Comb Generator using MTFX-C1

October 6, 2020

Introduction

- NEM customers desire a flexible comb source for use in amplifier testing

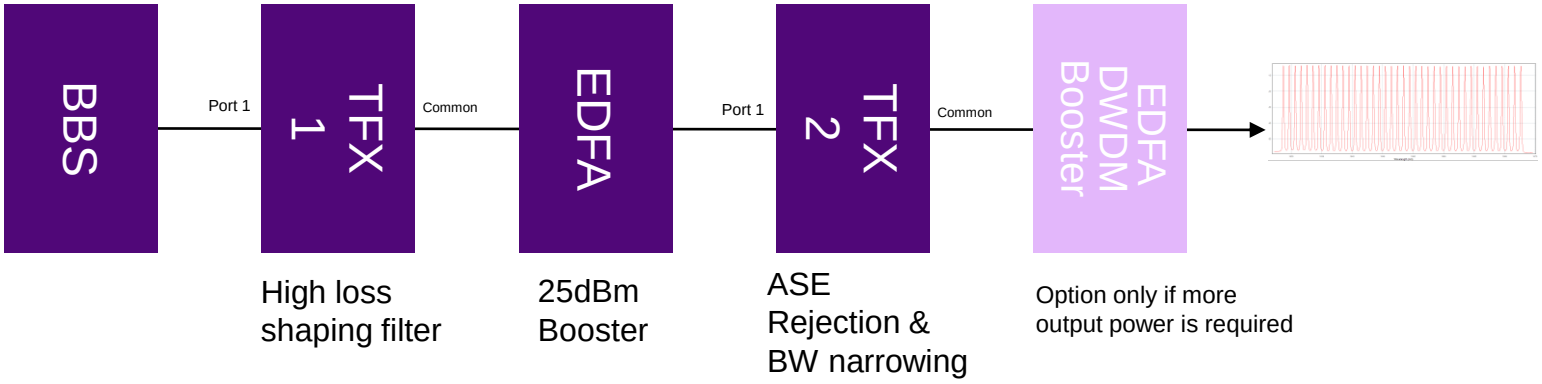
- The mTFX-C1 is an ideal tool as it combines many devices
  - Up to 80 independent tunable bandpass filters
  - 15dB of independent attenuation per filter
  - 8 port multiplexer for adding additional tones if required

- Need to maintain <0.5dB flatness and OSNR (0.1nm nBW) >45dB (50dB desired) with the maximum output power while remaining under the max input power specification of the mTFX

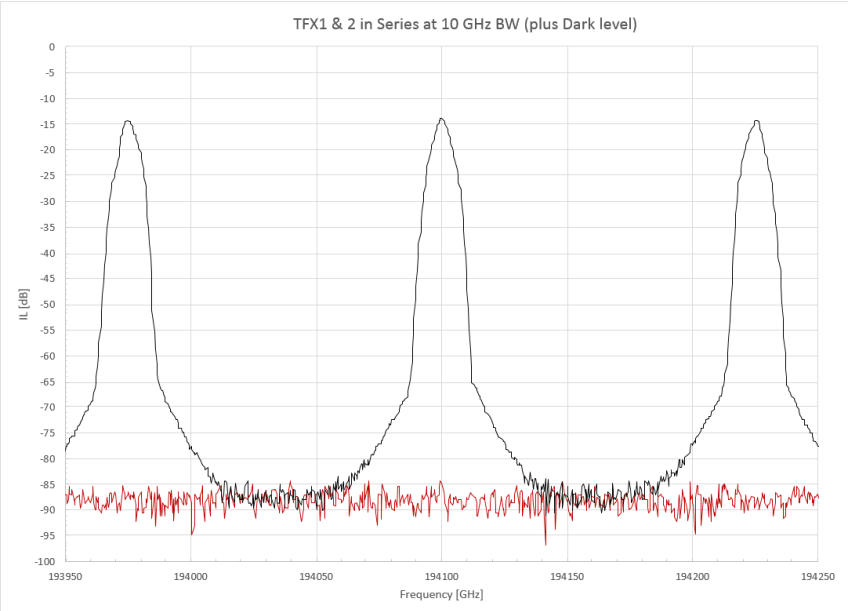
Summary

- High level observations from the investigations
  - The single pass TFX does not have high enough background rejection to achieve the OSNR required in a single stage implementation
  - Cascading two TFX significantly improves the rejection and has a positive impact on the minimum filter bandwidth (narrows)
  - The DWDM Booster, will achieve the output power required, but at the expense of the OSNR (not typically better than 35dB if used)
  - Trimming the attenuation of the TFX will achieve the desired flatness.

- Implementation
  - TFX 1 is used as a shaping filter and controls the flatness
  - After several trials, mEDFA-C1 / D-type, was selected with 25dB saturated output power
  - TFX 2 is used to assist in the BW narrowing and adding ASE rejection
  - TFX 2 can also be used to create additional grid shaping (band offsets, slopes etc)



