INSTRUCTION MANUAL

# NL116 Ethernet and CompactFlash® Module

Revision: 1/17

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# PLEASE READ FIRST

## About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

**Area:** 1 $in^2$ (square inch) = 645 $mm^2$

**Length:** 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

**Mass:** 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

**Pressure:** 1 psi ($lb/in^2$) = 68.95 mb

**Volume:** 1 UK pint = 568.3 ml
1 UK gallon = 4.546 litres
1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

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At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.

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# *Precautions*

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.eu or by telephoning +44(0) 1509 828 888 (UK). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

### General

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

### Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, or 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

### Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

### Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

# Table of Contents

*PDF viewers: These page numbers refer to the printed version of this document. Use the PDF reader bookmarks tab for links to specific sections.*


**1. Introduction ..... 1**

**2. Precautions ..... 1**

**3. Initial Inspection ..... 2**

**4. QuickStart ..... 2**

4.1 Physical Setup ..... 2
4.2 Communicating via Ethernet ..... 3
4.2.1 Step 1: Configure Datalogger ..... 3
4.2.2 Step 2: *LoggerNet* Setup ..... 4
4.2.3 Step 3: Connect ..... 7
4.3 Programming the Datalogger to Save Data to the CompactFlash® Card ..... 7
4.4 CF Card Data Retrieval ..... 8

**5. Overview ..... 9**

5.1 Buttons and Status LED ..... 10
5.2 Power ..... 10
5.3 CF Card Data Retention ..... 10

**6. Specifications ..... 10**

**7. Operation ..... 12**

7.1 TCP/IP Functionality ..... 12
7.1.1 Communicating Over TCP/IP ..... 12
7.1.1.1 Data Callback ..... 12
7.1.1.2 Datalogger-to-Datalogger Communication ..... 13
7.1.2 HTTP Web Server ..... 14
7.1.3 FTP ..... 15
7.1.3.1 FTP Server ..... 15
Step 1: Configure Datalogger ..... 16
Step 2: Access File System ..... 16
7.1.3.2 FTP Client ..... 17
7.1.4 Telnet ..... 17
7.1.5 Ping ..... 17
7.1.6 Serial Server ..... 17
7.1.6.1 Serial Input ..... 17
7.1.6.2 Serial Output ..... 18
7.1.7 TCP ModBus ..... 18
7.1.8 DHCP ..... 18
7.1.9 DNS ..... 18
7.2 File Formats ..... 18
7.2.1 Data Files ..... 18

7.2.2 Program Files ..... 19
7.2.3 Power-up Files (Powerup.ini) ..... 19
7.2.3.1 Creating and Editing Powerup.ini ..... 20
7.2.3.2 Applications ..... 21
7.2.3.3 Program Execution ..... 21
7.2.3.4 Example Powerup.ini Files ..... 21
7.2.4 Camera Files ..... 22
7.3 Programming ..... 22
7.3.1 The CardOut() Instruction ..... 22
CardOut(StopRing, Size) ..... 22
7.3.2 Program Examples ..... 23
7.3.2.1 Ring Mode ..... 23
7.3.2.2 Fill-and-Stop Mode ..... 23
7.3.2.3 Mixed Modes ..... 24
7.3.3 Table Size and Mode ..... 24
7.4 CF Card Data-Retrieval Details ..... 25
7.4.1 Via a Communication Link ..... 25
7.4.1.1 Fast Storage/Data-Collection Constraints ..... 25
7.4.2 Transporting CF Card to Computer ..... 26
7.4.2.1 Converting File Formats ..... 26
7.4.2.2 Reinserting the Card ..... 27
7.4.2.3 Card Swapping ..... 27

## Appendix

**A. CF Card Maintenance ..... A-1**

A.1 Formatting CF Card ..... A-1
A.1.1 Windows Explorer ..... A-1
A.1.2 CR1000KD ..... A-2
A.1.3 *LoggerNet* File Control ..... A-2
A.2 Checking CF Card Integrity ..... A-3

## Figures

4-1. NL116 attached to a CR1000 ..... 2
4-2. DevConfig setup ..... 3
4-3. Setup screen (EZ View) Datalogger Type ..... 4
4-4. Setup screen (EZ View) Connection Type ..... 5
4-5. Setup screen (EZ View) IP Port Settings ..... 6
4-6. Setup screen (EZ View) Datalogger Settings ..... 7
5-1. NL116 Ethernet/CompactFlash® Module ..... 9
7-1. Datalogger home page ..... 14
7-2. FTP root directory ..... 15
7-3. FTP CRD directory ..... 16
7-4. CardConvert ..... 27

## Table

7-1. Powerup.ini Commands ..... 20

## CRBasic Examples

7-1. Data Callback over TCP/IP ..... 12
7-2. Datalogger-to-Datalogger Communication ..... 13
7-3. FTPClient() Instruction ..... 17

7-4. Ring Mode .....23
7-5. Fill-and-Stop Mode .....23
7-6. Mixed Modes .....24

# NL116 Ethernet and CompactFlash® Module

## 1. Introduction

Campbell Scientific's NL116 Ethernet/CompactFlash® Module provides two independent capabilities: (1) it enables Ethernet communications and (2) stores data on a removable CompactFlash® (CF) card. It allows the datalogger to communicate over a local network or a dedicated Internet connection via Ethernet. It also expands on-site data storage and provides the user with a convenient method of transporting data from the field back to the office. This small, rugged communication device connects to the 40-pin peripheral port on a CR1000 or CR3000 datalogger.

This manual describes how to use *LoggerNet* to connect to your datalogger with an NL116 attached. You can also use other software packages such as *PC400*, *RTDAQ*, or *LoggerLink Mobile Apps for iOS and Android*.

Campbell Scientific recommends that only CF cards that have passed our testing be used with the NL116. For more information on CF cards, see Campbell Scientific's application note *CF Card Information (3SM-F)*. Note that it is not necessary to purchase the CF cards directly from Campbell Scientific as long as the manufacturer and model number match those shown in the application note.

Before using the NL116, please study:

- Section 2, *Precautions* *(p. 1)*
- Section 3, *Initial Inspection* *(p. 2)*
- Section 4, *QuickStart* *(p. 2)*

The QuickStart section explains how to quickly begin using an NL116 for straightforward Ethernet communications and data-storage operations. The remainder of the manual is a technical reference which describes in detail such operations as: IP functionality, file formats, datalogger programming, and data retrieval.

## 2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- The NL116 requires CR1000 or CR3000 operating system version 28 or later.
- The first time an NL116 is attached to a datalogger, the datalogger's memory has to be reorganized to allow room in memory for the IP stack. To avoid the loss of data, collect your data before attaching the NL116 to a datalogger.
- The NL116 is rugged, but it should be handled as a precision scientific instrument.

- The NL116 has integrated surge protection. In order for the surge protection to work correctly, the NL116 must be well grounded. The NL116 is grounded through the datalogger's ground lug via the thumb screw used to attach the NL116 to the datalogger. That connection is only made if the thumb screw on the NL116 is tightened down to the datalogger.
- Shielded Ethernet cable should be used for cable lengths longer than 9 ft.
- Always power down the datalogger before installing to or removing the NL116 from the datalogger.

# 3. Initial Inspection

Upon receipt of the NL116, inspect the packaging and contents for damage. File damage claims with the shipping company.

# 4. QuickStart

This section describes the basics of communicating via Ethernet and storing and retrieving datalogger data. These operations are discussed in detail in Section 7, *Operation* *(p. 12)*.

## 4.1 Physical Setup

**CAUTION** Always collect your data before attaching the NL116.

**CAUTION** Always power down the datalogger before installing to or removing the NL116 from the datalogger.

After powering down the datalogger, plug the NL116 into the datalogger peripheral port (see FIGURE 4-1). Attach Ethernet cable to the Ethernet port. Restore power to the datalogger. Insert formatted CF card. (For instructions on formatting a CF card, see Appendix A, *CF Card Maintenance* *(p. A-1)*.)

**NOTE** A CF card does not need to be present in order to use the NL116's IP functionality.

*FIGURE 4-1. NL116 attached to a CR1000*

## 4.2 Communicating via Ethernet

### 4.2.1 Step 1: Configure Datalogger

a. Connect serial cable from PC COM port to the datalogger **RS-232** port.

b. Open Campbell Scientific's *Device Configuration Utility* (*DevConfig*). Select the **Device Type** of the datalogger (CR1000 or CR3000), the appropriate **Communication Port**, and **Baud Rate**. **Connect** to the datalogger.

c. Under the **Ethernet** tab, input the **IP Address**, **Subnet Mask**, and **IP Gateway**. These values should be provided by your network administrator.

   Alternatively, note the **Eth IP** address assigned to the datalogger via DHCP. (This information is displayed on the right side of the window.) However, note that this address is not static and may change.

**NOTE** The *DevConfig* **Ethernet** tab displays other information about the Ethernet interface including the MAC address of the datalogger.

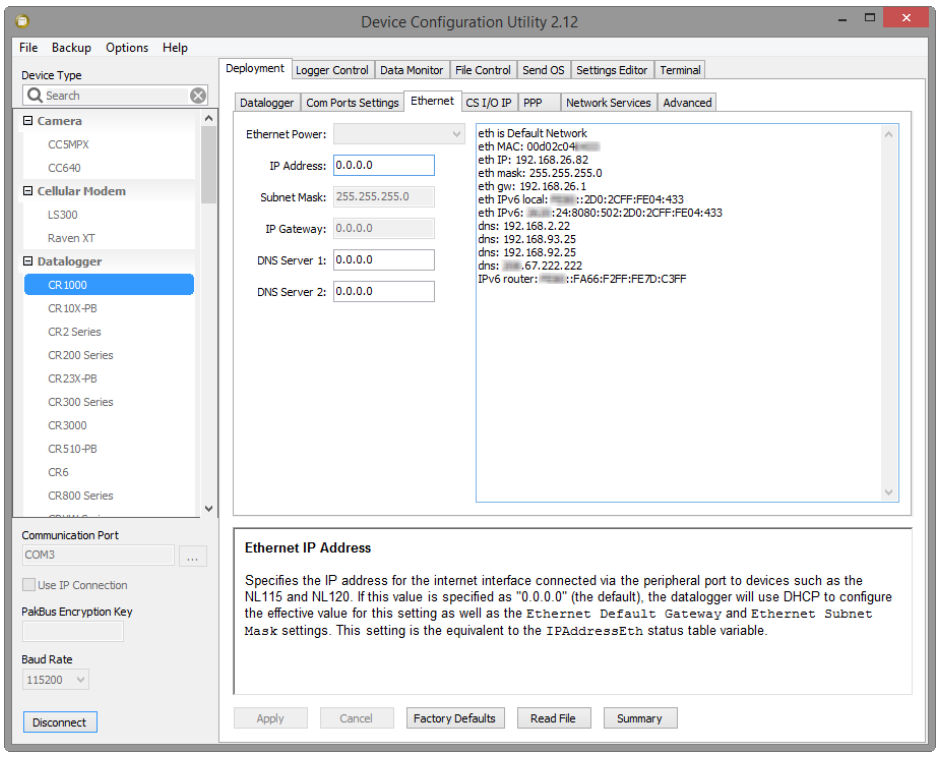



*FIGURE 4-2. DevConfig setup*

d. Press the **Apply** button to save the changes and then close *DevConfig*.

