# EXHIBIT 7

# USER'S MANUAL

*O'Neill Connectivities, Inc.*
*LT4LAWNIIPO*
*WLL Project #: 4691X*

# LAWNII Plus OEM

User's Manual

For Model Name: LAWNII Plus OEM
Model No.: 211

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FCC ID: LT4LAWNIIPO

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.

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## Warning:

**It is the responsibility of the installer to ensure that this device is properly installed to comply with the FCC adopted Radio frequency exposure limits. The 12 & 13 db Yagi antennas should be mounted with a minimal separation distance of 7.5cm from all persons in order to avoid RF exposures that may exceed the allowed limits. All Yagi antennas should be mounted with their main beam away from any person.**

OCI®

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*LAWNII-Plus TM* User's Manual

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O'Neill Connectivities, Inc.
2445 Maryland Road
Willow Grove, Pennsylvania 19090

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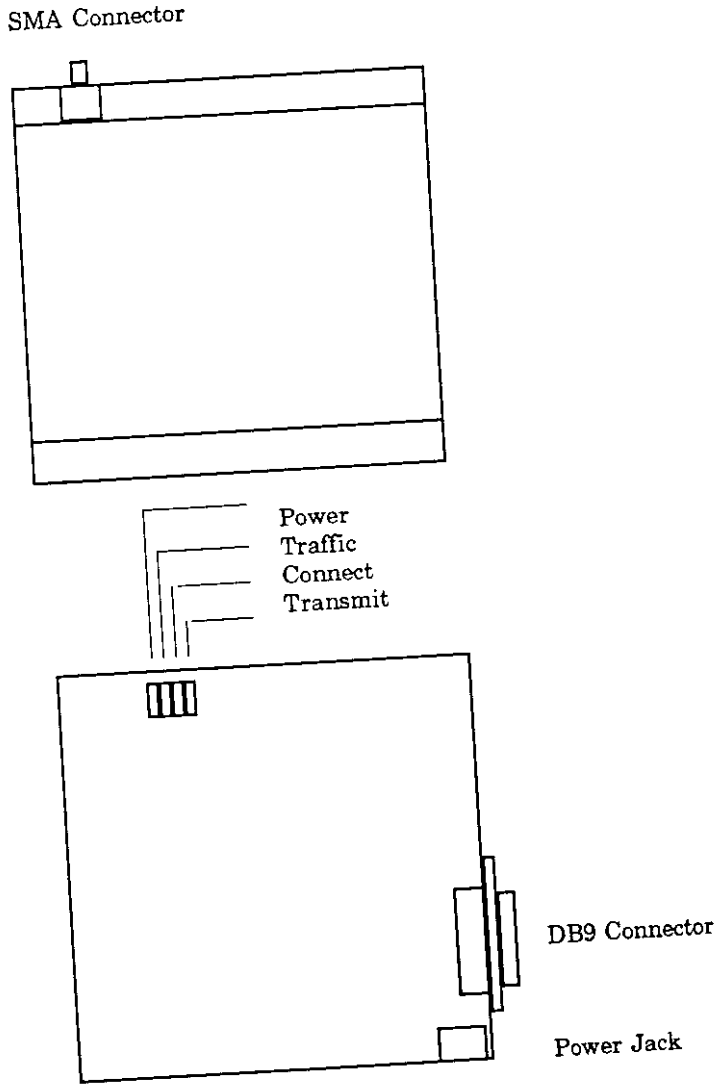
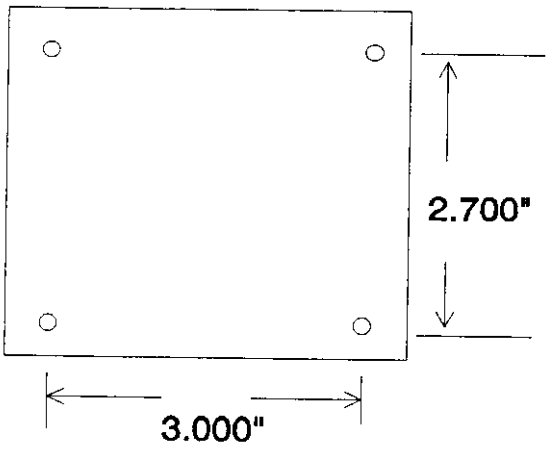
# Description of the interface connectors



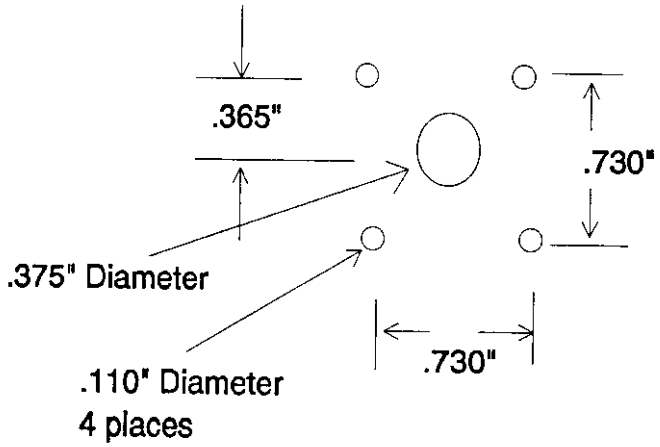
# Installation of LAWNII Plus OEM

Mounting holes location




Hole diameter: 0.1"

Antenna Connector mouting hole locations



## 0.0 Installation for *LAWNII-Plus*

1. Set the terminal to 9600,n,8,1. Select the Wyse-50 or a similar terminal. Set the terminal to HDX and choose XON/XOFF for handshaking. If you do not have a terminal, you may use a PC with a DOS based simulator program, such as PROCOMM or Carbon Copy. If you are using Windows, please refer to the next section for instructions.

2. Plug the power cube and RS-232 cable supplied by OCI to the *LAWNII-Plus*.

3. Type "‹CTRL› C" three times with one second of silence before and after the three "‹CTRL› C".

For example, wait one second without typing any key and then hold down the ‹CTRL› key and quickly hit "C" key three times and let go both keys and wait for one second.

4. The *LAWNII-Plus* should return a "cmd:" to the terminal. This indicates that the *LAWNII-Plus* is ready to accept commands.

5. If you are using *LAWNII-Plus* for multidrop applications, please follow the example 6.8 as shown in pages 35-37 to set up one master *LAWNII-Plus* and program all the other slave *LAWNII-Plus's* to be the same. For other applications, please follow the other examples. Before you start the programming, you should turn the auto-line-feed ON so that you can see the programming transaction easier.

To do this, at the command prompt, type "autolf on" and "ENTER"; the *LAWNII-Plus* will return "autolf was off" and give you a new command prompt. Now you can follow the example 6.8 and see all the transaction easily.

6. If the RS-232 port that the *LAWNII-Plus* will be interfaced with is not 9600,n,8,1, please refer to the commands as shown from pages 18-27 to change the serial port spec of *LAWNII-Plus*. Please note that some serial port spec, such as the parity and the number of bits, won't get changed right after a new spec is entered. They will be effective when a power up

restart or reset occurs. The baud rate, however, will be changed at the instant you enter a new baud rate command.

For example, if you want to change the baud rate to 38400. You will need to enter the "ab 38400" command at the command prompt. The *LAWNII-Plus* will be changed to 38400 baud instantly. You then need to change the terminal's port setting to 38400 baud so that you can still communicate with the *LAWNII-Plus*.

7. Depending upon the type of data that flows in and out of the *LAWNII-Plus*, you may optimize the system performance by using a right packet size and packet timeout. Please refer to the command set to build packets.

8. Use channel 2 or 4 for your system unless interference with the other devices or systems becomes a problem. Channel 2 or 4 locates at the center of the band and all the radio alignments are optimized for these channels.

9. The system number is the only security you have for a multidrop application. All units in the same system must have the same system number.

10. Please don't violate the following timing limit for *LAWNII-Plus* to ensure an error free communications:

a. Assuming that a *LAWNII-Plus* is running at 9600 baud with the packet length of 256 bytes and the fastest packet timeout (Pactime A 1), the data will be sent in 8 msec to 20 msec after the last data enters the RS-232 port.

b. The *LAWNII-Plus* will take up to 25 msec to process the raw data from the time that the radio receives the data to the time that the data shows up at the RS-232 port.

c. The total latency time of the system is under 50 msec which is from the time the data enters the RS-232 port of the transmitter to the time that the data appears on the RS-232 port of the receiver.

d. The latency time can be reduced significantly by running the serial port at higher baud rate and using smaller packet size. The latency time can be reduced to be less than 20 msec by running at 38400 baud with packet size of 1 byte. Smaller packet can survive a hostile environment better than a large packet and can have more coverage range. It is, however, less efficient in throughput due to the 20 bytes packet overhead.

