

D4000

40 GHz RF Downconverter/Tuner User Guide Version 1.1

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Preface

This preface describes the audience for, the organization of, and conventions used in this document. It also identifies related documentation and explains how to access electronic documentation.

Audience

This document is written for technical people who have basic understanding, familiarity and experience with network test and measurement equipment.

Conventions

This section describes the conventions used in this document.

Grayed-out Font

Indicates a command or a feature is not yet available in the current release.

Courier Font

Illustrates this is an example for a command or a concept.

Light Blue Font

Contains hyperlink to the referenced source that can be clicked on.

Normal Bold Font

When used within a sentence or a paragraph, it emphasizes an idea to be paid attention to particularly.

Red Font

Conveys special information of that section.



Note: This symbol means **take note**. Notes contain helpful suggestions or references to additional information and material.



Caution: This symbol means **be careful**. In this situation, you might do something that could result in equipment damage or loss of data.



Warning: This symbol means **danger**. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with the standard practices for preventing accidents.

Obtaining the Latest Documentation and Software

Please visit our website's resource page at http://www.thinkrf.com/resources/ to obtain the latest documentation and releases of new firmware and software.

Document Feedback

Please send your comments about this document or our other documentation to support@thinkrf.com.

Thank you, we appreciate your comments.

Obtaining Technical Assistance

For all customers who hold a valid end-user license, thinkRF provides technical assistance 9 AM to 5 PM Eastern Time, Monday to Friday. Contact us by filling out the form listed on http://www.thinkrf.com/support/.

Before contacting Support, please have the following information available:

- D4000 serial number, product version (and options if available), which are located on the identification label on The Underside of the D4000.
- The firmware version running on the D4000 (use *IDN? command).
- If applicable, the versions of thinkRF software you are using or any third-party applications.
- The operating system and version you are using.

For any other information, contact thinkRF at:

thinkRF Corporation 390 March Road Kanata, ON K2K 0G7 +1.613.369-5104 info@thinkrf.com www.thinkrf.com

Overview of the D4000



Note: This is a living and evolving document. We welcome your feedback. The features and functionality described in this section **may** exist in the current product or are scheduled for a future product release.

D4000 40 GHz RF Downconverter/Tuner is used to convert RF signals in the range of 24-40 GHz down to an intermediate frequency (IF) of 1.536 GHz. This is designed to extend the functionality of existing spectrum analyzers that can operate at 1.536 GHz to measure and analyze 5G signals in the range of 24-40 GHz band.



Getting Familiar with the D4000

This section provides information about the front and rear panels, connection ports and identification label of the D4000 RF Downconverter/Tuner.



Note: The type and placement of connectors and components on the panels and the case may vary depending upon the product version.

The Front Panel



The front panel of the D4000 contains, from left to right:

- +12 VDC LEMO connector, 4 pin
- RF IN port, 2.92 mm female connector, +10 dBm Max, +10 VDC Max
- IF OUT port, female bulkhead SMA connector
- 10 MHz IN port, female bulkhead SMA connector, 0 dBm Min, +10 dBm Max
- 10 MHz OUT port, female bulkhead SMA connector
- RST, factory reset button
- STS/PWR/EXT REF, Status LEDs
- CTRL, GPIO port, D-Sub high density receptacle 15 Position
- RJ-45 Ethernet port

The Rear Panel



The rear panel of the D4000 contains a power switch, and a gore vent for getting moisture out of the device.

The Underside

The underside of the D4000 provides an identification label, as illustrated below. The label on your product may vary depending on your product variant and version.

The product "Version" number is important for identifying which firmware can be used to update your product. The "Options" number is to identify which product model you have, see D4000's datasheet if the Options is not NONE.



Precautions and Operation Consideration

Ensure that you read and understand the following information about safety and electrostatic discharge before you unpack and set up the D4000.



Warning: Only trained and qualified personnel should be allowed to install or replace this equipment. Read the installation instructions before you connect the system to its power source.

Preventing Electrostatic Discharge Damage

Electrostatic Discharge (ESD) is a single-event, rapid transfer of electrostatic charge between two objects, such as an operator and a piece of electrical equipment. ESD can occur when a high electrostatic field develops between two objects in close proximity. ESD occurs when electronic components are improperly handled and is one of the major causes of device failures in the semiconductor industry.

Electrostatic discharge is more likely to occur with the combination of synthetic fibers and dry atmosphere. Always follow these steps to prevent ESD.



Warning: Never open the front or rear panels of the D4000 as personal injury may result and opening the chassis will void the warranty. There are no user-serviceable parts inside. Always contact thinkRF support for service through the online support form at http://www.thinkrf.com/support/.