Example Insertion Scan of Cascaded TFX

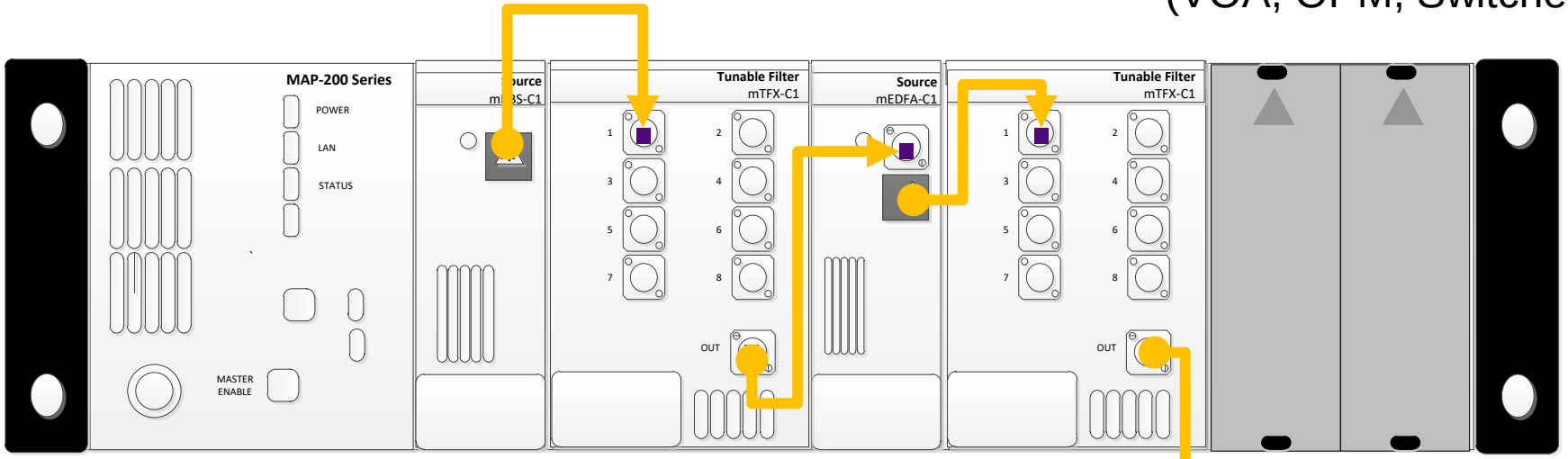


Measured using mSWS-A2 system

- Prior to building the comb source, a more detailed investigation of the filter response was performed
- Two cascaded TFX results in a minimum of 9.5 GHz 3dB bandwidth
- The inter-channel isolation can be as low high as 70dB as compared to 50dB for a single stage

Example Chassis Layout

Expansion slots
(VOA, OPM, Switches)

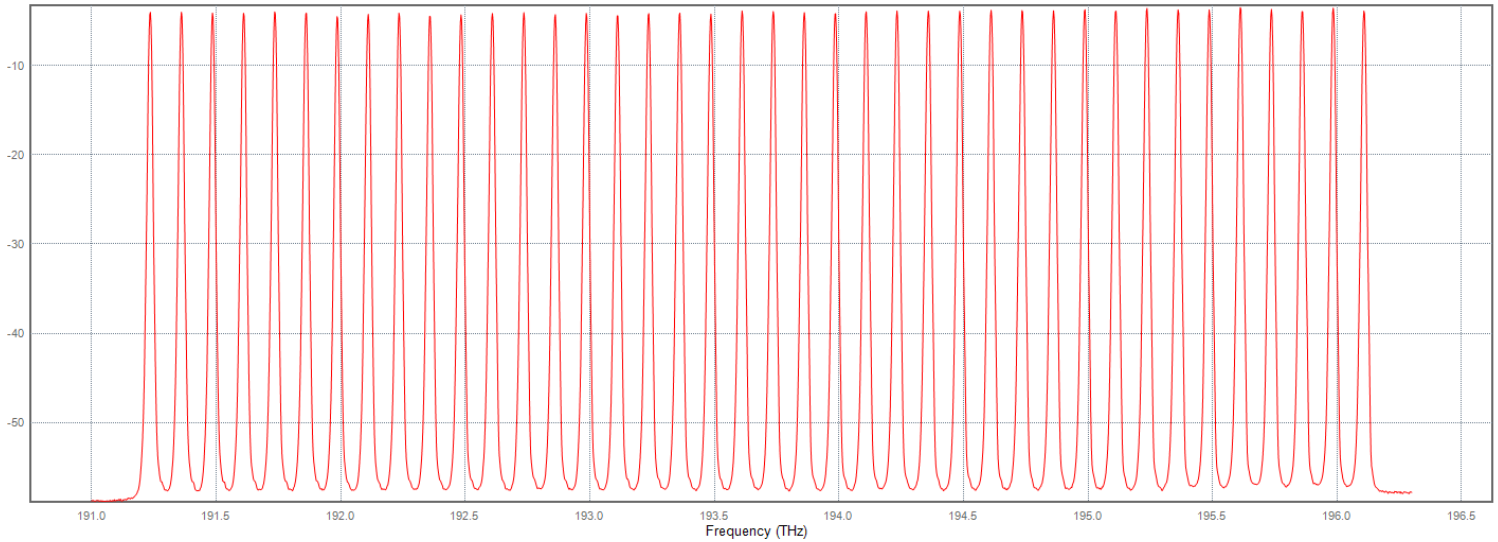


Ports 2-8 can be used to multiplex additional signals into the system

- Probe tone
- Live data channels

To Amplifier under test

Sample Results (Type D amplifier and no Booster)



(Power scaling off due to use of VOA to manage power to OSA)

1. Channels: 40 (set by TFX)
2. Spacing: 125 GHz (set by TFX)
3. Total Integrated Power: 17.5 dBm (OPM measured)
4. Channel Power: >1.4 dBm (calculation from OPM data)
5. OSNR (0.1dB NBW): >50 dB (OSA measured)
6. Average 1dB BW: 5.4 dB +/- 0.2 dB (OSA measured)
7. Average 2dB BW: 7.6 dB +/- 0.3 dB (OSA measured)
8. Average 3dB BW: 9.3 dB +/- 0.3 dB(OSA measured)