This 38400 baud and 1 byte settings will make the *LAW NII-Plus* work just like a real cable. In some timing critical applications, like real-time remote control that requires fast data transfer, these settings are strongly recommended. The true throughput with these settings is about 600 baud

## 0.1 Using the Terminal Simulation Program from the Windows 3.1

Since the ‹Ctrl›C is a special command (CO PY) for Windows, the Windows will not send it out to the serial port when you type ‹Ctrl›C. The only way to send the ‹Ctrl›C to the serial port is by using the Function Key feature of the Windows program.

To do this, first select the "Terminal Preference" option from the "Settings" command. The menu of the terminal preference should show up. Make sure that the "CR -› CR/LF" option for both the Inbound and Outbound are unchecked. Exit the "Terminal Preference option.

Select the "Function Keys" option from the "Settings" command. First, enable the check box for "Key visible" so that the function key will become visible at the bottom of the screen. Click at the Key Name column of F1 and enter "cmd:" as the key name for F1. Click the Command column of F1 and enter "^C^C^C". The ^ key is the [SHIFT] 6 key on the keyboard. Exit the Function keys.

Select the "Communications" option from the "Settings" command. Select the port to be used to program the *LAWNII-Plus* and select the default serial port specifications. Exit the "Communications" option and click the F1 key which now should be shown with the name "cmd:".

Whenever you click the function key for "cmd:", the program will send three ‹Ctrl›C to the *LAWNII-Plus* which will return a "cmd:" to the screen and wait for your commands.

Now you can follow the examples to program the *LAWNII-Plus*.

## 0.2 Using the Terminal Simulation Program from the Windows 95

The terminal simulation program of the Windows 95 is much simpler than the Windows 3.1.

Click the hyperterminal option from the accessaries of the main program manager.

Click the icon for "Hypertrm" to create a new connection. When the connection screen come up, enter a name for this connection, for example, "*LAWNII Plus*".

Click the scroll bar for the "Connect using" option and choose the Direct Connect to COM1 or COM2 (depending upon which port the *LAWNII-Plus* is used). At this moment, the phone number entry will be grayed out.

Click the "File" and the "Property" Option and click the "Settings".

Click the "Terminal" for the "Function, arrow and Ctrl key act as ".

Click the "VT100" for the terminal type.

Click the "Configure" option to select the right serial port specs.

Now the Windows 95 will work like a terminal.

## 1.0 Overview

The *LAWNII-Plus* provides a method for two devices with RS-232 interfaces to communicate with each other by using a connection oriented service. The *LAWNII-Plus* can also support an unconnected broadcast network to replace the wired RS-485 multidrop network.

In the connection oriented service, the *LAWNII-Plus* operates by providing a virtual connection between one computer and another computer (or printer, etc.). The connection must be established before the data transfer begins. The connection is established by sending a command to the *LAWNII-Plus*. After all the data has been sent to the destination *LAWNII-Plus*, the connection can be terminated by sending another command to the *LAWNII-Plus*. Each *LAWNII-Plus* may have only one active connection at a time.

**In order for two *LAWNII-Plus's* to talk to each other, they must have the same radio channel and the same system number and each *LAWNII-Plus* must have an unique name.**

In the broadcast service, the *LAWNII-Plus* operates in the unconnected operation. In this operation, there are only two kinds of *LAWNII-Plus* in the system, the master and the slaves. All the slaves have exactly the same settings. There will be no virtual connection between the master and the slaves. When the master broadcasts a message, all the slaves will receive it while when a slave broadcasts a message, only the master will receive it. The slaves usually does not communicate to each other.

Please note that all the *LAWNII-Plus*'s from the factory is programed as a peripheral device with the name as }PRNTR. The default serial port spec is 9600,N,8,1.

## 2.0 Operation Modes

By the nature of the input and output at the RS-232 port, the *LAWNII-Plus* is operated in two modes. They are the command mode and the transparent mode. By the function of the *LAWNII-Plus*'s firmware, the *LAWNII-Plus* can be operated in a few modes, such as the peripheral mode, DFC mode, converse mode and datagram mode.

In the command mode, the input and output at the RS-232 port are "commands" which are not sent to the air. The user can change the settings and operation of the *LAWNII-Plus* by sending new commands to it. Or the user can ask the status of firmware by issuing commands to it.

For example, the user can find out how many other *LAWNII-Plus* are active in the area by sending the "MHEARD" command. The *LAWNII-Plus* will return a list of the users that recently sent packets to the air.

Or if the user like to find out the robustness of a connected link, he can issue a "RESEND 0" command to clear the resend counter before sending the data in the transparent mode. At the end of transmission, he can issue a "RESEND" command to see how many resend had occurred during the transmission. This will indicate how robust the link is.

The command mode should be activated whenever the user needs to communicate with the firmware. While in the transparent mode, all the data in and out of the serial port are data which can be either data to be sent to the air or data received from the air.

### 2.1 Command mode

The command mode is the normal mode for communication between the user and the *LAWNII-Plus's* firmware. The command mode is noted by the presence of the "cmd:" prompt from the *LAWNII-Plus* after it receives a command.

The normal operation for the command mode is for the user to send a command to the *LAWNII-Plus*, the *LAWNII-Plus* will return the prior

state for that command, and then the *LAWNII-Plus* will execute the command and return a new "cmd:" prompt to the user for the next command.

The *LAWNII-Plus* has separate queues for the input and output. Therefore, it is not necessary to wait for the response from one command before issuing another command. Flow control on the serial port will prevent overrunning the input buffer.

**Normally, the *LAWNII-Plus* will be set to the transparent mode so that it can send or receive the data for you. (That's why you bought it.) Once it is set to the transparent mode, it will always be powered up in the transparent mode.**

**If you set the *LAWNII-Plus* to the command mode to change the settings and did not return to the transparent mode before turning the power off, the *LAWNII-Plus* will be in the command mode when it's power is up unless it is programed in either the peripheral mode or the DFC mode, as described below.**

2.2 Transparent mode

The transparent mode is the normal mode for the communication between two *LAWNII-Plus*'s. In the transparent mode, all the serial port input or output are treated as data. Transparent mode is entered via the "TRANS" command. In the transparent mode, all data passed to the *LAWNII-Plus* is transmitted to another *LAWNII-Plus*. If no virtual connection is currently in effect and the *LAWNII-Plus* is not in the broadcast mode, the data will be broadcasted and the sending *LAWNII-Plus* will be heard by all other *LAWNII-Plus*'s. However, no *LAWNII-Plus* will be able to extract the data if the virtual connection is not in effect. The Traffic LED will indicate that data was received.

While in the transparent mode, the data received by a *LAWNII-Plus* is sent to that *LAWNII-Plus*'s serial port. There is no protocol between the *LAWNII-Plus* and the device that it is connected to. The data is sent unsolicited from the *LAWNII-Plus* except for the flow control that the handshaking lines may exert.

Data may be received by a *LAWNII-Plus* that is in the command mode from another *LAWNII-Plus* that is in the transparent mode. However, that data will be stored in the *LAWNII-Plus* until the *LAWNII-Plus* enters the transparent mode. If the receiving *LAWNII-Plus* fills its buffer then the transmitting *LAWNII-Plus* will hold off the sending computer through the handshake until the receiver has space for more data.

2.3 Return to command mode from transparent mode

The *LAWNII-Plus* will return to the command mode from the transparent mode if it receives a BREAK on its async input. The *LAWNII-Plus* will also return to the command mode if it receives the following wake-up sequence on the async port, [one second of no activity][^C][^C][^C][one second of no activity].

If the *LAWNII-Plus* is in the peripheral mode as described below, then the asynchronous break does not return the *LAWNII-Plus* to the command mode. (The power up or down cycle of many peripherals looks like an async BREAK.)

2.4 Peripheral mode

The factory default condition is the peripheral mode. If the MYCALL name and the DFCNAME name are the same, then the *LAWNII-Plus* is assumed to be driving a printer or something similar, and is in the peripheral mode. The peripheral mode makes the *LAWNII-Plus* as transparent as possible to the equipment it is attached.

