• ID – Figures – Facilities
• Technology
• Markets
• Products
Photline Technologies is a leading supplier of optical modulation solutions based on the company lithium niobate (LiNbO₃) modulators and RF electronic modules. Photline Technologies serves the markets of telecommunication, defense and aerospace, sensing and instruments, research.
The iXBlue group
Sales over years
Sales all over the world

- Asia: 35%
- NorthAm: 18%
- EMEA: 30%
- FR: 15%
- Other: 2%
Certification & Qualification

- ISO 9001 certified
- MX-LN-10 has passed Telcordia tests
- MX-LN-20 space qualified (will be used in NASA Grace follow-on mission)
- custom IOC’s space qualified (more than 30 devices in operation in satellites: Planck, COMs, KazSat2, Galileo1/2/3/4, Pleiades1/2)
Facilities

- building 1500 m² (150 m² clean room) tooled up for in-house manufacturing

- complete control of the technology: from lithography to test

- qualification and measurement
Production

- x 1000 products shipped in 2013
- capacity of 10,000+ chips
Lithium Niobate Modulators Technology

3” and 4” crystals and wafers (courtesy of CTI)

3” processed wafer
Technologies: optical waveguides, RF electrodes

- photolithography, etching, deposition
- dicing, polishing
- pigtailng, packaging, test
- clean room
Optical waveguides process: APE and Ti diffusion

**APE**
- low $T^\circ$ process
- $n_e$ increasing only (decreasing of the ordinary index)
- single polarization waveguide
- decreasing of the photorefractive damage level

**Ti In-Diffusion**
- high $T^\circ$ process
- $n_o$, $n_e$ increasing ($Dn_e \sim 2Dn_o$)
- both polarizations are guided
- very low drift
Mach-Zehnder optical modulator

- DC electrodes
- Optical waveguides
- RF electrodes
- LiNb03 substrate
the Mach-Zehnder modulator principle

CW light input

V=0

In-phase

V=V_\pi

Out of phase

0
Markets

- Telecommunications up to 40 Gb/s
- Aerospace and defense: airborne fiber links, free space communications
- Sensing and instrumentation: lidars, fiber optics sensors
- Fiber Lasers
- Research community
Markets : Fiber Optics Telecommunications

- n° 1 market for LiNbO$_3$ modulators. Probably > 90%. Several x100,000 modulators operating in fiber networks worldwide.

- high data rate (2.5, 10, 40, 100 Gb/s) AND long haul (> 80 km)

- On/Off keying, Phase Shift Keying (PSK), DPSK, DQ. LiNbO$_3$ modulators accommodate a large variety of transmission formats thanks to intensity + phase modulation

- strongly competitive market. Price are driven low for commodity products (10 G intensity modulators)
Markets: Defense - Aerospace

- airborne radar links (20 GHz analog)
- remote antennas (20 GHz analog)
- remote sensing (ex: lidar based sensors with fiber laser sources)
- space communication
- high performance, high reliability
Markets: Sensing - Instruments

- fiber optics sensors: interferometric (ex Sagnac type Fiber Optics Gyrometers), Brillouin scattering based sensors, electric field sensors, new quantum optics based sensors

- lidar based sensors with fiber laser sources: pulse generation, pulse shaping @ 1550 nm, 1060 nm, 2 um

- frequency locking of absorption based sensors and instruments
Some Photline Customers

- Alcatel-Lucent, NEC, Nokia-Siemens, TYCO, Orange Labs, NICT, KDDI…


- CEA (French Nuclear Agency), CNRS (French Nat. Research Agency), DGA, Orange Labs, ONERA, MIT, Stanford Univ., Univ. College London, Princeton Univ., Georgia Tech. Univ…

- + confidential contracts.
3 products families

- **LiNbO$_3$ modulators**
  10, 20 & 40 Gbit/s
  phase / intensity
  1550 nm, 1300 nm
  1000 nm, 800 nm, 2 um

- **RF modules**
  10, 20 & 40 G
  digital / analog / pulse

- **ModBoxes and MBC**
  custom transmitters and modulation units, bias controllers
Digital transmission modulators

- **intensity modulators**
  10, 20 & 40 Gbit/s
  very low insertion loss (< 3 dB)
  drive voltage 4.5 V @ 10 Gb/s
  zero chirp
  high $V_{\text{bias}}$ stability

- **phase modulators**
  bandwidth 10 GHz, 20 GHz, 30 GHz
Digital transmission : 10 Gb/s