**NOTE** A temporary IP address may be obtained from a DHCP server. For more information, see Section 7.1.8, *DHCP* *(p. 18)*.

**NOTE** The NL116 must be connected to the datalogger before configuring the datalogger with *DevConfig*. If it is not connected, the TCP/IP settings will not be displayed.

### 4.2.2 Step 2: *LoggerNet* Setup

The next step is to run *LoggerNet* and configure it to connect to the datalogger via the Ethernet port.

a. In the *EZ View* of the *LoggerNet Setup* screen, press **Add**. Press **Next** to advance to the **Datalogger Type and Name** screen. Select your datalogger type and press **Next**.

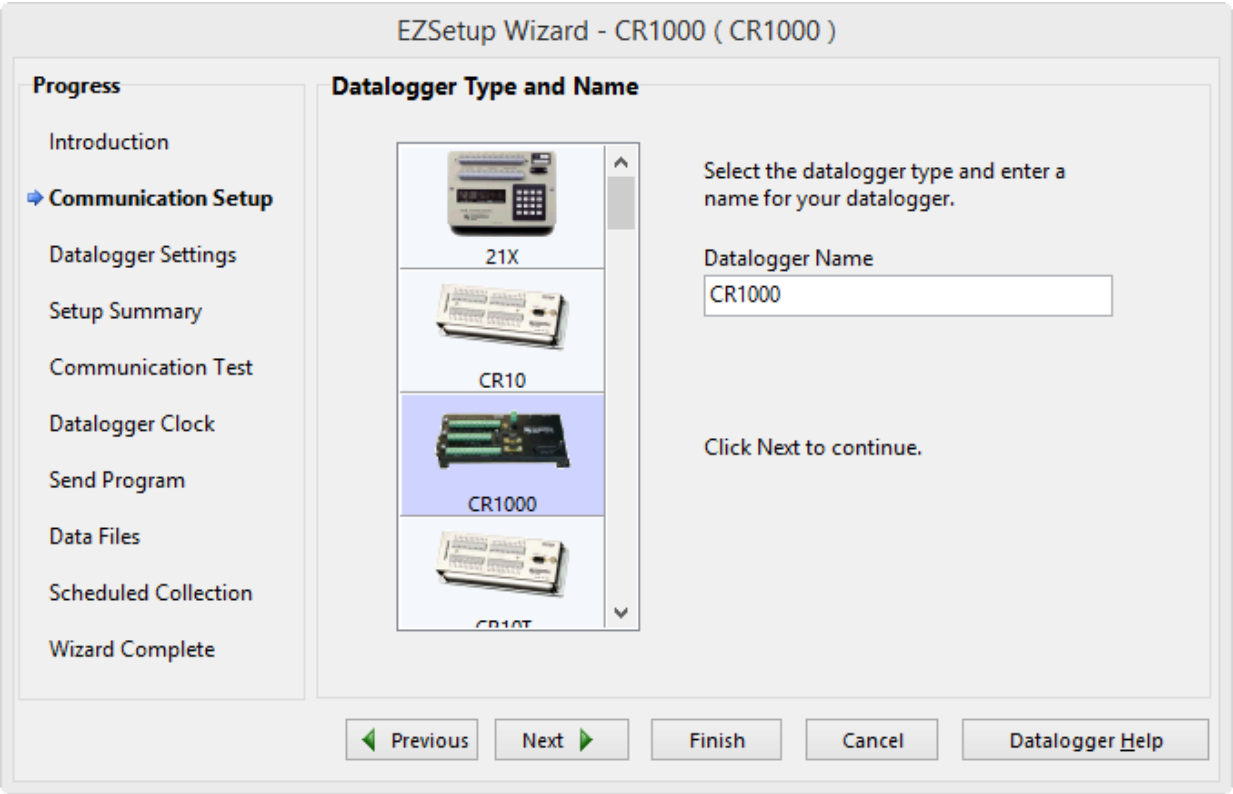



*FIGURE 4-3. Setup screen (EZ View) Datalogger Type*

b. Select **IP Port** and press **Next**.

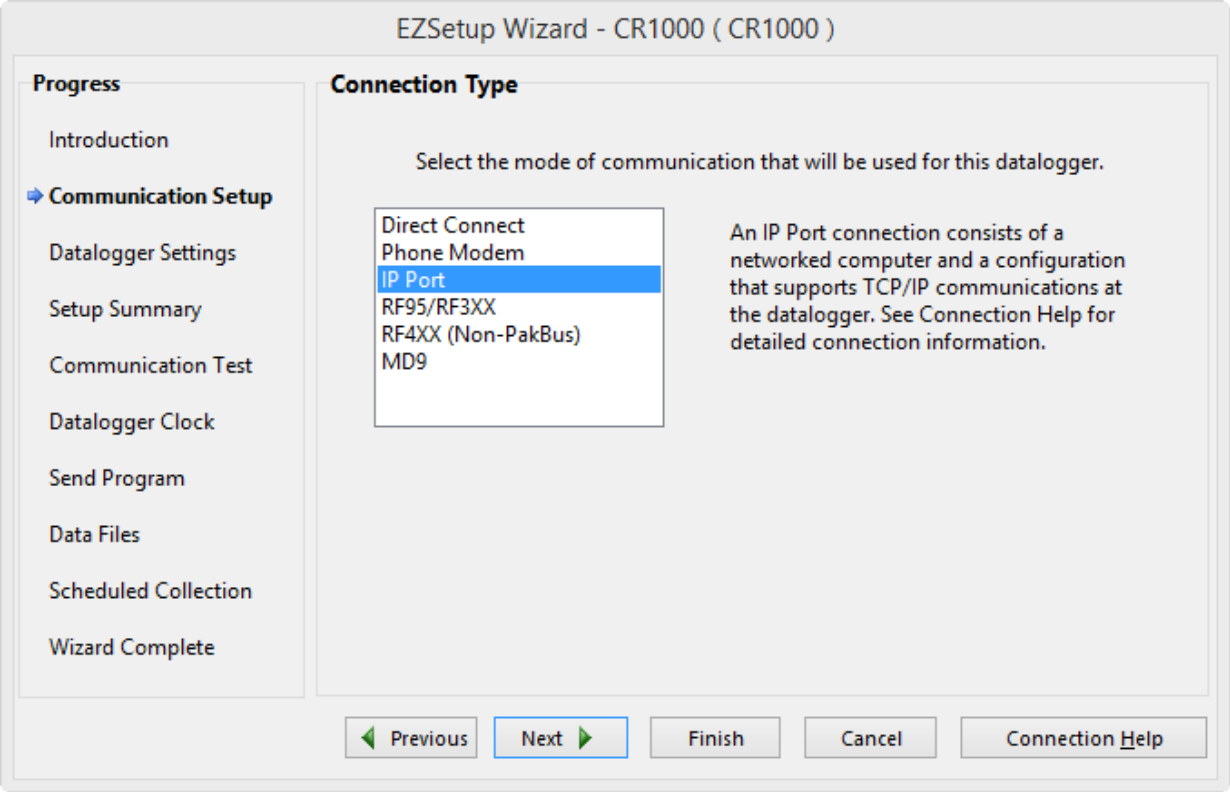



*FIGURE 4-4. Setup screen (EZ View) Connection Type*

c. Input the datalogger's IP address and port number and press **Next**. The IP address and port number are input on the same line separated by a colon. IPv6 addresses will need to be enclosed in square brackets. An IPv4 address may look like 192.168.1.100:6785. An IPv6 address may look like [2001:db8::1234:5678]:6785. (The datalogger default port number is 6785. It can be changed using *DevConfig*.)

