THRULINE® RF POWER METER MODEL 4421DN
AND
THRULINE® DIRECTIONAL RF POWER SENSORS
4020 SERIES, 4027A SERIES,
4027F SERIES, AND 4028 SERIES

Operation Manual

Instruction Book Part Number 920-4421DN Rev D

Safety Precautions

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication. These precautions must be thoroughly understood and apply to all phases of operation and maintenance.

WARNING

Keep Away From Live Circuits

Operating Personnel must at all times observe general safety precautions. Do not replace components or make adjustments to the inside of the test equipment with the high voltage supply turned on. To avoid casualties, always remove power.

WARNING

Shock Hazard

Do not attempt to remove the RF transmission line while RF power is present.

WARNING

Do Not Service Or Adjust Alone

Under no circumstances should any person reach into an enclosure for the purpose of service or adjustment of equipment except in the presence of someone who is capable of rendering aid.

WARNING

Safety Earth Ground

An uninterruptible earth safety ground must be supplied from the main power source to test instruments. Grounding one conductor of a two conductor power cable is not sufficient protection. Serious injury or death can occur if this grounding is not properly supplied.

WARNING

Resuscitation

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

WARNING

Remove Power

Observe general safety precautions. Do not open the instrument with the power on.

Safety Symbols

WARNING
Warning notes call attention to a procedure which, if not correctly performed, could result in personal injury.

CAUTION
Caution notes call attention to a procedure which, if not correctly performed, could result in damage to the instrument.

The caution symbol appears on the equipment indicating there is important information in the instruction manual regarding that particular area.

Note: Calls attention to supplemental information.

Warning Statements

The following safety warnings appear in the text where there is danger to operating and maintenance personnel and are repeated here for emphasis.

WARNING
Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied.
Leaking RF energy is a potential health hazard.

WARNING
Heavy load. Do not attempt to lift unaided.

WARNING
To avoid personal injury, disconnect the power cord from the ac line before performing any maintenance, including fuse replacement or changing the line voltage setting.

WARNING
Exposed ac line voltage (115 VAC or 230 VAC). Disconnect the power cord from the ac line before replacing the batteries. Failure to comply may result in severe electrical shock or death.

WARNING
To avoid personal injury, disconnect the power cord from the ac line before performing any maintenance, including fuse replacement or changing the line voltage setting.

Caution Statements

The following equipment cautions appear in the text whenever the equipment is in danger of damage and are repeated here for emphasis.

CAUTION
The interface module contains electrostatic discharge (ESD) sensitive components. Failure to observe ESD precautions can cause permanent damage.

CAUTION
Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

CAUTION
The Bird 4421DN must be powered off when connecting or disconnecting the power sensor from the power meter.

CAUTION
Do not use the power sensor with a load VSWR greater then 2:1. Damage to the power meter, power sensor, or the RF power source could occur.

CAUTION
During remote operation, periodically monitor the bus service request line. Failure to detect a service request could result in equipment damage.

CAUTION
Due to the complexity of the Bird Power Sensor, field repairs beyond general maintenance should not be attempted. Removal or disturbance of the power sensor cover can result in cancellation of lifetime warranty.

CAUTION
Failure to install the properly rated fuse may result in equipment damage or nuisance failures.

Safety Statements

USAGE

ANY USE OF THIS INSTRUMENT IN A MANNER NOT SPECIFIED BY THE MANUFACTURER MAY IMPAIR THE INSTRUMENT'S SAFETY PROTECTION.

USO

EL USO DE ESTE INSTRUMENTO DE MANERA NO ESPECIFICADA POR EL FABRICANTE, PUEDE ANULAR LA PROTECCIÓN DE SEGURIDAD DEL INSTRUMENTO.

BENUTZUNG

WIRD DAS GERÄT AUF ANDERE WEISE VERWENDET ALS VOM HERSTELLER BESCHRIEBEN, KANN DIE GERÄTESICHERHEIT BEEINTRÄCHTIGT WERDEN.

UTILISATION

TOUTE UTILISATION DE CET INSTRUMENT QUI N'EST PAS EXPLICITEMENT PRÉVUE PAR LE FABRICANT PEUT ENDOMMAGER LE DISPOSITIF DE PROTECTION DE L'INSTRUMENT.

IMPRIEGO

QUALORA QUESTO STRUMENTO VENISSE UTILIZZATO IN MODO DIVERSO DA COME SPECIFICATO DAL PRODUTTORE LA PROZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

SERVICE

SERVICING INSTRUCTIONS ARE FOR USE BY SERVICE-TRAINED PERSONNEL ONLY. TO AVOID DANGEROUS ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

SERVICIO

LAS INSTRUCCIONES DE SERVICIO SON PARA USO EXCLUSIVO DEL PERSONAL DE SERVICIO CAPACITADO. PARA EVITAR EL PELIGRO DE DESCARGAS ELÉCTRICAS, NO REALICE NINGÚN SERVICIO A MENOS QUE ESTÉ CAPACITADO PARA HACERIO.

WARTUNG

ANWEISUNGEN FÜR DIE WARTUNG DES GERÄTES GELTEN NUR FÜR GESCHULTES FACHPERSONAL.

ZUR VERMEIDUNG GEFÄHRLICHE, ELEKTRISCHE SCHOCKS, SID WARTUNGSARBEITEN AUSSCHLIEßLICH VON QUALIFIZIERTEM SERVICEPERSONAL DURCHZUFÜHREN.

ENTRENTIEN

L'EMPLOI DES INSTRUCTIONS D'ENTRETIEN DOIT ÊTRE RÉSERVÉ AU PERSONNEL FORMÉ AUX OPÉRATIONS D'ENTRETIEN. POUR PRÉVENIR UN CHOC ÉLECTRIQUE DANGEREUX, NE PAS EFFECTUER D'ENTRETIEN SI L'ON N'A PAS ÉTÉ QUALIFIÉ POUR CE FAIRE.

ASSISTENZA TECNICA

LE ISTRUZIONI RELATIVE ALL'ASSISTENZA SONO PREVISTE ESCLUSIVAMENTE PER IL PERSONALE OPPORTUNAMENTE ADDESTRATO. PER EVITARE PERICOLOSE SCOSSE ELETTRICHE NON EFFETTUARRE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.

UNITS ARE EQUIPPED WITH RECHAREABLE BATTERIES. THESE ARE TO BE REPLACED BY AUTHORIZED SERVICE PERSONNEL ONLY!!!

LAS UNIDADES VIENEN EQUIPADAS CON BATERIAS RECARGABLES. ¡¡¡Y SOLAMENTE EL PERSONAL DE SERVICIO AUTORIZADO PUEDE REEMPLAZARLAS!!!

GERÄTE SIND MIT WIEDER AUFLADBAREN BATTERIEN BESTÜCKT. BATTERIEN SIND NUR VON QUALIFIZIERTEM SERICE PERSONAL AUSZUWECHSELN!!!

CES DISPOSITIFS SONT ÉQUIPÉS DE BATTERIES RECHARGEABLES. SEUL LE PERSONNEL D'ENTRETIEN AUTORISÉ EST HABILITÉ À LES REMPLACER!

LE UNITÀ SONO DOTATE DI BATTERIE RICARICABILI, CHE DEVONO DA COME SPECIFICATO DAL PRODUTTORE LA PROTEZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

BE SURE THE 115/230V AC VOLTAGE SELECTOR IS SET TO THE PROPER LINE VOLTAGE, AND THE CORRECT AC LINE FUSE IS INSTALLED BEFORE AC POWER IS APPLIED.

S'ASSURER QUE LE SÉLECTEUR DE TENSION 115/230V C.A. EST BIEN RÉGLÉ POUR LA TENSION DU RÉSEAU ET QUE LE FUSIBLE DE LIGNE C.A. CORRECT EST EN PLACE AVANT DE METTRE SOUS TENSION C.A.

CERCIORESE QUE EL SELECTOR DE VOLTAJE DE 115/230V CA ESTE COLOCADO A LA LINEA DE VOLTAJE APROPIADA Y QUE EL FUSIBLE ESTE INSTALADO A LA LINEA CA ANTES DE APLICAR LA CORRIENTE ALTERNA.

VOR EINSCHALTEN DER WECHSELSTROMZUFUHR SICHERSTELLEN, DASS DER 115/230V WECHSELSPANNUNGS-SELEKTOR AUF DIE VORSCHRIFTSMÄSSIGE LEITUNGSSPANNUNG EINGESTELLT UND DIE RICHTIGE WECHSELSTROM-HAUPTSICHERUNG EINGESETZT IST.

PRIMA DI EROGARE CORRENTE, ASSICURARSI CHE IL SELETTORE DI VOLTAGGIO 115/230 V.C.A. SIA REGOLATO CORRETTAMENTE E CHE IL FUSIBLE ADATTO ALLA LINEA DI ALIMENTAZIONE C.A. SIA INSTALLATO.

About This Manual

This manual covers the Bird 4421DN RF Power Meter and the sensors it works with. Specific models include:

Power Meter	4421DN			
4020 Series Sensors	4021	4022	4024	4025
4027A Series Sensors	4027A250K	4027A400K	4027A800K	4027A2M
	4027A4M	4027A10M	4027A12M	4027A25M
	4027A35M	4027A60M	4027A100M	4027A150M
4027F Series Sensors	4027F2M	4027F10M	4027F60M	
4028A Series Sensors	4028A250K	4028A400K	4028A2M	4028A3M
	4028A4M	4028A10M	4028A25M	
4028B Series Sensors	4028B10M	4028B3M		
4028C Series Sensors	4028C10M			

This instruction book is arranged so that essential safety information appears in the front of the book. Reading the Safety Precautions before operating the equipment is strongly advised.

The remainder of this manual is divided into Chapters and Sections. At the start of each chapter, a general overview describes its contents.

Operation

First time users should read Chapter 1 – Introduction and Chapter 2 – Installation to get an overview of equipment capabilities and installation. Experienced operators can refer to Chapter 3 – Operating Instructions. All instructions necessary to manually operate the equipment appear in this chapter. If the power meter is equipped with a IEEE-488 GPIB Interface refer to Chapter 4 – DeviceNet Interface. For the DeviceNet Interface refer to Chapter 5 – Serial Command Set.

Maintenance

You should be familiar with preventative maintenance found in Chapter 7 – Maintenance. If a failure should occur, the troubleshooting section will aid in isolating and repairing the failure. A list of replacement parts with part numbers is also in this chapter.

Changes To This Manual

We have made every effort to ensure this manual is accurate. If you should discover any errors, or if you have suggestions for improving this manual, please send your comments to our factory. This manual may be periodically updated. When inquiring about updates to this manual refer to the part number and revision level on the title page.

Table of Contents

Chapter 1 Introduction

Power Meter

The Bird 4421DN RF Power Meter is one component of a complete RF power measurement system. An RF power sensor such as a Bird 4021 is also required. The system can be controlled with the front panel buttons, or remotely through an a DeviceNet connection or a GPIB-488 connection.

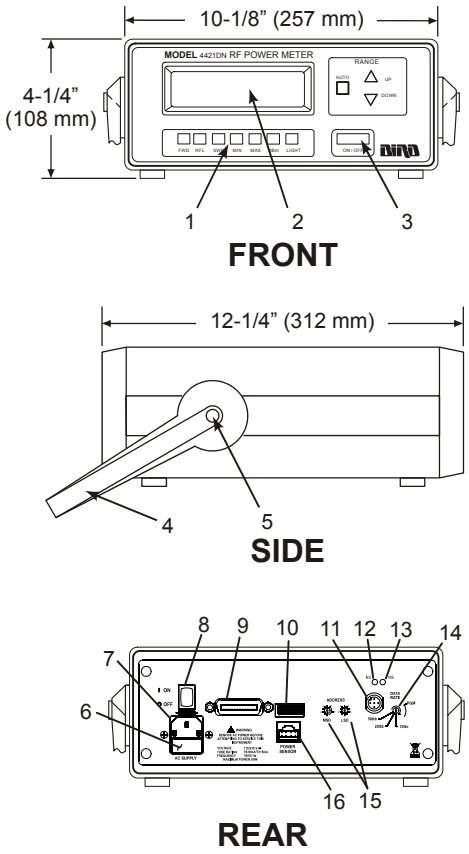
Items Supplied

- Bird 4421DN RF Power Meter
- AC Power Cord
- Sensor Cable
- Instruction Manual

Optional Accessories

Panel Mount Kit (P/N 4421-250): Allows the Bird 4421DN to be installed in a standard 19" panel for rack mount applications.

Figure 1
Bird 4421DN Meter
Outline Drawing



1. Operating Push Buttons
2. LCD
3. ON/OFF Push Button
4. Handle
5. Central Button
6. Fuse Access Door
7. AC Line Module
8. Master ON/OFF Switch
9. GPIB connector
10. GPIB DIP switches
11. DeviceNet connector
12. Network status LED
13. Module status LED
14. Baud rate switch
15. MAC ID address switches
16. Power Sensor Socket

Power Sensors

Power sensors are available with a variety of connectors; see "Maintenance" on page 54 for a complete list. Since the accuracy is critically dependent on the connectors used at calibration, do not remove or change the connectors.

CAUTION
Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

4020 Series

Bird 4020 Series Power Sensors are designed for lab or field use and are accurate to within ±3%(1σ) of reading.

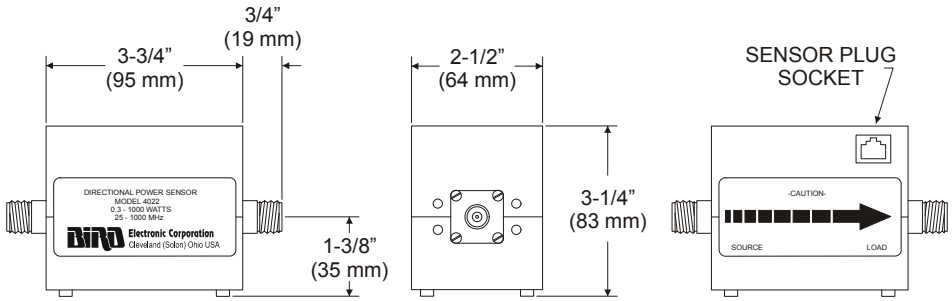
4027A Series

Bird 4027A Series Power Sensors are designed for use in semiconductor processing and calibration applications. Stringent calibration provides long-term unit-to-unit repeatability, allowing consistent amounts of RF energy to be applied to the etch process over many etch cycles. 4027A Sensors are accurate to ±1%(1σ) at specified calibration frequencies and power levels.

