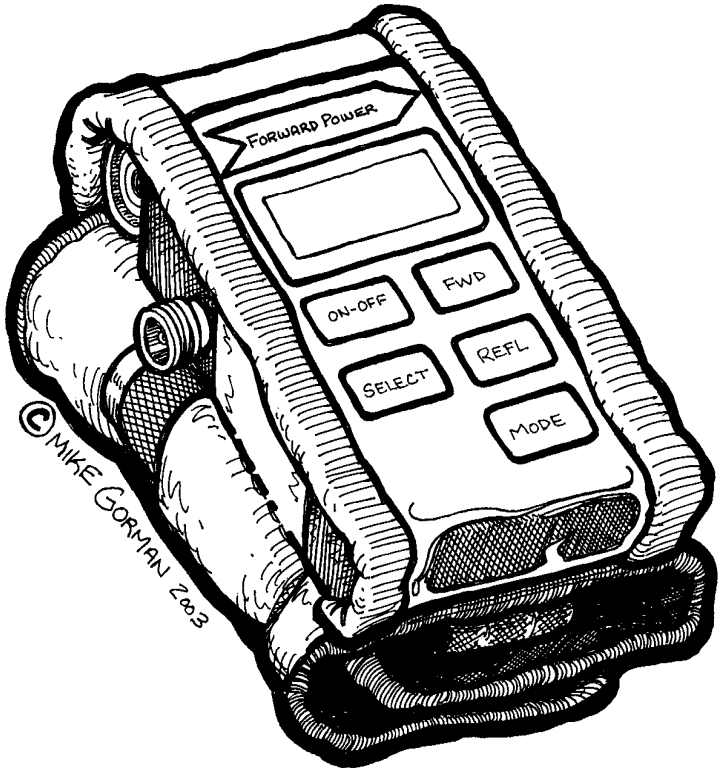
PRAXSYM
PRACTICAL SYSTEMS ENGINEERING

t-meter
VSWR•POWER METER

Broadband Wireless Power Meter *User's Manual*



Warranty concerns or claims should be pursued with the company from which the product was purchased.

PRAXSYM warrants that all items will be free from defects in material and workmanship under use as specified in this guide for a period of one year from date of delivery. PRAXSYM further agrees to repair or replace, at its discretion, any failure which upon PRAXSYM's inspection appears to be a result of workmanship or material defect. In no case, shall PRAXSYM's liability for breach of warranty exceed the purchase price of the items in question. PRAXSYM's liability on any claim of any kind, for any loss connected with, or resulting from the use of, performance or breach thereof, installation, inspection, operation or use of any equipment furnished by PRAXSYM, shall in no case exceed the purchase price of the goods which give rise to the claim.

Illustrations by Mike Gorman, Prairie Wind Communications, Inc.
Phone: 303-470-6367 / Email: mgdcabler@comcast.net

TABLE OF CONTENTS

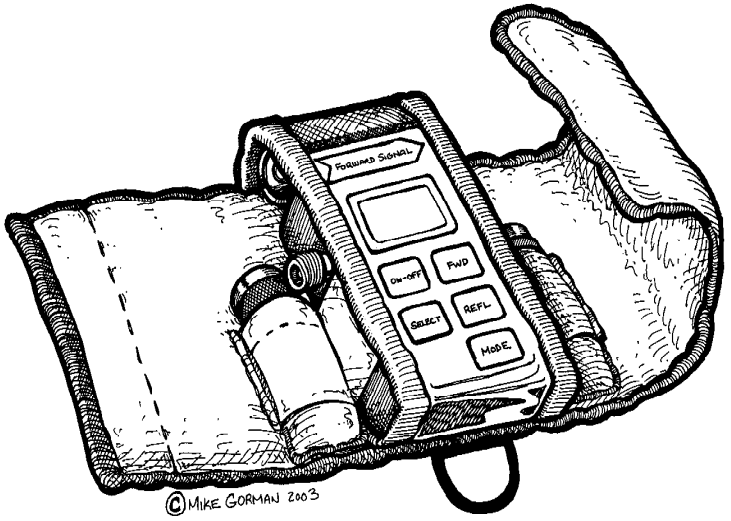
Introduction	1
Use	2
Measuring Transmitter Power	5
Measuring Transmission Line Loss	7
Measuring VSWR of Antenna and Terminations	9
Specifications	11
Appendix — VSWR Table	13
Appendix—Notes	15

