Photline TECHNOLOGIES
Delivering Modulation Solutions

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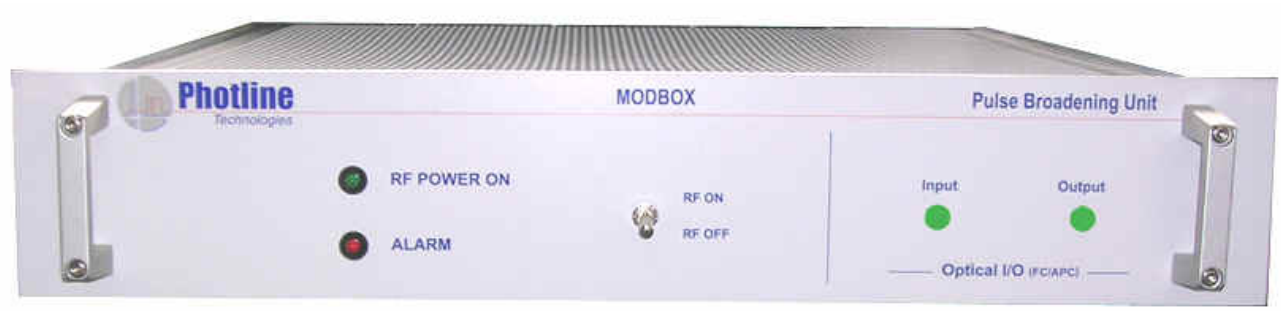

ModBox - Spectral Broadening Unit

The ModBox Family

The ModBox systems are a family of turnkey optical transmitters and external modulation benchtop units for digital and analog transmission, pulsed and other specific applications.

The Modbox design integrates within a bench-top or 2U 19” enclosure a laser source (optional), a complete modulation stage featuring an external LiNb03 modulator with its RF driver and bias control circuit, and a receiver stage (optional).

ModBoxes can be tailored to specific needs in order to provide systems engineers with reliable performance and high speed modulation capabilities together with the peace of mind of a ready-to-plug equipment.

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General Description : the 1053 nm Spectral Broadening ModBoxes

A Spectral Broadening ModBox is designed to suppress the Stimulated Brillouin Scattering (SBS) caused in optical fibers by high fluxes of highly coherent light. The SBS can lead to the destruction of the fiber and the optical components along the fiber. When the temporal coherence of the signal is destroyed, the SBS power threshold is significantly increased and thus its effects can be eliminated. The Spectral Broadening ModBox achieves this by modulating the phase of the optical signal and creating a number of lines over a spectral width that can reach more than 100 GHz.

The Pulse Broadening ModBox is a 19'' rackable Modulation Unit integrating a $LiNb0_3$ phase modulator (MPX-LN type) with a 38 dBm RF generator.

The exemple below shows a Spectral Broadening ModBox integrating a 14.25 GHz internal RF generator. This frequency is selected to obtain the widest possible spectral broadening. Other Spectral Broadening ModBoxes with lower frequency RF generator can be built.

Options

- choice of operating wavelength in the 790 nm – 2200 nm range
- choice of RF frequency : up to 14.25 GHz
- choice of optical connectors

Principle

The spectral analysis of the optical signal transmitted by a phase modulator driven at a fixed frequency f and with a fixed RF input power yields a spectrum with multiple lines centered around the optical frequency F, each line being spaced of f from its neighbors.

The spectral broadening is basically the product of the lines spacing by the number of lines. It depends on the RF power and the RF frequency, that last one being equal to the line spacing.

$$\text{Broaden Spectrum} = 2 \times m \times f$$

with m = modulation depth and f = RF modulation frequency.