Caution: To prevent ESD, wear an ESD-preventive wrist strap that you provide, ensuring that it makes good skin contact.



Caution: Do not touch any exposed contact pins or connector shells of interface ports that do not have a cable attached. If cables are connected at one end only, do not touch the exposed pins at the unconnected end of the cable.

Preventing RF Connector Damage

When connecting to an RF connector, whether it is SMA or other connectors, it is important that proper care and connector connection practice is used to prevent irreversible damage to the connector and its port.



Caution: When mating/demating the connectors,

- **Do:** align the mating connectors properly to prevent damaging the center pin, make preliminary connection by using fingers, use correct torque spanner for the final connection

- Do not: apply bending force to connection, over-tighten to a connector on the jack or

overturn point of the torque wrench. Using incorrect torque wrench, wrench, pliers or even your hand to over-tighten a connector can cause permanent damage to a D4000.

2.92 mm Female Connector



Caution: Use only 2.92 mm Male connector as the mating part to the D4000's RF IN port. **ONLY** use 2.92 mm cables and connectors.

Use only a proper torque wrench with torque setting intended for a 2.92 mm Male connector (not the same one for a SMA connector). The recommended torque setting is 100 N.cm (8.9lbs.in). An example of a torque wrench that can be used for this is Huber-Suhner P/N 74 Z-0-0-21.

SMA Connectors

The recommended torque setting for all SMA connectors is 45 N.cm (4lbs.in). An example of a torque wrench that can be used for this is Huber-Suhner P/N 74 Z-0-0-79.

Operation Consideration and Maintenance

The D4000 should be operated only within its specified operation temperature and specification of 14° F to 131° F (- 10° C to 55° C). The ideal operating temperature for optimum performance is between 68° F to 77° F (20° C to 25° C).



Caution: Do not expose the device to direct sunlight or radiation from other sources of heat.

Some regular maintenance is needed to maintain the unit in its good working state. This includes inspect and keep all the connectors clean, especially the threads by using, for instance, Lint Free cloth or Q-tip with Isopropyl alcohol.

Setting Up the D4000

Unpacking the Box

The following table lists the items that come with your D4000. If any of the items are missing or damaged, please contact your thinkRF customer service representative.

D4000 Shipping Box Contents:

- D4000 RF Downconverter/Tuner
 - Power supply with barrel connector
- Power cord Country specific by Type
- Ethernet cable
- Thank you/Reference card

Connecting the Ethernet and Cables

Follow the steps below to connect up the D4000 ports. The diagram bellow illustrates the setup steps.



 Before connecting D4000 to a spectrum analyzer (SA), if instead of the provided +12 VDC power adapter, a power source or power pack is used, then first power up the power source device and set the voltage to +12 VDC and 3 A min.

Connect the power supply source to D4000's LEMO power connector.



Caution: Do not supply a power source exceeding **+15 VDC** to the D4000. It can cause permanent damage to the device.

2. Connect one end of the Ethernet cable to the D4000's Ethernet port and the other end to an Ethernet port on the SA or a computer.



Caution: For the following RF connectors, see Preventing RF Connector Damage section for important cautions and torque suggestion.

- 3. Connect the Antenna or an RF input source to the D4000's RF IN port.
- Connect the SMA connector end of the cable coming from D4000's 10 MHz OUT port to the SA's External IN port. Important to see Preventing RF Connector Damage and its SMA Connectors section for caution and torque suggestion.
- 5. Connect the SMA connector end of the cable coming from SA's RF IN port to the D4000's IF OUT SMA port.
- Connecting to D4000's 10 MHz IN port is optional or on per needed basis for clock synchronization. See Use of D4000 with External 10 MHz Reference for more information and important cautions.
- 6. Connect the auxiliary GPIO to SA's control port for controlling (Future feature)

Use of D4000 with External 10 MHz Reference

The thinkRF D4000 can be synchronized with the use of an external 10 MHz reference, for example, from an external oscillator or from the digitizer section of the data acquisition system.

As well, this 10 MHz is redistributed within the D4000 and sent to the 10 MHz OUT SMA connector for use by external equipment that needs a 10 MHz reference source.

To set the D4000 to use the external 10 MHz reference, send the SCPI command :SOURce:REFerence EXT (Refer the D4000 Programmer's Guide for more details).



Cautions:

- When the external 10 MHz IN reference is used, its reference level must be between **0 dBm** and **+10 dBm**.

- The maximum power level to the D4000's 10 MHz IN is +10 dBm. Exceeding this value might degrade the product performance.

- The 10 MHz reference source to the 10 MHZ IN port must be powered down prior to powering down the D4000.

- See Preventing RF Connector Damage and its SMA Connectors section for important caution and torque suggestion.