4027F Series

Bird 4027F Series Power Sensors are similar to the 4027A series. However, additional filtering allows the 4027F to ignore harmonics of the signal being measured. The 4027F is also less sensitive to AM components of the signal. 4027F Sensors are accurate to ±1%(2σ) at specified calibration frequencies and power levels.

Figure 2 Power Sensor Outline Drawing, 4020, 4027A, 4027F, and 4028A Series



4028 Series

Bird 4028 Series Power Sensors are high power sensors otherwise similar to the 4027A series. 4028A sensors are based on a 7/8" line, 4028B sensors use a 1-5/8" line, and 4028C sensors use a 3-1/8" line. 4028 Sensors are accurate to ±2% at specified calibration frequencies and power levels.

Figure 3 Power Sensor Outline Drawing 4028B Series only

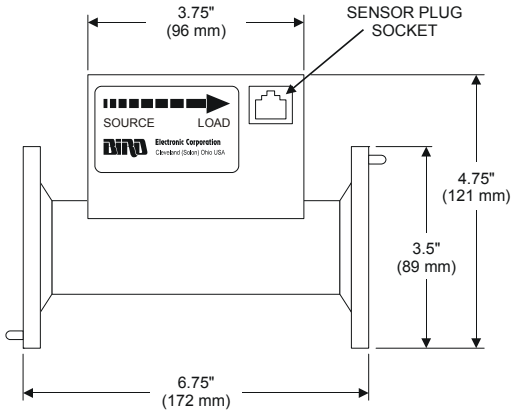
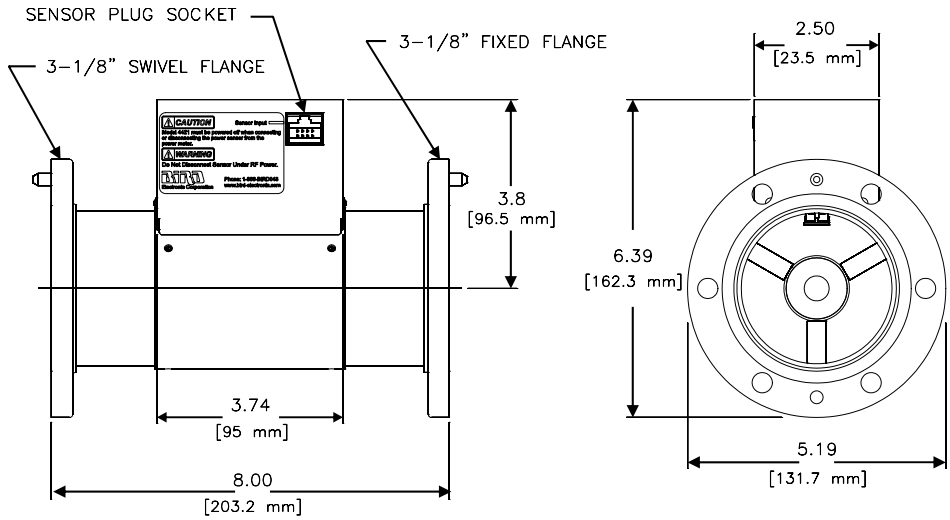


Figure 4 Power Sensor Outline Drawing 4028C Series only



Frequency and Power Ranges

4020 Series

Model	Frequency Range	RF Power Range
4021	1.8 – 32 MHz	300 mW – 1 kW
4022	25 – 1000 MHz	300 mW – 1 kW
4024	1.5 – 32 MHz	3 W – 10 kW
4025	100 kHz – 2.5 MHz	3 W – 10 kW

4027A Series

4027A250K	250 – 400 kHz	3 W – 10 kW
4027A400K	400 – 550 kHz	3 W – 10 kW
4027A800K	800 – 950 kHz	3 W – 10 kW
4027A2M	1.5 – 2.5 MHz	3 W – 10 kW
4027A4M	3 – 5 MHz	3 W – 10 kW
4027A10M	10 – 15 MHz	3 W – 10 kW
4027A12M	10 – 15 MHz	300 mW – 1 kW
4027A25M	25 – 30 MHz	3 W – 9 kW
4027A35M	35 – 45 MHz	3 W – 7.5 kW
4027A60M	45 – 65 MHz	3 W – 6 kW
4027A100M	95 – 105 MHz	3 W – 5 kW
4027A150M	150 – 170 MHz	3 W – 4 kW

4027F Series

4027F2M	1.8 – 2.2 MHz	100 W – 10 kW
4027F10M	12 – 15 MHz	100 W – 10 kW
4027F60M	57 – 63 MHz	100 W – 3 kW

4028 Series

4028A250K	250 – 400 kHz	1 kW – 20 kW
4028A400K	400 – 550 kHz	1 kW – 20 kW
4028A2M	1.5 – 2.5 MHz	1 kW – 25 kW
4028A3M	2.5 – 3.5 MHz	1 kW – 25 kW
4028A4M	3.5 – 4.5 MHz	1 kW – 25 kW
4028A10M	10 – 15 MHz	1 kW – 25 kW
4028A25M	25 – 30 MHz	1 kW – 25 kW
4028B3M	2.5 – 40 MHz	1 kW – 25 kW
4028B10M	10 – 15 MHz	1 kW – 25 kW
4028C10M	10 – 15 MHz	500W – 50 kW

This chapter provides information about preparing the Bird 4421DN for use.

Sensor Connection

CAUTION
Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

CAUTION
The Bird 4421DN must be powered off when connecting or disconnecting the power sensor from the power meter.

1. Turn OFF the ON/OFF rocker switch on the meter's *rear* panel.
2. Align the latch on the cable with the notch of the "Power Sensor" socket on the power meter's rear panel.
3. Insert the cable until it clicks into place.
4. Connect the other end of the sensor cable to the sensor.

RF Line Connection

WARNING
Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied.
Leaking RF energy is a potential health hazard.

CAUTION
Do not use the power sensor with a load VSWR greater then 2:1. Damage to the power meter, power sensor, or the
RF power source could occur.

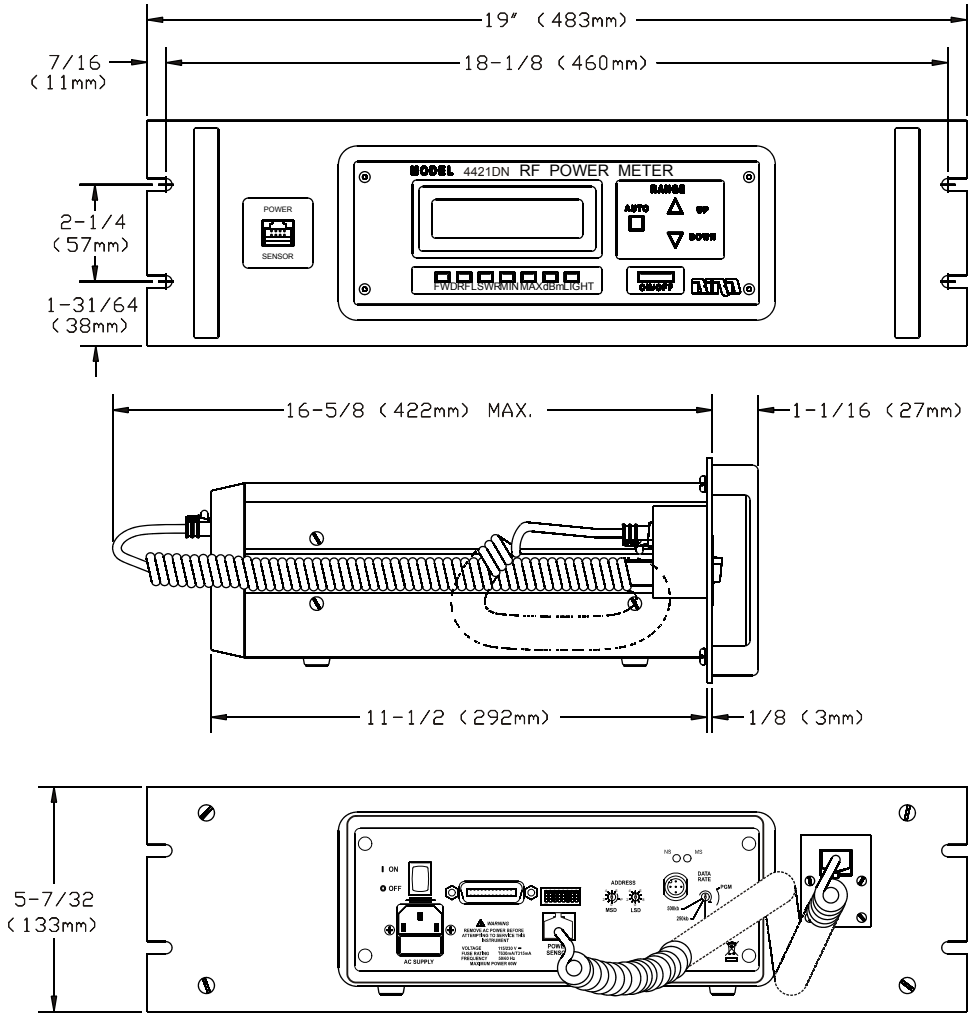
Connect the end of the power sensor labeled "SOURCE" to the RF source. Connect the end labeled "LOAD" to the load or antenna. Reversing these connections will cause measurement errors.

Panel Mounting the 4421DN Power Meter

You can install the 4421DN Power Meter in an equipment rack if you have the optional panel mount kit (refer to "Optional Accessories" on page 1). The panel mount kit includes complete installation instructions. Figure 5 shows the overall dimensions and mounting points for a 4421DN Power Meter installed in a panel mount kit.

Note: The power supply interrupt switch for the 4421DN Power Meter is located on the rear panel. When you install a unit in a panel mount kit, you need to provide a means to interrupt the power supply that is easily accessible to the user (such as a switch mounted in the panel).

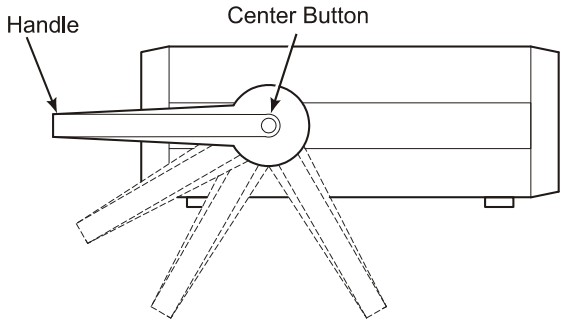
Figure 5 Panel Mounting Dimensions



Handle Operation

The handle on the Bird 4421DN can be set to four different positions (see Figure 6). To adjust the handle, press the center buttons on both sides. Releasing the buttons will lock the handle into position.

Figure 6 Handle Positions



AC Input Power

The internal power supply can operate at voltages ranging from 90 VAC to 264 VAC. There is no user setting to select the input voltage because the power supply automatically senses the input voltage. However, you must make sure that you have the correct power cord plug and fuses installed for the line voltage you are using (refer to "Replacing Fuses" on page 58).

AC Line Connectors

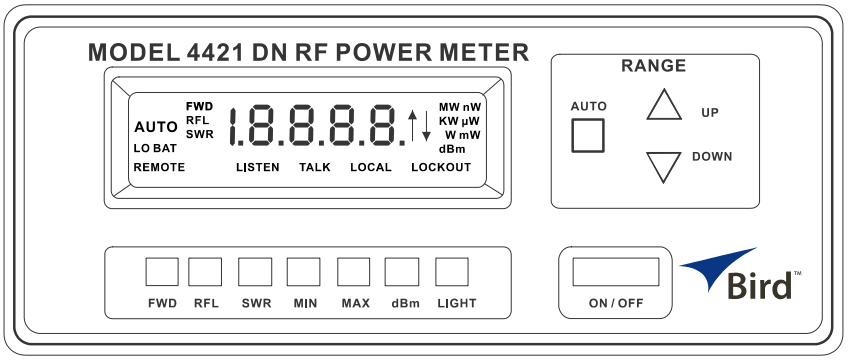
To make the ac line cord compatible with non-U.S. voltages, users must install the appropriate connector on the power cord.

Chapter 3 Operating Instructions

This chapter describes operator controls and indicators on the Bird 4421DN RF Power Meter. For remote operation using a GPIB or DeviceNet controller, refer to the instructions in "IEEE-488 GPIB Interface" on page 39 or "Serial Command Set" on page 29 respectively.

Push Button Functions

Figure 7 Push Buttons



Push Button	Description
FWD, RFL	Press to measure forward or reflected RF power. FWD or RFL indicator and current unit of measure turn on.
SWR	Press to measure standing wave ratio. SWR indicator turns on. Value displayed will be between 1.0 and 199.9
MIN, MAX	Used after pressing FWD, RFL, SWR, or dBm. Displays the minimum (maximum) measured value of the previous function as long as MIN (MAX) is held down.
dBm	Used after pressing FWD or RFL. dBm indicator turns on. Power is displayed in dBm units. Used after pressing SWR. Return loss is displayed.
LIGHT	Press to turn on or turn off the display's backlight. If left on, the light automatically shuts off after 30 minutes.
AUTO	Press to automatically set the scale. AUTO turns on.
UP, DOWN	Press to select the next higher (lower) scale. If the scale is too high for the power sensor, an error will be displayed. Used while AUTO indicator is on. Stops automatic scaling. AUTO indicator turns off.
ON/OFF	Press to turn the power meter on or off. This switch will not work if the master power switch on the rear panel is OFF. The display flashes for about 30 seconds when the unit is first turned on.

Error Codes

The Bird 4421DN displays error codes when the RF power is either below the selected range (underrange) or above the selected range (overrange). Figure 8 displays the error codes and Figure 9 lists the function limits.

