



VR5-HD

Functionality Verification Procedure

Application Note

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1. Introduction

This application notes will mainly focus on how to verify basic functionality as below:

- Input power level measurement accuracy.
- Output power level accuracy.
- Delay
- C/N Measurement
- Phase shift
- Rayleigh fading
- Frequency shift

2. Verification Procedure

2.1. Input Power Level Measurement

Test Item	Input power level measurement
Test Equipment	Signal generator, spectrum analyzer
Prerequisite Condition	This is pre-configured settings file for verification purpose only  Verification.hde
Test Procedure: <ol style="list-style-type: none">1, Setup signal generator to generate a CW tone signal @ 900MHz frequency2, Configure power level of signal generator to -10dBm3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator.4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to "File" – "Open Settings", find Verification.hde on the desktop (this file is provided by Spirent)5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel:6, Set the input expected power level to -10dBm for port A1:7, Set the threshold of the power meter for A1 to:<ul style="list-style-type: none">• Trigger Mode : RELATIVE• Trigger Threshold : -20	



- 8, Connect the signal generator RF output port to VR5 on Port 1 (Which is A1 in this case), as this is for measure port 1 (A1) power detection accuracy.
- 9, Connect the signal generator RF output port with RF cable to spectrum analyzer to measure the power level.

Pass Criteria:

Compare the result from step 8 and step 9, the input power meter measurement result should be the same with spectrum analyzer, and the measurement result both from VR5 input power meter and spectrum analyzer is the cable loss difference compare to the signal generator’s RF output port.

2.2. Output Power Level Accuracy

Test Item	Path loss and output power level accuracy
Test Equipment	Signal generator, spectrum analyzer
Prerequisite Condition	<ol style="list-style-type: none"> 1, For VR5-HD, load the setting file –Verification.hde 2, For spectrum analyzer: Preset all the parameter to factory default values and set parameter as follows: <ul style="list-style-type: none"> • Center Frequency = 900 MHz • Span = 1 MHz • RBW = 10 kHz • Sweep Time = 30 ms • Reference Level = -20 dBm
Test Procedure:	<ol style="list-style-type: none"> 1, Setup signal generator to generate a CW tone signal @ 900MHz frequency 2, Configure power level of signal generator to -10dBm

3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator.

4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to "File" – "Open Settings", find Verification.hde on the desktop (this file is provided by Spirent)

5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel:

6, Check the input expected power level setting for port 1 is -10dBm:

7, Check the threshold of the power meter for port A1 to:

- Trigger Mode : RELATIVE
- Trigger Threshold : -20



8, Connect signal generator to VR5 port 1.

9, Change RF output power from -20dBm to -50dBm with 10dB step size and measure output power of each step.

Pass Criteria:

The measurement result from spectrum analyzer for VR5 output port B1 should be the same as the measured output power level (if the RF cable loss is not counted).

Note:

As there is RF cable loss is involved in the measurement, sometimes it is a little hard to measure the input power and output power accurately, rule of thumb is to monitor the internal power meter in the output power section like below:

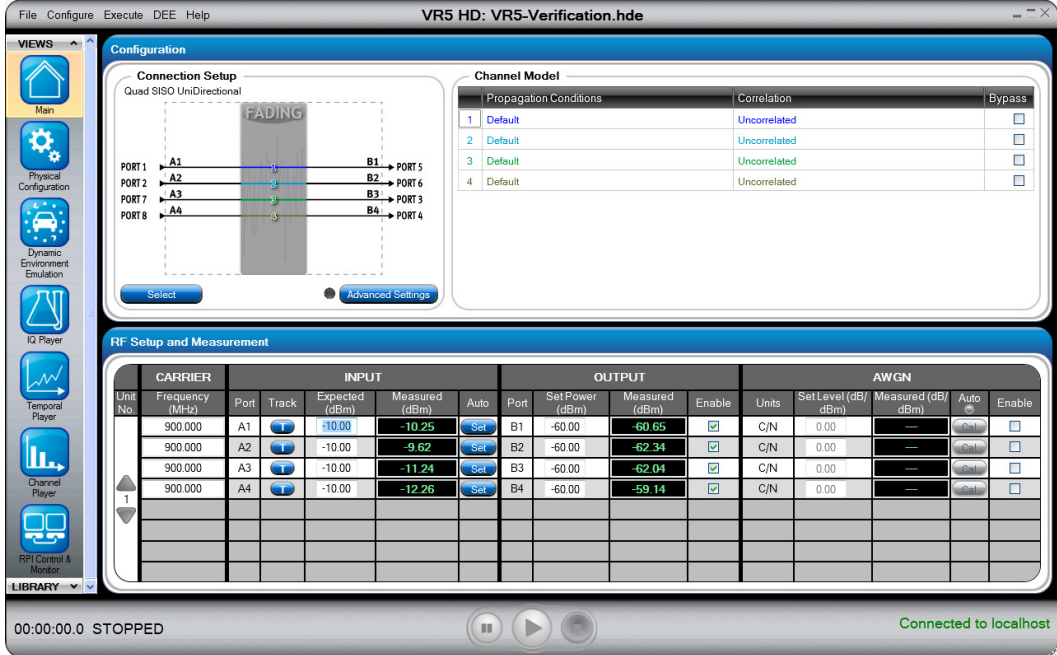
RF Setup and Measurement															
Unit No.	CARRIER			INPUT			OUTPUT				AWGN				
	Frequency (MHz)	Port	Track	Expected (dBm)	Measured (dBm)	Auto	Port	Set Power (dBm)	Measured (dBm)	Enable	Units	Set Level (dB/dBm)	Measured (dB/dBm)	Auto	Enable
1	900.000	A1	T	-10.00	-7.72	Set	B1	-20.00	-22.01	✓	C/N	0.00	---	Cal	☐
	900.000	A2	T	-10.00	-8.90	Set	B2	-60.00	-57.93	✓	C/N	0.00	---	Cal	☐
	900.000	A3	T	-10.00	-11.52	Set	B3	-60.00	-57.79	✓	C/N	0.00	---	Cal	☐
	900.000	A4	T	-10.00	-11.68	Set	B4	-60.00	-61.48	✓	C/N	0.00	---	Cal	☐

2.3. Delay

Test Item	Path Delay
Test Equipment	Network analyzer or vector network analyzer
Prerequisite Condition	For VR5-HD, load the setting file –Verification.hde

Test Procedure:

- 1, Setup signal generator to generate a CW tone signal @ 900MHz frequency
- 2, Configure power level of signal generator to -10dBm
- 3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator.
- 4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to “File” – “Open Settings”, find Verification.hde on the desktop (this file is provided by Spirent)
- 5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel:
- 6, Check the input expected power level setting for port 1 is -10dBm:
- 7, Check the threshold of the power meter for port A1 to:
 - Trigger Mode : RELATIVE
 - Trigger Threshold : -20



00:00:0.0 STOPPED Connected to localhost

- 8, Connect signal generator to VR5 port 1.
- 9, Configure delay values in the static path to different value and measure the delay through VNA or Spectrum.

Path	Fading Type	Fading Doppler (Hz)	Fading Doppler Vel. (km/h)	Cluster Modeling	Relative Path Loss (dB)	Delay Mode	Delay Value (µs)	Minimum (µs)	Maximum (µs)	Rate of Osc. (rad/sec)	Delay
<input checked="" type="checkbox"/>	Static			<input type="checkbox"/>	0	Fixed	10				

Pass Criteria:

The accuracy of delay measurement is within 0.0001us (1ns).