Introduction

The unit is a handheld broadband power meter capable of detecting forward and reflected power in a microwave radio system. The meter is capable of detecting various types of wireless broadband modulation schemes in many popular licensed and unlicensed frequency bands worldwide.

The meter was designed with the system integrator and installer in mind. It is the perfect tool for the verification of transmitter power, transmission line loss characteristics, and antenna performance.

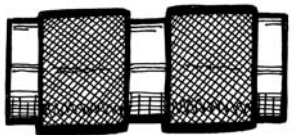
Key features
-affordability
-portability
-quad-band use in the microwave bands
-verification of system installation



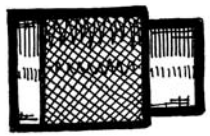
Use

The meter ships with a durable nylon case that is secured with hook and loop flaps. The package is designed such that the meter can be used while still in the nylon case. The flaps that cover and protect the meter can be secured behind the unit while it is in use. This is shown on the front cover of this manual.

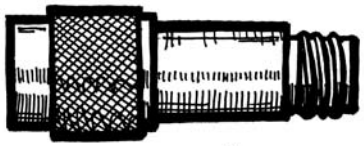
Packaged with the meter is a male-to-male type "N" adapter (in the left pocket), a 50 Ω termination (right pocket), and a 2 W 10 dB attenuator (in the pocket above the meter).



Male-to-male adapter



50 Ω termination



2 W 10 dB attenuator

Most transmitters have a female type "N" connector on them. The double male adapter can be used to connect the meter directly to the transmitter. The meter should always have a 50 Ω load on its output when connected to a transmitter. Depending on the type of test, this can be an antenna or the 50 Ω termination included in the kit. The 10 dB attenuator is included for use when the device under test transmits a signal higher than 20 dBm in amplitude. When using the 10 dB attenuator it is a good idea to change the offset to "10 attn" in the MODE settings (page 4). Note that the input to the 2 W 10 dB attenuator should not exceed 33 dBm (2 W). If an attenuator with a higher power rating is used, the input into the attenuator can be increased such that the output of the attenuator does not exceed 20dBm. The attenuator offset should be set for "00 attn" when no attenuator is used.

The meter should always be inserted into the system in the forward power direction. Use the arrow labeled "FORWARD SIGNAL" as a guide when connecting the meter.

Pressing and quickly releasing the ON-OFF button turns the meter on. The meter will display "Below Range" if it is not connected to a source that is within it's dynamic range (0 to 20 dBm).

Once the meter is connected to a source, and a 50 Ω termination is placed on it's output, the forward and reflected power can be measured. If the meter is not properly terminated the forward power measurement may be inaccurate.

If the signal applied to the meter exceeds 20 dBm, the meter will read "Exceed Range".

VSWR is automatically calculated and displayed according to the forward and reflected measurements. The accuracy of the VSWR measurement depends on several variables (forward and reflected power levels, attenuation in the transmission line, etc).

Button Description

ON-OFF: Turns the unit ON or OFF. Unit also powers down five minutes after last key depression. Powers up to the last state that it was in.