Figure 8 Error Codes

Symbol	Explanation
⊓⊓	Value greater than overrange limit of function
⊔⊔	Value less than underrange limit of function

Figure 9 Function Limits

Function	Limit	Error
FWD, RFL	Power > 199.9% of full scale or 120% of top range	Overrange
FWD dBm, RFL dBm	Power > 120% of full scale Power < 3% of low range	Overrange Underrange
SWR	FWD < 20% of low range FWD – RFL = 0	Underrange Overrange
Return Loss	FWD < 20% of low range RFL < 20% of low range Return Loss > 40 dB	Underrange Underrange Underrange

Audible Warning

If the RF power level exceeds 120% of the power sensor's maximum power capability, the power meter will sound a warning buzzer.

This chapter provides a detailed description of the 4421DN DeviceNet implementation. Its purpose is to serve as a reference for users integrating the 4421DN in a DeviceNet network, including software developers interested in data structure details used when communicating with the 4421DN over DeviceNet. It describes unit configuration and initialization, and outlines in detail the DeviceNet Object Model.

Definitions

- Network Host - The DeviceNet network master. Commonly a scanner card in a Programmable Controller.
- Network Slave - A DeviceNet device implementing sever functionality in a DeviceNet system.
- PLC - Programmable Logic Controller - refers to the DeviceNet Network Host.

This is a description of the different data types that are used in the documentation of the object model. These are standard definitions of the Open DeviceNet Vendor Association (ODVA).

Definitions

The following table has a description of all of the CIP elementary data types used.

USINT	Unsigned Short Integer (8-bit)
UINT	Unsigned Integer (16-bit)
UDINT	Unsigned Double Integer (32-bit)
STRING	Character String (1 byte per character)
SHORT_STRING	Character String (1 byte per character, 1 byte length indicator).
BYTE	Bit String (8-bits)
WORD	Bit String (16-bits)
DWORD	Bit String (32-bits)
REAL	Floating Point (32-bit)

Reference Documents

- CIP Library Volume 3 "DeviceNet Adaptation of CIP" Edition 1.2
- CIP Library Volume 1 "Common Industrial Protocol (CIP™)" Edition 3.0

Open DeviceNet Vendor Association, Inc. (ODVA)

ODVA is an independent supplier organization that manages the DeviceNet specification and supports the worldwide growth of DeviceNet.

ODVA on the web: www.odva.org

DeviceNet System Operation

Overview

The 4421DN provides a standard DeviceNet communications interface. You can set the DeviceNet interface for a specific MAC ID and for a specific baud rate. When power is applied to the DeviceNet interface, it reads the settings (MAC ID and baud rate). When you change the interface settings (MAC ID or baud rate), you must remove and then reapply power to the interface unit so it will read and store the new settings. You can cycle the power on and off by removing the DeviceNet connector at the 4421DN rear panel or at the power supply for the entire DeviceNet communications network. The interface at the 4421DN instrument consists of the following standard DeviceNet hardware components:

- One (1) 5-pin shielded micro-style male connector.
- Two (2) rotary switches for setting the MAC ID.
- One (1) rotary switch for setting the baud rate.

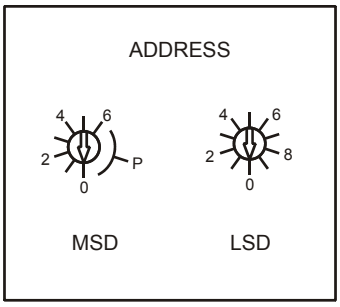
Note: DeviceNet cables must be terminated with a resistor as specified in the DeviceNet specification.

When the DeviceNet is in control of the communication with the sensor, the bottom line of the power meter's display shows the word REMOTE which means that the power meter is being controlled through the interface and that the local operator buttons will not work.

MAC ID & Baud Rate Configuration

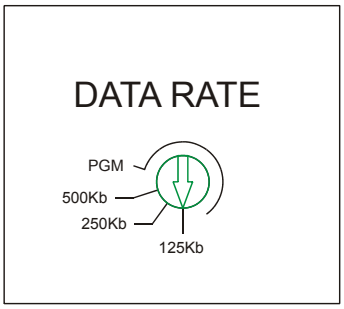
Three rotary switches are used to configure the MAC ID (Node Address) and Baud Rate (Data Rate) of the device. The rotary switches are defined as follows:

Figure 10 MAC ID Rotary Switches



Rotary switches S2 (MSD) and S3 (LSD) are used to select the DeviceNet MAC ID (Node Address). The valid range of addresses is: 0-63.

Figure 11 Baud Rate Rotary Switch



The S1 rotary switch (DATA RATE) is used to select the DeviceNet baud rate. The following is a valid range of baud rates:

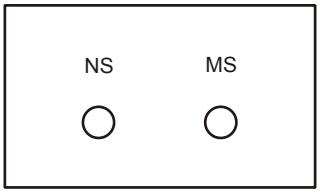
- 0 - 125 kbps
- 1 - 250 kbps
- 2 - 500 kbps
- 3 and above - "Baud Rate software configuration mode"

All values above 2 will force the device into a "Baud Rate configuration mode". While in the "Baud Rate configuration mode" the device baud rate will be set to the last baud rate the device was powered up at and will allow software configuration tools to modify the value of the baud rate.

LED Operation

Two LED's are provided on the back panel of the 4421DN: Network Status and Module Status. See the figure below.

Figure 12 LED Labeling



Network Status LED Operation (NS)

LED Color	LED State	Description
None	Off	No power applied to device.
Red	Solid	Unrecoverable fault detected.
	Flashing	Output error or configuration error (recoverable fault).
Green	Solid	Normal runtime operation.
	Flashing	Device is idle or not allocated to a master.

Module Status LED Operation (MS) - Corresponds to the Status attribute of the Identity Object

LED Color	LED State	Device State	Description
None	Off	Power Off	No power applied to device.
Red	Flashing	Minor Fault	Recoverable Fault.
	Solid	Unrecoverable Fault	Device has detected an unrecoverable fault. All module-level faults are considerable unrecoverable.
Green	Flashing	Device Self-Test	Device is in Self-test. The DeviceNet Specification defines blink rates and patterns for the Module Status LED during Self-test.
	Solid	Device Operational	Device is operating normally.

DeviceNet Interface

Overview

DeviceNet™ is an open industrial network that is used to connect industrial I/O devices (such as sensors and limit switches) to controllers (such as PLC's). It is a digital, multi-drop network based on CAN (Controller Area Network) and CIP™ (Common Industrial Protocol). DeviceNet is a very robust protocol designed to meet the strict reliability and performance requirements of the industrial environment.

Configuration

The 4421DN supports the standard DeviceNet MAC ID (Node Address) and Baud Rate (Data Rate) selections. The MAC ID and Baud Rate and be selected from the rotary switches on the back panel or through DeviceNet configuration software. See section 2.2 for details.

All configuration data is saved in non-volatile memory.

Cable connections to the DeviceNet must be terminated with resistors per the DeviceNet specification.

Initialization

The 4421DN supports standard duplicate MAC ID detection processing during power on initialization of the DeviceNet.

Messaging

The data is obtained from the 4421DN through Explicit and polled I/O messaging. The following is a list of supported DeviceNet message types.

Supported Message Types

Group	Identifier Bits	Message Type Description
1	01111xxxxxxBIN	Slave's I/O Poll Response Acknowledge Message
2	10xxxxxx011BIN	Slave's Explicit / Unconnected Response Message
2	10xxxxxx100BIN	Master's Explicit Request Messages
2	10xxxxxx101BIN	Master's I/O Poll Command Message
2	10xxxxxx110BIN	Group2 Only Unconnected Explicit Request Messages
2	10xxxxxx111BIN	Duplicate MAC ID Check Messages
xxxxxx = MAC ID		

Group 2 Only Slave Operation

The 4421DN supports allocation of the DeviceNet Group 2 Master/Slave connection set through the Group 2 Unconnected message port.

Certification

Although this unit has been tested using ODVA software conformance tools, it has not been officially tested and certified by ODVA. This is not an official ODVA conformance tested product and therefore does not carry the ODVA seal.

4421DN Object Model

Identity Object (01_{HEX} - 1 Instance)

Class Attributes (instance 0)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

Instance Attributes (instance 1)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Vendor Number	UINT	1000_{DEC}	Get
2	Device Type	UINT	00_{HEX}	Get
3	Product Code Number	UINT	4421_{DEC}	Get
4	Product Major Revision Product Minor Revision	USINT USINT	01 01	Get
5	Status	WORD	See Below	Get
6	Serial Number	UDINT	Unique 32 Bit Value	Get
7	Product Name **Structure of:** Size of String String	 SHORT_ STRING]	 6 '4421DN”	Get

Status Word

Bit	Bit = 0	Bit = 1
0	Not Owned	Owned
1	Unused	Unused
2	No configuration since the last Out of Box reset.	The device has been configured since the last Out of Box reset.
3 - 15	Unused	Unused

Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
05_{HEX}	No	Yes	Reset

Message Router (02_{HEX} - 1 Instance)

No Parameters or Services

DeviceNet Object (03_{HEX} - 1 Instance)

Class Attributes (Instance 0)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	2	Get

Instance Attributes (Instance 1)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Mac ID	USINT	12	Get / Set[1]
2	Baud Rate	USINT	2	Get / Set[2]
5	**Structure of:** Allocation Choice Byte Master's Mac ID	BYTE USINT	0x0FF 0	 Get Get

6	Mac ID Switch Changed	BOOL	0	Get
7	Baud Rate Switch Changed	BOOL	0	Get
8	Mac ID Actual Switch Value	USINT	12	Get
9	Baud Rate Actual Switch Value	USINT	2	Get

Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Assembly Object (04_{HEX} - 5 Instances)

Class Attributes

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	INT	2	Get
2	Max Instance	UINT	112	Get
100	Assembly Input Instance ID 100 - Int Data 101 - Int Data w/Status 102 - Float Data 103 - Float Data w/Status	USINT	100	Get / Set
101	Assembly Input Size (in bytes) (4, 6, 8 or 10 bytes)	UINT	4	Get

Instance 100 Attributes (Input Instance 1 (4 Bytes))

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Integer Data (4 bytes) [0] = Forward Power [1] = Reflected Power	 UINT UINT	 0 0	Get

Instance 101 Attributes (Input Instance 2 (6 Bytes))

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Integer Data w/status [0] = Forward Power [1] = Reflected Power [2] = Status	 UINT UINT UINT	 0 0 0	Get

Instance 102 Attributes (Input Instance 3 (8 Bytes))

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Float Data [0] = Forward Power Float [1] = Reflected Power Float	 REAL REAL	 0.0 0.0	Get

Instance 103 Attributes (Input Instance 4 (10 Bytes))

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
3	Float Data w/status [0] = Forward Power Float [1] = Reflected Power Float [2] = Status	 REAL REAL UINT	 0.0 0.0 0	Get

Instance 112 Attributes (Output Instance (0 Bytes))

Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	Yes	Yes	Set_Attribute_Single

Assembly Data Attribute Mapping

Data Component Name	Class		Instance Number	Attribute		Data Type
	Name	Number		Name	Number	
Forward Power	Power Object	100 (64_{HEX})	1	Power (Integer)	1	UINT
Reflected Power	Power Object	100 (64_{HEX})	2	Power (Integer)	1	UINT
Status	Power Object	100 (64_{HEX})	0	Sensor Status Word	0	UINT
Forward Power Float	Power Object	100 (64_{HEX})	1	Power (Floating Point)	2	REAL
Reflected Power Float	Power Object	100 (64_{HEX})	2	Power (Floating Point)	3	REAL

Connection Object (05_{HEX} - 2 Instances)

Class Attributes (Instance 0)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get

Instance Attributes (Instances 1-2)

Attribute ID	Name	DeviceNet Data Type	Data Value		Access Rule
			Instance 1 (Explicit)	Instance 2 (Polled)	
1	State	USINT	0 = NonExistent 3 = Established 5 = Deferred Delete	0 = NonExistent 1 = Configuring 3 = Established 4 = Timed Out	Get
2	Instance Type	USINT	0	1	Get
3	Transport Trigger	USINT	83_{HEX}	82_{HEX}	Get
4	Produced Connection ID	UINT	$10x0xxxxx011_{BIN}$ xxxxxx = Node Address	$01111xxxxxx_{BIN}$ xxxxxx = Node Address	Get
5	Consumed Connection ID	UINT	$10x0xxxxx100_{BIN}$ xxxxxx = Node Address	$10x0xxxxx100_{BIN}$ xxxxxx = Node Address	Get
6	Initial Comm. Character	USINT	21_{HEX}	01_{HEX}	Get
7	Produced Connection Size	UINT	40	n	Get
8	Consumed Connection Size	UINT	40	n	Get
9	Expected Packet Rate	UINT	2000 msec	0	Get / Set

12	Watchdog Timeout Action	USINT	4 = Deferred Delete	0 = Timeout	Get
13	Produced Connection Path Length	UINT	0	4	Get
14	Produced Connection Path	USINT Array	NULL	20h 04h 24h 64h 30h 03h	Get
15	Consumed Connection Path Length	UINT	0	0	Get
16	Consumed Connection Path	USINT Array	NULL	20h 04h 24h 70h 30h 03h	Get

Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Power Object (64_{HEX} - 2 Instances)

Class Attributes (Instance 0)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get
100	Sensor Status Word	UINT	0	Get

Instance Attributes (Instance 1-2)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Power (Integer)	UINT	0	Get
2	Power (Floating Point)	REAL	0.0	Get

Attribute Descriptions

ID	Name	Attribute Description
100	Sensor Status Word	Class-level attribute giving the current status of the 4421DN. See the "Sensor Status Word" section below for bit field descriptions.
1	Power (Integer)	Power in Watts as a 16-bit unsigned integer value. Range: 0-65,535 Watts (1 bit per Watt). Default value: 0
2	Power (Floating Point)	Power in Watts as a 32-bit floating-point value. This attribute can provide power as fractions of a Watt and can also provide power measurements exceeding 65kW. Range: 0-nMW (Mega Watt upper range). Default value: 0.0

Object Instances

Instance Number	Name	Instance Description
1	Forward Power	Forward power carrier wave readings ("FC" command).
2	Reflected Power	Reflected power carrier wave readings ("RC" command).

