

O-03 Submarine Cable & Data Reach Test

ENGINEER: __Sonnichsen / Lerner_____

DATE: 09/07/2004

COMMENTS:

Testing done on MARS fibre at the Il De Re

O-03 Submarine Cable & Data Reach Test (overview)

Prior to laying the MARS shielded cable the ability to port data at the proper Bit Error Rate is to be tested. This will represent the first complete end-to-end test of the MARS data communications system. This test is comprised of a physical layer and link layer (ISO-0,1) BER test to insure that the optical and electrical media are capable of conducting gigabit ethernet frames with an error rate of less than 1 error in 10^{12} . Also a Layer4 Data Rate test will be performed.

- 1) The test will be performed with both pre-amp and booster EDFAs
- 2) An additional test will be performed to determine the maximum optical reach of the equipment over the MARS type cable
- 3) Tests are done separately for the East then the West paths of the node
- 4) These tests may be running while the OBC tests are commenced
- 5) This complete test will be run prior to attending the ship, using a 100km length of SMF28E test fiber in the lab. This will:
 - a) Insure that the test procedure that follows is accurate
 - b) Provide future information for the NEPTUNE project

The required equipment for this test is:

- 1) Suitable gigabit ethernet BER optical test set
- 2) Rack Mounted MARS subsea node assembly completely fibered including Switches, NE optical assemblies, and EDFAs
- 3) MARS cable possibly properly cut to length
- 4) Rack Mounted MARS shore station completely fibered including Switches, NE optical assemblies, and EDFAs
- 5) Optical Power Meter
- 6) Optical attenuators per following text
- 7) Optical Laser Source
- 8) LANforge Test Set

Possible Additional Tools:

- 1) Fusion splicer
- 2) Spare FC and SC connectors
- 3) FC and SC couplers

Issues to confirm with Alcatel

- 1) What connector types will be available at the 2 ends of each fiber in the bundle
- 2) Will the cable be pre-cut to the actual length that it will occupy in the ocean

MARS
Org: WHOI
Engr: Fritz Sonnichsen
Date: 07/06/04

O-03 Submarine Cable & Data Reach Test

Each of the 3 sea to shore channels will be tested concurrently via loopback techniques.

- > Proper fiber handling and safety techniques are assumed throughout and not further mentioned.
- > Use SM fiber for all loopbacks
- > **CAUTION!** We cannot discuss the optical test set configuration since this will vary with the unit procured for the test. However, be sure to insert an appropriate attenuator or you may damage the receiving MRTR transponder. Using a power meter insure that the output of the test set measured *after* the attenuator is at -6dBm or slightly less.
- > The MARS node will be tested in two stages-the east side and the west side. The test procedures are identical.

FIBER SELECTION-

Each of the 8 fibers in the MARS cable should be permanently labeled. Pairs should be selected and labeled as follows:

PAIR1: Data East Transmit - Data East Receive	PAIR2: Data West Transmit - Data West Receive
PAIR3: OBC East A - OBC East B	PAIR4: OBC West A - OBC West B

PRELIMINARY SETUP TEST - OPTICAL BER TEST

- 1) This test will verify basic setup of the BER tester and Cable
- 2) Using the following two diagrams (Setup 0), set up SM fiber loopbacks and attenuators to complete the optical circuit
- 3) After setup run the BER test per the test-set vendor for 15 minutes
- 4) No errors should be detected.
- 5) If errors are detected chase the optical path with a power meter to insure proper connections

FIRST TEST - OPTICAL BER TEST with Loopbacks

- 1) This test will verify basic optical transport of the system. Start with fiber pair 1
- 2) Using the two diagrams (Setup 1), set up SM fiber loopbacks and attenuators to complete the optical circuit
- 3) After setup run the BER test per the test-set vendor for 1/2 hours
- 4) No errors should be detected in 1/2 hour
- 5) Repeat this test for fiber pair 2

SECOND TEST - ELECTRICAL BER TEST

- 1) Start with fiber pair 1
- 2) Using the diagram Setup 2 set up SM fibers and attenuators as shown. Note the loopback for the 3rd regeneration channel
- 3) Attach BER testers as available to each pair of GbE converters/SPFs
- 4) After setup run the BER test per the test-set vendor for 24 hours
- 5) No more than 1 error in 10^{12} should be detected Record the error number in the results table
- 5) Repeat this test for fiber pair 2

THIRD TEST - SWITCHED DATA THROUGHPUT

- 1) Start with fiber pair 1
- 2) Using the diagram Setup 3, set up SM fiber loopbacks to complete the optical circuit
- 3) Replace the BER test set with a LAPtop based data generator set to run at the maximum possible data rate which should be about 8Mbs
- 4) Record the error numbers in the results table
- 5) Repeat this test for fiber pair 2

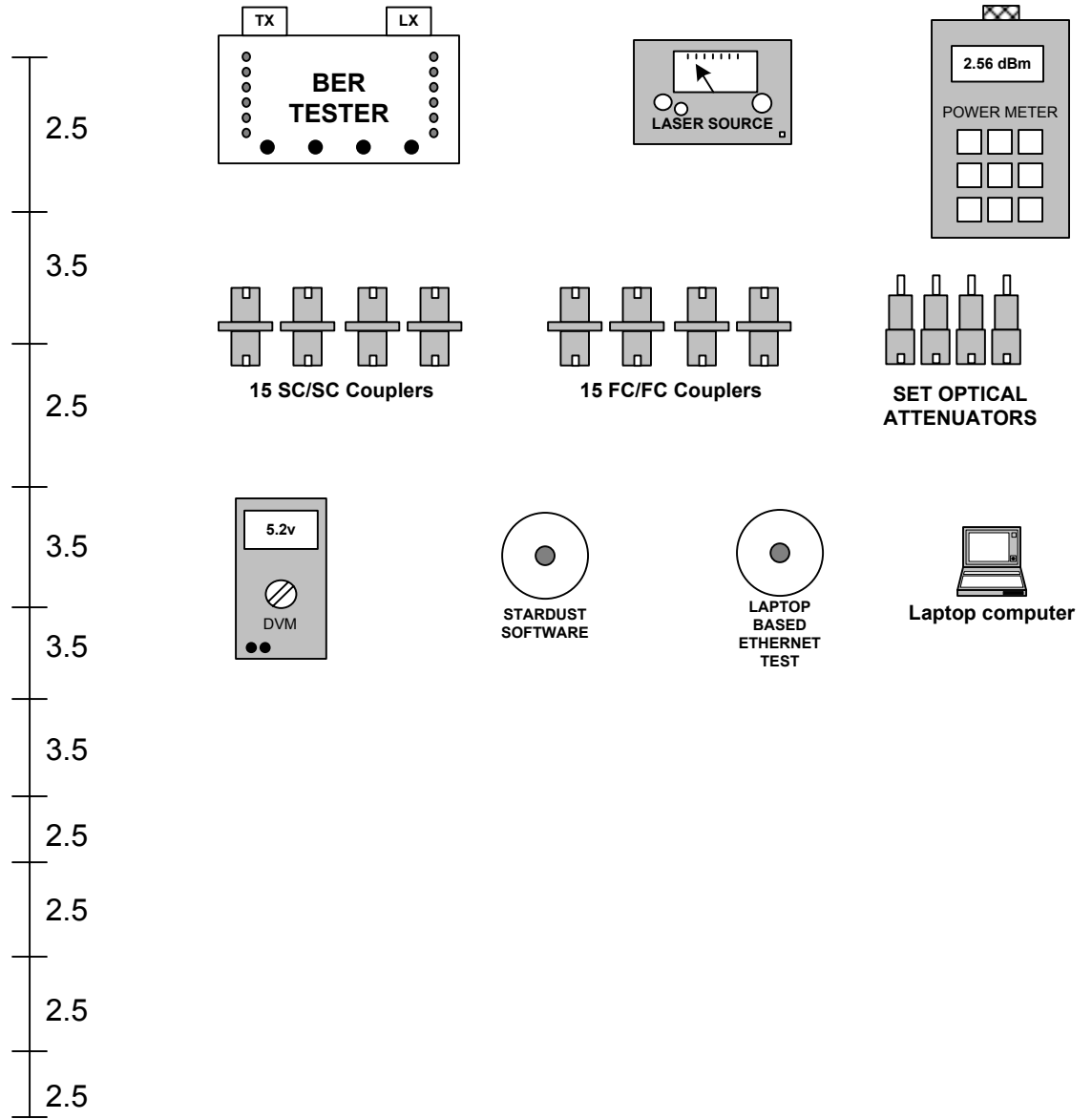
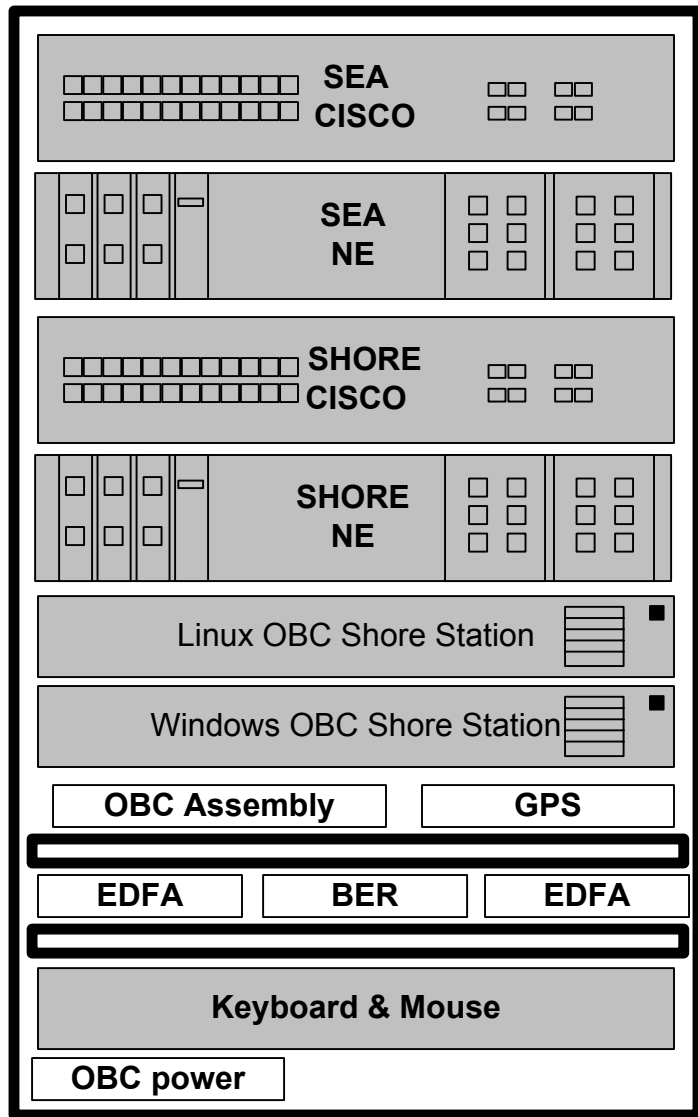
FOURTH TEST - OPTICAL REACH