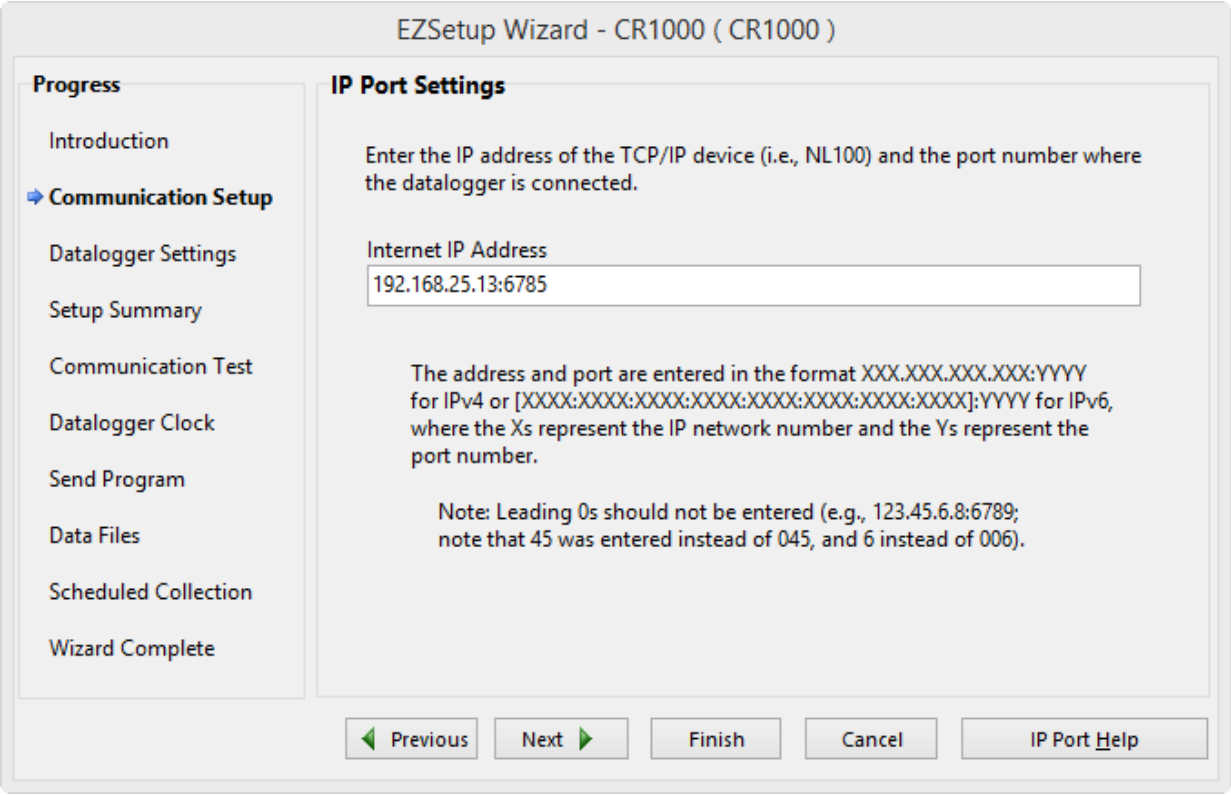



*FIGURE 4-5. Setup screen (EZ View) IP Port Settings*

d. Input the **PakBus Address** of the datalogger.

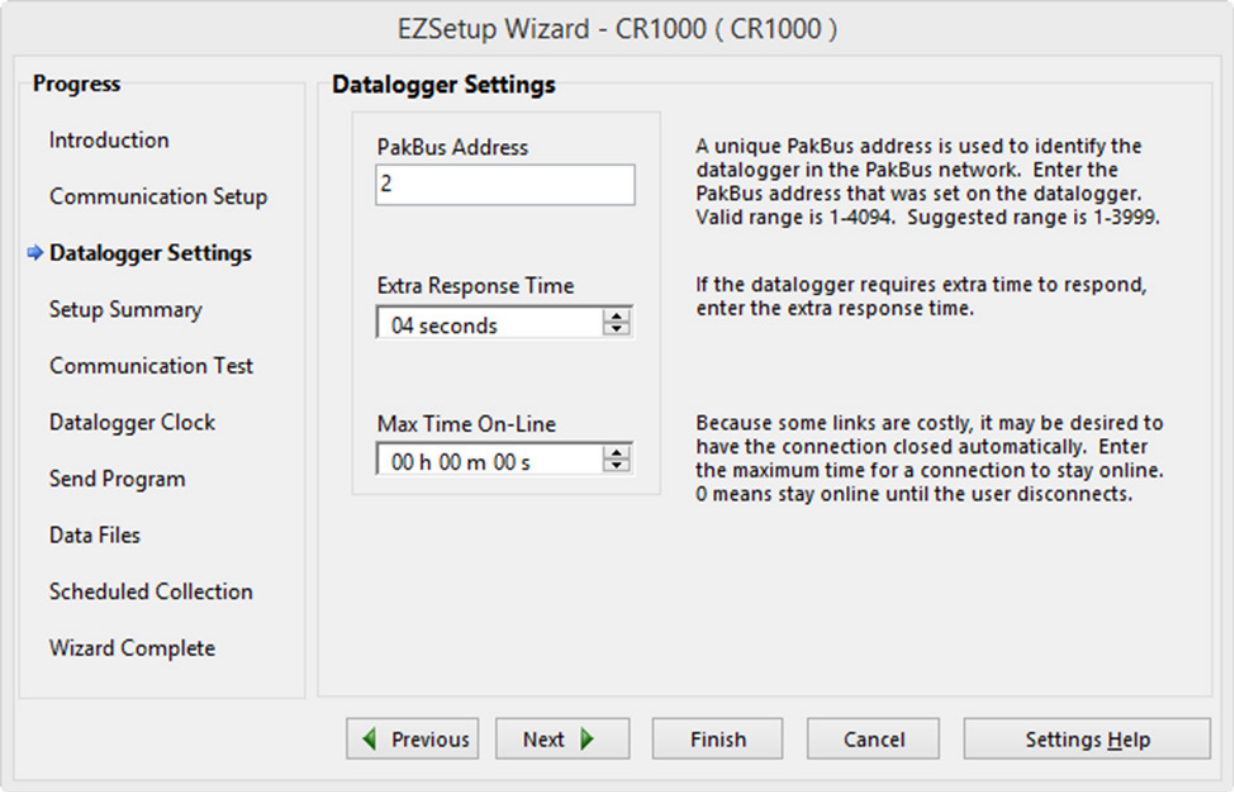



*FIGURE 4-6. Setup screen (EZ View) Datalogger Settings*

e. Press **Next** until you reach the **Communication Setup Summary** screen. Press **Finish** to complete the setup.

### 4.2.3 Step 3: Connect

You are now ready to connect to your datalogger using the *LoggerNet Connect* screen.

Datalogger program transfer, table-data display, and data collection are now possible.

## 4.3 Programming the Datalogger to Save Data to the CompactFlash® Card

The **CardOut()** instruction is used in the datalogger program to send data to the CF card. **CardOut()** must be entered within each **DataTable** declaration that is to store data on the CF card. The file is saved on the card with the name stationname.tablename and a .DAT extension.

The **CardOut()** instruction has the following parameters:

*StopRing*: A constant is entered for the *StopRing* parameter to specify whether the **DataTable** created should be a ring-mode table (0) or a fill-and-stop table (1).

*Size*: A constant is entered in the *Size* to define the size of the DataTable on the Card. Size can be defined as a fixed number of records, as auto-allocate, or as the size of the datalogger memory.

To set the table size to a fixed number of records, enter that value. Enter a –1 to set the size to auto-allocate. If set to auto-allocate, all memory that remains after creating fixed-sized tables will be allocated to this table. If multiple data tables are declared with a –1 for size, the available memory will be divided among the tables. The datalogger attempts to allocate memory to the tables so that all tables are filled at the same time. Enter –1000 to set the size of the table on the card to the size of the table in the datalogger's memory.

In the following example, the minimum *batt_volt* and a sample of *PTemp* are written to the card each time the data table is called. The *StopRing* parameter is 0 for ring mode. This means that once the data table is full, new data will begin overwriting old data. The *size* parameter is –1, so all available space on the card will be allocated to the table.

**DataTable(***Table1,1,-1***)**

**CardOut(***0 ,-1***)**

**Minimum(***1,batt_volt,FP2,0,False***)**

**Sample(***1,PTemp,IEEE4***)**

**EndTable**

**CAUTION** To prevent losing data, collect data from the CF card before sending the datalogger a new or modified program. When a program is sent to the datalogger using the Send button in the *Connect* screen of *LoggerNet* or *PC400*, an attribute is sent along with the program that commands the datalogger to erase all data on the CF card from the currently-running program.

For other methods of saving data to the CF card, see the **TableFile()** instruction in the *CRBasic Editor* help.

## 4.4 CF Card Data Retrieval

Data stored on cards can be retrieved through a communication link to the datalogger or by removing the card and carrying it to a computer with a CF adapter. With large files, transferring the CF card to a computer may be faster than collecting the data over a communication link. CF card-data retrieval is discussed in detail in Section 7.4, *CF Card Data-Retrieval Details* *(p. 25)*.

**CAUTION** Removing a card while it is active can cause garbled data and can actually damage the card. **Always** press the Initiate Removal button and wait for a green light before removing card.

**CAUTION** *LoggerNet File Control* should not be used to retrieve an open file (for example, a file created using CardOut or the latest file created by TableFile, option 64) from a CF card. Using *File Control* to retrieve the data can result in a corrupted data file. However, *File Control* can be used to retrieve closed files such as JPEG images or files (other than the latest) created by TableFile, option 64.

# 5. Overview

*FIGURE 5-1. NL116 Ethernet/CompactFlash® Module*

The NL116 Ethernet/CompactFlash® Module enables Ethernet communication with the datalogger. It also has a slot for a Type I or Type II CompactFlash® (CF) card (3.3 V, 75 mA).

The NL116/CF card combination can be used to expand the datalogger memory, transport data/programs from the field site(s) to the office, upload power-up functions, and store JPEG images from a Campbell Scientific camera. Data stored on cards can be retrieved through a communications link to the datalogger or by removing the card and carrying it to a computer. The computer can read the CF card either with the CF1 adapter or #17752 reader/writer. The CF1 adapter allows the PC's PCMCIA card slot to read the CF card; the #17752 reader/writer allows the PC's USB port to read the CF card. User-supplied CF adapters may also be used.

**CAUTION** *LoggerNet File Control* should not be used to retrieve an open file (for example, a file created using CardOut or the latest file created by TableFile, option 64) from a CF card. Using *File Control* to retrieve the data can result in a corrupted data file. However, *File Control* can be used to retrieve closed files such as JPEG images or files (other than the latest) created by TableFile, option 64.

## 5.1 Buttons and Status LED

There is one red-green-orange LED (light-emitting diode) and two buttons: **Initiate Removal** and eject. The **Status** LED indicates the status of the module. The LED will flash red when the CF card is being accessed, solid green when it is OK to remove the card, solid orange to indicate an error, and flashing orange if the card has been removed and has been out long enough that CPU memory has wrapped and data is being overwritten without being stored to the card. The **Initiate Removal** button must be pressed before removing a card to allow the datalogger to store any buffered data to the card and then power off. The eject button is used to eject the CF card. Note that if the eject button cannot be pressed, it may have been disabled by bending it to the right. Straighten and press the eject button to eject the CF card.

## 5.2 Power

The Ethernet/CompactFlash® module is powered by 12 Vdc received from the datalogger through the peripheral port.

Additional power consumption occurs if the **Status** LED is continuously lit. At 12 Vdc, an additional 1 mA is drawn by the red or green LED; an additional 2 mA is drawn by the orange LED.

## 5.3 CF Card Data Retention

The module accepts CF cards which do not require power to retain data.

