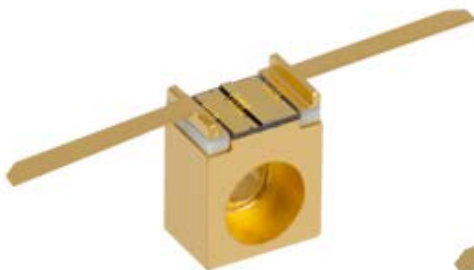


IF3420CM2 - March 07, 2018

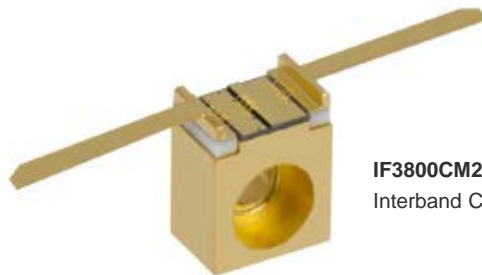
Item # IF3420CM2 was discontinued on March 07, 2018. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

QUANTUM CASCADE LASERS AND INTERBAND CASCADE LASERS: FABRY-PEROT

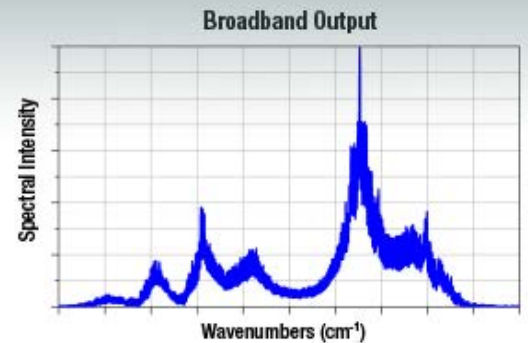
- ▶ Center Wavelengths: 3.30 - 9.55 μm (3030 - 1047 cm^{-1})
- ▶ Output Powers up to 500 mW
- ▶ Broadband Emission over a Roughly 50 cm^{-1} Range
- ▶ Shipped from Stock



QF9150CM1
Quantum Cascade Laser



IF3800CM2
Interband Cascade Laser



OVERVIEW

Features

- Broadband Fabry-Perot Quantum Cascade Lasers (QCLs) & Interband Cascade Lasers (ICLs)
- CW Output:
 - Up to 30 mW for ICLs
 - Up to 500 mW for QCLs
- Center Wavelengths Between 3.30 μm and 9.55 μm (3030 cm^{-1} and 1047 cm^{-1})
- Compact Two-Tab C-Mount Package: 6.4 mm x 4.3 mm x 7.9 mm (L x W x H)
- Lasers are Electrically Isolated from their C-Mounts
- Custom Wavelengths and Mounts Also Available (Contact Tech Support for Details)
- Gain Chips with AR-Coated Front Facets Also Available as a Custom Order

Thorlabs' Fabry-Perot Quantum Cascade Lasers (QCLs) and Interband Cascade Lasers (ICLs) exhibit broadband emission in a range spanning roughly 50 cm^{-1} . Each laser's specified output power is the sum over the full spectral bandwidth. Because these lasers have broadband emission, they are well suited for medical imaging, illumination, and microscopy applications. Thorlabs also manufactures Distributed Feedback QCLs, which emit at a well defined center wavelength and are tunable over a narrow frequency range.

MIR Laser Types	
Fabry-Perot	Two-Tab C-Mount
	Turnkey
Distributed Feedback	Two-Tab C-Mount
	D-Mount
	HHL

Laser Diode Selection Guide ^a
Shop by Package / Type
TO Can (Ø3.8, Ø5.6, Ø9, and Ø9.5 mm)
TO Can Pigtail (SM)
TO Can Pigtail (PM)
TO Can Pigtail (MM)
FP Butterfly Package
FBG-Stabilized Butterfly Package
Chip on Submount
MIR Fabry-Perot Two-Tab C-Mount
One-Tab C-Mount
Single-Frequency Lasers
DFB TO Can Pigtail (SM)
VHG-Stabilized TO Can or Pigtail (SM)
ECL Butterfly Package
DBR Butterfly Package
MIR DFB Two-Tab C-Mount
MIR DFB D-Mount
MIR DFB High Heat Load

Before shipment, the output spectrum and L-I-V curve are measured for each serial-numbered device by an automated test station. These measurements are available below and are also included on a data sheet with the laser. Each Fabry-Perot laser has an HR-coated back facet. As a custom option, our Fabry-Perot lasers can be ordered with an AR coating on the front facet; however, the custom item will operate as a gain chip and not as a CW laser. Though these QCLs and ICLs are specified for CW output, they are compatible with pulsed applications. To order a Fabry-Perot QCL or ICL with a tested and specified pulsed optical power or other custom features, please contact Tech Support.

Packages

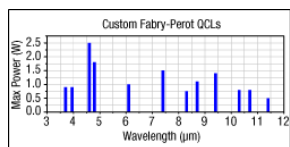
Each laser is mounted on a two-tab C-mount that provides high thermal conductivity and can be secured using a 2-56 or M2 screw with the counterbored Ø2.4 mm (Ø0.09") through hole. As measured from the bottom of the C-mount, the emission height of the QCLs is 7.15 mm, while that of the ICLs is 7.28 mm; the outer dimensions of the C-mounts are the same. All lasers sold on this page are electrically isolated from their C-mounts. Please see the *Handling* tab for more tips and information for handling these laser packages.

Mounts, Drivers, and Temperature Control

We generally recommend the LDMC20 C-Mount Laser Mount and ITC4002QCL or ITC4005QCL Dual Current / Temperature Controller for these lasers. This device combination includes all the necessary components to mount, drive, and thermally regulate a two-tab C-mount laser. Other compatible current and temperature controllers are listed in the *Drivers* tab.