- intensity modulators
- drive voltage 4.5 V @ 10 Gb/s
- zero chirp
- high $V_{\text{bias}}$ stability
- Very low insertion loss : < 3 dB

- dedicated RF drivers
- NRZ, RZ
Digital transmission : 40 Gb/s

- modulation at 40 Gb/s
- MX-LN modulator + DR-DG-40 driver
- jitter RMS : 845 fs
- jitter peak-to-peak : 5.85 ps
- vertical eye opening: 80%
- rise and fall time : 9.33 ps

Ultra-low insertion loss < 3 dB option
Co-packaged modulator-drivers

- **compact modulator-drivers**
  - RF driver + modulator chip
  - Bandwidth 10 GHz, 20 GHz
  - 400 mV voltage control
  - Zero chirp
  - Single voltage supply 12 V
  - Gain control

- **High speed**
  - LiNbO3 circuit
  - GaAs driver
Dual parallel Mach-Zehnder modulators

- DQPSK transmission
  40 Gb/s (2 x 20 Gb/s)
  20 Gb/s (2 x 10 Gb/s)

- SSB modulation
  Single side band modulation

- OFDM

- DR-DG-20-HO RF driver
  High output voltage RF drivers designed for 2 x $V\pi$ drive
Dual parallel Mach-Zehnder modulators

- DR-DG-20-HO RF driver
- NRZ 20-28 Gb/s
- High output voltage : 12 Vp-p
- Internal bias board
Modulators for analog transmission

- MXAN-LN series for 1300 nm and 1550 nm

  - High H2 rejection (> 60 dB over 1-10 GHz)
  - Low Insertion Loss (3.5 dB typ.)
  - Dedicated bias control circuit in end of development

↑ MXAN-LN-20 Analog Modulator
Modulators for analog transmission

- MXDO-LN-20 Dual Output 20 GHz 1550 nm

Two complementary optical outputs ideal for balanced detection
Modulators for sensing, pulses and instruments

- **MXER** series for 1300 & 1550 nm
  - high extinction ratio > 40 dB

↑ MXPE-LN-10 high extinction ratio modulator
NIR-LN series of intensity and phase modulators for 1064 nm and 800 nm

- high extinction ratio ≥ 30 dB
- high power handling > 100 mW
- low drive voltage: ≤ 4 V @ 1MHz
- single drive electrodes
- bandwidth up to 10 GHz, rise time < 50 ps

↑ 10 ns pulse @ 1064 nm, rise time 30 ps
Integrated Optical Circuits for Fiber Optics
Gyrometers ("IOCs for FOGs")

- high polarization extinction
- packaged devices, pigtailed chips
- 1550 nm, 820 nm
- high volume capacity
- space version
Specialty Modulators

- IMZIs: imbalanced Mach-Zehnder interferometers with optical delay up to 1000 μm

- Reflection modulators
MBC Modulator Bias Controllers

- specifically designed for LiNbO₃ modulators
- continuously tunable: Min, Max, Quad+, Quad- and any operating point
- digital (dither signal based) MBC-DG and analog MBC-AN (ditherless) versions
- allows high extinction ratio

↑ MBC-DG-BT bench-top bias controller
RF modules: a comprehensive range of modulators RF drivers

- a RF driver for every modulator and application

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR-DG-10-MO-NRZ</td>
<td>12.5 Gb/s NRZ Medium Output Voltage Driver Module</td>
</tr>
<tr>
<td>DR-DG-10-MO-RZ</td>
<td>12.5 Gb/s RZ Medium Output Voltage Driver Module</td>
</tr>
<tr>
<td>DR-DG-12-MO</td>
<td>12.5 Gb/s NRZ/RZ High Performance Driver Module</td>
</tr>
<tr>
<td>DR-DG-10-HO</td>
<td>10 Gb/s High Output Voltage Driver Module</td>
</tr>
<tr>
<td>DR-DG-20-HO</td>
<td>22 Gb/s High Output Voltage Driver Module</td>
</tr>
<tr>
<td>DLL-RF-30</td>
<td>30 Gb/s / 15 GHz Adjustable Delay Line</td>
</tr>
<tr>
<td>DFF-DG-30</td>
<td>30 Gb/s D-type Flip-Flop Module</td>
</tr>
<tr>
<td>DR-DG-40-MO</td>
<td>40 Gb/s NRZ/RZ Medium Output voltage Driver Module</td>
</tr>
<tr>
<td>DR-AN-10-MO</td>
<td>10 GHz Analog Driver Module</td>
</tr>
<tr>
<td>DR-AN-10-HO</td>
<td>10 GHz Analog High Output Voltage Driver Module</td>
</tr>
<tr>
<td>DR-AN-20-MO</td>
<td>20 GHz Analog Driver Module</td>
</tr>
<tr>
<td>DR-AN-20-HO</td>
<td>20 GHz Analog High Output Voltage Driver Module</td>
</tr>
<tr>
<td>DR-AN-40-MO</td>
<td>40 GHz Analog Driver Module</td>
</tr>
<tr>
<td>DR-PL-10-MO-LR</td>
<td>Pulse Medium Output Voltage Driver Module, Low Repetition Rate</td>
</tr>
<tr>
<td>DR-PL-10-MO-HR</td>
<td>Pulse Medium Output Voltage Driver Module, High Repetition Rate</td>
</tr>
</tbody>
</table>
RF modules