Sensor Status Word

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	0	0	0	0	0

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	Comm Timeout	Rfl Underflow	Rfl Overflow	Fwd Underflow	Fwd Overflow

A bit that is set (a value of 1) means that an error condition is present. A bit that is cleared (a value of 0) means the error is not present. Error conditions are cleared automatically by the 4421DN.

Status Field Descriptions

Field Name	Description of Error (when bit is set - a value of 1)
Fwd Overflow	Forward CW Overflow error. Measured forward power > 120% full scale.
Fwd Underflow	Forward CW Underflow. Measured forward power < 3% low range.
Rfl Overflow	Reflected CW Overflow error. Measured reflected power > 120% full scale.
Rfl Underflow	Reflected CW Underflow error. Measured reflected power < 3% low range.
Comm Timeout	Communications timeout error.

Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get Attribute Single
32_{HEX}	No	Yes	Serial Pass Through

Serial Pass Through

The Serial Pass Through service is an application-defined service code that allows 4421DN serial commands to be issued over DeviceNet. The master issues the serial command to the 4421DN by using the "REQUEST" service code (via Explicit Messaging). Responses are returned by the 4421DN.

Refer to "Serial Command Set" on page 29 for serial command descriptions and syntax.

REQUEST

BYTE	VALUE	DESCRIPTION
0	0x32	Service Code (Serial Pass Through)
1	0x64	Class (Power Object)
2	0x01	Instance (1)
3	0xNN	String Length (1-32)
4-n	Varies	String (no termination (CR/LF))

SUCCESSFUL RESPONSE

BYTE	VALUE	DESCRIPTION
0	0xB2	Response Code (Serial Pass Through)
1	0xNN	String Length (1-32)
2-n	Varies	String (no termination (CR/LF))

ERROR RESPONSE

BYTE	VALUE	DESCRIPTION
0	0x94	Error Response
1	Varies	General Error Code
2	Varies	Additional Error Code (0xFF is unused)

EXAMPLE (FC Command)

Use Explicit Message

REQUEST (HEX): 32 64 01 05 46 43 45 4E 54 (“FCENT” in ASCII)

RESPONSE (HEX): 0F 4E 46 43 20 20 31 35 32 2E 37 36 20 20 20 57 (“NFC” 152.76 W” in ASCII)

Information Object (65_{HEX} - 2 Instances)

Class Attributes (Instance 0)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Revision	UINT	1	Get
100	Timeout (ms) (50 - 60,000 milliseconds)	UINT	500	Get/Set

Instance Attributes (Instances 1-2)

Attribute ID	Name	DeviceNet Data Type	Data Value	Access Rule
1	Model Number "XX" Command	SHORT_ STRING	""	Get
2	Serial Number "XX" Command	SHORT_ STRING	""	Get
3	Firmware Revision "XX" Command	SHORT_ STRING	""	Get

Attribute Descriptions

ID	Name	Attribute Description
100	Timeout (ms)	Class-level attribute. The time given for the 4421DN to respond to a request from the master. The value is in milliseconds. Range: 50-60,000 milliseconds. Default: 500
1	Model Number	The model number of the device. (e.g. "4027A4M" for sensor model number. Range: 0-8 characters in the string. Default: "" (empty string) On Error: "ERROR" (If unable to obtain).
2	Serial Number	The unique serial number of the device. Range: 0-16 characters in the string. Default: "" (empty string) On Error: "ERROR" (If unable to obtain).
3	Firmware Revision	The revision level of the device firmware. (e.g. "26JUL06") Range: 0-8 characters in the string. Default: "" (empty string) On Error: "ERROR" (If unable to obtain).

Object Instances

Instance Number	Name	Instance Description
1	Device Information	4421DN information.
2	Sensor Information	4020-series sensor information.

Common Services

Service Code	Implemented for		Service Name
	Class Level	Instance Level	
$0E_{HEX}$	Yes	Yes	Get Attribute Single
10_{HEX}	Yes	No	Set_Attribute_Single

Serial Command Set, Used in Pass-through Mode

The Bird 4421DN accepts two types of commands. General bus commands are commands, such as Initialize (INT), that apply to any DeviceNet interfaced device. Device-dependent commands are specific to the 4421DN.

If an invalid command is sent to the unit, an error condition is placed in the serial poll byte and the offending command is not executed.

A group of device-dependent commands can be sent as a single string as long as like command categories are not repeated. For example: “PNFCFDT3TRG”. This string sets up the 4421DN to send no prefixes, read forward dBm, make one reading on “TRG”, and triggers a measurement.

Note: Commands can be entered in either upper or lower case.

Note: Only the last command entered of each category will be executed. As a command string is processed by the 4421DN, each category of command is stored in a separate location. Two commands of the same category will be stored in the same location, so that the second will overwrite and erase the first one.

General Bus Commands

The general bus commands supported by the serial command pass-through service are listed in Table 1.

Table 1 Serial Pass-through Service General Bus Commands

Command	Effect on Bird 4421DN
INT	Returns to default conditions
ENT	Sends a reading to the controller
TRG	Triggers reading in T3 mode
B1 to B7	Selects a baud rate
XO/XF	Enables/disables software handshake

Device **S**erial **N**umber and Model Number (DSN)

Function:

Gets the serial number and model number of the 4421DN unit.

Remarks:

Response is the command prefix, followed by 8 bytes for the model number of the 4421DN unit (padded with spaces if it is less than 8 characters) plus 16 bytes for the serial number (padded with spaces if it is less than 16 bytes). This response is terminated with the same terminator selected with the "Y_x"command.

Example Response:

DSN 4421 12345678

ENTer (ENT)

Function

Makes the power meter transmit a reading to the controller.

Remarks

A measurement must have already been triggered, placing a reading in the output buffer.

To send a reading whenever a measurement is triggered, set DIP switch 2 to OFF. The ENT command will not need to be sent.

INiTialize (INT)

Function

Resets the Bird 4421DN and returns it to the factory defaults.

Remarks

If INT is linked with any other command within a string, it must be separated from that command by a space.

Sensor **S**erial **N**umber and Model Number (SSN)

Function:

Gets the serial and model number of the sensor connected to the 4421DN

Remarks:

Response is the command prefix, followed by 8 bytes for the model number of the sensor (padded with spaces if it is less than 8 characters plus 16 bytes for the serial number (padded with spaces if it is less than 16 bytes). This response is terminated with the same terminator selected with the "Y_x"command

If the response is a model number and a serial number of ---N/A--- then the sensor does not have the proper firmware to communicate this information to the 4421DN.

Example Response:

SSN 1234 12345678

TRiGger (TRG)

Function

Initiates a measurement if the power meter is in trigger mode (T3).

Device Dependent Commands

The device-dependent commands used by the 4421DN Power Meter are listed in Table 2, organized by category.

Table 2 Device Dependent Command Summary

Category	Command	Description
Measurement	FC	Forward carrier wave
	FD	Forward dBm
	RC	Reflected carrier wave
	RD	Reflected dBm
	SW	Standing wave ratio
	RL	Return loss
	MN	Minimum value
	MX	Maximum value
Range	RYY	Auto range on
	R00 to R17	Manual ranges
	RNN	Auto range off, stay at present range
Terminators	YT	Two terminators: CR, LF
	YO	One terminator: CR
	YN	No terminator
Prefixes	PY	Prefix YES
	PN	Prefix NO
Triggers	T0	Continuous on ENT
	T1	One shot on ENT
	T3	One shot on TRG
	T5	One shot on measurement command
Status	U0	Send back current machine state
	U1	Send back error conditions
	U2	Send back revision levels
Self-Test	J0	Run self-test
Writable Store	WXXXXXX	Place XXXXXX in RAM

Forward **C**arrier Wave (FC)
Forward **d**Bm (FD)
Reflected **C**arrier Wave (RC)
Reflected **d**Bm (RD)

Function

Selects forward or reflected RF power measurement mode.

Remarks

Measurement results are returned in Watts or dBm.

Standing **W**ave Ratio (SW)
Return **L**oss (RL)

Function

Selects SWR or return loss match measurement mode.

Remarks

Measurement results are returned in VSWR or dB.

MiNimum Value (MN)
MaXimum Value (MX)

Function

Selects minimum or maximum measurement mode.

Remarks

Another measurement must be selected before selecting min or max.

Returns the minimum (or maximum) value of the previous measurement type.

Range (Rxx)

Function

Selects a measurement range listed in Table 3.

Remarks

If the selected range is outside the range of the connected power sensor, the command is ignored.

Table 3 Measurement Ranges

Command	Power Range
RYY	Turn auto range on
RNN	Turn auto range off. Keep present range
R17	18.0 – 199.9 MW
R16	1.80 – 19.99 MW
R15	0.180 – 1.999 MW
R14	18.0 – 199.9 kW
R13	1.80 – 19.99 kW
R12	0.180 – 1.999 kW
R11	18.0 – 199.9 W
R10	1.80 – 19.99 W
R09	0.180 – 1.999 W
R08	18.0 – 199.9 mW
R07	1.80 – 19.99 mW
R06	0.180 – 1.999 mW
R05	18.0 – 199.9 µW
R04	1.80 – 19.99 µW
R03	0.180 – 1.999 µW
R02	18.0 – 199.9 nW
R01	1.80 – 19.99 nW
R00	0.180 – 1.999 nW

Terminators (Yx)

Function

Selects the characters that follow the end of a data string. Set x to:

- “T” for two terminators; a carriage return(CR) and a line feed(LF).
- “O” for one terminator; a carriage return(CR).
- “N” for no terminator.

Remarks

Many controllers use the terminator sequence to recognize the end of an input string. Using incorrect terminators can lock the bus.

Prefixes (Px)

Function

Turns the prefix mode on or off. Set x to:

- “Y” to enable prefixes.
- “N” to disable prefixes.

Remarks

Prefixes are sent over the bus with the measurement, and indicate the status of the current measurement (see Figure 4 for examples):

- “FC”,”FD”,”RC”,”RD”,”SW”,”RL”,”MN”,”MX” indicates the measurement type.
- “U” indicates underflow; the value sent is “.000”.
- “O” indicates overflow; the value sent is “199.9”.
- “N” indicates normal; the value sent is a normal on-scale reading.
- “4421” indicates the Bird model number.

Table 4 Prefix Examples

Data String	Description
NFC.0.123W(CR)(LF)	Normal (N) forward carrier wave (FC), prefixes on
OFC 199.9W(CR)(LF)	Overflowed (O) forward carrier wave (FC), prefixes on
199.9W(CR)(LF)	Overflowed forward carrier wave, prefixes off
URD .000W(CR)(LF)	Underflowed (U) reflected dBm (RD), prefixes on

Triggers (Tx)

Function

Selects the condition which will trigger a reading (see Table 5).

Remarks

Failure to trigger device before requesting a reading will lock the bus.

Fastest reading rate is 2.4 readings/second; slowest is 1 reading/sec.

Table 5 Trigger Conditions

Command	Trigger Condition
T0	Continuous on ENT
T1	One shot on ENT
T3	One shot on TRG
T5	One shot on measurement command (FC, FD, RC, RD, SW, RL, MN, MX)

Status (Ux)

Function

Reads a status word and returns the information as a string. Set x to:

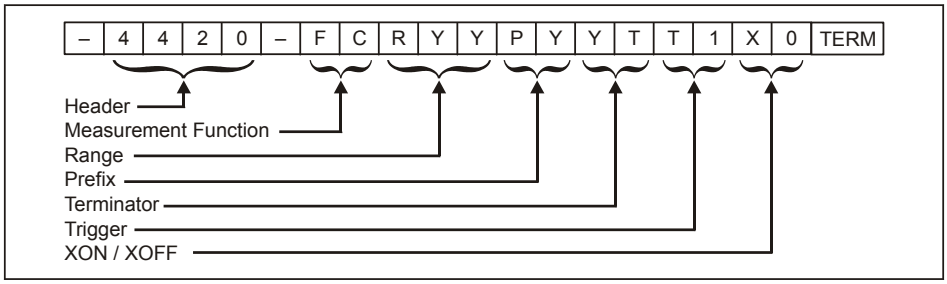
- "0" for machine status.
- "1" for error status.
- "2" for revision history.

Remarks

After sending the status command, a status word is sent the next time the unit is addressed to talk. To ensure the correct status is transmitted, the status word should be requested as soon as possible after the command is sent.

Machine Status Word (U0): The format of the machine status word is shown in Figure 13. The default values are also shown.

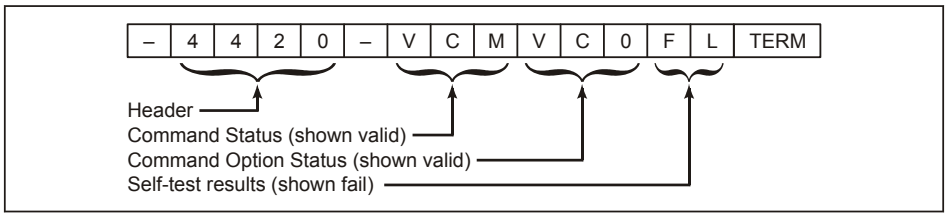
Figure 13 Machine Status Word Format



Note: This command sets the unit to the settings that were last issued remotely (through DeviceNet or GPIB). Therefore, it will over ride any manual changes selected at the front panel of the unit.

Error Status Word (U1): The format of the error status word and the possible error messages are shown in Figure 14. All flags will revert to their non-error states after the U1 command is sent.