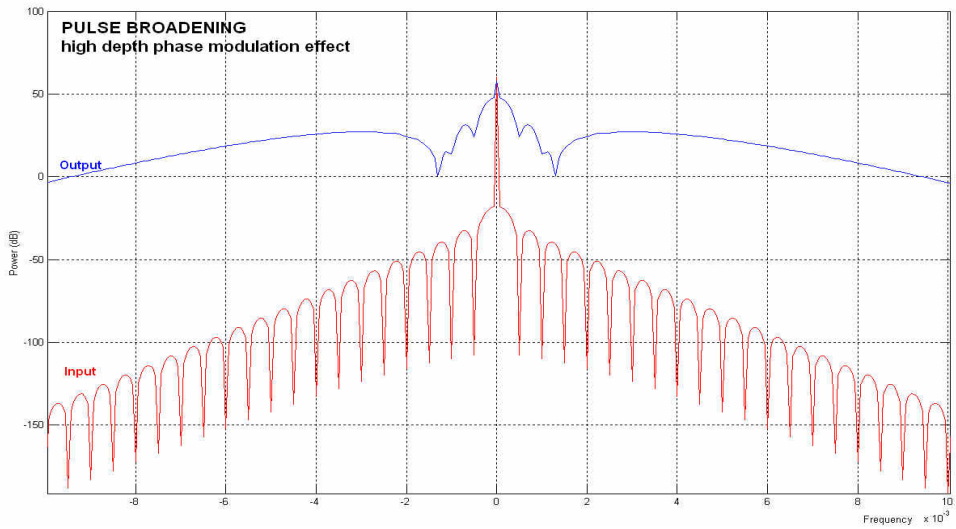

Figure 1 : Spectral broadening : approximate theoretical model

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The 14.25 GHz 1053 nm Spectral Broadening ModBox

The 14.25 GHz Pulse Broadening ModBox is optimized to produce a ≥ 0.5 nm spectral width optical pulsed signal from a customer supplied, 1053 nm pulsed , narrow spectrum (typ ; few MHz) optical signal.

The 14.25 GHz RF generator deliver a pulsed sine wave signal to an internal phase modulator. This signal is gated by the pulse laser and is sent to the phase modulator only in presence of an optical pulse, so as to reduce the RF power absorbed by the modulator. The resulting phase shift during the pulses is thus a sine function and the optical spectrum of the laser source is modified : a number of lines appears.

The lines are separated from a frequency spacing equal to the modulation frequency 14.25 GHz. The number of lines depends on the RF applied power. The proposed ModBox, when used at maximum RF power allows to make appear at least 10 lines so as to create an optical spectrum broadened to minimum 135 GHz (0,5 nm).

The ModBox is supplied with a USB interface for instrument remote.