Interfacing with the D4000

This section provides instruction for different methods of accessing the D4000 via its Ethernet port and obtaining its IP address.

The D4000 is network ready devices conveying SCPI (Standard Commands for Programmable Instruments) commands and data using the TCP/IP protocol via a Gigabit Ethernet connection. Network application access is via SCPI Raw or SCPI Telnet.



Note: The SCPI commands consist of network configuration, device status checking, input filter selection, frequency settings, bandwidth and attenuation values, etc. To see a complete SCPI command list for D4000, please refers to the D4000 Programmer's Guide.

The D4000 also supports different methods of obtaining its IP address including:

- Dynamic IP address allocation via the Dynamic Host Configuration Protocol (DHCP), which is applicable to a routed network topology that has a DHCP server;
- Static IP address allocation, which is applicable to any network topology.



Note: The D4000's default factory configuration at the first power up or after a factory reset is set to STATIC type with IP 192.168.1.2.

Network Application Access Methods

SCPI Raw

SCPI Raw uses a TCP/IP connection to establish a bidirectional link with minimal overhead. Although it can be used as a command line interface, it is better suited for use with an application.

SCPI Raw is accessible via TCP port 5025, see the following figure.



Establishing Ethernet Connection with D4000

This section provides instruction on connecting the D4000 directly to a SA via their Ethernet ports using an Ethernet cable.

To connect the D4000 directly to your SA:

- If this is not the very first time connecting to the D4000, skip to the next step. Otherwise, your SA's Ethernet interface must be configured first to use static IP mode in order to work with the D4000's factory default IP of 192.168.1.2. This involves setting your SA to have an IP address of 192.168.1.x (x cannot be 2) with a subnet mask 255.255.255.x and a gateway 192.168.1.x. If still not sure of the setting, please contact your network administration for valid settings.
- 2. Connect the Ethernet cable to both your SA's and the D4000 Ethernet ports.
- 3. Power up the D4000 if haven't done so and wait until the status LED turns green.
- 4. Check to ensure that either your SA's or the D4000 Ethernet's jack LINK indicator is illuminated. If it is not, then your SA may not support automatic crossover on its Ethernet connection and you may require an RJ-45 crossover Ethernet cable.
- 5. Choose one of the methods mentioned in Network Application Access Methods to verify the established connection with the D4000.
- 6. With an assigned IP, the D4000 could now be controlled through SCPI commands described in the D4000 Programmer's Guide document.
- 7. If necessary, after establishing a successful connection, configure the D4000 to your chosen method of IP allocation following the instruction in the Changing the Method of IP Address Allocation for D4000 section.

Changing the Method of IP Address Allocation for D4000

This section provides instruction for re-configuring one IP address allocation type to another for a D4000.



Notes:

- The D4000 is configured to STATIC IP 192.168.1.2 by factory default.

- Decide on whether you will be using static or dynamic IP allocation. Regardless of which method you choose, **both** your SA's and the D4000's Ethernet interface must be configured for the same method of IP allocation.

If your D4000 is configured for static IP allocation, then it may be reconfigured for dynamic IP address allocation using the :SYSTem:COMMunicate:LAN command set (see D4000 Programmer's Guide document).

If your D4000 is configured for dynamic IP allocation, then it may be reconfigured for static IP address allocation either using the :SYSTem:COMMunicate:LAN command set (see D4000 Programmer's Guide) or via a hardware factory reset. Using the hardware factory reset to reconfigure to static IP allocation is the simplest method and is described in the Device Reset section.

Device Reset

The pushbutton is accessible using a thin object such as a paperclip through the access hole. It is used only during powerup to request a factory reset or restore. The pushbutton must be depressed before turning on power.

Reset to Factory IP Configuration

If for any reason you cannot connect to the D4000 via the Ethernet, then performing this following procedure will reset the D4000 network configuration to the factory installed static IP configuration with IP address of 192.168.1.2.

Follow the steps below to reset your box.

- 1. Power off the D4000
- 2. Use a small pin to access the reset button locating in The Front Panel of the D4000
- 3. Press and hold while powering on the unit
- 4. The reset button **must** be released within 5 seconds after powering up the unit Please ensure the reset button is not held longer than 5 seconds to avoid initiating a Factory Reset
- 5. After the reset button is released, three fast flashing yellow LED light up on PWR LED
- 6. LED becomes normal start-up sequences: PWR solid yellow, then solid green
- 7. Follow Establishing Ethernet Connection with D4000 section to setup the connection

Restore to Factory Settings

If for any reason, unit need to be restore to factory load firmware, then performing this following procedure will restore the D4000 to the factory load firmware.

Follow the steps below to reset your box.