- 1) Start with fiber pair 1
- 2) Using the diagram Setup 4, set up SM fiber loopbacks and attenuators to complete the optical circuit as shown. Here, pairs of the 8 fibers in the cable bundle will be joined to form a longer cable. Since there are 4 xmit and recv pairs in the cable lengths of 1,2,3 and 4 times the full cable length will be tested.
- 3) After looping back the fibers, inject a light signal into the coupled length and measure the attenuation with a power meter
- 4) Record the above results in the results table
- 5) After each length setup run the BER test per the test-set vendor for 2 hours
- 6) Record the error number in the results table

FIFTH TEST - DUAL AMPLIFIER

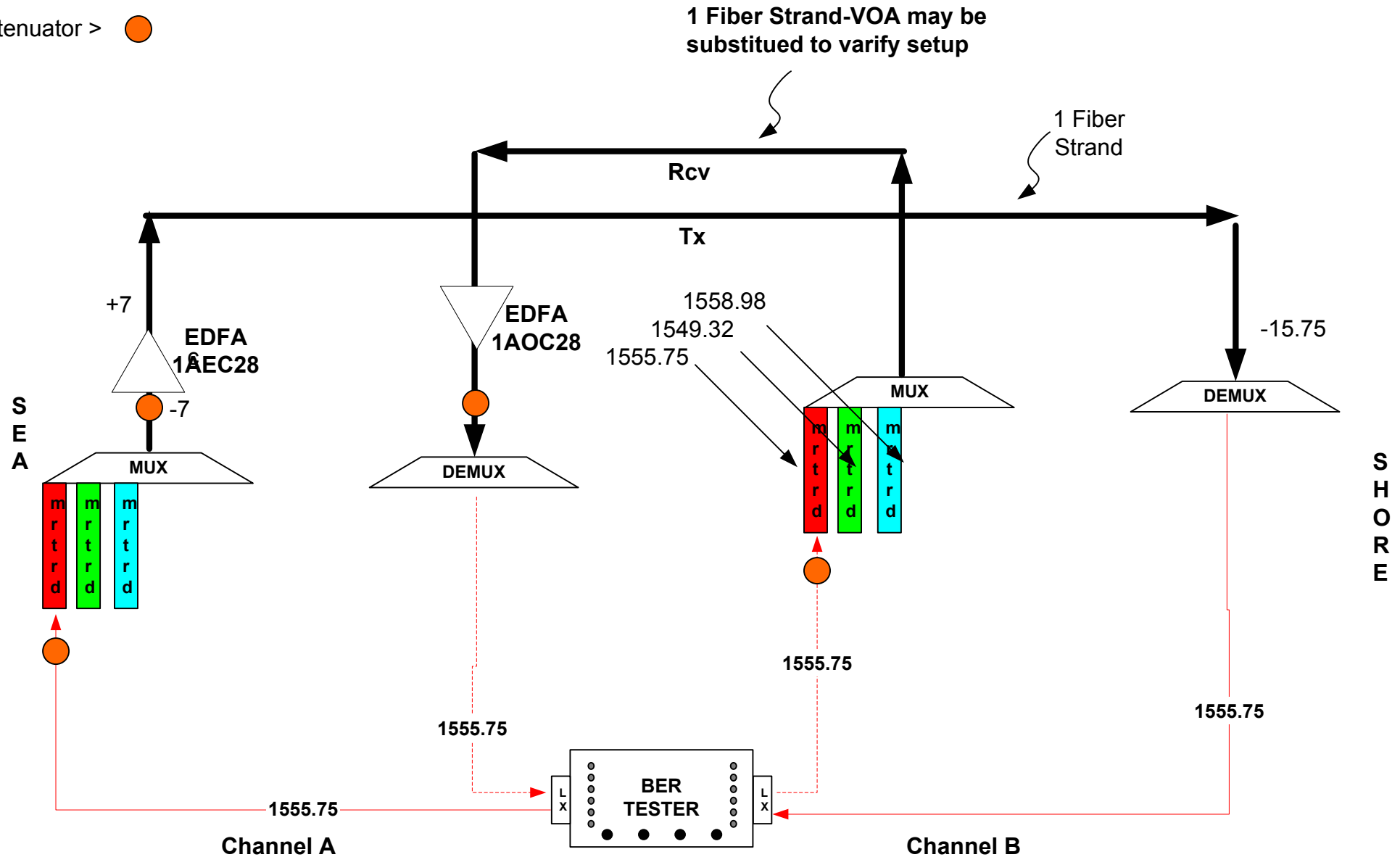
- 1) Start with fiber pair 1. Note the rearrangement of the EDFAs in push-pull fashion. Be sure to attenuate input into the booster !AEC28 EDFA as required to limit input below -6dBm.
- 2) Using the diagram Setup 5, set up SM fiber loopbacks to complete the optical circuit as shown. Here, pairs of the 8 fibers in the cable bundle will be joined to form a longer cable. Since there are 4 xmit and recv pairs in the cable lengths of 1,2,3 and 4 times the full cable length will be tested.
- 3) After looping back the fibers, inject a light signal into the coupled length and measure the attenuation with a power meter
- 4) Record the above results in the results table
- 5) After each length setup run the BER test per the test-set vendor for 2 hours
- 6) Record the error number in the results table

O-03 Submarine Cable & Data Reach Test-portable chassis and travel tools list



O-03 Submarine Cable & Data Reach Test (schematic) Setup 0: Preliminary Test Setup