While in the peripheral mode, the *LAWNII-Plus* does not return to the command mode after a disconnect. The *LAWNII-Plus* can only be brought to the command mode by the wake-up sequence. The ASYNC break does not return the *LAWNII-Plus* to the command mode. This prevents unintentional "break" conditions, such as the power-up or power-down of the attached equipment, from causing the *LAWNII-Plus's* to return from the peripheral mode to the command mode. While in the peripheral mode, a *LAWNII-Plus* will not send any messages to the connected peripheral, such as the "cmd:".

## 2.5 Default Connect operation

If the *LAWNII-Plus* is not in a state of virtual connection and has the default-connect-mode (DFC) enabled, then the *LAWNII-Plus* will initiate a connection to the destination *LAWNII-Plus*, that is named by the "DFCNAME" command, automatically when the data enters the serial port.

The data will then be sent after the virtual connection is established. The *LAWNII-Plus*'s will remain connected until all the data are sent. The virtual connection will be dropped when the serial port becomes quiet for some time longer than the user defined time-out. When new data arrives, the whole process will repeat.

The DFC Mode is most useful for one-to-one communication that requires 100% data integrity. The data will be re-sent automatically if the receiving unit does not send back a positive acknowledge to the sending unit. The data is guaranteed to be delivered with 100% accuracy. The user can simply treat the *LAWNII-Plus* as a smart cable that guarantees the data delivery.

The *LAWNII-Plus* exerts flow control to handle any delay in establishing the connection. The *LAWNII-Plus* remains in the transparent mode. If there is no activity on the RS-232 port for a user-defined time-out period (default = 45 seconds) then the *LAWNII-Plus* initiates a disconnection from the destination *LAWNII-Plus*. The *LAWN-Plus* remains in the transparent mode afterward without sending any message to the device it is connected to.

The *LAWNII-Plus* will enter the DFC mode when it receives the "DFC ON" command. This will cause the *LAWNII-Plus* to go into the transparent mode immediately. Power up or reset also cause the *LAWNII-Plus* to enter the transparent mode if the DFC is on.

The DFC mode has an inherent lockup potential. If a character enters the *LAWNII-Plus* and the destination *LAWNII-Plus* is busy or does not respond, the *LAWNII-Plus* will continually try to connect. The only way out is to reset the *LAWNII-Plus* or wait until the destination *LAWNII-Plus* becomes available.

## 2.6 Converse mode

The converse mode is similar to the transparent mode. The normal operation of the converse mode is for a *LAWNII-Plus* to make conversations with another *LAWNII-Plus*. The converse mode normally uses a termination character, defined by the SENDPAC command, to send a packet.

For example, two operators are using *LAWNII-Plus*'s configured in the converse mode to talk to each other and the SENDPAC character is 13h (CR). The operator can type in his words and edit them if needed. The *LAWNII-Plus* will not send the words out until the operator is finally satisfied and hits the ‹CR›.

The converse mode is not a truly transparent mode because it allows the user to edit the data. The following characters, that are needed for editing, are reserved for the converse mode,

| | | |
|---|---|---|
| BACKSPACE | 08h | delete character |
| CANLIN | 18h | cancel line |
| CANPAC | 19h | cancel packet |
| COMMAND | 03h | command mode character |
| DELETE | 07h | delete character |
| REDISPLA | 12h | re-display the current line |
| SENDPAC | 0dh | send packet |
| XOFF | 13h | stop sending character |
| XON | 11h | start sending character |

The converse mode is the only mode that the user can adjust the size of packet without going into and out of the command mode. This unique feature enables the *LAWNII-Plus* to response quickly and send data fast at the same time. Normally, these two conditions can not co-exist. A quick response from the *LAWNII-Plus* will require a small packet size which, however, will limit the throughput.

Another great feature of the Converse mode is that it can send the source and destination address of the packet along with the data to the user. All these features, however, reduce the transparency of the converse mode.

## 2.7 Datagram mode

The datagram mode provides unconnected data communications between two or more *LAWNII-Plus*'s. The data is sent as unconnected packets without protocol. The data between *LAWNII-Plus*'s is checked for errors and only correct packets are sent to the RS-232 port. The datagram mode provides a method for a user to send a message to a specific user or to all users. No acknowledgment is required and no retry is attempted. The datagram mode is only available for *LAWNII-Plus*'s operated in the transparent mode or converse mode. Only unconnected packets are monitored by a datagram *LAWNII-Plus*. This prevents the datagram *LAWNII-Plus*'s from monitoring other *LAWNII-Plus*'s traffic.

The datagram mode is enabled by the "UNPROTO" and "LCALLS" commands.

The datagram mode is designed to replace RS-485 multidrop network.

## 3.0 Operation requirements

### 3.1 Name

The name, as defined by the "MYCALL" command, consists of up to 6 characters. Each *LAWNII-Plus* needs to have an unique name, except when they are used in the datagram mode. The name may be extended with a -1 to -9. Names may include all alpha-numeric characters and other characters including, ], [, <, >. Examples of valid names are STEVE-3, JOHN, JOSEPH-9, LASER-1.

Each packet sent from one *LAWNII-Plus* to another has both the source name and the destination name in it. OCI uses the convention that computer *LAWNII-Plus*'s have no suffix, printer *LAWNII-Plus* have a -1 suffix and modem *LAWNII-Plus*'s have a -2 suffix.

When the *LAWNII-Plus* is used with a printer and has a -1 suffix in its name, this *LAWNII-Plus* will only be operated as a peripheral *LAWNII-Plus*. The -1 suffix overrides the "DFC ON" command.

### 3.2 Security Code

A number between 0 to 65353 is included in the address of every packet. Both the system number and destination name must match for a *LAWNII-Plus* to accept the packet. The system number is set by the "SYSNUM" command. The default of the SYSNUM is 0.

### 3.3 Via

*LAWNII-Plus*'s may route their messages through other *LAWNII-Plus*'s, that are used as the repeaters, before reaching the final destination. This is accomplished by naming the repeater path in the connect command as follows:

CONNECT JOHN VIA JILL,BARRY

The *LAWNII-Plus* supports up to seven via. However, each via adds more delay to the data path. A *LAWNII-Plus* can connect to itself through via.

For example: CONNECT JOHN VIA JILL,LASER-1,JILL

This will send data from JOHN to JOHN through 2 other *LAWNII-Plus*'s assuming the *LAWNII-Plus* initiating the connection is JOHN.

This feature can be used for the diagnostic purpose. It also provides a round about way of sending data to yourself through the same mechanism that data is sent to others. (If LASER-1 is out of range, then JILL will be needed for the return trip of the data from LASER-1 to reach JOHN.) OCI recommends the use of up to three via. This is the limit that the user can still run at the full speed of 9600 baud assuming there is no other user sending signals to the air. (The air speed of *LAWNII-Plus* is 76.8K baud and three via will allow a maximum of 9.6Kbaud which is 76.8K/8 because every data packet will be handled four times plus four positive acknowledges.

The maximum throughput and the number of via can be related by the followings:

| No of via | Maximum throughput |
|---|---|
| 0 | 38.4K |
| 1 | 19.2K |
| 2 | 12.8K |
| 3 | 9.6K |
| 4 | 7.7K |
| 5 | 6.4K |
| 6 | 5.4K |
| 7 | 4.8K |

3.4 E-mail

All *LAWNII-Plus*'s except those in the peripheral mode allow a connection to their built-in E-MAIL server. Operation of the E-MAIL is shown in the example section.

3.5 Baud rate

The *LAWNII-Plus* supports baud rates from 300 to 38400 baud. The baud rates are software selectable. The baud rate is set by the "ABAUD" command. The default is 9600 baud.

3.6 Radio channel

The *LAWNII-Plus* has 3 channels of operation. The three radio channels provide isolation for different systems and also provide a way to prevent interference to and from other radio equipments that are also using the 902-928 ISM band. The channel is set by the "CHA" command. For the channel frequency, please see the Section 4.

3.7 Power LED

The Power LED is firmware controlled. It is also used to indicate the number of E-MAIL received. The LED will flash once for each E-MAIL message up to a maximum of 8.

The "BLINK" command can be used to flash the LED as the user desires. However, reception of mail after the "BLINK" command will reset the flashing to the number of mail items in the *LAWNII-Plus*.

3.8 Hardware reset

The hardware reset switch resets the processor. Action on hardware reset will force the *LAWNII-Plus* to return to command mode (except if the *LAWNII-Plus* is in peripheral mode or if DFC is ON). The software RESTART command provides a similar action. No parameters are changed by a hardware reset.