2.4. C/N Accuracy Measurement

Test Item	C/N accuracy measurement
Test Equipment	Signal generator, spectrum analyzer
Prerequisite Condition	For VR5-HD, load the setting file –Verification.hde

Test Procedure:

- 1, Setup signal generator to generate a CW tone signal @ 900MHz frequency
- 2, Configure power level of signal generator to -10dBm
- 3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator.
- 4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to “File” – “Open Settings”, find Verification.hde on the desktop (this file is provided by Spirent)
- 5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel:
- 6, Check the input expected power level setting for port 1 is -10dBm:
- 7, Check the threshold of the power meter for port A1 to:
 - Trigger Mode : RELATIVE
 - Trigger Threshold : -20

The screenshot shows the VR5 HD: VR5-Verification.hde software interface. The interface is divided into several sections:

- Configuration:** Shows a connection diagram with ports A1-A4 and B1-B4. A 'FADING' block is visible between A1 and B1. Below the diagram are 'Select' and 'Advanced Settings' buttons.
- Channel Model:** A table with columns: Propagation Conditions, Correlation, and Bypass. It lists four entries, all with 'Default' propagation conditions and 'Uncorrelated' correlation.
- RF Setup and Measurement:** A table with columns: CARRIER, INPUT, OUTPUT, and AWGN. It shows settings for four ports (A1, A2, A3, A4) at 900.000 MHz. The INPUT column shows Expected and Measured power levels. The OUTPUT column shows Set Power and Measured power levels. The AWGN column shows Set Level and Measured dB/dBm.

Unit No.	CARRIER	INPUT	OUTPUT	AWGN										
Frequency (MHz)	Port	Track	Expected (dBm)	Measured (dBm)	Auto	Port	Set Power (dBm)	Measured (dBm)	Enable	Units	Set Level (dB/dBm)	Measured (dB/dBm)	Auto	Enable
1	900.000	A1	-10.00	-10.25	Set	B1	-60.00	-60.65	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>
2	900.000	A2	-10.00	-9.62	Set	B2	-60.00	-62.34	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>
3	900.000	A3	-10.00	-11.24	Set	B3	-60.00	-62.04	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>
4	900.000	A4	-10.00	-12.26	Set	B4	-60.00	-59.14	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>

- 8, Connect signal generator to VR5 port 1, connect VR5 port 5 to spectrum analyzer

9, Enable AWGN from RF Setup and Measurement Grid.

10, Configure C/N from RF Setup and Measurement to 0dB, 3dB, 6dB, -3dB, -6dB separately.

RF Setup and Measurement															
CARRIER		INPUT					OUTPUT				AWGN				
Unit No.	Frequency (MHz)	Port	Track	Expected (dBm)	Measured (dBm)	Auto	Port	Set Power (dBm)	Measured (dBm)	Enable	Units	SetLevel (dB/dBm)	Measured (dB/dBm)	Auto	Enable
	900.000	A1		-10.00	-8.45	Set	B1	-60.00	-61.47	<input checked="" type="checkbox"/>	C/N	0.00	2.70	Cal	<input checked="" type="checkbox"/>
	900.000	A2		-10.00	-12.38	Set	B2	-60.00	-58.40	<input checked="" type="checkbox"/>	C/N	0.00	---	Cal	<input type="checkbox"/>
	900.000	A3		-10.00	-10.50	Set	B3	-60.00	-58.00	<input checked="" type="checkbox"/>	C/N	0.00	---	Cal	<input type="checkbox"/>
	900.000	A4		-10.00	-10.61	Set	B4	-60.00	-58.49	<input checked="" type="checkbox"/>	C/N	0.00	---	Cal	<input type="checkbox"/>

11, Measure from spectrum analyzer to see whether the total RF power is the summation of result from in-band power and noise power.



CtoN
Measurement.xls

Pass Criteria:

The measurement result from spectrum analyzer is the same as CtoN Measurement table.

