46 GBaud Multi-Format Optical Transmitter
OM5110 Datasheet

The OM5110 Multi-Format Optical Transmitter is a C-and L-Band transmitter capable of providing the most common coherent optical modulation formats such as PM-QPSK and PM-16QAM up to 46 GBaud. When combined with a signal source, such as the Tektronix AWG70001A Arbitrary Waveform Generator or the Tektronix PPG3204 32 Gb/s Programmable Pattern Generator, the OM5110 offers a complete coherent optical test signal generation system.

Features and benefits
- Multi-format optical transmitter supports modulation of formats such as BPSK, PM-QPSK, and PM-16QAM
- Excellent linearity supports modulation of multi-level signals
- Modulates single or dual-polarization signals
- Built-in C or L-band lasers for setup convenience
- Supports external laser sources
- Supports manual and automatic bias control of amplifiers and modulator
- Remotely control all setup and operations over Ethernet

Applications
- Testing coherent optical receivers
- Golden reference coherent optical transmitter
- Transmitter for multi-carrier superchannel systems

100G / 400G / 1Tb/s Coherent optical test system
The OM5110 Multi-Format Optical Transmitter is a C-and L-Band transmitter capable of modulating the most common coherent optical modulation formats such as PM-QPSK and PM-16QAM up to 46 GBaud. When combined with a signal source, such as the Tektronix AWG70001A Arbitrary Waveform Generator or the Tektronix PPG3204 32 Gb/s Programmable Pattern Generator, the OM5110 offers a complete coherent optical test signal generation system. The flexibility to automatically or manually set all amplifier and modulator bias points provides the user the freedom to simulate less-than-ideal performance of their device.

Coherent optical transmitter or transceiver manufacturers can use the OM5110 as a golden reference against which to compare module designs. For transmitters under development, use the Tektronix OM4245 Optical Modulation Analyzer to measure transmitter performance, and then compare the results against the OM5110 reference transmitter.

Coherent optical receiver manufacturers can also use the OM5110 as the ideal transmitter with which to test their receiver’s performance and prove functionality under best-case conditions. Used along with the AWG70001A Arbitrary Waveform Generator, the user can add optical impairments to the signal to test the receiver under a wide range of real-world scenarios.
As the demand for network bandwidth has increased, new transmission schemes such as multi-carrier “superchannels” are under investigation. The OM5110 can function as the heart of a superchannel system. Multiple optical carriers can be externally combined and used as the laser source to the OM5110 using the external signal input. Tektronix offers external laser sources, such as the OM2012 Tuneable Laser Source, which can be used to create a superchannel system. With such a configuration, systems with aggregate data rates such as 400G, 1Tb/s, and beyond, can be created.

The OM5110 offers the convenience of built-in laser sources, either C-band or L-band. Setup and operation of the laser, such as wavelength and optical power, can all be controlled remotely over Ethernet. Alternatively, an external laser source may be connected to the front panel of the instrument in place of the built-in lasers.
The data from the external signal generator is first amplified by four, high-linearity amplifiers. The bias points for these amplifiers can be monitored and automatically controlled by the included Tektronix control software. The user may also take control of the bias points and set the amplifier bias voltages manually. The high-linearity of these amplifiers makes them ideal for multi-level signals such as 16QAM. For two-level signals, such as QPSK, the amplifiers can be driven into saturation so that the modulator drive is less sensitive to input drive level variations due to external rf cable losses.

The output of either the on-board laser, or a customer-supplied external laser is passed through a beam splitter and then fed to each of the four internal Mach-Zehnder modulators. Like the amplifiers, each Mach-Zehnder modulator has bias controls that can be automatically controlled or manually set by the user. The amplified signals feed these four modulators whose outputs are optically combined to create a complex, dual-polarized optical signal available on the front-panel of the instrument.
Coherent optical signal generation system

The OM5110 is a key part of a coherent optical signal generation system. The other major component is the signal generator itself. The Tektronix PPG3000 series programmable pattern generators and the Tektronix AWG70000 Series Arbitrary Waveform Generators (AWG) offer the flexibility to choose the type of signal generation instrument suited to the test requirements.