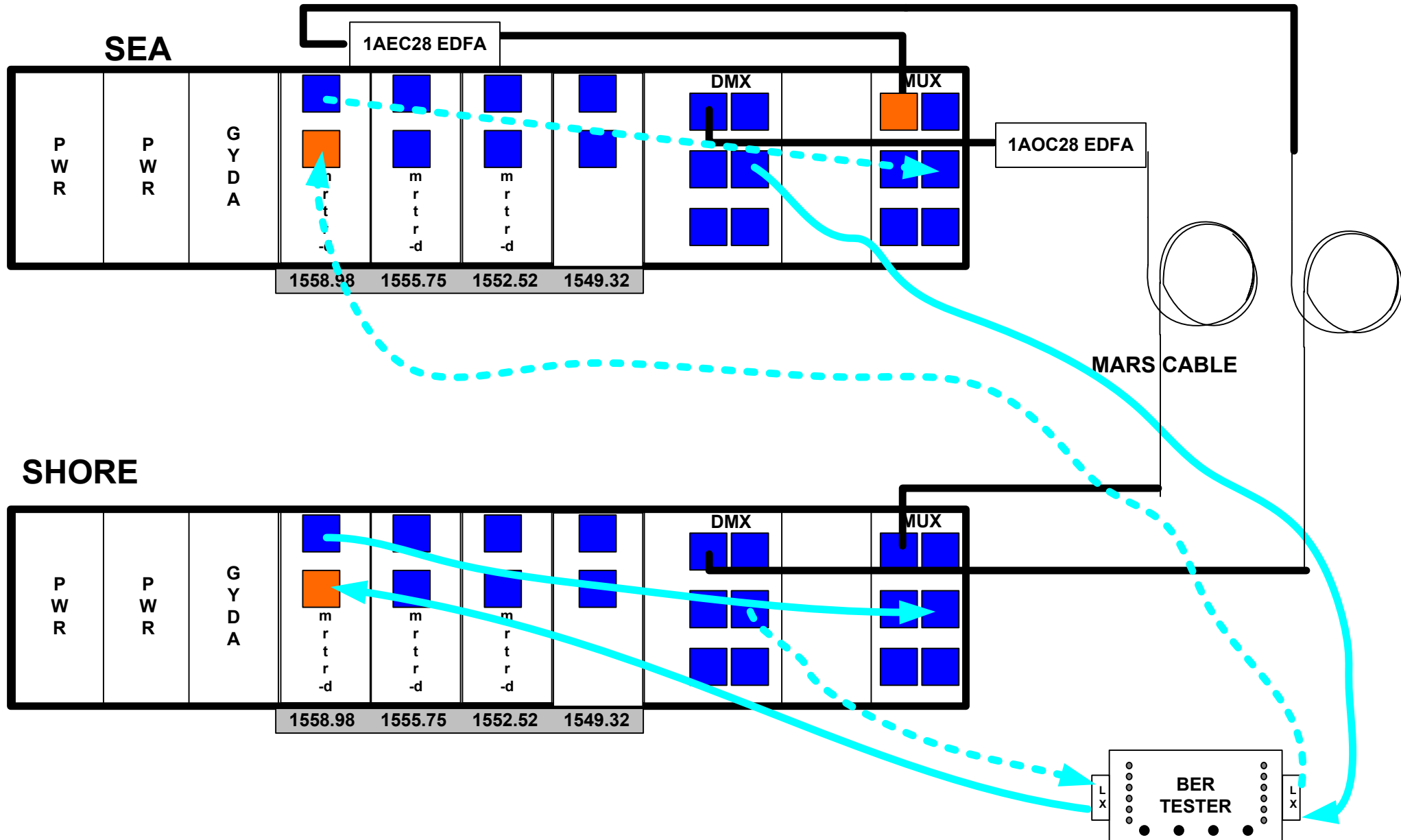
Attenuator > 



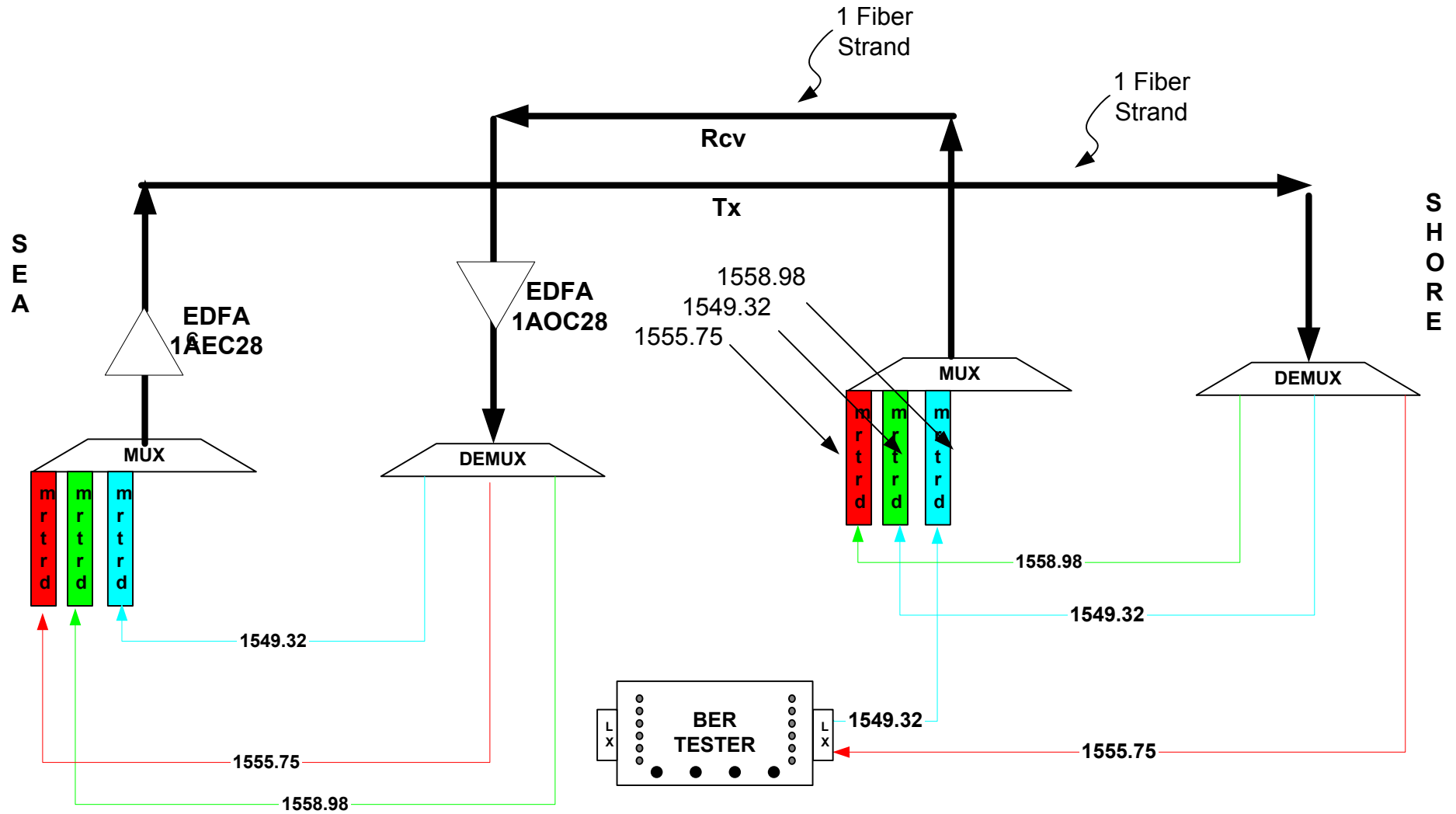
O-03 Submarine Cable & Data Reach Test Setup 0: Physical Diagram Preliminary Setup Test