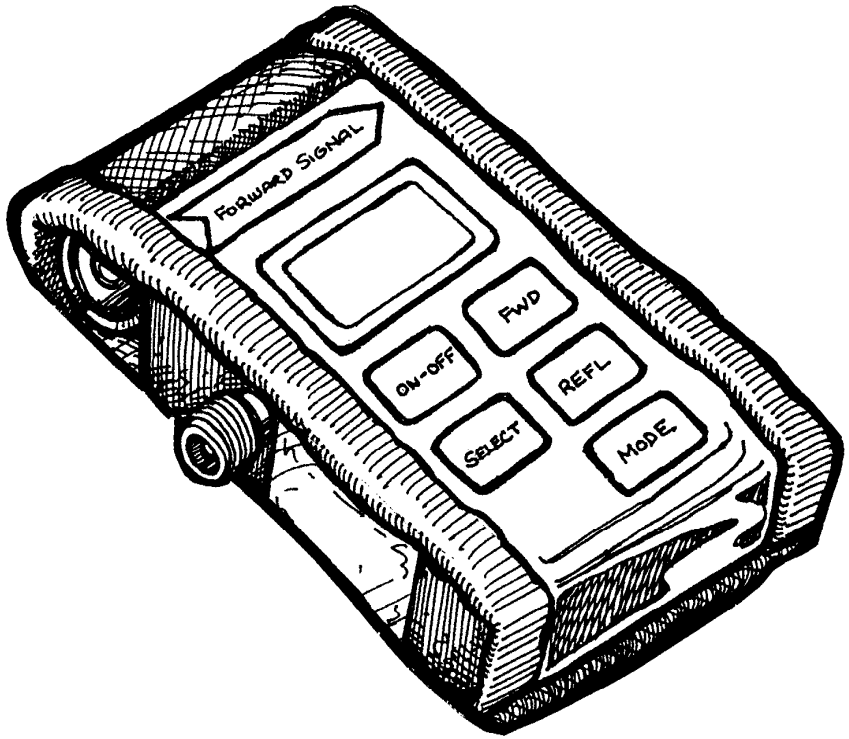
SELECT: Depressing the SELECT button cycles through the options available in each mode. The arrow points to the selected option. Once the desired option has been selected depress the mode button until the main screen returns.

MODE: First push - Displays remaining battery life.
Second push - Allows selection of the unit of power (dBm or mW) on the display.
Third push - Allows selection of the frequency band of interest
Fourth push - Allows selection of the inline attenuator offset (0, 10, 20, or 30 dB).
Fifth push - Exits MODE and returns to selected monitoring state (FWD or REFL.)

Depressing FWD or REFL also exits MODE at any time.

FWD: Displays forward power and VSWR. A right-pointing arrow in the upper right of the display indicates the meter is measuring forward power. The power measurement is displayed continuously. The VSWR is displayed for two seconds on the bottom display line and then is replaced for one second by the band indicator ("2.4G", for example) and the in-line attenuator setting ("00 attn", "10 attn", "20 attn", or "30 attn").

REFL: Similar in function to the FWD button, except it dis-



Measuring Transmitter Power

The meter should be connected to the transmitter according to the "FORWARD SIGNAL" label on the meter (see the illustration on the opposite page). Depending on the gender of the type "N" connector on the transmitter it may be necessary to use the double male type "N" adapter. The meter should be terminated with the 50 Ω load included in the kit.

Turn the unit on by pressing the ON-OFF button. Select the frequency band of interest by pressing the MODE button until the frequency list is shown. Use the SELECT button to scroll through, and select the appropriate band. A small arrow will be displayed beside the band.

