

2002-09-15

:

:

(Tel. 02-2123-2874, Fax. 02-312-4584)

:

:

(Tel. 052-288-7550, Fax. 052-288-7551)

Part No.	Name	Description	Quantity
NRD60TX001	60 GHz	Main Body	1
		LNA Module ()	1
		Local Oscillator ()	1
		Horn Antenna	2
		Waveguide to Coaxial Transition	2
NRD60RX001	60 GHz	Main body	1
		Horn Antenna	1
NRD60LNA001	60GHz LNA module	LNA Module ()	1



Seo, Young-Kwang

> Ph.D student

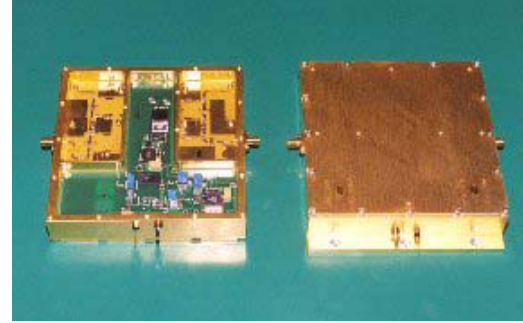
> Electrical and Electronic Engineering, Yonsei Univ.

> 134, Shinchon-Dong, Sudaemoon-Ku, Seoul 120-749, Korea

> Tel : +82-2-2123-2874 > Fax : +82-2-312-4584

> e-mail : west@yonsei.ac.kr , west_000@hotmail.com

38 GHz Transceiver Modules for Local Multipoint Distribution Service



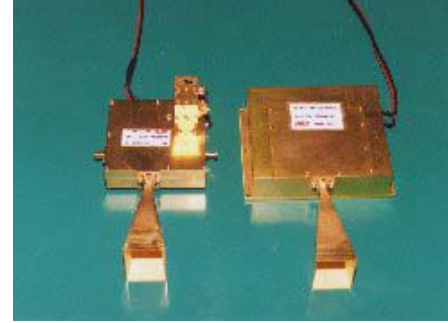
◆ Descriptions

- 38 GHz millimeter-wave radio links to provide a cost-effective means to link multipoint base station networks
- The use of innovation engineering in the design to lower manufacturing cost allows NRD to provide 38 GHz transceivers at the most competitive prices in the market for these applications
- The inherent simplicity of the design results in much greater reliability
- Custom specifications are available

” Specifications

	Parameters	Specifications
Transmitter	RF Frequency Range [GHz]	38.60 ~ 40.00
	IF Frequency Range [GHz]	1.60 ~ 3.00
	Total Conversion Gain [dB]	30
	Output Power (P1dB) [dBm]	25
	Output Power (IP3) [dBm]	30
	RF VSWR	1.5 : 1
	IF VSWR	1.5 : 1
Receiver	RF Frequency Range [GHz]	38.60 ~ 40.00
	IF Frequency Range [GHz]	1.60 ~ 3.00
	Noise Figure [dB]	5.5
	Input Level [dBm]	-80 ~ -20
	Total Conversion Gain [dB]	18
	RF VSWR	1.5 : 1
	IF VSWR	1.5 : 1
LO	Image Rejection [dBc]	50
	Input Frequency [GHz]	37.000
Interfaces	Input Power [dBm]	15
	RF Port	WR-28
	IF Port	SMA Female

60 GHz Wireless Link Systems for Ultra High Speed Digital Video Link and Local Area Network



Descriptions

- 60 GHz millimeter-wave radio links to provide cost-effective solutions
- Ultra High Speed operations up to 622 Mbps
- The use of innovation engineering in the design to lower manufacturing cost allows NRD to provide 60 GHz solutions at the most competitive prices in the market for these applications.
- Compatible with Fiber-Optic interface
- Custom specifications are available

Specifications

	Parameters	Specifications
Transmitter	RF Frequency Range [GHz]	59.00 ~ 60.50
	LO Frequency [GHz]	59.00
	Output Power [dBm]	10
	Conversion Loss [dB]	8
	Antenna Gain [dBi]	23
	Modulation	ASK
	Data Bitrate [Mbps]	622
Receiver	RF Frequency Range [GHz]	59.00 ~ 60.50
	Noise Figure [dB]	5.0
	Conversion Gain [dB]	12
	Antenna Gain [dBi]	23
	BER	10 ⁻⁸ @622 Mbps 10 ⁻⁹ @400 Mbps
	Coverage [m]	100 @622 Mbps 150 @400 Mbps

Local Oscillators

| [Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
| [Couplers](#) | [Circulators](#) | [Antennas](#) |



Features

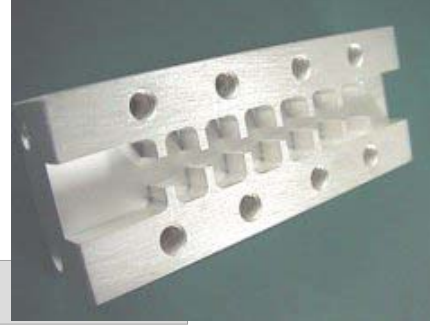
- Millimeter-wave generator to provide stable carrier output for Transmitter, Receiver, Transceiver, Modulator and Up/Down Converter etc.
- Cost-effective simple NRD guide structures compared with Waveguide cavity type
- Various applications available such as Car-Radar, Ultra High Speed Wireless LAN etc.
- Custom specification is available

Typical Specifications

Parameters	Specifications / Applications		
	38 GHz	37.000	60 GHz
Output Frequency [GHz]	36.650	37.000	60.000
Output Power [dBm]	18.5	20.0	15.0
Phase Noise [dBc]	62	65	65
Mechanical Tuning Range [MHz]	~ 300	~ 300	~ 500
Electrical Tuning Range [MHz]	~ 60	~ 60	~ 100
Pushing Figure [Hz/V]	120	120	200
PTD [Hz/s]	100	100	150
Fo Drift [kHz/°C]	390	390	400
Stability			
Temperature Factor [ppm/°C]	-10.5	-10.0	-15.0
DC Bias			
Voltage [V]	4.5	4.5	3.8
Current [A]	1.0	1.0	1.2
Interface	WR-28	WR-28	WR-15
Dimension (L x W x H) [mm]	60 x 40 x 30	60 x 40 x 30	66 x 48 x 20

Filters

[Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
[Couplers](#) | [Circulators](#) | [Antennas](#) |



Features

- Millimeter-wave NRD guide bandpass filters with newly designed structure
- NRD guide and Waveguide structure all available
- Frequency range cover up to 60 GHz
- Applications include Base Station Links, BWLL, LMDS and Car-Radar
- Standard and custom packaging are available

Typical Specifications

Applications	Frequency Range [GHz]	BW [MHz]	Insertion Loss [dB]	Return Loss [dB]	VSWR	Rejection [dB]
38 GHz	38.60 ~ 38.95	350	1.0	-25	1.12 : 1	-50
	39.30 ~ 39.65	350	1.0	-25	1.12 : 1	-50
	39.35 ~ 39.75	400	1.4	-25	1.12 : 1	-50
	39.37 ~ 39.79	420	1.6	-18	1.28 : 1	-50
60 GHz	58.75 ~ 59.25	500	1.3	-25	1.12 : 1	-50
	59.75 ~ 60.25	500	1.3	-29	1.07 : 1	-50





Diplexers

| [Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
| [Couplers](#) | [Circulators](#) | [Antennas](#) |

Features

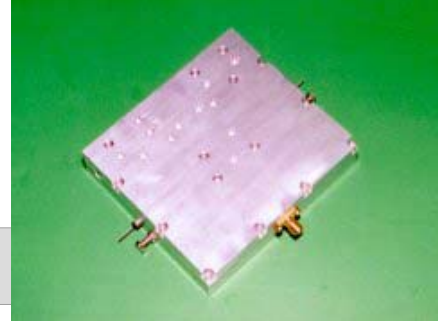
- High performance to separate the TX and RX signals with superior isolations
- Base Station or Repeater system applications in LMDS, BWLL
- Waveguide cavity filter design with low loss
- Custom specification is available

Typical Specifications

Applications	Frequency Range [GHz]		Insertion Loss [dB]	VSWR	Rejection [dB]	Interface
	Lower Band	Upper Band				
38 GHz	38.60 ~ 38.95	39.30 ~ 39.65	1.6	1.3 : 1	-65	WR-28

Mixers

| [Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
| [Couplers](#) | [Circulators](#) | [Antennas](#) |



Features

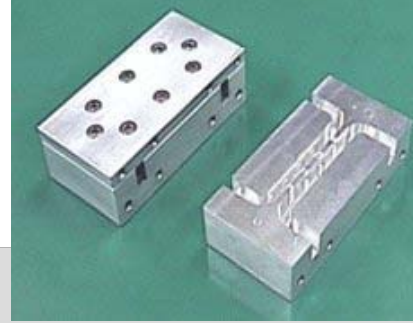
- Low conversion loss in millimeter-wave
- Newly designed Hybrid structure using Waveguide and NRD guide to perform superior broadband characteristics
- Application cover-up to millimeter-wave frequency systems such as Up/Down Converter, Car-Radar, LMDS, BWLL and Wireless LAN

Typical Specifications

Applications	RF [GHz]	IF [MHz]	LO [GHz]	Conversion Loss [dB]	LO-RF Isolation [dB]	LO-IF Isolation [dB]
38 GHz	38.6 ~ 40.0	1600 ~ 3000	37.000	8	25	25
60 GHz	59.0 ~ 63.0	1000 ~ 3000	60.000	8	25	25

Couplers

| [Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
| [Couplers](#) | [Circulators](#) | [Antennas](#) |



Features

- Broadband design cover -up to 60 GHz U-band with low loss
- Millimeter-wave communication system such as LMDS, BWLL, ISM High Speed Wireless LAN applications
- High performance for Power or Signal Combiner/Divider
- Custom specifications are available for various applications

Typical Specifications

Applications	Frequency Range [GHz]	BW [MHz]	Coupling [dB]	Loss [dB]	Isolation [dB]	VSWR
38 GHz	37 ~ 41	4000	3.0	0.3	-25	1.2 : 1
60 GHz	59 ~ 63	4000	3.0	0.3	-20	1.3 : 1

Circulators

| [Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
| [Couplers](#) | [Circulators](#) | [Antennas](#) |



Features

- High performance circulator to separate Tx and Rx signal with low loss NRD guide structure in millimeter-wave communication systems
- Transceiver applications in Q-band with broadband characteristic of 3 GHz bandwidth
- Ultra High Speed Wireless LAN, Car-Radar front-end and other Millimeter-wave Radio Link system applications
- Isolator applications are available

Typical Specifications

Applications	Frequency Range [GHz]	BW [MHz]	Loss [dB]	Isolation [dB]	VSWR
60 GHz	58 ~ 62	4000	1.0	18	1.35 : 1

Antennas

| [Local Oscillators](#) | [Filters](#) | [Diplexers](#) | [Mixers](#) |
| [Couplers](#) | [Circulators](#) | [Antennas](#) |



Features

- Millimeter-wave communication system front-end antenna with high gain performance
- Simple and compact design to provide reliable products with cost-effective characteristics
- LMDS, MVDS, ISM band solution are applicable
- Custom specifications for various applications are available

Typical Specifications

Applications	Frequency Range [GHz]	Gain [dB]	Half-power BW [E/H]	First Side Lobe Level [dB]	VSWR
38 GHz	37 ~ 41	20	15°/10°	-20	1.2 : 1
60 GHz	50 ~ 75	24	11°/10°	-20	1.2 : 1

V-BAND H-PLANE 90° BEND

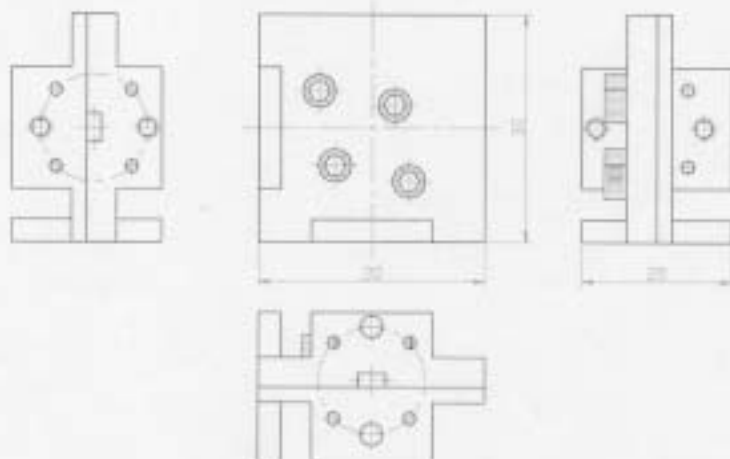
Model Name : **NRD60BD101**
 Serial Number : **B90H020827-01**