OSNR

Channel	CW	OSNR (0.1nm)	Spacing
1.000	191.235	51.32	0.126
2.000	191.361	51.08	0.125
3.000	191.486	50.97	0.125
4.000	191.611	50.9	0.125
5.000	191.736	51.03	0.125
6.000	191.861	50.85	0.125
7.000	191.986	50.51	0.124
8.000	192.111	50.85	0.124
9.000	192.235	50.86	0.124
10.000	192.358	50.54	0.125
11.000	192.483	50.76	0.126
12.000	192.609	51	0.126
13.000	192.735	51.06	0.126
14.000	192.861	50.77	0.125
15.000	192.986	50.98	0.125
16.000	193.111	50.74	0.125
17.000	193.236	50.98	0.125
18.000	193.361	51.06	0.125
19.000	193.486	50.98	0.125
20.000	193.612	51.37	0.125
21.000	193.737	51.42	0.125
22.000	193.861	51.31	0.125
23.000	193.986	51.12	0.124
24.000	194.109	51.29	0.124
25.000	194.233	51.42	0.126
26.000	194.359	51.43	0.126
27.000	194.485	51.42	0.125
28.000	194.611	51.54	0.125
29.000	194.736	51.55	0.126
30.000	194.862	51.53	0.125
31.000	194.987	51.57	0.124
32.000	195.111	51.46	0.125
33.000	195.236	51.79	0.126
34.000	195.362	51.46	0.125
35.000	195.487	51.27	0.125
36.000	195.612	51.47	0.124
37.000	195.736	51.17	0.124
38.000	195.860	50.96	0.124
39.000	195.984	51.43	0.124
40.000	196.108	51.43	

Other Advantages

- Small compact solution (simple 3U rack integration)
- Simple SCPI based control SW over ethernet (simple VNC login for remote GUI use)
- Use SET and RECAL state function to save and recall global settings for entire chassis in one command. Set Power-Up state to create comb filter directly.
- Leverage additional MAP modules to simplify integration (power meter, switches, attenuators, splitters, tunable laser)
- Leverage the power of the MTFX to create additional test cases
  - Flexibility :Simple to add and subtract channels
  - Simulate mixed modulation environments by changing bandwidth
  - Insert live data
  - Insert probe signal