Typical set-up

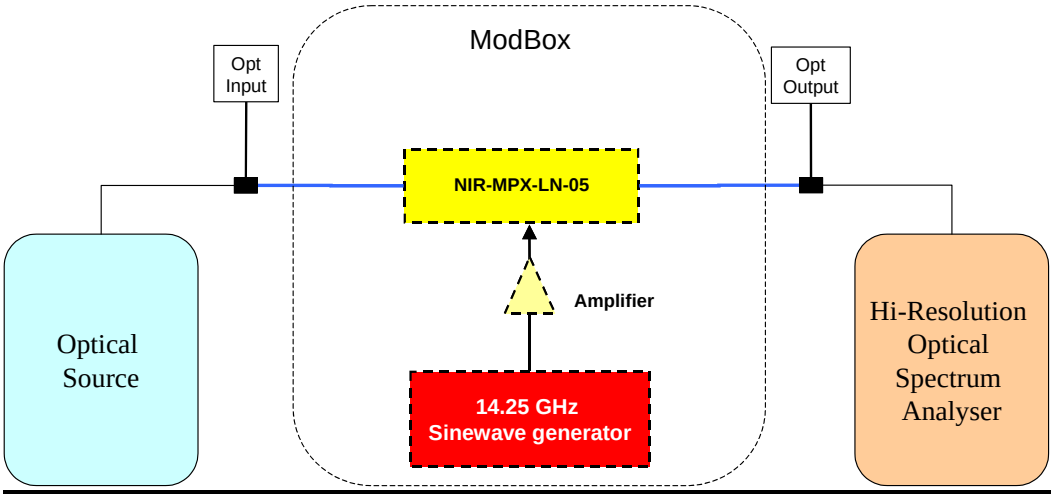

Figure 2 : ModBox Spectral broadening schematic

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Panel features

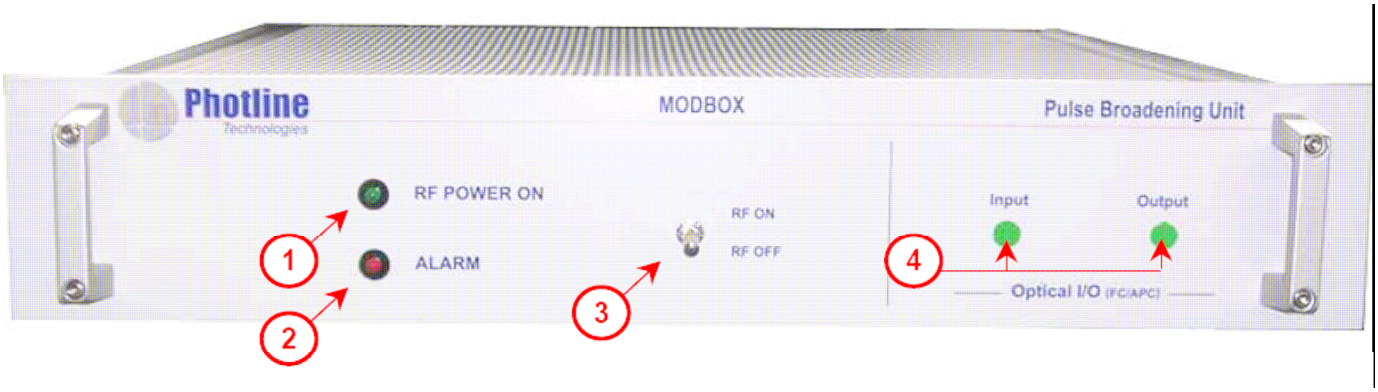

Figure 3 : ModBox front panel

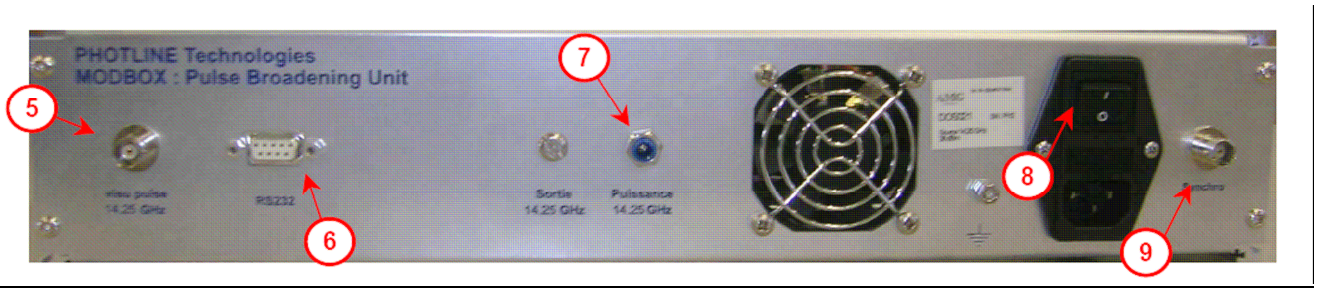

Figure 4 : ModBox back panel

Features	Notice
1. RF Power LED Status	lights up green when the RF switch is turned ON.
2. Alarm LED Indicator	lights up red when an error occured.
3. RF Power switch	Turn it on to proceed the pulse broadening
4. Optical I/O Ports	FC/APC fiber optical connector – Panda fiber with polarization in slow axis // key
5. Pulse monitoring output	BNC connector. 1V when power is maximum
6. RS232 female socket	For RF Generator remote control and monitoring. A standard RS232 direct cable is required
7. RF Power adjustement	Full range trimmer
8. AC Power Plug	System On/Off switch
9. Synchronization Input	BNC connector. TTL Signal

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Specifications

INPUT SIGNAL	Unit	Min	Typ	Max
OPTICAL INPUT SIGNAL *(user supplied, not a ModBox specification)*				
Wavelength of operation	nm	-	1053	-
Polarization extinction ratio	dB	25	-	-
Optical power	dBm	-	-	20

