

# LF Series Infrared Gas Cells and Integrated Sampling Systems

*Providing rapid response, fixed calibration, and robust reliability for demanding laboratory and process applications*

The LF Series has evolved through a collaboration of Axiom Analytical's technical staff with scientists and engineers in diverse industries. The result is a family of products with some clearly defined benefits, including:

- **Absolutely constant and precise calibrations** - With the LF Series, you will never again have to back-calibrate for pathlength. The pathlength is a simple function of cell structure and can literally be measured with a tape measure.
- **Fast response, negligible sample carryover** - Plug flow operation ensures extremely fast and accurate response to changes in sample concentration. And when combined with a lack of dead volume, it provides virtually total sample elimination with just a fraction over one cell volume of purge flow.
- **Choice of Axiot or Fiber-optic Coupling** – Fiber-optic coupling is the method of choice for the near-IR range. Axiot or direct sample compartment coupling is generally preferable for mid-IR.
- **Pneumatic switching between multiple cells** - Axiot pneumatic switches and optical transfer modules make it possible to rapidly and efficiently switch between cells having different pathlengths or to eliminate cross-contamination by using individual cells for different sample streams.
- **Robust construction** - Designed from the start for process applications, LF Series cells are extremely rugged and adjustment-free. A choice of materials of construction and sealing techniques enable these cells to withstand virtually all corrosive gases and to provide highly reliable operation even after extensive temperature and pressure cycling.
- **Easy maintenance** - LF Series cells and Axiot transfer systems are designed to allow rapid on-site service for minimum downtime. If necessary, the cells can be completely disassembled, cleaned, and reassembled with no change in calibration.

## INDIVIDUAL CELL MODELS

Standard LF Series gas cell models are divided into the three groups, (LFG, LFT, and LFC), described below. In addition, versions are available for use with corrosive gases. These are designated by the -C suffix, and are equipped with special features such as: solid nickel mirrors, modified seal designs, and welded VCR fittings.

## LFG Series Gas Cells

- Designed for outboard (Axiot-coupled) operation
- Standard Pathlengths to 8 meters

Axiom's linear flow gas cells offer the highest optical stability and fastest response to changes in sample composition of any gas cell of comparable path length. LFG Series cells have demonstrated significantly higher levels of performance compared to multi-pass or "White cell" designs. The Axiom advantage lies in the use of a tubular flow path which exactly overlaps the IR beam. This yields plug flow conditions, allowing a complete exchange of sample gas within seconds.

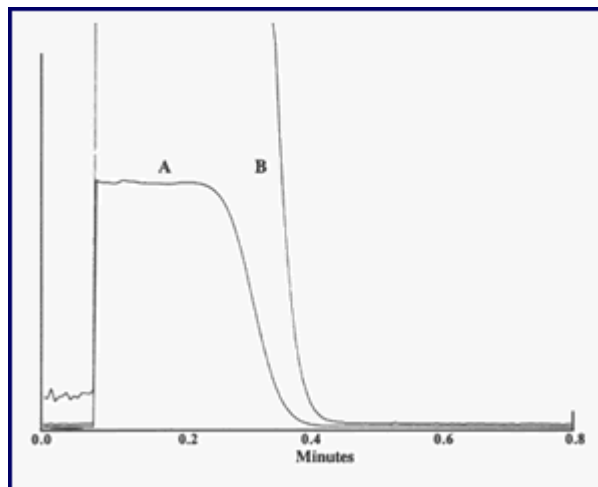
Standard LFG cells employ nickel-plated brass light guides with an inside diameter of 32mm (1.25"). Gold-coated glass mirrors are used to fold the path into convenient 2, 4, or 8 tube configurations (with total pathlengths from 2 to 8 meters). Since mirror alignment is machined into the cell structure, the design is inherently adjustment-free. LFG cells remain perfectly aligned even at high temperature and pressure. KBr windows are standard. Alternative window materials including BaF<sub>2</sub>, CaF<sub>2</sub>, ZnSe and others are available.

LFG Series cells are designed for use in a collimated beam and are easily connected to Axiot optical transfer modules for outboard use. Please contact Axiom to discuss your specific system requirements.

LFG cells can also be fiber-optically coupled by means of FAC-100 Axiot to fiber adaptors.