Apendix

Module Details

NEW

MAP-200 Multiport Tunable Filter Module, MTFX-C1

New Tunable Filter - mTFX-C1

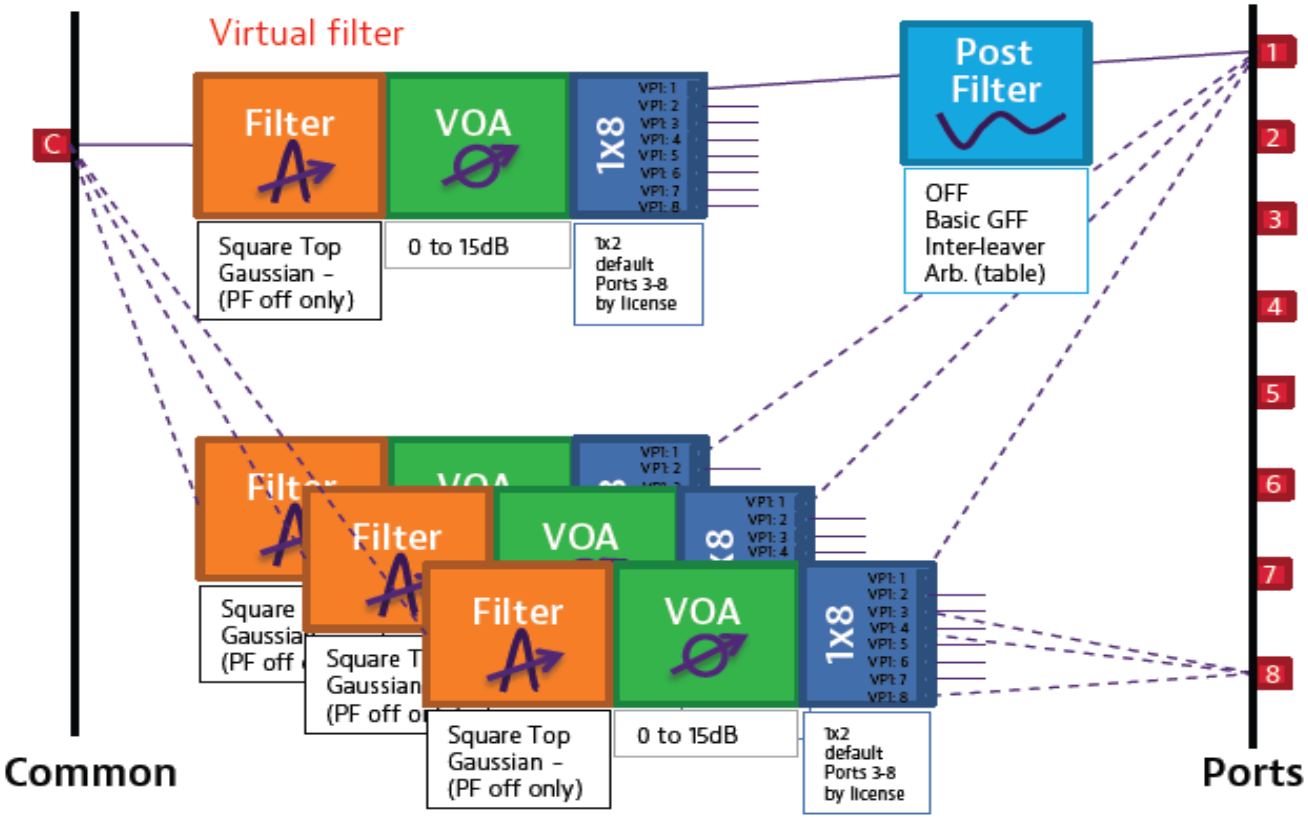
Light Direct

Key Features and Benefits

- Tunable filter with bandwidth adjustment from 16 to 5100 GHz with 0.5 GHz resolution
- Low loss (<5.5 dB), continuous extended C-band coverage with ±3.5 GHz wavelength accuracy
- Up to 80 independent filters, each with independent attenuation and output port assignment
- New filters can be added and removed without disturbing existing connections
- Internal power meter option with automated single and multiple peak find algorithms
- Automated peak tracking function without loss of transmitted power
- Fast, simple GUI and SCPI control interfaces for filter generation
- Optional SW license to enable up to 8 output ports

Not tied to ITU Grid
[Flex-Spectrum]
[Flex-Grid]
[Ture-Flex]

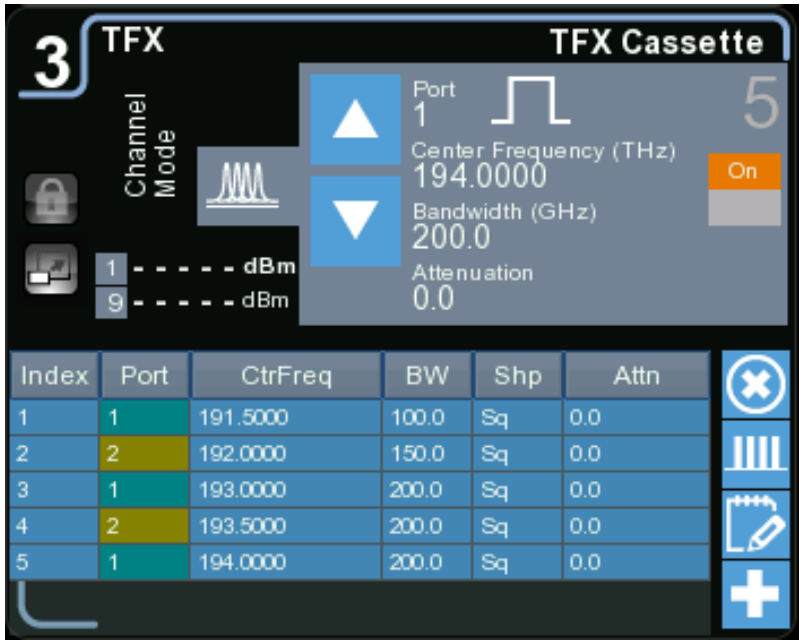
Basic Functional Visualization

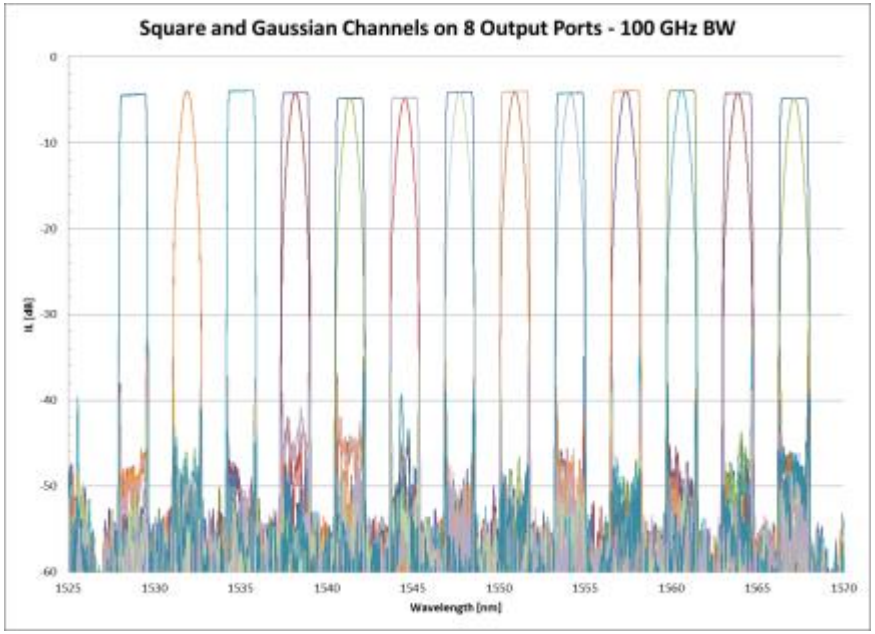


Notes:

- Up to 120 VF can be created. Once created (set BW, shape) move by changing CW only
- Setting CW=0 puts the VF into the parking lot ready for use later
- A “Slice” of spectrum as set by the BW can only be allocated to an output port once. A another VF can not be set over top allocated spectrum
- Unit will assume at least 1 VF created – in this mode – acts like MTBF

