Quantum Key Distribution - QKD

Principle

- QKD offers a forever privacy guaranteed by the laws of physics.
- Modern encryption techniques
- E-banking, E-health, government communications, key infrastructure, …
- Inter & Intra Data-Center links, Space communication, between buildings,…

- Alix sends a random signal to Bob via a quantum channel.
- Bob performs a measurement.
- Alix and Bob extract a key from the shared information.
- Secret key ?

  Quantum channel: a measurement by Eve would modify the state received by Bob.
  If limited excess is noise is detected by Bob, the key is indeed secret.

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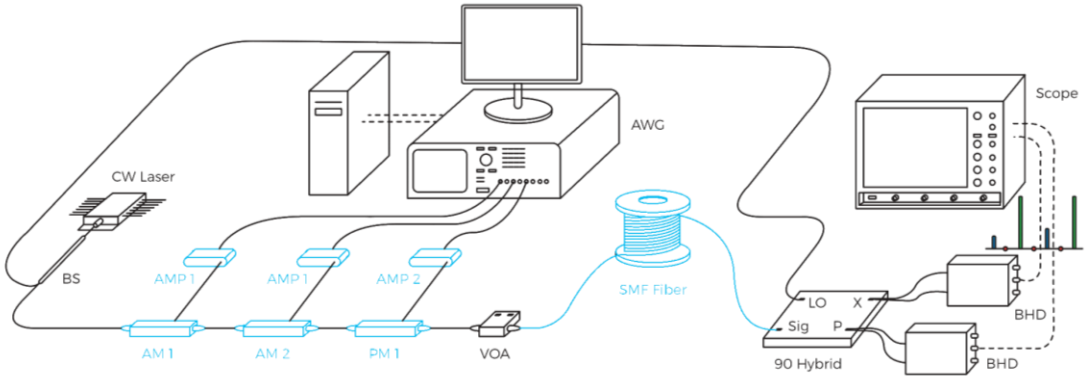
A Continuous Variable QKD – Set-up example



- CV-QKD
  Information encoded in the amplitude and phase of laser pulses.
  Using standard telecom components: laser, modulators and coherent receivers
- AM1: Amplitude modulator 1 to generate very short optical pulse.
- AM2: Amplitude modulator 2 to randomize the optical pulse amplitude
- PM1: Phase modulator to randomize the optical phase

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A Continuous Variable QKD – $LiNbO_3$ modulators performances requirements

- Inter & Intra Data-Center links, Space communication, between buildings,…
  - ▶ Terrestrial Data-Com, fiber telecom infrastructure ⇒ C-Band (1550 nm), O-Band (1310 nm), 850 nm
  - ▶ Space Communication ⇒ Space grade and qualified components
- AM1: Amplitude modulator 1 to generate very short optical pulse
  - ▶ Short optical pulse from 30 ps ⇒ fast pulse rise & fall times based on wide RF frequencies components
  - ▶ Optical pulse contrast 30 dB ⇒ high extinction ratio $LiNbO_3$ amplitude modulator
- AM2: Amplitude modulator 2 to randomize the optical pulse amplitude
  - ▶ Cascaded modulator ⇒ Low insertion loss $LiNbO_3$ amplitude modulator
  - ▶ Ramdom optical pulse amplitude ⇒ high linear RF amplifier
- PM1: Phase modulator to randomize the optical phase
  - ▶ Cascaded modulator ⇒ Low insertion loss $LiNbO_3$ phase modulator
  - ▶ Ramdom phase optical pulse ⇒ wide EO-bandwidth,

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$LiNbO_3$ Amplitude modulators

- One specific Amplitude Modulator per wavelength
- iXblue “Magic Junction” patent to ensure Low Insertion Loss and High Extinction Ratio
- Low DC drift based on a specific (RF and DC electrodes separated) and X-Cut design

λ	850 nm	NEW 1310 nm	1550 nm
Modulator	NIR-MX800-LN-10 NIR-MX800-LN-20	MXER1300-LN-10	MXER-LN-10
Insertion loss (Typ)	< 5,5 dB (4,5 dB)	< 4.5 dB (3,5 dB)	< 4.5 dB (3,5 dB)
Extinction Ratio (Typ)	> 20 dB (25 dB)	> 26 dB (30 dB)	> 30 dB (33 dB)
Rise / Fall times	NIR-MX800-LN-10: < 50 ps NIR-MX800-LN-20: < 20 ps	< 20 ps	< 20 ps
Optical power handling	> 60 mW	> 16 mW	100 mW