2.5. Phase Accuracy Measurement

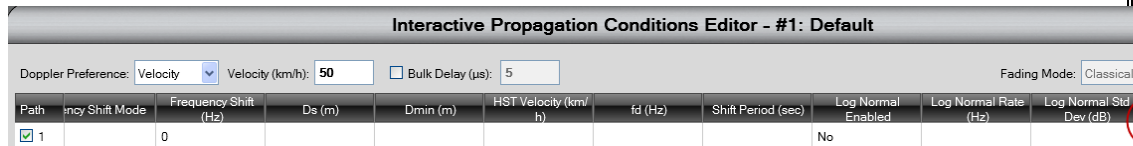
Test Item	Phase accuracy measurement
Test Equipment	Network analyzer or vector network analyzer
Prerequisite Condition	For VR5-HD, load the setting file –Verification.hde
Test Procedure:	
<ol style="list-style-type: none"> 1, Setup signal generator to generate a CW tone signal @ 900MHz frequency 2, Configure power level of signal generator to -10dBm, set output power level for VR5 port B1 to -60dBm. 3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator. 4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to “File” – “Open Settings”, find Verification.hde on the desktop (this file is provided by Spirent) 5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel: 6, Check the input expected power level setting for port 1 is -10dBm: 7, Check the threshold of the power meter for port A1 to: <ul style="list-style-type: none"> • Trigger Mode : RELATIVE • Trigger Threshold : -20 	



8, Connect network analyzer port 1 to VR5 port 1, connect port 2 of network analyzer to VR5 port 5.

9, Enable AWGN from RF Setup and Measurement Grid.

10, Configure different Phase Shift on a single static path like below:



11, Measure the phase difference before and after change the phase offset.

Pass Criteria:

The measured phase difference between before and after phase change should be within 1 °

2.6. Rayleigh Fading

Test Item	Rayleigh Fading verification
Test Equipment	Signal generator, spectrum analyzer
Prerequisite Condition	<p>1, For VR5-HD, load the setting file –Verification.hde</p> <p>2, For spectrum analyzer:</p> <p>Preset all the parameter to factory default values and set parameter as follows:</p> <ul style="list-style-type: none"> Center Frequency = 900 MHz Span = 1 kHz Resolution Bandwidth = 10 Hz

- Sweep Time = 30 sec
- Reference Level = -20 dBm
- Scale = 10 dB/div

Test Procedure:

- 1, Setup signal generator to generate a CW tone signal @ 900MHz frequency
- 2, Configure power level of signal generator to -10dBm, set the output power of VR5 for port B1 to -60dBm.
- 3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator.
- 4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to “File” – “Open Settings”, find Verification.hde on the desktop (this file is provided by Spirent)
- 5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel:
- 6, Check the input expected power level setting for port 1 is -10dBm:
- 7, Check the threshold of the power meter for port A1 to:
 - Trigger Mode : RELATIVE
 - Trigger Threshold : -20

The screenshot displays the VR5 HD: VR5-Verification.hde software interface. The main window is titled "VR5 HD: VR5-Verification.hde" and contains several panels:

- Configuration Panel:**
 - Connection Setup:** Shows a diagram of a fading channel with ports A1, A2, A3, A4 and B1, B2, B3, B4. A "FADING" block is shown between the input and output ports.
 - Channel Model:** A table showing propagation conditions and correlation values.
- RF Setup and Measurement Panel:** A table with columns for CARRIER, INPUT, OUTPUT, and AWGN. The table contains data for four ports (A1, A2, A3, A4) at 900.000 MHz.

The status bar at the bottom indicates "00:00:00.0 STOPPED" and "Connected to localhost".

CARRIER		INPUT				OUTPUT				AWGN					
Unit No.	Frequency (MHz)	Port	Track	Expected (dBm)	Measured (dBm)	Auto	Port	Set Power (dBm)	Measured (dBm)	Enable	Units	Set Level (dB/dBm)	Measured (dB/dBm)	Auto	Enable
1	900.000	A1	T	-10.00	-10.25	Set	B1	-60.00	-60.65	<input checked="" type="checkbox"/>	C/N	0.00	---	Auto	<input type="checkbox"/>
	900.000	A2	T	-10.00	-9.62	Set	B2	-60.00	-62.34	<input checked="" type="checkbox"/>	C/N	0.00	---	Auto	<input type="checkbox"/>
	900.000	A3	T	-10.00	-11.24	Set	B3	-60.00	-62.04	<input checked="" type="checkbox"/>	C/N	0.00	---	Auto	<input type="checkbox"/>
	900.000	A4	T	-10.00	-12.26	Set	B4	-60.00	-59.14	<input checked="" type="checkbox"/>	C/N	0.00	---	Auto	<input type="checkbox"/>