Typically, a CF card can be erased and rewritten a minimum of 100,000 times. Industrial CF cards, graded for 2,000,000 write cycles, are recommended for most applications.

# 6. Specifications

| | |
|---|---|
| **Datalogger Compatibility:** | CR1000, CR3000 (both require OS version 28 or later) |
| **Storage Capacity:** | Depends on card size<br>Maximum individual file size is 2 GB |
| **Power Requirements:** | 12 V supplied through datalogger's peripheral port |
| **Current Drain:** | 64 mA w/Ethernet Active @ 10 Mb<br>58 mA w/Ethernet Active @ 100 Mb<br>3 mA w/Ethernet Not Active, CF Card Only<br><br>Note: Ethernet can be put into a low-power state (not connected to the network, essentially off) using the **IPNetPower()** or **EthernetPower()** instruction. |
| **Operating Temperature Range:** | –40 to 70 °C Standard<br>–40 to 85 °C Extended |
| **Compliance Information:** | View the EU Declaration of Conformity at *www.campbellsci.eu/nl116* |

| | |
|---|---|
| **Cable Requirements:** | Use a straight-through Ethernet cable when the cable is run from the hub to the NL116. Use a shielded cable when the cable length is more than 9 ft.<br><br>Note: The maximum recommended segment length for 10BaseT and 100BaseTx networks using CAT5 cable is 100 metres. Segment length is the length of cable between the NL device and the Ethernet repeater, hub, switch, or router it is connected to. |
| **CF Card Requirements:** | Industrial grade |
| **Ethernet Speed:** | 10/100 Mbps (10Base-T / 100Base-Tx), full and half duplex, all auto-negotiated. Typical access speeds vary and range from 20 KBytes/sec to 200 KBytes/sec depending on multiple factors (*** see note). |
| **Memory Configuration:** | User-selectable for either ring style (default) or fill-and-stop. |
| **Dimensions:** | 10.2 x 8.9 x 6.4 cm (4.0 x 3.5 x 2.5 in) |
| **Weight:** | 154 g (5.4 oz) |

*** The NL116 will automatically negotiate the speed and duplex mode used for the Ethernet link. However, the speed at which data can be transferred to and from a datalogger over the NL116 depends on multiple factors including:

- the datalogger processor speed, that is, CR1000 vs CR3000
- how busy the datalogger is performing measurement, processing, control and other communication tasks; measurement tasks take priority over communication tasks
- the IP protocol used for the data transfer and how/if the link is encrypted
- where the data is being transferred from or to, for example, USR vs CRD
- limitation of the IP connection due to congestion, the number of “hops”, and the quality of the physical media between the client and host

Below are some example data transfer rates observed over an ideal connection. A laptop computer was connected directly to the NL116 interface, transferring a 1.7 MB file to and from the datalogger USR drive.

CR1000
(Sending from computer to datalogger; retrieving from datalogger to computer)

- PakBus: 30 KBytes/sec; 30 KBytes/sec
- FTP/HTTP: 55 Bytes/sec; 90 KBytes/sec

CR3000
(Sending from computer to datalogger; retrieving from datalogger to computer)

- PakBus: 65 KBytes/sec; 65 KBytes/sec
- FTP/HTTP: 135 KBytes/sec; 210 KBytes/sec

# 7. Operation

## 7.1 TCP/IP Functionality

This section describes the main TCP/IP functionality of a datalogger with an NL116 attached. Additional functionality may be added in the future. For more information, refer to the Information Services section of the datalogger manual and *CRBasic Editor* help.

### 7.1.1 Communicating Over TCP/IP

Once the datalogger, the NL116, and *LoggerNet* have been set up as described in Sections 4.1, *Physical Setup* (p. 2), and 4.2, *Communicating via Ethernet* (p. 3), communication is possible over TCP/IP. This includes program send and data collection. These are straightforward operations and are accomplished through the *LoggerNet Connect* screen. For more information, see the *LoggerNet* manual.

Data callback and datalogger-to-datalogger communications are also possible over TCP/IP, as well as the creation of simple HTML pages to view datalogger variables using a web browser.

#### *7.1.1.1 Data Callback*

The following program is an example of doing data callback over TCP/IP. It first checks to see if a port to the *LoggerNet* server already exists. (The *LoggerNet* server is assumed to be at the default PakBus address, 4094.) If not, a socket to *LoggerNet* is opened using the **TCPOpen()** instruction. The **SendVariables()** instruction is then used to send data.

**CRBasic Example 7-1. Data Callback over TCP/IP**

```
' CR1000
' IP_Callback.cr1
' LoggerNet server Pak Bus Address assumed = 4094
' PC IP address assumed = 192.168.7.231
' LoggerNet IPPort "IP Port Used for Call-Back" = 6785
' LoggerNet IPPort "Call-Back Enabled" is checked
' LoggerNet CR1000 "Call-Back Enabled" is checked
' LoggerNet PakBusPort "PakBus Port Always Open" is checked
' IP Call-back using auto-discover (-1) neighbor in SendVariables

Public PanelTemperature, BatteryVoltage, Result1, dummy1

Dim Socket as LONG

DataTable (CLBK1,1,1000)
  DataInterval (0,0,Sec,10)
  Sample (1,PanelTemperature,FP2)
  Sample (1,BatteryVoltage,FP2)
EndTable

BeginProg

  Scan (5,Sec,6,0)

    PanelTemp (PanelTemperature,250)
    Battery (BatteryVoltage)

    If not Route(4094) then Socket = TCPOpen ("192.168.7.231",6785,0)
```

```
    SendVariables (Result1,Socket,-1,4094,0000,100,"Public","Callback",dummy1,1)

    CallTable CLBK1

  NextScan

EndProg
```

#### 7.1.1.2 Datalogger-to-Datalogger Communication

Communication between dataloggers is possible over TCP/IP. In order to do this, a socket must be opened between the two dataloggers using the **TCPOpen()** instruction or using the **PakBus/TCP Client** setting. Note that only one datalogger should be set up to open the connection. The socket opened by the **TCPOpen()** instruction or the **PakBus/TCP Client** setting is used by the instructions performing datalogger-to-datalogger communication.

The example program below gets the battery voltage from a remote datalogger and sends its panel temperature to the remote datalogger. The remote datalogger is at IP address 192.168.7.125 and port 6785 is used for communication between the dataloggers. The remote datalogger must have its battery voltage stored in a public variable, *BattVolt*. It must also have a public variable declared, *PTemp_Base*. This will be used to store the panel temperature of the base datalogger.

**CRBasic Example 7-2. Datalogger-to-Datalogger Communication**

```
'CR1000
'DL-to-Dl_Comms_1.cr1
'Send this program to CR1000 #1
'Remote CR1000 #2 has PBA = 2, IP addr = 192.168.7.125, and port 6785

Public BattVolt,, BattVolt_Remote
Public PTemp
Public Result1, Result2

Dim Socket as LONG

DataTable (Test,1,-1)
  DataInterval (0,12,Sec,10)
    Minimum (1,BattVolt,FP2,0,False)
EndTable

BeginProg

  Scan(2,Sec,0,0)

    Socket = TCPOpen("192.168.7.125",6785,0)

    BatteryVoltage(BattVolt)
    PanelTemp(PTemp,250)

    GetVariables (Result1,Socket,-1,2,0000,50,"Public","BattVolt",BattVolt_Remote,1)
    SendVariables (Result2,Socket,-1,2,0000,50,"Public","PTemp",PTemp_Base,1)

    CallTable(Test)

  NextScan

EndProg
```

### 7.1.2 HTTP Web Server

Typing the datalogger's IP address into a web browser will bring up its home page, as shown in FIGURE 7-1. This default home page provides links to the current record in all tables, including data tables, the Status table, the DataTableInfo table, and the Public table. Clicking on a **Newest Record** link will bring up the latest record for that table. It will be automatically refreshed every 10 seconds. Links are also provided to the last 24 records in each data table. Clicking on a **Last 24 Records** link will bring up the last 24 records for that table. The **Last 24 Records** display must be manually refreshed. In addition, links are provided to all HTML files, all XML files, and all JPEG files in the datalogger.

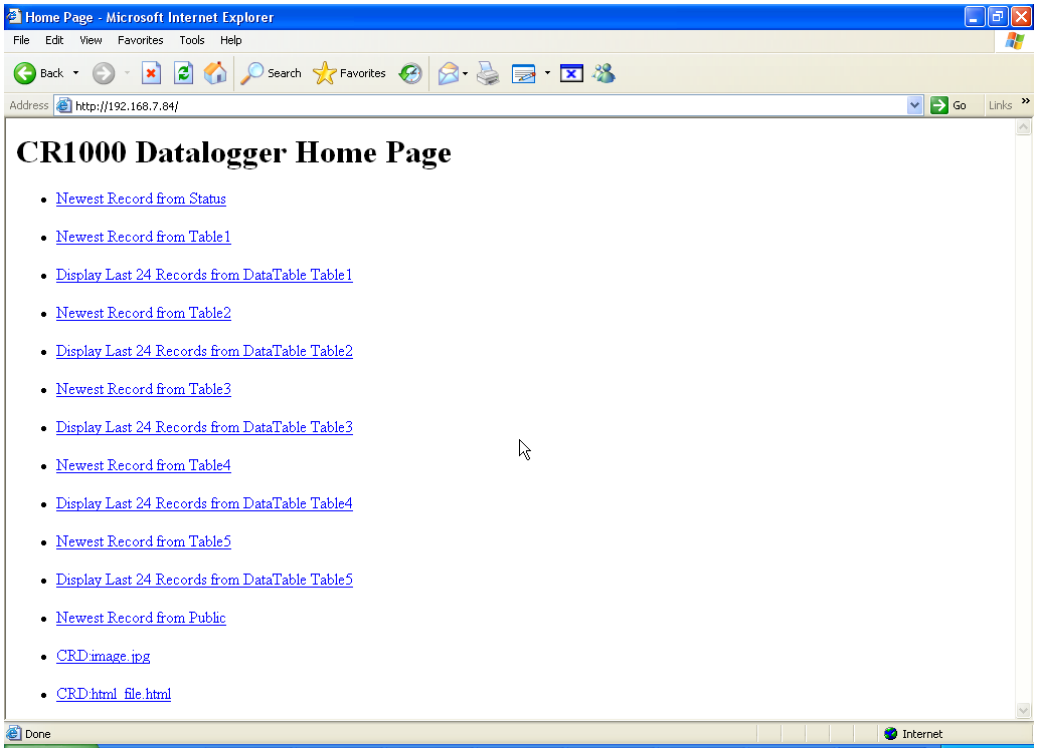



*FIGURE 7-1. Datalogger home page*

If there is a default.html file on the datalogger, this will automatically become the user-configurable home page.

