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<http://www.photonics.ixblue.com/>

contact.photonics@ixblue.com

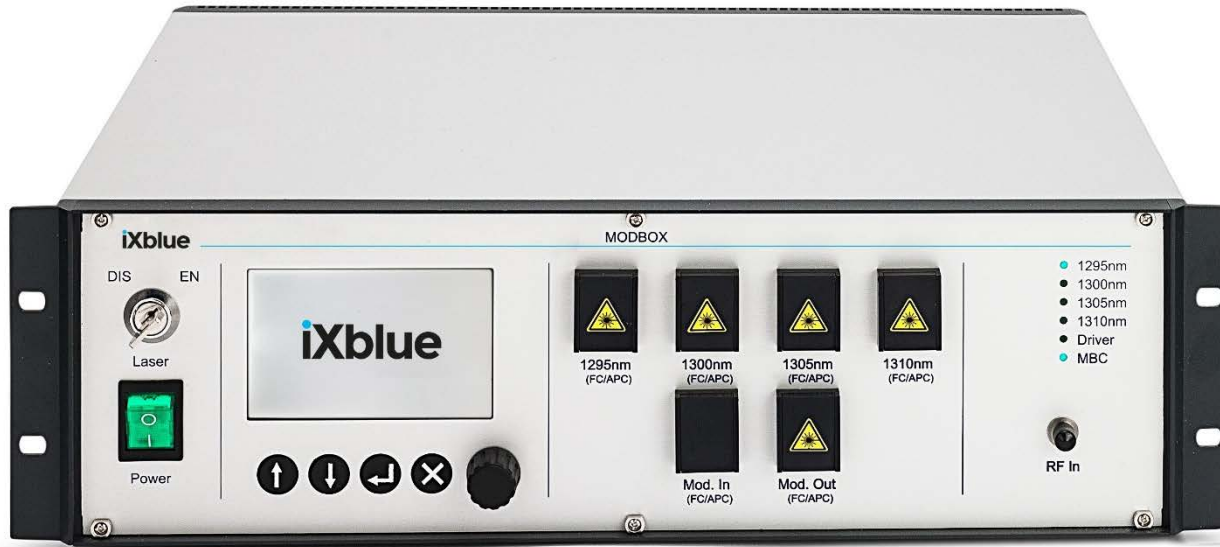
October 2017



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NRZ & PAM-4 Reference Transmitters