If designing your own mounting solution, note that due to these lasers' heat loads, we recommend that they be mounted in a thermally conductive housing to prevent heat buildup. Our ICLs feature low heat loads of up to 2.5 W, while heat loads for Fabry-Perot QCLs can be up to 18 W (see the *Handling* tab for additional information).

The typical operating voltages of our ICLs and QCLs are 2.5 - 3.1 V and 7 - 16 V, respectively. These lasers do not have built-in monitor photodiodes and therefore cannot be operated in constant power mode.



Click to Enlarge
Maximum Output Power of Custom Fabry-Perot QCLs

High-Power OEM & Custom Lasers



Thorlabs manufactures custom and OEM quantum cascade lasers in high volumes. We maintain chip inventory from 3 µm to 12 µm at our Jessup, Maryland laser manufacturing facility, and can reach multi-watt output on certain custom orders.

More details are available on the *Custom & OEM Lasers* tab. To inquire about pricing and availability, please contact us. A semiconductor specialist will contact you within 24 hours or the next business day.

Shop By Wavelength

- Our complete selection of laser diodes is available on the *LD Selection Guide* tab above.

Webpage Features

	Clicking this icon opens a window that contains specifications and mechanical drawings.
	Clicking this icon allows you to download our standard support documentation.
Choose Item	Clicking the words "Choose Item" opens a drop-down list containing all of the in-stock lasers around the desired center wavelength. The red icon next to the serial number then allows you to download L-I-V and spectral measurements for that serial-numbered device.

DRIVERS

Current and Temperature Controllers

Use the tables below to select a compatible controller for our MIR lasers. The first table lists the controllers with which a particular MIR laser is compatible, and the second table contains selected information on each controller. Complete information on each controller is available in its full web presentation. We particularly recommend our ITC4002QCL and ITC4005QCL controllers, which have high compliance voltages of 17 V and 20 V, respectively. Together, these drivers support the current and voltage requirements of our entire line of Mid-IR Lasers. To get L-I-V and spectral measurements of a specific, serial-numbered device, click "Choose Item" next to the part number below, then click on the Docs Icon next to the serial number of the device.

Table Key

Current Controllers
Dual Current / Temperature Controllers

Laser Mount Compatibility

Thorlabs' LDMC20 C-Mount Laser Mount ships with current and TEC cables for the LDC4005, ITC4001, ITC4002QCL, ITC4005, and ITC4005QCL controllers. To use the LDMC20 with our other controllers, custom cables will be required. If designing your own mounting solution, note that due to these lasers' heat loads, we recommend that they be secured in a thermally conductive housing to prevent heat buildup. Our ICLs feature low heat loads of up to 2.5 W, while heat loads for Fabry-Perot QCLs can be up to 18 W.

Laser and Controller Compatibility

Laser Item #	Wavelength	Current Controllers	Dual Current / Temperature Controllers

		Small Benchtop	Large Benchtop	Rack Mounted	Large Benchtop	Rack Mounted
IF3300CM2	3.30 μm (3030 cm^{-1})	LDC210C, LDC240C	LDC4005	LDC8010, LDC8020, LDC8040	ITC4001, ITC4002QCL, ITC4005, ITC4005QCL	ITC8102
IF3420CM2	3.42 μm (2920 cm^{-1})	LDC210C, LDC240C	LDC4005	LDC8010, LDC8020, LDC8040	ITC4001, ITC4002QCL, ITC4005, ITC4005QCL	ITC8102
IF3800CM2	3.80 μm (2632 cm^{-1})	LDC210C, LDC240C	LDC4005	LDC8010, LDC8020, LDC8040	ITC4001, ITC4002QCL, ITC4005, ITC4005QCL	ITC8102
QF4050CM1	4.05 μm (2469 cm^{-1})	-	-	-	ITC4002QCL, ITC4005QCL	-
QF4400CM1	4.40 μm (2273 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF4550CM1	4.55 μm (2198 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF4800CM1	4.80 μm (2083 cm^{-1})	-	-	-	ITC4002QCL, ITC4005QCL	-
QF5300CM1	5.30 μm (1887 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF7200CM1	7.20 μm (1389 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF7700CM1	7.70 μm (1299 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF8350CM1	8.35 μm (1198 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF9150CM1	9.15 μm (1093 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-
QF9550CM1	9.55 μm (1047 cm^{-1})	-	LDC4005	-	ITC4002QCL, ITC4005, ITC4005QCL	-

Controller Selection Guide

Controller Item #	Controller Type	Controller Package	Current Range	Current Resolution	Voltage	Cables for LDMC20 Laser Mount
LDC210C	Current	Small Benchtop (146 x 66 x 290 mm)	0 to ± 1 A	100 μA	>10 V	Not Included with LDMC20 ^a
LDC240C			0 to ± 4 A	100 μA	>5 V	Not Included with LDMC20 ^a
LDC4005		Large Benchtop (263 x 122 x 307 mm)	0 to 5 A	1 mA (Front Panel) 80 μA (Remote Control)	12 V	Included with LDMC20
LDC8010		Rack Mounted	0 to ± 1 A	15 μA	>5 V	Not Included with LDMC20 ^a
LDC8020			0 to ± 2 A	30 μA	>5 V	Not Included with LDMC20 ^a
LDC8040			0 to ± 4 A	70 μA	>5 V	Not Included with LDMC20 ^a
ITC4001	Current / Temperature	Large Benchtop (263 x 122 x 307 mm)	0 to 1 A	100 μA (Front Panel) 16 μA (Remote Control)	11 V	Included with LDMC20
ITC4002QCL			0 to 2 A	100 μA (Front Panel) 32 μA (Remote Control)	17 V	Included with LDMC20
ITC4005			0 to 5 A	1 mA (Front Panel) 80 μA (Remote Control)	12 V	Included with LDMC20
ITC4005QCL		20 V		Included with LDMC20		
ITC8102		Rack Mounted	0 to ± 1 A	15 μA	>5 V	Not Included with LDMC20 ^a

- Thorlabs does not currently offer cables that connect the LDMC20 mount to this controller. Custom cables will be required.