The **WebPageBegin/WebPageEnd** declarations and the **HTTPOut()** instruction can be used in a datalogger program to create HTML or XML files that can be viewed by the browser. For more information on using these instructions, see the datalogger manual or *CRBasic Editor* help.

See Web Server API in the contents of the *CRBasic Editor* help for more information on using HTTP to access datalogger data.

**NOTE** **FileOpen()** and **FileWrite()** can be used to create HTML pages, but this requires first writing the file to the datalogger USR, CRD, or USB drive. It is less convenient, and the page will be only as current as it is written to the file.

## 7.1.3 FTP

### *7.1.3.1 FTP Server*

With an NL116 attached, the datalogger will automatically run an FTP server. This allows Windows Explorer to access the datalogger's file system via FTP. In the FTP world, the "drives" on the datalogger are mapped into directories (or folders). The "root directory" on the datalogger will include CPU and possibly USR, USB, and/or CRD. The files will be contained in one of these directories. Files can be pasted to and copied from the datalogger "drives" as if they were drives on the PC. Files on the datalogger drives can also be deleted through FTP.

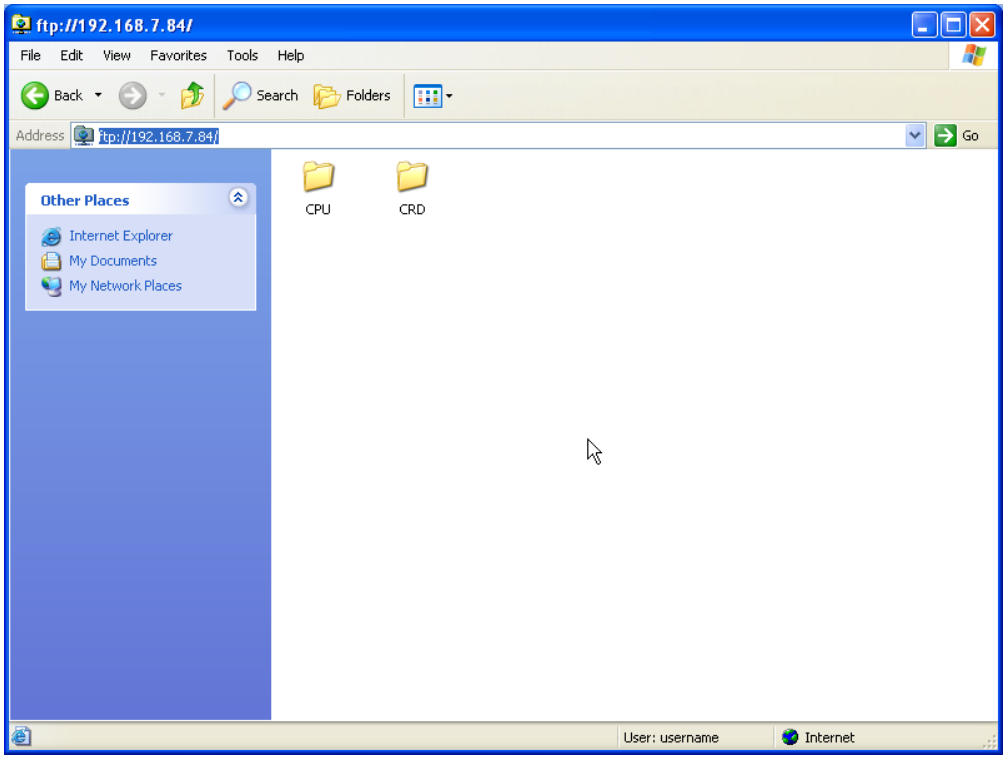



*FIGURE 7-2. FTP root directory*

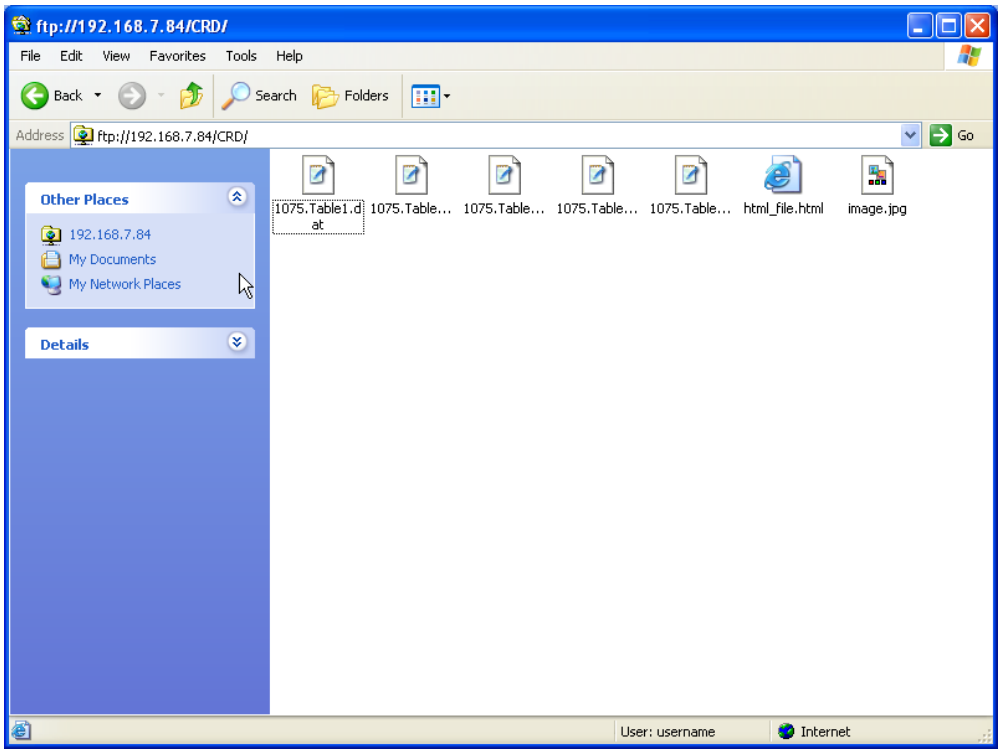



*FIGURE 7-3. FTP CRD directory*

In order to use FTP, the datalogger's FTP User Name and FTP Password must be set. This is done using *DevConfig*.

### *Step 1: Configure Datalogger*

a. Connect serial cable from PC COM port to datalogger **RS-232** port.

b. Open Campbell Scientific's *DevConfig*. Select the **Device Type** of the datalogger (CR1000 or CR3000), the appropriate **Communication Port** and **Baud Rate**. **Connec**t to the datalogger.

e. Under the **Network Services** tab, verify that **FTP Enabled** is checked. Input the **FTP User Name** and **FTP Password**.

f. Press the **Apply** button to save the changes and then close *DevConfig*.

**NOTE** Using **anonymou**s as the user name with no password allows FTP access without inputting a user name or password.

### *Step 2: Access File System*

a. The datalogger must be set up for Ethernet communications as explained in Sections 4.1, *Physical Setup* *(p. 2)*, and 4.2, *Communicating via Ethernet* *(p. 3)* (Step 1 only).

b. Open a Windows Explorer window. Enter **ftp://username:password@nnn.nnn.nnn.nnn** where nnn.nnn.nnn.nnn is the IP address of the datalogger.

**NOTE** If the user name is "anonymous" with no password, enter **ftp://nnn.nnn.nnn.nnn** where nnn.nnn.nnn.nnn is the IP address of the datalogger.

#### 7.1.3.2 FTP Client

The datalogger can be an FTP client for the purpose of putting, getting, and managing files on an FTP server. It can also be used to transfer table data easily. This is done using the **FTPClient()** instruction. The following program is an example of using **FTPClient()** to send a file to another datalogger and get a file from that datalogger. For more information, see the **FTPClient()** instruction in the *CRBasic Editor* help.

**CRBasic Example 7-3. FTPClient() Instruction**

```
' CR1000
' FTPClient.cr1

Public Result1, Result2

BeginProg

  Scan (20,Sec,1,1)

    Result1 = FTPClient("192.168.7.85","user","password","CRD:pic.jpg","CRD:pic.jpg",0)
    Result2 = FTPClient("192.168.7.85","user","password","CRD:file.html","CRD:file.html",1)

  NextScan

EndProg
```

### 7.1.4 Telnet

Telnetting to the datalogger's IP address allows access to the same commands as the *Terminal Emulator* in the *LoggerNet Connect* screen **Datalogger** menu.

### 7.1.5 Ping

Pinging the datalogger's IP address may be used to verify communications.

### 7.1.6 Serial Server

With an NL116 attached, the datalogger can be programmed to act as a serial server over the Ethernet port. (A serial server is a device that allows serial communication over a TCP/IP port.) This function may be useful when communicating with a serial sensor over an Ethernet.

#### 7.1.6.1 Serial Input

The **TCPOpen()** instruction must be used first to open a TCP socket. An example of this instruction is shown below. For more information on this instruction, see the *CRBasic Editor* help.

*socket* = **TCPOpen(***"",6784,100***)**

Once a socket has been opened with the **TCPOpen()** instruction, serial data may be received with a **SerialIn()** instruction. An example of this instruction is shown below. For more information on this instruction, see the *CRBasic Editor* help.

**SerialIn(***Received,socket,0,13,100***)**

#### 7.1.6.2 Serial Output

The **TCPOpen()** instruction must be used first to open a TCP socket. An example of this instruction is shown below. For more information on this instruction, see the *CRBasic Editor* help.

*socket* = **TCPOpen(***"192.168.7.85",6784,100***)**

Once a socket has been opened with the **TCPOpen()** instruction, serial data may be sent out with **SerialOut()**. An example of this instruction is shown below. For more information on this instruction, see the *CRBasic Editor* help.

