Telewave.io

44DL Digital/Analog Broadband RF Wattmeter - User Manual

20 September 2023
Firmware Version TiF.01.15M23

Telewave.io

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Warranty:
Products sold by Telewave.io. and covered by this Warranty are warranted to be free from defects in material and workmanship at the time of and for a specified period after delivery to the Buyer. Seller's entire warranty obligation is limited to making adjustments by repair, replacement, or refunding the purchase price of any product which is returned to the Seller as provided below within the specified period from the date of shipment by the Seller. In no event shall Seller be liable for direct, special, or consequential damages for breach of warranty.

Adjustment will not be allowed for products which have been damaged by lightning, subjected to abuse, improper application or installation, alteration or accident, or negligence in use, storage, transportation, or handling. Alteration or removal of the serial number or identification markings voids the Warranty. Seller shall have the right of final determination as to the existence and cause of a defect, whether adjustment will be allowed, and if allowed, whether adjustment will be by repair, replacement, or refund. Where adjustment is not allowed, a charge of 5% of the original purchase price will be made to the Buyer to cover the Seller's cost of inspection and handling.

Shipping and packaging instructions must be obtained from the Seller before products are returned for adjustment. The Buyer will pay for packing, transportation, and transit insurance costs for returned products. The Seller reserves the right to discontinue models at any time or change specifications, design, or price without notice and without incurring any obligation. Products will be returned to the Buyer with transportation cost collect.

Subject to the provisions of its "Patent Indemnity" clause, the Seller also warrants that it has the right to sell its products, that the Buyer shall have and enjoy quite possession thereof as against any lawful claims existing at the time of the sale by the Seller, and that said products are free from any charge of encumbrance in favor of third persons existing at the time of sale by the Seller.

The foregoing constitutes the Seller's entire warranty, express, implied, or statutory with respect to its products and states the full extent of its liability for breach of Warranty and for damages, whether direct, special or consequential resulting from any such breach. No change whatsoever thereto shall be binding upon the seller unless made in writing and signed by a duly authorized representative of the Seller.

Warranty Periods:

- Antennas and antenna mounting hardware - 5 years
- All other products - 1 year

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Precautions and Safety Instructions

1. Read the user manual carefully. All **Warnings** and **Cautions** should be noted.
    - Contact Telewave.io Technical Support with any questions.
    - Keep the user manual(s) for future reference.
2. Keep the 44DL away from sources of moisture or excessive humidity.
    - Never pour any liquid into the openings or connectors.
    - Do not immerse into any liquid. The 44DL is water resistant, not waterproof
3. Do not store this 44DL in an unconditioned environment for an extended time. Prolonged exposure to extreme heat, cold or moisture may cause damage.
4. Check the current capacity of the USB charger/power supply before connecting to the 44DL.
5. Do not attempt to disassemble the 44DL, there are no user serviceable parts inside.
6. Inspect the 44DL if it has been dropped or exposed to excessive vibration.
7. Contact Telewave.io Technical Support if any of the following conditions arise:
    - There are any obvious signs of damage – case, display, connectors, switches, or etc.
    - Any liquid appears to have penetrated the case.
    - The 44DL appears to malfunction or is giving obviously incorrect readings.
    - The 44DL has been tampered with or opened by anyone other than Telewave.io.
8. Follow all normal Radio Frequency safety rules and High Voltage safety rules.
    - Double check all connections and configurations before applying power to transmitters
    - Double check all connections and configurations before keying any transmitters
    - Be mindful of short and long-term exposure risks to Radio Frequency Radiation

WARNING: This symbol alerts you to the risk of personal injury, hardware damage or irrevocable loss of data.


CAUTION: This symbol denotes situations where instructions must be followed carefully to avoid personal discomfort or to obtain expected results.

