

FIELAX Gesellschaft für wissenschaftliche Datenverarbeitung mbH Schleusenstr. 14, D-27568 Bremerhaven, GERMANY Fon: +49 (0)471 30015-0, Fax: +49 (0)471 30015-22, Mail: info@fielax.de

Quick Start Guide for Teledyne RD Instruments Ocean Surveyor 150 kHz ADCP on RV 'Heincke'



Source: Teledyne RDI Ocean Surveyor Datasheet

Contact:

FIELAX Gesellschaft für wissenschaftliche Datenverarbeitung mbH Schleusenstr. 14, D-27568 Bremerhaven, GERMANY Fon: +49 (0)471 30015-0, Fax: +49 (0)471 30015-22 Mail: echo-support@fielax.de

Ref.:	Vers.:	Date:	Status:
RV_Heincke_ADCP_Support_150kHz.pdf	6	2019-02-27	final

Bank Account: Weser-Elbe Sparkasse, IBAN: DE17 2925 0000 0004 0162 20, BIC: BRLADE21BRS VATIN: DE221948243, Tax No 60/137/00794, FA Bremen Comm. Reg.: HRB 3506, AG Bremen, Managing Director: Dr. Regina Usbeck



Contents

С	ontent	s2
Do	ocume	ent history 2
1	A	CP Installation Overview
	1.1	Sensor Equipment 3
	1.2	Sensor Structure
	1.3	Software 5
2	Sy	/stem Start-up5
	2.1	Switch on ADCP 5
	2.2	System Test (BBTalk) 6
3	Vr	nDas Acquisition Software7
	3.1	Communications Settings 8
	3.2	ADCP Settings
	3.3	Changes in the ADCP Setup File10
	3.4	Recording Settings11
	3.5	Navigation Settings12
	3.6	Transformation Settings13
	3.7	Averaging Settings14
	3.8	Data Screening Settings14
	3.9	User Exits15
	3.10	Sim Inputs15
	3.11	Short Term Averages (STA) in VmDas16
4	W	inADCP17
	4.1	Exporting Data17
Ap	pend	ix19
	BBTal	k Test Result

Document history

Version	Date	Description
1	2012-04-03	First version of this manual
2	2015-03-18	600 kHz ADCP added
3	2016-06-22	600 kHz ADCP and Saab DGPS changes
4	2016-08-15	Separate manual for 150 kHz and 600 kHz ADCPs
5	2017-02-17	Complete removal of 600 kHz ADCP information; updated wiring chart
6	2019-02-27	Communication settings changed, BBTalk result added



1 ADCP Installation Overview

1.1 Sensor Equipment

The following sensors are installed on the RV 'Heincke' (Table 1).

Sensor	Model	Details from Manufacturer
ADCP 150 kHz	Teledyne RDI Ocean Survevor	Range: 400 m Vertical resolution cell size: 4 - 8 m
		relative to the ADCP \pm 0.5 cm/s Velocity resolution: 9 - 30cm/s Number of depth cells: 1 - 128
Inertial Navigation	IXSea Phins	Heading accuracy: 0.05 deg (without aiding)
System		Heave accuracy: 5 cm or 5%
(INS)		
Primary Positioning	Trimble SP461	Primary Positioning system DGPS
Unit		0.5 - 5 m accuracy
Backup Positioning	Saab R5	Secondary Positioning system DGPS
Unit		

Table 1: Sensor specification

1.2 Sensor Structure

Table 1 and Figure 1 show the sensor structure of the Teledyne RDI Ocean Surveyor 150 kHz ADCP hardware and Figure 2 shows the installation in the laboratory. The 150 kHz transducer is hull mounted. The deck units of both ACDPs (Teledyne RDI Ocean Surveyor 150 kHz and Teledyne RDI Workhorse Mariner 600 kHz) are permanently installed in the server rack next to the operator PC. The operator PC receives data from one ADCP deck unit at a time (no parallel operation!), position information from the Trimble DGPS receiver, as well as attitude data (heading) from the IXSea PHINS III Inertial navigation system (INS). Recorded data should be regularly copied to the network shares of the XDC storage server.



Setup using the 150 kHz ADCP and VmDas



Figure 1: Wiring diagram



Figure 2: Photo showing the system in the lab



1.3 Software

The software *VmDas* (Vessel-mount data acquisition system) is used for data acquisition and configuration of the Teledyne RDI Ocean Surveyor 150 kHz ADCP. The software *WinADCP* can be used for visualization and export of recorded raw data. Both software packages are installed on the ADCP operator PC.