DATE: SEP/06/2002

Specifications

Parameters	Specifications
Frequency Range	55GHz - 65GHz
Loss	0.5dB typical
VSWR	1.07:1
IN/OUT Port	WR-15/4-40 Tap/Hole
Size(LxWxD)[mm]	30x30x20

Dimensions



Descriptions

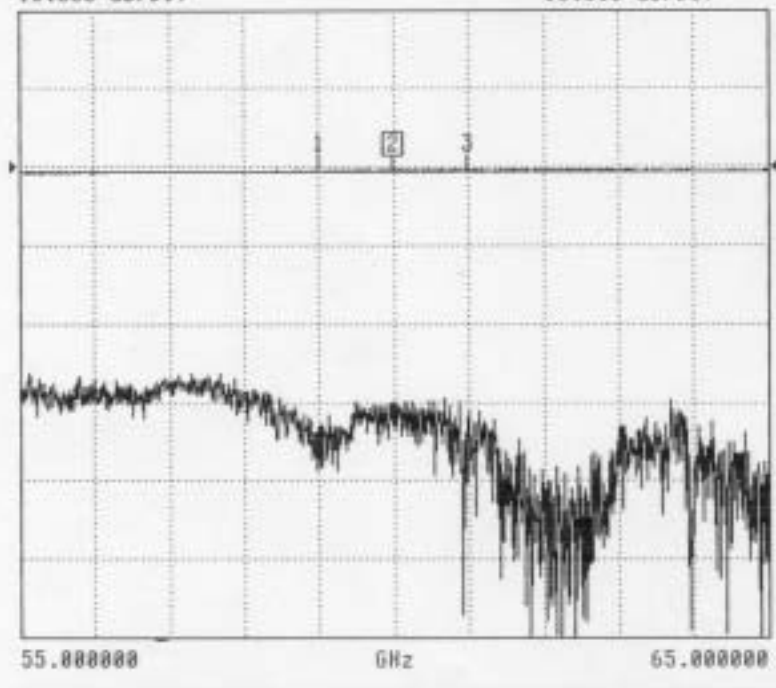
1. The port is compatible with WR-15 standard V-band rectangular waveguide. One port fit to 4-40 UNC bolt and the other reserved just hole of $\phi 3$.
2. All Dimensions of above drawing are in millimeters.

37397A

MODEL: *NRD600D101*
DEVICE ID: *B90H0200m-01*

DATE: 09/09/2002 15:13

Page 1

OPERATOR: *gs Kim*START: 55.000000 GHz
STOP: 65.000000 GHz
STEP: 0.006250 GHzGATE START: -
GATE STOP: -
GATE: -
WINDOW: -ERROR CORR: 12-TERM
AVERAGING: 1 PT
IF BANDWIDTH: 1 KHzPARAMETER: *Bend - V*
NORMALIZATION:
REFERENCE PLANE:
SMOOTHING:
DELAY APERTURE:-----CH1-----
-S11-
OFF
0.0000 mm
0.0 PERCENT-----CH3-----
-S21-
OFF
0.0000 mm
0.0 PERCENTCH1: S11 FWD REFL
LOG MAGNITUDE
REF=0.000 dB
18.000 dB/DIVCH3: S21 FWD TRANS
LOG MAGNITUDE
REF=0.000 dB
18.000 dB/DIVCH 3 - S21
REFERENCE PLANE
0.0000 mmMARKER 2
60.000000 GHz
-8.541 dBMARKER TO MAX
MARKER TO MIN1 59.000000 GHz
-8.567 dB3 61.000000 GHz
-8.627 dBMARKER READOUT
FUNCTIONS

60GHz BANDPASS FILTER

Model Name : **NRD60FT101**

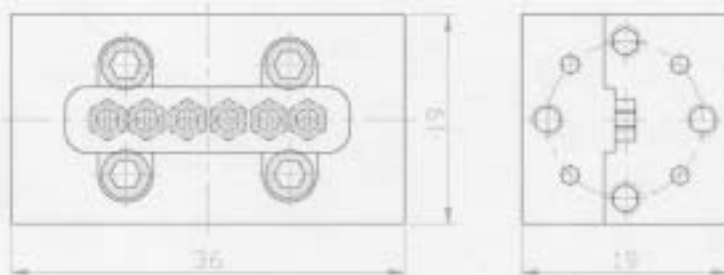
DATE: SEP/06/2002

Serial Number : **FC020902-04**

Specifications

Parameters	Specifications
Center frequency	59.850GHz
Pass Band	59.550GHz ~ 60.150GHz
Band Width	600MHz
Insertion Loss	3.7dB max
VSWR	1.28:1
Rejection	58dBc@1GHz
IN/OUT Port	WR-15
Size(LxWxD)[mm]	36x19x19

Dimensions



Descriptions

1. The port is compatible with WR-15 standard V-band rectangular waveguide.
2. Do not turn the tuning screw placed in center pocket voluntarily. The filter tuned precisely for maximum performance already.
3. All Dimensions of above drawing are in millimeters.

4

37397A

MODEL: *NRD 60 57101*
 DEVICE ID: *PC020902-04*

DATE: 09/09/2002 13:11
 OPERATOR: *YS Kim*

Page 1

START: 57.000000 GHz
 STOP: 62.000000 GHz
 STEP: 0.003125 GHz

GATE START: -
 GATE STOP: -
 GATE: -
 WINDOW: -

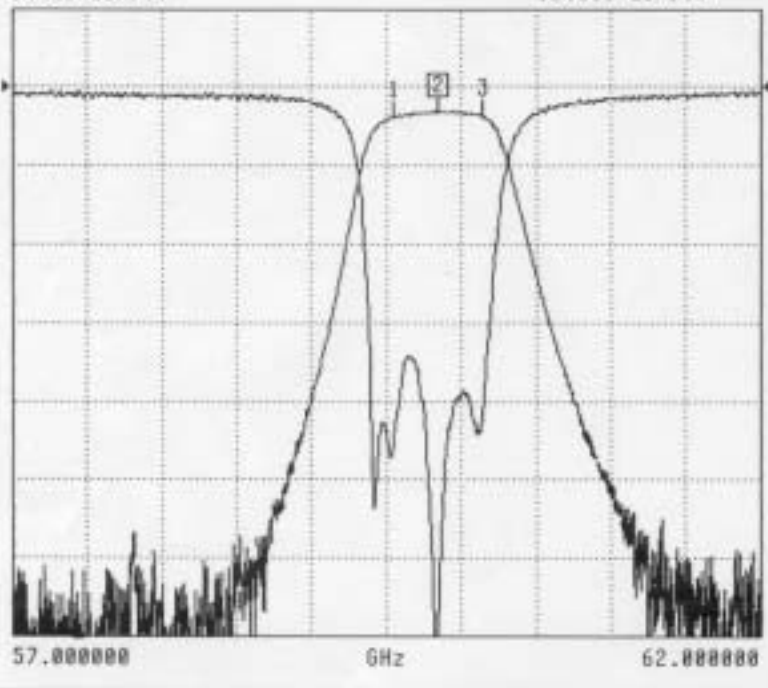
ERROR CORR: 12-TERM
 AVERAGING: 1 PT
 IF BANDWIDTH: 10 Hz

PARAMETER:	-----CH1-----	-----CH3-----
NORMALIZATION:	-S11-	-S21-
REFERENCE PLANE:	OFF	OFF
SMOOTHING:	0.0000 mm	0.0000 mm
DELAY APERTURE:	0.0 PERCENT	0.0 PERCENT

CH1: S11 FWD REFL
 LOG MAGNITUDE
 REF=0.000 dB
 5.000 dB/DIV

CH3: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 18.000 dB/DIV

CH 3 - S21
 REFERENCE PLANE
 8.0000 mm



▶ MARKER 2
 59.850000 GHz
 -3.289 dB

MARKER TO MAX
 MARKER TO MIN

- 1 59.550000 GHz
-3.924 dB
- 3 60.150000 GHz
-3.784 dB

MARKER READOUT
 FUNCTIONS

60GHz LNA MODULE

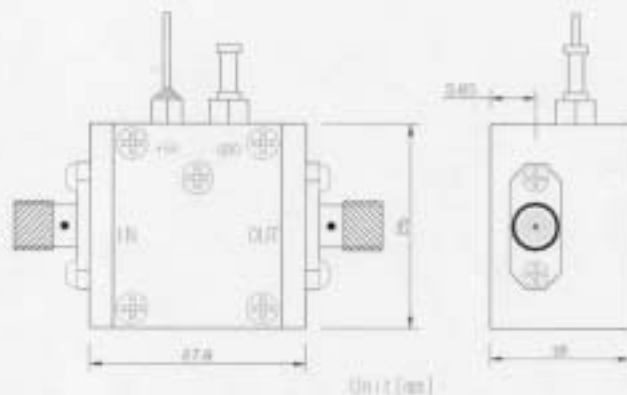
Model Name : **NRD60LNA101**
 Serial Number : **LV020830-02/03**

DATE: AUG/30/2002

Specifications

Parameters	Specifications		
	Min	Typical	Max
Frequency Range[GHz]	56		64
Gain[dB]	15	16	
NF[dB]		5	
Input RL[dB]	15		8
Output RL[dB]	10		6
P1dB[dBm]		11	
Voltage[V]	4.5	5.0	5.5
Current[mA]	60	70	100

Dimensions



Descriptions

1. Input and Output port are V-female flanges.
2. It contains voltage regulation circuit and over-current protection function.

37397A

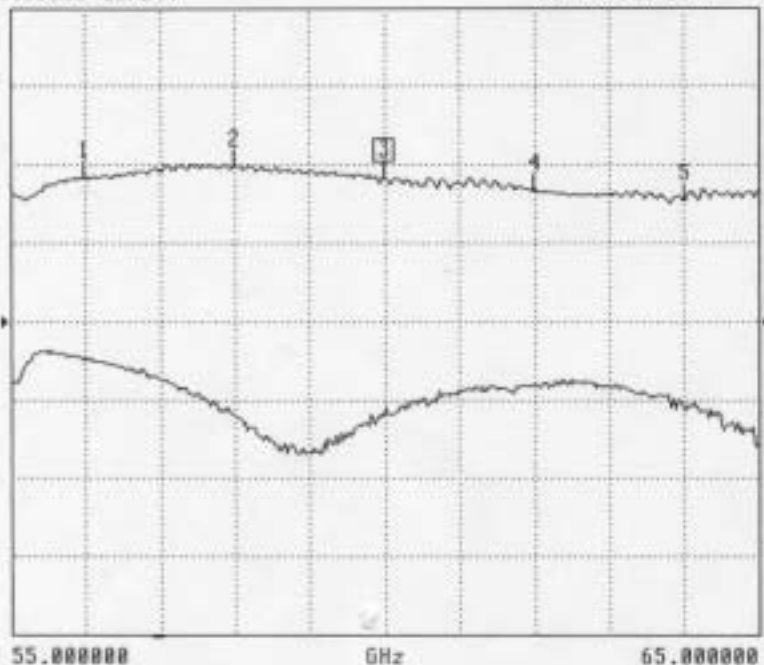
MODEL: *NR160LNA(01* DATE: 08/31/2002 15:55 Page 1
 DEVICE ID: *LV020820-02* OPERATOR: *kyung Dong. Choi,*
 START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BNDWIDTH: 1 KHz
 WINDOW: -

PARAMETER:	-----CH1-----	-----CH3-----
NORMALIZATION:	-S11-	-S21-
REFERENCE PLANE:	OFF	OFF
SMOOTHING:	0.0000 mm	0.0000 mm
DELAY APERTURE:	0.0 PERCENT	0.0 PERCENT

CH1: S11 FWD REFL
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH3: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH 3 - S21
 REFERENCE PLANE
 0.0000 mm



MARKER 3
 60.000000 GHz
 18.420 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
18.333 dB
- 2 58.000000 GHz
19.775 dB
- 4 62.000000 GHz
16.689 dB
- 5 64.000000 GHz
15.446 dB

MARKER READOUT
 FUNCTIONS

* Description

1) Bias Condition $V_{DC} = +5V$
 $I = 10mA$

17397A

MODEL: NRd to LNA 101
 DEVICE ID: LV 420740 - 02

DATE: 08/31/2002 15:57

Page 1

OPERATOR: *hymy hong, Chod*

START: 55.000000 GHz
 STOP: 65.000000 GHz
 STEP: 0.025000 GHz

GATE START: -
 GATE STOP: -
 GATE: -
 WINDOW: -

ERROR CORR: 12-TERM
 AVERAGING: 1 PT
 IF BNDWDTH: 1 KHz

PARAMETER:	-----CH1-----	-----CH3-----
NORMALIZATION:	-S11-	-S21-
REFERENCE PLANE:	OFF	OFF
SMOOTHING:	0.0000 mm	0.0000 mm
DELAY APERTURE:	0.0 PERCENT	0.0 PERCENT