Quick Start Guide

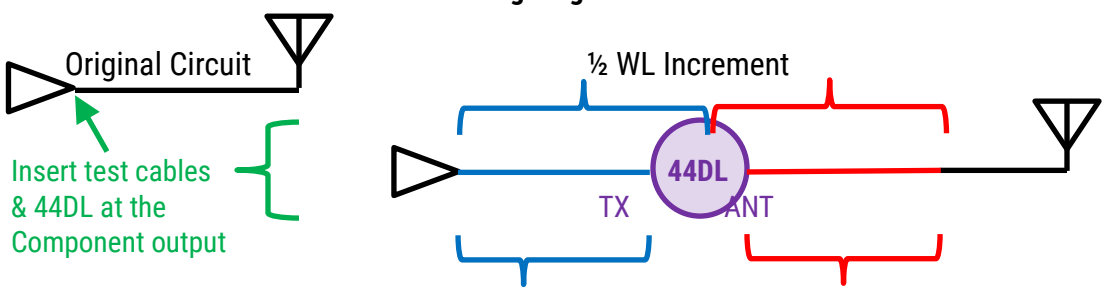
The complete 44DL User Manual is available for download at www.telewave.com.

- Unpack the 44DL and accessories (USB cable, AC power supply, & AC adapter kit)
- Check the box and contents for any damage immediately after it arrives
- In case of damage or missing items, contact Telewave.io immediately, 408-929-4400 Opt 1.
- Charge the Batteries
  - Connect the supplied USB cable into the 44DL (connector on the back) and into the supplied AC power supply. Plug the power supply into a 90 to 250 VAC (50 or 60 Hz) wall socket (Charging will begin automatically - when the 44DL is turned off the display will flash on for a moment & then go dark, the blue power ring will remain on.)
  - The 44DL must be fully charged before turning on for first use.
  - The 44DL cannot be switched ON or OFF while charging via the USB. Disconnect the USB cable, toggle the power button, and then re-connect the USB to continue charging.
  - See the section "Lithium Battery Management" for battery management details
- Build or procure "Primary Cables" (see "Appendix - Connecting the 44DLto the Circuit")
- Press and release the power button. The blue power indication in the switch will illuminate.
- The 44DL will be functional in three to five seconds as indicated by:
  - Backlight will be illuminated
  - Frequency, battery indicators are displayed
- The HOME screen & menu tree:
  - Freq Range > Set operating frequency range*
  - Modulation > Selects the modulation type*
  - Settings > Select dB, watts, backlight Adj.
  - Info & Help > Show Version, Telewave.io contact

*Set the Frequency Range and Modulation before use or measurement will be inaccurate, other settings are optional
When in any MENU screen other than the HOME Screen, the function buttons will be UP, SELECT/EXIT, and DOWN.
Press SELECT implements the selection & returns HOME

- Once the 44DL has been configured, the cables can be connected.
- Connect the primary cable to the port labeled TX on the left side of the 44DL (RF input)
- Connect the cable leading to the antenna to the port on the right side of the 44DL (RF output)
- The RF Sample port can be connected to any monitor or source test equipment. The sample port is bi-directional, with connectivity to both the Thru Line TX and Thru Line ANT port.

Wiring Diagram



Primary Cable (1/2 WL increment minus 3") Secondary Cable (Optional = ½ WL incr. - 3")

Lithium Battery Management

Lithium-ion batteries are used in the 44DL to supply power. The behavior of the 44DL batteries is like other devices that use the same battery technology (cell phones, iPads, etc.). Please carefully read this section regarding battery safety and operation details.

Battery charging and discharging

The battery can be charged when the 44DLis on or off. The 44DL and can be charged from any USB source that can support a 2.4-amp load, though we recommend using the supplied power supply and cable (do not charge via a laptop USB port). Charging begins automatically when power is applied to the USB port.

NOTE: Two Power Management Rules

1. Always make sure that there is at least one bar (2 hours) battery life before using the 44D.
2. Unplug the USB cable before operating the power switch (turning the power on or off) and then plug USB cable back in if needed for charging or operation.

- When the 44DL is powered off; the power switch ring will be blue, the display will be dark.
- When the 44DL is on, the battery life indicator turns yellow indicating that the batteries are charging.
- Depleted batteries will require 6 hours of charging time to reach a full charge.
- Fully charged batteries will support about 6 hours of active operation.

NOTE: The 44DL can be used when charging, but when the charger is in trickle mode (less than 1 hour battery life) there is not enough current provided to operate the 44D; the batteries will eventually be depleted.

WARNING

- The batteries must be discharged to 1/3 or less capacity before the meter can be shipped by Air. This is a legal and safety requirement for all lithium batteries.
- The 44DL can be carried into the cabin of any passenger flight (at any charge level), but it cannot be checked into luggage on any passenger flight.
- The internal batteries are not user serviceable. The 44DLmust be returned to Telewave.io for service if the batteries no longer accept or retain a sufficient charge.
- Excessive cold or hot temperature can damage the batteries or create a fire hazard.