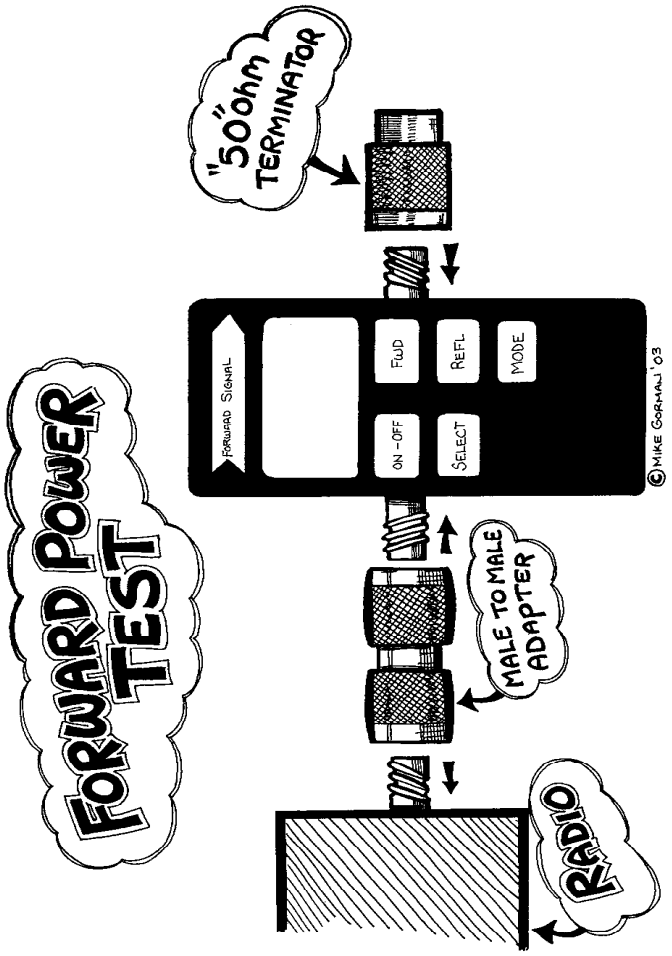
Press the FWD button to read the forward power. A small right-pointing arrow will appear in the upper right side of the display. This is the amplitude of the signal (in dBm or mW, depending on the unit selected in the MODE menu) in the forward direction.

The meter is designed to detect signals between 0 and 20 dBm in the forward direction, and -20 to 17 dBm in the reflected. Damage can occur to the meter if the forward power into the meter (without the attenuator) exceeds 33 dBm.

Most broadband radio transmitters deliver less than 100 mW (20 dBm). The 2 W 10 dB attenuator can be used for sources that are between 20 and 30 dBm in amplitude. Remember to apply the appropriate offset in the MODE setting ("10 attn" if the attenuator included in the kit is used). If the output of the transmitter exceeds 33 dBm (2 W), an attenuator of the appropriate power rating and insertion loss should be used to lower the signal to a level below 20 dBm. Using the MODE button an offset can be configured for attenuators up to 30 dB. If an attenuator is not used, the offset should be set to "00 attn".

While the forward power is displayed constantly on the top line of the display, the bottom line alternates between the VSWR and the frequency band and offset settings.

NOTE: A good way to verify proper operation of the 50 Ω termination (included in the kit) is to make sure that a VSWR of 1.3:1 is displayed when the meter is connected according to the diagram on the opposite page. If the VSWR is not 1.3:1 the termination should be replaced.


FORWARD POWER TEST
"50ohm TERMINATOR
FORWARD SIGNAL
FWD
REFL
MODE
ON-OFF
SELECT
©MIKE GORMAN '03
MALE TO MALE ADAPTER
RADIO