CH1: S11 FWD REFL
 LOG MAGNITUDE
 REF=0.000 dB
 18.000 dB/DIV

CH3: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 18.000 dB/DIV

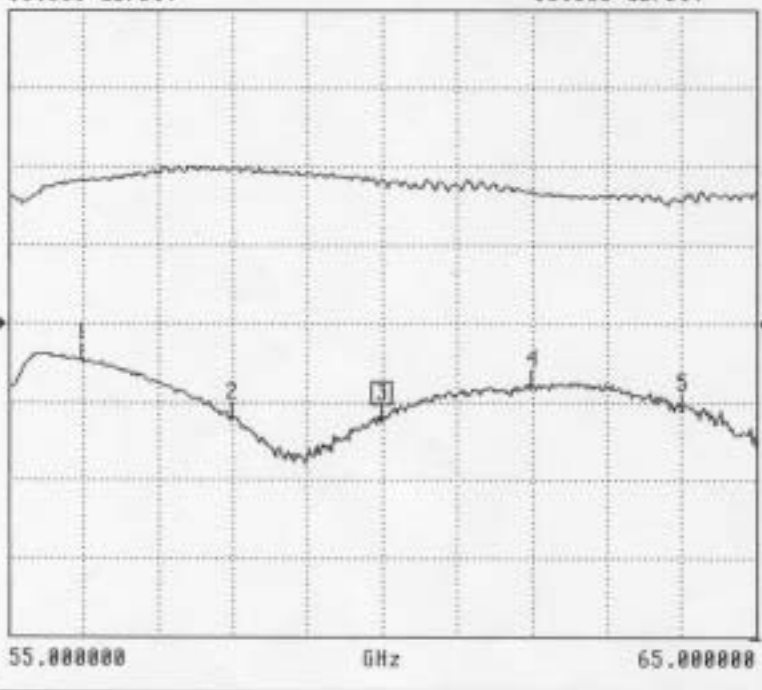
CH 1 - S11
 REFERENCE PLANE
 0.0000 mm

MARKER J
 60.000000 GHz
 -12.506 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
-4.634 dB
- 2 58.000000 GHz
-12.229 dB
- 4 62.000000 GHz
-8.828 dB
- 5 64.000000 GHz
-11.107 dB

MARKER READOUT
 FUNCTIONS



37397A

MODEL: *NA660 LNA 101*
 DEVICE ID: *LJ 020840-02*

DATE: 08/31/2002 15:59
 OPERATOR: *hyung Dng. Cha*

Page 1

START: 55.000000 GHz
 STOP: 65.000000 GHz
 STEP: 0.025000 GHz

GATE START: -
 GATE STOP: -
 GATE: -
 WINDOW: -

ERROR CORR: 12-TERM
 AVERAGING: 1 PT
 IF BNDWDTH: 1 KHz

PARAMETER:
 NORMALIZATION:
 REFERENCE PLANE:
 SMOOTHING:
 DELAY APERTURE:

-----CH2-----
 -S22-
 OFF
 0.0000 mm
 0.0 PERCENT

-----CH4-----
 -S21-
 OFF
 0.0000 mm
 0.0 PERCENT

CH2: S22 REV REFL
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

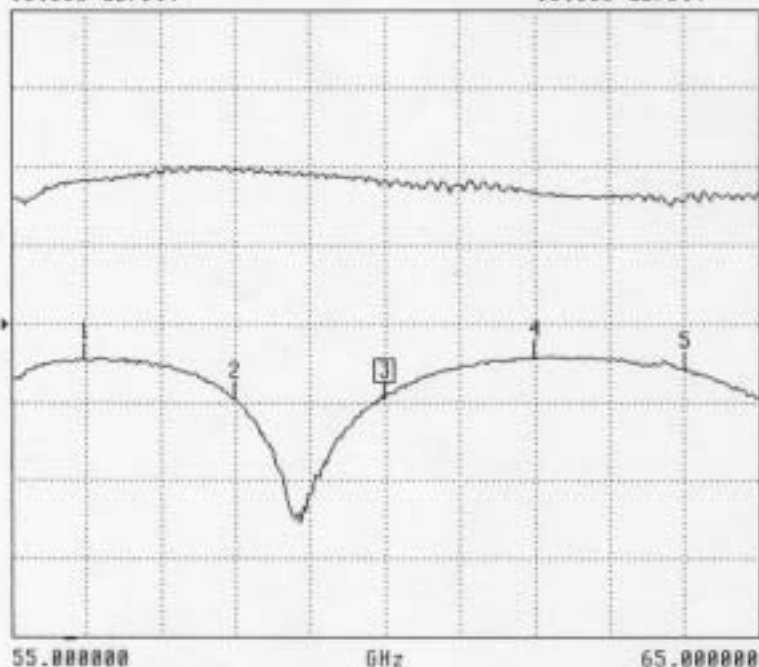
CH4: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH 2 - S22
 REFERENCE PLANE
 0.0000 mm

MARKER 3
 60.000000 GHz
 -9.500 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
-4.495 dB
- 2 58.000000 GHz
-9.614 dB
- 4 62.000000 GHz
-4.362 dB
- 5 64.000000 GHz
-5.861 dB

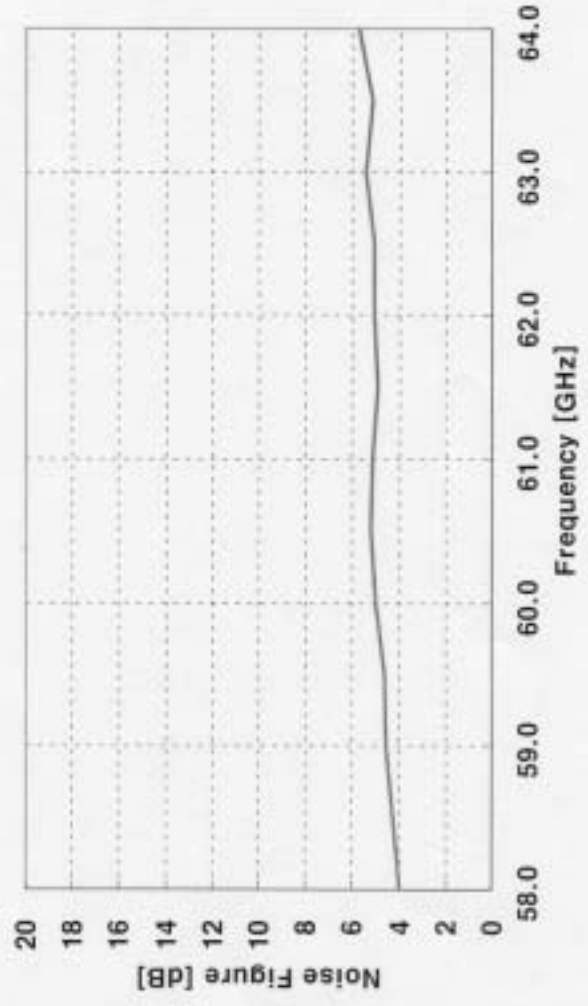


MARKER READOUT
 FUNCTIONS

MODEL : NRD 604WA/01
DEVICE ID : LU020530-02
OPERATOR : hyung bong . Choi

DATA : 2002, 8, 30

Noise Figure Measured Result



37391A

MODEL: *NRA60LNA101* DATE: 08/31/2002 16:16 Page 1
 DEVICE ID: *LVD20870-03* OPERATOR: *Hyung Dong Choi*

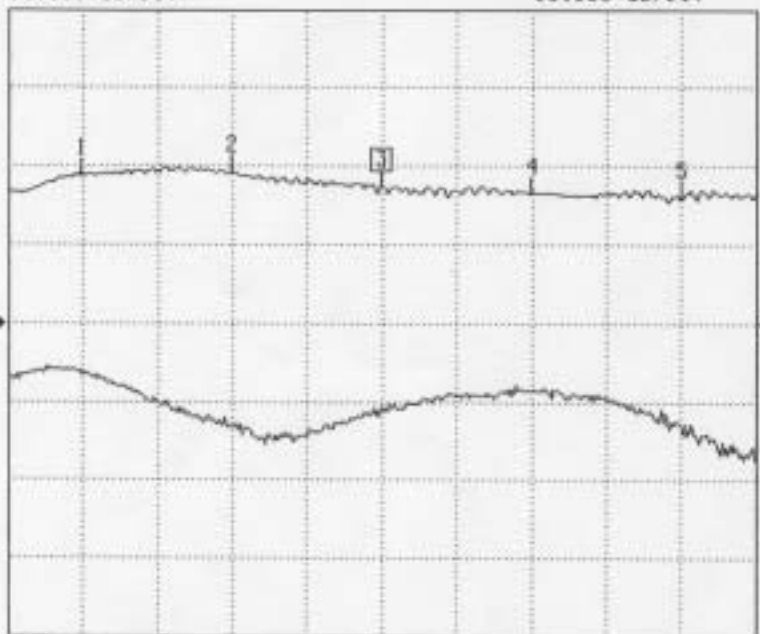
START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BANDWIDTH: 1 KHz
 WINDOW: -

PARAMETER:	-----CH1-----	-----CH3-----
NORMALIZATION:	-S11-	-S21-
REFERENCE PLANE:	OFF	OFF
SMOOTHING:	0.0000 mm	0.0000 mm
DELAY APERTURE:	0.0 PERCENT	0.0 PERCENT

CH1: S11 FWD REFL
 LOG MAGNITUDE
 REF=0.000 dB
 18.000 dB/DIV

CH3: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH 3 - S21
 REFERENCE PLANE
 0.0000 mm



MARKER 3
 60.000000 GHz
 17.350 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
18.082 dB
- 2 58.000000 GHz
19.169 dB
- 4 62.000000 GHz
16.471 dB
- 5 64.000000 GHz
15.028 dB

MARKER READOUT
 FUNCTIONS

* Description

1) Bias Condition $V_{in} = +5V$
 $I_{in} = 10mA$

37397A

MODEL: NR0 to LNA 1-1
 DEVICE ID: LV020840-02

DATE: 08/31/2002 16:18
 OPERATOR: hyung Dong Choi

Page 1

START: 55.000000 GHz
 STOP: 65.000000 GHz
 STEP: 0.025000 GHz

GATE START: -
 GATE STOP: -
 GATE: -
 WINDOW: -

ERROR CORR: 12-TERM
 AVERAGING: 1 PT
 IF BNDWIDTH: 1 KHz

PARAMETER:
 NORMALIZATION:
 REFERENCE PLANE:
 SMOOTHING:
 DELAY APERTURE:

-----CH1-----
 -S11-
 OFF
 0.0000 mm
 0.0 PERCENT

-----CH3-----
 -S21-
 OFF
 0.0000 mm
 0.0 PERCENT

CH1: S11 FWD REFL
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

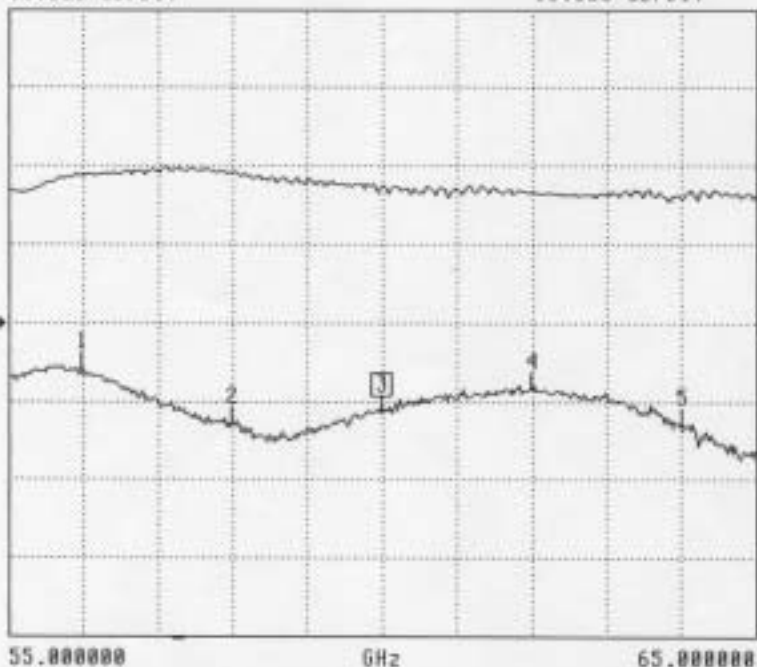
CH3: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH 1 - S11
 REFERENCE PLANE
 0.0000 mm