The PPG3000 Series can generate patterns up to 32 Gb/s and offers 1, 2, or 4 channels in a single instrument. The patterns may be standard PRBS patterns or user-defined. Using a 4-channel pattern generator makes creating dual-polarization I-Q waveforms very simple.

Coherent optical signal generation is one of the more demanding applications for an AWG. The requirements in terms of number of channels, sampling rate, bandwidth, record length, and timing and synchronization quality can be only met by the highest performance instruments, such as the Tektronix AWG70000 Series. The unique capability of generating ideal or distorted signals and the ease to add new modulation schemes and signal processing algorithms without the need to add any extra hardware make AWGs an ideal tool for coherent optical communication research and development.

The AWG70000 Series can reach sampling rates as high as 50 GS/s with 10 bits vertical resolution. Such level of performance allows for the direct generation of IQ basebands signals required by modern coherent optical communication systems. The arbitrary waveform generation capabilities of the AWG70000 Series makes it possible to create multi-level signals such as 16QAM, add impairments to a signal, or to create waveforms that are precompensated for the real-world effects of the test system.

OM5110

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**Specifications**

Values stated in the following tables are typical unless stated otherwise.

### System characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Maximum symbol rate</td>
<td>46 GBaud: for binary formats such as BPSK, QPSK</td>
</tr>
<tr>
<td></td>
<td>34 GBaud: for multi-level formats such as 16QAM</td>
</tr>
<tr>
<td>Modulation formats</td>
<td>3-State OOK, BPSK, PM-BPSK, QPSK, PM-QPSK, 16QAM, PM-16QAM</td>
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<tr>
<td></td>
<td>Higher order formats are possible depending on baud rate and frequency compensation available.</td>
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### Absolute maximum ratings

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<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Input Optical Power</td>
<td>18 dBM</td>
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<tr>
<td>Input Electrical Signal, AC</td>
<td>6 $V_{pp}$</td>
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<tr>
<td>Input Electrical Signal, DC</td>
<td>5 $V_{dc}$</td>
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### Electrical characteristics

<table>
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<th>Parameter</th>
<th>Value</th>
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<tr>
<td>3 dB bandwidth relative to 2 GHz</td>
<td>23 GHz</td>
</tr>
<tr>
<td>6 dB bandwidth relative to 2 GHz</td>
<td>&gt; 30 GHz</td>
</tr>
<tr>
<td>Modulation percent of $2\pi$ at 1 $V_{pp}$, 23 GHz input</td>
<td>&gt; 90%</td>
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<tr>
<td>EVM, 25 GBaud 16QAM</td>
<td>&lt;10%</td>
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### Optical characteristics

<table>
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<th>Parameter</th>
<th>Value</th>
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<tr>
<td>External input wavelength range</td>
<td>1526.6 nm to 1609.6 nm</td>
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<tr>
<td>Modulator insertion loss</td>
<td>&lt; 14 dB</td>
</tr>
<tr>
<td>(specification)</td>
<td></td>
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<tr>
<td>DC extinction ratio</td>
<td>&gt; 20 dB</td>
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<tr>
<td>Optical return loss</td>
<td>&gt; 27 dB</td>
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<tr>
<td>PDL (typical)</td>
<td>&lt; 0.8 dB</td>
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<tr>
<td>Power readout accuracy</td>
<td>± 2 dB</td>
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</table>
Internal laser optical characteristics

Internal laser wavelength range
- C-Band: 1526.6 nm to 1567.5 nm
- L-Band: 1567.5 nm to 1609.6 nm

Output power: > 13 dBm

Minimum grid spacing: 10 GHz

Minimum frequency step: 100 MHz

Absolute wavelength accuracy: 10 pm

Linewidth (short term): 100 kHz

Sidemode suppression ratio: 55 dB

Power requirements

Power requirements: 100 - 240 V \(_{RMS} \pm 10\%\), 50/60 Hz, 100 W

Fuse rating: Slo-Blo 3.15 A, 250 V \(_{AC}\)

Physical characteristics

Dimensions
- Height: 89 mm, 3.5 in.
- Width: 432 mm, 17 in.
- Depth: 298.5 mm, 11.75 in.