RF SOURCE	Unit	Min	Typ	Max
INTERNAL RF SIGNAL				
Frequency	GHz	-	14.25	-
Frequency accuracy	MHz	-5	-	+5
Stability	KHz/℃	-	100	-
Power	dBm	38	-	-
Power tenability	dB	-	13	
Phase noise @10kHz	$dBc.Hz^{-1}$	-	-	-95
Pushing	$KHz.V^{-1}$	-	100	-
High order harmonics rejection	dBc	-35	40	-
INTERNAL PULSE SIGNAL				
External trigger isignal type	-	-	TTL	-
External trigger repetition rate	Hz	1	10 M	200 M
Rise time	ns	-	-	150
Fall time	ns	-	-	500
Jitter	ns	150	-	400
Pulse width	µs	2	-	-

OPTICAL MODULATION STAGE	Unit	Min	Typ	Max
MODULATOR				
Modulator reference	NIR-MPX-LN-05			
Crystal	Lithium Niobate z-cut, y-propagating			
Modulator electro-optic bandwidth S21 @-3 dB	GHz	-	14	-
Insertion loss	dB	-	3	4
Optical return loss	dB	-	-40	-

MAXIMUM RATINGS	Unit	Min	Typ	Max
Maximum optical input power	100 mW			

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GENERAL SPECIFICATIONS	Unit	Min	Typ	Max
INTERFACES				
Input / Output fiber and connector	Front Panel - 980 nm Polarization maintaining fibre - Panda type - - FC/APC - Polarization in slow axis // key			
Input external trigger connectors	BNC			
Output pulse monitoring	BNC			
RF modulating signal power	Manual trimmer			
RF port remoting	RS 232 – SubD9 - Female			
MBC Interface	RS 232 – SubD9 – Female or USB			
ENVIRONMENTAL				
Operating temperature	15 °C – 35 °C			
Storage temperature	-20 °C – +50 °C			
POWER SUPPLY				
AC Voltage (Automatic Switch)	V	90	110	240
	Hz	50		60
Electrical plug	Rear panel			
DIMENSIONS				
Modulation unit	19” 2U			
Weight	Kg	-	3	-
COMPLIANCE				
Safety	EN 60825-1			
Other	CE marking			

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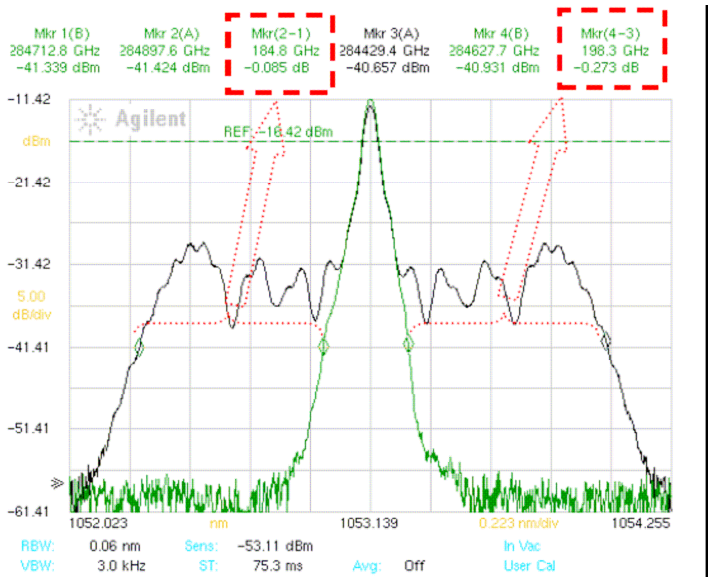
Test Results

Next screenshots show the spectra of the input optical signal (in green), and of the spectrally broadened optical signal (in black). In regards of OSA resolution, bandwidth and sampling characteristics, the repetition rate was increased up to 100 kHz to obtain a better rendering.
NB : input laser spectrum is limited by the OSA resolution (0,06 nm = 16 GHz)

One can see that the optical signal width has been increased from a few MHz to nearly 500 GHz (1.8 nm), a sufficient spectral width to eliminate the SBS and its undesirable effects.