HANDLING

Handling Two-Tab C-Mount Lasers

Proper precautions must be taken when handling and using two-tab C-mount lasers. Otherwise, permanent damage to the device will occur. Members of our Technical Support staff are available to discuss possible operation issues.

Do

- ▶ Provide External Temperature Regulation (e.g., Heat Sinks, Fans, and/or Water Cooling)
- ▶ Use a Constant Current Source Specifically Designed for Lasers
- ▶ Observe Static Avoidance Practices
- ▶ Be Careful When Making Electrical Connections

Do Not

- ▶ Use Thermal Grease
- ▶ Expose the Laser to Smoke, Dust, Oils, Adhesive Films, or Flux Fumes
- ▶ Blow on the Laser
- ▶ Drop the Laser Package

Avoid Static

Since these lasers are sensitive to electrostatic shock, they should always be handled using standard static avoidance practices.

Avoid Dust and Other Particulates

Unlike TO can and butterfly packages, the laser chip of a two-tab C-mount laser is exposed to air; hence, there is no protection for the delicate laser chip. Contamination of the laser facets must be avoided. Do not blow on the laser or expose it to smoke, dust, oils, or adhesive films. The laser facet is particularly sensitive to dust accumulation. During standard operation, dust can burn onto this facet, which will lead to premature degradation of the laser. If operating a two-tab C-mount laser for long periods of time outside a cleanroom, it should be sealed in a container to prevent dust accumulation.

Use a Current Source Specifically Designed for Lasers

These lasers should always be used with a high-quality constant current driver specifically designed for use with lasers, such as any current controller listed in the *Drivers* tab. Lab-grade power supplies will not provide the low current noise required for stable operation, nor will they prevent current spikes that result in immediate and permanent damage.

Thermally Regulate the Laser

Temperature regulation is required to operate the laser for any amount of time. The temperature regulation apparatus should be rated to dissipate the maximum heat load that can be drawn by the laser. For our interband cascade lasers, this value is up to 2.5 W, while for our quantum cascade lasers, it can be up to 18 W. The LDMC20 C-Mount Laser Mount, which is compatible with our two-tab C-mount lasers, is rated for >20 W of heat dissipation.

The back face of the C-mount package is machined flat to make proper thermal contact with a heat sink. Ideally, the heat sink will be actively regulated to ensure proper heat conduction. A Thermoelectric Cooler (TEC) is well suited for this task and can easily be incorporated into any standard PID controller.

A fan may serve to move the heat away from the TEC and prevent thermal runaway. However, the fan should not blow air on or at the laser itself. Water cooling methods may also be employed for temperature regulation. Do not use thermal grease with this package, as it can creep, eventually contaminating the laser facet. Pyrolytic graphite is an acceptable alternatives to thermal grease for these packages. Solder can also be used to thermally regulate two-tab C-mount lasers, although controlling the thermal resistance at the interface is important for best results.

Carefully Make Electrical Connections

When making electrical connections, care must be taken. The flux fumes created by soldering can cause laser damage, so care must be taken to avoid this. Solder can be avoided entirely for two-tab C-mount lasers by using the LDMC20 C-Mount Laser Mount. If soldering to the tabs, solder with the C-mount already attached to a heat sink to avoid unnecessary heating of the laser chip.

Minimize Physical Handling

As any interaction with the package carries the risk of contamination and damage, any movement of the laser should be planned in advance and carefully carried out. It is important to avoid mechanical shocks. Dropping the laser package from any height can cause the unit to permanently fail.

COLLIMATION

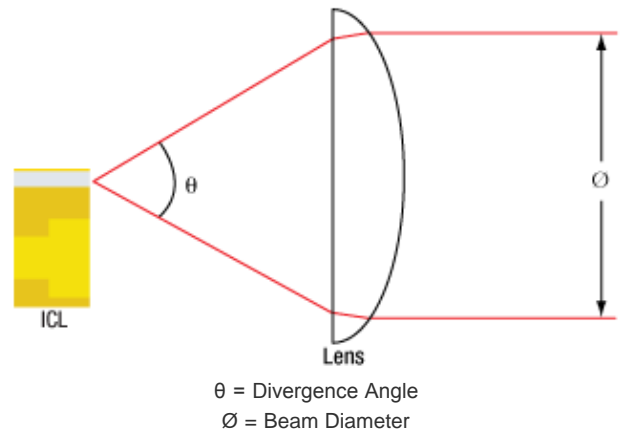
Choosing a Collimating Lens

Since the output of our MIR lasers is highly divergent, collimating optics are necessary. Aspheric lenses, which are corrected for spherical aberration, are commonly chosen when the desired beam diameter is between 1 - 5 mm. The simple example below illustrates the key specifications to consider when choosing the correct lens for a given application.