*result* = **SerialOut(***socket,sent,"",0,100***)**

### 7.1.7 TCP ModBus

With an NL116 attached, the datalogger can be set up as a TCP ModBus Master or Slave device. For information on configuring the datalogger as a TCP ModBus Master or Slave, see the ModBus section of the datalogger manual.

### 7.1.8 DHCP

The IP address of the datalogger may be obtained through DHCP, if a DHCP server is available. The DHCP address will be automatically assigned if there is a DHCP server available and no static IP address has been entered. The IP address should be available a few minutes after the datalogger has been powered up with the NL116 attached and Ethernet cable plugged in. The IP address can be found with the *DevConfig* **Ethernet** tab. It can also be found using a CR1000KD attached to the datalogger. Go to **Configure, Settings | Settings (general)**, scroll down to **IPInfo** and press the right arrow.

An IP address obtained through DHCP is not static but is leased for a period of time set by the network administrator. The address may change, if the datalogger is powered down.

### 7.1.9 DNS

The datalogger provides a DNS client that can query a DNS server to resolve a fully qualified domain name. When a DNS server is available, domain names can be used in place of the IP address in the datalogger instructions.

## 7.2 File Formats

This section covers the different types of files stored on the CF card.

### 7.2.1 Data Files

The datalogger stores data on the CF card in TOB3 format. TOB3 is a binary format that incorporates features to improve reliability of the CF cards. TOB3 allows the accurate determination of each record's time without the space required for individual timestamps.

TOB3 format is different than the data file formats created when data is collected via a communication link. Data files read directly from the CF card generally need to be converted into another format to be used.

When TOB3 files are converted into another format, the number of records may be slightly greater or fewer than the number requested in the data-table declaration. There is always some additional memory allocated. When the file is converted, this will result in additional records if no lapses occurred. If more lapses occurred than were anticipated, there may be fewer records in the file than were allocated.

The *CardConvert* software included in *LoggerNet*, *PC400*, and *PC200W* will convert data files from one format into another.

### 7.2.2 Program Files

The CF card can be used to provide extra program-storage space for the datalogger. Program files can be copied to the card while it is attached as a drive on the computer. They can also be sent to the card using *LoggerNet File Control*. They may also be copied from CPU memory to the card (or from the card to CPU memory) using the CR1000KD.

### 7.2.3 Power-up Files (Powerup.ini)

Users can insert a properly-configured CF card into the NL116, cycle through the datalogger power, and have power-up functions automatically performed.

Power-up functions of CompactFlash® cards can include:

a) Sending programs to the CR1000 or CR3000
b) Setting attributes of datalogger program files
c) Setting disposition of old CF files
d) Sending an OS to the CR1000 or CR3000
e) Formatting memory drives
f) Deleting data files

**CAUTION** Test the power-up functions in the office before going into the field to ensure the power-up file is configured correctly.

The key to the CF power-up function is the powerup.ini file, which contains a list of one or more command lines. At power-up, the powerup.ini command line is executed prior to compiling the program. Powerup.ini performs three operations:

1) Copies the specified program file to a specified memory drive

2) Sets a file attribute on the program file

3) Optionally deletes CF data files from the overwritten (just previous) program

Powerup.ini takes precedence during power-up. Though it sets file attributes for the programs it uploads, its presence on the CF does not allow those file attributes to control the power-up process. To avoid confusion, either remove the CF card or delete the powerup.ini file after the powerup.ini upload.

#### 7.2.3.1 Creating and Editing Powerup.ini

Powerup.ini is created with a text editor, then saved as "powerup.ini".

**NOTE** Some text editors (such as WordPad) will attach header information to the powerup.ini file, causing it to abort. Check the text of a powerup.ini file with the datalogger keyboard display to see what the datalogger actually sees.

Comments can be added to the file by preceding them with a single-quote character ('). All text after the comment mark on the same line is ignored.

**Syntax**
Syntax allows functionality comparable to *File Control* in *LoggerNet*. Powerup.ini is a text file that contains a list of commands and parameters. The syntax for the file is:

*Command,File,Device*

where

*Command* = one of the numeric commands in TABLE 7-1.
*File* = file on CF associated with the action. Name can be up to 22 characters.
*Device* = the device to which the associated file will be copied Options are CPU:, USR:, and CRD:. If left blank or with an invalid option, it will default to CPU:.

**TABLE 7-1. Powerup.ini Commands**

| Command | Description |
|---|---|
| 1 | Run always, preserve CF data files |
| 2 | Run on power-up |
| 5 | Format |
| 6 | Run now, preserve CF data files |
| 9 | Load OS (File = .obj) |
| 13 | Run always, erase CF data files now |
| 14 | Run now, erase CF data files now |

By using **PreserveVariables()** instruction in the datalogger CRBasic program, with options 1 and 6, data and variables can be preserved. The powerup.ini code is shown below.

**EXAMPLE 7-1. Powerup.ini code.**

```
'Command = numeric power-up command
'File = file on CF associated with the action
'Device = the device to which File will be copied.  Defaults to CPU:

'Command,File,Device
13,Write2CRD_2.cr1,CPU:
```

#### 7.2.3.2 Applications

- Command 1 copies the specified program to the designated drive and sets the run attribute of the program to Run Always. Data on a CF card from the previously running program will be preserved.
- Command 2 copies the specified program to the designated drive. The program specified in command 2 will be set to Run Always unless command 6 or 14 is used to set a separate Run Now program.
- Command 5 formats the designated drive.
- Command 6 copies the specified program to the designated drive and sets the run attribute of the program to Run Now. Data on a CF card from the previously running program will be preserved.
- Command 7 copies the specified file to the designated drive with no run attributes.
- Command 13 copies the specified program to the designated drive and sets the run attribute of the program to Run Always. Data on a CF card from the previously running program will be erased.
- Command 14 copies the specified program to the designated drive and sets the run attribute to Run Now. Data on a CF card from the previously running program will be erased.

#### 7.2.3.3 Program Execution

After File is processed, the following rules determine what datalogger program to run:

1) If the Run Now program is changed, it will be the program that runs.
2) If no change is made to the Run Now program, but the Run on Power-up program is changed, the new Run on Power-up program runs.
3) If neither the Run on Power-up nor the Run Now programs are changed, the previous Run on Power-up program runs.

#### 7.2.3.4 Example Powerup.ini Files

Examples 7-2 through 7-7 are example powerup.ini files.

**EXAMPLE 7-2. Run Program on Power-up.**

```
'Copy pwrup.cr1 to USR:, will run only when powered up later
2,pwrup.cr1,usr:
```

**EXAMPLE 7-3. Format the USR: Drive.**

```
'Format the USR: drive
5,,usr:
```

**EXAMPLE 7-4. Send OS on Power-up.**

```
'Load this file into FLASH as the new OS
9,CR1000.Std.28.obj
```

**EXAMPLE 7-5. Run Program from CRD: Drive.**

```
'Leave program on CRD:, run always, erase CRD: data files
13,toobigforcpu.cr1,crd:
```

**EXAMPLE 7-6. Run Program Always, Erase CF Data.**

```
'Run always, erase CRD: data files
13,pwrup_1.cr1,crd
```

**EXAMPLE 7-7. Run Program Now, Erase CF Data.**

```
'Copy run.cr1 to CPU:, erase CF data, run CPU:run.cr1, but not if later powered up
14,run.cr1,cpu:
```

### 7.2.4 Camera Files

JPEG images taken by a CC640 digital camera (retired) connected to the datalogger can be stored to the CF card rather than CPU memory. This is done by configuring the PakBus setting **Files Manager** for the datalogger. This can be done using *DevConfig* or *PakBus Graph*.

## 7.3 Programming

### 7.3.1 The CardOut() Instruction

The **CardOut()** instruction is used to send data to a CF card. **CardOut()** must be entered within each **DataTable()** declaration that is to store data to the CF card. Data is stored to the card when a call is made to the data table.

***CardOut(StopRing, Size)***

| **Parameter**<br>*Data Type* | **Enter** |
|---|---|
| **StopRing**<br>*Constant* | A code to specify if the data table on the CF card is fill-and-stop or ring (newest data overwrites oldest).<br>**Value** — **Result**<br>0 — Ring<br>1 — Fill and stop |
| **Size**<br>*Constant* | The size to make the data table. The number of data sets (records) for which to allocate memory in the CF card. Each time a variable or interval trigger occurs, a line (or row) of data is output with the number of values determined by the output instructions within the table. This data is called a record. |
| | **Note** Enter –1000 and the size of the table on the card will match the size of the internal table on the datalogger. Enter any other negative number and all remaining memory (after creating any fixed-size data tables) will be allocated to the table or partitioned among all tables with a negative value for size. The partitioning algorithm attempts to have the tables full at the same time. |

## 7.3.2 Program Examples

### 7.3.2.1 Ring Mode

The following program outputs the maximum and minimum of the panel temperature to the card once a second. The first parameter of the **CardOut()** instruction is 0, which sets the table on the card to ring mode. The second parameter is negative, so all available memory on the card will be allocated to the data table. Once all available memory is used, new data will begin overwriting the oldest.

**CRBasic Example 7-4. Ring Mode**

```
'CR1000

Public temp

DataTable (Table1,1,-1)
  CardOut (0, -1)
  Maximum (1,temp,FP2,False,False)
  Minimum (1,temp,FP2,False,False)
EndTable

BeginProg
  Scan(1,SEC,3,0)
    PanelTemp(temp,250)
    CallTable Table1
  NextScan
EndProg
```

### 7.3.2.2 Fill-and-Stop Mode

The following program outputs a sample of the panel temperature to the card once a second. The first parameter of the **CardOut()** instruction is 1, which sets the table on the card to fill-and-stop mode. The second parameter (1000) is the number of records which will be written before the table is full and data storage stops. Once 1000 records have been stored, data storage to the specified table on CRD: and CPU: datalogger memory drives will stop.

**CRBasic Example 7-5. Fill-and-Stop Mode**

```
'CR1000

Public temp

DataTable (Table1,1,1000)
  CardOut (1,1000)
  Sample(1,temp,IEEE4)
EndTable

BeginProg
  Scan(1,SEC,3,0)
    PanelTemp(temp,250)
    CallTable Table1
  NextScan
EndProg
```

To restart data storage to the fill-and-stop table, the table must be reset.