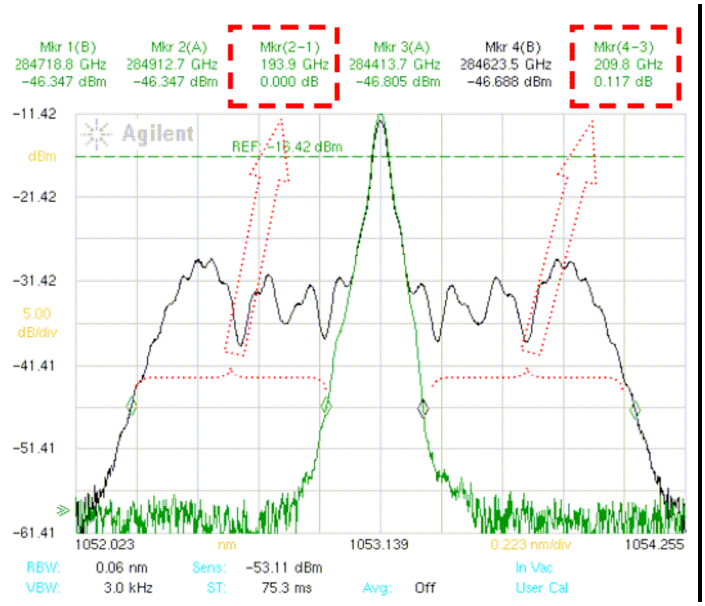


Figure 5 : Spectral broadening

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Figure 6 : Modulation frequency lines

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Appendix 1 : the internal 14.25 GHz RF Source

Inside the Spectral Broadening ModBox, a sine-wave synthesizer generates a 14.25 GHz pure modulating frequency.

This carrier is then amplified through a two stage amplifier in order to obtain a maximum output power of 38 dBm. The modulator RF line has limited thermal dissipation capacity, thus the Modbox operates in pulsed mode. The RF signal is externally triggered by a customer supplied signal and the RF power is applied only during 2 µs with a repetition rate adjustable between 1 Hz and 200 kHz.

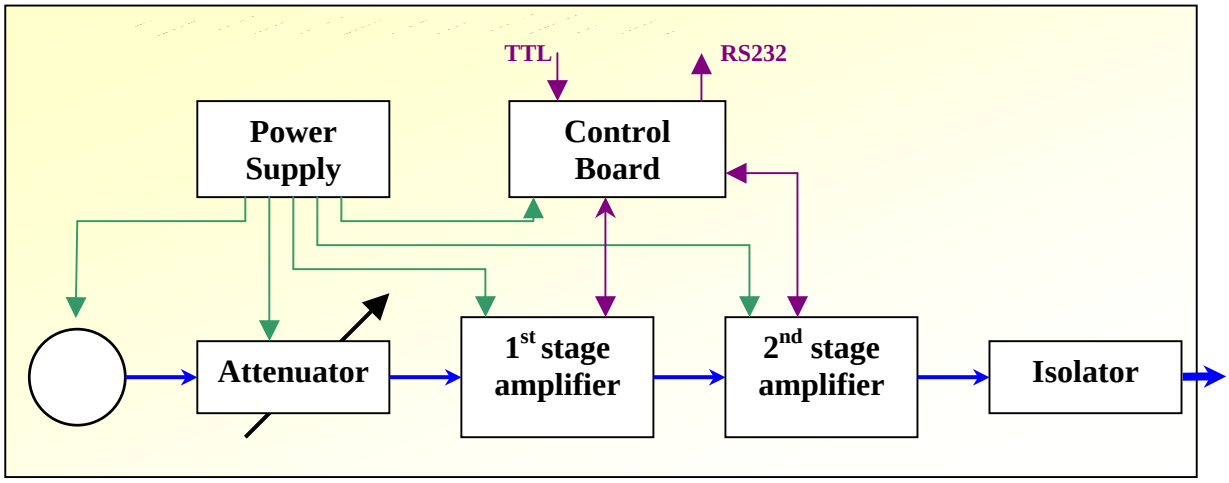

Figure 7: basic scheme of the RF source

Next figures show measures of the 14.25 GHz source generator RF spectrum. On figure 8, the first harmonic can not be seen at 28.5GHz, which is the sign of a good linearity.
On figure 9, with a 10 MHz span, no spurious frequencies are around the fundamental.