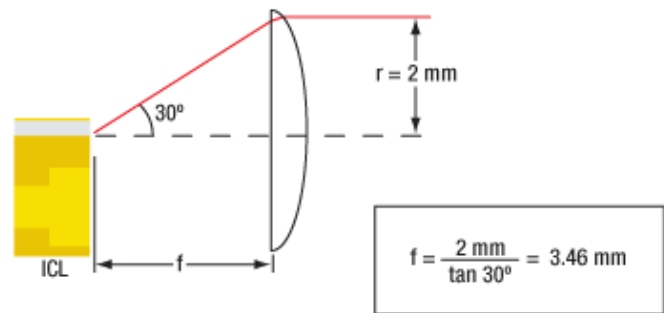
Example

- Center Wavelength: 3.80 μm
- Laser Item #: IF3800CM2
- Desired Collimated Beam Diameter: 4 mm (Major Axis)

The specifications for the IF3800CM2 indicate that the typical parallel and perpendicular FWHM divergences are 40° and 60°, respectively. Therefore, as the light propagates, an elliptical beam will result. To collect as much light as possible during the collimation process, consider the larger of these two divergence angles in your calculations (in this case, 60°).



Using the information above, the focal length needed to obtain the desired beam diameter can be calculated:



This information allows the appropriate collimating lens to be selected. Thorlabs offers a large selection of black diamond aspheric lenses for the mid-IR spectral range. Since this laser emits at 3.80 μm , the best AR coating is our -E coating, which provides $R_{\text{avg}} < 0.6\%$ per surface from 3 to 5 μm . The lenses with focal lengths closest to the calculated value of 3.46 mm are our 390036-E (unmounted) or C036TME-E (mounted) Molded Aspheric Lenses, which have $f = 4.00 \text{ mm}$. Plugging this focal length back into the equation shown above gives a final beam diameter of 4.62 mm along the major axis.

Next, we verify that the numerical aperture (NA) of the lens is larger than the NA of the laser:

$$NA_{\text{Lens}} = 0.56$$

$$NA_{\text{Laser}} \sim \sin(30^\circ) = 0.5$$

$$NA_{\text{Lens}} > NA_{\text{Laser}}$$

Since $NA_{\text{Lens}} > NA_{\text{Laser}}$, the 390036-E or C036TME-E lenses will give acceptable beam quality. However, by using the FWHM beam diameter, we have not accounted for a significant fraction of the beam power. A better practice is to use the $1/e^2$ beam diameter. For a Gaussian beam profile, the $1/e^2$ beam diameter is approximately equal to 1.7X the FWHM diameter. The $1/e^2$ beam diameter is therefore a more conservative estimate of the beam size, containing more of the laser's intensity. Using this value significantly reduces far-field diffraction (since less of the incident light is clipped) and increases the power delivered after the lens.

A good rule of thumb is to pick a lens with an NA of twice the NA of the laser diode. For example, either the 390037-E or the C037TME-E could be used as these lenses each have an NA of 0.85, which a little less than twice that of our IF3800CM2 laser (NA 0.5). Compared to the first set of lenses we identified, these have a shorter focal length of 1.873 mm, resulting in a smaller final beam diameter of 2.16 mm.

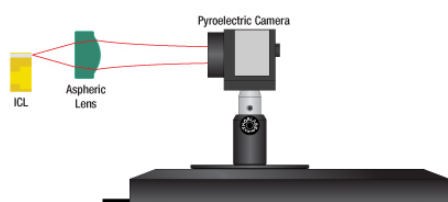
M² MEASUREMENT

Beam Profile Characterization of a Mid-IR Laser

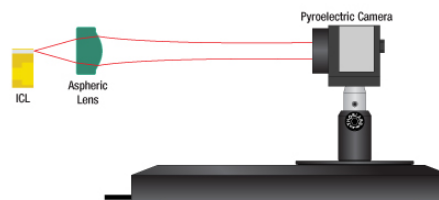
Because quantum cascade lasers (QCLs) and interband cascade lasers (ICLs) have intrinsically large divergence angles, it is necessary to install collimating optics in front of the laser face, as shown in the *Collimation* tab. We are frequently asked what beam quality can be reasonably expected once the beam has been collimated. This tab presents an M² measurement we performed using our 3.80 μm Interband Cascade Laser (Item # IF3800CM2).

For this system, we obtained $M^2 = 1.2 \pm 0.08$ in the parallel direction and $M^2 = 1.3 \pm 0.2$ in the perpendicular direction. While this is just one example, we believe these results to be representative of well-collimated mid-IR lasers manufactured by Thorlabs, as corroborated by supplementary measurements we have performed in-house.

Experimental Setup



Click to Enlarge
Pyroelectric Camera Upstream of Focus



Click to Enlarge
Pyroelectric Camera Downstream of Focus

The apparatus we used to determine M² is shown schematically in the figure above. In order to ensure that our results were rigorous, all data acquisition and analysis were consistent with the ISO11146 standard.

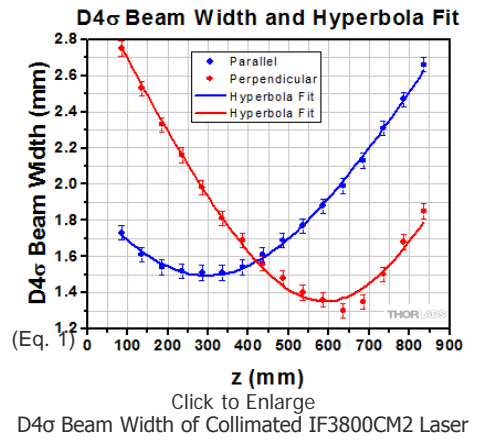
The IF3800CM2 Interband Cascade Laser used for this measurement emitted CW laser light with a center wavelength of 3.781 μm. Our LDMC20 temperature-stabilized mount held the laser's temperature at 25 °C. The output beam was collimated by a C037TME-E lens located immediately downstream of the laser face. This lens was selected because of its large NA of 0.85 (which helped maximize collection of the emitted light) and because of its AR coating ($R_{\text{avg}} < 0.6\%$ per surface from 3 μm to 5 μm). We measured 10 mW of output power after the lens.