To reset a table after a fill-and-stop table has been filled and stopped, either use the reset button in ***LoggerNet (Connect | Datalogger | Station Status | Table Fill Times, Reset Tables)*** or use the CRBasic **ResetTable()** instruction.

#### 7.3.2.3 Mixed Modes

The following program stores four data tables to the card. The first two tables will output samples of the panel temperature and battery voltage to the card once a second. The first parameter of the **CardOut()** instruction is 1, which sets the tables on the card to fill-and-stop mode. The second parameter is 1000, so 1000 records will be written to each table before stopping.

Tables 3 and 4 will output the maximum and minimum of the panel temperature and battery voltage to the card every five seconds. (The tables will be called once a second. The **DataInterval()** instruction causes data to only be stored every five seconds.) The first parameter of the **CardOut()** instruction is 0, which sets the tables on the card to ring mode. The second parameter is negative, so all available memory on the card will be allocated to these tables, once space for the fixed-size tables has been allocated. The datalogger will attempt to size the tables so that both will be full at the same time.

**CRBasic Example 7-6. Mixed Modes**

```
'CR1000

Public temp
Public batt

DataTable (Table1,1,-1)
  CardOut (1,1000)
  Sample(1,temp,IEEE4)
EndTable

DataTable (Table2,1,-1)
  CardOut (1,1000)
  Sample(1,batt,IEEE4)
EndTable

DataTable (Table3,1,1000)
  DataInterval(0,5,sec,4)
  CardOut (0 ,-1)
  Maximum (1,temp,FP2,False,False)
  Minimum (1,temp,FP2,False,False)
EndTable

DataTable (Table4,1,1000)
  DataInterval(0,5,sec,4)
  CardOut (0 ,-1)
  Maximum (1batt,FP2,False,False)
  Minimum (1,batt,FP2,False,False)
EndTable

BeginProg
  Scan(1,SEC,3,0)
    PanelTemp(temp,250)
    Battery(Batt)
    CallTable Table1
    CallTable Table2
    CallTable Table3
    CallTable Table4
  NextScan
EndProg
```

### 7.3.3 Table Size and Mode

The size of each data table in CPU memory is set as part of the **DataTable()** instruction and the size of each data table on the CF card is set with the

**CardOut()** instruction. Because they are set independently, they can be different. It is important to note that if the CPU memory is set to fill-and-stop mode, once a table is full, all data storage to the table will stop. No more records will be stored to the CPU memory or the card.

## 7.4 CF Card Data-Retrieval Details

Data stored on CF cards can be retrieved through a communication link to the datalogger or by removing the card and carrying it to a computer.

### 7.4.1 Via a Communication Link

Data can be transferred to a computer via a communication link using one of Campbell Scientific's datalogger support software packages (for example, *PC200W*, *PC400*, *LoggerNet*). There is no need to distinguish whether the data is to be collected from the CPU memory or a CF card. The software package will look for data in both the CPU memory and the CF card.

The datalogger manages data on a CF card as final-storage table data, accessing the card as needed to fill data-collection requests initiated with the **Collect** button in datalogger support software. If desired, binary data can be collected using the *File Control* utility in datalogger support software. Before collecting data this way, stop the datalogger program to ensure data is not written to the CF card while data is retrieved. Otherwise, data corruption and confusion will result.

#### *7.4.1.1 Fast Storage/Data-Collection Constraints*

When *LoggerNet* collects data from ring tables that have filled, there is the possibility of missing records due to the collection process. *LoggerNet* uses a "round-robin" collection algorithm that collects data from multiple tables in small blocks as it sequences around to all the tables. Collection starts at the oldest data for each table. When a ring table has filled, the oldest data is overwritten by current data.

With filled ring tables, as collection begins *LoggerNet* queries the datalogger for the oldest data starting with the first table. When this data block is returned, *LoggerNet* goes to the next table and so on until all of the tables are initially collected. By the time *LoggerNet* makes the second pass requesting more data from the tables, the possibility exists that some of that data may have been overwritten, depending on how fast the datalogger is storing data (that is, data storage rate, number of table values, and number of tables).

Normally, *LoggerNet* gets ahead of the storing datalogger and the remaining data is collected without gaps; however, if the datalogger is storing data fast enough, it is possible to get into an always-behind scenario where *LoggerNet* never catches up and the datalogger repeatedly overwrites uncollected data.

**CAUTION** The possibility of missing records is greater when collecting data via IP. This is due to the high demand of IP on processor time. The risk is greatest with a CR1000 datalogger using IP, because of its slower processor speed relative to the CR3000.

## 7.4.2 Transporting CF Card to Computer

With large files, transferring the CF card to a computer may be faster than collecting the data over a link.

**CAUTION** Removing a card while it is active can cause garbled data and can actually damage the card. Do not switch off the datalogger power if a card is present and active.

To remove a card, press the **Initiate Removal** button on the NL116. The datalogger will transfer any buffered data to the card and then power off. The **Status** LED will turn green when it is OK to remove the card. The card will be reactivated after 20 seconds if it is not removed.

When the CF card is inserted into a computer, the data files can be copied to another drive or used directly from the CF card just as one would from any other disk. In most cases, however, it will be necessary to convert the file format before using the data.

**NOTE** When dealing with large data files, it may be faster to use an external card reader (such as pn #17752) rather than a PC card slot.

### *7.4.2.1 Converting File Formats*

Files can be converted using *LoggerNet CardConvert*. Open *CardCovert* from the **Data** category on the *LoggerNet* toolbar. Click on **Select Card Drive**. Select where the files to be converted are stored and press **OK**. Next, click on **Change Output Dir** and select where you would like the converted files to be stored. Place check marks next to the files to be converted. A default destination filename is given. It can be changed by right-clicking with the filename highlighted. Press the **Destination File Options** button to select what file format to convert to and other options. Press **Start Conversion** to begin converting files. Green checkmarks will appear next to each filename as conversion is complete. Refer to *CardConvert* online help for more information.

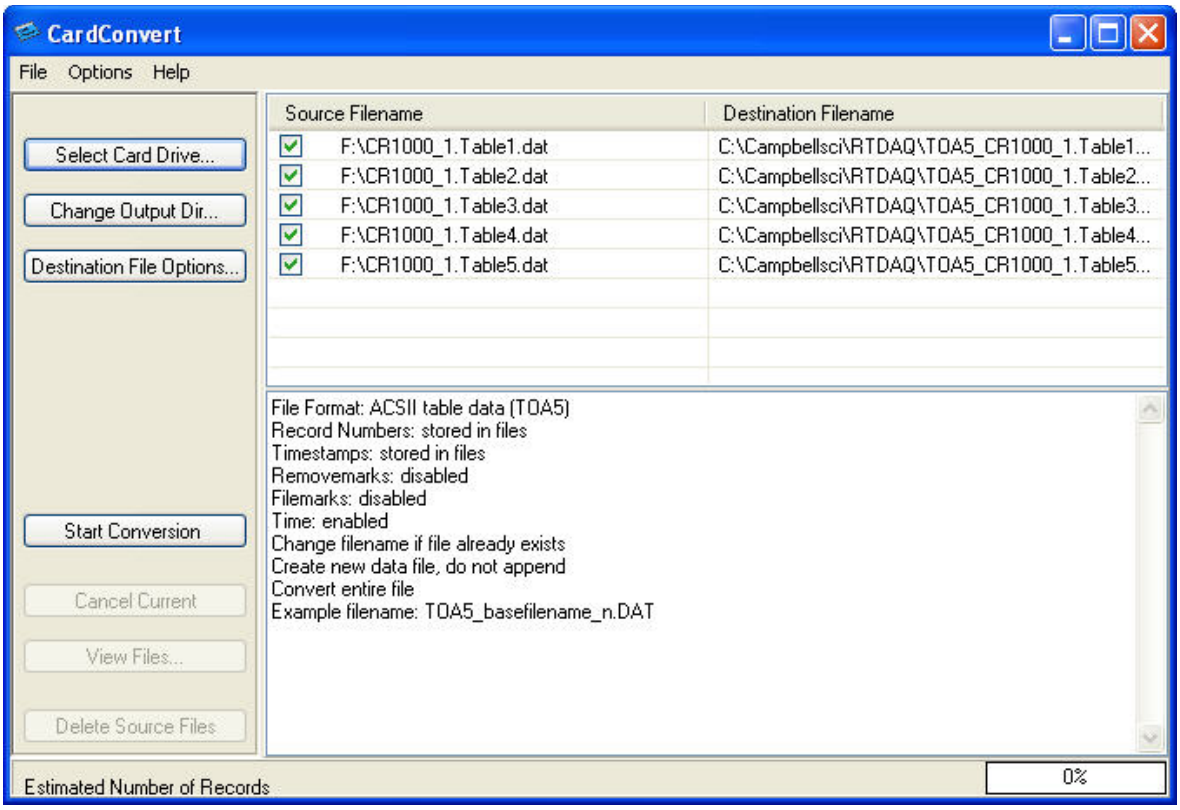



*FIGURE 7-4. CardConvert*

#### *7.4.2.2 Reinserting the Card*

If the same card is inserted again into the NL116, the datalogger will store all data to the card that has been generated since the card was removed that is still in the CPU memory. If the data tables have been left on the card, new data will be appended to the end of the old files. If the data tables have been deleted, new ones will be generated.

**CAUTION** Check the status of the card before leaving the datalogger. If a CF card was not properly accepted, the **Status** LED will flash orange. In that case, the user needs to reformat and erase all data contained on the CF card. Formatting or erasing a CF card might be done on a PC or datalogger. The procedure for formatting a CF card is explained in Appendix A, *CF Card Maintenance* *(p. A-1)*.

#### *7.4.2.3 Card Swapping*

When transporting a CF card to a computer to retrieve data, most users will want to use a second card to ensure that no data is lost. For this method of collection, use the following steps.

1. Insert formatted card ("CF-A") in NL116 attached to datalogger.

2. Send Program containing **CardOut()** instruction(s).

3. When ready to retrieve data, press the NL116 **Initiate Removal** button to remove the card. The LED will be red while the most-current data is stored to the card and then turn green. Eject the card while the LED is green.

4. Put in the clean card ("CF-B").

5. Use *CardConvert* to copy data from CF-A to PC and convert. The default *CardConvert* filename will be TOA5_*stationname_tablename*.dat. Once the data is copied, use Windows Explorer to **delete all data files from the card**.