MARKER 3
 60.000000 GHz
 -11.423 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
-6.027 dB
- 2 58.000000 GHz
-12.904 dB
- 4 62.000000 GHz
-8.454 dB
- 5 64.000000 GHz
-13.139 dB



MARKER READOUT
 FUNCTIONS

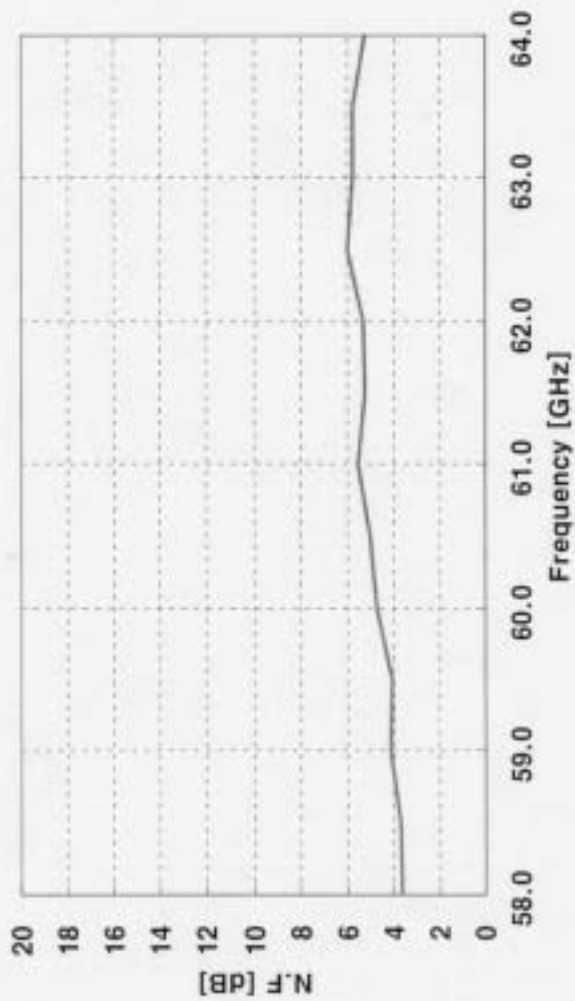
MODEL : NRD 60 LNA 1-1

DEVICE ID : LV020840-07

OPERATOR : hyung seung. choi

DATA : LV02. 8, 40

Noise Figure Measured Result



31357A

MODEL: 60GHz LNA (w/g)
 DEVICE ID: #06

DATE: 08/21/2002 17:23
 OPERATOR:

Page 1/3

START: 55.000000 GHz
 STOP: 65.000000 GHz
 STEP: 0.025000 GHz

GATE START: -
 GATE STOP: -
 GATE: -
 WINDOW: -

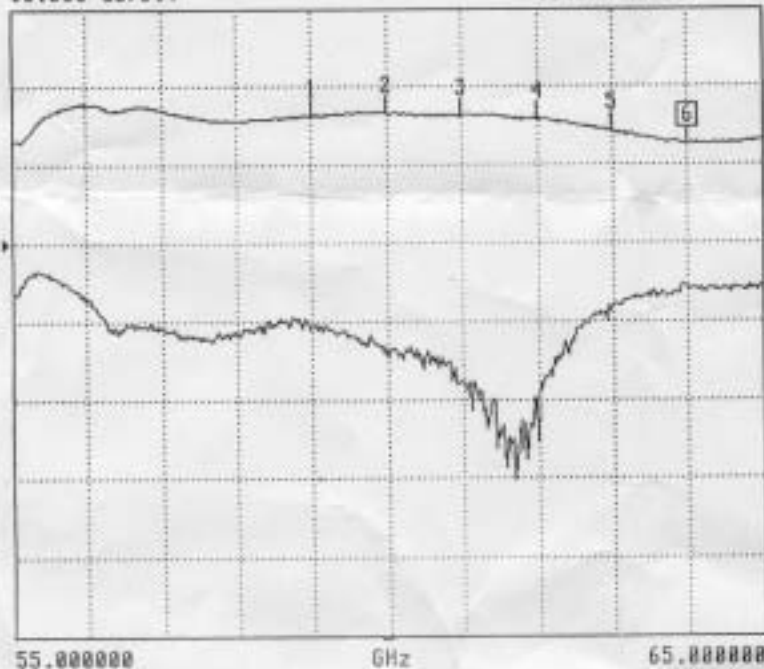
ERROR CORR: 12-TERM
 AVERAGING: 1 PT
 IF BNDWDTH: 1 KHz

PARAMETER:	-----CH1-----	-----CH3-----
NORMALIZATION:	-S11-	-S21-
REFERENCE PLANE:	OFF	OFF
SMOOTHING:	0.0000 mm	0.0000 mm
DELAY APERTURE:	0.0 PERCENT	0.0 PERCENT

CH1: S11 FWD REFL
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH3: S21 FWD TRANS
 LOG MAGNITUDE
 REF=0.000 dB
 10.000 dB/DIV

CH 3 - S21
 REFERENCE PLANE
 0.0000 mm



MARKER 6
 64.000000 GHz
 12.672 dB

MARKER TO MAX
 MARKER TO MIN

- 1 59.000000 GHz 16.312 dB
- 2 60.000000 GHz 16.693 dB
- 3 61.000000 GHz 16.383 dB
- 4 62.000000 GHz 15.970 dB
- 5 63.000000 GHz 14.300 dB

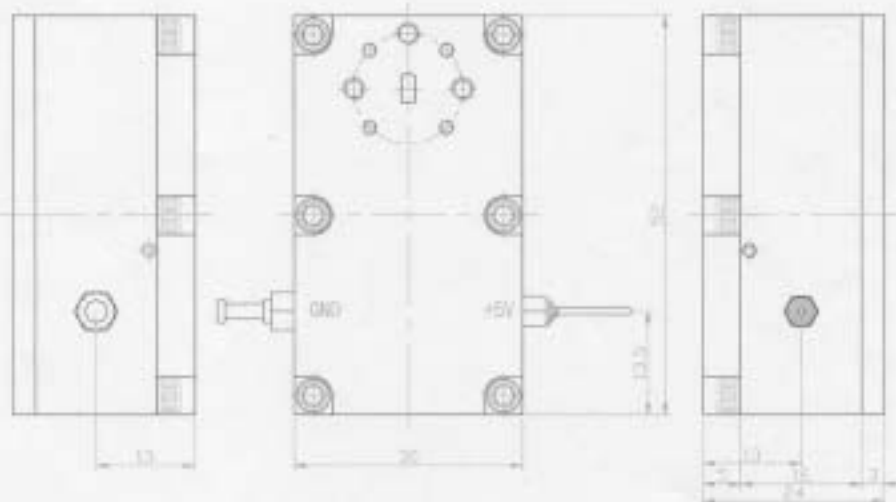
MARKER READOUT
 FUNCTIONS

60GHz LOCAL OSCILLATORModel Name : **NRD60LO201**

DATE: SEP/06/2002

Serial Number : **LH020906-05****Specifications**

Parameters	Specifications
Output Frequency	60.250GHz
Output Power	15dBm
Phase Noise	80dBc@500KHz
Electrical Tuning Range	440MHz
Pushing Figure	303MHz/V
Output Port	WR-15
Bias	+5V/980mA
Size(LxWxD)[mm]	52x30x24

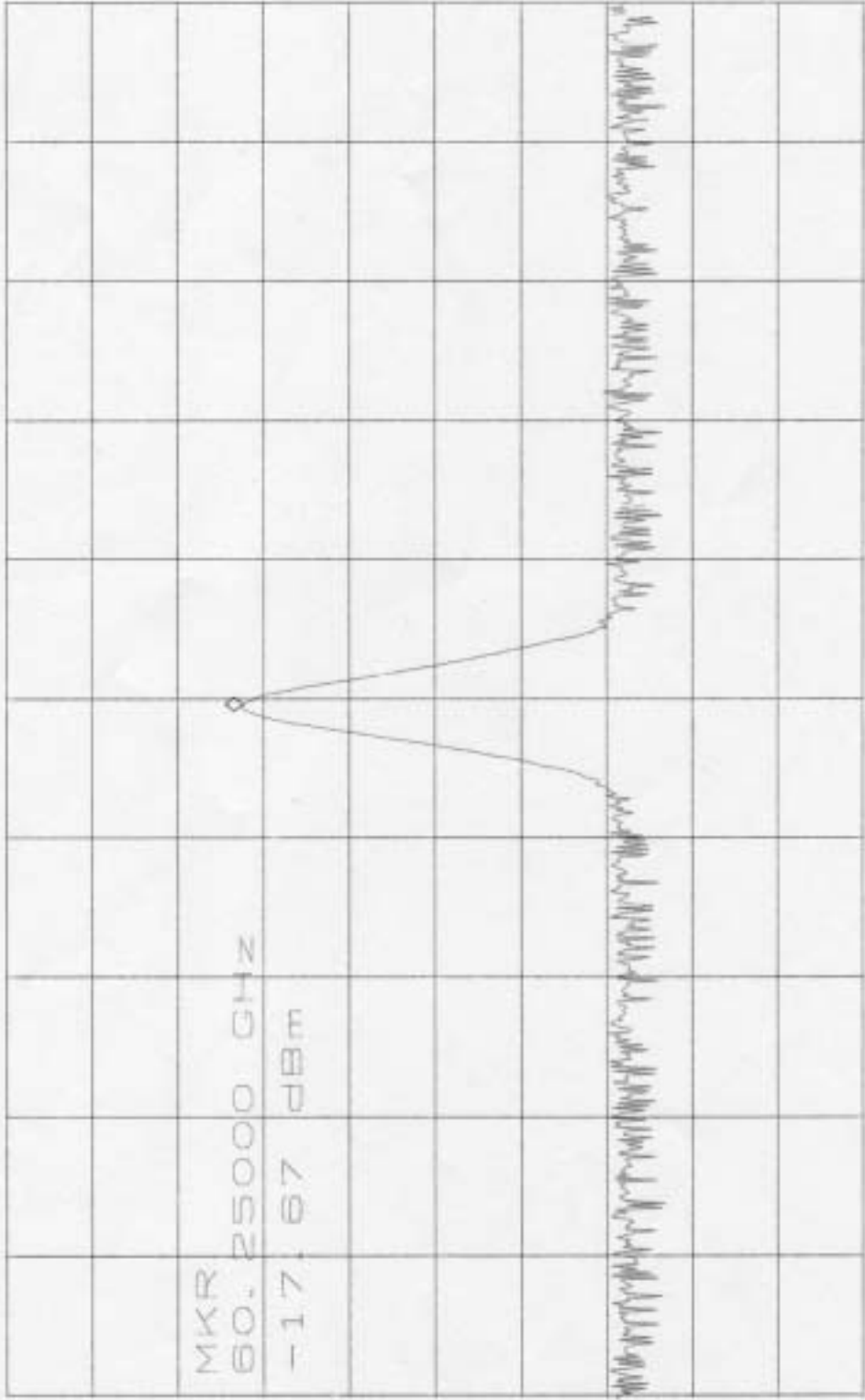
Dimensions**Descriptions**

1. DC Bias should be connected ground(GND) first, and then +5V next.
2. RF port is compatible with WR-15 standard V-band rectangular waveguide.
3. Do not turn the screw voluntarily located in front wall side so as optimum power output.
4. All Dimensions are in millimeters.