mTFX-C1 – Different shapes/BW to different ports



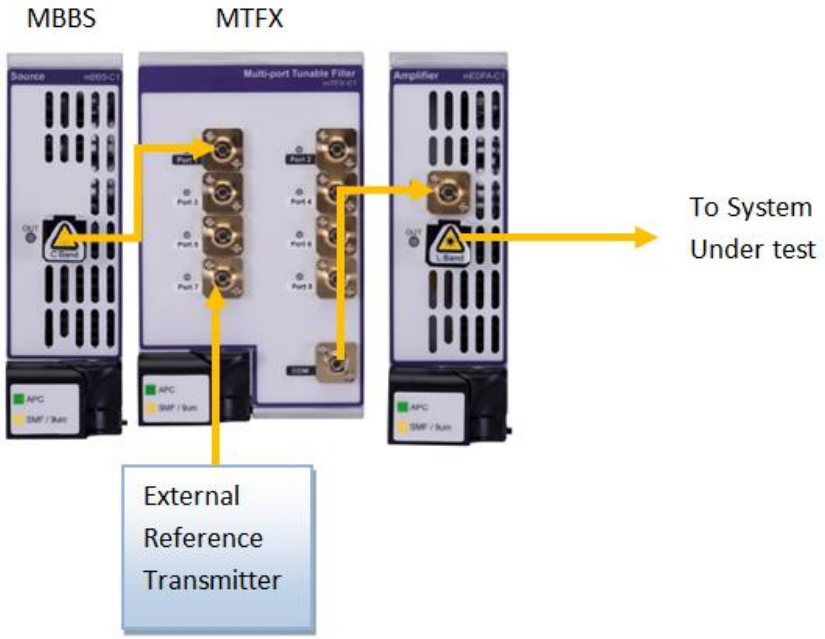


- Set different channels shapes (Gaussian or flat top)
- Set different bandwidths
- Set different centre frequencies
- Assign port

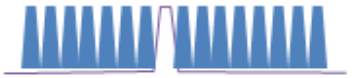
- Will warn of channel conflict (cannot have two channels overlapping)

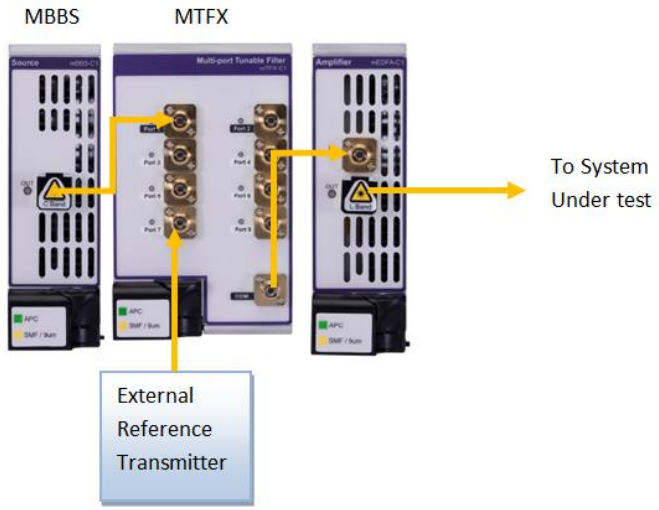
Application: Building a DWDM Test Source

- Amplified line system testing is extremely expensive if full channel loads are required to make do accurate ONSR, NF or Gain Measurements
- Can't afford to have 96 channels of 100G coherent TX
- Solution: Generate simulated signals a "shaped" white light spectrum and insert a single reference TX



Application: Building a DWDM Test Source

Step	Action	Result
1	Generate the Comb filter and assign to the MBSS port (port 1 shown above)	
2	Set the low pass filter	
3	Set the high pass filter	
4	Verify the Channel has been removed	
5	Set the insertion filter	
6	Enable test channel	



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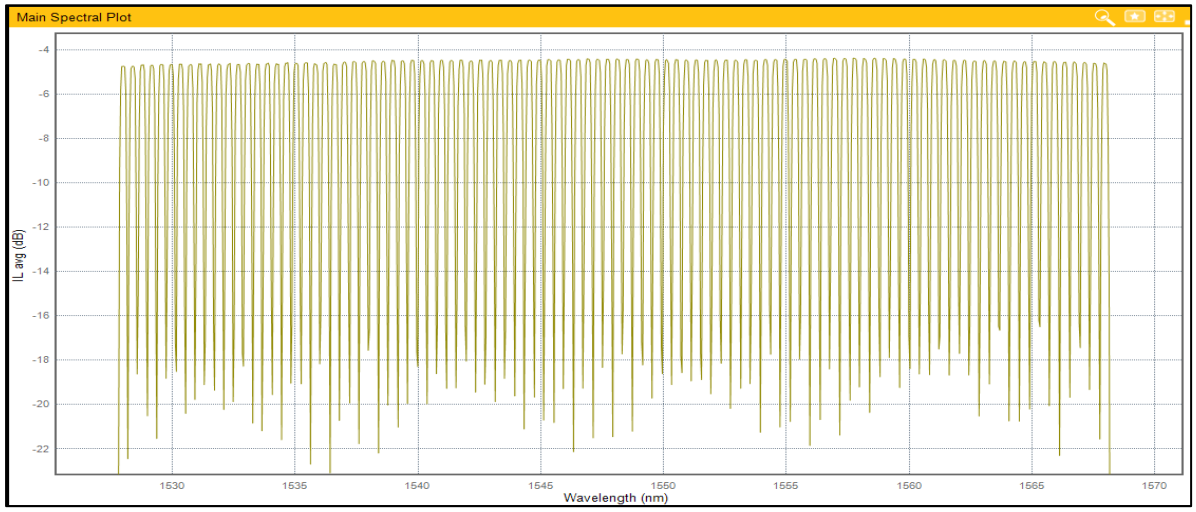