3.9 RS-232 Interface

The *LAWNII-Plus* is configured as a DCE device, just like a modem. *LAWNII-Plus's* data is transmitted on pin 3 and data to the *LAWNII-Plus* is received on pin 2.

Data Set Ready (6) is asserted whenever the *LAWNII-Plus* is powered on.

Normally, the *LAWNII-Plus* is used in the multidrop broadcast network which requires only pin 2, 3 and 7 for communications. The *LAWNII-Plus* is normally operated without flow control so that it will pass the XON/ XOFF for the equipments.

The *LAWNII-Plus* can be operated with the software flow control if needed by using the "XF ON" command. In this case, the XON/XOFF characters will not be sent through the air. The XON/XOFF characters will only be used to control the data flow between the *LAWNII-Plus* and the equipment it is connected to.

If the hardware flow control is required, OCI will install a special version of firmware that will handle the hardware flow control according to the standard industrial standard. When a device sets Data Terminal Ready (20) or Request To Send (4) false, transmission of data to that device from the *LAWNII-Plus* over the RS-232 link will be halted.

The *LAWNII-Plus* uses Clear To Send (5) to tell the other device to stop sending data.

OCI connects the status of the "CONNECT" light at the front panel to the RS-232 Received Line Signal Detector (carrier detect) pin (8).

The pin assignments and functions of the *LAWNII-Plus*'s RS-232 connector are described as in the appendix.

## 4.0 Commands the user can modify

The *LAWNII-Plus* firmware has many commands. Some of these commands are related to the radio or protocol and have been locked to the user. These commands will be listed with the "DISPLAY" command but are not available to the user. The *LAWNII-Plus* command processor requires only partial commands to distinguish among its command set. The required letters are underlined in the command description.

**ABAUD n** Default:9600

Sets the serial port baud rate. Valid baud rates are 38400, 19200, 9600, 4800, 2400, 1200, 600, 300. This command is an immediate command. Upon the receipt of this command, the *LAWNII-Plus* will switch to the new baud rate immediately. The user will have to change the computer's or terminal's baud rate immediately after issuing the new baud rate command if the user wants to send more commands to the *LAWNII-Plus*.

*Example:* ***AB 38400*** will set the baud rate to 38400.

**AUTOLF ON/OFF** Default:Off

If ON, a line feed is added after each carriage return is entered in the command mode. If OFF, all characters are passed as received. This command is very useful when the user is communicating with the *LAWNII-Plus* through a terminal. Without the auto-line-feed, all the conversations between the *LAWNII-Plus* and user are displayed on one line.

*Example:* ***AU ON*** will turn on the auto-line-feed.

AWLEN 7/8 Default:8

Defines the word length used by the serial port. The value can be either 7 or 8. The *LAWNII-Plus* will not change to the new word length immediately. The new word length will be in effect after the reset, either software or hardware or power on/off cycle occurs.

*Example:* ***AW 7*** will set the word length to 7 bits.

**BEACON EVERY N** Default: E 12
**BEACON AFTER N**

The purpose of beaconing is to let other *LAWNII-Plus* users know the presence of your *LAWNII-Plus* so that your *LAWNII-Plus*'s name will show up in the other *LAWNII-Plus*'s user list. The "BEACON" command sets the time interval to send a beacon in 3.3 sec increments. 0 turns off beaconing completely. The EVERY parameter sets the beacon to occur at every Nx3.3 seconds. The AFTER parameter sets the beacon to occur after Nx3.3 seconds of no packet activity. However, only one beacon is sent.

*Example: **BE E 99*** will send out a beacon every 5 minutes.

**BLINK n** Default: 0

Sets the number of blinks to occur on the power LED. Maximum value is 8. The "BLINK" command is mainly used to tell the user about the E-mail status. If the *LAWNII-Plus* has MAIL stored in it then the number of blink reflects the number of mail files stored inside.

**BREAK**

Causes a break to be sent to the RS-232 port of the remotely connected *LAWNII-Plus*. This is intended to support a remote modem where breaks may be required at the remote computer.

**BREAKLNn** Default: 2

Length of break to be sent to async port of the remote connected *LAWNII-Plus* in 33.3 ms increments.

**CHAN 1/2/3/4** Default: 2

Sets the *LAWNII-Plus*'s channel of operation. The frequencies for the channels are:

| | |
|---|---|
| CHA 1 | 907.45 MHz |
| CHA 2 | 914.81 MHz |
| CHA 3 | 921.10 MHz |
| CHA 4 | 914.81 MHz |

**CMDTIME n** Default: 1

Sets the delay required before the "^c^c^c" sequence to get back to the command mode. Measured in 1 second increments.

**CONNECT name**

If no name is specified, then this command returns the state of the current connection. If a name is supplied, then a connection to that name is attempted.

For example.

*C LASER-1* will cause the *LAWNII-Plus* to connect to the printer *LAWNII-Plus* named LASER-1. or
*C* will cause the *LAWNII-Plus* to report the current connection status for example, "CONNECTED TO JIM" or "CONNECT IN PROGRESS".

**CONOK ON/OFF** Default: ON

If Conok is on, then other *LAWNII-Plus*'s are allowed to connect to this *LAWNII-Plus*. If conok is off, then *LAWNII-Plus*'s attempting to connect to this *LAWNII-Plus* will get a busy message on a connect attempt.

**CONVERS**

Convers is an immediate command similar to Transparent. The *LAWNII-Plus* will use its line editing capabilities and waiting for the "SENDPAC" character before sending a line of text to the connected *LAWNII-Plus*.

**DFC ON/OFF** Default: Off

"DFC ON" turns on default-connect mode and immediately enters the transparent mode.

**DFCNAME name** Default: }PRNTR

Sets the default-connect-to name.

**DIGIPEAT ON/OFF** Default: ON

If Digipeat is set ON, it will allow the *LAWNII-Plus* to act as a VIA for other *LAWNII-Plus*'s.

**DISCONNECT**

Disconnects from the current connection if a connection exists. If all the data has not been sent, then the remaining data will be lost.

**DISPLAY option**

Shows the current status of all commands, including those which the user cannot modify. Several classes of display are possible:

| Option | Description |
|---|---|
| ASYNC | display async port parameters |
| CHARACTE | display special characters |
| ID | display ID parameters |
| LINK | display link parameters |
| MONITOR | display monitor parameters |
| TIMING | display timing parameters |
| HEALTH | display health parameters |

**ECHO ON/OFF** Default: ON

Sets *LAWNII-Plus* to echo data from the async port if in the command mode.

**E-MAIL ON/OFF** Default: OFF

E-MAIL ON places *LAWNII-Plus* in email mode. E-MAIL OFF turns off email mode.

**EMSGS**

Immediate command, which responds with number of email messages in the *LAWNII-Plus*.

**FCC**

Sets the *LAWNII-Plus* to the FCC test mode. This command locks the *LAWNII-Plus's* transmitter on and transmits all ones. A ‹CR› turns the FCC test mode off. No communication on the selected channel is possible by other *LAWNII-Plus* if any *LAWNII-Plus* is in FCC mode.

This FCC mode is useful for setting up and aiming the *LAWNII-Plus* in outdoor communications. The user can lock on the transmitting *LAWNII-Plus* and observe the traffic light of the receiving *LAWNII-Plus* while aligning the receiver's antenna. A solid traffic light indicates a solid radio link.

**MHEARD**

Displays the name of users of this system. The *LAWNII-Plus* will store up to 18 names. *LAWNII-Plus's* that are heard through a via path have a * appended to their name.

Changing the channel or the system number does not affect the mheard list immediately. Therefore, the mheard list will have invalid data after either of these parameters is changed. To prevent this problem, the "MHEARD" list should be cleared with a "MHCLEAR" command after changing the channel and security code.

User may extend the length of the "MHEARD" list by polling the *LAWNII-Plus* every few seconds and building a list in the computer. Each "MHEARD" command must be followed by a "MHCLEAR" command for this approach to function properly.

**MHCLEAR**

Clears the "MHEARD" list in the *LAWNII-Plus*.

**MYCALL name** Default: )PRNTR

Sets a new name for the attached *LAWNII-Plus*. The *LAWNII-Plus* will return its name if the "MYCALL" command is entered without a name.

*For example:*
***MY STEVE*** will set the *LAWNII-Plus* to a new name STEVE.
***MY*** will ask the *LAWNII-Plus* to return its name, for example, the *LAWNII-Plus* will return "MYCALL IS STEVE".