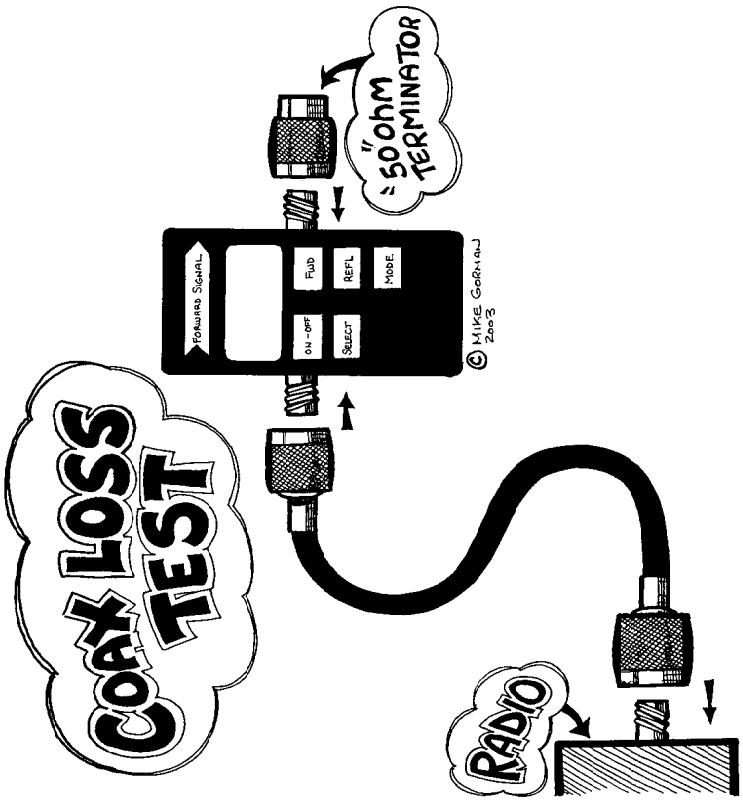
Measuring Transmission Line Loss

Measure the forward power of the transmitter as shown on the previous pages. Use the 50 Ω termination included in the kit as the load. Make note of the forward power reading.

Disconnect the meter from the transmitter. **NOTE:** The transmitter should always be powered down when there is no load present, or when connecting the meter or transmission line. Connect the transmission line directly to the transmitter with the proper amount of attenuation (if necessary).

Move the power meter to the opposite end of the transmission line. Connect the meter as shown on the opposite page. Take another forward power reading. Subtract this forward power reading from that taken directly off the back of the transmitter. This is the amount of signal lost due to attenuation in the transmission line and terminations.

This value can be compared to the loss specifications of the transmission line and connectors to verify that the coax is properly terminated.


COAX LOSS TEST
~50 ohm TERMINATOR
FORWARD SIGNAL
FWD
REFL
MODE
ON - OFF
SELECT
© MIKE GORMAN 2003
RADIO

Measuring VSWR of Antenna and Terminations

To measure the VSWR of an antenna, place the meter into the system between the transmission line and the antenna. Use the "FORWARD SIGNAL" arrow on the meter to orient the meter properly. The arrow will point towards the antenna when it is properly inserted. The double male type "N" adapter can be used if the antenna has a female type "N" connector.

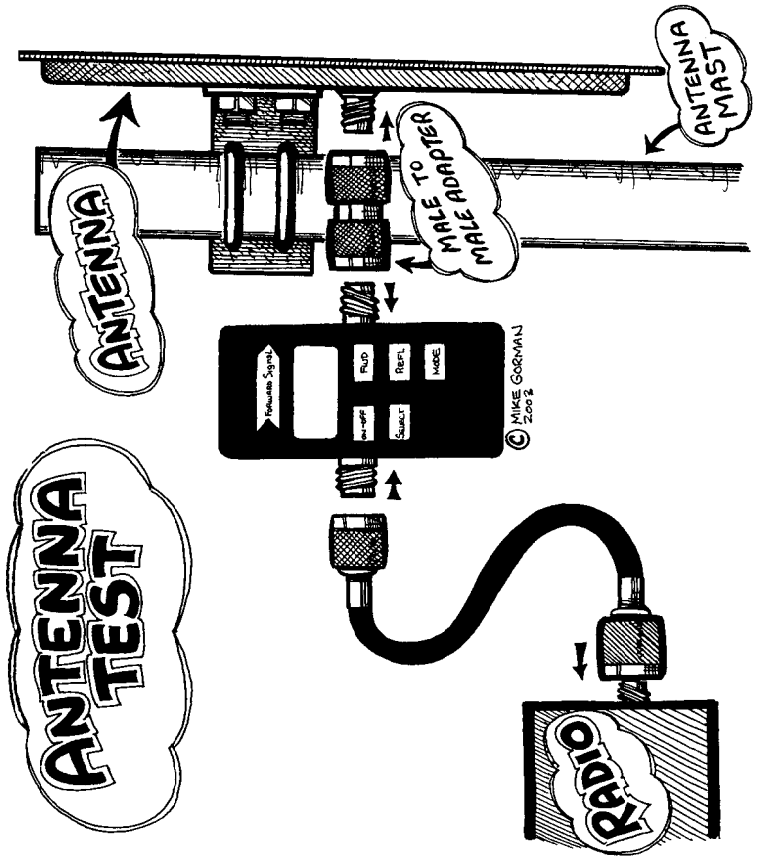
Apply power to the transmitting device. The meter will display the VSWR so long as there is sufficient power reaching it (between 0 and 20 dBm). In other words, if the transmit power of the radio minus the transmission line loss is less than 0 dBm, the meter will read "Below Range". Likewise, if for some reason the power at the meter exceeds 20 dBm it will display "Exceed Range".