A pyroelectric camera (Spiricon Pyrocam IV) with 80 μm square pixels was scanned along the beam propagation direction, and the beam width was measured along the parallel and perpendicular directions using the second-order moment ($D4\sigma$) definition. Hyperbolas were fit to the beam width to extract M² for each direction. The camera's internal chopper was triggered at 50 Hz since the pyroelectric effect is sensitive to changes in temperature rather than absolute temperature differences. A ZnSe window was present in front of the detector array to help minimize visible light contributions to the signal.

Data Analysis

Presented to the right are the second-order moment ($D4\sigma$) beam widths for the parallel and perpendicular directions as a function of distance from the laser face (denoted as z). Along the parallel direction, we obtained a minimum beam width of 1.5 mm, while along the perpendicular direction, we obtained a minimum beam width of 1.3 mm. The spatial profiles we observed at the two minimum beam width positions, as obtained by the pyroelectric camera, are shown below.

The divergence of the beam can be described by a hyperbola, as written in Equation 1:



$$D4\sigma(z) = \sqrt{a + bz + cz^2}$$

In order to obtain the hyperbola coefficients a, b, and c for the parallel and perpendicular directions, we fit the discrete beam width measurements along each direction to hyperbolas, as shown in the graph to the right. These coefficients were substituted into Equation 2 (taking $\lambda = 3.781 \mu\text{m}$) to yield M^2 .

$$M^2 = \frac{\pi}{8\lambda} \sqrt{4ac - b^2}$$

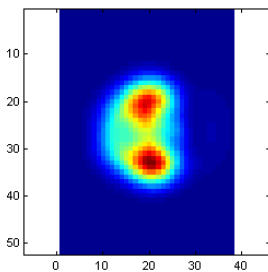
(Eq. 2)

The hyperbola coefficients and M^2 values derived by this method are listed in the table below.

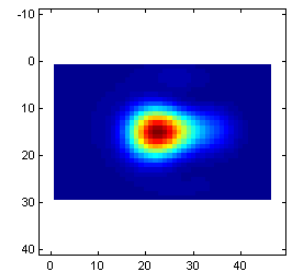
Value	Parallel	Perpendicular
a	$3.6 \pm 0.1 \text{ mm}^2$	$9.7 \pm 0.2 \text{ mm}^2$
b	$-0.0096 \pm 0.0007 \text{ mm}$	$-0.0268 \pm 0.0008 \text{ mm}$
c	$(1.61 \pm 0.08) \times 10^{-5}$	$(2.27 \pm 0.08) \times 10^{-5}$
M^2	1.2 ± 0.08	1.3 ± 0.2

The 0.85 NA of the collimating lens we used is the largest NA of any lens for this wavelength range that is offered in our catalog. Despite this large NA, we observed lobes in the far field (shown by the figure below) that are consistent with clipping of the laser-emitted light. An ideal measurement would not contain these artifacts.

As shown by the graph above and to the right, we observed significant astigmatism in the collimated beam: the beam waist of the parallel direction occurred around $z = 300 \text{ mm}$, while the beam waist of the perpendicular direction occurred around $z = 600 \text{ mm}$. This astigmatism corresponds closely to what is expected for this laser, given that the IF3800CM2 laser is specified with a parallel FWHM beam divergence of 40° and a perpendicular FWHM beam divergence of 60° .



Beam Profile at Beam Waist of Parallel Direction
(Each Pixel is $80 \mu\text{m}$ Square)



Beam Profile at Beam Waist of Perpendicular Direction
(Each Pixel is $80 \mu\text{m}$ Square)

CUSTOM & OEM LASERS

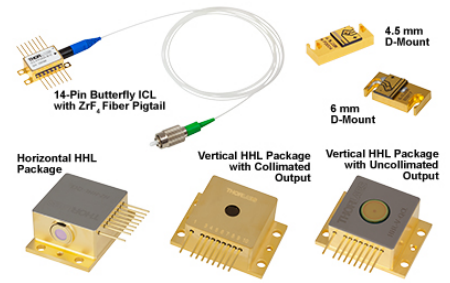
Custom & OEM Quantum Cascade and Interband Cascade Lasers

At our semiconductor manufacturing facility in Jessup, Maryland, we build a wide range of mid-IR lasers and gain chips. Our engineering team performs in-house epitaxial growth, wafer fabrication, and laser



packaging. We maintain chip inventory from 3 μm to 12 μm , and our vertically integrated facilities are well equipped to fulfill unique requests.

Click for Details Wire Bonding a Quantum Cascade Laser on a C-Mount



Click to Enlarge Some of Our Available Packages

High-Power Fabry-Perot QCLs

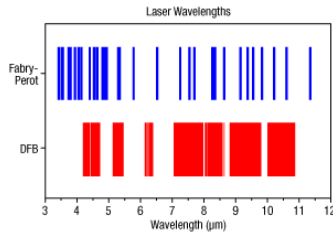
For Fabry-Perot lasers, we can reach multi-watt output power on certain custom orders. The available power depends upon several factors, including the wavelength and the desired package.

DFB QCLs at Custom Wavelengths

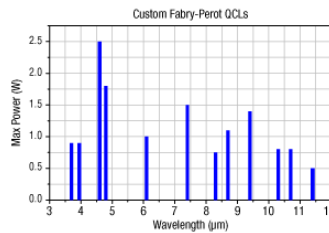
For distributed feedback (DFB) lasers, we can deliver a wide range of center wavelengths with user-defined wavelength precision. Our semiconductor specialists will take your application requirements into account when discussing the options with you.