**NEWMODE ON/OFF** Default: OFF

OCI only supports the NEWMODE OFF setting.

**NOMODE ON/OFF** Default: OFF

OCI only supports the NOMODE OFF setting.

**OCIMODE ON/OFF** Default: OFF

OCIMODE causes the *LAWNII-Plus* to remain in the command mode after a connection is made. It also minimizes the messages back to the computer from the *LAWNII-Plus*. This mode is mainly used by the proprietary LAWNTSR software to run the *LAWNII-Plus* as a peer-to-peer wireless network.

**PACLEN n** Default: 0

Sets the packet length used between *LAWNII-Plus*. n can vary between 1 and 256, which is represented by 0. Longer packets are more efficient in throughput for a busy network. Shorter packets are more efficient in time and is more suitable for most real-time system, for example, an entry at the terminal usually require immediate response from the terminal server. A packet has approximately 20 bytes of overhead and a packet also requires 20 bytes of key up time for the transmitter, as a result, small packet size is not efficient to send data.

**PACTIME AFTER/ N**
**PACTIME EVERY/ N** Default: After 10

EVERY sets PACTIME to be a timed interval of every Nx3.3 milliseconds. AFTER sets the packets to be sent after Nx3.3 milliseconds of no activity on the async port. Packets are sent when PACLEN data bytes have been

received on the async port or the PACTime has expired.

*For example,* the following two commands,
***PACT A 1***
***P 0***
will send the packet with packet size of 256 bytes after a continuous 256 bytes are received from the serial port. If the 256 bytes coming from the serial port has a pause of 4 msec between the 1st byte and 2nd byte, the 256 bytes will be sent is two packets, one contains only one byte and the other contains 255 bytes.

**PARITY n** Default: 0

Sets the parity on the async port. Data is always sent on the RF link in 8 bit mode. If the data length is set to 7 bits, then the parity bit or stop bit is sent to the destination *LAWNII-Plus*.

| | |
|---|---|
| 0 | no parity |
| 1 | odd parity |
| 2 | no parity |
| 3 | even parity |

**READ**

Immediate command, which transfers one e-mail message from the *LAWNII-Plus*'s E-mail server to the terminal. The data read from the *LAWNII-Plus* is terminated with a Ctrl + Z.

**RESENTS n**

Counts the number of re-transmissions of packets. Reset to 0 by using parameter 0. This command is useful to evaluate the robustness of the radio path. A robust link should not need to resend any packet.

**RESET**

Resets *LAWNII-Plus* to the factory default values. The *LAWNII-Plus* will have the name of ]PRNTR and stay in the peripheral mode.

**RESTART**

The "RESTART" command is the same as a power up or hardware reset.

**RETRY n** Default: 15

Sets the number of retries to use when a packet fails to be received correctly.

**STATUS**

Returns a message with number of packets left to be transmitted. The zero value is the only reliable number and tells the user that all packets have been sent. If no high level protocol is used between computers, then a disconnect should not be issued until the status command returns 0 packets outstanding. Otherwise, data will be lost.

OCI's experience indicates that if STATUS is continuously requested, packets remaining will not be transmitted. Issue the STATUS command approximately every half second for proper operation.

**SYSNUM n** Default: 0

Allows setting of system number which may be 0 through 65535. SYSNUM is preserved through RESET, RESTART, a hardware reset or power on. **All units in the same system must have the same system number.**

**TIMEOUT n** Default: 15

Sets the timeout for the default-connections. If there is no action on the RS-232 port for the length of the timeout, the connection is disconnected. The unit of TIMEOUT is 3.3 seconds. A setting of 0 prevents timeout disconnect; only a hardware reset or power on/off cycle can disconnect the link.

**TRANSPARENT**

Causes the *LAWNII-Plus* to switch from the command mode to the trans-

parent mode. In the transparent mode, all data entering the *LAWNII-Plus* is sent over the air through the packetizing mechanism. If no connection exists the data is sent to CQ, a universal address. However, as programmed, no *LAWNII-Plus's* can receive this data. After switching to transparent mode. the user should wait for at least 50 msec before sending characters to the *LAWNII-Plus*.

**TRFLOW ON/OFF** Default: OFF

Enables XON/XOFF handshake on RX line.

**TRIES**

Returns the number of retries of the current packet if not yet acknowledged or the number of retires required for the last packet if it has been acknowledged.

**TXFLOW ON/OFF** Default: OFF

Enables XON/XOFF handshake on TX line.

**XFLOW ON/OFF** Default: OFF

Master switch for XON/XOFF handshake. Overrides TRFLOW and TXFLOW commands. Please contact OCI if the hardware flow control is needed.

## 4.1 Datagram Commands

**BUILDLIST**

Default: ON

Activates checking of LCALLS list.

**COMMAND n** Default: 03 (^C)

Allows changing the character used to return to command mode to n.

**CONVERSE**

Converse mode is used instead of Transparent mode.

**CPACTIME ON/OFF** Default: OFF

If CP is on, the packets will be transmitted when the PACTIME timer expired. If OFF, the packets are sent when the sendpac character is received or PACLEN bytes of data are received.

**CR ON/OFF** Default: OFF

If ON, then the sendpac character is sent as the last character of the packet. If OFF, the sendpac character is not sent.

**LAWNGRAM ON/OFF** Default: OFF

If ON, suppresses the source and destination name and formatting of the monitored packets. If OFF, the source and destination are displayed along with other screen formatting.

**LCALLS n1,n2,..**

Sets the list of destination names that will be monitored.

**SENDPAC n** Default: 13

Use character n to cause transmission of a packet. A value of 0 disables the use of a send character for Converse mode.

**TRANSGRA ON/OFF** Default: OFF

Set ON to receive datagrams in transparent mode instead of converse mode.

**UNPROTO name** Default: CQ

Name of the destination *LAWNII-Plus* or *LAWNII-Plus*'s; default is CQ.

## 5.0 Messages from the *LAWNII-Plus*

5.1 Command mode messages

**bbRAM loaded with defaults**

This message appears along with the sign on message if the battery backup RAM checksum verification fails at power up time. (This can indicate a hardware problem.)

**cmd:**

This is the command prompt. It appears in response to a carriage return if in command mode or a break if in transparent mode.

**was**

The current state of a command is reported when a parameter is changed.

**too many packets outstanding**

This will appear if the outgoing packet buffer is full and you attempt to go from command mode to transparent mode. It usually indicates a failure in the link between the sender and the receiver.

5.2 Command mode error messages

**?bad**

The command entered is correct but the rest of the command line is incorrect.

**?call**

The name entered for MYCALL or DFCNAME is invalid.

**?EH**

An invalid command has been issued.

**?not enough**

Not enough arguments were given for the command.

**?not while connected**

MYCALL can not be changed while the *LAWNII-Plus* is connected. Other parameters are also not changeable while connected.

**?range**

An argument is too large.

**?too long**

The command line entered is too long.

**?too many**

Too many arguments were given on the command line.

**?VIA**

More than one name was issued for the connect command without a via.

**?valid baud rates are 38400 19200 9600 4800 2400 1200 600 300**

This message appears if a valid baud rate is not used.

**?valid channel numbers are 1 2 3 4**

This message is used if a invalid channel is specified.

**?cannot change**

Many parameters in the *LAWNII-Plus* are 'locked' in the firmware and cannot be adjusted by the user. This message appears if one of those commands is issued with a value.

5.3 Messages from e-mail commands

**?Mail from [NAME] [+ N others]**

There is 1 mail message from NAME plus N more messages in the EMAIL queue.

**?No mail**

No mail is present in the *LAWNII-Plus*.

**?xxxx bytes Free**

This tells how many bytes are free on the destination *LAWNII-Plus* if in E-MAIL mode.

**?Ready**

This message appears if the message ID is OK.

**?Duplicate message ID**

This appears if the message ID already exists.

**?OK**

This message appears after the Ctrl + Z is sent after a mail message.

5.4 Link status messages

Link status messages are returned by the connect command with no arguments.

**Link state is: CONNECTED to NAME**

This will occur if the *LAWNII-Plus* is connected to NAME.

**Link state is: DISCONNECTED**

This will occur if the *LAWNII-Plus* is not connected.

**Link state is: CONNECT in progress**

This will occur if the *LAWNII-Plus* is attempting to connect to another *LAWNII-Plus*.

**Link state is: DISCONNECT in progress**

This will occur if the *LAWNII-Plus* is attempting to disconnect from another *LAWNII-Plus*.