NRZ & PAM-4 Reference Transmitters



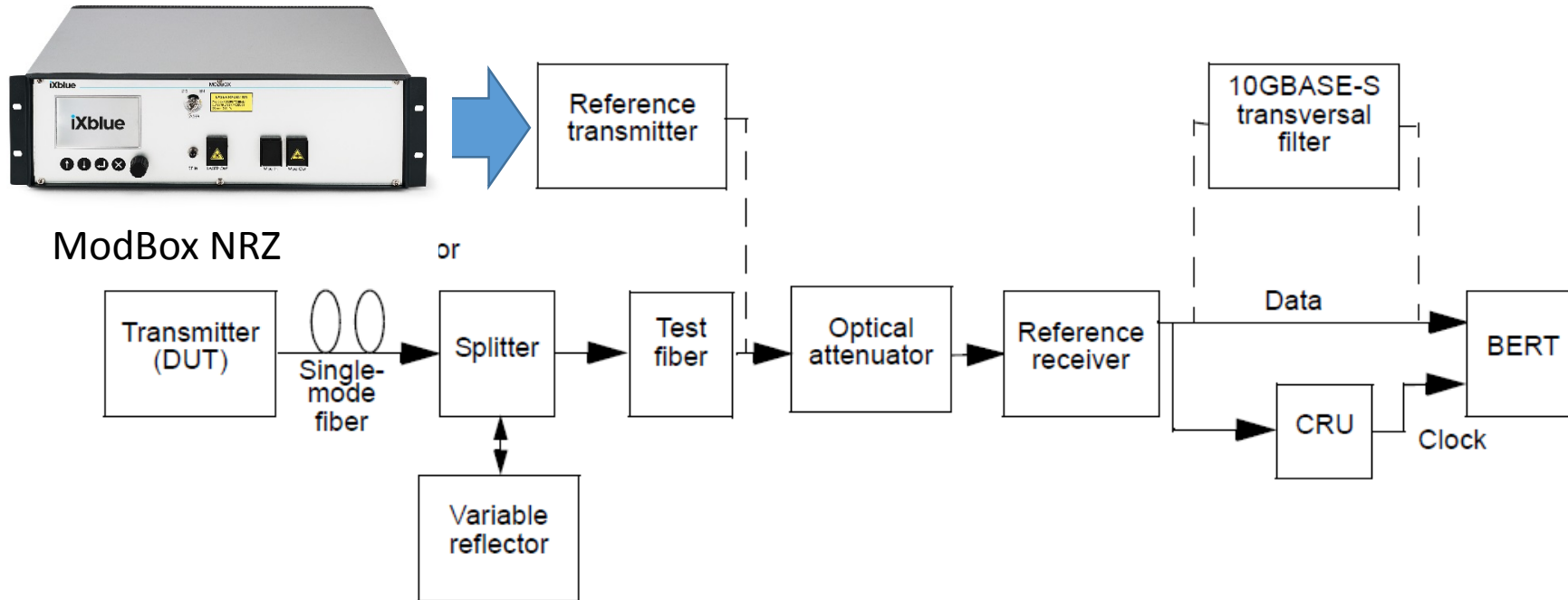
- ModBox-NRZ: 28 Gb/s, 44 Gb/s, 50 Gb/s
- ModBox-PAM4: 28 GBaud
- ModBox-VNA: 40GHz, 65GHz
- Operating optical bands:
 - 850 nm
 - C-Band & 1490 nm
 - Full O-Band (CWDM, LAN-WDM)
 - 1310 nm & 1550 nm

NRZ & PAM-4 Reference Transmitters

- The ModBox Reference Transmitter is a high-quality instrument-grade system
- Repeatable & Reproducible measurements (symmetric Eye, pass the transmitter waveform test)
- Very high quality Eye Diagrams (low jitter, eye shape,..)
- Lane lasers and tunable lasers integration (to ensure OOP and eye shape stability and shape):
 - ER/LR: O-band (5nm spacing, LANWDM): 1295 nm, 1300 nm, 1305 nm, 1310 nm
 - ER/LR: O-band (20nm spacing, CWDM): 1271 nm, 1291 nm, 1311 nm, 1331 nm
 - ER/LR: Tunable C, L lasers, 1490 nm
 - SR: 850 nm
- Extinction Ratio wide range adjustment

NRZ & PAM-4 Reference Transmitters

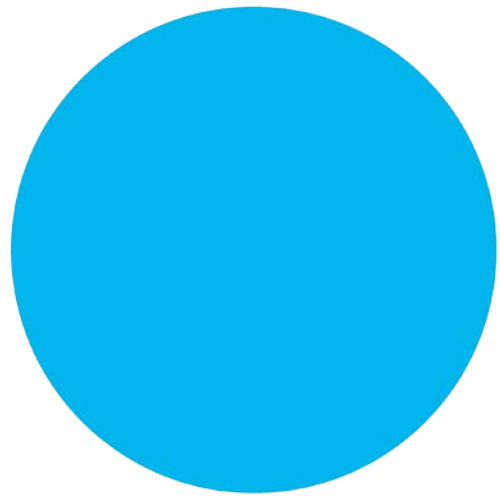
Transmitter and dispersion penalty measurement



58.7.9.1 Reference transmitter requirements

The reference transmitter is a high-quality instrument-grade device, which can be implemented by a CW laser modulated by a high-performance modulator. It should meet the following basic requirements:

- The rise/fall times should be less than 0.15 UI at 20% to 80%.
- The output optical eye is symmetric and with good margin to the eye mask test for the transmitter (PMD) type under test.
- In the center 20% region of the eye, the worst-case vertical eye closure penalty, as defined in 58.7.11.2, is less than 0.5 dB.
- Jitter less than 0.20 UI peak-peak.
- $RIN_{12}OMA$ should be minimized to less than -120 dB/Hz for 100BASE-X and -125 dB/Hz for 1000BASE-X.