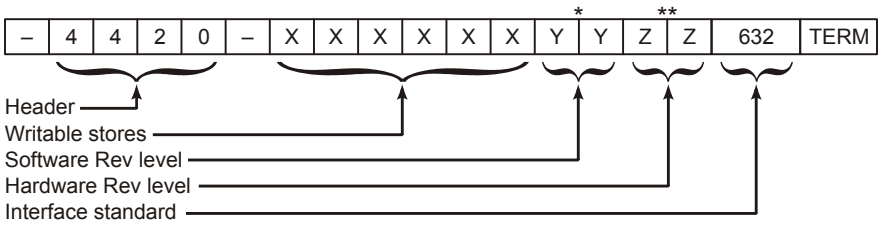
Figure 14 Error Status Word Format



Status	Meaning	Description
ICM	Invalid Command	Set when an illegal device-dependent command (IDDC) such as V2 is received. (V is illegal)
VCM	Valid Command	Set when no IDDC is received.
ICO	Invalid Command Option	Set when an illegal device-dependent command option (IDDCO) such as T6 is received. (6 is illegal)
VCO	Valid Command Option	Set when no IDDCO is received.
PS	Self-test Pass	Set when a self-test has been initiated by the J0 command and the test result is acceptable.
FL	Self-test Fail	Set when the self-test has failed. (This is the default condition.)

Revision History Word (U2): The format of the revision history word is shown in Figure 15.

Figure 15 Revision History Word Format



* YY is replaced with current software revision level.
** ZZ is replaced with current hardware revision level.

Self Test (J0)

Function

Initiates a hardware and software test.

Remarks

Results are stored in the U1 status word (see "Status (Ux)" on page 36).

“J0” must be sent each time before reading the result.

Writable Store (Wxxxxxx)

Function

Storage for six bytes of ASCII data.

Remarks

Data stored is lost when the 4421DN is turned off.

Data is sent back as part of the U2 status word.

Chapter 6 IEEE-488 GPIB Interface

This chapter discusses setup of the IEEE-488 interface feature and describes the IEEE commands that apply to the Bird 4421DN. Operators should understand IEEE standard 488-1978 and have basic computer programming skills before attempting to write any programs.

> CAUTION
> During remote operation, periodically monitor the bus service request line. Failure to detect a service request could result in equipment damage.

Description

The Bird 4421DN IEEE-488 (GPIB) interface has an eight-position DIP switch that sets operational conditions and interface addresses. The bottom line of the display indicates the current bus status.

Cable Connector

The interface uses a standard IEEE-488 cable connector. Pin assignments are listed in Table 6.

Table 6 IEEE-488 Pin Assignments

Pin	Designation	Type
1	D101	Data
2	D102	Data
3	D103	Data
4	D104	Data
5	EOI	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	D105	Data
14	D106	Data
15	D107	Data
16	D108	Data
17	REN	Management
18	GROUND	Ground
19	GROUND	Ground
20	GROUND	Ground
21	GROUND	Ground
22	GROUND	Ground
23	GROUND	Ground
24	GROUND, LOGIC	Ground

Interface Capabilities

The interface capability function codes are listed in Table 7.

Table 7 IEEE-488 Interface Module Capabilities

Code	Name	Description
SH1	Source Handshake	Can handshake data or command bytes when the unit is acting as a source.
AH1	Acceptor	Can handshake the bus when it is acting as the acceptor of data or commands.
T5	Talker	Can send data over the bus to other devices. This capability exists only after the instrument has been addressed to talk, or after a reading in talk-only mode.
L4	Listener	Can receive device-dependent data over the bus. This capability exists only after the unit has been addressed to listen.
SR1	Service Request	Can request service from the controller.
RL1	Remote-Local	Can be placed in remote or local mode.
PP0	Parallel Poll	Does not have parallel polling capability.
DC1	Device Clear	Can be reset to factory settings.
DT1	Device Trigger	Can have its readings triggered.
C0	Controller	Does not have controller capability.
E1	Bus Driver Type	Has open-collector bus drivers.
TE0	Extended Talker	Does not have extended talker capability.
LE0	Extended Listener	Does not have extended listener capability.

Indicators

The bottom line of the power meter's display shows indicators describing the status of the Bird 4421DN when used with the IEEE interface. These are:

REMOTE: When REMOTE is displayed, the power meter is being controlled through the interface. Measurements, units of measure, and certain other parameters may be changed from a remote location.

LISTEN: When LISTEN is displayed, the power meter is receiving data.

TALK: When TALK is displayed, the power meter is transmitting data. This is always shown when the unit is in "talker-only" mode.

LOCAL LOCKOUT: When LOCAL LOCKOUT is displayed, the push buttons are disabled and the power meter's functions are being remotely controlled.

Setup

Dip Switch

Set the interface to ADDR (Addressable) by positioning DIP switch 1 to ON. This makes the 4421DN respond to controller commands.

Note: There are several button styles on DIP switches (slide, rocker, lever). Examine the DIP switch to determine the ON and OFF positions.

Set the primary address using the DIP switches. The primary address is factory set to 6, but can be set to any value between 1 and 31 (0 is reserved for the controller) To set the primary address, turn OFF switches 4 – 8 so that the sum of the bits turned off equals the desired primary address. In Figure 16 below, the address is set to 6 (the off switches have values of 4 and 2).

Figure 16 IEEE Interface Default DIP Switch Settings

Note: The primary address is used by the controller to refer to specific devices on the bus. When programming the controller, the address in the program must be the same as the address set on the interface module. Each device on the bus must have a different primary address.

Talker-Only Mode

The Bird 4421DN can be set up for manual operation while automatically sending data to an output device (Talker-Only Mode). To do so, turn DIP switch 1 OFF and cycle the power. TALK will be displayed.

In Talker-Only mode, pressing a button on the meter triggers a measurement. When the measurement is complete, the information is sent to the bus and LISTEN turns on momentarily. A listen-only device on the bus, such as a printer, can read the value. The power meter is then ready to accept another button press.

Command Syntax

The Bird 4421DN accepts two types of commands. General bus commands are commands, such as Device Clear (DCL), that apply to any IEEE interfaced device. Device-dependent commands are specific to the 4421DN.

If an invalid command is sent to the unit, an error condition is placed in the serial poll byte and the offending command is not executed.

A group of device-dependent commands can be sent as a single string as long as like command categories are not repeated, for example: “PNFCFDT3TRG”. This string sets up the 4421DN to send no prefixes, read forward dBm, make one reading on “TRG”, and triggers a measurement.

Note: Commands can be entered in either upper or lower case.

Note: Only the last command entered of each category will be executed. As a command string is processed by the 4421DN, each category of command is stored in a separate location. Two commands of the same category will be stored in the same location, so that the second will overwrite and erase the first one.

General Bus Commands

The general bus commands supported by the IEEE-488 interface feature are listed in Table 8. The syntax for executing general commands varies among controllers; check the documentation supplied with your controller for the proper command structure.

Table 8 IEEE-488 General Bus Commands

Command	Effect on Bird 4421DN
IDN?	Gives product identification
REN	Goes into remote mode when next addressed
GTL	Cancels remote mode, restores local operation
LLO	Locks out local operation
IFC	Goes into talker and listener-idle status
DCL	Returns to default conditions
SDC	Returns to default conditions
GET	Triggers reading in T2 and T3 modes
SPE, SPD	Puts the status byte on the bus

IDentificatio**N** (IDN?)

Function

Product identifies itself

Remarks

Replies command same as U2

Remote **EN**able (REN)

Function

Enables remote operation.

Remarks

The unit must be addressed to listen after setting REN true.

The REMOTE indicator turns on when this command is received.

Go **T**o **L**ocal (GTL)

Function

Returns device to local operation.

Remarks

Issuing a GTL command while the device is in Local Lockout mode does not clear the lockout condition.

The REMOTE indicator turns off.

The LISTEN indicator remains on.

Local **LO**ckout (LLO)

Function

Disables local operation of all devices on the bus.

Remarks

REN must be true to use LLO.

LLO is cleared by setting REN false.

Inter**F**ace **C**lear (IFC)

Function

Terminates all bus activity and passes control to the system controller.

Remarks

All devices are set to talker and listener idle states.

LISTEN mode is canceled, and its indicator is turned off.

Device **CL**ear (DCL)

Function

Resets the status of all devices to an initialized state.

Remarks

Does not change the current interface mode.

The 4421DN returns to the factory default condition listed in Table 9.

Table 9 IEEE-488 Default Conditions

Default Condition	Related Command
Forward Carrier Wave	FC
Auto Range ON	RYY
Two Terminators (CR LF)	YT
Prefixes YES	PY
Trigger One Shot on Talk Address	T1
All SRQ's OFF	M00
Send EOI with last byte of message	KY

Selective **D**evice **C**lear (SDC)

Function

Resets the status of a selected device to an initialized state.

Remarks

Only the device addressed will be cleared.

The 4421DN returns to the factory default condition.

Group **E**xecute **T**rigger (GET)

Function

Initiates a measurement for all devices set to trigger on GET.

Remarks

The 4421DN must be already set to trigger on GET.

Used to synchronize measurements of multiple instruments.

Serial Polling Enable/Disable (SPE/SPD)

Function

Enables or disables the serial polling sequence.

> CAUTION
> During remote operation, periodically monitor the bus service request line. Failure to detect a service request could result in equipment damage.

Remarks

The SPE command puts all devices in serial poll mode waiting to be addressed. The SPD command clears the SRQ bit (bit 6) and ends the polling sequence.

When addressed a device sends its status byte to the controller. A value of 1 for a bit means that the device condition that bit refers to is true. A value of 0 means that the condition is false.

The 4421DN does not use all bits of the status byte. Table 10 lists the bits used, along with a description and how to reset them.

Table 10 IEEE Status Byte Description

Bit	Name	Condition
6	SRQ	Set if a service request is generated by the 4421DN. If an SRQ has been received by the controller and this bit is cleared, other instruments on the bus should be checked to determine where the SRQ occurred. Cleared by a serial poll of the 4421DN.
3	Measurement Complete	Set when the power meter has completed a reading. Cleared by requesting a reading over the bus.
2	Reading Underflow	Set when the RF power is underrange and a reading has been completed. Cleared by requesting a reading over the bus.
1	Reading Overflow	Set when the RF power is overrange and a reading has been completed. Cleared by requesting a reading over the bus.
0	Error	Set if an illegal device-dependent command (IDDC) or illegal device-dependent command option (IDDCO) was received, or if the power meter fails the self test. Cleared by reading the U1 status word. The U1 word contains details on the error, see "Status (Ux)" on page 51.

Device Dependent Commands

The device-dependent commands used by the 4421DN Power Meter are listed in Table 11, organized by category.

Note: The programming card also has a complete command list.

Table 11 IEEE-488 Device Dependent Command Summary

Category	Command	Description
Measurement	FC	Forward carrier wave
	FD	Forward dBm
	RC	Reflected carrier wave
	RD	Reflected dBm
	SW	Standing wave ratio
	RL	Return loss
	MN	Minimum value
	MX	Maximum value
Range	RYY	Auto range on
	R00 to R17	Manual ranges
	RNN	Auto range off, stay at present range
Terminators	YT	Two terminators: CR, LF
	YO	One terminator: CR
	YN	No terminator
Prefixes	PY	Prefix YES
	PN	Prefix NO
Triggers	T0	Continuous on TALK
	T1	One shot on TALK
	T2	Continuous on GET
	T3	One shot on GET
	T4	Continuous on measurement command
	T5	One shot on measurement command
Serial Polling	M00	Do not generate SRQ
	M01	Generate SRQ on error
	M02	Generate SRQ on measurement overrange
	M04	Generate SRQ on measurement underrange
	M08	Generate SRQ on operation complete
Status	U0	Send back current machine state
	U1	Send back error conditions
	U2	Send back revision levels
Self-Test	J0	Run self-test
EOI Response	KY	Send EOI on last byte
	KN	Do not send EOI on last byte
Writable Store	WXXXXXX	Place XXXXXX in RAM

Forward **C**arrier Wave (FC)
Forward **d**Bm (FD)
Reflected **C**arrier Wave (RC)
Reflected **d**Bm (RD)

Function

Selects forward or reflected RF power measurement mode.

Remarks

Measurement results are returned in Watts or dBm.

Standing **W**ave Ratio (SW)
Return **L**oss (RL)

Function

Selects SWR or return loss match measurement mode.

Remarks

Measurement results are returned in VSWR or dB.

MiNimum Value (MN)
MaXimum Value (MX)

Function

Selects minimum or maximum measurement mode.

Remarks

Another measurement must be selected before selecting min or max.

Returns the minimum (or maximum) value of the previous measurement type.

Range (Rxx)

Function

Selects a measurement range listed in Table 12.

Remarks

If the selected range is outside the range of the connected power sensor, the command is ignored.

Table 12 Measurement Ranges

Command	Power Range
RYY	Turn auto range on
RNN	Turn auto range off. Keep present range
R17	18.0 – 199.9 MW
R16	1.80 – 19.99 MW
R15	0.180 – 1.999 MW
R14	18.0 – 199.9 kW
R13	1.80 – 19.99 kW
R12	0.180 – 1.999 kW
R11	18.0 – 199.9 W
R10	1.80 – 19.99 W
R09	0.180 – 1.999 W
R08	18.0 – 199.9 mW
R07	1.80 – 19.99 mW
R06	0.180 – 1.999 mW
R05	18.0 – 199.9 µW
R04	1.80 – 19.99 µW
R03	0.180 – 1.999 µW
R02	18.0 – 199.9 nW
R01	1.80 – 19.99 nW
R00	0.180 – 1.999 nW

Terminators (Yx)

Function

Selects the characters that follow the end of a data string. Set x to:

- “T” for two terminators; a carriage return(CR) and a line feed(LF).
- “O” for one terminator; a carriage return(CR).
- “N” for no terminator; message can be terminated by EOI.

Remarks

Many controllers use the terminator sequence to recognize the end of an input string. Using incorrect terminators can lock the bus.

Prefixes (Px)

Function

Turns the prefix mode on or off. Set x to:

- “Y” to enable prefixes.
- “N” to disable prefixes.

Remarks

Prefixes are sent over the bus with the measurement, and indicate the status of the current measurement (see Table 13 for examples):

- “FC”,”FD”,”RC”,”RD”,”SW”,”RL”,”MN”,”MX” indicates the measurement type.
- “U” indicates underflow; the value sent is “.000”.
- “O” indicates overflow; the value sent is “199.9”.
- “N” indicates normal; the value sent is a normal on-scale reading.
- “4421” indicates the Bird model number.