- **D-flip-flop DFF-DG-30**
  - 10 Gb/s 20 Gb/s 30 Gb/s
  - data retiming
  - optical communication DPSK (28 Gb/s), DQPSK (2x28 Gb/s) Dual
  - drive LiNb03 modulators

- **Tunable Delay Line DLL-RF-30**
  - 15 GHz – 30 Gb/s
  - 5 to 140 ps adjustable delay
  - data / signal synchronization
ModBox Transmitters and Modulation Units

Laser Source
(DFB, TLS…)
Optional

Receiver
(PIN, APD, …)
Optional

light source + bias control + modulator + RF driving electronics + receiver
ModBox : NRZ reference transmitters

- 100 Mbps to 44 Gbps
- 850 nm, 1310 nm, 1550 nm
- short rise and fall time
- high SNR
- high stability

↑ 44 Gbps NRZ eye diagram
ModBox: DPSK and DQPSK reference transmitters

- 100 Mbps to 100 Gbps
- 1310 nm, 1550 nm
- short rise and fall time
- high SNR
- high stability

↑ 56 Gbps DQPSK eye diagram
100 Gbps DQPSK-Tx
input: 2 x electrical NRZ 50 Gb/s
output: optical DQPSK 100 Gb/s
high stability eye diagram

100 Gbps DQPSK-Rx
integrated: SOA, DLI, balanced receiver, CDR, demux
output: 8 x 12.5 Gb/s NRZ
ModBox Transmitters and Modulation Units

- WDM 4 x 10 Gb/s channel
- NRZ format
- High stability eye diagram
ModBox Transmitters and Modulation Units

- Multiformat Modulation Unit
  - NRZ / RZ
  - NRZ-DPSK / RZ-DPSK
  - CS-RZ

High stability eye diagrams
ModBox Transmitters and Modulation Units

- **NRZ → RZ Conversion**
  - Input: electrical NRZ 10 Gb/s
  - Output: optical RZ 10 Gb/s
  - High stability eye diagram
Pulse Generation

- Tunable pulse width down to 100 ps
- Short rise / fall time: 30 ps
- High extinction ratio > 30 dB
- High stability, pulse-to-pulse repeatability
- Reference pulse transmitter
- Test in R&D and production
- Pulse generation / picking / slicing
ModBox Transmitters and Modulation Units

- 50 dB extinction ratio
- High energy laser front end
  - Seeder for ultra-intense lasers
  - Versatile pulse shaping allows pre-distorsion
  - High ER allows optical amplification
ModBox Transmitters and Modulation Units

- **Pulse Picker**
  - Input: 20 GHz pulse train
  - Output: selected pulses
Custom devices

- Photline complete LiNbO₃ technology mastery allows to design and produce custom devices for a variety of demanding applications.
Custom devices

- Photoline complete LiNbO$_3$ technology mastery allows to design and produce custom devices for a variety of demanding applications.
Custom devices

- Photline complete LiNbO$_3$ technology mastery allows to design and produce custom devices for a variety of demanding applications.
Sales Channel in Russia – Special-Systems:

- a partner with committed people and technical competencies
- best service to Photline customers thanks to the local presence
- collaboration in mutual trust and transparency, long term view
- Special-Systems is a helping Photline to understand the customers needs, wishes, difficulties…
- offering complete solutions to the customers (Photline + complementary products)
iXFiber : 2006-2014

• Founded in 2006
• From 8 to 32 employees
• iXFiber is now an identified Trademark ®
  • for Specialty Fibers
  • for Fiber Optic Components
• Subsidiary of the French holding :
  • iXCore ( 2006-2010)
  • now iXBlue ( since mid 2010 )
    • but still with Separated Annual Balance Sheet and Income Statement
Specialty Fiber