Weight
- Net: 7.4 kg, 16.3 lb.
- Shipping: 14.6 kg, 32.2 lb.

Environmental characteristics

Temperature
- Operating: +10 °C to +35 °C
- Non-operating: -20 °C to +60 °C

Humidity
- Operating: 10% to 85% RH up to +35 °C, noncondensing
- Non-operating: 10% to 85% RH up to +35 °C, noncondensing
- 10% to 45% RH up to +60 °C, noncondensing

Altitude
- Operating: 3000 meters; derate maximum operating temperature by 1 °C per 300 meters above 1500 meters altitude
- Non-operating: 12,000 meters
Environmental characteristics

**Vibration**
- **Operating**
  - Sine: 0.33 mm pk-pk (0.013 inch p-p) constant displacement, 5-55 Hz, 3 axes
  - Random: 0.24 GRMS, 5-500 Hz, 10 minutes per axis

- **Non-operating**
  - Random: 2.22 GRMS, 5-500 Hz, 10 minutes per axis

**Mechanical shock**
- Half-sine mechanical shocks, 30g peak amplitude, 11 second duration, 3 drops in each direction of each axis

**EMC, environment, and safety**
- **Immunity**
  - IEC61326, IEC61000-4-2/3/4/5/6/11

- **Emissions**
  - CISPR11, Class A, EN 61000-3-2, EN61000-3-3

- **Safety**
  - UL61010-1, CAN/CSA-22.2, No.61010-1, EN61010-1, IEC61010-1, 21

Ordering information

**Models**
- OM5110

  46 GBaud Multi-Format Optical Transmitter

**Instrument options**

**OM5110 options**
- Opt. C
  - Built-in C-band laser

- Opt. L
  - Built-in L-band laser

- Opt. NL
  - No built-in lasers. Requires external laser source

**Power plug options**
- Opt. A0
  - North America power plug (115 V, 60 Hz)

- Opt. A1
  - Universal Euro power plug (220 V, 50 Hz)

- Opt. A2
  - United Kingdom power plug (240 V, 50 Hz)

- Opt. A3
  - Australia power plug (240 V, 50 Hz)

- Opt. A5
  - Switzerland power plug (220 V, 50 Hz)

- Opt. A6
  - Japan power plug (100 V, 50/60 Hz)

- Opt. A10
  - China power plug (50 Hz)

- Opt. A11
  - India power plug (50 Hz)

- Opt. A12
  - Brazil power plug (60 Hz)

**User manual options**
- Opt. L0
  - English manual
Service options

- Opt. C3: Calibration Service 3 Years
- Opt. C5: Calibration Service 5 Years
- Opt. R3: Repair Service 3 Years (including warranty)
- Opt. R5: Repair Service 5 Years (including warranty)

Installation options

- OMINSTALL AMR: On-site OM-series install for the Americas
- OMINSTALL JPN: On-site OM-series install for Japan
- OMINSTALL EMEA: On-site OM-series install for Europe, Middle East, and Africa
- OMINSTALL APAC: On-site OM-series install for the Asia Pacific

Recommended accessories

Related products

- OM4245: 45 GHz Optical Modulation Analyzer
- OM4245 MCS: Adds multi-carrier Superchannel support
- OM4225: 25 GHz Optical Modulation Analyzer
- OM1106: Optical Modulation Analyzer Software, included with OM4225 and OM4245
- OM2210: Coherent Receiver Calibration Source
- OM2012: Tunable Laser Source
- AWG70001A: Tektronix Arbitrary Waveform Generator
- PPG3204: Tektronix 32 Gb/s Programmable Pattern Generator
- DPO73304DX: Tektronix 33 GHz Digital Phosphor Oscilloscope

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.
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<td>Belgium</td>
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<td>Brazil</td>
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<td>Central Europe &amp; Greece</td>
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<td>Balkans, Israel, South Africa and other ISE Countries</td>
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<td>Mexico, Central/South America &amp; Caribbean</td>
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* European toll-free number. If not accessible, call: +41 52 675 3777

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