**Link state is: FRMR in progress**

This will occur if two or more *LAWNII-Plus*'s with the same name are used in a network and one of them has had a packet error. Be careful about the use of *LAWNII-Plus*'s out of the box with the name ]PRNTR.

**?already connected**

This message is received if you try to connect to *LAWNII-Plus* while another connection exists.

5.5 Other messages

***** retry count exceeded**

This occurs if the destination *LAWNII-Plus* did not respond in RETRIES attempts. A disconnect occurs.

***** ‹name› busy**

This appears if the destination *LAWNII-Plus* is busy. This could be because it is connected to another *LAWNII-Plus* or because its CONOK is OFF.

## 6.0 Examples

Developing codes for the *LAWNII-Plus* is best done by using a terminal emulator to verify the exact data sequences to and from the *LAWNII-Plus* for a given application. An RS-232 line monitor will prove invaluable in the debugging stages. In the following examples the responses from the *LAWNII-Plus* are highlighted.

### 6.1 E-mail Send Sequence

| | |
|---|---|
| **cmd:** E-MAIL ON | ; put *LAWNII-Plus* into E-MAIL mode |
| **E-MAIL was OFF** | |
| **cmd:**CONNECT SUE | ; issue a connect to the designated *LAWNII-Plus* |
| **cmd:**TRANSPARENT | ; go to the transparent mode |
| **?1543 Free** | ; remote *LAWNII-Plus* returns number of bytes free |
| 0123456789012345 | ; send the message id (MID) - up to 16 characters |
| **?Ready** | ; the remote *LAWNII-Plus* responds ready if MID is OK |
| Now is the time^z | ; send E-MAIL - ASCII only terminated by ^z |
| **?OK** | ; remote *LAWNII-Plus* returns OK |
| **?1530 free** | ; ready for next message |
| ^C^C^C | ; return *LAWNII-Plus* to command mode |
| **cmd:**DISCONNECT | ; disconnect from remote *LAWNII-Plus* |
| **cmd:**E-MAIL OFF | ; turn E-MAIL off |
| **E-MAIL was ON** | |
| **cmd:** | ; ready for next command |

### 6.2 E-mail read sequence

| | |
|---|---|
| **cmd:**EMSGS | ; get the number of messages in the *LAW NII-Plus* |
| **1 message from STEVE + 0 others** | |
| **cmd:**READ | ; read the message |
| **Now is the time^z** | ; text of message including ^z |
| **cmd:** | ; ready for next command |

### 6.3 Send data sequence

```
cmd:CONNECT STEVE        ; connect to destination
                         ; go to transparent mode
                           put data here, can be binary .
^c^c^c                   ; get back to command mode
cmd:DISCONNECT           ; disconnect from LAWNII-Plus.
```

### 6.4 Receive data sequence

```
cmd:TRANSPARENT          ; put LAWNII-Plus in transparent mode
                           read other LAWNII-Plus's sent data here
^C^C^C
cmd:                     ; return to command mode after disconnect
```

### 6.5 Initialization

This is a typical initialization sequence

```
cmd:ECHO OFF             ; so LAWNII-Plus won't echo
ECHO was OFF
cmd:AUTOLF OFF           ; no line-feeds with carriage returns
AUTOLF was OFF
cmd:EMAIL OFF            ; not in EMAIL mode
EMAIL was OFF
cmd:DFC OFF              ; default connect to off
DFC was OFF
cmd:DFCNAME ]PRNTR       ; set a dfc name
DFCNAME was ]PRNTR
cmd:NEWMODE OFF          ; set up modes correctly
NEWMODE was OFF
cmd:NOMODE OFF
NOMODE was ON
cmd:OCIMODE ON
OCIMODE was OFF
cmd:BEACON EVERY 12      ; set beacon to every 40 seconds
BEACON was EVERY 12
cmd:XFLOW OFF            ; XON/XOFF handshake off
cmd:XFLOW was OFF
```

**cmd:**TRFLOW OFF
**TRFLOW was OFF**
**cmd:**TXFLOW OFF
**TXFLOW was OFF**
**cmd:**PACTIME AFTER 10 ; packet sent if not full after 330 ms
**PACTIME was AFTER 10**
**cmd:**PACLEN 0 ; packets are 256 bytes
**PACLEN 0**
cmd:MYCALL STEVE ; set this *LAWNII-Plus*'s name
**MYCALL STEVE**
**cmd:**CHANNEL 2 ; setup channel
**CHANNEL was 2**

## 6.6 Datagram

The first example will enable the datagram features and will show names of the source and destination *LAWNII-Plus* of unconnected packets for CQ and Jim. Packets will be sent when the *LAWNII-Plus* receives a CR.

The commands should be entered in this order:

| command | comment |
|---|---|
| CPACTIME OFF | ; don't send packet until sendpac character |
| CR OFF | ; don't send the sendpac character |
| SENDPAC 13 | ; send packet after carriage return |
| UNPROTO CQ | |
| LCALLS CQ,JIM | ; use CQ as broadcast address, user name is JIM |
| CONVERSE | |

The *LAWNII-Plus* will now return all unnumbered information packets including the source and destination. All responses are terminated with a carriage return and line feed. The destination address is set by the UNPROTO command.

Since some characters may be difficult to receive transparently, i.e. CR and LF, the user protocol should probably include a transparency mechanism to send otherwise confusing characters. An example of a protocol to use is AFT as defined by HAYES.

Preliminary timing indicates that the delay from the SENDPAC character

and the packet transmission is under 10 ms. The delay from reception of the packet to transmission of the packet over the RS-232 interface is about 10 ms.

A single Ctrl + C after 1 second of silence will return to the command prompt. However, monitoring of packets continues. To send new data to another unit requires the user to enter the CONVERSE command again.

## 6.7 example for converse mode

An example of how to send commands transparently using Ctrl + K as the command character and Ox7f as the sendpac character is as follows.

```
command              comment
COMMAND 11           ; set command character to ^k
CPACTIME OFF         ; send after sendpac character only
CR ON                ; send  the sendpac character
SENDPAC 127          ; Ox7f is the sendpac character
UNPROTO CQ
LCALLS CQ,JIM        ; use CQ as broadcast address, user name is JIM
CONVERSE
```

The *LAWNII-Plus* will now return all unnumbered information packets as they were sent. The destination address is set by the UNPROTO command.

## 6.8 Master-slave network

An example of how to setup a master slave network to replace RS-485 or similar networks follows. All of the data from the master will be sent to all of the slaves. All of the data from all of the slaves will be heard only by the master. There is no limit for the number of slaves in a system.

The master-slave broadcast network can move data faster because the data is broadcasted and no acknowledgment from the receiving unit is required. As a result, the latency time of a broadcast network is only half of the latency time of a connection-oriented network. The broadcast network, however, does not guarantee the delivery of data. If the data got lost, it is lost. The *LAWNII-Plus* will not resend the bad packet. The user has to

deal with the possibility of losing data in the user's protocol. Program the master as follows:

```
command             comment
MYC MASTER
DFCN MASTER         ; put into peripheral mode
SYS 0               ; use default system number.
CHA 2               ; pick a channel
PACTIME A 1         ; send after 3 ms. of no chars
BE E 0              ; turn off beacons
UNPROTO SLAVE       ; send data to LAWNII-Plus's with LCALLS SLAVE
LAWNGRAM ON         ; prevent addresses
TRANSGRA ON         ; allow monitor in transparent mode
LCALLS MASTER       ; listen only for packets to master
TRANS               ; go to transparent mode
```

Program all the rest slaves as follows:

```
command             comment
MYC SLAVE
DFCN SLAVE          ; put into peripheral mode
SYS 0               ; use the same default system number
CHA 2               ; use same channel as master
PACTIME A 1         ; send after 3 ms. of no characters
BE E 0              ; turn off beacon
UNPROTO MASTER      ; send data to LAWNII-Plus's with LCALL
                      MASTER
LAWNGRAM ON         ; prevent addresses
TRANSGRAM ON        ; allow monitoring in transparent mode
LCALLS SLAVE        ; listen only for packets to slaves
TRANS               ; go to transparent mode
```

The slaves may use independent names but must have a common broadcast name that is used for LCALLS. In this configuration, both the master and slave are operated in the unconnected broadcast mode.

In the master-to-slave network, the user must provide the specific address for the equipment that the slave is attached to, along with the data for

that equipment. All slaves will receive the same address code and data from the master and pass them on to the equipment. The equipment will respond only when the address code matches its own address. The user needs to provide his own protocol for polling and resend.