- 1. Power off the D4000
- 2. Use a small pin to access the reset button locating in The Front Panel of the D4000
- 3. Press and hold while powering on the unit
- After powering up the unit for more than 10 seconds, three fast flashing yellow will be displayed on PWR LED to confirm the section of factory restore
- 5. Release the pin from reset button, and three fast flashing yellow LED will be displayed again on PWR LED to indicate restoring in progress
- 6. All LEDs will dim during the restore process until it finishes, it may take a few mins
- 7. LED becomes normal start-up sequences

Status Indicator LED

The D4000 has a status (STS) indicator LED located on The Front Panel.

Using different colours and blink codes, the STS LED indicates the following device conditions.

STS Indicator LED	Internal Status
Green	All internal power conditions are good and the device is ready
Yellow	The RF path and LOs are settling after a tune request
Red	One or more PLLs remain unlocked past the expected time
3 fast yellow blinks	No network connection is present (e.g. unplugged, or remote peer is not connected)
2 fast, 1 slow yellow blinks	The device has not received an IP address from a DHCP server
3 slow red	Hardware failure
Off	n/a

PWR Indicator LED	Internal Status
Green	All internal power conditions are good and the device is ready
Yellow	Device is in power down state
Red	One of the power rails, other than the 3.3V rail, is reporting a fault. This may also indicate a microcontroller failure (e.g. unprogrammed or broken)
3 fast yellow blinks	Factory Reset request is detected (pushbutton is released in less than 10s)
2 fast, 1 slow yellow blinks	Factory Restore request is detected (pushbutton held for at least 10s)
Long short long yellow blinks	A temperature sensor is reporting a temperature above the warning threshold.
Long short long red blinks	A temperature sensor is reporting a temperature above the error threshold.
3 slow red	Hardware failure
Off	Not receiving power from the power source

EXT REF Indicator LED	Internal Status
Green	Internal 10 MHz Lock
Yellow	Overload Warning
Red	Overload Error
3 slow Green	External 10 MHz Lock
Off	Not receiving power from the power source

Fast blink is defined as 0.25 second long and **slow** blink is 0.75 second.

Hardware Reference

This section provides physical and performance specifications, and port and cable pinouts for the D4000.

System Specifications

The following table outlines the physical and electrical specifications for the D4000.

Description	Design Specification
Dimensions (W x L x H)	7.6 x 7.6 x 1.6 in. (19.3 x 19.3 x 4.1 cm)
Weight (approximately)	Approx 1.7 Kg (3.7 lb)
Digital interface ports	Ethernet 10/100/1000
Analog interface ports	RF IN, IF OUT, 10 MHz IN and OUT
Input supply voltage	12 VDC +/- 5%
Input supply current	1.73 A at 12V
Power Consumption	20.76 Watts
Operating temperature	14 to 131°F (-10 to 55°C)
Storage temperature	-60 to 160°F (-51 to 71°C)

2.92 mm and SMA Connectors

The 2.92 mm and SMA connectors on the front panel are all female jacks. The SMAs are with 50Ω nominal impedance. The following table outline the maximum and minimum power level restrictions on these connectors.



Caution: Injecting signal levels that exceed the specifications described in the following table will result in permanent damage to the RF Downconverter/Tuner.

Connector Name	Direction	Max Power Level	Min Power Level
RF IN ¹	in	+10 dBm ⁴ , 10 Vdc ⁴	
10 MHz IN ^{2,3}	in	+10 dBm ⁴	0 dBm⁴
10 MHz OUT	out	+10 dBm ⁴	+5 dBm min ⁴

¹ It is recommended that the output of a signal source be verified with the use of a power meter prior to connecting the source directly to the RF IN connector. It is best to inject signals equal to or lower than -20 dBm; otherwise, an external attenuator should be considered to prevent damaging the D4000. Additionally, any external signal sources connected to RF IN must be turned on only after powering on the D4000 and turned off prior to powering down the D4000.

² The 10 MHz reference input must be powered down prior to powering down the D4000. See also the Caution Note of Use of D4000 with External 10 MHz Reference section on page 18.

³ To set the D4000 to use the external 10 MHz reference, apply a :SOURce:REFerence EXT command, see the D4000 Programmer's Guide.

⁴ By design.

RJ-45 Ethernet Port Pinout



Pin	Signal
1	BI_DA+
2	BI_DA-
3	BI_DB+
4	BI_DC+
5	BI_DC-
6	BI_DB-
7	BI_DD+
8	BI_DD-

RJ-45 Straight-Through Ethernet Cable



RJ-45 Crossover Ethernet Cable



Document Revision History

This section summarizes document revision history.

Document Version	Release Date	Revisions and Notes
v1.0	July 31, 2020	First release
V1.1	April 26, 2023	Updated Reset and Restore procedure