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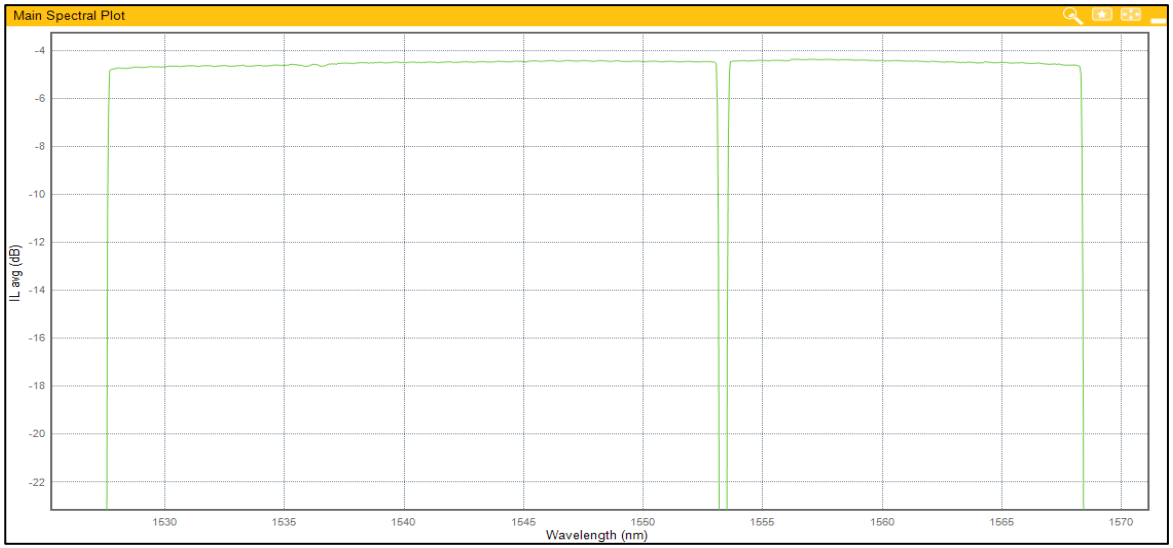

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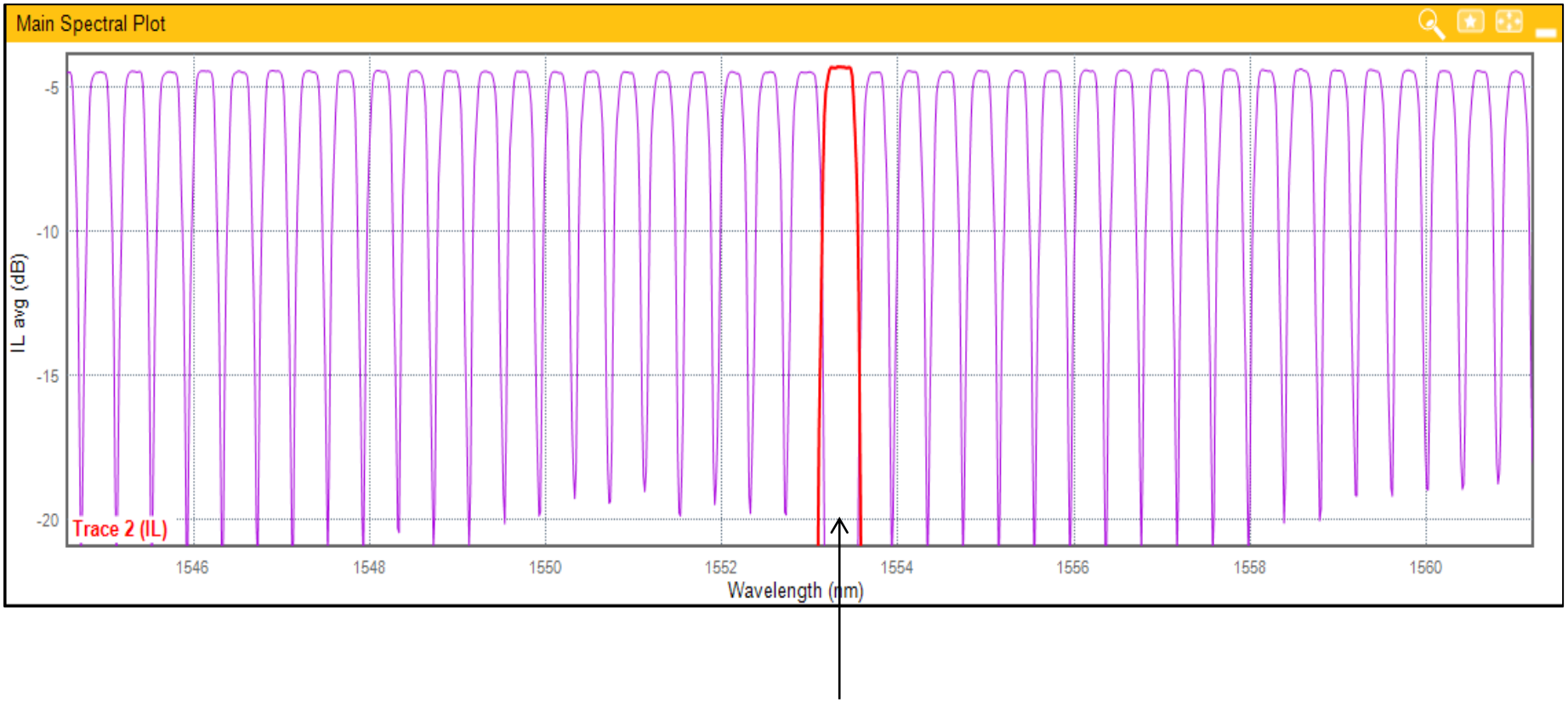


