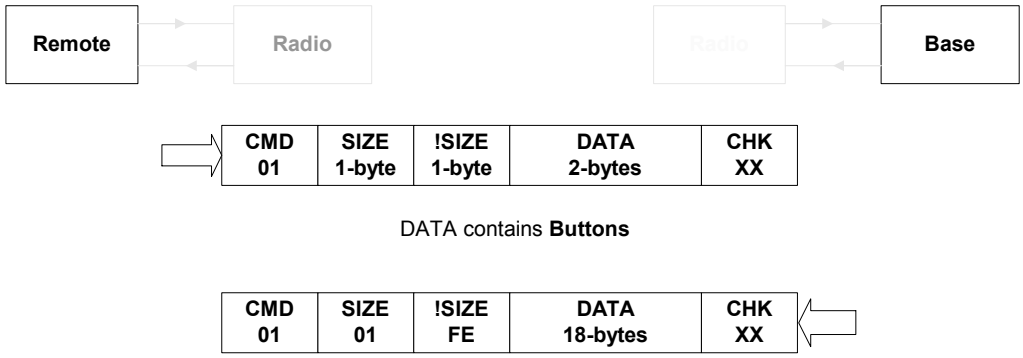

Pass Through Packets – CMD 01 sending data to & from

Pass Through Packets – CMD 03, request to disconnect

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ELECTRICAL INTERFACE

Power

Radio requires a regulated source of 4.5-5.5 volts DC at a maximum current of 170mA.

Communications interface

The serial link data-rate is 9600 baud, 8 data bits, 1 stop bit, no parity. Communications signal path is 5V TTL level only.

PINS

TX, RX & GND – Self-explanatory.

5VDC – max current required by the radio (see above.)

SRDY – When pulled low, the radio is ready to serially communicate with its host.

Master/Slave- Slave radio is defined as that which is configured with its Master/Slave pin set to logic 0. Master radio is defined as that which is configured with its Master/Slave pin set to logic 1. The EZ Pro or Command Side (Host) sets logic for either case.