CAUTION

- Fully charge the batteries upon initial receipt, also before and after long term storage.
- Fully charge the batteries at least once a month during long term storage.
- The batteries may self-deplete and malfunction unless they are periodically re-charged.
- Once the internal charging controller detects that the batteries are fully charged, it will reduce the charging rate to trickle. The rate will remain at a trickle until the USB is unplugged.
- The 44DL can be left on the charger for longer than 24 hours, but this is not recommended.
- The 44DL is protected by internal fuses. If the USB charging port is shorted the fuses may blow requiring factory replacement.

Charging Power Supply & International Power Adapters

The included power supply for charging batteries supports 100 to 240 volts at 50 or 60 hertz and is an IEC international "Plug Type A".

Use only 1 USB port on the charger when charging a 44DL Wattmeter (leave the second port open.)

The appropriate type C, G, or I adapters are included for the destination "ship to" country that supports the adapter standard to allow the power supply to be safely connected to the power socket in the designated country.

Visit the International Electro technical Commission (IEC) website for a complete list of socket types, and power voltage/frequencies used in various countries: http://www.iec.ch/worldplugs/.

Description	Picture	Short list of Areas/Countries where the "Type" is used
Type A Plug on the power supply		North and Central America, Japan Directly compatible with **Type B** sockets
Type C Universal to Euro 2P AC Power Plug		Europe (except UK), Ireland, Cyprus, Malta Directly compatable with **Type E, F, J, K, & N** sockets
Type G Universal to UK 3P AC Power Plug		UK, Ireland, Cyprus, Malta, Malaysia, Singapore, Hong Kong
Type I Universal to AUS 3P AC Power Plug		Australia, New Zealand, Papua New Guinea, Argentina, China

Power Control

The 44DL has a latching push power button in the lower left corner of the front panel.

To turn the 44DL ON, push the power button until you hear a clicking sound and/or you see that the power switch rim is illuminated with a blue glow. After a few seconds the display backlight will illuminate, and the power up sequence will be shown in the display.

The power up sequence, as is seen in the display is:

- The screen backlight will illuminate after about two seconds
- Then the HOME screen will display
- After that the frequency, temperature and battery status indications will be displayed
- After the power up, the user needs to setup the frequency band and modulation type

Once the power up sequence is complete the HOME screen will indicate the settings that were selected when the 44DL was previously turned off (units of measurement, backlight level, etc.) The power switch will remain partially depressed while the 44DL is turned on.

To turn the 44DL OFF, push the power button in slightly further, and release. The switch will return to the flush position, the blue rim light will extinguish, the display backlight will turn off and the display will become blank. There are no lights or display activity when the unit is off.

Plugging in USB power when the 44DL is powered off

The blue power switch indicator & display backlite will turn on, the 44DL is not operational

Push the power switch in to turn the 44DL on for use (freq counter & temp indication show)

Turning off the 44DL when USB power is applied

The blue power switch indicator & display backlite will remain on, 44DL is not operational

Unplug the 44DL for a few seconds and then plug in and/or turn the 44DL back on for use.

NOTE: RF signals will flow though the through line sensor un-impeded with the 44DL power turned On or Off.

Menu Tree

HOME Screen and Fields Description

		Battery Status
FWD (measured forward power)	Measured Value	Avg W / dBm
REFL (measured reflected power)	Measured Value	Avg W / dBm
VSWR (Voltage Standing Wave Ratio)	Calculated Value	Value
Measured Frequency MHz		Frequency Range (Low, Med, High)
	MENU	

After the system has completed the power up sequence the default screen configuration is shown.

Top Row indicates the Battery Life

The second and third rows indicate results measured from the main thru line connectors.

The fourth row indicates the Calculated VSWR value (VSWR is displayed in WATTS or dBm mode.) When the display is set to indicate the measured power in dBm, the Return Loss can be manually calculated by subtracting the reflected power “dBm” from the forward power “dBm”.

The fifth row indicates the measured frequency of the RF signal, and the frequency range setting.

NOTE: All measured power indications show a dash “---“dBm or “0.0” Watts until the average forward power detected exceeds 5 watts.