- 8, Connect network analyzer port 1 to VR5 port 1, connect VR5 port 5 to spectrum analyzer.
- 9, Change first path of Fading type to Rayleigh and fading doppler velocity to 100km/h (Corresponding Doppler frequency shift : 83.4Hz)
- 10, Verify that the signal on the spectrum analyzer takes the shape of the “Classic Rayleigh Spectrum” with a bandwidth of approximately 167 Hz. See Figure 5.
- 11, Change the following settings on the spectrum analyzer to verify Rayleigh fading in the time domain:
 - Span = Zero Span
 - Resolution Bandwidth = 100 kHz
 - Sweep Time = 100 msec
 - Scale = 7 dB/div
- 12, Verify the signal on the spectrum analyzer is fluctuating rapidly with deep fades that range from approximately 30 dB to 60 dB.

Pass Criteria:

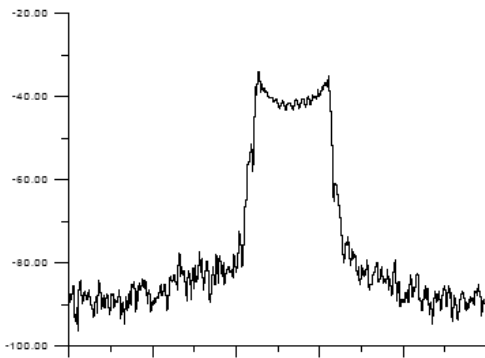


Figure 5. Rayleigh Fading (Frequency Domain)

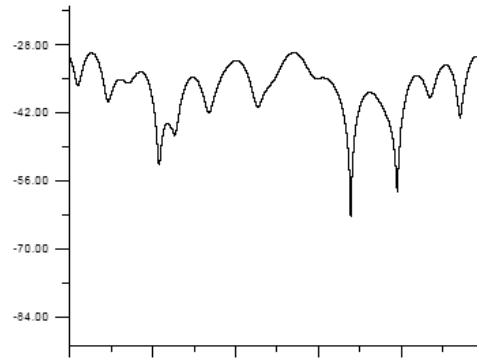


Figure 6. Rayleigh Fading (Time Domain)

2.7. Frequency Shift

Test Item	Frequency shift verification
Test Equipment	Signal generator, spectrum analyzer
Prerequisite Condition	<p>1, For VR5-HD, load the setting file –Verification.hde</p> <p>2, For spectrum analyzer:</p> <p>Preset all the parameter to factory default values and set parameter as follows:</p> <ul style="list-style-type: none">• Center Frequency = 900 MHz• Span = 1 kHz• Resolution Bandwidth = 10 Hz• Sweep Time = 30 sec• Reference Level = -20 dBm• Scale = 10 dB/div
Test Procedure:	<p>1, Setup signal generator to generate a CW tone signal @ 900MHz frequency</p> <p>2, Configure power level of signal generator to -10dBm, set the output power of VR5 for port B1 to -60dBm.</p> <p>3, Configure center frequency of the signal generator to Low/Mid/High frequency range of channel emulator, according to your test requirement, make sure center frequency of the signal generator is the same as center frequency set on the channel emulator.</p> <p>4, From controller PC, launch VR5-HD Spatial Emulator Software, connected to VR5 with correct IP address, go to “File” – “Open Settings”, find Verification.hde on the desktop (this file is provided by Spirent)</p> <p>5, Check the Carrier Frequency to 900MHz on RF Setup and Measurement Grid panel:</p> <p>6, Check the input expected power level setting for port 1 is -10dBm:</p> <p>7, Check the threshold of the power meter for port A1 to:</p> <ul style="list-style-type: none">• Trigger Mode : RELATIVE• Trigger Threshold : -20