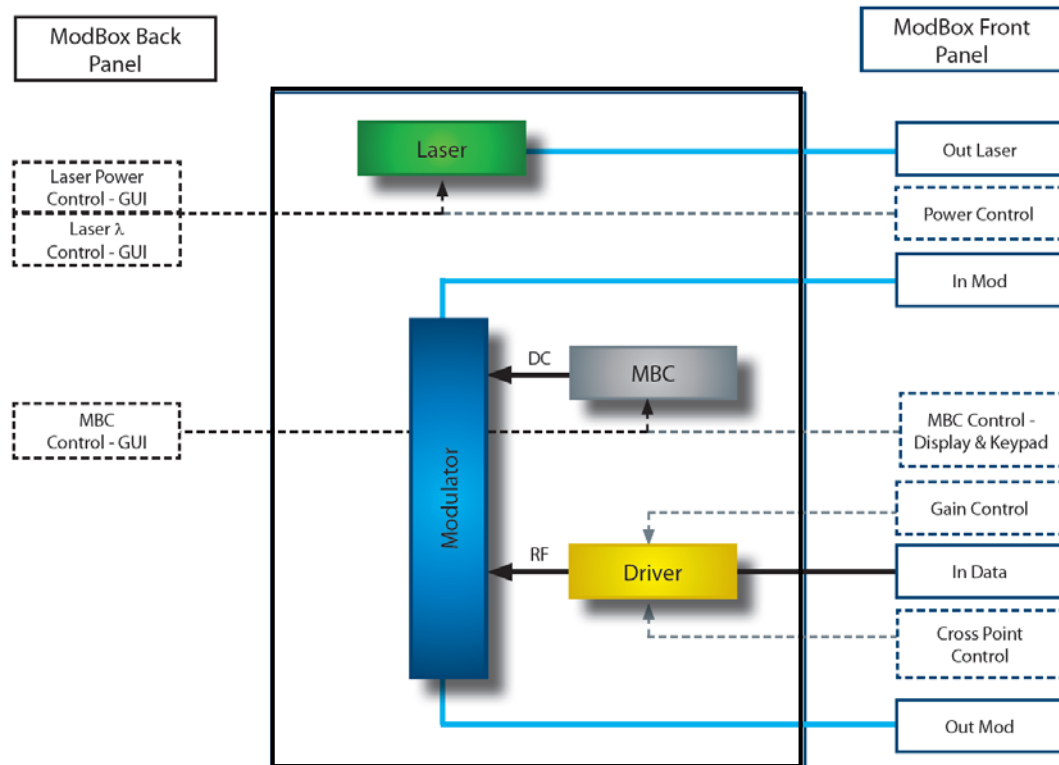


NRZ & PAM-4

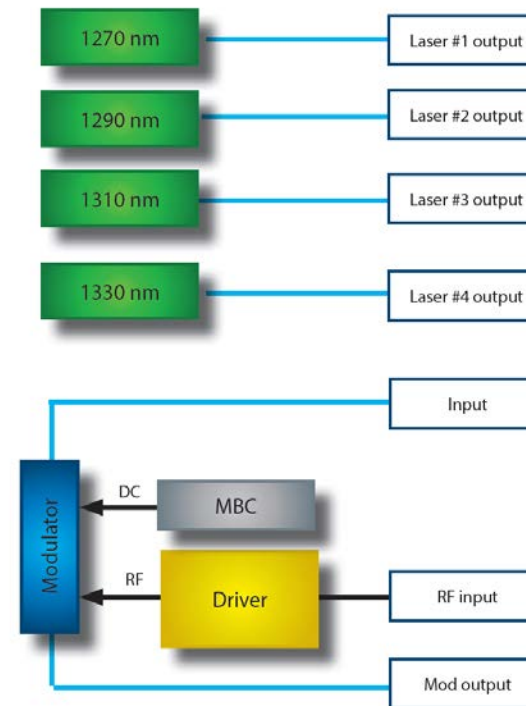
Reference Transmitters

Internal set-up

NRZ & PAM-4 Reference Transmitters – Internal set-up – I/II

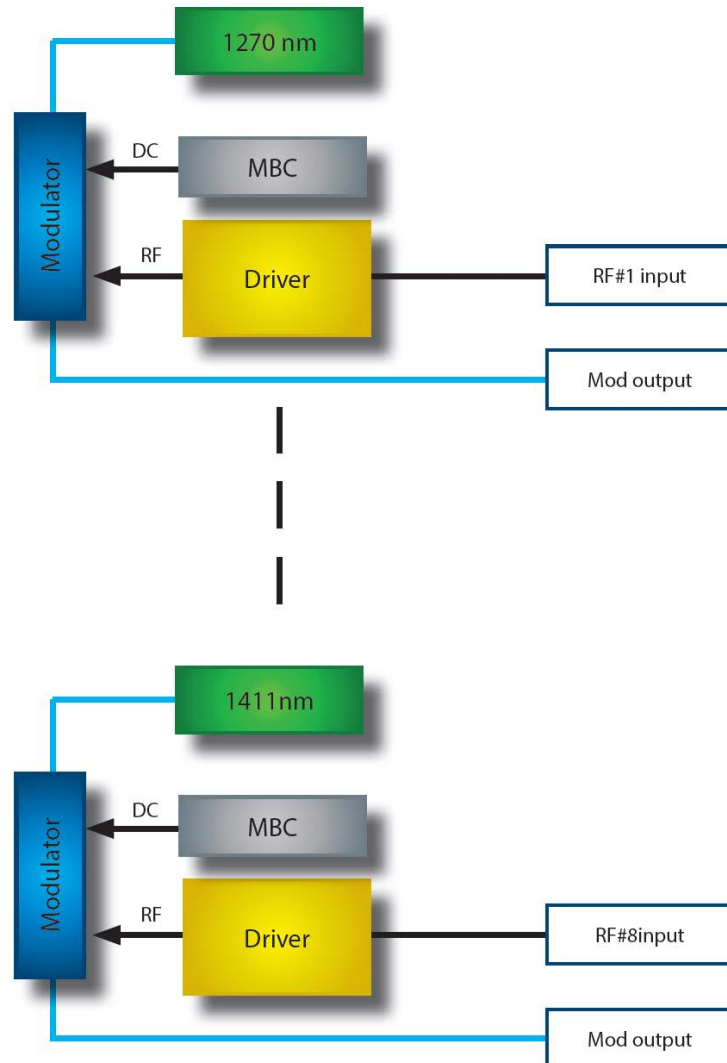


- External modulation for Zero-Chirp modulation
- High bandwidth Modulator & Driver
- Up to 4 lasers integration

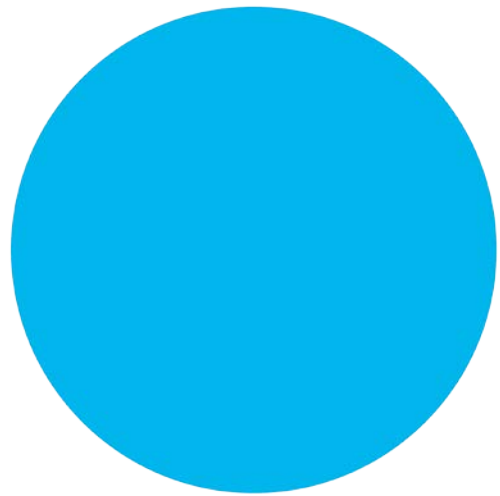


NRZ & PAM4

Reference Transmitters – Internal set-up – II/II



- External modulation for Zero-Chirp modulation
- High bandwidth Modulator & Driver
- Aggressor source and cross-talk measurement
- Option: optical output multiplexing