The graphs below and photos to the right illustrate some of our custom capabilities. Please visit our semiconductor manufacturing capabilities presentation to learn more.

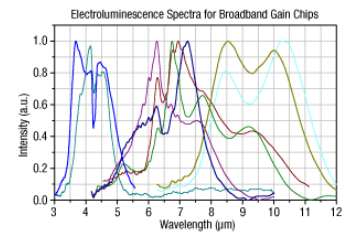
Contact Us



Click to Enlarge Available Wavelengths for Custom QCLs and ICLs



Click to Enlarge Maximum Output Power of Custom Fabry-Perot QCLs



Click to Enlarge Electroluminescence Spectra of Available Gain Chip Material

3.30 - 3.80 μm Center Wavelength Fabry-Perot ICLs

Item #	Info	Center Wavelength ^a	Power	Typical/Max Operating Current	Wavelength Tested	Spatial Mode
IF3300CM2		3.30 μm (3030 cm^{-1})	20 mW	480 mA / 600 mA	Yes	Single
IF3420CM2		3.42 μm (2920 cm^{-1})	30 mW	510 mA / 650 mA	Yes	Single
IF3800CM2		3.80 μm (2632 cm^{-1})	30 mW	550 mA / 650 mA	Yes	Single

- a. These lasers exhibit broadband emission. The center wavelength is defined as a weighted average over all the modes. Each device has a unique spectrum. To get the spectrum of a specific, serial-numbered device, click "Choose Item" below, then click on the Docs Icon next to the serial number of the device. If you need spectral characteristics different than those shown below, please contact Tech Support to request a custom laser.

Part Number	Description	Price	Availability
IF3300CM2	Fabry-Perot Interband Cascade Laser, 3.30 μm CWL, 20 mW, Two-Tab C-Mount	\$5,006.16	Lead Time
IF3420CM2	Fabry-Perot Interband Cascade Laser, 3.42 μm CWL, 30 mW, Two-Tab C-Mount	\$5,006.16	Lead Time
IF3800CM2	Fabry-Perot Interband Cascade Laser, 3.80 μm CWL, 30 mW, Two-Tab C-Mount	\$5,006.16	Lead Time


4.05 - 4.80 μm Center Wavelength Fabry-Perot QCLs

Item #	Info	Center Wavelength ^a	Power	Typical/Max Operating Current	Wavelength Tested	Spatial Mode
QF4050CM1		4.05 μm (2469 cm^{-1})	150 mW	1030 mA / 1150 mA	Yes	Single
QF4400CM1		4.40 μm (2273 cm^{-1})	500 mW	1020 mA / 1100 mA	Yes	Single
QF4550CM1 ^b		4.55 μm (2198 cm^{-1})	450 mW	900 mA / 1100 mA	Yes	Single
QF4800CM1		4.80 μm (2083 cm^{-1})	500 mW	850 mA / 1050 mA	Yes	Single

- a. These lasers exhibit broadband emission. The center wavelength is defined as a weighted average over all the modes. Each device has a unique spectrum. To get the spectrum of a specific, serial-numbered device, click "Choose Item" below, then click on the Docs Icon next to the serial number of the device. If you need spectral characteristics different than those shown below, please contact Tech Support to request a custom laser.
- b. If emission at a single wavelength is preferred, please consider our 4.00 - 5.00 μm Distributed Feedback Lasers.

Part Number	Description	Price	Availability
QF4050CM1	Fabry-Perot Quantum Cascade Laser, 4.05 μm CWL, 150 mW, Two-Tab C-Mount	\$5,006.16	Lead Time
QF4400CM1	Fabry-Perot Quantum Cascade Laser, 4.40 μm CWL, 500 mW, Two-Tab C-Mount	\$5,006.16	Today
QF4400CM1	Center Wavelength: 4.40 μm , 500 mW, (971 mA), 25 °C	\$5,006.16	Today
QF4400CM1	Center Wavelength: 4.40 μm , 500 mW, (976 mA), 25 °C	\$5,006.16	Today
QF4400CM1	Center Wavelength: 4.40 μm , 500 mW, (985 mA), 25 °C	\$5,006.16	Today
QF4550CM1	Fabry-Perot Quantum Cascade Laser, 4.55 μm CWL, 450 mW, Two-Tab C-Mount	\$5,006.16	Today
QF4550CM1	Center Wavelength: 4.61 μm , 450 mW, (963 mA), 25 °C	\$5,006.16	Today
QF4800CM1	Fabry-Perot Quantum Cascade Laser, 4.80 μm CWL, 500 mW, Two-Tab C-Mount	\$5,006.16	Today
QF4800CM1	Center Wavelength: 4.77 μm , 500 mW, (902 mA), 25 °C	\$5,006.16	Today



5.30 μm Center Wavelength Fabry-Perot QCLs

Item #	Info	Center Wavelength ^a	Power	Typical/Max Operating Current	Wavelength Tested	Spatial Mode
QF5300CM1 ^b		5.30 μm (1887 cm^{-1})	150 mW	1200 mA / 1300 mA	Yes	Single

- a. These lasers exhibit broadband emission. The center wavelength is defined as a weighted average over all the modes. Each device has a unique spectrum. To get the spectrum of a specific, serial-numbered device, click "Choose Item" below, then click on the Docs Icon next to the serial number of the device. If you need spectral characteristics different than those shown below, please contact Tech Support to request a custom laser.
- b. If emission at a single wavelength is preferred, please consider our 5.20 - 5.30 μm Distributed Feedback Lasers.