Table 13 Prefix Examples

Data String	Description
NFC.0.123W(CR)(LF)	Normal (N) forward carrier wave (FC), prefixes on
OFC 199.9W(CR)(LF)	Overflowed (O) forward carrier wave (FC), prefixes on
199.9W(CR)(LF)	Overflowed forward carrier wave, prefixes off
URD .000W(CR)(LF)	Underflowed (U) reflected dBm (RD), prefixes on

Triggers (Tx)

Function

Selects the condition which will trigger a reading (see Table 14).

Remarks

Failure to trigger device before requesting a reading will lock the bus.

T1 halts the bus until a reading is available.

T0 and T1 do not set the measurement complete SRQ.

T2, T3, T4, and T5 set a SRQ when the measurement is complete.

Fastest reading rate is 2.4 readings/second; slowest is 1 reading/sec.

Table 14 Trigger Conditions

Command	Trigger Condition
T0	Continuous on talk
T1	One shot on talk
T2	Continuous on GET
T3	One shot on GET
T4	Continuous on measurement command (FC,FD, RC, RD, SW, RL, MN, MX)
T5	One shot on measurement command (FC, FD, RC, RD, SW, RL, MN, MX)

SRQ Mask (Mxx)

Function

Selectively masks status bits to prevent unwanted service requests.

Set xx to the sum of the binary values of the desired SRQ trigger bits. For example, M12 would set the SRQ for both operation complete and underrange (values 8 and 4). Set xx to “00” to never generate an SRQ.

Remarks

If a status bit is masked (bit set to 0), SRQs won’t be generated for that condition.

Table 15 SRQ Mask Bits

Binary Value	Bit Number	Message
1	0 (LSB)	Error (IDDC, IDDCO, self-test fail)
2	1	Measurement overrange
4	2	Measurement underrange
8	3	Operation complete
	4	Not Used
	5	Not Used
	6	Can’t mask
	7 (MSB)	Not Used

Status (Ux)

Function

Reads a status word and returns the information as a string. Set x to:

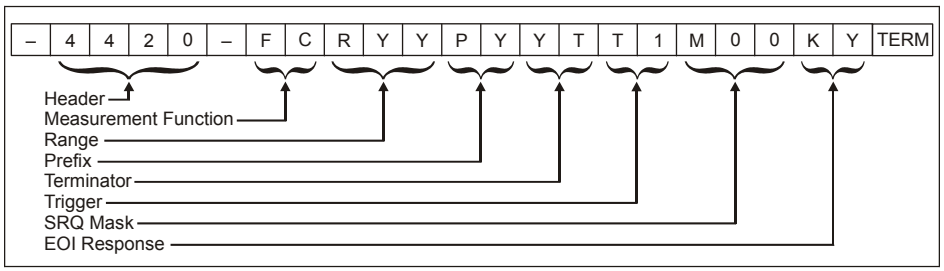
- “0” for machine status.
- “1” for error status.
- “2” for revision history.

Remarks

After sending the status command, a status word is sent the next time the unit is addressed to talk. To ensure the correct status is transmitted, the status word should be requested as soon as possible after the command is sent.

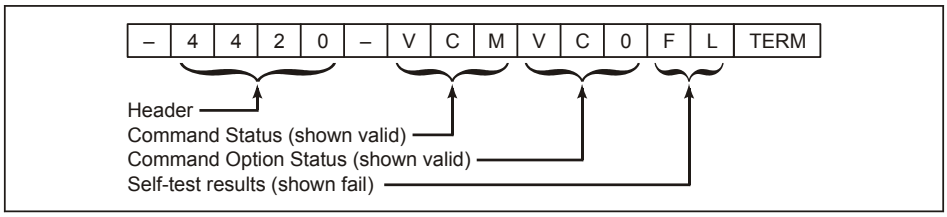
Machine Status Word (U0): The format of the machine status word is shown in Figure 17. The default values are also shown.

Figure 17 Machine Status Word Format



Error Status Word (U1): The format of the error status word and the possible error messages are shown in Figure 18. When an error occurs, an error is also flagged in the status (serial poll) byte, and a SRQ may be generated (See "SRQ Mask (Mxx)" on page 50). All flags will revert to their non-error states after the U1 command is sent.

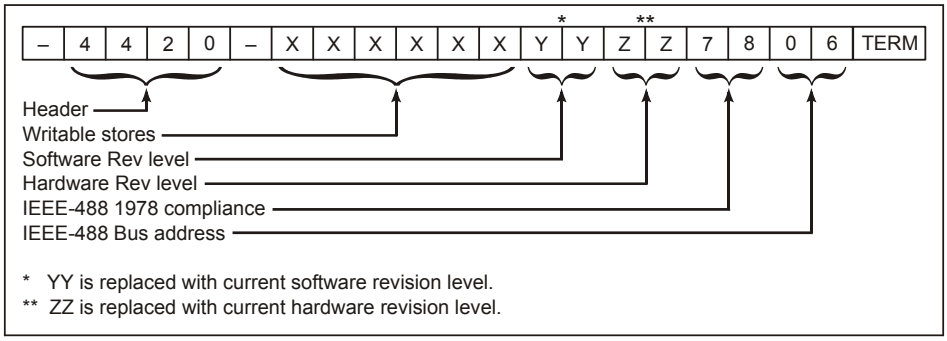
Figure 18 Error Status Word Format



Status	Meaning	Description
ICM	Invalid Command	Set when an illegal device-dependent command (IDDC) such as V2 is received. (V is illegal)
VCM	Valid Command	Set when no IDDC is received.
ICO	Invalid Command Option	Set when an illegal device-dependent command option (IDDCO) such as T6 is received. (6 is illegal)
VCO	Valid Command Option	Set when no IDDCO is received.
PS	Self-Test Pass	Set when a self-test has been initiated by the J0 command and the test result is acceptable.
FL	Self-Test Fail	Set when the self-test has failed. (This is the default condition.)

Revision History Word (U2): The format of the revision history word is shown in Figure 19.

Figure 19 Revision History Word Format



Note: If Writable stores parameter has not been set, this command responds only with -4420-.

Self Test (J0)

Function

Initiates a hardware and software test.

Remarks

Results are stored in the U1 status word (see "Status (Ux)" on page 51).

"J0" must be sent each time before reading the result.

End Or Identify (Kx)

Function

Enables or disables the End or Identify (EOI) signal. Set x to:

- "Y" to enable.
- "N" to disable.

Remarks

Disabling EOI can cause some controllers to lock unless another terminator is used.

When enabled, EOI is only asserted at the end of a multiple byte string.

Writable Store (Wxxxxxx)

Function

Storage for six bytes of ASCII data.

Remarks

Data stored is lost when the 4421DN is turned off.

Data is sent back as part of the U2 status word.

Chapter 7 Maintenance

This chapter describes routine maintenance, along with troubleshooting instructions for the power meter and power sensor. Disassembly instructions for the Bird Cal Cart are also provided. For service beyond this level, return the unit to a qualified service center.

> WARNING
> To avoid personal injury, disconnect the power cord from the ac line before performing any maintenance, including fuse replacement or changing the line voltage setting.

> WARNING
> Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied.
> Leaking RF energy is a potential health hazard.

> WARNING
> The Bird 4421DN contains no user-serviceable parts.
> Do not remove its cover.

The Bird 4421DN Power Meter requires only simple, routine maintenance.

- Wipe off dust and dirt regularly.
- Check the connectors and cables for damage.
- Clean the connector contacts with alcohol or dry cleaning solvent.

Cleaning

> CAUTION
> Do not use harsh or abrasive detergents for cleaning.

Clean the Bird 4421DN Power Meter and its display with a soft cloth dampened with mild detergent and water only. Clean sensors with a dry cleaning solvent that leaves no residue.

Troubleshooting

Since the power meter and power sensor can only work together, the first step is to determine which is malfunctioning. Connect the power sensor to the meter and perform the "Functional Test" on page 56. If the power meter is malfunctioning, refer to the troubleshooting table below. If the power sensor is malfunctioning, return it for service.

> CAUTION
> Due to the complexity of the Bird Power Sensor, field repairs beyond general maintenance should not be attempted.
> Removal or disturbance of the power sensor cover can result in cancellation of lifetime warranty.

This manual cannot list all malfunctions that may occur, or corrective actions. If a malfunction is not listed or is not corrected by the listed corrective actions, contact a qualified service center.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Power meter has no power	Have the batteries been charged?	Recharge the batteries
	Is the power meter's ac power cord connected?	Connect the power cord
	Is the ON/OFF rocker switch on the rear panel set to OFF?	Set the switch to ON
	Blown fuse?	Check fuse rating and replace fuse (See "Replacing Fuses" on page 58)
Dash moves across the display	Is the sensor cable connected to both the power meter and power sensor?	Connect sensor cable
	Is the sensor cable defective?	Replace sensor cable
Display blank or not updating	Have the batteries been charged?	NO: Recharge battery YES: Return meter for service
Power meter turns off while on battery power	Is "LO BAT" displayed?	YES: Recharge battery NO: Return meter for service
Push buttons do not respond	Test the push buttons (see "Push Button Test" on page 57). Are they defective?	Return meter for service.
Every segment on the display is lit		Return meter for service
Display indicates ---N/A--- for both model number and serial number of the sensor	Sensor does not have the proper firmware to communicate this information to the 4421DN.	Upgrade the sensor with the proper firmware.
IEEE-488 Interface does not respond to the interface link	Are the address in the interface program and the address setting on the DIP switches on the interface module the same?	Change the program or DIP switch setting so that the addresses are the same (See "Dip Switch" on page 40)
	Send the "J0" self test command, then check the status. Does the power meter fail the self test?	Replace I/O hub PCB
	Is the IEEE cable defective?	Replace IEEE interface cable
DeviceNet does not respond to the interface link. Fails J0 self-test command.	Is the 4421DN connected to the DeviceNet network?	If no, connect it If yes, refer to LED indicator meanings ("LED Operation" on page 15)

Functional Test

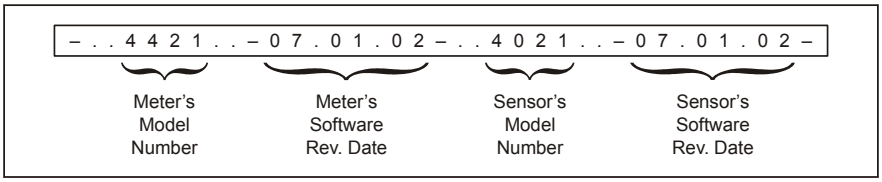
This test determines whether the power meter or the sensor is malfunctioning.

1. Turn the power meter off. The ON/OFF switch on the *rear* panel should be OFF and the ac power cable should be connected.
2. Turn ON the ON/OFF switch on the *rear* panel of the meter.
3. While holding down the FWD and SWR push buttons, press the ON/OFF button on the *front* panel of the power meter. Immediately release all three.

   The unit tests the display on power up cycling through and activating each segment two times and then activating all segments at once two times.

4. The power meter's model number and revision date should scroll across the display. If a dash "–" is displayed instead, then the meter is malfunctioning.
5. The power sensor's model number and revision date should scroll across the display. If a dash is displayed after the power meter data, then the power sensor is malfunctioning.

Figure 20 Test Display, No Malfunction



Push Button Test

This test checks that the push buttons and display are functioning properly. If a push button is malfunctioning, return the power meter.

1. Disconnect the power sensor.
2. Turn the power meter ON.
3. After the power up display disappears, a dash "–" should scroll across the display.
4. Turn the power meter OFF.
5. Connect the power sensor.
6. Turn the power meter ON.
7. "AUTO" and "FWD" should be displayed, and a reading of "0.00 W" (or a very low number).
8. Press RFL. "FWD" should change to "RFL" on the display. The reading should remain the same.
9. Press SWR. "RFL" should change to "SWR". "0.00 W" should change to "⌴ ⌴" (underrange error).
10. Hold down MIN. "⌴ ⌴" should change to "⊓ ⊓" (overrange error).
11. Release MIN. "⊓ ⊓" should change to "⌴ ⌴".
12. Hold down MAX. "⌴ ⌴" should change to ".000".
13. Release MAX. ".000" should change to "⌴ ⌴".
14. Press dBm. "SWR" should turn OFF and "dBm" should turn ON.
15. Press dBm. "dBm" should change to "SWR".
16. Press FWD. "SWR" should change to "FWD" and "⌴ ⌴" to ".000 W" (or a very low number).
17. Press LIGHT. The back-light should turn on.
18. Press LIGHT. The back-light should turn off.
19. Press s (up). The power meter should change ranges each time it is pressed until it reaches "0.000 KW".
20. Press t (down). The power meter should change ranges each time it is pressed until it reaches "0.00 W".
21. Turn the power meter OFF.

Repair

> WARNING
> To avoid personal injury, disconnect the power cord from the ac line before performing any maintenance, including fuse replacement or changing the line voltage setting.

Replacing Fuses

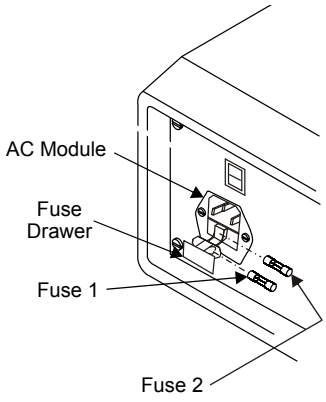
> WARNING
> To avoid personal injury, disconnect the power cord from the ac line before performing any maintenance, including fuse replacement.

> CAUTION
> Failure to install the properly rated fuse may result in equipment damage or nuisance failures.

1. Gently pry the fuse drawer out of the ac module. The fuse holder does not detach from the ac module.
2. Install the replacement fuses then close and secure the fuse holder. Fuse 1 is a spare fuse and fuse 2 is the active fuse.