CL 47.2dB
RL 10.0dBm

MKR -17.67dBm
60.25000GHZ

10dB/



CENTER 60.25000GHZ
RBW 300KHZ *VBW 10KHZ

SPAN 20.00MHZ
SWP 50.0ms

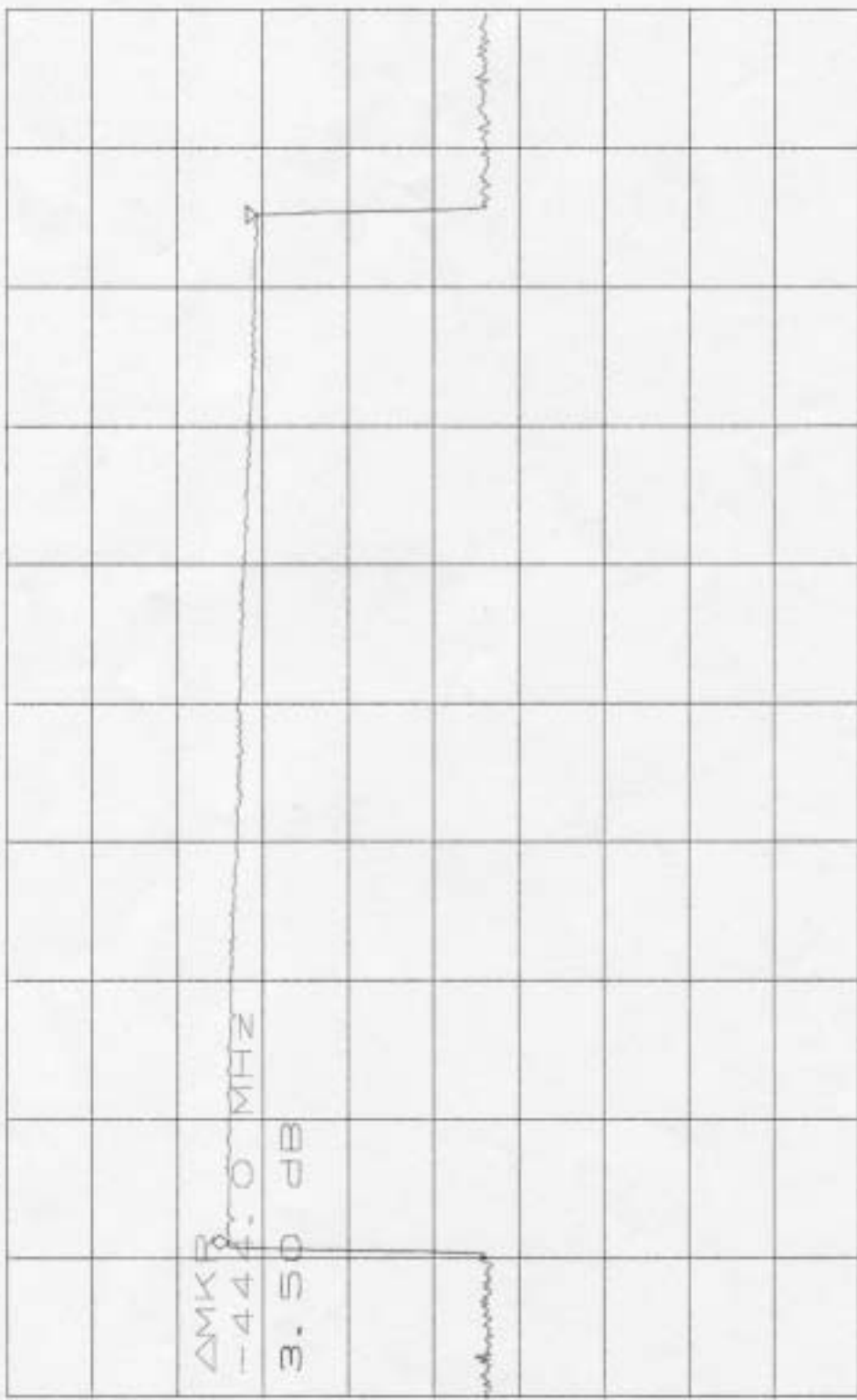
-412 : 30dB Attenuator AB.

. Model Name : NR060201

CL 47.2dB
RL 10.0dBm

Δ MKR 3.50dB
-444.0MHz

10dB/



Δ MKR
-444.0 MHz
3.50 dB

CENTER 60.2500GHZ
RBW 1.0MHZ VBW 1.0MHZ

SPAN 600.0MHZ
SWP 50.0ms

Mod Name: NR0610201

Measurement with 30dB Attenuator.

V-BAND PHYRAMIDAL HORN ANTENNA

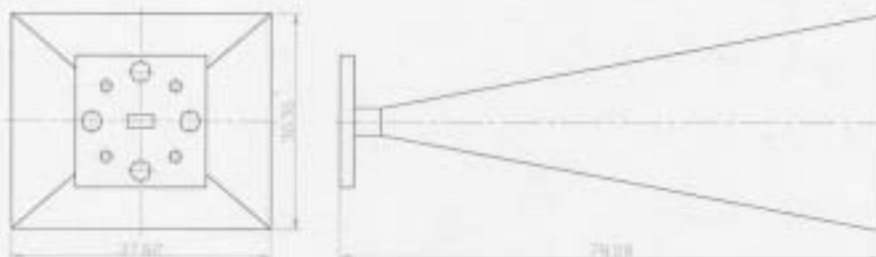
Model Name : **NRD60PH201**
 Serial Number : **HW020820-06/07/08**

DATE: SEP/04/2002

Specifications

Parameters		Specifications
Frequency Range		50GHz - 75GHz
Waveguide Size		WR-15
VSWR		1.13:1 max
Mid-band Gain		24dB typical
3dB Beamwidth	E-plane	9.0°
	H-plane	10.1°
Size(Lx#xH)[mm]		78.58x37.62x30.36

Dimensions

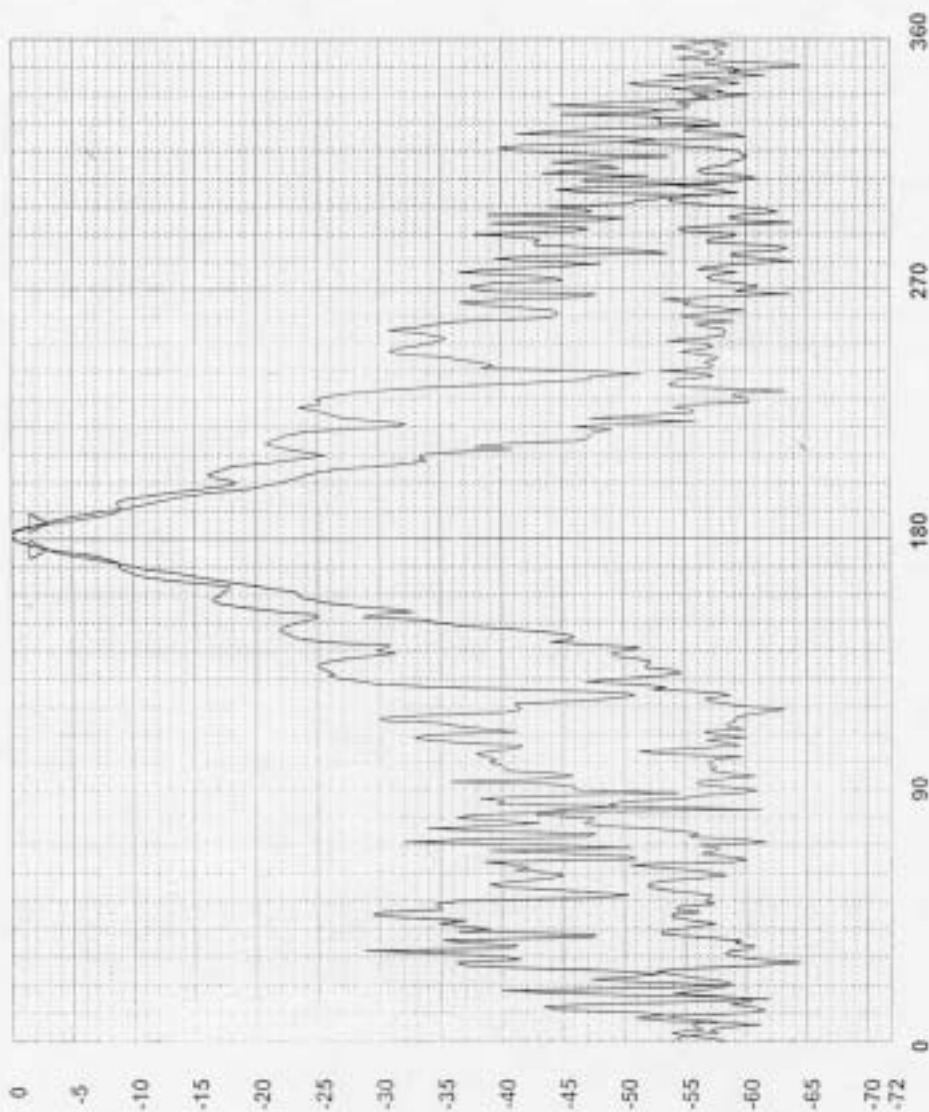


Descriptions

1. The port is compatible with WR-15 standard V-band rectangular waveguide.
2. All Dimensions are in millimeters.

Antenna Performance Test

Model : N8060PH201
Serial : HW020820-0x
E-Plane Pattern
Freq.(GHz) : 60
Date : 2002.08.23
BW(Deg/dB) : 9.0/-3
SLL(Deg/dB) :
BeamPeak : 24.5
Average : -36.79



H-Plane Pattern
Freq.(GHz) : 60
Date : 2002.08.23
BW(Deg/dB) : 10.1/-3
SLL(Deg/dB) :
BeamPeak : 24.28
Average : -49.06

17337A

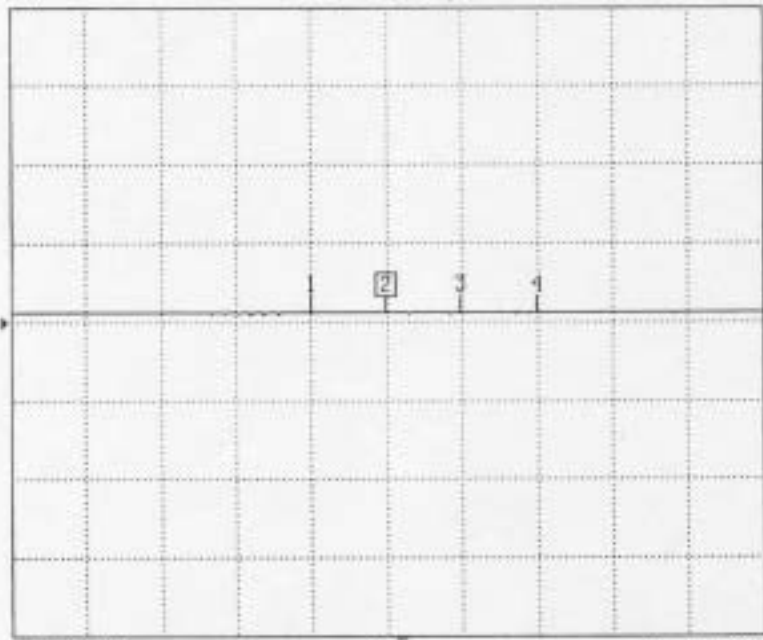
MODEL: NRD60PH201 DATE: 09/06/2002 09:54 Page 1
 DEVICE ID: HW020820-0x OPERATOR:

START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.012500 GHz GATE: - IF BNDWDTH: 1 KHz
 WINDOW: -

-----CH1-----
 PARAMETER: -S11-
 NORMALIZATION: OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S11 FORWARD REFLECTION

SWR REF=0.000 pU 10.000 U/DIV



CH 1 - S11
 REFERENCE PLANE
 0.0000 mm

MARKER 2
 60.000000 GHz
 1.119 U

MARKER TO MAX
 MARKER TO MIN

- 1 59.000000 GHz
1.137 U
- 3 61.000000 GHz
1.086 U
- 4 62.000000 GHz
1.117 U

MARKER READOUT
 FUNCTIONS

55.000000 GHz 65.000000

60GHz RECEIVER

Model Name : **NRD60RX001**

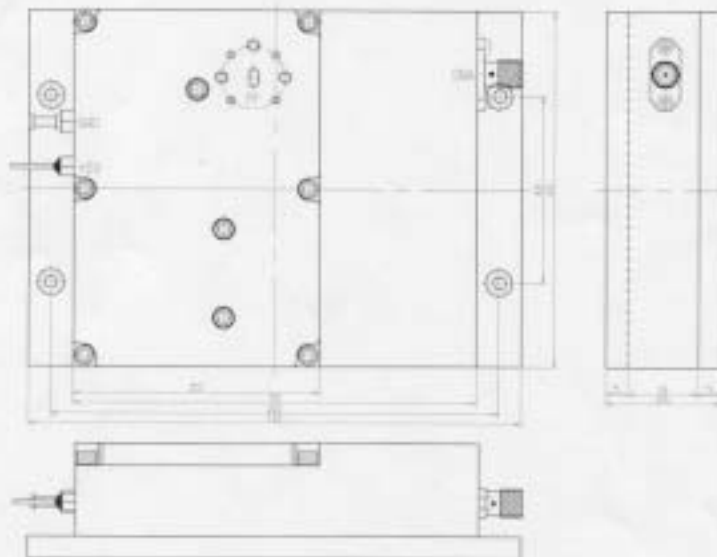
DATE: SEP/06/2002

Serial Number : **RA020906-03**

Specifications

Parameters	Specifications
RF Frequency Range	58GHz - 60GHz
Conversion Gain	47dB
Dynamic Range	-20dBm to -60dBm
Noise Figure	6.0dB max
RF Input VSWR	1.5:1
Base band Output VSWR	2.0:1
RF Port	WR-15
Signal Output Port	SMA(f)
Bias	+5V/140mA
Size(LxWxH) [mm]	80x110x26

Dimensions



Descriptions

1. DC Bias should be connected ground(GND) first, and then +5V next.
2. RF port maximum power must be permitted below -15dBm.
3. SMA female port is matched at 50Ω impedance.
4. RF port is compatible with WR-15 standard V-band rectangular waveguide.
5. All Dimensions are in millimeters.