Please note: On the operator PC, also the software WinRiver II is installed. WinRiver II does not support the Teledyne RDI Ocean Surveyor 150 kHz ADCP. Do not use WinRiver for this system, it is exclusively installed for use with the Teledyne RDI Workhorse Mariner.

2 System Start-up

This manual is created for the specific use of the Teledyne Ocean Mariner 150 kHz ADCP (ADCP in the following text) on RV 'Heincke' and focuses on the most important parameters to be looked after during data acquisition. We recommend to additionally check the *VmDas Quick Start Guide* and *VmDas User Guide*.

2.1 Switch on ADCP

- 1. Power up the ADCP operator PC (Figure 2, right)
- 2. Power up the deck unit in the server rack (Figure 2, right)



2.2 System Test (BBTalk)

Before you start a survey, you should perform a hardware system test.

- 1. Start the BBTalk program from the desktop of the operator PC.
- 2. Connect to the ADCP unit by selecting the settings:

Device: Broadband	Baud Rate: 9600	
Connect Using	Parity : None 💌	
COM Port : COM4	Stop Bits : 1	
	Flow Control : None	

Figure 3: Define COM port and serial connection settings in BBTalk

3. Select Options as shown below:

Options	×
Send Break On New Connection	
Use Software Break ("===") With Radio Modems	
Connect To Last Open Port On Startup	
Ovenwrite Log Files When Opening	
Error Checking For Script Files	
Send CK On Baud Rate Change (CB Command)	
Echo Characters	
Wait for Prompt in Script File	
Finis	h Abbrechen

Figure 4: Program settings in BBTalk

- 4. To run the test, several commands need to be sent to the ADCP.
- 5. Select the menu *File* → *Send script file* or press <*F*2>.
- 6. Select the file C:\Program Files (x86)\RD Instruments\RDI Tools\ TestOS.rds.

This file contains the following set of commands for the ADCP which is executed one after another (The Enter button can be pressed to skip the delays.):

CR1, TS?, PS0, PA, PT3, PT6

The results can be saved to a text file via copy & paste (see Appendix).

3 VmDas Acquisition Software



The software VmDas is used for data acquisition and playback.

- 1. Start the VmDas program from the desktop of the operator PC
- Select *File* → *Collect Data* and then import the default configuration settings using *Options* → *Load*. The default configuration is:

C:\ADCP\150kHz_OceanSurveyor\config\150kHz_OceanSurveyor_TCPIP.ini.

- The configuration settings should be checked before data acquisition. Enter the menu Options → Edit Data Options and edit the settings as described in the section 3.1 to 3.11.
- After checking the settings carefully, start the data acquisition. Select the menu *File* → *Collect Data* or press the button at the upper left of the main window. The data recording starts immediately and the screen looks about the same as the screenshot in Figure 5.







3.1 Communications Settings

The Communications tab (in menu **Options** \rightarrow **Edit Data Options**) configures the serial or network connections to the ADCP, the GPS and the motion sensor. Make sure that the inputs correspond to those in Figure 6 (red rectangle).

Select Item to Set		Current Se	ttinas:		
		COM F	Port Setup	Ethernet	Setup
· · · · · ·		on		on	
ADCP Input		COM4	. 9600, N, 8, 1	0.0.0.0:56	70
C NMEA I Input		I COM1	. 4800, N, 8, 1	192.168.1	60.60:5013
C NMEA 2 Input		I∕ COM5	, 19200, N, 8, 1	0.0.0.0:56	79
		None,	4800, N, 8, 1	0.0.0.0:56	80
C Ensemble Output (Binary LTA)	□ None,	9600, N, 8, 1	0.0.0.0:54	33
C Ensemble Output (ASCII)	□ None,	9600, N, 8, 1	□0.0.0.0:54	33
C Speed Log Output		□ None,	9600, N, 8, 1	□0.0.0.54	34
Enable Network	Port IP 5670 Local Address	TCP UDP	Server	0	Set

Figure 6: Required communication settings for 150 kHz ADCP

Please note: Due to several problems with the COM1 Port, the NMEA 1 Input (GPS input) has now been changed to TCP/IP (Figure 7).