The bottom row indicates the current function of the three buttons located just below the screen. The purpose of each of these buttons change as the needed for easy configuration of the 44DL.

The HOME screen function buttons are:

- MENU Setup before measuring - Open the MAIN menu

MAIN Menu

The main MENU allows access to these categories:

- FREQ RANGE Configure the frequency range Low, Medium or High
- MODULATION Choose the desired modulation type
- SETTINGS Adjust the display parameters
- INFO & HELP Read only attributes and Telewave.io contact information

CAUTION: The frequency range must be set to the proper range before reading the power.

For the main MENU and all Sub-Menus

- Scroll up and down in the options by pressing the UP and DOWN buttons.
- Pressing the SELECT key will select the currently highlighted item.
- Selecting EXIT will return to the HOME screen without making any changes.

Frequency Range Menu

The frequency range sets the search window for locking onto the target signal (Low, Med, High.)

- 88-100 MHz Select for measuring frequencies between 88 and 100 MHz
- 101-400 MHz Select for measuring frequencies between 101 and 400 MHz
- 401-1000 MHz Select for measuring frequencies between 401 and 1000 MHz

CAUTION: The Frequency Range is a mandatory parameter setting. The 44DL may not be able to accurately measure the power of a signal if the range is not set correctly.

CAUTION: The frequency counter indication is only a reference to validate that the transmitter is close to the expected frequency or that the correct transmitter is transmitting during testing. The 44DL counter should not be used to adjust the output frequency of a transmitter. Due to the step size of the 44DL counter there may be occasional toggling between indicated frequencies.

Modulation

The supported list of modulation/radio types are:

Menu Selection	Radio System Type
FM/FSK	CW, FM, DMR Downlink, P25-P1 (C4FM Yaesu Fusion), dPMR, NXDN (Kenwood NEXEDGE / ICOM IDAS), D-Star
DMR/P25-P2 UL	DMR, P25-P2 Uplink (both TDMA), TETRA Uplink (TDMA & Quadrature)
LSM/P25-P2 DL	LSM, P25-P2, TETRA Downlink (all Quadrature)

Settings Menu

This menu is for setting the units of measurements and other behavioral parameters of the 44DL:

- Power Units Select forward and reverse power display in Watts or dBm
- Backlight Select the backlight intensity: Low, Medium, High

Info & Help Menu

This menu is for query of the attributes of the 44DL:

- About Display the serial number and firmware version of the 44DL
- Help Display the phone number and email address of Telewave.io Technical Support
- EXIT Return to the HOME screen

Specifications

If the 44DL is reading a signal that is outside the range of these specifications; the 44DL will indicate "---" dBm or "0.0" Watts as the measurement.

The 44DL is only certified for use on a 50 Ω coax style cables.

Frequency Range

Calibrated Range	136 MHz to 869 MHz

Power Range (Constant Envelope) Modulation

Forward Power Average (Min to Max)	5 Watt to 500 Watts (37 dBm to 57 dBm)
Reflected Power Average (Min to Max)	1 Watt to 100 Watts (30 dBm to 50 dBm)

RF and Measurement

Thru-Line RF connectors	N-Female
Sample RF port connector	SMA-Female
RF Impedance of all RF Ports	50 Ω
Mismatch introduced by 44DL (50 Ω coax)	< 1.2:1 VSWR (> 21.0 dB Return Loss)
RF Coax Termination Range (see Note)	< 2.0:1 VSWR (> 9.5 dB Return Loss)
RF Insertion Loss (through main RF connectors)	Less than 0.02 dB up to 500 MHz Less than 0.04 dB up to 1 GHz
RF Sample Port Insertion Loss	-50 dB +/- 2 dB from 200 MHz to 1 GHz -50 dB +0/-12 dB from 88 MHz to 200 MHz

See "Appendix – RF Sample Port Isolation" for isolation by frequency details

Frequency Counter Accuracy	+/-200 KHz at all frequencies
Typical Settling Time	3 to 5 Seconds (FM Analog / FSK Digital)
Thru Line Coupler Directivity	>20 dB
RMS RF Power Measurement Accuracy	± 0.4 dB