Part Number	Description	Price	Availability
QF5300CM1	Fabry-Perot Quantum Cascade Laser, 5.30 μm CWL, 150 mW, Two-Tab C-Mount	\$5,006.16	Today
QF5300CM1	Center Wavelength: 5.22 μm , 150 mW, (1187 mA), 25 °C	\$5,006.16	Today
QF5300CM1	Center Wavelength: 5.26 μm , 150 mW, (1214 mA), 25 °C	\$5,006.16	Today

7.20 - 7.70 μm Center Wavelength Fabry-Perot QCLs

Item #	Info	Center Wavelength ^a	Power	Typical/Max Operating Current	Wavelength Tested	Spatial Mode
QF7200CM1 ^b		7.20 μm (1389 cm^{-1})	250 mW	1300 mA / 1500 mA	Yes	Single
QF7700CM1 ^b		7.70 μm (1299 cm^{-1})	250 mW	1100 mA / 1300 mA	Yes	Single


- a. These lasers exhibit broadband emission. The center wavelength is defined as a weighted average over all the modes. Each device has a unique spectrum. To get the spectrum of a specific, serial-numbered device, click "Choose Item" below, then click on the Docs Icon next to the serial number of

the device. If you need spectral characteristics different than those shown below, please contact Tech Support to request a custom laser.

- b. If emission at a single wavelength is preferred, please consider our 7.00 - 8.00 μm Distributed Feedback Lasers.

Part Number	Description	Price	Availability
QF7200CM1	Fabry-Perot Quantum Cascade Laser, 7.20 μm CWL, 250 mW, Two-Tab C-Mount	\$5,006.16	Today
QF7200CM1	Center Wavelength: 7.20 μm , 250 mW, (1361 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF7200CM1	Center Wavelength: 7.19 μm , 250 mW, (1234 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF7200CM1	Center Wavelength: 7.20 μm , 250 mW, (1244 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF7700CM1	Fabry-Perot Quantum Cascade Laser, 7.70 μm CWL, 250 mW, Two-Tab C-Mount	\$5,006.16	Today
QF7700CM1	Center Wavelength: 7.69 μm , 250 mW, (1031 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF7700CM1	Center Wavelength: 7.68 μm , 250 mW, (931 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF7700CM1	Center Wavelength: 7.68 μm , 250 mW, (935 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF7700CM1	Center Wavelength: 7.68 μm , 250 mW, (987 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today



8.35 μm Center Wavelength Fabry-Perot QCLs

Item #	Info	Center Wavelength ^a	Power	Typical/Max Operating Current	Wavelength Tested	Spatial Mode
QF8350CM1		8.35 μm (1198 cm^{-1})	300 mW	1750 mA / 2000 mA	Yes	Single

- a. These lasers exhibit broadband emission. The center wavelength is defined as a weighted average over all the modes. Each device has a unique spectrum. To get the spectrum of a specific, serial-numbered device, click "Choose Item" below, then click on the Docs Icon next to the serial number of the device. If you need spectral characteristics different than those shown below, please contact Tech Support to request a custom laser.

Part Number	Description	Price	Availability
QF8350CM1	Fabry-Perot Quantum Cascade Laser, 8.35 μm CWL, 300 mW, Two-Tab C-Mount	\$5,006.16	Today
QF8350CM1		\$5,006.16	Today

9.15 - 9.55 μm Center Wavelength Fabry-Perot QCLs

Item #	Info	Center Wavelength ^a	Power	Typical/Max Operating Current	Wavelength Tested	Spatial Mode
QF9150CM1		9.15 μm (1093 cm^{-1})	180 mW	1500 mA / 1750 mA	Yes	Single
QF9550CM1 ^b		9.55 μm (1047 cm^{-1})	80 mW	1500 mA / 1700 mA	Yes	Single

- a. These lasers exhibit broadband emission. The center wavelength is defined as a weighted average over all the modes. Each device has a unique spectrum. To get the spectrum of a specific, serial-numbered device, click "Choose Item" below, then click on the Docs Icon next to the serial number of the device. If you need spectral characteristics different than those shown below, please contact Tech Support to request a custom laser.
- b. If emission at a single wavelength is preferred, please consider our 9.00 - 10.00 μm Distributed Feedback Lasers.

Part Number	Description	Price	Availability
QF9150CM1	Fabry-Perot Quantum Cascade Laser, 9.15 μm CWL, 180 mW, Two-Tab C-Mount	\$5,006.16	Today
QF9150CM1	Center Wavelength: 9.16 μm , 180 mW (1653 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF9150CM1	Center Wavelength: 9.17 μm , 180 mW (1688 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF9550CM1	Fabry-Perot Quantum Cascade Laser, 9.55 μm CWL, 80 mW, Two-Tab C-Mount	\$5,006.16	Today
QF9550CM1	Center Wavelength: 9.68 μm , 80 mW, (1440 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF9550CM1	Center Wavelength: 9.69 μm , 80 mW, (1427 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF9550CM1	Center Wavelength: 9.68 μm , 80 mW, (1519 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today

QF9550CM1	Center Wavelength: 9.68 μm , 80 mW, (1447 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today
QF9550CM1	Center Wavelength: 9.69 μm , 80 mW, (1481 mA), 25 $^{\circ}\text{C}$	\$5,006.16	Today

IF3420CM2 - Fabry-Perot Interband Cascade Laser, 3.42 μm CWL, 30 mW, Two-Tab C-Mount + x

Specs
Spectrum
L-I-V Curve
Far Field
Drawing

Optical Electrical Characteristics ($T_{\text{CASE}} = 25\text{ }^{\circ}\text{C}$, $P = 30\text{ mW}$)