Select Item to Set:		Current Settin	gs:		
		COM Port	Setup	Etherne	t Setup
C ADCP Input		COM4	9600 N 8 1	on	670
• NMEA 1 Input		□ сом1, 4	4800, N, 8, 1	₩ 192.168	160.60:5013
C NMEA 2 Input		I COM5, 1	9200, N, 8, 1	□0.0.0.0	679
C NMEA 3 Input		None, 4	800, N, 8, 1	T0.0.0.0	680
C Ensemble Output (Binary LTA)	None, 9	600. N. 8. 1	T0.0.0.0	433
C Ensemble Output (ASCII)	None, 9	600, N, 8, 1	0.0.0.0	5433
C Speed Log Output		□ None, 9	□ None, 9600, N, 8, 1 □ □ 0,0,0,5434		i434
	Port IP	TCP UDP	c	-	
	5013 192.168.160.60		Server	C	Set
Finable Network			Client	, e	1
Enable Network					
✓ Enable Network					
✓ Enable Network					
I Enable Network					
✓ Enable Network					

Figure 7: Changed NMEA 1 Input (GGA, VTG from Trimble DGPS)



3.2 ADCP Settings

For the 150 kHz ADCP, both ADCP Setup are possible in VmDas. For standard usage, we recommend however to use *ADCP Setup from File*. Please do not overwrite the default file *OS150BBDEF_shortrange_broadband_highres.txt*. If bottom tracking is activated (default setting and recommended), the *Ensemble Time* should be set to *Ping as fast as possible* (Figure 8).

Use Options	Water Current Profile Water Current Profile Set Profile Parameters Number of Bins: 80 Bin Size: 8 meters Blank Distance: 8 meters Transducer 4 meters Depth: meters Set Processing Mode C Hirresolution (short range) C Low-resolution (long range)		Heading Sensor Set Sensor Type Internal Sensor External Analog Gyro (Synchro/Stepper) Tilt Sensor Set Sensor Type Internal Sensor Set Sensor Type Internal Sensor External Analog Gyro (Synchro) Bottom Track Set On Range: 30 Salinity 35 ppt			
					nchro) m ppt	
ADCP Setup from F GUse File View/Edit	ile Command File C:\ADCP\150kHz_Oce Ensemble Time © Ping as fast a C Set time betw	s possible een ensemble	config\OS150	BBDEF_shortrange	e_broadband_hit	Browse

Figure 8: ADCP and auxiliary sensor setup



3.3 Changes in the ADCP Setup File

The setup file contains the following commands (Table 2) that can be modified by the user:

Command	Description	Default
CR	Retrieve Parameters	CR1
CF	Flow Control	CF11110
BM	Bottom Track Mode	BM5
BP	Bottom-Track Pings Per Ensemble	BP1
BX	Maximum Tracking Depth	BX1500
EA	Heading Alignment	EA03400
EB	Heading Bias	EB0
ED	Depth of Transducer [decimeter]	ED40
ES	Salinity [PSU]	ES35
EX	Coordinate Transformation	EX11111
EZ	Sensor Source	EZ111101
WA	False Target Threshold Maximum	WA50
WB	Mode 1 Bandwidth Control	WB0
WD	Data Out	WD111100000
WF	Blank after Transmit [centimeter]	WF200
WN	Number of Depth Cells	WN23
WP	Pings Per Ensemble	WP1
WS	Depth Cell Size [centimeter]	WS200
WV	Ambiguity Velocity	WV175
TE	Time Per Ensemble	TE00:00:01.46
TP	Time Between Pings	TP00:00.73
СК	Keep Parameters	CK
CS	Start Pinging (Go)	CS

Table 2: command description

Only the settings marked red should be modified according to the desired range and resolution. WB0 stands for wide bandwidth with a high sample rate and a low profiling range, WB1 should be chosen for narrow bandwidth with a low sample rate and a high profiling range. Blank after transmit specifies the space between the transducer and the first depth cell.



3.4 Recording Settings

The Recording tab (in menu **Options** \rightarrow **Edit Data Options**) configures the recording options for your survey/expedition. Choose an adequate name for your survey/expedition. Set the primary path for recorded files to **C:\ADCP\150kHz_OceanSurveyor\data** as shown inFigure 9. If a backup is desired, check **Dual Output Directories** and provide a path (**H:\Scientist\data\ADCP**).