NRZ & PAM-4

Reference Transmitters

The Smart Interface

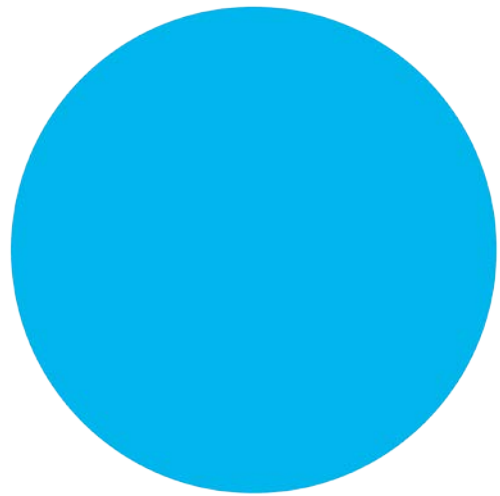
NRZ & PAM-4 Reference Transmitters – The Smart Interface



Smart large LCD screen

The ModBox SMART digital interface enables system main parameters monitoring and full modulation parameters control including:

- driver's gain and cross point (NRZ ModBox version only),
- ER selection (from 3 dB to 12 dB for NRZ ModBox version only)
- laser power and wavelength adjustments,
- automatic/manual stability selection,
- Impairments controls (Stress-Eye Units),
- Users can also remotely control the unit through proprietary software (USB).



NRZ & PAM-4

Reference Transmitters

Comparison

NRZ & PAM-4 Reference Transmitters

ModBox Type	Integrated lasers	Modulation scheme	Data bit-Rate	Extinction Ratio	Optical output modulated signal
ModBox-NRZ type					
<u>ModBox-850nm-NRZ</u>	- 850 nm (by default)	NRZ	Up to 50 Gb/s	Variable	> 2 dBm > 5 dBm (option)
<u>ModBox-Oband-NRZ</u>	- 1310 nm (by default) - CWDM (option) - LAN-WDM (option)	NRZ	Up to 50 Gb/s	Variable	> 2 dBm > 5 dBm (option @1310 nm)
<u>ModBox-1310nm-1550nm-NRZ</u>	- 1310 nm (by default) - 1550 nm (by default)	NRZ	Up to 44 Gb/s	Variable	> 2 dBm @1310 nm > 6 dBm @1550 nm
<u>ModBox-Cband-NRZ</u>	- 1550 nm (by default) - C-Band tunable (option) - L-Band tunable (option)	NRZ	Up to 50 Gb/s	Variable	> 5 dBm (option @1550 nm)
ModBox PAM-4					
<u>ModBox-850nm-PAM4</u>	- 850 nm (by default)	PAM-4 & NRZ	NRZ up to 28 Gb/s PAM4 up to 28 Gbaud	Variable	> 2 dBm > 5 dBm (option)
<u>ModBox-Oband-PAM4</u>	- 1310 nm (by default) - CWDM (option) - LAN-WDM (option)	PAM-4 & NRZ	NRZ up to 28 Gb/s PAM4 up to 28 Gbaud	Variable	> 2 dBm > 6 dBm (option @1310 nm)
<u>ModBox-1310nm-1550nm-PAM4</u>	- 1310 nm (by default) - 1550 nm (by default)	PAM-4 & NRZ	NRZ up to 28 Gb/s PAM4 up to 28 Gbaud	Variable	> 2 dBm @1310 nm > 6 dBm @1550 nm
<u>ModBox-Cband-PAM4</u>	- 1550 nm (by default) - C-Band tunable (option) - L-Band tunable (option)	PAM-4 & NRZ	NRZ up to 28 Gb/s PAM4 up to 28 Gbaud	Variable	> 6 dBm @1550 nm