USE SM FIBER FOR LOOPBACKS

ORANGE REPRESENTS ATTENUATORS > 

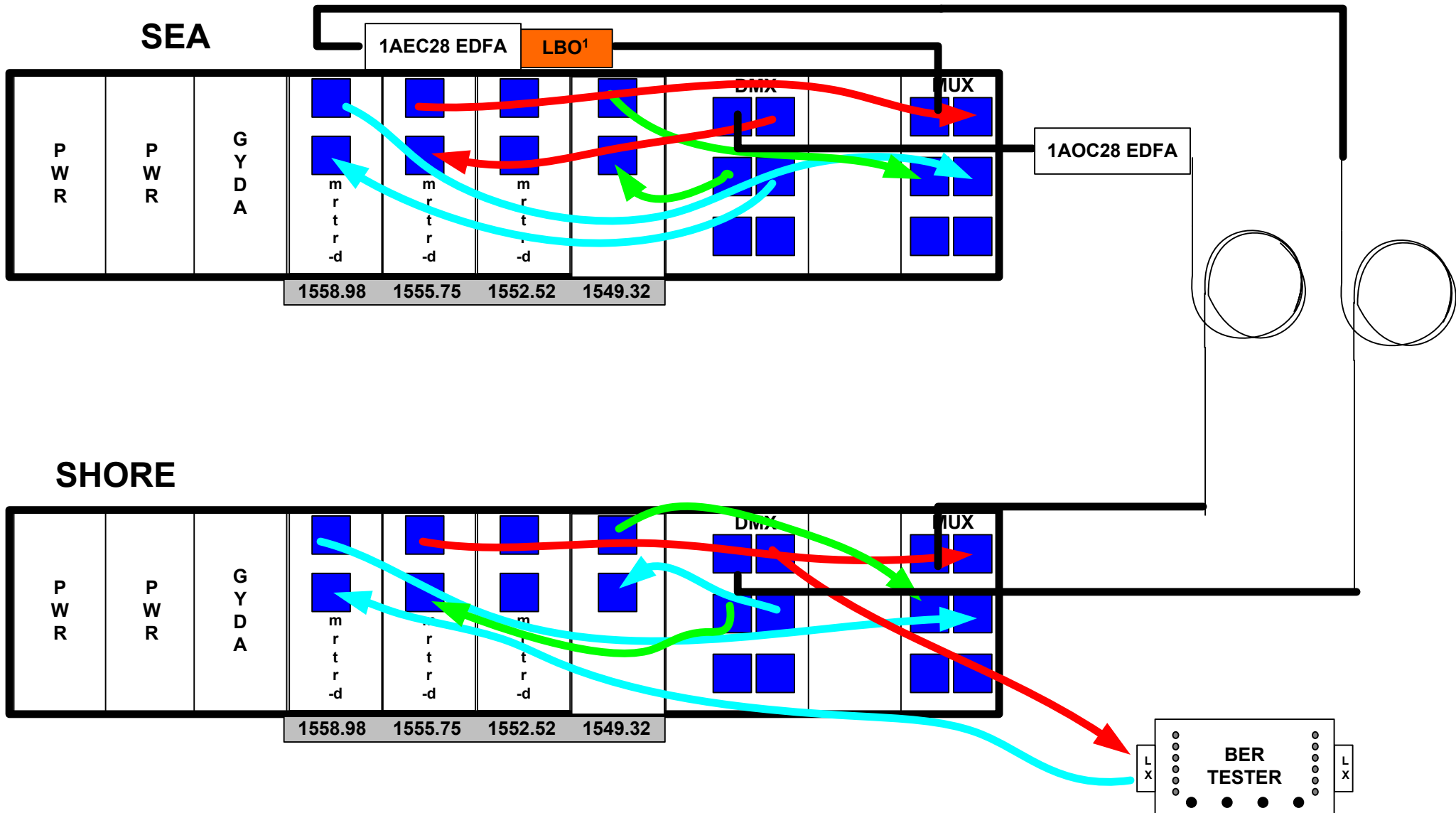


O-03 Submarine Cable & Data Reach Test (schematic) Setup 1: Optical Loopback

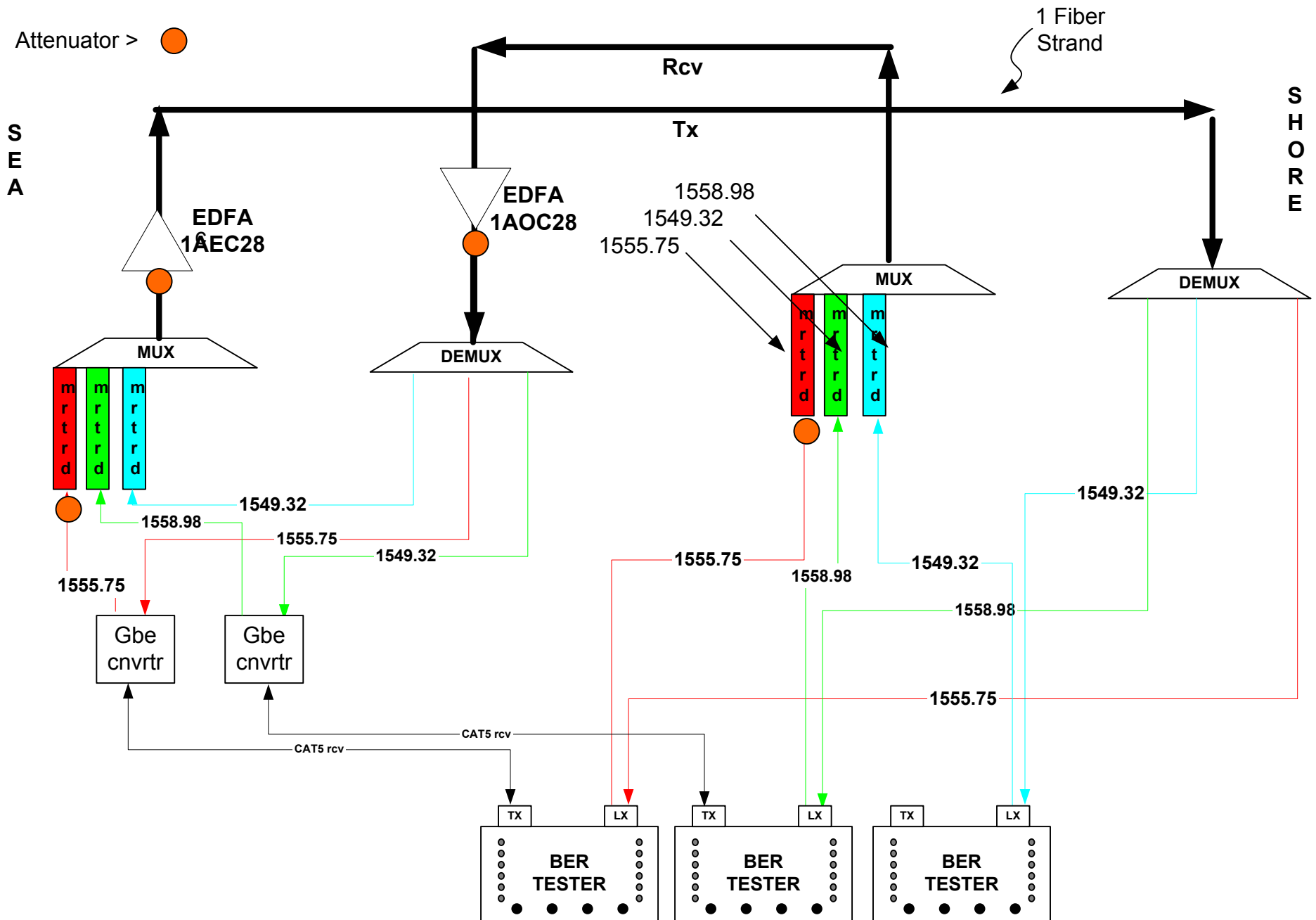


O-03 Submarine Cable & Data Reach Test Setup 1: Physical Diagram for Optical Loopback test

USE SM FIBER FOR LOOPBACKS ORANGE REPRESENTS ATTENUATORS



O-03 Submarine Cable & Data Electrical Test (schematic) Setup 2: Electrical BER Test

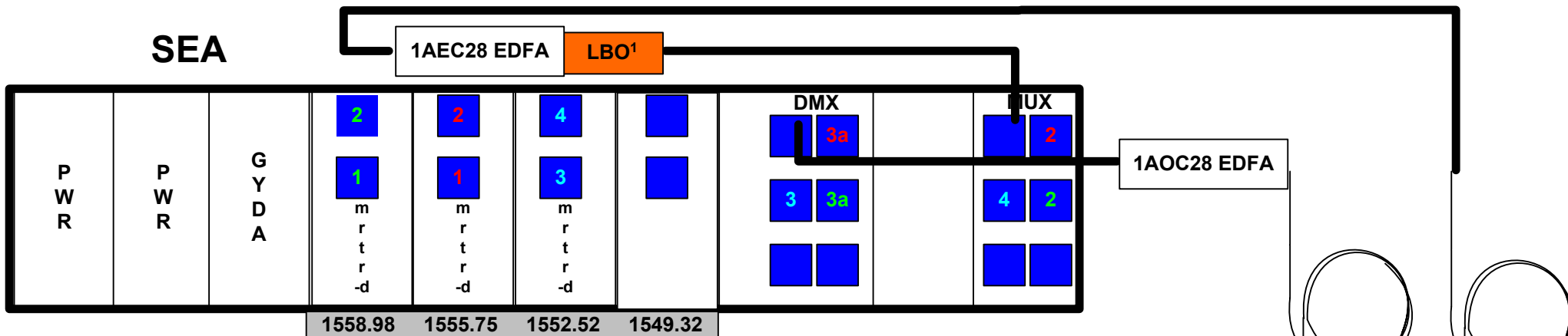


O-03 Submarine Cable & Data Reach Test Setup 2: Physical Diagram for Electrical Test