Channel Insertion with active 100G TX

NEW

New Amplifier and Noise Sources: MEDFA-C1 / MBBS-C1

New mEDFA-C1

- Simplified range with broader range of applications per module
- Extended C-Band and L-band
- MAP-220 LightDirect Compatible
- Simple controls with no network management overhead

Simple amplification for test automation applications

- Over come losses in test integration with minimal NF penalty
- OSNR loading applications
- Receiver power saturation and recovery testing

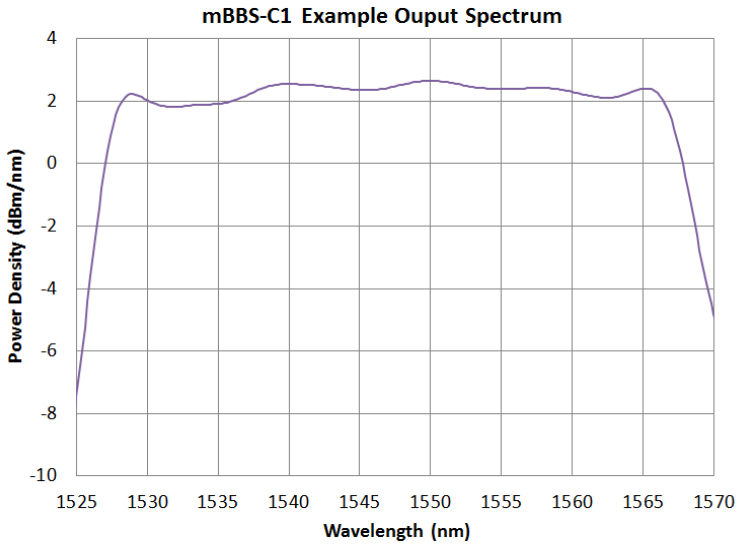
Light Direct

mEDFA-C1 Selection Primer

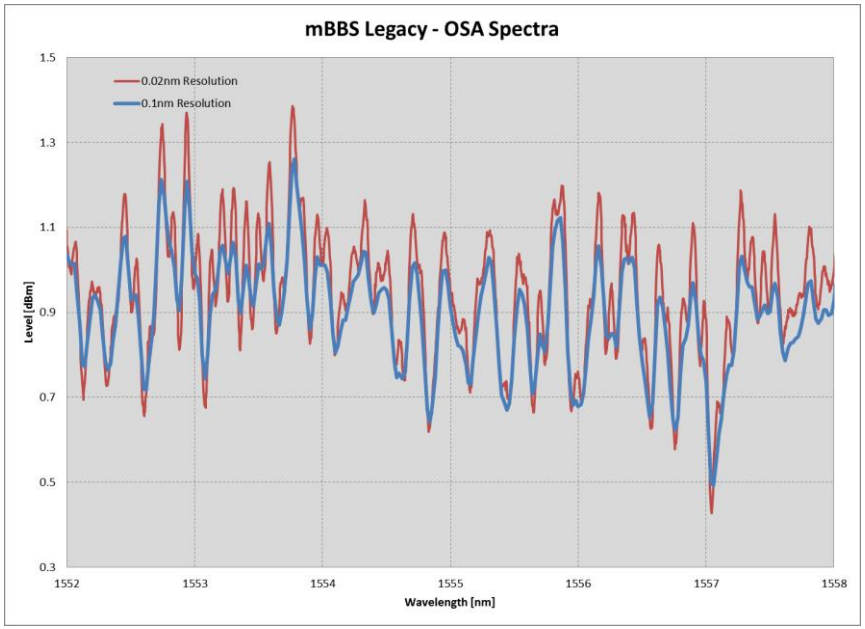
Version	Amplifiers per module	Input Type	Band	Gain and Power Control	Saturated Output Power	Application
MEDFA-C11CA Preamp	1	Single Channel	C	No	Standard	Preamp. Minimize noise figure while providing enough gain to ensure test signal at required power.
MEDFA-C12CA Dual Preamp	2	Single Channel	C	No	Standard	Dual CA version amplifiers. Improves test system density for applications requiring more than one.
MEDFA-C11CB Booster	1	Single Channel	C	Yes	Standard	Booster. Adding gain and power control simplifies power level control but increases noise figure slightly. Ideal for single channel tunable signal applications.
MEDFA-C11CF DWDM Booster	1	DWDM	C	Yes	Standard	DWDM Booster. For full multichannel input applications. Power and Gain control is available.
MEDFA-C11CD Max Power	1	Single Channel	C	Yes	High	Maximum Power. Amplifier optimized to deliver the maximum allowable saturated output power for standard lab safety protocols. Ideal for signal splitting or power saturation recovery testing.
MEDFA-C11LB L-band Booster	1	Single Channel	L	Yes	Standard	L-band version of the Booster amplifier.