Characteristic	MIN	TYP	MAX	UNIT
Center Wavelength	3.32	3.42	3.52	μm
Spectral Bandwidth (5% - 95% Integrated Power)	-	50	-	nm
Optical Output Power	30	-	-	mW
Beam Divergence (FWHM) - Perpendicular	-	45	-	deg.
Beam Divergence (FWHM) - Parallel	-	30	-	deg.
Operating Voltage	-	2.6	4.0	V
Operating Current	-	510	650	mA
Threshold Current	-	120	-	mA
Slope Efficiency	-	0.1	-	W/A

Absolute Maximum Ratings^a ($T_{\text{CASE}} = 25\text{ }^{\circ}\text{C}$)

Characteristic	VALUE	UNIT
Optical Output Power (CW)	50	mW
LD Reverse Voltage	1	V
Absolute Max Current	800	mA
Operating Temperature ^b	15 to 50	$^{\circ}\text{C}$
Storage Temperature ^b	-40 to 85	$^{\circ}\text{C}$

a. These lasers have not been extensively tested beyond the values shown in this table. Device damage may occur if these values are exceeded.
b. Non-condensing environment.

General Specifications

Characteristic	Value
Spatial Mode	Single Mode
Wavelength Tested	Yes

IF3420CM2 - Fabry-Perot Interband Cascade Laser, 3.42 μm CWL, 30 mW, Two-Tab C-Mount + x

Specs
Spectrum
L-I-V Curve
Far Field
Drawing

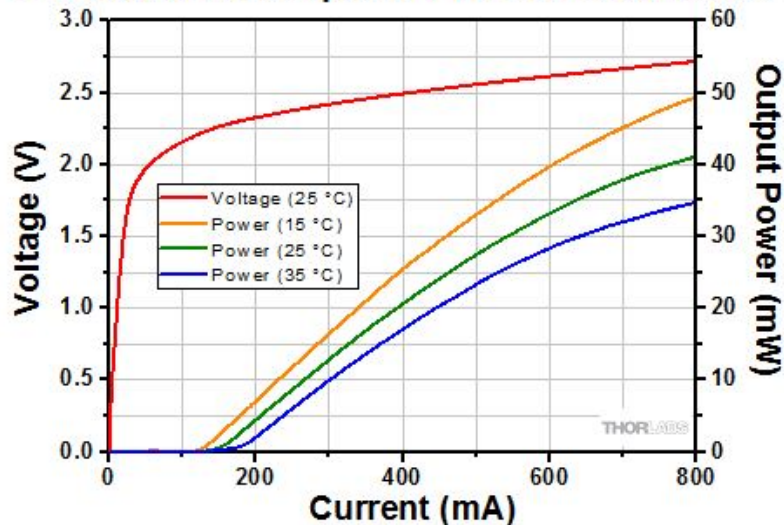
IF3420CM2 Sample Output Spectrum

All values are measured at 25 $^{\circ}\text{C}$. To view an Excel file that lists all of the measured spectral and L-I-V characteristic values of the sample ICL shown above, please click [here](#). Serial-number-specific documentation is available by clicking "Choose Item" on the left side of the price box.

The spectrum above shows the fine structure of the Fabry-Perot modes, which can be seen in the raw data file. Please note that the resolution bandwidth of this measurement is 0.125 cm^{-1} (3.75 GHz).

Specs Spectrum **L-I-V Curve** Far Field Drawing

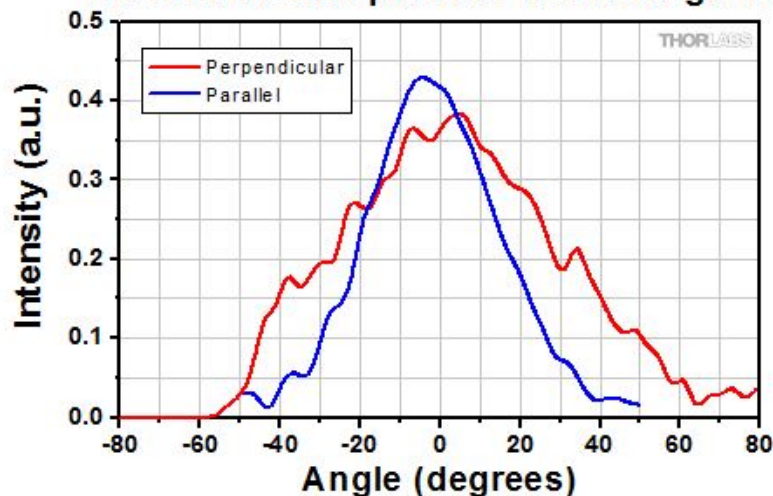
IF3420CM2 Sample L-I-V Characteristics



To view an Excel file that lists all of the measured spectral and L-I-V characteristic values of the sample ICL shown above, please click [here](#). Serial-number-specific documentation is available by clicking "Choose Item" on the left side of the price box.

Specs Spectrum L-I-V Curve **Far Field** Drawing

IF3420CM2 Sample Far Field Divergence



All values are measured at 25 °C. To view an Excel file that lists all of the measured spectral, L-I-V, and far field characteristic values of the sample ICL shown above, please click [here](#). Serial-number-specific documentation is available by clicking "Choose Item" on the left side of the price box.

Far field divergence values are measured at 25 °C and at a distance of 89.4 mm from the laser. The detector's aperture is $\varnothing 10$ mm, and the sampling step size is 3°. The angle subtended by the detector is 6.4°. The far field profile appears noisy due to the low signal-to-noise ratio of the measurement.

Specs

Spectrum

L-I-V Curve

Far Field

Drawing