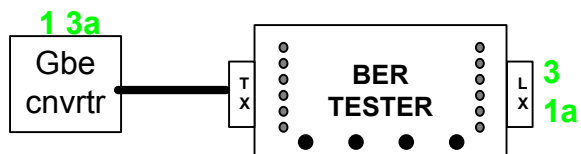
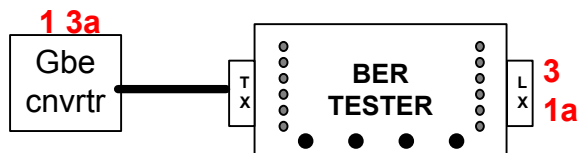
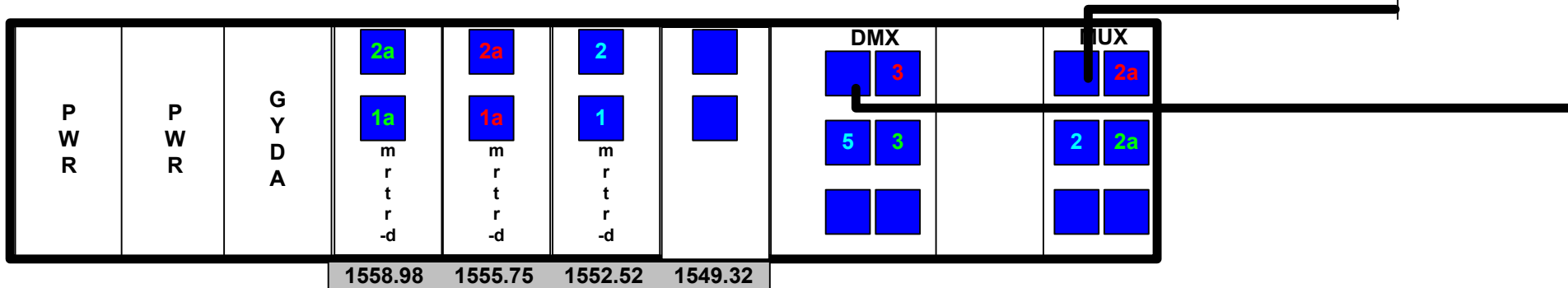
USE SM FIBER FOR LOOPBACKS