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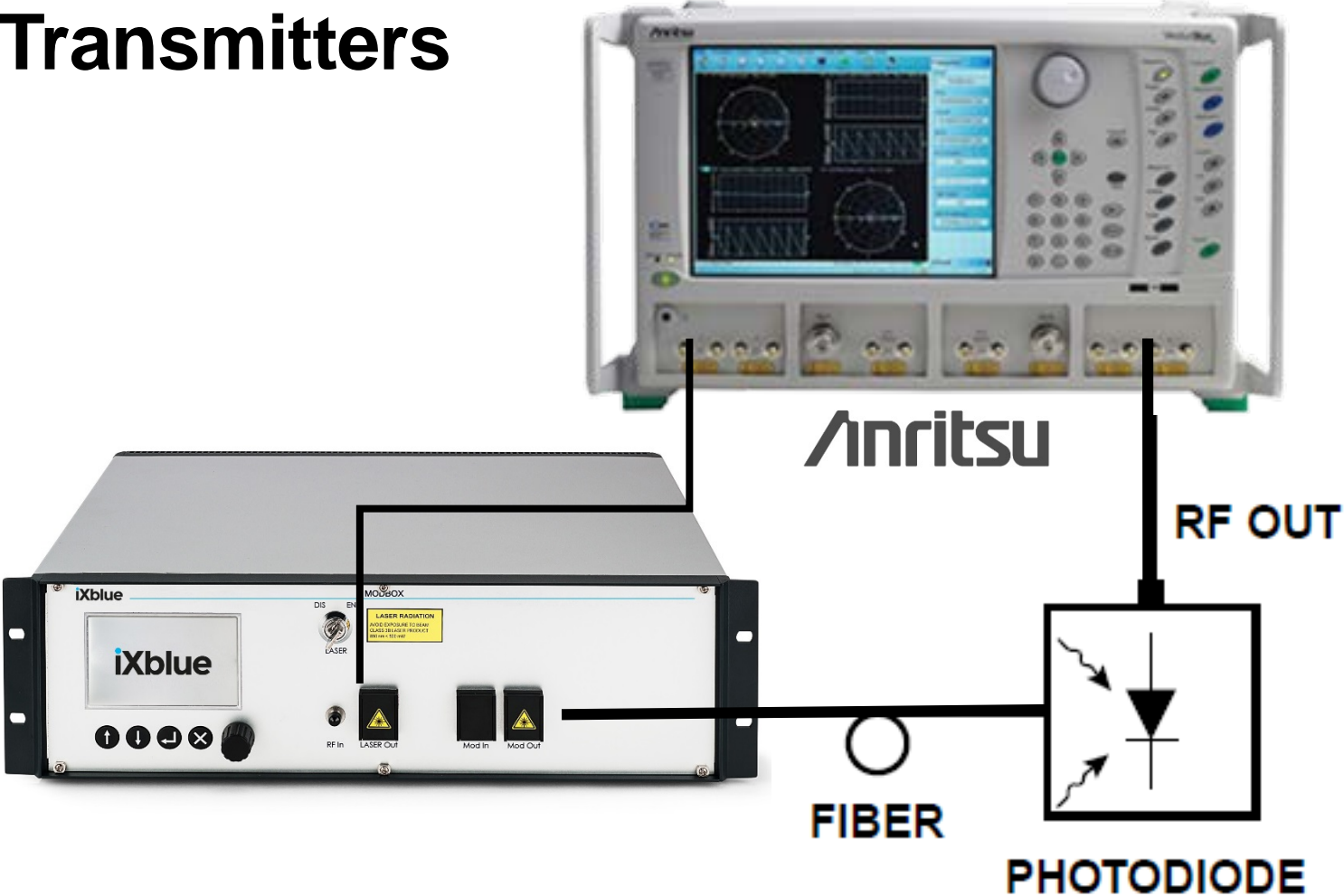
VNA Reference Transmitters