Figure 8 : Harmonic Rejection

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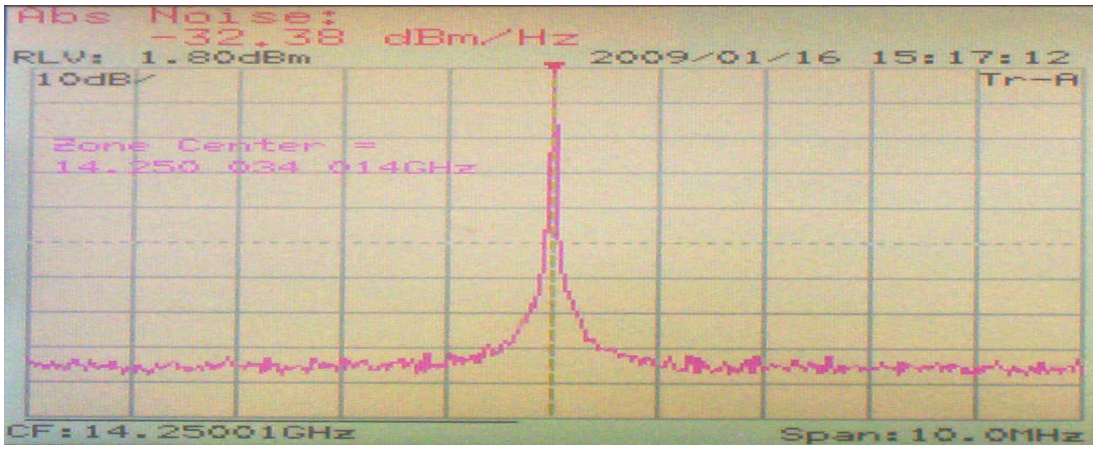

Figure 9 : 14.25 GHz source spectral purity

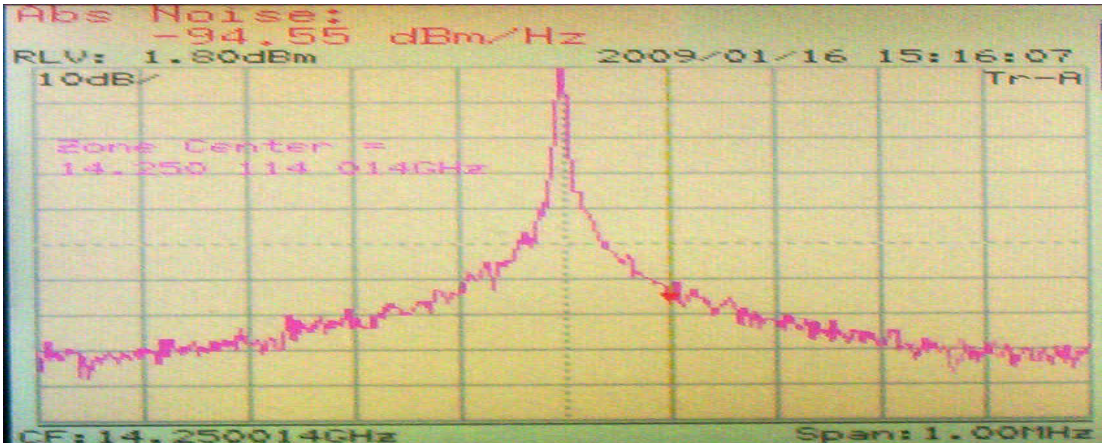

Figure 10 : 14.25 GHz source spectrum (phase noise)

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Test report

The 14.25 GHz Pulse Broadening ModBox is delivered with an individual test report.
The tests are performed at 25℃ using the following equipments :

- AWG = Agilent 33120
- Optical Spectrum Analyzer = Agilent 86142B
- Optical Source = 1053nm DFB fiber laser (linewidth <50 kHz)

The test report includes :

- Optical and microwave measurement

Content

The 14.25 GHz Pulse Broadening ModBox comes with

- 110 V US main cord
- CD driver for MBC
- Test report
- User manual