USB Connector, Battery and Charging

Battery Life	6 hours on time for fully charged batteries
Battery Charge Time	6 hours to fully charge depleted batteries
USB Charger VAC Requirements	100 to 240 VAC at 50 or 60 Hz
Universal Power Plug Adapter Kit IEC (International Electrotechnical Commission)	Charger comes with an IEC **Type A** plug Adapter kit converts to **Type C, G or I** plug Compatible **Type B, E, F, J, K, & N** socket
USB Charger VDC Requirements *Supplied adapter depends on Destination Country*	5.1 Volts DC at maximum 3.1 Amps (Simultaneous charging and operation)
USB Connector Back of 44DL	USB 2.0 Type B Jack

Mechanical

44DL weight	3 lb (1.4 kg)
44DL dimensions (LWH) inches (CM) Incl. knobs/feet/connectors - not incl. the handle	6.75” x 5.5” x 4.0” (17.14 x 13.97 x 10.16 cm)
Shipping weight 44DL only Shipping weight with optional case	4 lb (1.8 kg) 5 lb. (2.3 kg)
Shipping dimensions (LWH) inches (cm)	10.0” x 8.0” x 6.0" (25.40 x 20.32 x 15.24 cm)

Environmental

Humidity Range (Operating / Storage)	35% to 85% non-condensing
Temperature Range Operating (USB Connected)	+32°F to +113°F (0°C to +45°C)
Temperature Range Operating (USB Disconnected)	-4°F to +122°F (-20°C to +50°C)
Temp Range Storage (Long) (USB Disconnected)	+68°F to +86°F (+20°C to +30°C)

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Miscellaneous: Accessories, Options, Maintenance

Included Accessories

The 44DL comes with:

- Universal USB power supply (2.1 Amp load capacity)
- 3-foot-long USB 2.0 type A to type B charging cable
- For meters shipped outside the United States, an appropriate type C, G, or I Male to US Female power adapter will be included (per the destination country plug configuration.)

Visit the International Electro technical Commission (IEC) website for a complete list of socket types, and power voltage/frequencies used in various countries: http://www.iec.ch/worldplugs/.

NOTE: It is recommended to use the Telewave.io supplied power supply and charging cable.

Optional TC44-R Carry Case

Contact Telewave.io sales for a quote or to order a carry case.

Maintenance & Calibration

There are no user serviceable parts inside the 44DL. Opening the cover voids the calibration.

Telewave.io recommends returning the 44DL to the factory every year for inspection & calibration. Calibration must be done at Telewave.io, contact Telewave.io sales for a quote.

Before each 44DL is calibrated it will be inspected. A report will be provided detailing any issues found (including battery health test report.) Any deficiencies found will be repaired (warranty for free, non-warranty if customer authorized) and then the 44DL will be calibrated. Unrepaired deficiencies may cause calibration failure. Firmware version will be updated to latest, no charge.

To return a 44DL to Telewave.io for calibration or repair; complete the RMA request form located on our web site at https://www.telewave.com/rma-request-form/.

For Sales / RMA request assistance contact sales@telewave.com or call 408-929-4400 Option 1.

For Technical Support assistance contact support@telewave.com or call 408-929-4400 Option 2.

Storage

The 44DL can be stored for long periods of time in a climate controlled (cool & dry) environment with no damage. It is recommended to store the 44DL in the TC44-R Case, or it can be wrapped in a cloth and placed into a box or other container.

If the 44DL is accidently left on or turned on when placed into storage, the power controller will eventually turn off the 44DL. Even when turned off, the batteries will discharge during storage. The 44DL should be removed from storage one a month & fully charged before return to storage.

WARNING:

- Excessive cold or hot temperature can damage the batteries or create a fire hazard.
- Verify that the 44DL is completely dry before long term storage inside any container.

CAUTION:

- Fully charge the batteries upon initial receipt; also before and after long term storage.
- Fully charge the batteries at least once a month during long term storage
- The batteries may self-deplete and malfunction unless they are periodically re-charged.

Cleaning

The 44DL will not be damaged by wiping with a wet cloth, fog, mist, or light rain; when positioned with the display facing to the side or up (either set of rubber feet are facing down.)

To clean the 44DL, put some mild liquid soap onto a soft but moist cloth or towel. Wipe the dirt from the 44DL with a light touch. Use a rinsed moist towel to clean any residual soap from the 44DL. The 44DL can air dry or be towel dried.

The optional TC44-R case can be cleaned using the same procedure.