Deployment Files			
Name:	HE476_		
Number:	1 The second sec	he deployment number displayed here is automatic ne software each time data is collected or reproces	ally chosen by sed. Change
Max Size (MB):	10 th	ne number to override the software's choice.	
Output Directorie	1		
DISABLED			
Primary Path:	Directories	an Surveyor\data\HE476	Browse
Backup Path:	Z:\Scientists\HE476\add	cp\150kHz_OceanSurveyor	Browse
1010000000000000	,		

Figure 9: Recording settings; make sure to set correct output and backup directories.



3.5 Navigation Settings

This tab configures the navigation input sources for the ship's position and the ship's speed over ground. Ensure the settings are as shown in Figure 10.

ogram Options				(
Communications ADCP	Setup Recording NAV	Transform Averaging Data	Screening User Exits Sim	Inputs	
NMEA Ship Position (GGA) Source	NMEA Ship Speed (VT	G) Source		
🔽 Enable	Enable Backup	🔽 Enable	Enable Backup	Enable Backup	
NMEA1 -	<u></u>	NMEA1 -	<u> </u>		
		-] [

Figure 10: Required navigation input settings



3.6 Transformation Settings

The reference beam 3 of the ADCP is mounted 45° relative to the ship's longitudinal axis which has been detected by a bottom and water track measurement. Ensure this offset is given as the EA Heading Alignment Error in the configuration!

The Transform tab configures heading and roll/pitch input sources as well as angular offsets for each parameter.

Janding Source	- Tit Source		
NMEA Port	NMEA Port		
PRDID VI NMEA2 VI	PRDID V NMEA2 V		
Pixed Heading (deg)			
	0 Fixed Roll (deg)		
Enable Backup Source NMEA Port	Enable Backup Source NMEA Port		
ADCP Compass 💌	ADCP Tilt Sensor 💌		
Fixed Heading (deg)	Fixed Pitch (deg)		
	0 Eved Boll (deg)		
Custom NMEA: C:\Program Files (x86)\RD Inst	ruments\VmDas Browse		
Joading Sanaar Magnetic (Electrical Competings	- ADCR Alignment Competion		
reading Sensor Magnetic/Electrical Corrections	ADCF Alignment Correction 45°		
D D D D D D D D D D D D D D D D D D D			
U EV: Primary Heading error	A Heading alignment error		
U EV: Backup Heading error	U EJ Pitch alignment error		
	0 El Roll alignment error		
V = Vessel true Heading - Sensor Heading	EA = Beam 3 Heading when Vessel heads North		
	EJ = Vessel Roll when ADCP is level		
	EI = Vessel Pitch when ADCP is level		

Figure 11: Required transformation settings



3.7 Averaging Settings

This tab (in menu **Options** \rightarrow **Edit Data Options**) configures the averaging of the ADCP raw data. Configure as shown in Figure 12 or adjust the settings according to your requirements. The settings will not affect the raw data.

Communications ADCP Setup Reco	rding NAV	Transform	Averaging	Data Screening	User Exits	Sim Inputs
Averaging Method						
Temporal						
First Time Interval (STA):	120	seconds				
Second Time Interval (LTA):	600	seconds				
Profile Ping Normalization Reference	Layer					
Enable						
Start bin:	1	1				
Endhin	,					
	110					

Figure 12: Averaging settings, adjustable to your requirements

3.8 Data Screening Settings

The Data Screening tab (in menu **Options** \rightarrow **Edit Data Options**) configures the screening settings for the visualization of the ADCP raw data. Adjust these settings according to your requirements.

You can set limits for RSSI (amplitude), correlation, percent good, error velocity, vertical velocity and fish screening. If the raw values are below the selected minimum limits the values will not be displayed nor included in the short time and long-time averages. The raw data is of course not affected by these settings.