File Configure Execute DEE Help VRS HD: VR5-Verification.hde

Configuration

Connection Setup
Quad SISO UniDirectional

Channel Model

Propagation Conditions	Correlation	Bypass
1 Default	Uncorrelated	<input type="checkbox"/>
2 Default	Uncorrelated	<input type="checkbox"/>
3 Default	Uncorrelated	<input type="checkbox"/>
4 Default	Uncorrelated	<input type="checkbox"/>

RF Setup and Measurement

Unit No.	CARRIER	INPUT				OUTPUT				AWGN					
		Frequency (MHz)	Port	Track	Expected (dBm)	Measured (dBm)	Auto	Port	Set Power (dBm)	Measured (dBm)	Enable	Units	Set Level (dB)	Measured (dB)	Auto
	900.000	A1	T	-10.00	-10.25	Set	B1	-60.00	-60.65	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>
	900.000	A2	T	-10.00	-9.62	Set	B2	-60.00	-62.34	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>
	900.000	A3	T	-10.00	-11.24	Set	B3	-60.00	-62.04	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>
	900.000	A4	T	-10.00	-12.26	Set	B4	-60.00	-59.14	<input checked="" type="checkbox"/>	C/N	0.00	---	<input type="checkbox"/>	<input type="checkbox"/>

00:00:00.0 STOPPED Connected to localhost

- 8, Connect network analyzer port 1 to VR5 port 1, connect VR5 port 5 to spectrum analyzer.
- 9, Change first path of Frequency shift to 200Hz like below:

Interactive Propagation Conditions Editor - #1: Unsaved Profile

Doppler Preference: Velocity Velocity (km/h): 100 Bulk Delay (µs): 5 Fading Mode: Classical Channel Model

Path	Incy Shift Mode	Frequency Shift (Hz)	Ds (m)	Dmin (m)	HST Velocity (km/h)	fd (Hz)	Shift Period (sec)	Log Normal Enabled	Log Normal Rate (Hz)	Log Normal Std Dev (dB)	Phase Shift (Deg)
<input checked="" type="checkbox"/> 1		200						No			10

- 10, Verify the signal on the spectrum analyzer is frequency shifted by approximately 200 Hz

Pass Criteria:

Verify the signal on the spectrum analyzer is frequency shifted by approximately 200 Hz

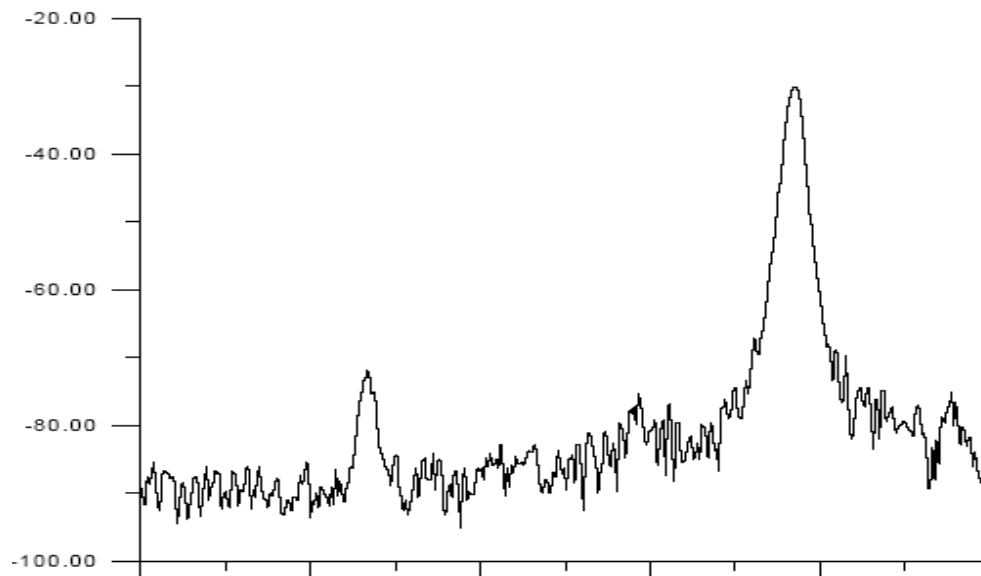


Figure 8. Frequency Shift Signal