ORANGE REPRESENTS ATTENUATORS

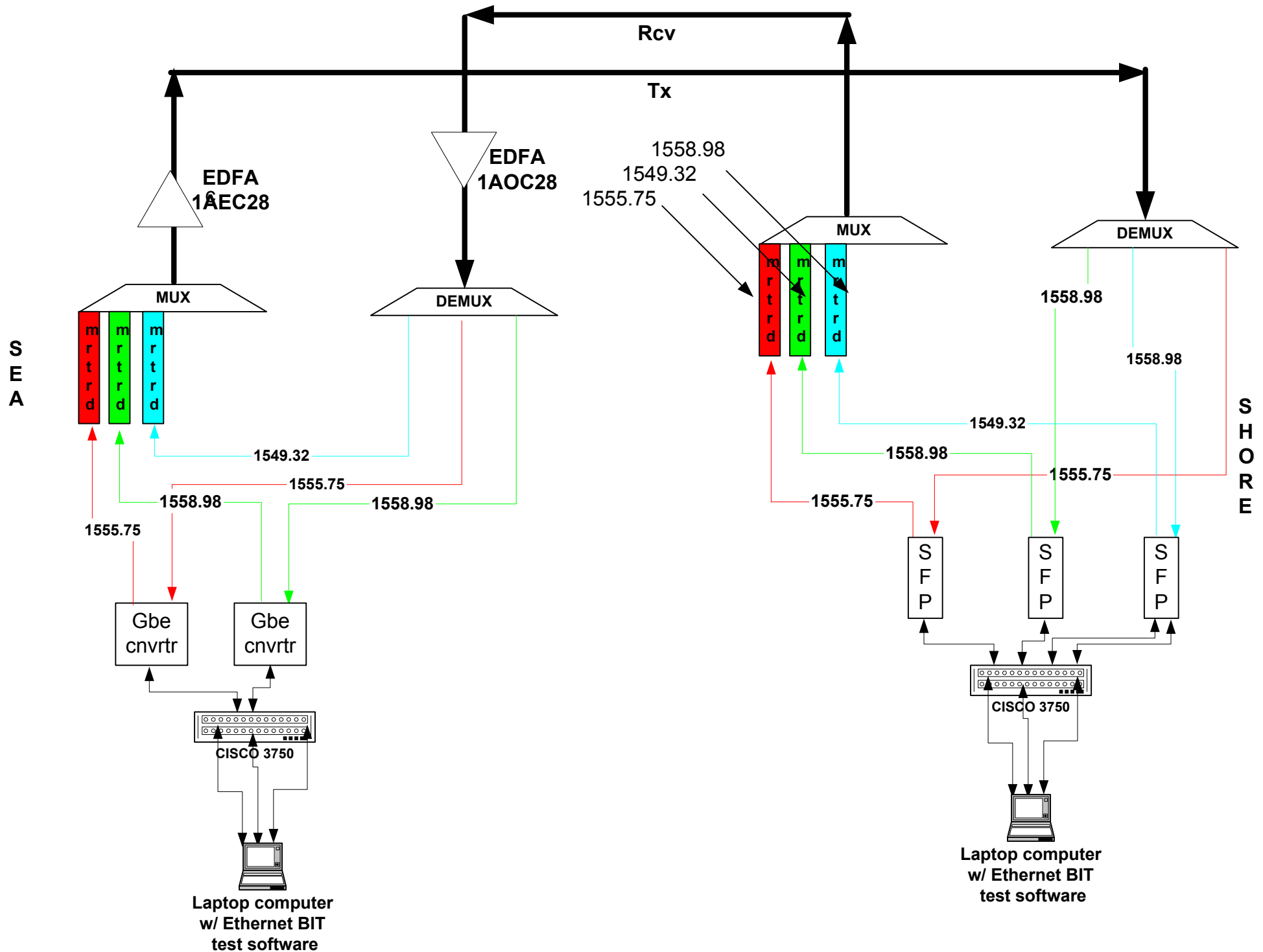
SEA



SHORE

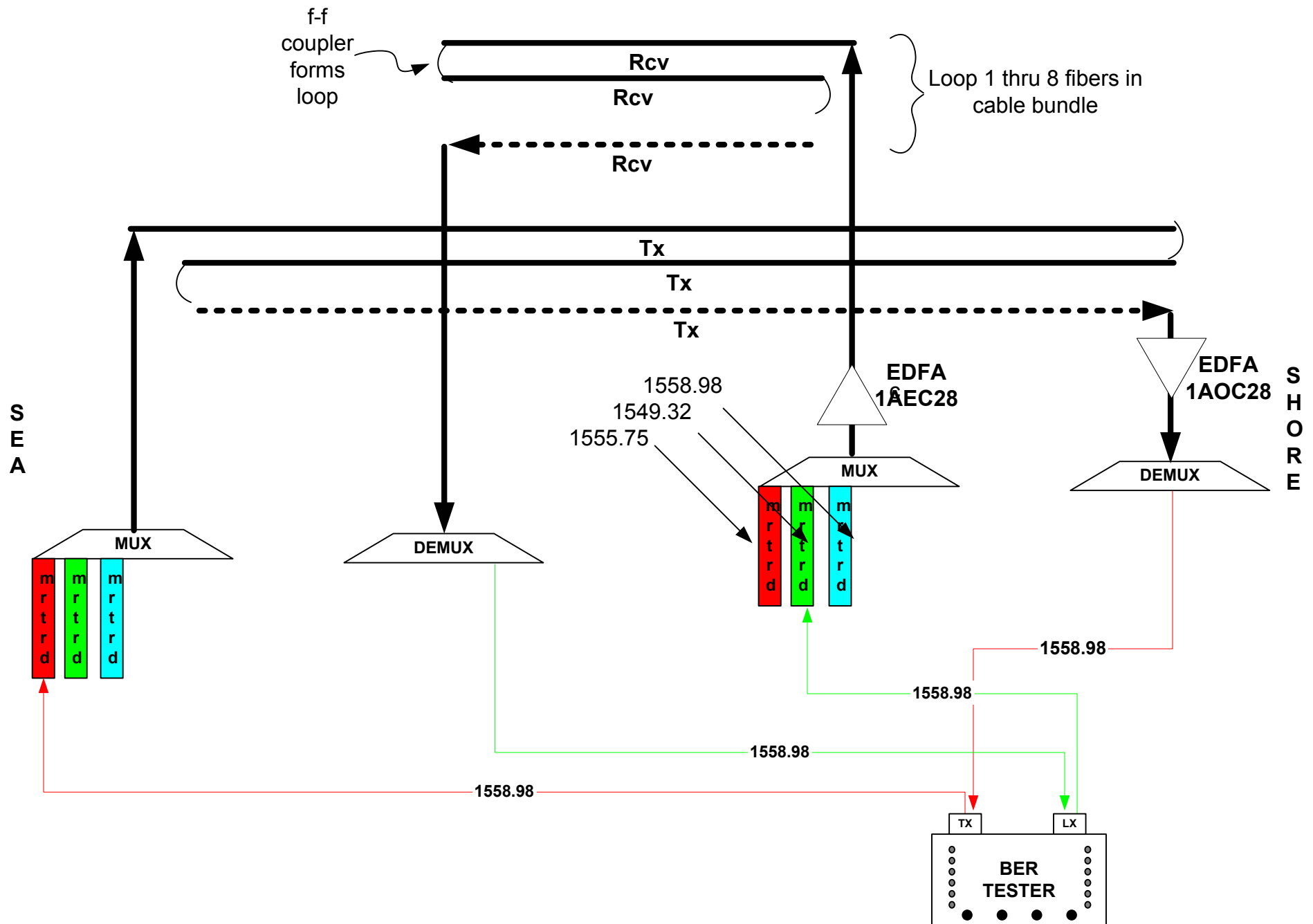


O-03 Submarine Cable & Data Reach Test (schematic) Setup 3: Switched Data Throughput

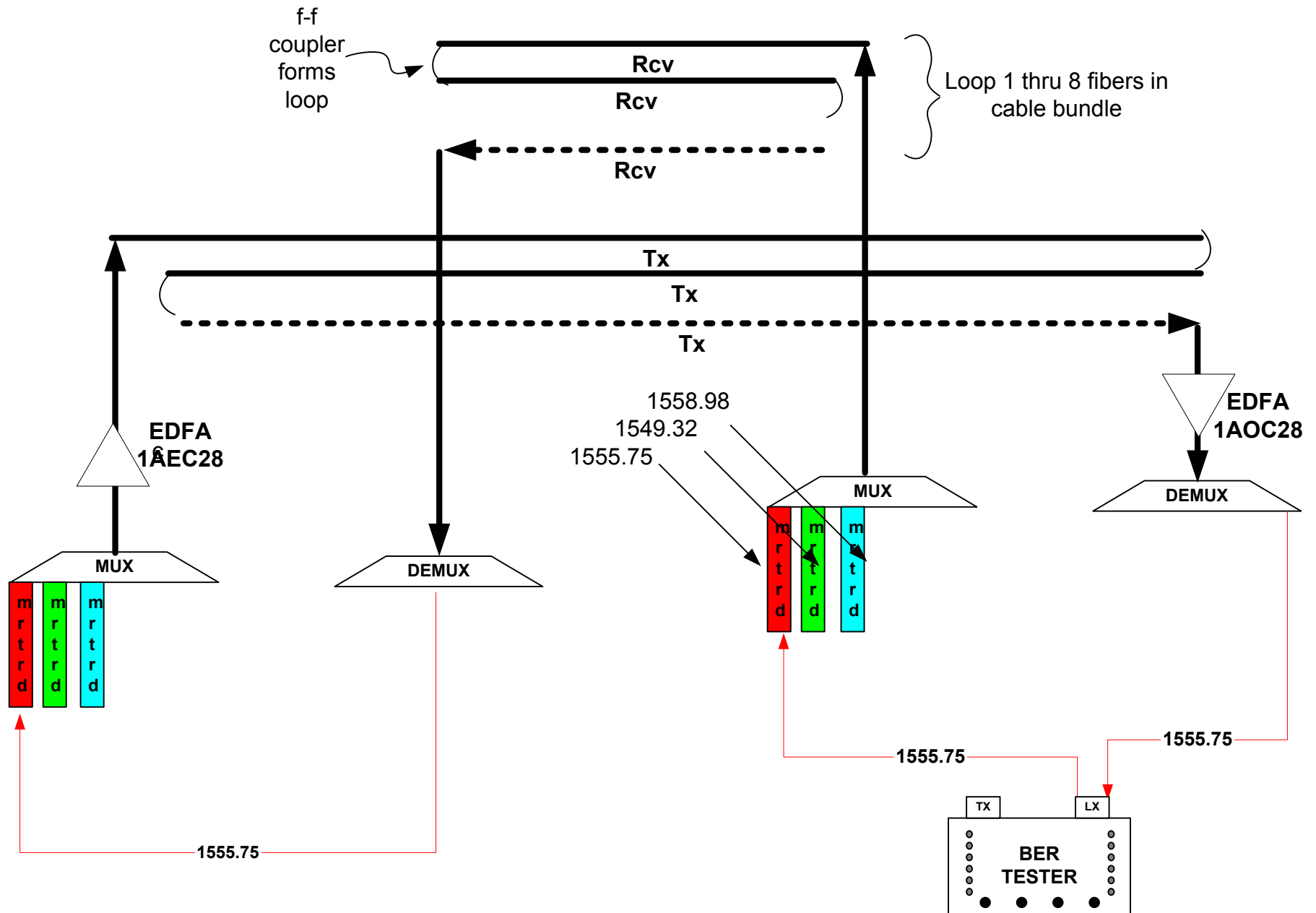


O-03 Submarine Cable & Data Reach Test (schematic)

Setup 4: Reach Test Setup



O-03 Submarine Cable & Data Reach Test (schematic) Setup 5: Dual EDFA Test



Some Useful Details about Optical Components

com-mon	1555.75
1549.32	1558.98
1552.52	upgrade

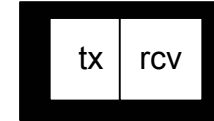
NE Mux and DeMux port layouts

	Tx
	Rcv

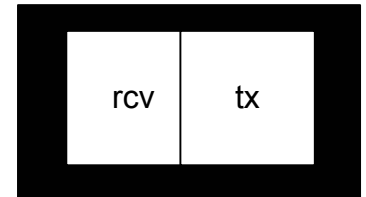
NE MR-TR-D15xx
Port Layout



DIP settings for MRTRD
in gB ether mode



CISCO SFP GBIC Paths



CISCO GBIC Paths

GYDA CONNECTION PROCEDURE

Set up a 10 network on the PC.

Give the PC and ethernet address of 10.0.0.49

Connect Ethernet Crossover cable from PC to GYDA Ethernet 10BaseT

arp -s 10.0.0.50 00-01-C0-00-7A-0D

Turn off the GYDA

Turn on the GYDA

ping 10.0.0.50

WEB browser to 10.0.0.50

EDFA SERIAL COMMUNICATIONS CONNECTION PROCEDURE

The PC need only be placed in a minicom or hyperterm mode with an RS232 connection to the EDFA "evaluation" card, per Bookham's instructions.

Setup Parm's are:

8N1 flowcontrol off 9600b.

To login type:

AD FFFF 1234

Some Important Optical Specs

Device	Sensitivity dBm	Overload dBm	Damage dBm	Output dBm	Loss /Gain dB
NE MRTRD	-20	-3	-1	-0 (1mW)	
NE MRTR	-25			-7.5	
NE MRTR enhancd	-3 to -19			6 (4mW)	
LX SFP ¹	-3 to -19			-3 to -9.5	
GbE Converter	-3 to -21			-3 to -9.5	
1AEC28 EDFA		-6			+23
1AOC28 EDFA		-10			+23
NE Mux/Demux					-3 per side
MARS Cable					-15

1 - SFP is same spec as a GBIC

NE Channels		
Channel	Wavelength	frequency Ghz
493	1549.32	193500
557	1555.75	192700
589	1558.98	192300

O-03 Submarine Cable & Data Reach Test - Results Sheet- GENERAL

GENERAL	
Date	09/06/2004
RUN	01
Cable Length	72.026 km
Ambient Temp.	72
COMMENTS	no cable/ test run only

SERIAL NUMBERS		
Shore	1558.98	00161 4-5
Shore	1555.75	00161 4-5
Shore	1549.32	00208 5-8
Sea	1558.98	173 5-5
Sea	1555.75	172 5-5
Sea	1549.32	209 5-8
sfp lx	cisco	p11uhes 03-20
spf lx	cisco	p4b0jfs 03-37
sfp lx	fiberxon	2w2040308084
spf lx	fiberxon	2w2040308085
sfp tx	n/a	dm7041 d/c04016
spf tx	n/a	hbcu5710r a00008505