3.9 User Exits

In this tab it is recommended to check the Launch WinAdcp box as shown in Figure 13.

mmunications ADCP Se	etup Recording NAV Transform Averaging Data Screening	g User Exits Sim Input
WinAdcp Application		
🔽 Launch WinAdcp		
WinAdcp Path:	C:\Program Files\RD Instruments\WinAdcp\WinAdcp.exe	Browse
Data File To Open:	.ENX - Single ping Earth data	
Refresh Interval (sec):	10	
Enable		
Enable External Raw Nav Dat Enable	a Screening/Pre-Averaging	
Enable	a Screening/Pre-Averaging	
Enable External Raw Nav Dat Enable	a Screening/Pre-Averaging	
Enable	a Screening/Pre-Averaging	

Figure 13: Recommended User Exits settings

3.10 Sim Inputs

This tab shows options to replay already recorded data. For data collection (default) it should be configured as shown in Figure 14.

gram Options	
ommunications ADCF	Setup Recording NAV Transform Averaging Data Screening User Exits Sim Inputs
- For Testing in Collec	t Mode Only
- ADCP Data Simula	
 Collect real AD 	CP data.
C Generate simu	lated data for a real ADCP collecting in air.
C Simulate ADCF	data from a pre-recorded file. (Remote input disabled)
Ping Time:	2 seconds
Filename	C\ADCR\d++\HETert_20120206\Heimdro_20120206004_000000_EN
nonano.	
- NMEA Data Simula	tion
NMEA Data Simula Ollect real NN	tion
NMEA Data Simula Collect real NM	tion IEA or Simrad data.
NMEA Data Simula Collect real NM Simulate COM	ation MEA or Simrad data. NMEA data from a pre-recorded file. (Remote input disabled)
NMEA Data Simula Ollect real NM O Simulate COM Filename:	tion
NMEA Data Simula C Collect real NM C Simulate COM Filename:	tion
NMEA Data Simula © Collect real NN © Simulate COM Filename:	tion
NMEA Data Simula © Collect real NN © Simulate COM Filename:	tion
NMEA Data Simula Collect real NN CSimulate COM Filename:	tion
NMEA Data Simula Collect real NN C Simulate COM Filename:	tion
NMEA Data Simula Collect real NM Simulate COM Filename:	tion
NMEA Data Simula Collect real NM Simulate COM Filename:	tion
NMEA Data Simula Collect real NM Simulate COM Filename:	tion
NMEA Data Simula Collect real NM Simulate COM Filename:	tion
NMEA Data Simula Collect real NN C Simulate COM Filename:	tion
NMEA Data Simula Collect real NM Simulate COM Filename:	tion

Figure 14: Configuration for data collection



3.11 Short Term Averages (STA) in VmDas

VmDas offers the possibility to display already averaged velocities (according to the averaging settings, Figure 12) on a map including the ship movement on a map (screenshot

in Figure 15). Therefore, press the tab \square in the toolbar. You can change the references / displayed velocities under **Options** \rightarrow **Edit Display Option** (this will not affect the raw data collection).

🕿 Teledyne F	RDI VmDas - [Tes 010 <vm[< th=""><th>Das1>]</th><th></th><th></th><th></th><th></th><th></th><th></th></vm[<>	Das1>]						
🕿 File Vie	w Options Control C	Chart Window Hel	lp					_ 8 ×
	BN		💹 🖓 🎹 🎦 🔀					
Profiles	⊂ Ship Track 1 ⊂ Ship Tr	ack 2 🛛 👍 🛉	12 12 12 1		Keep on screen			
NAV	Speed Avg	Made good Star	rt Time 9:05:37 A.M.	End Time 9:06:07 A.M	l. Heading 268.56			
Ens Num 3	Mag 1.944	1.928 m/s St	tart Lat 55 03 17 N	End Lat 55 03 17 N	Pitch			
Date 09	9 Jul 2014 Dir 259.5	260.4 deg Sta	art Lon 8 28 02 E	End Lon 8 27 59 E	Roll			
S	Short Average Velocity - I Velocity (m/s), Dir	Ens 3, 09 Jul 2014 rection (deg) Ref: Detta	4 09:05:40.00 a pos		Short Average Data Qu	uality - Ens 3, 09 Ju Counts & Percent	ıl 2014 09:05:40.00	
0.00	0.25	0.50	0.75 1.00	0	64	128	192	256
	2							
25				25				
							>	
50			<u>.</u>	50	····· ÷.,	> ,Z ₁		
75				75				
100				100				
U Depth (m)	90	180	270 360	Depth (m)	25	50	75	100
		Magnitu	ude — Directio	n		RSSI	Correlation	Percent good
		Ship Trac Ship Trad	k 1 - NAV - Ref: Delta p Bin 1 — Bin 2	00S -Bin 3				
55.063	1							
55.058 g	9							
8								
- 1.0 deg)								
<u>्</u> 55.054 क	8		and the second s					
55.050	0							
55.048								
8.	.451	8.459	8.467	8.476	8.484			
1			Lon (deg)				Ens Sim Mode	/ Sim Mode
								Sintinoue //

Figure 15: Screenshot of VmDas during data replay

4 WinADCP



The WinADCP software can be used for visualization and export of the recorded ADCP data (screenshot in Figure 16). For a detailed description, please read the *WinADCP User Manual* for help on how to use the software.