If the latency time is critical to the system performance, the user can reduce the latency time by running the RS-232 port at a higher baud rate and using faster packet time-out and smaller packet size. Using converse mode with the sendpac character is another way to speed-up the delivery of data. The packet will be sent in about 10 msec after the sendpac character enters the RS-232 port.

### 6.9 RS-232 cable replacing (one-to-one)

This is an example to use a pair of datagram *LAWNII-Plus*'s to replace a single RS-232 cable by using the DFC mode. In this mode, the virtual connection between the datagram *LAWNII-Plus*'s will be established automatically as soon as the data enters the serial port of either *LAWNII-Plus*. The connection may be kept on until power-up reset occurs or after the disconnect time-out expired. Program the two datagram *LAWNII-Plus*'s as follows:

| commands for host | commands for remote |
|---|---|
| MYC HOST | MYC REMOTE |
| DFCN REMOTE | DFCN HOST |
| SYSN 0 | SYSN 0 |
| CHA 2 | CHA 2 |
| TIMEOUT 10 | TIMEOUT 10 |
| DFC ON | DFC ON |

The RS-232 port and packet specifications of the two ends need not be the same. For example, **if you are connecting a terminal to a computer by using *LAWNII-Plus's*, the packet size and the baud rate of the *LAWNII-Plus* that is connected to the terminal should be as 1 and 38400 respectively (if possible)** and 256 and 38400 (or system's maximum baud rate) for the *LAWNII-Plus* that is connected to the computer. This is because that the input from terminal is key stoke and the computer should response to it right away by quickly updating the screen whenever the user hits the keyboard of the terminal.

## 6.10 Radio propagation investigation

You may find out the conditions of your radio network by using the "FCC" command. This investigation is a must for a network that is spreading out to the limit of the *LAWNII-Plus*'s coverage range. This "FCC" command will turn on the transmitter constantly until you type any key to the keyboard.

For example, you will enter the "FCC" command to the master *LAWNII-Plus* of a multidrop system and then check the "Traffic" light of each slave *LAWNII-Plus*. Each slave must have a solid traffic light to ensure that the link is solid. Flicking "Traffic" light indicates the presence of nulls or a weak signal. You may also use the "Traffic" light as the guide to aim the *LAWNII-Plus's* for the best reception in outdoor point-to-point applications.

## 6.11 Using repeater-set to extend coverage range in the broadcast mode.

You may use up to 7 repeaters to extend the range in the connected mode by specifying the repeaters' name in the connect path as shown in page 13. The repeater can be any other *LAWNII-Plus* that is located between you and your destination. You do not need to dedicate a *LAWNII-Plus* solely as a repeater.

In the broadcast mode, you will need to dedicate a repeater-set to extend your coverage. A repeater-set is a pair of *LAWNII-Plus* that is hard-wired together with the pin 2 & 3 of the DB9 crossed. (Pin 5 for ground will go straight through.) You will configure one of the repeater-set like the rest of the slaves in your system and the other one as a new master that will re-broadcast to the slave that is out-of-reach of the original master. You may use a different channel for the second broadcast network.

There is no limit for the number of repeater-set that you can use. You may extend your network indefinitely. You may re-use the frequency for the network that is farther away from the original network to reduce the radio traffic congestion.

The repeater-set is a very easy way to extend your network. You do not

need to modify your polling software except allowing more delay for responses from your slave. The maximum length of the cable between the repeater-set depends on the baud rate. You may use a cable at least 50' long and even longer if the baud rate is lower.

## 6.12 Flow control

Normally, the *LAWNII-Plus* is operated like an RS-485 network without flow control so that it will pass the software flow control signals (XON/XOFF) for your system. If your data is moved too fast for the *LAWNII-Plus* and it causes data overrun problem, then you may turn on the flow control for the *LAWNII-Plus* to prevent this problem. However, the XON/XOFF flow control signal will no longer be sent through the air between your equipments. If you need to send the XON/XOFF flow control over the air, then you will need to use the hardware flow control signals between *LAWNII-Plus* and your equipment and use the software flow control between your equipments. Please contact OCI for this requirements.

## 6.13 Packet formation

The packet formation determines how fast and how quickly the data to be sent over the *LAWNII-Plus's*. The packet formation, just like the baud rate, of the two ends of a link needs not be the same. The user should find out the system's requirement and design the optimal packet for the system.

For example, for a scale that constantly sending out 20 bytes of data to the indicators, the packet size should be exactly 20. Or for a data collector that sends 5 bytes of data to the computer and receives 2 bytes of acknowledge from the computer should have 5 bytes as the packet size for the *LAWNII-Plus* with the data collector and 2 bytes for the *LANWII-Plus* with the computer.

**Please note that the packet size must be 1 for the *LAWNII-plus* used with a terminal.**

The packet size of 1 will ensure that the keystroke is sent to the computer as soon as the user enters it.

## 7.0 Programming notes

7.1 E-mail
When another *LAWNII-Plus* connects to your *LAWNII-Plus* in EMAIL mode, the connect line will indicate a connection for only a short period of time.

7.2 Timing
When switching from the command mode to the transparent mode, be aware that the switching may take up to 50 msec. Since separate data queues are maintained for the command mode and the transparent mode, the data could end up in the wrong queue if insufficient delay is inserted.

7.3 Conok off busy message
When conok is off, no *LAWNII-Plus* can connect to your *LAWNII-Plus*, however, each connect attempt by another *LAWNII-Plus* is accompanied by a message indicating that another *LAWNII-Plus* attempted to connect.

7.4 CTS lockup
It is possible to send data to the *LAWNII-Plus* and fill its input buffer as indicated by the *LAWNII-Plus* asserting CTS. Unfortunately, this condition may prevent you from entering the command mode of the *LAWNII-Plus* if your serial driver works with CTS. A possible solution is to ignore CTS if your software times out on this condition. Then switch to the command mode and disconnect. This should flush the buffers. However, your driver will have to ignore the CTS from the *LAWNII-Plus*.

7.5 ^C^C^C
This may return three cmd: or one cmd:, depending on the state of the *LAWNII-Plus*.

7.6 Datagram and beaconing
To prevent unwanted characters in the receive data stream, beaconing should be turned off for all Datagram *LAWNII-Plus*'s in the system. Datagram *LAWNII-Plus*'s should not use UNPROTO CQ or use CQ in LCALLS if regular *LAWNII-Plus*'s may be nearby. Beaconing normally sends a space character in a datagram packet.

## 8.0 *LAWNII-Plus* error counters

The *LAWNII-Plus* maintains several counters with statistics of the *LAWNII-Plus* performance. Each of the counters increments when a specific event occurs. Several counters may be affected by one event. The counters are reset to 0 by a RESTART. The counts are observed with the DISPLAY command. Each count is listed with the event that causes it to increment.

| | |
|---|---|
| ASYRXOVR | overruns from async port. |
| DIGISENT | frames digipeated. |
| HOVERR | receiver overruns in HDLC link. |
| HUNDERR | transmitter underruns in HDLC link. |
| RCVDFRMR | frame reject frames received. |
| RCVDIFRA | I frames received. |
| RCVDREJ | REJECT frames. |
| RCVDRNR | receive RNR packet. |
| RCVDSABM | SABM frames received. |
| RXABORT | received abort in data. |
| RXCCOUNT | frames received with good CRC. |
| RXERRORS | bad frames received. |
| RXLENERR | packets received that are too short. |
| RXRESYNC | receiver resync after error. |
| SENTFRMR | frame rejects sent. |
| SENTIFRA | I frames sent. |
| SENTREJ | REJECT frames sent. |
| SENTRNR | transmit RNR packet. |
| TXCOUNT | correctly transmitted frames. |
| TXQOVFLW | frame discarded if output queue is too small. |

# Appendix:

## A: Antenna

The *LAWNII-Plus* can be used with high gain Yagi or omni-directional antennas to increase the coverage range. The Yagi antenna is normally used for fixed, line-of-sight applications while the omni-directional antenna is mainly used for mobile applications or the host computer of the wireless network.

The mast of the antenna needs to be grounded properly to prevent the damage caused by the lightnings. The proper way of grounding is to connect the mast to the earth ground by using a twisted pair of #12 copper wire buried into the earth for at least 10' in depth.

## B: Sleep Mode

The optional sleep allows the *LAWNII-Plus* to turn itself off when the serial port has been idle for a time longer than the idle time which is typically 10 seconds. The idle time is fixed and only can be set by the factory. The range of idle time is from 5 seconds to 1 minutes.