WARNING:

- Make sure the power supply and USB cable are dry before connecting to AC power. An electrical shock hazard exists if the components are wet when plugged in to a mains outlet.
- Do not use more than a few drops of water or soap when cleaning the 44DL
- Excessive water or soap could leak into the 44DL and may cause damage or a malfunction.
- The USB connector on the back of the 44DL is vulnerable to water intrusion if the 44DL is positioned display down.

CAUTION:

- Do not use powder or abrasive soap. These soaps may scratch the case or display cover glass. Scratches or similar damage to the display cover glass are not warrantied.

Appendix: Connecting the 44DL to the Circuit

Concepts

RF power will transfer from the source to the destination with the most efficiency when:

- The source and load impedance are the same
- The source and the load are separated from each other by a cable that has been cut so that the electrical length of that cable is a ½ wavelength increment.

When the cables are ½ electrical wavelength increment long, any reflected energy from a load or source mismatch will arrive at the source 180 degrees out of phase compared to the energy emanating from that source. The reflected energy will cancel a portion of the source energy.

Cutting the cables to the proper length in the LMR environment has the following advantages:

- Energy reflected by mismatches is dissipated, rather than bounce back and forth
- Power amplifiers and other components will run cooler (less energy to dissipate)
- Power meters can more accurately measure forward vs. reflected power in the circuit
- Impedance mismatches at an antenna/feed interface are less likely to be masked by the losses encountered with long feed lines.
- Inserting a meter into the circuit has less impact on the behavior of the circuit.

To properly connect the 44DL to the circuit to be tested, the cables used to insert the 44DL into the circuit should be of a length that is close (within 10%) to an increment of ½ wavelength. These cables are a "Primary Cable" (always need) and a "Secondary Cable" (sometimes need).

When calculating the length of the "Primary" (sometimes called a "Launch") or "Secondary" cable, subtract 3 inches (7.6 cm) from the length of the cable to allow for the insertion of the 44DL.

It is suggested to have one or two test cables built for each band that needs to be tested. For example, a cable built to 159 MHz would cover 144 MHz to 174 MHz. Another cable built for 455 MHz would cover 440 to 470 MHz. The key is to use the same cables in a consistent manner so that the test results are repeatable, thus any system changes will be noticed during maintenance.

CAUTION: The formulas for calculating the cut length of the test cable does not consider the length of any lead wire inside a radio, amplifier, or other device in the RF system. In some situations, the length of the primary and secondary cables should be shortened to compensate.

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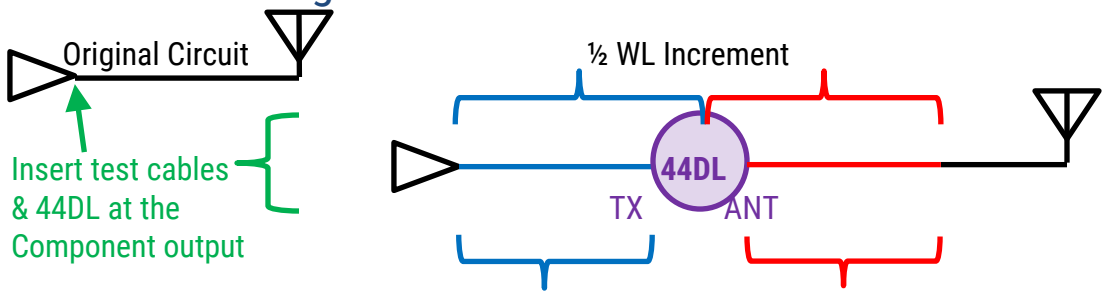
44DL Connection Diagram



Primary Cable (1/2 WL increment minus 3") Secondary Cable (Optional = ½ WL incr. - 3")

Calculating the Primary & Secondary Cable Cut Length

The steps to calculate the length of the cables are:

Find the base cable length:
(Speed of Light in a vacuum (299,792,458 Meters/Second) divided by (Frequency in Hertz))
Times (Velocity Factor of the cable in %) Times (wavelength required… 0.5 for ½ etc.)