FIBER PAIR ASSIGMENTS and Optical Loss Measurements						
	Xmit	In	Out	Recv	In	Out
DCS EAST	blue	-5.11	-20.3	red	-5.11	-20.3
DCS WEST	green	-5.2	-20.5	yellow	-5.2	-20.3
OBC EAST	pink			brown		
OBC WEST						

O-03 Submarine Cable & Data Reach Test - Results Sheet- preliminary

PRELIMINARY SETUP TEST-Channel A

fibre colour		blue		
Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
1558.98	1h20m	10dB	0	-14.9
1555.75				
1549.32				
Attenuator on Line EDFA input			10dB	
Input into EDFA from Mux			-11.4	
Input into Cable from EDFA			+6.7	
Output returned from Cable			-14.8	

PRELIMINARY SETUP TEST-Channel B

fibre colour		red		
Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
1558.98	1h20m	10	0	-13.5
1555.75				
1549.32				
Attenuator on preamp EDFA output			10dB	
Input into EDFA from Cable			-17.8	
Input into Cable from Mux			-2.7	
Output from preamp EDFA+atten			-20.9	

COMMENTS:

Initital run to verify system after shipping. Only one channel tested on only one fiber pair (reb/blue)

O-03 Submarine Cable & Data Reach Test - Results Sheet- preliminary

PRELIMINARY SETUP TEST-Channel A

fibre colour		blue		
Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
1558.98	15h34m	10dB	0	-14.9
1555.75	15h36m	10dB	0	-6.55
1549.32	1h19m	10dB	0	-13.4
Attenuator on Line EDFA input			10dB	
Input into EDFA from Mux			-8.2	
Input into Cable from EDFA			+7.44	
Output returned from Cable			-10.6	

PRELIMINARY SETUP TEST-Channel B

fibre colour		red		
Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
1558.98	15h34m	10dB	0	-13.5
1555.75	15h36m	10dB	45	-14.07
1549.32	1h19m	10dB	0	-15.4
Attenuator on preamp EDFA output			10dB	
Input into EDFA from Cable			-14.2	
Input into Cable from Mux			+1.0	
Output from preamp EDFA+atten			+8.6	

COMMENTS:

Only one channel tested on only one fiber pair (reb/blue)

O-03 Submarine Cable & Data Reach Test - Results Sheet- Electrical Test Using Converters

S E A	ELECTRICAL TEST NUMBER: 1				
	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	4h32m	10	0	-15.2
	1555.75	4h29m	10	0	-16.3
	1549.32	4h29m	10	0	-13.28
S H O R E	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	4h32m	10	0	-15.8
	1555.75	4h29m	10	0	-16.8
	1549.32	4h29m	10	0	-15.9
p r e	Fibre Colour			blue	
	Attenuator on preamp EDFA output			10dB	
	Input into EDFA from Cable			-14.2	
	Input into Cable from Mux			+1.0	
	Output from preamp EDFA+atten			+8.6	
l i n e	Fibre Colour			red	
	Attenuator on Line EDFA input			10dB	
	Input into EDFA from Mux			-8.2	
	Input into Cable from EDFA			+7.44	
	Output returned from Cable			-10.6	

S E A	ELECTRICAL TEST NUMBER: 2				
	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	13h36m	10	1	-15.2
	1555.75	13h47m	10	0	-16.3
	1549.32	13h47m	10	0	-13.28
S H O R E	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	13h36m	10	0	-15.8
	1555.75	13h47m	10	0	-16.8
	1549.32	13h47m	10	0	-15.9
p r e	Fibre Colour			yellow	
	Attenuator on preamp EDFA output			0	
	Input into EDFA from Cable			-12.4	
	Input into Cable from Mux			+3.1	
	Output from preamp EDFA			-2.9	
l i n e	Fibre Colour			green	
	Attenuator on Line EDFA input			10dB	
	Input into EDFA from Mux			-8.3	
	Input into Cable from EDFA			+13.7	
	Output returned from Cable			-1.6	

COMMENTS: Test 2 used software to cut output of preamp: SA 1 O -2 resulting in listed output of -2.3 and measured output of -2.9. Attenuator was removed
All tests were done with Ancot BER tester on channels 1555.75 and 1549.32 and CISCO Stardust on 1558.98

O-03 Submarine Cable & Data Reach Test - Results Sheet- Electrical Test Using Converters

S E A	ELECTRICAL TEST NUMBER: 3				
	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	30m	10	1	-15.2
	1555.75	30m	10	0	-16.3
	1549.32	30m	10	0	-13.28
S H O R E	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	30m	10	0	-15.8
	1555.75	30m	10	0	-16.8
	1549.32	30m	10	0	-15.9
p r e	Fibre Colour			pink	
	Attenuator on preamp EDFA output			0	
	Input into EDFA from Cable			-12.24	
	Input into Cable from Mux			+3.0	
	Output from preamp EDFA+atten			-3.0	
l i n e	Fibre Colour			brown	
	Attenuator on Line EDFA input			10	
	Input into EDFA from Mux			-8.3	
	Input into Cable from EDFA			+13.6	
	Output returned from Cable			-1.95	

S E A	ELECTRICAL TEST NUMBER: 4				
	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	30m	10	0	-15.2
	1555.75	30m	10	0	-16.3
	1549.32	30m	10	0	-13.28
S H O R E	Xpondr	Duration	MRTR Rcv Attenuation	# Errors	power into mrtr
	1558.98	30m	10	0	-15.8
	1555.75	30m	10	0	-16.8
	1549.32	30m	10	0	-15.9
p r e	Fibre Colour			orange	
	Attenuator on preamp EDFA output			0	
	Input into EDFA from Cable			-11.8	
	Input into Cable from Mux			+3.0	
	Output from preamp EDFA			-2.94	
l i n e	Fibre Colour			black	
	Attenuator on Line EDFA input			10	
	Input into EDFA from Mux			-8.3	
	Input into Cable from EDFA			+13.5	
	Output returned from Cable			-1.2	

COMMENTS: Test 2 used software to cut output of preamp: SA 1 O -2 resulting in listed output of -2.3 and measured output of -2.9. Attenuator was removed
All tests were done with Ancot BER tester on channels 1555.75 and 1549.32 and CISCO Stardust on 1558.98

O-03 Submarine Cable & Data Reach Test - Reach Tests

FOURTH TEST - OPTICAL REACH - loss -line EDFA		
1 length	Input Signal	
	Measured Output	
2 lengths	Input Signal	
	Measured Output	
3 lengths	Input Signal	
	Measured Output	
4 lengths	Input Signal	
	Measured Output	

FOURTH TEST - OPTICAL REACH - BER -line EDFA		
1 length	Duration of Run	2 min
	Number of Errors	
	Number of BITS	
2 lengths	Duration of Run	
	Number of Errors	
	Number of BITS	
3 lengths	Duration of Run	
	Number of Errors	
	Number of BITS	
4 lengths	Duration of Run	
	Number of Errors	
	Number of BITS	

FOURTH TEST - OPTICAL REACH - loss-pre-amp EDFA		
1 length	Input Signal	
	Measured Output	
2 lengths	Input Signal	
	Measured Output	
3 lengths	Input Signal	
	Measured Output	
4 lengths	Input Signal	
	Measured Output	

FOURTH TEST - OPTICAL REACH - BER - preamp		
1 length	Duration of Run	2 min
	Number of Errors	
	Number of BITS	
2 lengths	Duration of Run	
	Number of Errors	
	Number of BITS	
3 lengths	Duration of Run	
	Number of Errors	
	Number of BITS	
4 lengths	Duration of Run	
	Number of Errors	
	Number of BITS	