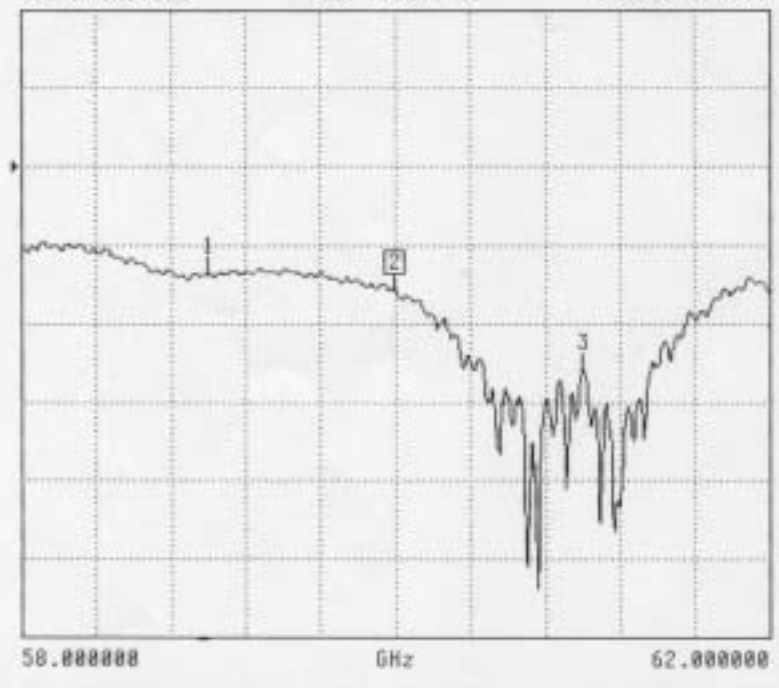
37371A

MODEL: *NRD60Rx001* DATE: 09/09/2002 15:06 Page 1
DEVICE ID: *RA120901-03* OPERATOR: *Y.S. Kim*
START: 58.000000 GHz GATE START: - ERROR CORR: 12-TERM
STOP: 62.000000 GHz GATE STOP: - AVERAGING: 1 PT
STEP: 0.006250 GHz GATE: - IF BANDWIDTH: 100 Hz
WINDOW: -

-----CH1-----
PARAMETER: *R_n port* -S11-
NORMALIZATION: OFF
REFERENCE PLANE: 0.0000 mm
SMOOTHING: 0.0 PERCENT
DELAY APERTURE: -

S11 FORWARD REFLECTION

LOG MAGNITUDE REF=0.000 dB 10.000 dB/DIV



CH 1 - S11
REFERENCE PLANE
0.0000 mm

▶ MARKER 2
60.000000 GHz
-15.768 dB

MARKER TO MAX
MARKER TO MIN

1 59.000000 GHz
-13.707 dB
3 61.000000 GHz
-25.929 dB

MARKER READOUT
FUNCTIONS

373371A

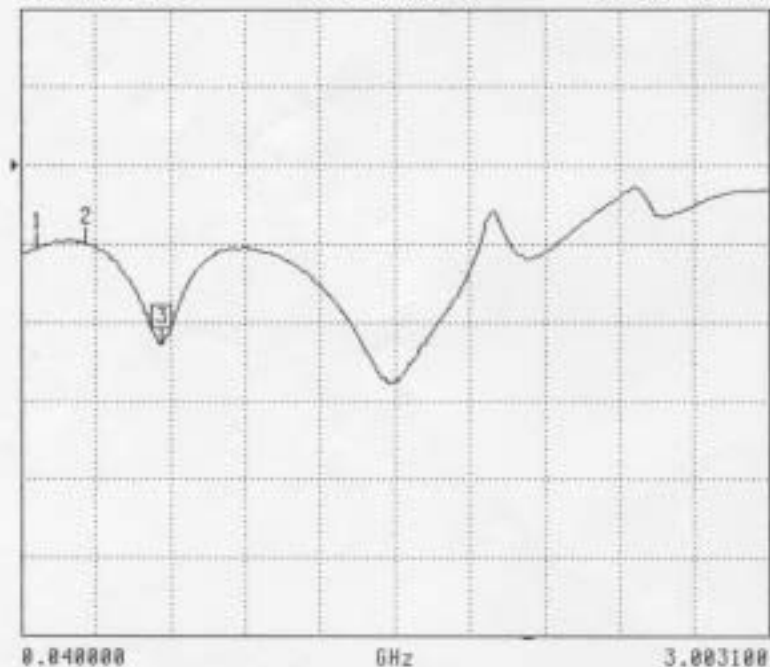
MODEL: *NRD60 2X00/*
DEVICE ID: *RA020906-03*DATE: 09/09/2002 15:44
OPERATOR: *ORAYU*

Page 1

START: 0.040000 GHz
STOP: 3.003100 GHz
STEP: 0.006225 GHzGATE START: -
GATE STOP: -
GATE: -
WINDOW: -ERROR CORR: 12-TERM
AVERAGING: 1 PT
IF BANDWIDTH: 1 KHz-----CH1-----
PARAMETER: *Base band Output USWR* -S11-
NORMALIZATION: OFF
REFERENCE PLANE: 0.0000 mm
SMOOTHING: 0.0 PERCENT
DELAY APERTURE: -

S11 FORWARD REFLECTION

LOG MAGNITUDE REF=-8.000 dB 10.000 dB/DIV

CH 1 - S11
REFERENCE PLANE
0.0000 mm▶ MARKER 3
0.600250 GHz
-22.915 dBMARKER TO MAX
MARKER TO MIN1 0.102250 GHz
-10.660 dB
2 0.301450 GHz
-10.003 dBMARKER READOUT
FUNCTIONS

WAVEGUIDE to COAXIAL TRANSITION

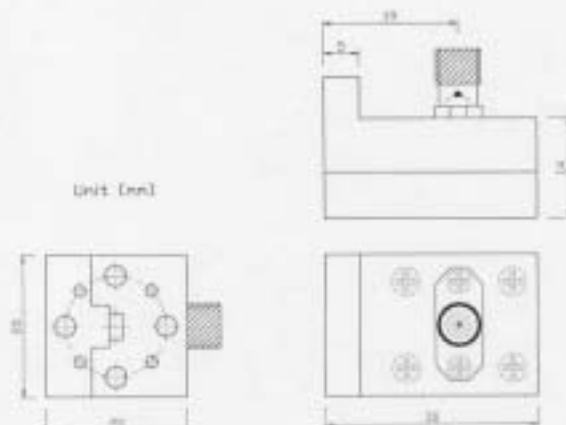
Model Name : **NRD60TS201**
 Serial Number : **WV020831-01/ 02**

DATE: AUG/31/2002

Specifications

Parameters	Specifications
Frequency Range	55GHz - 65GHz
Insertion Loss	0.5dB typical
Waveguide Port RL	15dB typical
Coaxial Port RL	12dB typical

Dimensions



Descriptions

1. V-band standard waveguide(WR-15) from/to Coaxial (V-connector) transition.

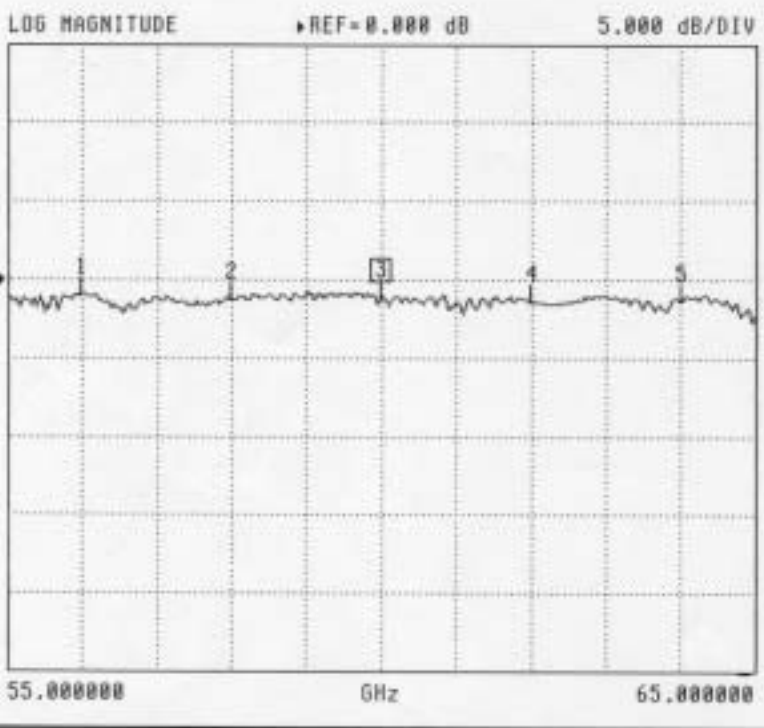
37397A

MODEL: NRD60TSG201 DATE: 08/31/2002 18:23 Page 1
 DEVICE ID: WVO20811-01/02 OPERATOR: Hyung Dong - Choi .

START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BNDWIDTH: 1 KHz
 * Straight (WRIS) loss : -0.2dB WINDOW: -

-----CH3-----
 PARAMETER: -S21-
 NORMALIZATION: -S21-
 OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S21 FORWARD TRANSMISSION



CH 3 - S21
 REFERENCE PLANE
 0.0000 mm

▶ MARKER 3
 60.000000 GHz
 -1.198 dB

MARKER TO MAX
 MARKER TO MIN

1	56.000000 GHz	-0.931 dB
2	58.000000 GHz	-1.235 dB
4	62.000000 GHz	-1.376 dB
5	64.000000 GHz	-1.398 dB

MARKER READOUT
 FUNCTIONS

* Description

- 1) U-Conn. Calibration & 보정 Back to Back 측정 결과의 삽입손실
- 2) Back to Back 측정시 WRIS straight 삽입. Straight 손실 0.2dB

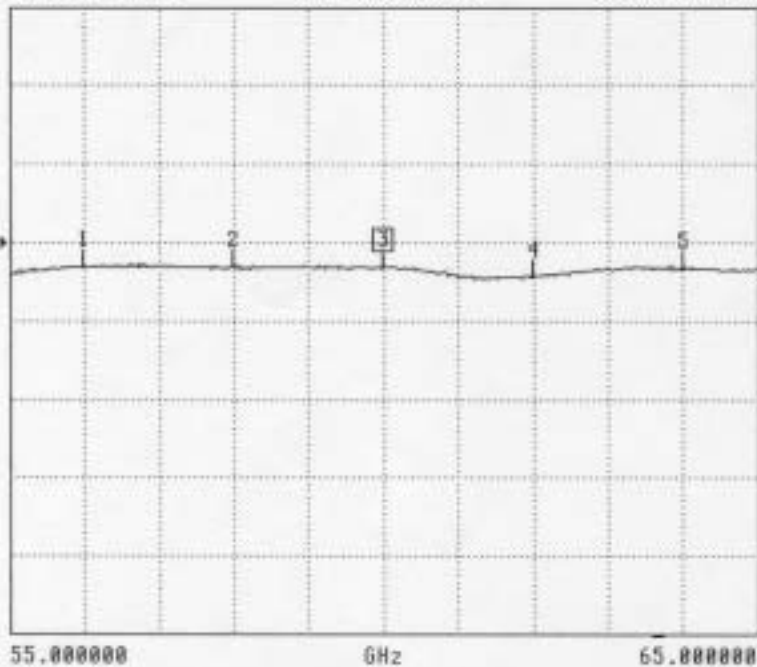
37397A

MODEL: NRD60TS201 DATE: 08/31/2002 18:41 Page 1
 DEVICE ID: WY020821-01/02 OPERATOR: *Hyung Dong Choi*
 START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BANDWIDTH: 1 KHz
 * V-loss less = -0.5dB WINDOW: -

-----CH3-----
 PARAMETER: -S21-
 NORMALIZATION: OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S21 FORWARD TRANSMISSION

LOG MAGNITUDE REF=0.000 dB 5.000 dB/DIV



CH 3 - S21
 REFERENCE PLANE
 0.0000 mm

▶ MARKER 3
 60.000000 GHz
 -1.589 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
-1.629 dB
- 2 58.000000 GHz
-1.645 dB
- 4 62.000000 GHz
-2.223 dB
- 5 64.000000 GHz
-1.714 dB