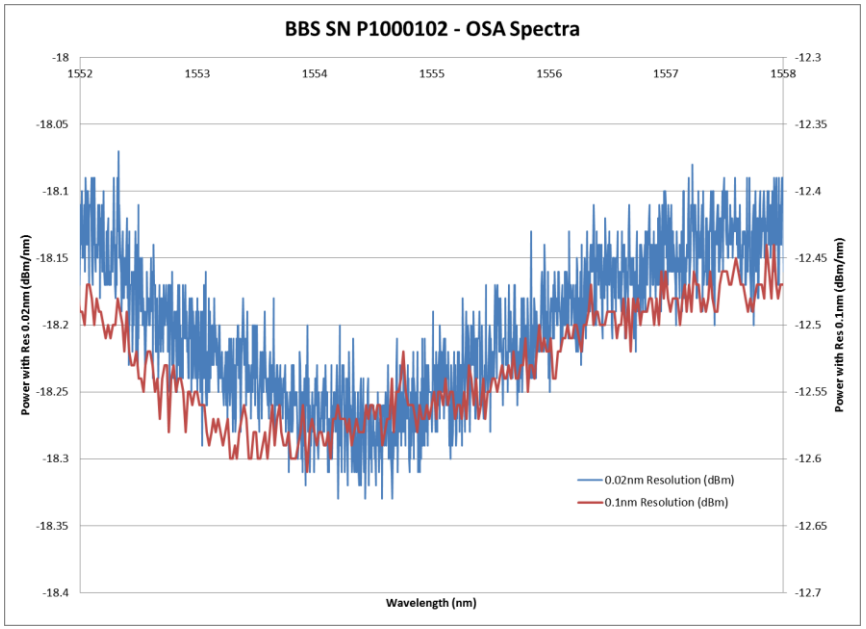
mBBS-C1

Parameter[1]	
Operating Wavelength Range	1525nm –1568nm
Saturated Power[2]	≥ 20dBm
Spectral Gain Flatness (spectra range 1529nm – 1565nm)	≤ 1.8dB
Total Power Stability[3]	≤ 0.02dB
Laser Safety Class[4]	1M
Fiber Type[5]	Single Mode Fiber
Connector Type	FC/APC
Operation temperature	0 – 40 °C
Operation humidity	Maximum 95% RH, 0 to 40 °C non condensing
Storage temperature	-30 to 60 °C
Dimensions (W x H x D)	4.06cm x 13.26cm x 37.03cm
Weight	2.3kg



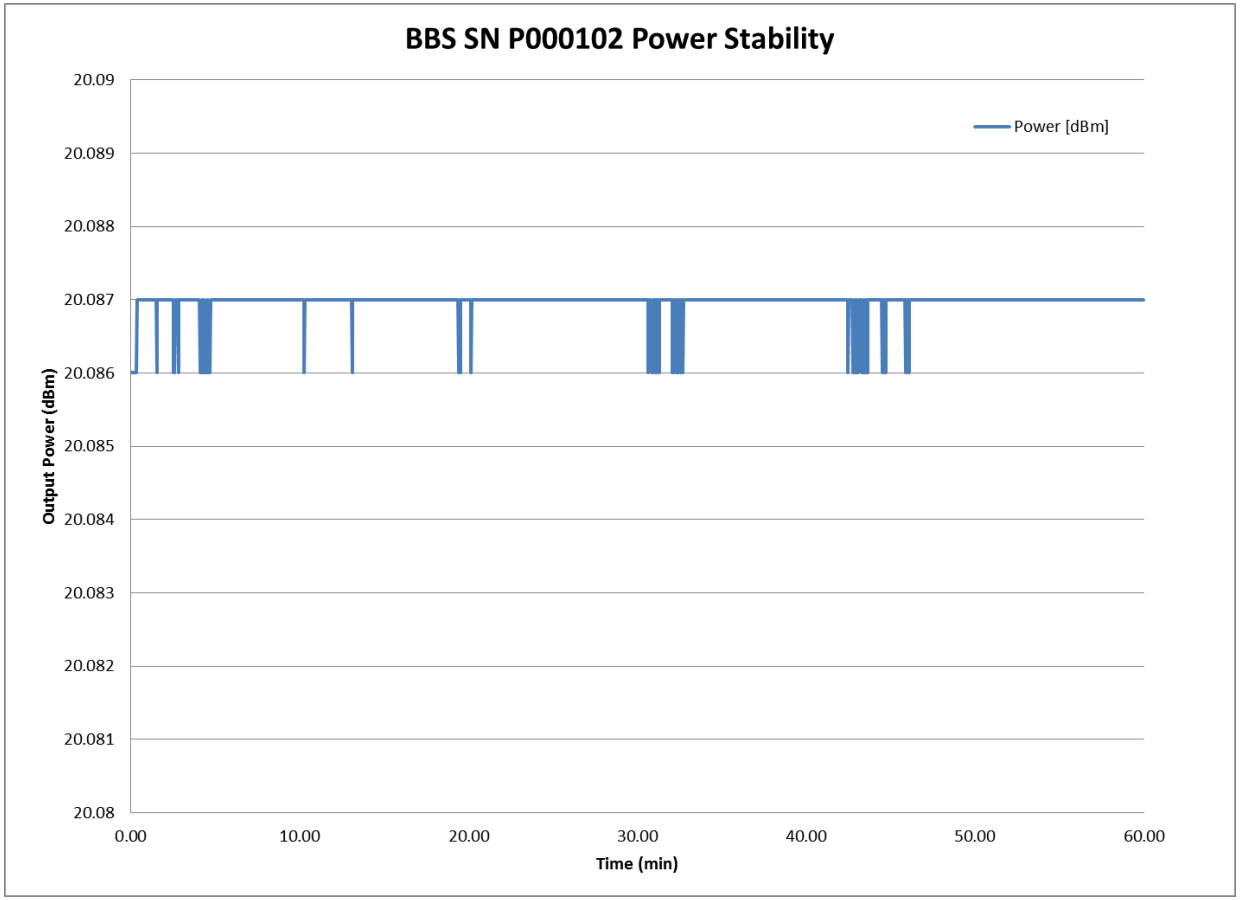
Improved BBS Spectral Ripple





- High frequency P-P spectral ripple is 0.75dB (0.02nm Res) and 0.55dB (0.1nm Res)
- High frequency P-P spectral ripple is 0.12dB (0.02nm Res) and 0.06dB (0.1nm Res)

Superior Power Stability



±0.5mdB in 60 min