6. At the next card swap, eject CF-B and insert the clean CF-A.

7. Running *CardConvert* on CF-B will result in separate data files containing records since CF-A was ejected. CardConvert can increment the filename to TOA5_*stationname_tablename*_0.dat.

8. The data files can be joined using a software utility such as *WordPad* or *Excel*.

| *CardConvert* File | CF-A Record Numbers | CF-B Record Numbers |
|---|---|---|
| TOA5_*tablename*.dat | 0-100 | |
| TOA5_*tablename*.dat | | 101-1234 |
| TOA5_*tablename*.dat | 1235-…. | |

# Appendix A. CF Card Maintenance

## A.1 Formatting CF Card

The CF card can be formatted using 1) Windows Explorer, 2) the CR1000KD, or 3) *LoggerNet File Control*.

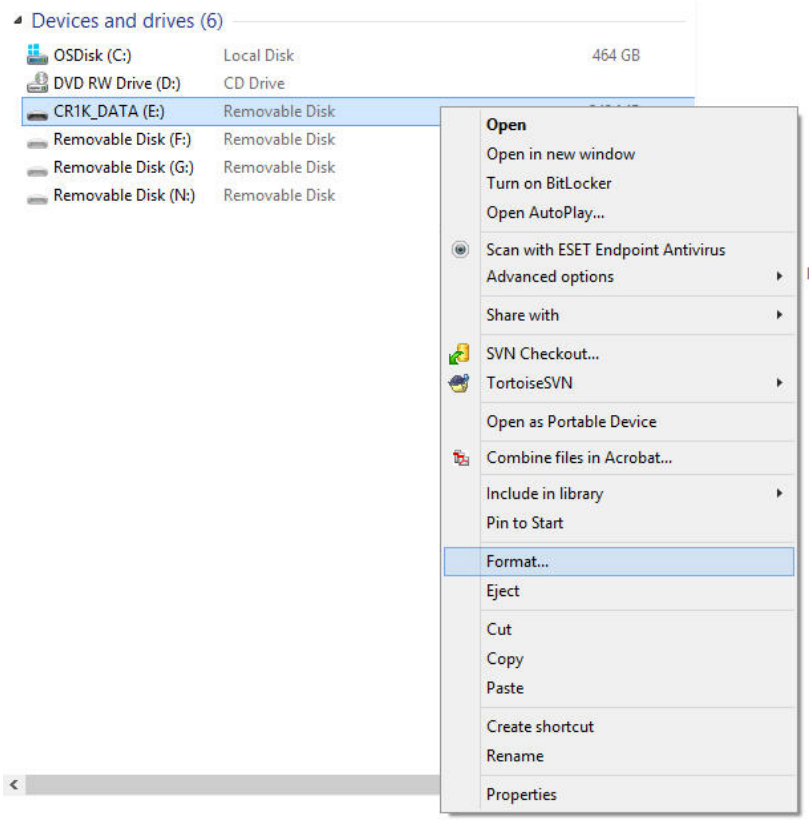
### A.1.1 Windows Explorer

To format card using Windows Explorer:

1) Insert CF card into CF adapter or CF reader.

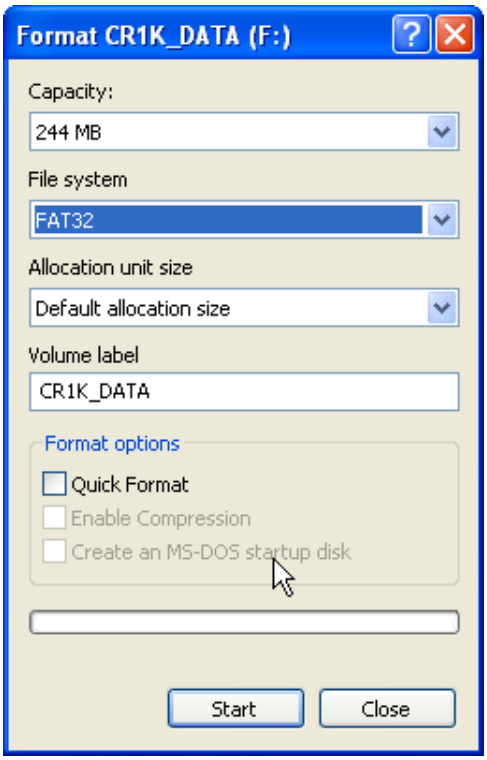
2) Windows Explorer should identify a drive as a removable disk.

3) Select that drive and right-click.




4) Choose **Format**.

5) Choose **FAT32** under file system, give the card a label, and press **Start**. (The datalogger will work with either FAT or FAT32.)




## A.1.2 CR1000KD

To format card using the CR1000KD:

1) Insert CF card into NL116.

2) From the main menu of CR1000KD, choose **PCCard**.

3) Choose **Format Card**.

4) Choose **Yes** to proceed.

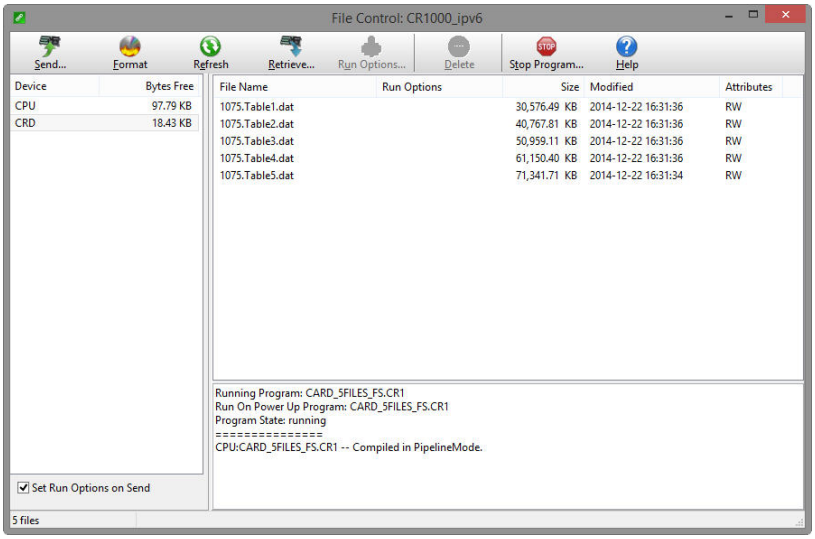
## A.1.3 *LoggerNet* File Control

To format card using *LoggerNet File Control*:

1) Insert CF card into NL116.

2) Use *LoggerNet* to connect to datalogger.

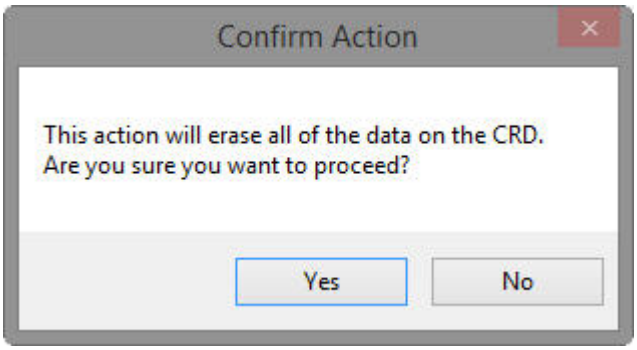
3) Choose *FileControl* under the **Tools** menu of the *Connect* screen.




4) Highlight **CRD**.

5) Press **Format**.

6) Press **Yes** to confirm.




## A.2 Checking CF Card Integrity

The Windows Check Disk tool can be used to check the integrity of a CF card. To access the Check Disk tool:

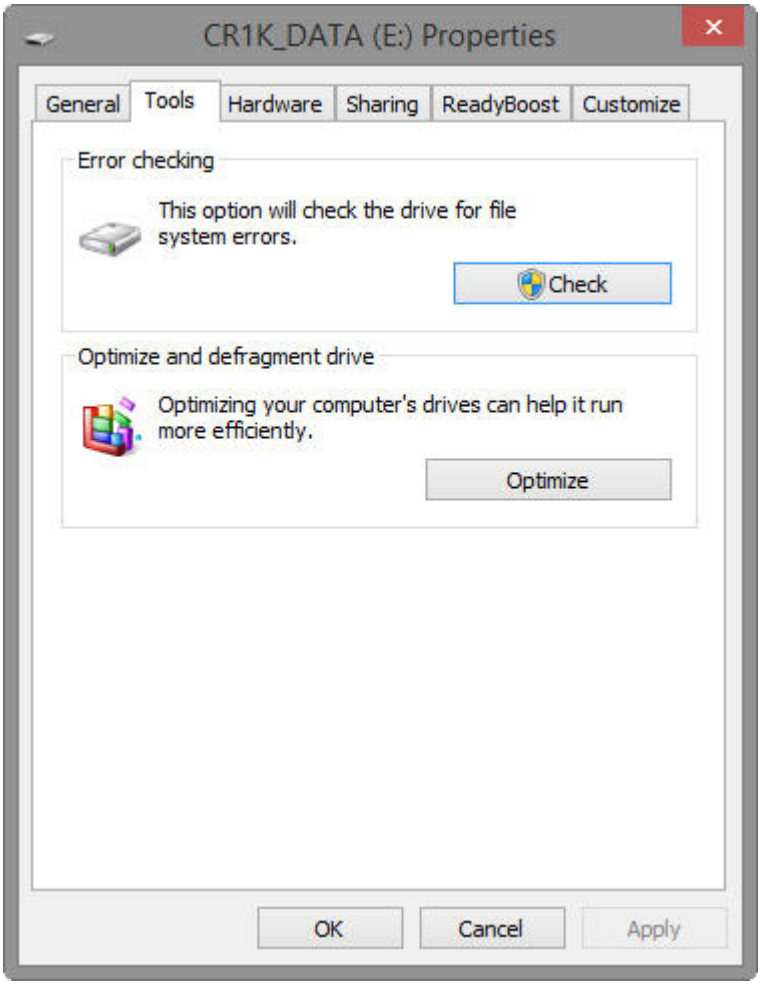
1) Insert CF card into CF reader.

2) Windows Explorer should identify a drive as removable disk.

3) Select that drive and right-click.

4) Choose **Properties**.

5) Navigate to the **Tools** tab.




6) Press **Check**.

7) Select **Scan and Repair Drive**.

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