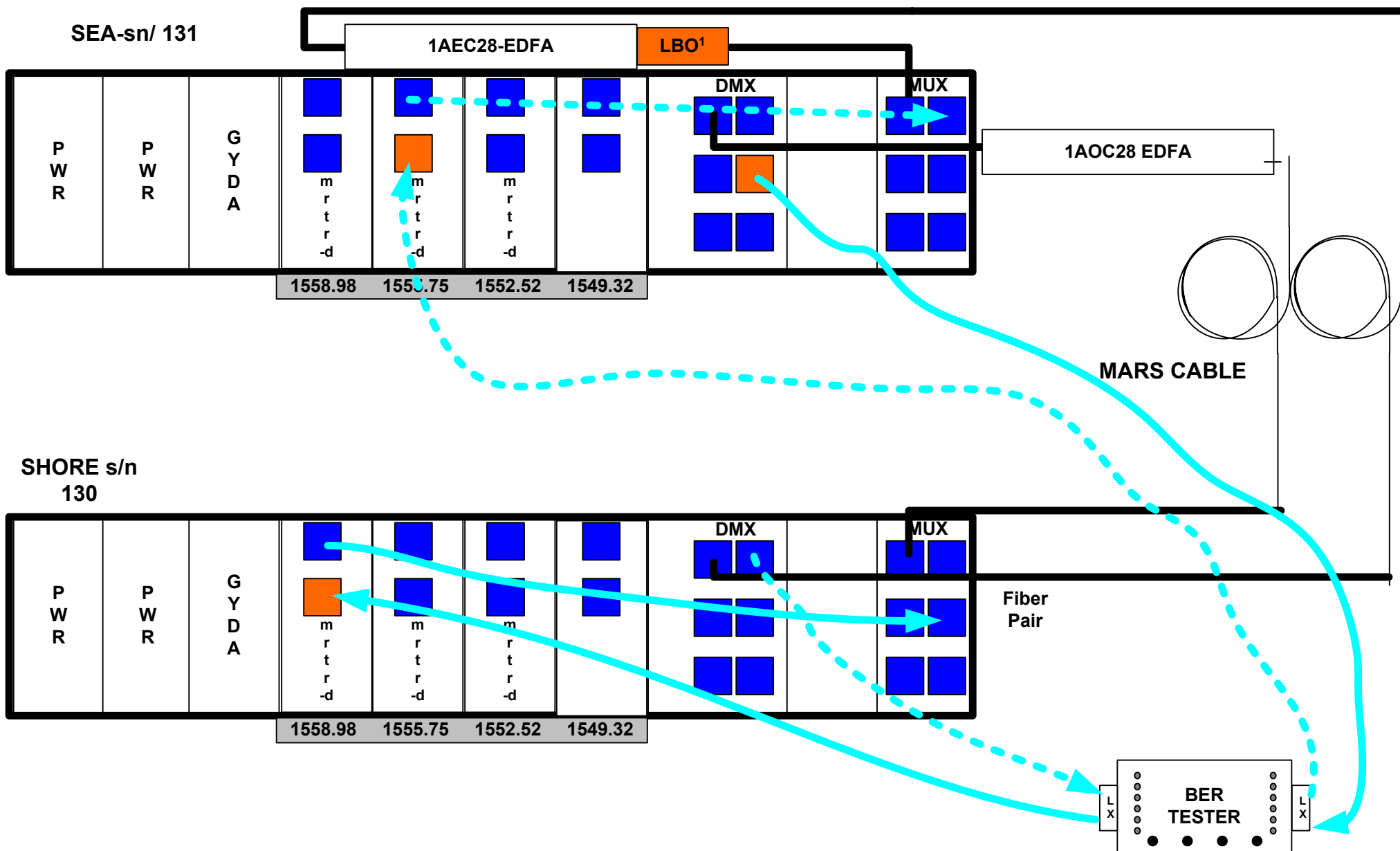
O-03 Submarine Cable & Data Reach Test - Reach Tests with DUAL EDFA

FIFTH TEST - DUAL EDFA - Attenuation		
1 length	Input Signal	
	Measured Output	
2 lengths	Input Signal	
	Number of Errors	
3 lengths	Input Signal	
	Number of Errors	
4 lengths	Input Signal	
	Number of Errors	

FIFTH TEST - DUAL EDFA- BER		
1 length	Duration of Run	1/4 Hours
	Number of Errors	
	Number of BITS	
2 lengths	Duration of Run	2 hours
	Number of Errors	
	Number of BITS	
3 lengths	Duration of Run	2 hours
	Number of Errors	
	Number of BITS	
4 lengths	Duration of Run	2 hours
	Number of Errors	
	Number of BITS	

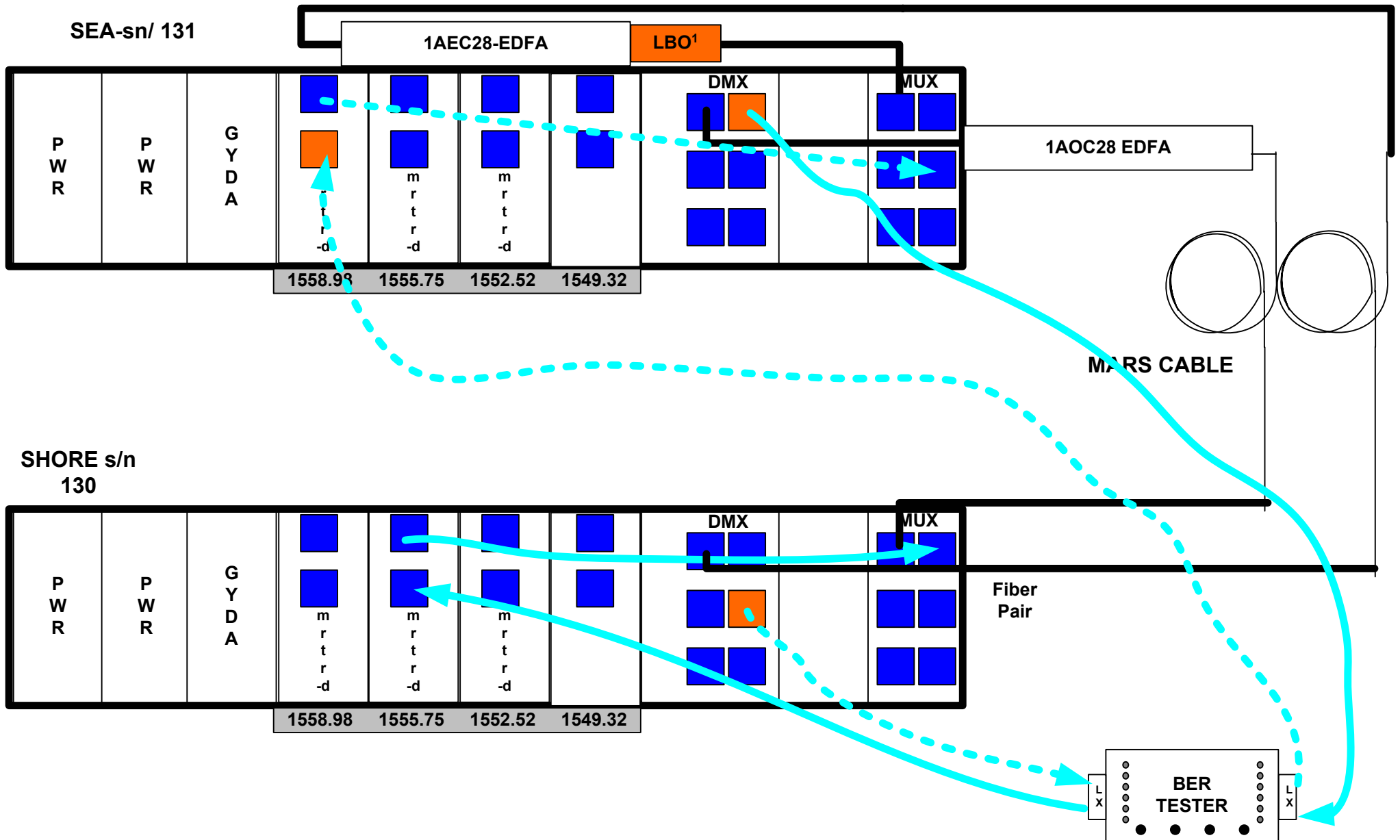
O-03 Submarine Cable & Data Reach Test CONDITION PRIOR TO SHIPMENT TO CABLE SHIP CONFIGURATION 1

USE SM FIBER FOR LOOPBACKS



O-03 Submarine Cable & Data Reach Test
CONDITION PRIOR TO SHIPMENT TO CABLE SHIP-CONFIGURATION 2

USE SM FIBER FOR LOOPBACKS



O-03 Submarine Cable & Data Reach Test
CONDITION PRIOR TO SHIPMENT TO CABLE SHIP

Attenuation Values for Prior Pages-CONFIGURATION 1

Preamp EDFA	in=0 out=0
Booster EDFA	in=10 out=0
Sea xpndr 1555.75	in=5 out=0
Shore xpndr 1558.98	in=5 out=0
Sea DeMux 1558.98	5
BERT rate 1555.75	7 errors in 18 hours
BERT rate 1558.98	0 errors in 18 hours

Attenuation Values for Prior Page-CONFIGURATION 2

Preamp EDFA	in=0 out=0
Booster EDFA	in=10 out=0
Sea xpndr 1555.98	in=5 out=0
Shore xpndr 1555.75	in=5 out=0
Sea DeMux 1555.75	5
BERT rate 1555.75	0 errors in 18 hours
BERT rate 1558.98	0 errors in 18 hours