When the sleep mode is activated, the *LAWNII-Plus* will not be able to receive any data from the air. The user has to wake the *LAWNII-Plus* up regularly to see if there is any message for him. To wake the *LAWNII-Plus*, the user only needs to send one character to the serial port and the *LAWNII-Plus* will be ready to take or give data in 150 msec.

Please do not send any data to the serial port during the wake-up period. The data sent in this period may or may not be sent to the air.

## C: Circular Connector

Normally, a *LAWNII-Plus* is operated in a multidrop network with XON/XOFF flow control or no flow control at all, like an RS-485 network.

Please contact OCI if the hardware flow control is needed. OCI supports all the hardware flow control by using a modified version of the firmware.

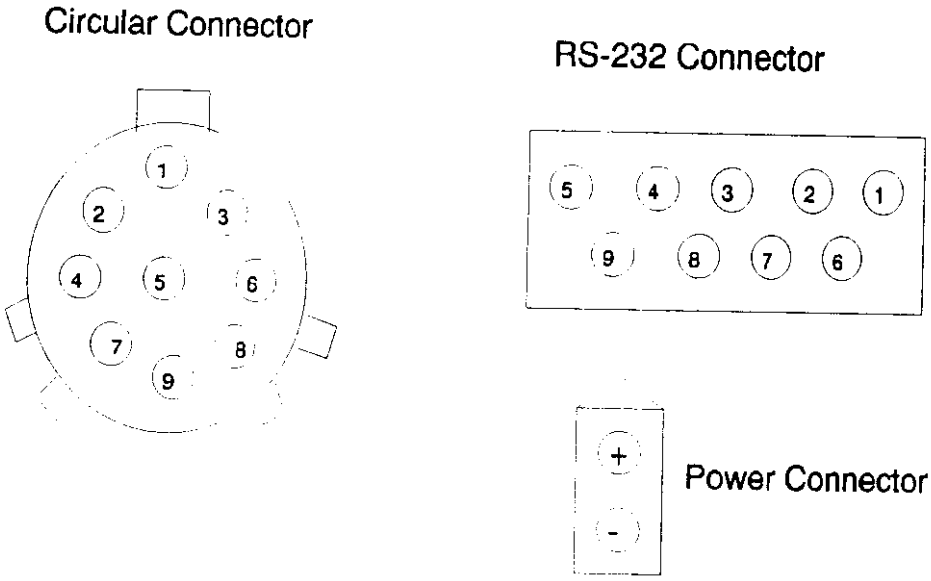
The pin assignments and functions of the circular connector are as follows.

| Pin | Name | Dir | Description |
|---|---|---|---|
| 1 | DCD | Out | Indicates the *LAWNII-Plus* is connected. |
| 2 | TXD | Out | Transmit data from *LAWNII-Plus* |
| 3 | RXD | In | Receive data to *LAWNII-Plus*. |
| 4 | DTR | In | Hardware handshake to hold data from *LAWNII-Plus*. |
| 5 | GND | | |
| 6 | DSR | Out | Indicated that *LAWNII-Plus* is powered. |
| 7 | RTS | In | Hardware handshake to hold data from *LAWNII-Plus*. |
| 8 | CTS | Out | Hardware handshake to hold data from computer. |
| 9 | PWR | In | Power supply to the *LAWNII-Plus*. |

Pin 4 or 7 may be used for flow control of data from *LAWNII-Plus*. The *LAWNII-Plus* includes pull-up resistors on its flow control input lines. It can operate with only 3 wires, RXD, TXD, and GND if flow control is not required or if software flow control (XON/XOFF) is used.

DCD indicates that *LAWNII-Plus* has a virtual connection between itself and another.

**Wiring diagram of the circular -to RS-232 cable.**



## *D. LAWNII-Plus* Specifications

Interface: RS-232 Serial port
Flow Control: software
RF Channels: 3
Transmit Power: 13dbm, typ.
Sensitivity: -97dbm, typ.
Frequency:
channel 1 ----------907.45 MHz
channel 2 ----------914.81 MHz
channel 3 ----------921.10 MHz
Modulation: FSK, spread spectrum
Antenna: one, external
No. of chip per bit: 16
Bit rate (raw): 76.8 Kb/sec
Throughput: 38.4 Kb/sec
Protocol: AX.25
Contention: CSMA/CD
Range: 300 feet typical, indoors w/monopole antenna
For outdoor, point-to-point applications and using same antenna on both ends,
0.8 mile typical w/unity gain antenna
1.6 miles typical w/3 db gain antenna
3.2 miles typical w/6 db gain antenna
6.4 mile typical w/9 db gain antenna
12.8 mile typical w/12 db gain antenna
14 miles typical w/13 db gain antenna

Dimension: 4.5"x3.5"x2.5"" (LxWxH)
Power supply: DC 9V .2A
w/optional Sleep mode: DC 9 .3A

Operating temperature: -40° C to +75° C

FCC license: not required

## E: Example of making RS-232 cables for *LAWNII-Plus*

1. Connect a *LAWNII-Plus* to a PC or printer with DB25 connector

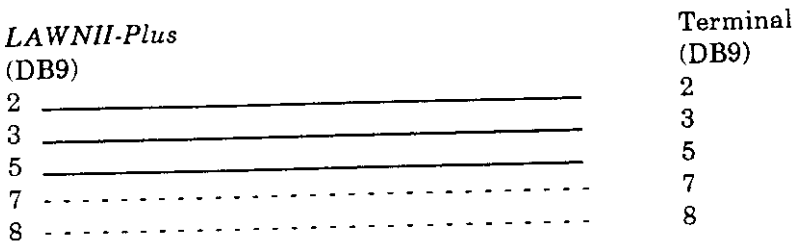
| *LAWNII-Plus* DB9 | | Computer DB25 |
|---|---|---|
| 1 | ——— | 8 |
| 2 | ——— | 3 |
| 3 | ——— | 2 |
| 4 | ——— | 20 |
| 5 | ——— | 7 |
| 6 | ——— | 6 |
| 7 | ——— | 4 |
| 8 | ——— | 5 |
| 9 | | |

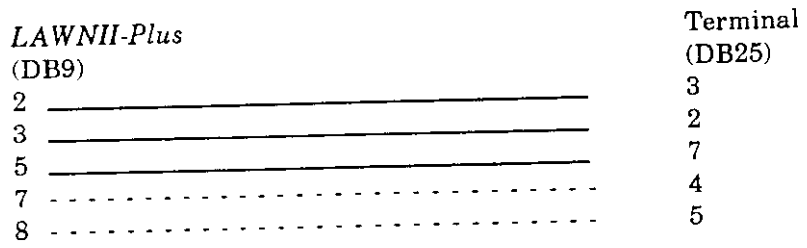
2. Connect a *LAWNII-Plus* to a modem

| *LAWNII-Plus* (DB9) | | Modem (DB9) |
|---|---|---|
| 2 | ——— | 3 |
| 3 | ——— | 2 |
| 5 | ——— | 5 |
| 7 | - - - - - | 8 |
| 8 | - - - - - | 7 |

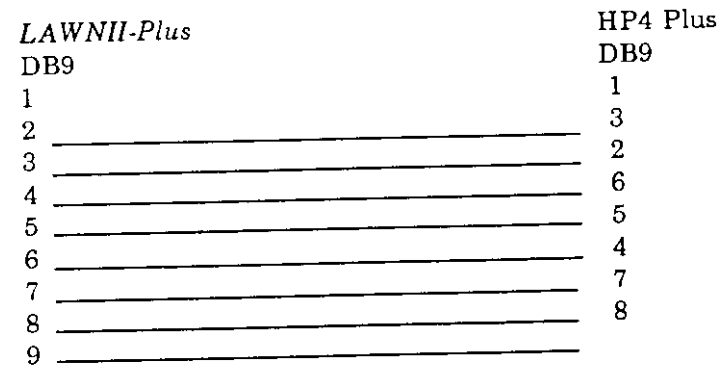
| *LAWNII-Plus* (DB9) | | Modem (DB25) |
|---|---|---|
| 2 | ——— | 2 |
| 3 | ——— | 3 |
| 5 | ——— | 7 |
| 7 | - - - - - | 5 |
| 8 | - - - - - | 4 |

3. Connect a *LAWNII-Plus* to a terminal




4. Connect a *LAWNII-Plus* to a HP4 Plus printer




Dot lines are needed for optional hardware flow control.