Figure 16: Screenshot of WinADCP during data replay

4.1 Exporting Data

Besides several displaying and replay features of the collected data, WinADCP is used to Export the data to ASCII-format. Before that, open the *WinADCP Chart Options* with a right-mouse-click in either the *Whole Set* or *Sub Set* window (Figure 17). Here you can choose under *Processing* if the velocity is already corrected using the *Bottom Track* or the *Navigation (VMDAS)*, or if it is not corrected (*None*). We recommend the not-corrected output, so you can choose during further processing the most suitable correction.



Contour Profile Series Ancillary Velocity Reference © None © Bottom Track © Navigation (VMDAS) © GPS(GGA) © GPS(VTG) © Water Mass (BK ⇔1) End of Profile BT Depth BT Depth BT Depth © BTSI Bump Detection © Cos(BeamAngle) © Cut 1 Bin © Cut 2 Bins	Processing
Load Save	OK Cancel Apply

Figure 17: WinADCP Chart Options window

The ASCII-export is done choosing *Export* in the menu and then select *Series/Ancillary* (Figure 18). Here, a selection can be made which bins should be exported and which primary data types (typically the zonal, meridional, and error velocities) and which ancillary data types should be exported (typically Bottom Track and Navigation data). If bottom track has been chosen as velocity reference, the exported velocities are already representing the true water velocities (i.e. ship movement corrected).

Contour Profile Se	eries/Ancillary			
File Type TXT MAT Bins All None 37 38 39 40	Series Data Types Velocity Correl Velocity Correl Vorth (v) Vertical (w) Vertical (w) Magnitude Direction Anc Data Types Prich Real	ation Echo Amplitude Bm1 F Bm1 Bm2 F Bm2 Bm3 Bm3 Bm3 Bm4 Bm4 Avg Avg Bottom Track F East (u)	Percent Good PG1 PG2 PG3 PG4	Ensemble First 1 Last 1417 Step 1
♥ 41 ♥ 42 ♥ 43 ♥ 44 ♥ 45 ♥ 46 ♥ 46	Heading Temperature Depth Orientation BIT Battery	North (v) Vert (w) Error Mag Dir BT Depth	North (v) Vert (w) Error Mag	East (u) North (v) Mag Dir Lat/Lon MicroCAT

Figure 18: Data export in WinADCP



Appendix

BBTalk Test Result

```
Ocean Surveyor Broadband/Narrowband ADCP
Teledyne RD Instruments (c) 1997-2008
All rights reserved.
Firmware Version: 23.19
>CR1
[Parameters set to FACTORY defaults]
>TS?
TS 18/09/26,20:20:44.01 ----- Set System Date and Time
>PS0
       Frequency: 153600 HZ
 Configuration: 4 BEAM, JANUS
Transducer Type: ROUND 32x32
  Beamformer Rev: A02 or later
Beam Angle: 30 DEGREES
Beam Pattern: CONVEX
Orientation: DOWN
CPU Firmware: 23.19
    FPGA Version: A0
Sensors: TEMP SYNCHRO
>PA
RAM test.....PASS
ROM test.....PASS
Receive test.....PASS
Bandwidth test....PASS
>PT3
Correlation Magnitude:
                              Bm3
1.00
0.82
0.43
0.11
0.05
0.04
0.04
0.07
      Lag Bm1 Bm2
0 1.00 1.00
                                           Bm4
                                           1.00
            0.82
                    0.81
0.42
                                          0.81
       1
       2
                                           0.39
       3
            0.16
                    0.12
                                          0.05
             0.02
                       0.02
                                          0.08
       4
                                          0.07
                       0.05
        5
             0.05
                    0.05
        6
             0.08
                                          0.03
       7
             0.10
                                           0.01
RSSI: 169 164 171 161
PASSED
>PT6
Receive Bandwidth:
Expected Bm1 Bm2 Bm3 Bm4
   15500 13272 14711 14456 14651
PASSED
```