Speed of Light M/S / Frequency Hz (445 MHz)
Math = ((299792458 / 445000000) * 0.85 *0.5) = 0.286 meters or 28.6 cm

Subtract 2 cm for the 2 N Male connectors (one on the end of the cable):
Sample = 28.6 cm minus 2 cm (for two each N Male connectors = 26.6 cm

Subtract 7.6 cm (3") for the 44DL:
Sample = 26.6 cm minus 7.6 cm (the distance across the thru line sensor) = 19.0 cm

In this example, the final cut length for the cable would be 19.0 cm (7.5")

If a cable is required after the 44DL to reach back to the feed line, that cable should be built to the same specifications as the "Primary" or "Launch" cable.

The samples above are for a ½ wavelength cable. The cables can be made longer as needed in lengths at a ½ wavelength increment: 1.0, 1.5, 2.0, etc.

CAUTION: The formulas for calculating the cut length of the test cable does not consider the length of any lead wire inside a radio, amplifier, or other device in the RF system. In some situations, the length of the primary and secondary cables should be shortened to compensate.

Appendix: RF Sample Port Isolation

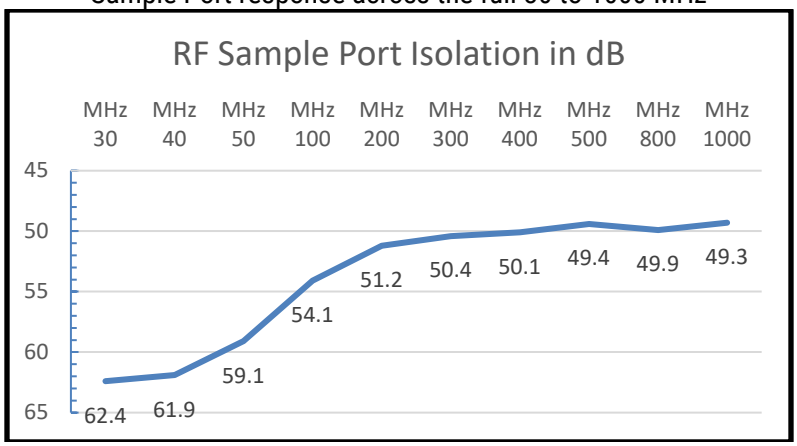
The "RF Sample Port" provides a simple and safe path to connect test equipment to the circuit under test. The port is bi-directional, meaning that a signal from either direction of the thru line coupler can be monitored, or a signal can be injected into both directions of the thru line coupler.

The Sample Port is passive and has a usable bandwidth from 30 to 960 MHz.
The active components of the 44DL have a narrower bandwidth of 136 to 960 MHz.

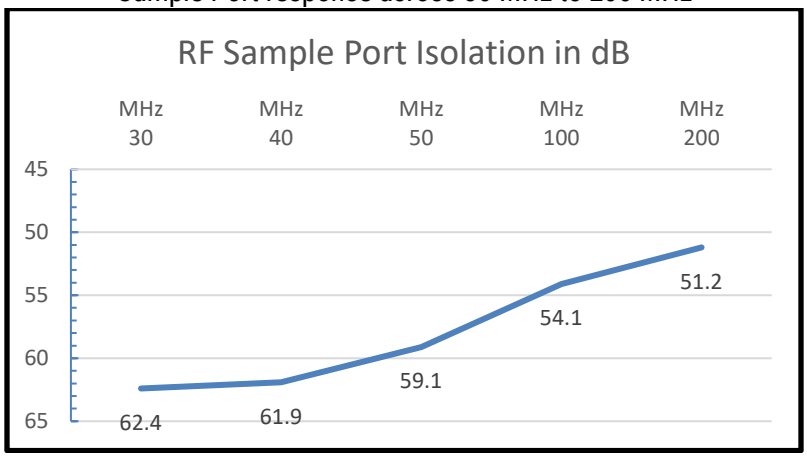
The isolation provided by the sample port is consistent at 50 dB +/- 2 dB from 200 MHz up though 960 MHz (the highest frequency supported by the 44DL.)

Below 200 MHz the isolation begins to increase as shown in the tables below until it reaches a maximum of ~62.5 dB at 30 MHz. The response is detailed below for situations where absolute power levels need to be measured (from the circuit under test) or injected (into the circuit).

Sample Port response across the full 30 to 1000 MHz



Sample Port response across 30 MHz to 200 MHz



NOTE: RF signals will flow though the through the sample port un-impeded with the 44DL power turned On or Off.