The best return loss* that the meter can read accurately in any of the bands is roughly 20.8 dB. This correlates to a VSWR of approximately 1.2:1. Most antenna manufactures in the license-exempt broadband wireless market advertise a VSWR of 1.5:1. Therefore, a defective or damaged antenna feed should be pretty evident using the t-meter, as they will indicate a VSWR higher than 1.5:1.

It is possible to measure the VSWR (or return loss) of a transmission line termination by placing the meter between it and the radio. It is necessary to properly terminate the far-end termination with the 50 Ω termination, and typically a type "N" double female adapter (not included). These measurements are often only accurate for the 'local' terminations, or the terminations that are physically close to the meter. The two-way transmission line loss may mask any reflections further down the transmission line or at the far-end terminations (i.e. make the VSWR look better than it really is). The problem becomes more pronounced as the two-way loss of the transmission line approaches the dynamic range of the meter, which is 20 dB. Therefore, it is best to have as little transmission line loss as possible when attempting to measure return loss or VSWR of a termination with the meter. A VSWR vs. return loss table is included in the Appendix.

NOTE: Reflections are usually due to bad terminations, kinks in the transmission line, bend radii which are too tight, or moisture in the line or connectors.

*Return loss is simply the forward power minus the reflected power.


ANTENNA MAST
MALE TO MALE ADAPTER
ANTENNA
ANTENNA TEST
RADIO
Forward Signal
FWD
REFL
MODE
ON-OFF
SQUELCH
© MIKE GORMAN 2002

Electrical Specifications

Frequency Range:	2.4-2.4835 GHz
All t-meter models	5.15-5.35 GHz
	5.47-5.5975 GHz
	5.5975-5.725 GHz
	5.725-5.85 GHz
PM-900	902-926 MHz
PM-3500	3.4-3.7 GHz
PM-4900	4.94-4.99 GHz

Forward Power Measurement Range:

0 dBm to 20 dBm (no inline attenuation)
10 dBm to 30 dBm (10 dB inline attenuator)
20 dBm to 40 dBm (20 dB inline attenuator)
30 dBm to 50 dBm (30 dB inline attenuator)

Reflected Power Measurement Range:

-20 dBm to 17 dBm (no inline attenuation)
-10 dBm to 27 dBm (10 dB inline attenuator)
0 dBm to 37 dBm (20 dB inline attenuator)
10 dBm to 47 dBm (30 dB inline attenuator)

Power Measurement Accuracy: +/- 0.5 dBm (with a 1.2:1 LOAD)

Insertion Loss:	0.4 dB @ 2.4 GHz
All t-meter models	0.6 dB @ 5.3 GHz
	0.6 dB @ 5.5 GHz
	0.6 dB @ 5.6 GHz
	0.7 dB @ 5.8 GHz
PM-900	0.2 dB @ 900 MHz
PM-3500	0.5 dB @ 3.5 GHz
PM-4900	0.6 dB @ 4.9 GHz