MARKER READOUT
 FUNCTIONS

* Description

- 1) WR15 - Calibration을 시켜 Back to Back 측정값과의 일치성을
- 2) Back to Back 측정의 V-loss. 확인. V-loss 현상 0.5dB

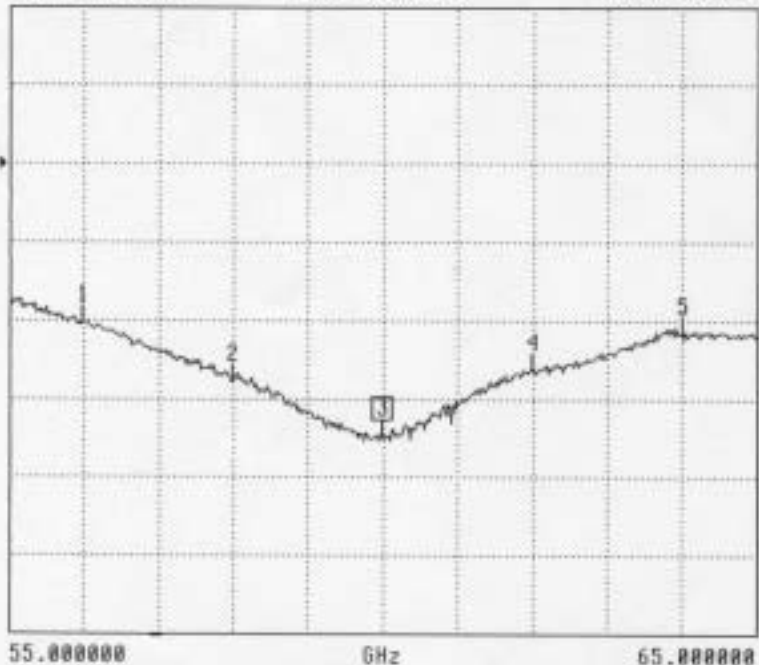
37397A

MODEL: *NRD60TS201* DATE: 08/31/2002 18:14 Page 1
 DEVICE ID: *WVO20841-01* OPERATOR: *Hyung-Dong Chai*
 START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BNDWDTH: 1 KHz
 WINDOW: -

-----CH1-----
 PARAMETER: -S11-
 NORMALIZATION: OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S11 FORWARD REFLECTION

LOG MAGNITUDE REF=0.000 dB 5.000 dB/DIV



CH 1 - S11
 REFERENCE PLANE
 0.0000 mm

▶ MARKER 3
 60.000000 GHz
 -17.345 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
-10.200 dB
- 2 58.000000 GHz
-13.917 dB
- 4 62.000000 GHz
-13.103 dB
- 5 64.000000 GHz
-10.903 dB

MARKER READOUT
 FUNCTIONS

* Description

1) Coax (U-low) port ~~at~~ R/L

37397A

MODEL: *NRD 60TS201*
 DEVICE ID: *WV020931-01*

DATE: 08/31/2002 18:37
 OPERATOR: *Byung Dong Choi*

Page 1

START: 55.000000 GHz
 STOP: 65.000000 GHz
 STEP: 0.025000 GHz

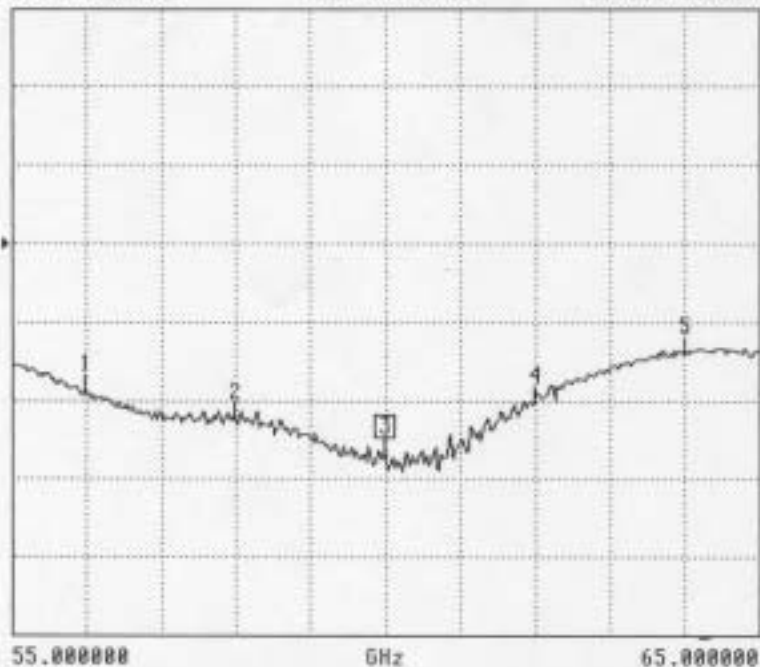
GATE START: -
 GATE STOP: -
 GATE: -
 WINDOW: -

ERROR CORR: 12-TERM
 AVERAGING: 1 PT
 IF BANDWIDTH: 1 KHz

PARAMETER: -----CH4-----
 NORMALIZATION: -S22-
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S22 REVERSE REFLECTION

LOG MAGNITUDE REF=0.000 dB 10.000 dB/DIV



CH 4 - S22
 REFERENCE PLANE
 0.0000 mm

▶ MARKER 3
 60.000000 GHz
 -26.930 dB

MARKER TO MAX
 MARKER TO MIN

- 1 56.000000 GHz
-18.972 dB
- 2 58.000000 GHz
-22.522 dB
- 4 62.000000 GHz
-20.427 dB
- 5 64.000000 GHz
-14.003 dB

MARKER READOUT
 FUNCTIONS

x Description

U waveguide port R/L

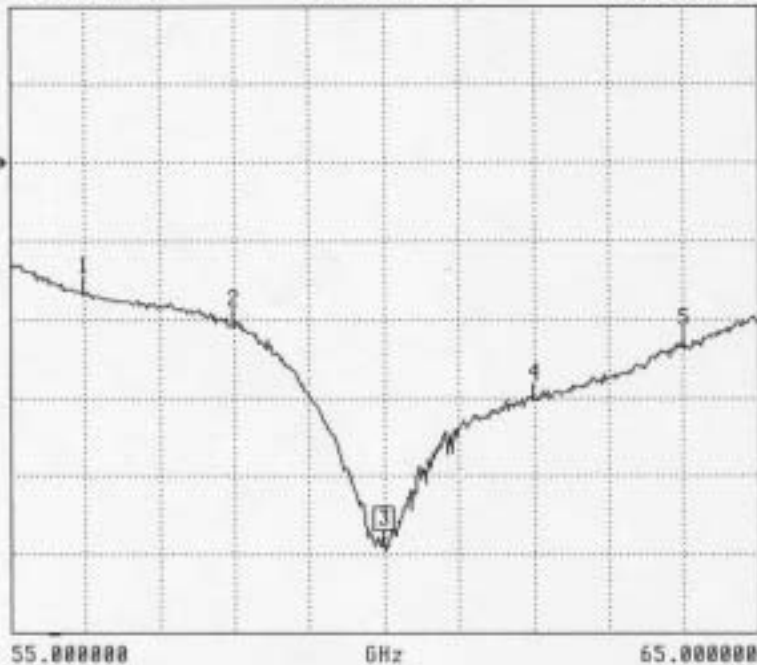
37397A

MODEL: *NRD 60 TS 01* DATE: 08/31/2002 18:12 Page 1
 DEVICE ID: *WV020B21-02* OPERATOR: *Hyung-Dong . Chi*
 START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BNDWIDTH: 1 KHz
 WINDOW: -

-----CH1-----
 -S11-
 NORMALIZATION: OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S11 FORWARD REFLECTION

LOG MAGNITUDE REF=0.000 dB 5.000 dB/DIV



CH 1 - S11
 REFERENCE PLANE
 0.0000 mm
 ▶ MARKER 3
 60.000000 GHz
 -24.464 dB
 MARKER TO MAX
 MARKER TO MIN
 1 56.000000 GHz
 -8.417 dB
 2 58.000000 GHz
 -10.449 dB
 4 62.000000 GHz
 -15.152 dB
 5 64.000000 GHz
 -11.760 dB
 MARKER READOUT
 FUNCTIONS

x Description

1) Coax (V-term.) port R/L

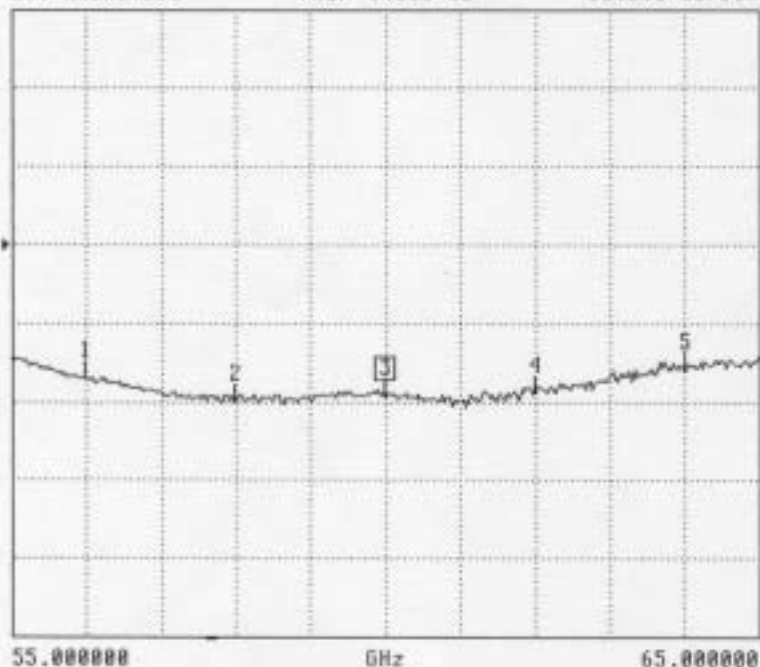
37397A

MODEL: *NRD 60TS 201* DATE: 08/31/2002 18:38 Page 1
 DEVICE ID: *WV020571-02* OPERATOR: *hyung bong Choi*
 START: 55.000000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 65.000000 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.025000 GHz GATE: - IF BANDWIDTH: 1 KHz
 WINDOW: -

-----CH4-----
 PARAMETER: -S22-
 NORMALIZATION: OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S22 REVERSE REFLECTION

LOG MAGNITUDE REF=0.000 dB 10.000 dB/DIV



CH 4 - S22
 REFERENCE PLANE
 0.0000 mm

- ▶ MARKER 3
 60.800000 GHz
 -19.409 dB
- MARKER TO MAX
 MARKER TO MIN
- 1 56.800000 GHz
 -17.830 dB
- 2 58.800000 GHz
 -20.051 dB
- 4 62.800000 GHz
 -18.928 dB
- 5 64.800000 GHz
 -15.887 dB

MARKER READOUT
 FUNCTIONS

*Description

1) waveguide port R/L

60GHz TRANSMITTER

Model Name : **NRD60TX001**

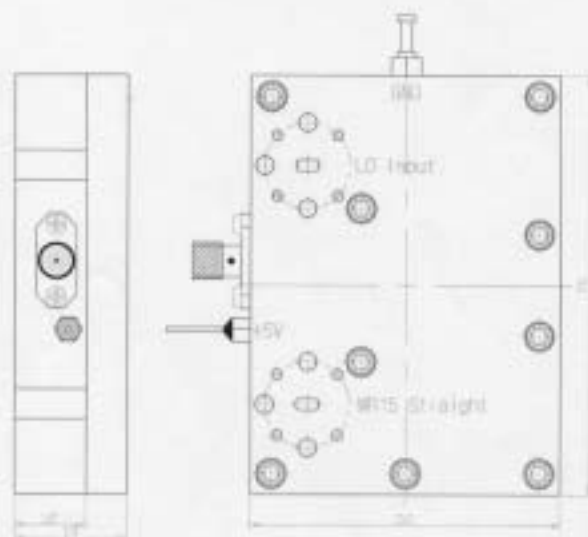
DATE: SEP/06/2002

Serial Number : **TA020906-02**

Specifications

Parameters	Specifications
RF Frequency Range	59GHz ~ 62GHz
Loss(ASK)	12dB
Loss(straight)	0.7dB
LO Input VSWR	1.5:1
Signal Input VSWR	1.6:1
RF Port	WR-15
Signal Input Port	SMA(f)
Bias	+5V/30mA
Size(LxWxH)[mm]	70x52x20

Dimensions



Descriptions

1. DC Bias should be connected ground(GND) first, and then +5V next.
2. SMA female port is matched at 50Ω impedance.
3. RF port is compatible with WR-15 standard V-band rectangular waveguide.
4. All Dimensions are in millimeters.