- MCVD
- Fiber Drawing Tower
- UV & Excimer Lasers
- Qualification Lab.
iXFiber: Virtual Facility Tour
Fiber Optics Components

- Fiber Bragg Grating Writing Laser
- Phase Mask, Lloyd Mirror
## iXFiber: Products & Markets

<table>
<thead>
<tr>
<th>Product</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Fiber</strong></td>
<td></td>
</tr>
<tr>
<td>• Yb</td>
<td>• Laser, Amplifier, Lidar</td>
</tr>
<tr>
<td>• Er/Yb</td>
<td>• Marking, welding, splicing</td>
</tr>
<tr>
<td>• Thulium,</td>
<td>• Lidar, High Power Amplifier</td>
</tr>
<tr>
<td>• Neodymium</td>
<td>• Lidar, source, Laser</td>
</tr>
<tr>
<td><strong>Passive Fiber</strong></td>
<td></td>
</tr>
<tr>
<td>• PM @ 1550nm</td>
<td>• Frequency doubling</td>
</tr>
<tr>
<td>• PM @ 820nm</td>
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<tr>
<td>• Photosensitive Fiber</td>
<td></td>
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<tr>
<td><strong>Bragg Filters</strong></td>
<td></td>
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<tr>
<td>• Selective W.L Mirror</td>
<td>• Sensor</td>
</tr>
<tr>
<td>• High Reflector, Output Coupler</td>
<td>• Gyroscopes</td>
</tr>
<tr>
<td>• Large Band Filter</td>
<td>• Current, Voltage Sensor</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strain, T°</td>
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<tr>
<td></td>
<td>• Laser Cavity</td>
</tr>
<tr>
<td></td>
<td>• Telecom Optical Filter</td>
</tr>
</tbody>
</table>
Strategic Distribution:

• taking benefit of a unique position on our local market
• leveraging our high-tech image, our technical competence and our market knowledge
• becoming an inescapable provider for high-bandwidth/high-data-rate fiber transmission components and systems
• selecting a limited number of first class partners and products
• offering complete solutions to our customers
• increasing the company revenues and accelerating the growth
• NOT becoming a generalist distributor in fiber optics
Photline Technologies Position in France

• A recognized manufacturer of components and systems for fiber optics transmission and sensors
• A supplier and partner for many large organizations: Alcatel, Thales, France Telecom, CEA (French Nuclear Agency), CNRS, ESA, CNES…
• A management team renowned in the community:
  
  ▶ Henri Porte: former Senior Scientist at the CNRS (National Scientific Research Center), authored or co-authored 100+ publications,
  ▶ Philippe Le Roux: 20 years in the sales of fiber optics products in France and Europe. Previously in NetTest and Photonetics. Distributor for JDSU, Yokogawa, ILX LightWave, Furukawa, Seikoh-Giken…
  ▶ Pascal Mollier: former Professor of Optics at the University of Besançon, authored or co-authored 50+ publications,
  ▶ Jérôme Hauden: PhD. From University of Besançon, Post Doc. at Stanford University
  
  + engineers and PhD’s previously in Alcatel, HighWave, France Telecom…
What we offer to our partners

• a unique position in our domestic market
• an unparalleled knowledge of the market
• three technical Sales Engineers in France
• an introduction at high level at customers
• a trust based relationship, complete transparency towards customers
• the technical skills of a high bandwidth specialists team
• the flexibility to operate on a case by case basis as a distributor or a representant
• the possibility of joined developments to break in customers
Means of success

• three technical sales person (Hervé, PhD + Philippe + Philippe G.)

• intensively visiting french customers

• participation to major french exhibitions: OPTO, HYPER and specialized conferences (ex: MicroWave Photonics, JNOG)

• press release and articles in the local press (Photoniques, Lumières)

• organize seminars (in October 2010, Photline organized in Besançon the JNOG: National Days for Guided Optics: 250 participants)
Emcore : Empower with Light

- Lasers : DFB, Tunable lasers
- High Speed Photodiodes, Receivers
- EDFA
- Microwave Fiber Links
- THz spectrometer
• Ultra high speed photodetectors and photoreceivers for optical communications and microwave photonics

• Pico-Second Lasers
QDLaser

QDLASER

- Quantum dot lasers 1064 nm, 1053 nm
- 660 nm High Power visible lasers
- Pure green compact laser modules
• External cavity lasers with high spectral purity and low phase noise
Alnair Labs

- 10 G, 25 G, 40 G BERT and PRBS
- Wavelength and Bandwidth Tunable Filters
- Optical Sampling Scopes