VNA Reference Transmitters

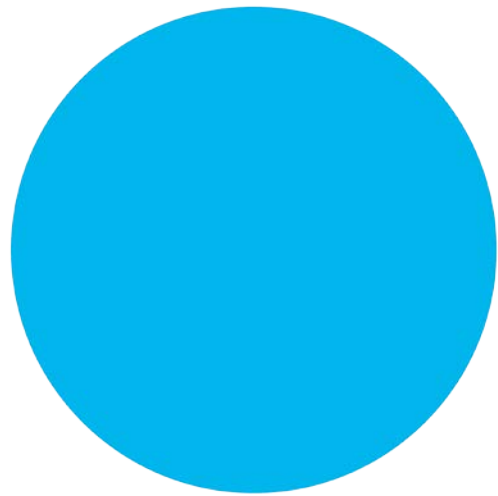


- Analog Modulation: 40GHz, 65GHz
- Bands: 850nm, O-Band, C&L-Bands

VNA Reference Transmitters



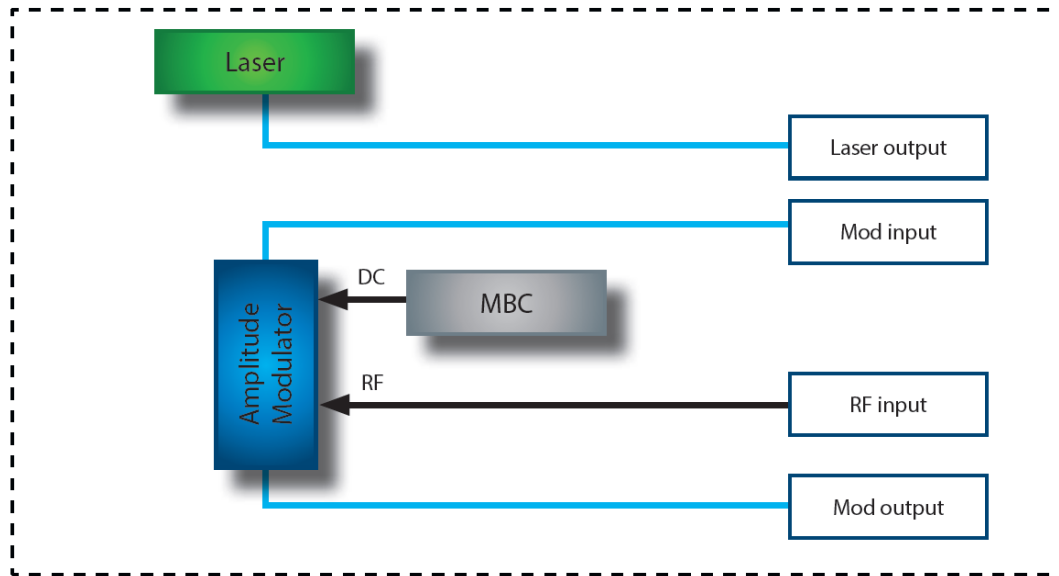
Receiver test for upper cut-off frequency and [S] parameters



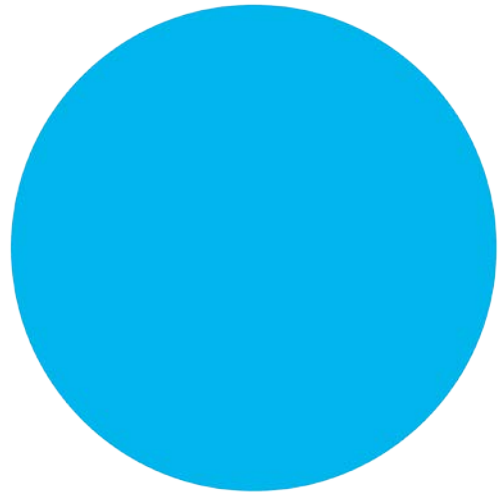
VNA Reference Transmitters

Internal set-up

VNA Reference Transmitters – Internal set-up



- External modulation
- High bandwidth Modulator of 40GHz, 65GHz and beyond
- Low Noise Laser Embedded laser
- Tunable C, L Bands lasers



VNA Reference Transmitters

Comparison

VNA Reference Transmitters

ModBox Type	Integrated lasers	Bandwidth	Optical output modulated signal
ModBox-VNA type			
<u>ModBox-850nm-VNA</u>	- 850 nm (by default)	30 GHz	> 7 dBm
<u>ModBox-Oband-VNA</u>	- 1310 nm (by default)	40 GHz, 65 GHz	> 7 dBm
<u>ModBox-1310nm-1550nm-VNA</u>	- 1310 nm (by default) - 1550 nm (by default)	40 GHz	> 2 dBm @1310 nm > 2 dBm @1550 nm
<u>ModBox-Cband-VNA</u>	- 1550 nm (by default) - C-Band tunable (option) - L-Band tunable (option)	40 GHz, 65 GHz	> 7 dBm (@1550 nm)

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