AC Line Voltage	Fuse Rating
115 Vac	T630 mA, 5x20 mm Time Lag Fuse
230 Vac	T315 mA, 5x20 mm Time Lag Fuse

Figure 21 AC Line Fuse



Replacing Batteries

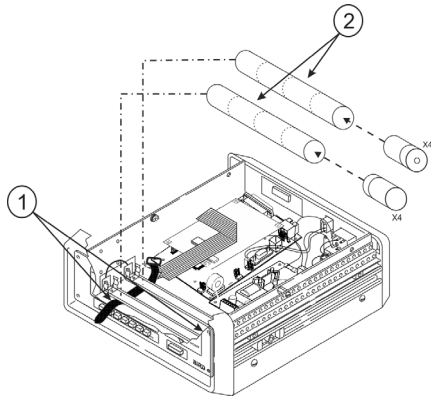
There are two battery configurations in the 4421 Power Meter. In the larger case models (before 2016), the batteries are horizontally arranged, in units with a smaller case the batteries are vertically arranged in a battery assembly.

Replace Batteries (Older models)

> WARNING
> Exposed ac line voltage (115 VAC or 230 VAC). Disconnect the power cord from the ac line before replacing the batteries. Failure to comply may result in severe electrical shock or death.

1. Disconnect the ac power cord from the ac mains supply.
2. Remove the four screws that secure the top cover.
3. Lift the top cover to access the attached ground wire then disconnect the ground wire and remove the cover.
4. Unfasten the battery retaining belts then remove the battery tubes (Figure 22). Be sure to note the polarity and orientation of the battery tubes before removing them.
5. Remove the batteries from each tube and insert replacement batteries. Be sure to note the polarity (positive and negative) arrangement of the batteries.
6. Install the battery tubes into the unit and secure with the retaining belts. Be sure to position the retaining belts as they were before removal and tighten them securely.
7. Connect the ground wire to the top cover.
8. Install the top cover and secure it with the four screws removed earlier.

Figure 22 Batteries



Item	Description
1	**Battery retaining belt**
2	**Battery tube (batteries inside)**

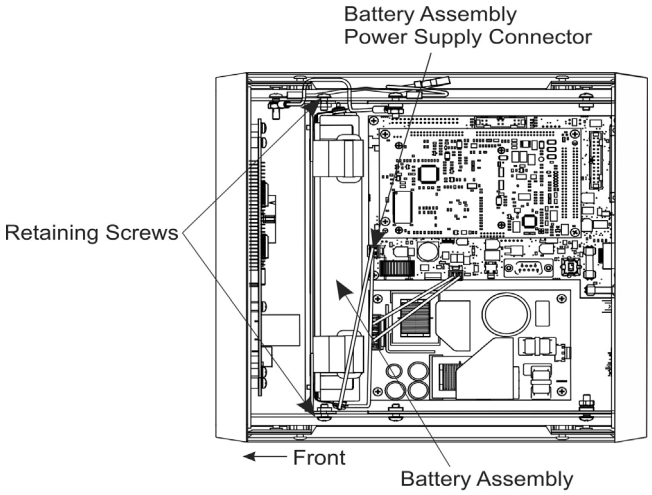
Replace Batteries (Newer Models)

> WARNING
> Exposed AC line voltage (115 VAC or 230 VAC). Disconnect the power cord from the AC line before replacing the batteries. Failure to comply may result in severe electrical shock or death.

> WARNING
> Use only Nickel Metal Hydride (NiMH) batteries that have a minimum capacity of 4500 milliampere hours (mAh). Do not install batteries that are not Nickel Metal Hydride. Do not install NiMH batteries that have less than 4500 mAh capacity. Failure to comply may result in damage to the batteries, damage to the instrument, and injury to personnel from battery chemicals.

1. Disconnect the AC power cord from the ac mains supply.
2. Remove the four screws that secure the top cover.
3. Lift the top cover to access the attached ground wire then disconnect the ground wire and remove the cover.
4. Remove two retaining screws securing the battery assembly. See Figure 23.
5. Disconnect battery assembly power supply connector.

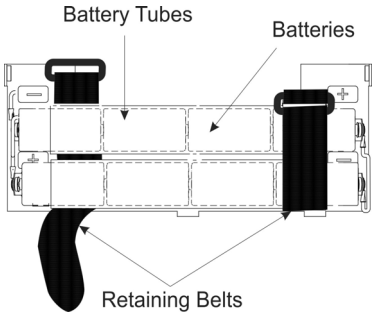
Figure 23 Battery Assembly Removal



6. Lift the battery assembly out of the Power Meter.
7. Unfasten the battery retaining belts then remove the battery tubes (Figure 24).

Note: *Be sure to note the polarity and orientation of the battery tubes before removing them.*

Figure 24 Battery Assembly



8. Remove the batteries from each tube and insert replacement batteries. Be sure to note the polarity (positive and negative) arrangement of the batteries.
9. Install the battery tubes into the battery assembly and secure with the retaining belts. Be sure to position the retaining belts as they were before removal and tighten them securely.
10. Install battery assembly in the Power Meter. Align tabs on battery assembly with slots in Power Meter.
11. Install two screws to secure battery assembly to Power Meter.
12. Connect the battery assembly power supply connector to the main board.
13. Connect the ground wire to the top cover.
14. Install the top cover and secure it with the four screws removed earlier.

Specifications, 4421DN Power Meter

Bird 4421DN RF Power Meter

Frequency Range	Sensor dependent
Power Range	Sensor dependent
VSWR Display	1.0 – 199.9 max
Return Loss Display	0 to 40 dB max
Display Accuracy	± 1 on least significant digit
AC Power	90 to 264Vac @ 50/60 Hz; 60 W
Batteries	8 Nickel Metal Hydride 1.2 v cells, rechargeable
Battery Life	Approximately 8 hours continuous usage
Battery Charger	Built-in battery charger. Drained batteries require approximately 28 hours to recharge.
Display	LCD, 4½ digit display. Indicates mode, measurement units, battery condition, remote status, and signal increase/decrease. Self contained backlight.
Optional Interfaces	IEEE-488 GPIB DeviceNet
Fuse Rating 115 Vac 230 Vac	IEC (5 x 20 mm) Time Lag Type T T630 mA T315 mA
CE	CE Compliant. Refer to Declaration of Conformity for specific standards.
Humidity	95% max. (noncondensing)
Altitude	Up to 10,000 feet (3,000 m)
Temperature Range Operating Storage	 0 to 50 °C (32 to 122 °F) –20 to +50 °C (–4 to +122 °F)
Dimensions	15.5”L x 12.25”W x 4.25”H (393 x 311 x 108 mm)
Weight, Nominal	9.5 lbs. (4.3 kg)

Specifications, Power Sensors

CAUTION
Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

Specifications Common to all Sensors

Impedance, Nominal	50 ohms
Max. Allowable Terminating VSWR	2.00:1
Calibration Technique	Frequency-specific calibration factors stored in nonvolatile memory in each sensor. Sensor output corrected for frequency and temperature within specified ranges.
Calibration Cycle, Nominal	4027A and 4027F, 6 months All other models, 1 year
Accuracy, Reflected	Calculated from FWD accuracy and FWD power $\text{RFL Accuracy} = \text{FWD Accuracy} + \frac{\text{FWD Power}}{10^{\text{Directivity}/10}}$
Accuracy, VSWR	Calculated from FWD and RFL power $\text{VSWR} = \left(1 + \sqrt{\frac{P_R}{P_F}}\right) \Big/ \left(1 - \sqrt{\frac{P_R}{P_F}}\right)$
Sampling Rate, Nominal	2 readings/second
Operating Power	Supplied by power meter via sensor cable
Connectors	
4028B10M	1-5/8" EIA Flanged
4028C10M	3-1/8" EIA Flanged
4028A Series	7-16 DIN, LC, HN, or 7/8"
All other models	Customer specified from QC list, appropriate for frequency and power.
CE	CE Compliant. Refer to Declaration of Conformity for specific standards.
Humidity, Max.	95% (noncondensing)
Altitude, Max.	10,000 feet (3,000 m)
Temperature Range	
Operating	0 to 50 °C (32 to 122 °F)
Storage	–20 to +70 °C (–4 to +158 °F)
Dimensions	
4028B3M, 4028B10M	6.75"L x 3.5"W x 4.75"H (175 x 89 x 121 mm)
4028A Series	4.7"L x 3.2"W x 3.8"H (120 x 82 x 97mm)
All other models	5.2"L x 2.5"W x 3.25"H (137 x 64 x 83 mm)

Weight, Nominal	
4028B3M, 4028B10M, 4028C10M	5 lb. 2 oz. (2.33 kg)
4028A2M, 3M, 4M, 10M, and 25M	3 lb. 5 oz. (1.5 kg)
All other models	1 lb. 13 oz. (0.8 kg)

Bird 4020 Series RF Power Sensors

RF Power Range	
4021, 4022	300 mW – 1 kW
4024, 4025	3 W – 10 kW
Frequency Range	
4021	1.8 – 32 MHz
4022	25 MHz – 1 GHz
4024	1.5 – 32 MHz
4025	100 kHz – 2.5 MHz
Accuracy, Fwd, Best Case*	± 3% (1σ)
VSWR, Max.	
4021, 4024, 4025	1.05:1
4022	1.05:1, 25 – 512 MHz
	1.10:1, 512 MHz – 1 GHz
Insertion Loss, Max.	
4021, 4024, 4025	0.05 dB
4022	0.05 dB, 25 – 512 MHz
	0.13 dB, 512 MHz – 1 GHz
Directivity, Min.	
4021	30 dB
4022	26 dB (28 dB typ), 400 – 1000 MHz
	30 dB, 25 – 400 MHz
4024	28 dB, 1.5 – 2.5 and 25 – 32 MHz
	30 dB, 2.5 – 25 MHz
4025	28 dB, 100 – 125 kHz
	30 dB, 125 – 2500 kHz

* For rated accuracy, no more than 1% AM; Harmonics –50 dBc or less
Derate accuracy by 3.0% (1σ) below 15 °C and above 35 °C

CAUTION

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

Bird 4027A Series RF Power Sensors

Frequency Range			
4027A250K	250 – 400 kHz	4027A12M	10 – 15 MHz
4027A400K	400 – 550 kHz	4027A25M	25 – 30 MHz
4027A800K	800 – 950 kHz	4027A35M	35 – 45 MHz
4027A2M	1.5 – 2.5 MHz	4027A60M	45 – 65 MHz
4027A4M	3 – 5 MHz	4027A100M	95 – 105 MHz
4027A10M	10 – 15 MHz	4027A150M	150 – 170 MHz
RF Power Range			
4027A12M	300 mW – 1 kW	4027A100M	3 W – 5 kW
4027A25M	3 W – 9 kW	4027A150M	3 W – 4 kW
4027A35M	3 W – 7.5 kW	All other models	3 W – 10 kW
4027A60M	3 W – 6 kW		
Accuracy, Fwd, Best Case*	± 1.0% (1σ)		
Calibration Frequencies, Typical (MHz)†			
4027A250K	0.25, 0.40	4027A12M	10.0, 13.56, 15.0
4027A400K	0.40	4027A25M	25.76, 27.12, 28.48
4027A800K	0.90	4027A35M	40.68
4027A2M	1.8, 2.0, 2.17	4027A60M	55.0, 60.0
4027A4M	4.0, 5.0	4027A100M	95.0, 100.0
4027A10M	10.0, 13.56, 15.0	4027A150M	162.0
Calibration Power, Typical			
4027A12M	700 W		
All other models	1.7 kW		
VSWR, Max.	1.05:1		
Insertion Loss, Max.	0.05 dB (with female "N" connectors)		
Directivity, Min.			
4027A12M	30 dB		
All other models	28 dB		

* For rated accuracy, no more than 1% AM; Harmonics –50 dBc or less
Derate accuracy by 1% (1σ) outside cal. power or cal. frequency
Derate accuracy by 1% (1σ) below 15 °C and above 35 °C

† Other calibration frequencies available upon request

Bird 4027F Series RF Power Sensors

Frequency Range	
4027F2M	1.8 – 2.2 MHz
4027F10M	12 – 15 MHz
4027F60M	57 – 63 MHz
RF Power Range	
4027F2M, 4027F10M	0.1 – 10 kW
4027F60M	0.1 – 3 kW
Accuracy, Fwd, Best Case	± 1.0% (2σ)
Calibration Frequencies, Typical*	
4027F2M	1.8, 2.0, 2.17 MHz
4027F10M	12.0, 12.5, 13.56, 14.0, 15.0 MHz
4027F60M	57.0, 58.5, 60.0, 61.5, 63.0 MHz
Calibration Power, Typical	1.7 kW
Harmonic Rejection, Min.	
4027F2M	26 dB @ 3.6 – 3.8 MHz, 30 dB @ > 3.8 MHz
4027F10M	30 dB @ > 25 MHz
4027F60M	30 dB @ > 114 MHz
Low Frequency Rejection, Min.	
4027F10M	30 dB @ < 1 MHz
4027F60M	30 dB @ < 15 MHz
Max Error Induced by 10% AM	
4027F2M, 4027F10M	0.2% @ < 5 kW, 1.0% @ 5 – 10 kW
4027F60M	0.2% @ < 1.5 kW, 1.0% @ 1.5 – 3 kW
VSWR, Max.	1.05:1
Insertion Loss, Max.	0.05 dB (with female "N" connectors)
Directivity, Min.	28 dB

* Other calibration frequencies available upon request

Uncertainty Budget, 4027F Series*		**4027F2M**	**4027F10M**	**4027F60M**
Frequency Error...	at cal freq	± 0.1%	± 0.1%	± 0.1%
	not at cal freq	± 0.5%	± 1.5%	± 0.5%
Power Linearity...	at cal power	± 0.1%	± 0.1%	± 0.1%
	not at cal power	± 1.0%	± 0.5%	± 1.0%
Temperature Uncert...	within 20 to 30°C	± 0.65%	± 0.6%	± 0.5%
	outside 20 to 30°C	± 3.2%	–3.0, +0.75%	± 2.9%
Calibration Uncertainty		± 0.6%	± 0.6%	± 0.6%
Resolution Uncert...	at cal power	± 0.06%	± 0.06%	± 0.06%
	not at cal power†	± 0.34%	± 0.34%	± 0.34%
Other sources of error		± 0.4%	± 0.5%	± 0.6%
Best Case RSS Uncertainty		± 1.0%	± 1.0%	± 1.0%