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$LiNbO_3$ Phase modulators

- One specific Phase Modulator per wavelength
- Low insertion Modulator option
- Low driving voltage and low S_{11} for higher modulation efficiency
- NEW DC coupled versions for RAM and pyroelectrical effect mitigations

λ	850 nm	NEW 1310 nm	1550 nm
Modulator	NIR-MPX800-LN-10 NIR-MPX800-LN-20	MPZ1300-LN-10	MPZ-LN-01 MPZ-LN-10
Insertion loss (Typ)	< 3,5 dB (2,5 dB)	< 5 dB (3 dB)	MPZ-LN-01: < 2,5 dB (3,5 dB) MPZ-LN-10: < 2 dB (2 dB)
Operating bandwidth	NIR-MPX800-LN-10: 12 - 14 GHz NIR-MPX800-LN-20: 16 – 18 GHz	> 15 GHz	MPZ-LN-01: 4 – 5 GHz MPZ-LN-10: > 15 - 16 GHz
Vπ Vs Frequency	NIR-MPX800-LN-10 @10 GHz ~ 5 V NIR-MPX800-LN-20 @14 GHz ~ 5,5 V	MPZ-LN-10 @10 GHz ~ 4 V / @16 GHz ~ 5 V	MPZ-LN-01 @1 GHz ~ 3 V / @4 GHz ~ 5 V MPZ-LN-10 @10 GHz ~ 5 V / @16 GHz ~ 6 V

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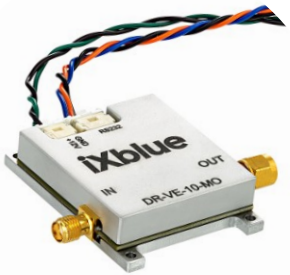
Linear and Limiting Amplifier RF amplifiers

NEW

The DR-VE-10-MO

- Versatile modulator driver: Limiting (Pulse) and Linear (multi-level) RF amplifier
- Integrated µcontroller and embeds the latest microwave chips generation



Specifications	DR-VE-10-MO
Bandwidth	> 14 GHz
Output voltage swing	> 9 Vpp
Gain	> 30 dB
Rise a fall times	20 ps

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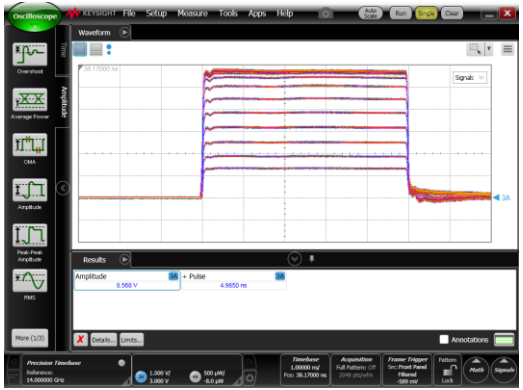
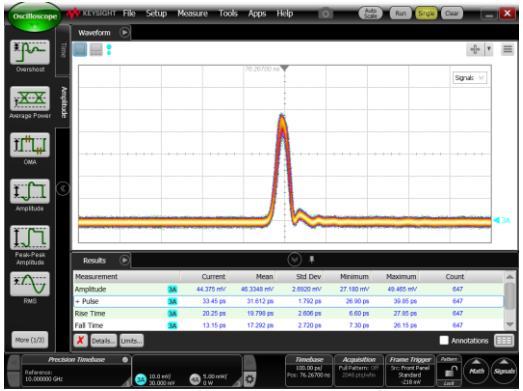
Modulation performances



- DR-VE-10-MO electrical output swings
  From 0 to 9 Vpp

- DR-VE-10-MO + MXER-LN-10
  Optical Pulse output swings

- 70 ps Optical pulse
  DR-VE-10-MO + MXER-LN-10



- 30 ps Optical pulse
  DR-VE-10-MO + MXER-LN-10

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