VSWR Measurement Range: 1.2:1 to 6.0:1 (all bands)

Environmental Specifications

Temperature Range:	-10 to 50˚C
Humidity:	0 to 95% RH non-condensing
Altitude:	0 to 15,000 feet

Mechanical Specifications

RF Connectors:	Type "N" female (input, output)
Display:	2 lines by 8 characters, LCD – not illuminated
Keypad:	Five keys – see definition on page 3
Enclosure:	Black ABS
Power Source:	2 AA alkaline batteries – industrial grade
Size:	4.9 x 2.7 inches (exc. N connector)
Weight:	10 ounces

Appendix - VSWR Table

VSWR	Return Loss (dB)	Reflected Power (%)	Transmiss. Loss (dB)
1	oo	0	0
1.01	46.1	0.005	0.0002
1.02	40.1	0.01	0.0005
1.03	36.6	0.022	0.0011
1.04	34.1	0.04	0.0018
1.05	32.3	0.06	0.0028
1.06	30.7	0.082	0.0039
1.07	29.4	0.116	0.0051
1.08	28.3	0.144	0.0066
1.09	27.3	0.184	0.0083
1.1	26.4	0.228	0.01
1.11	25.6	0.276	0.0118
1.12	24.9	0.324	0.0139
1.13	24.3	0.375	0.016
1.14	23.7	0.426	0.0185
1.15	23.1	0.488	0.0205
1.16	22.6	0.55	0.0235
1.17	22.1	0.615	0.026
1.18	21.6	0.682	0.0285
1.19	21.2	0.75	0.0318
1.2	20.8	0.816	0.0353
1.21	20.4	0.9	0.0391
1.22	20.1	0.98	0.0426
1.23	19.7	1.08	0.0455
1.24	19.4	1.15	0.049
1.25	19.1	1.23	0.053
1.26	18.8	1.34	0.056
1.27	18.5	1.43	0.06
1.28	18.2	1.52	0.064
1.29	17.9	1.62	0.068
1.3	17.68	1.71	0.073
1.31	17.4	1.81	0.078
1.32	17.2	1.91	0.083
1.33	17	2.02	0.087
1.34	16.8	2.13	0.092
1.35	16.53	2.23	0.096
1.36	16.3	2.33	0.101
1.37	16.1	2.44	0.106

VSWR	Return Loss (dB)	Reflected Power (%)	Transmiss. Loss (dB)
1.38	15.9	2.55	0.112
1.39	15.7	2.67	0.118
1.4	15.55	2.78	0.122
1.41	15.38	2.9	0.126
1.42	15.2	3.03	0.132
1.43	15.03	3.14	0.137
1.44	14.88	3.28	0.142
1.45	14.7	3.38	0.147
1.46	14.6	3.5	0.152
1.47	14.45	3.62	0.157
1.48	14.3	3.74	0.164
1.49	14.16	3.87	0.172
1.5	14	4	0.18
1.55	13.3	4.8	0.21
1.6	12.6	5.5	0.24
1.65	12.2	6.2	0.27
1.7	11.7	6.8	0.31
1.75	11.3	7.4	0.34
1.8	10.9	8.2	0.37
1.85	10.5	8.9	0.4
1.9	10.2	9.6	0.44
1.95	9.8	10.2	0.47
2	9.5	11	0.5
2.1	9	12.4	0.57
2.2	8.6	13.8	0.65
2.3	8.2	15.3	0.73
2.4	7.7	16.6	0.8
2.5	7.3	18	0.88
2.6	7	19.5	0.95
2.7	6.7	20.8	1.03
2.8	6.5	22.3	1.1
2.9	6.2	23.7	1.17
3	6	24.9	1.25
3.5	5.1	31	1.61
4	4.4	36	1.93
4.5	3.9	40.6	2.27
5	3.5	44.4	2.56
6	2.9	50.8	3.08

Notes

Notes

PRAXSYM

070110 Rev C
900-000002-002