* All values 2σ

† Resolution uncertainty is error due to limited display digits. Actual uncertainty can be calculated as

± (1 in least significant digit) / Reading

For a 3.5-digit display, worst case is at 300W. Least significant digit is one watt, uncertainty is ± 1W out of 300 or 0.34%. For a 4.5-digit display, least significant digit is 0.1W, so the uncertainty is 0.034%

Bird 4028A and 4028B Series RF Power Sensors

Frequency Range	
4028A250K	250 – 400 kHz
4028A400K	400 – 550 kHz
4028A2M	1.5 – 2.5 MHz
4028A3M	2.5 – 3.5 MHz
4028A4M	3.5 – 4.5 MHz
4028A10M, 4028B10M, 4028C10M	10 – 15 MHz
4028A25M	25 – 30 MHz
4028B3M	2.5 – 40 MHz
RF Power Range	
4028A250K, 4028A400K	1 kW – 20 kW
4028C10M	500W – 50 kW
All other models	1 kW – 25 kW
Accuracy, Fwd, Best Case*	± 2.0% (2σ)
Calibration Frequencies, Typical (MHz)†	
4028A250K	0.25, 0.40
4028A400K	0.40
4028A2M	1.8, 2.0, 2.17
4028A3M	2.5, 3.2, 3.5
4028A4M	3.5, 4.0
4028A10M, 4028B10M, 4028C10M	10.0, 13.56, 15.0
4028A25M	25.76, 27.12, 28.48
4028B3M	2.5, 3.2, 3.5, 4.0
Calibration Power, Typical	3.5 kW
VSWR, Max.	1.05:1
Insertion Loss, Max.	0.05 dB (with female 7-16 DIN connectors)
Directivity, Min.	28 dB

* For rated accuracy, no more than 1% AM; Harmonics –50 dBc or less
Derate accuracy by 2% (2σ) outside cal. power or cal. frequency
Derate accuracy by 2% (2σ) below 15 °C and above 35 °C

† Other calibration frequencies available upon request

Specifications, DeviceNet

DeviceNet Protocol Specifications

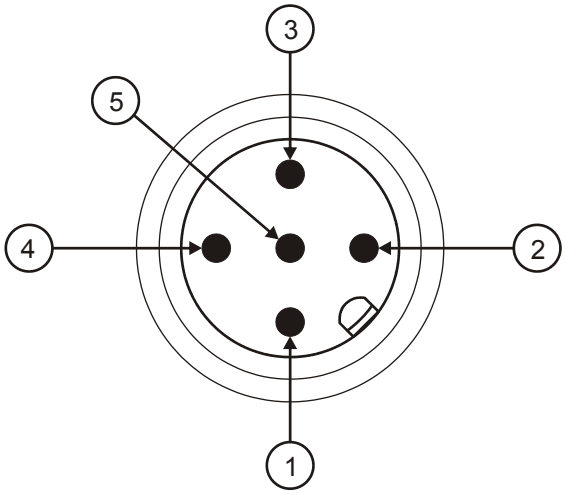
DeviceType:	0x00 - Generic Device
Protocol:	DeviceNet, Group 2 slave only
Cable Lengths	125kbps: 500m (1650ft) 250kbps: 250m (825ft) 500kbps: 100m (330ft)
Data Rates:	125kbps, 250kbps, 500kbps. The rotary switch labeled "DATA RATE" located on the back panel sets the data rate.
MAC ID	(address 00-63) The two (2) rotary switches labeled "ADDRESS" located on the back panel sets the MAC ID (MSD and LSD).
Network Size:	Up to 64 nodes per segment. Network and Module Status LEDs are available on the back
Specification for DeviceNet "Custom Profile"	
Explicit peer-to-peer messaging:	no
I / O peer-to-peer messaging:Configuration consistency value:	no no
Faulted node recovery:	no
Master / Scanner:	no
I / O Slave Messaging	
Bit Strobe: Polling: Cyclic: Change of State (COS):	no yes no no
Configuration Methods	
Hardware Switches: EDS: Parameter Object: Custom Software:	yes yes no no
Materials (DeviceNet connector)	
Contact: Insert: Shell: Coupling nut:	Solid, machined brass Gold over nickel plating per DeviceNet spec Nylon, black Brass, nickel plated Brass, nickel plated

Mechanical Data (DeviceNet connector)	
Protection:	IP68, NEMA 6P (fully locked)
O-ring:	Viton
Insertion force:	< 2.0n, 0.45lbs.
Withdrawal force:	> 0.5N, 0.11lbs.
Electrical Data (DeviceNet connector)	
Contact resistance:	< 5mOhms
Current rating:	3A
Working voltage:	250 VAC
Dielectric withstanding voltage:	2 KVAC eff/60 seconds VDE 0110
Insulation resistance:	> 109 Ohms

Connector Specifications

Connector Type: DeviceNet 5-pin shielded micro-style male connector.

Figure 25 Connector Pin Assignment



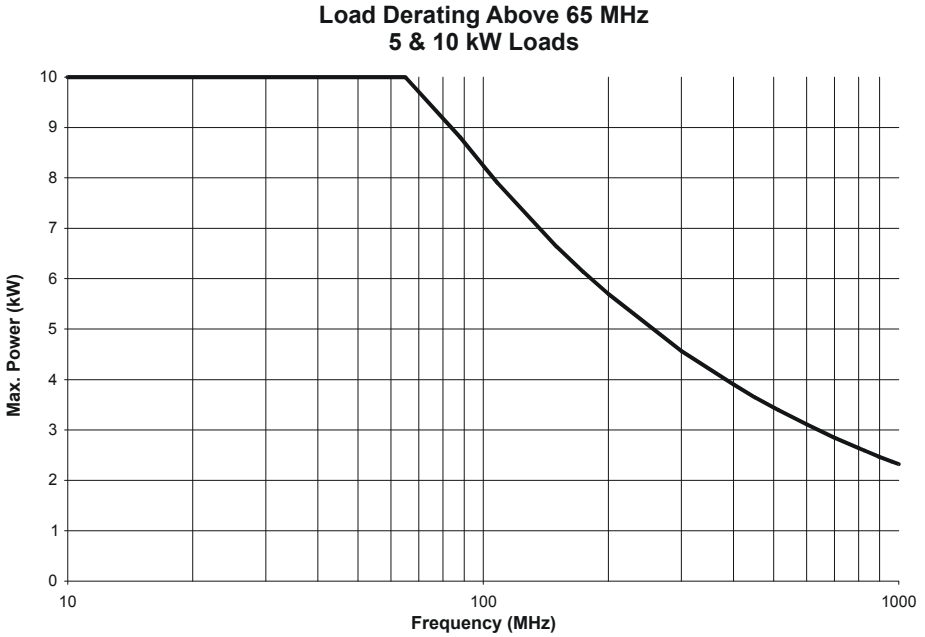
Item	Description
1	Drain
2	V +
3	V –
4	CAN_H
5	CAN_L

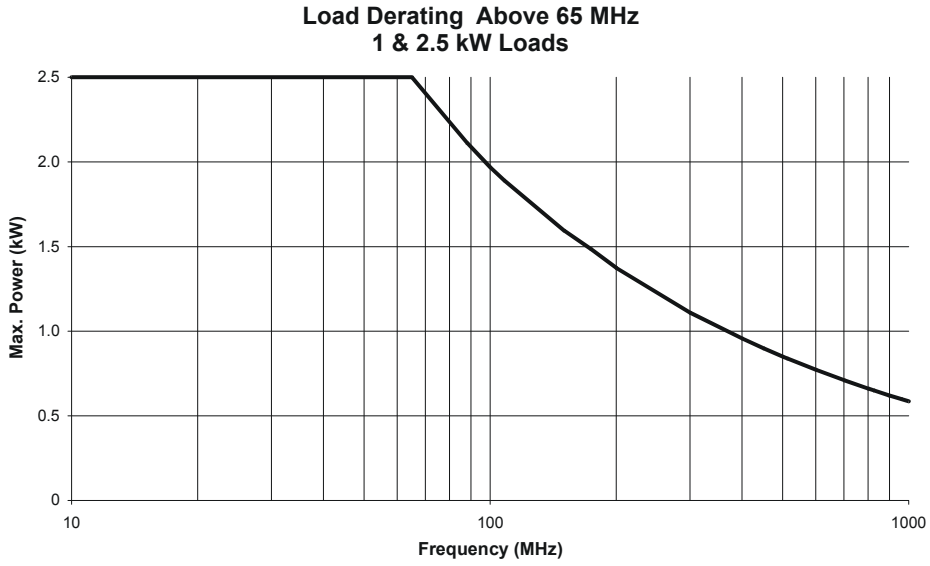
Specifications, IEEE-488 GPIB Interface

IEEE-488 Interface

Logic Levels	Meets all IEEE Standard 488-1978 specifications
Modes of Operation	Switch and bus selectable
Talk Only	Allows the 4421DN to send to the bus keyboard-initiated measurements only
Addressable	Allows the 4422 to be addressed as talker or listener under the command of an IEEE-488 bus controller
Connector	Standard IEEE-488 bus type
Humidity, Max	95% (non-condensing)
Altitude, Max	10,000 feet (3,000 m)
Temperature Range	
Operating	0 to 50° C (32 to 122° F)
Storage	–20 to +50° C (–4 to +122° F)
Dimensions	6.5”L x 4.5” W (165 x 115 mm)
Weight, Nominal	0.5 lbs (0.23 kg)

High Frequency Derating





Replacement Parts

Description	Qty	Part Number
Fuse, IEC (5 x 20 mm) Time Lag Type T 115 Vac, T630 mA 230 Vac, T315 mA	1	 5A2257-10 5A2257-7
Cord, AC Power 115 Vac 230 Vac Harmonized	1	 5-1286 5A2416
Plug, 115 Vac	1	5A2626
Cable, Sensor	1	4421-038
Grommet	1	4421A372
Cordreel	1	4421A383
Casters	4	4421A384
Handle	1	4421A385
Cable, IEEE-488 2 m 1 m	1	 5-1317-2 5-1317-1
Panel Mount Kit	1	4421-250
Battery, C size, NiMH	8	5A1230

Available Connectors

CAUTION
Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

Connector	P/N	Connector	P/N	Connector	P/N
BNC-Female	4240-125	LT-Female	4240-018	Mini UHF-Female	4240-346
BNC-Male	4240-132	LT-Male	4240-012	UHF-Female	4240-050
C-Female	4240-100	N-Female	4240-062	UHF-Male	4240-179
C-Male	4240-110	N-Male	4240-063	1-5/8" EIA Fixed	4240-096
HN-Female	4240-268	SC-Female	4240-090	1-5/8" EIA Swivel	4240-208
HN-Male	4240-278	SMA-Female	4240-336	7/8" EIA	4240-002
LC-Female	4240-031	SMA-Male	4240-334	TNC-Female	4240-156
LC-Male	4240-025	7/16 Jack, IEC Type 169-4	4240-344	TNC-Male	4240-160
Open Term. # 10-32 Nut	4240-080	7/16 Plug, IEC Type 169-4	4240-363		
TRU 6934 (F)	4240-371	TRU 7958 (F)	4240-372		

Customer Service

Any maintenance or service procedure beyond the scope of those in this chapter should be referred to a qualified service center.

If the unit needs to be returned for any reason, request an Return Material Authorization (RMA) through the Bird Technologies website. All instruments returned must be shipped prepaid and to the attention of the RMA number.

Bird Service Center
30303 Aurora Road
Cleveland (Solon), Ohio 44139-2794
Fax: (440) 248-5426
E-mail: *bsc@birdrf.com*

For the location of the Sales Office nearest you, visit our Web site at:

http://www.birdrf.com

Limited Warranty

All products manufactured by Seller are warranted to be free from defects in material and workmanship for a period of one (1) year, unless otherwise specified, from date of shipment and to conform to applicable specifications, drawings, blueprints and/or samples. Seller's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by Seller.

If Seller's products are claimed to be defective in material or workmanship or not to conform to specifications, drawings, blueprints and/or samples, Seller shall, upon prompt notice thereof, either examine the products where they are located or issue shipping instructions for return to Seller (transportation-charges prepaid by Buyer). In the event any of our products are proved to be other than as warranted, transportation costs (cheapest way) to and from Seller's plant, will be borne by Seller and reimbursement or credit will be made for amounts so expended by Buyer. Every such claim for breach of these warranties shall be deemed to be waived by Buyer unless made in writing within ten (10) days from the date of discovery of the defect.

The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's request and/or to Buyer's specifications. Routine (regularly required) calibration is not covered under this limited warranty. In addition, Seller's warranties do not extend to the failure of tubes, transistors, fuses and batteries, or to other equipment and parts manufactured by others except to the extent of the original manufacturer's warranty to Seller.

The obligations under the foregoing warranties are limited to the precise terms thereof. These warranties provide exclusive remedies, expressly in lieu of all other remedies including claims for special or consequential damages. SELLER NEITHER MAKES NOR ASSUMES ANY OTHER WARRANTY WHATSOEVER, WHETHER EXPRESS, STATUTORY, OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS, AND NO PERSON IS AUTHORIZED TO ASSUME FOR SELLER ANY OBLIGATION OR LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING.

Special Lifetime Warranty - Series 4020, Series 4027A, Series 4027F, and Series 4028 Power Sensor Head

In addition to its standard warranty, the Bird Electronic Corporation warrants its Series 4020, Series 4027A, Series 4027F, and Series 4028 Thruline® Power Sensor Heads for lifetime to original purchaser. This extended warranty is against burnout. For the warranty to apply, the Sensor Head must be used with the correct Bird Electronic Corporation Display Unit, the maximum power rating of the Sensor must not be exceeded, the Sensor RF circuit must be properly terminated and the Sensor not subjected to physical abuse.

Bird Electronic Corporation, at its option, will repair or replace the defective Sensor at its world Headquarters at 30303 Aurora Road, Solon, Ohio 44139.

The customer is responsible to pay transportation charges to return the defective sensor to Bird.