Anritsu

DATA

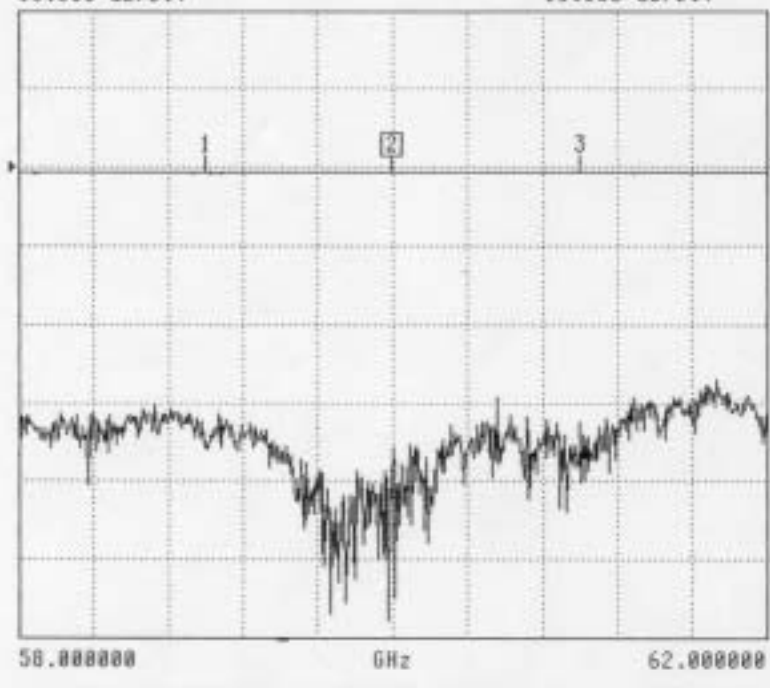
MODEL: *NRD 60 & 001* DATE: 09/09/2002 15:18 Page 1
DEVICE ID: *TA020906-02* OPERATOR: *ys Kim*
START: 58.000000 GHz GATE START: - ERROR CORR: 12-TERM
STOP: 62.000000 GHz GATE STOP: - AVERAGING: 1 PT
STEP: 0.006250 GHz GATE: - IF BNDWDTH: 1 KHz
WINDOW: -

-----CH1----- -----CH3-----
PARAMETER: *WR-it straight* -S11- -S21-
NORMALIZATION: OFF OFF
REFERENCE PLANE: 0.0000 mm 0.0000 mm
SMOOTHING: 0.0 PERCENT 0.0 PERCENT
DELAY APERTURE: - -

CH1: S11 FWD REFL
LOG MAGNITUDE
REF=0.000 dB
18.000 dB/DIV

CH3: S21 FWD TRANS
LOG MAGNITUDE
REF=0.000 dB
18.000 dB/DIV

CH 3 - S21
REFERENCE PLANE
0.0000 mm



37397A

MODEL: *NRD 60 & 001*
DEVICE ID: *TA02906-02*

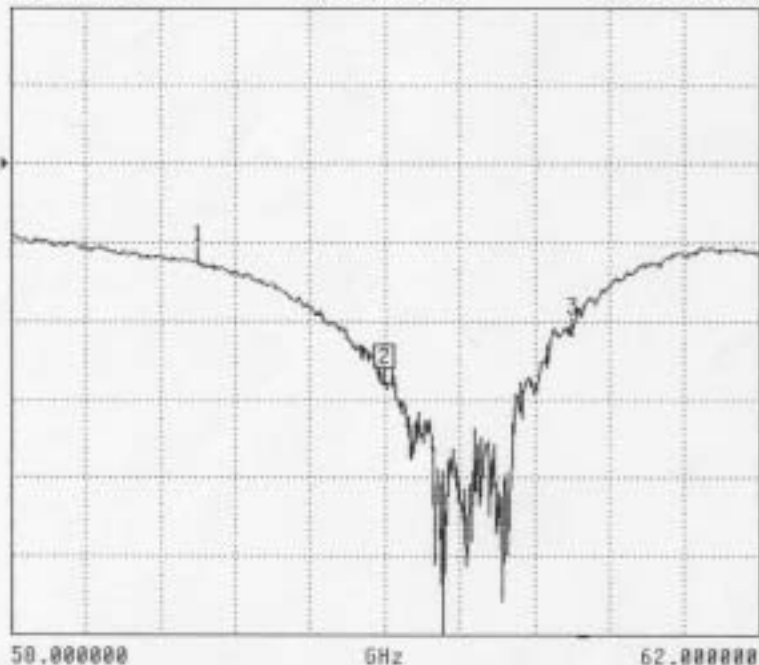
DATE: 09/09/2002 15:21

Page 1

OPERATOR: *js kim*START: 58.000000 GHz
STOP: 62.000000 GHz
STEP: 0.006250 GHzGATE START: -
GATE STOP: -
GATE: -
WINDOW: -ERROR CORR: 12-TERM
AVERAGING: 1 PT
IF BANDWIDTH: 1 KHz-----CH1-----
PARAMETER: *LO Input* -S11-
NORMALIZATION: OFF
REFERENCE PLANE: 0.0000 mm
SMOOTHING: 0.0 PERCENT
DELAY APERTURE: -

S11 FORWARD REFLECTION

LOG MAGNITUDE REF=0.000 dB 10.000 dB/DIV

CH 1 - S11
REFERENCE PLANE
0.0000 mm▶ MARKER 2
60.000000 GHz
-20.059 dBMARKER TO MAX
MARKER TO MIN1 59.000000 GHz
-12.569 dB3 61.000000 GHz
-21.603 dBMARKER READOUT
FUNCTIONS

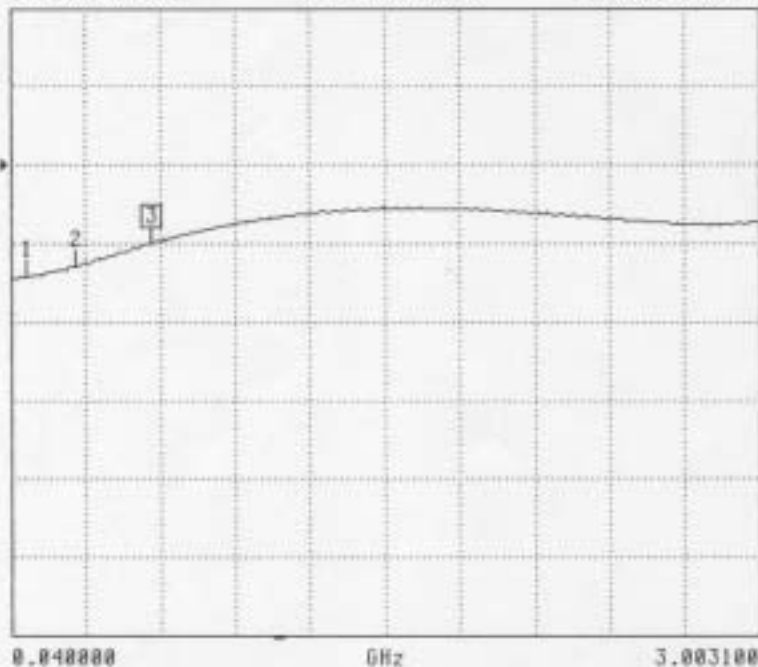
11197A

MODEL: *NRD 60 TX 001* DATE: 09/09/2002 15:38 Page 1
 DEVICE ID: *TA02096-02* OPERATOR: *ORRYU*
 START: 0.040000 GHz GATE START: - ERROR CORR: 12-TERM
 STOP: 3.003100 GHz GATE STOP: - AVERAGING: 1 PT
 STEP: 0.006225 GHz GATE: - IF BANDWIDTH: 1 KHz
 WINDOW: -

-----CH1-----
 PARAMETER: *Signal Input VSWR* -S11-
 NORMALIZATION: OFF
 REFERENCE PLANE: 0.0000 mm
 SMOOTHING: 0.0 PERCENT
 DELAY APERTURE: -

S11 FORWARD REFLECTION

LOG MAGNITUDE REF=0.000 dB 10.000 dB/DIV



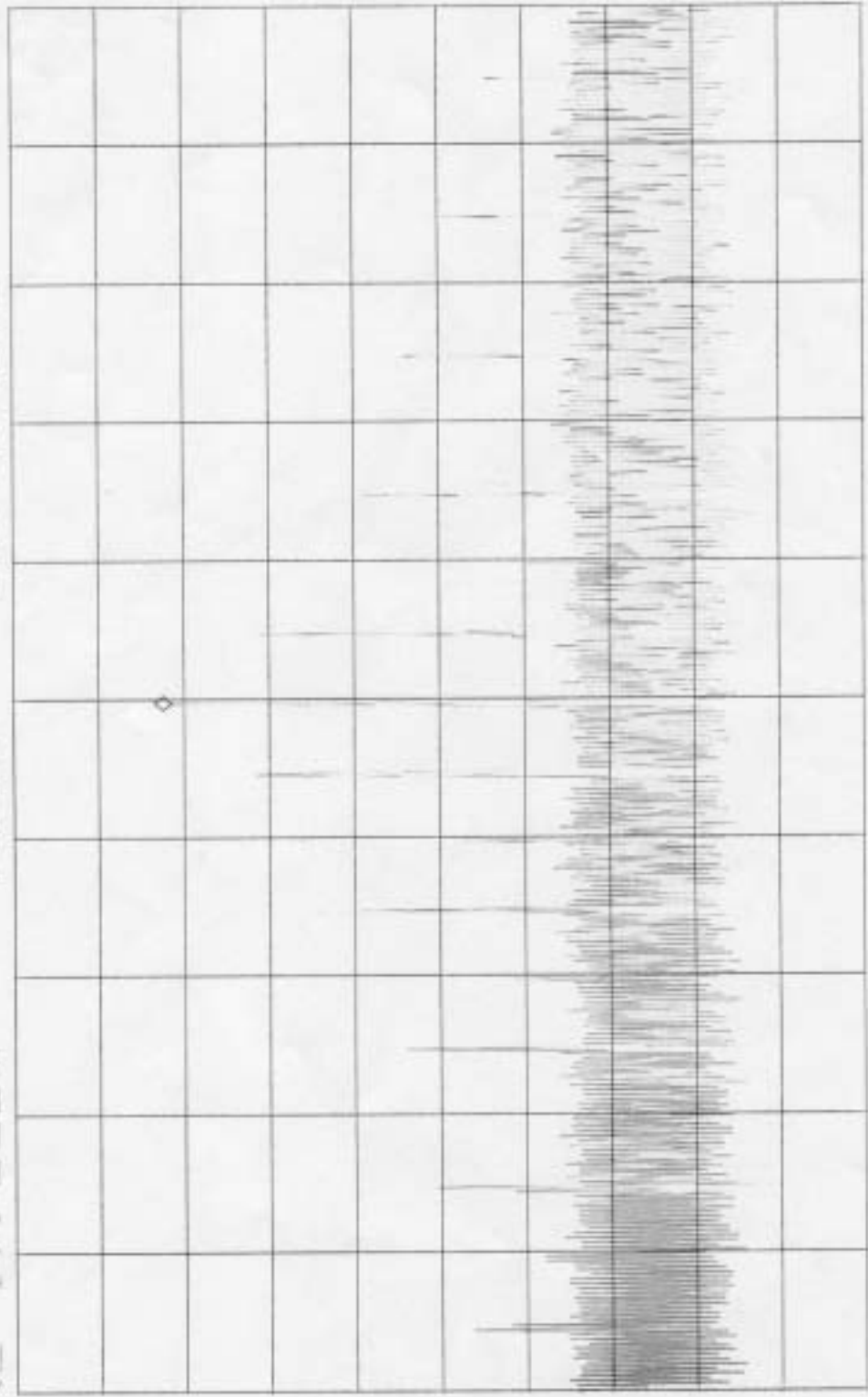
CH 1 - S11
 REFERENCE PLANE
 0.0000 mm
 ►MARKER 3
 0.600250 GHz
 -10.892 dB
 MARKER TO MAX
 MARKER TO MIN
 1 0.102250 GHz
 -14.228 dB
 2 0.301450 GHz
 -12.976 dB

MARKER READOUT
 FUNCTIONS

CL 47.2dB
RL 17.2dBm

MKR -1.52dBm
60.007GHz

10dB/



CENTER 60.007GHz
RBW 1.0MHz VBW 1.0MHz

SPAN 2.000GHz
SWP 50.0ms

8. 111111 11.111111 11.111111 11.111111 11.111111 11.111111 11.111111 11.111111 11.111111 11.111111

Model: NRD 607K001

K