In addition to the folded path models, single tube LFG cells are available in short to moderate path lengths. With fewer seals and less exposure of critical elements to the sample, these models are often preferred for corrosives analysis.

### LFG Response Time:



Response of an LFG-404 Gas Cell to the injection of a short "plug" of absorbing vapor in the presence of a constant flow of nitrogen. The measured concentration remains constant, despite diffusion, as the vapor flows through the cell. Trace B (a 10x vertical expansion of Trace A) indicates that the vapor level had fallen to less than 0.05% of its initial value with a total purge of less than 1.5 cell volumes.

## LFT Series Gas Cells

- Ultra low volume
- Pathlengths to 2 meters

LFT cells employ small diameter, tubular, gold-coated brass light guides which provide extremely low volume operation and rapid sample exchange for intermediate path lengths. Permanently aligned optics and fixed, unalterable pathlengths provide reliable, adjustment-free operation. Like the LFG Series, these cells feature plug-flow gas transfer and an exact overlap of sample and optical paths resulting in rapid response to changes in sample concentration.

Standard LFT cells are designed to mount in any FTIR sample compartment with conventional focused beam geometry. They include a pair of telescoping purge shrouds which seal the beam path within the open sample compartment, a mounting stand to match your particular spectrometer model, 1/8 NPT inlet and outlet fittings, Viton seals, and KBr windows. Alternate window and seal materials are available. In addition, adapters are available for direct coupling with Axiot transfer optics in outboard sampling configurations. Please refer to the specifications table for individual model details.

Fiber-optic coupled versions of the LFT gas cells are also available and are primarily used in the near-IR spectral range. (See the FFT-200 Series data sheet.)

## LFC Series Gas Cells

- Suitable for inboard or outboard use
- Operable at pressures to 65 bar
- Pathlengths of 3 and 10 cm

The most rugged and reliable short path gas cells available anywhere, LFC cells are at home in any environment, from the research lab to the process line. Two models are available: the LFC-103 with a 3 cm path length, and the LFC-110 with a 10 cm path length. Both are capable of operation to 65 bar (1000 psi) and 200°C, and are available in sample compartment or outboard configurations. Inboard models are equipped with a baseplate matched to your specific spectrometer. Once installed in the sample compartment, LFC cells can be quickly removed or replaced without adjustment. Both models are easily plumbed into external sampling systems via Axiot optical modules.

Each LFC cell is supplied with a thermocouple, insulated stand, and provision for either fluid or electrical temperature control. Standard cell bodies are constructed from 316 stainless steel and include 1/8 NPT fittings; Hastelloy construction is optional. Standard materials include Viton seals and ZnSe windows, (KBr, CaF<sub>2</sub>, BaF<sub>2</sub>, AgCl, SiO<sub>2</sub>, and AMTIR-1 are also available).

## LF SERIES GAS CELL SPECIFICATIONS

Model	# of Optical Conduits	Path Length (meters)	Cell Vol. (liters)	Purge Vol. * (liters)	Trans. %T**	Max. Press. (Bar)	Dims. (DxWxH, in.)
LFG-1015	1	0.15	0.12	0.2	75	10	9x4x4
LFG-1100	1	1	0.8	1.1	60	10	42x4x4
LFG-1200	1	2	1.6	2.1	50	10	82x4x4
LFG-202	2	2	1.6	2.1	50	10	4x6x42
LFG-204	2	4	3.2	4.2	38	10	4x6x82
LFG-404	4	4	3.2	4.2	35	10	6x6x42
LFG-408	4	8	6.4	8.4	16	10	6x6x82
LFG-808	8	8	6.4	8.4	14	10	8x6x42
LFG-816	8	16	12.8	16.8	3	10	8x6x82
LFT-205	2	0.5	0.025	0.03	40	10	4x5x14
LFT-210	2	1	0.05	0.06	20	10	4x5x24
LFT-220	2	2	0.1	0.12	8	10	4x5x44
LFC-103	N/A	0.03	0.005	0.02	20	60	4x3.5x3.5
LFC-110	N/A	0.1	0.018	0.04	30	80	4x3.5x6.25

\* for 99% sample exchange

\*\* with a 1 mm IR detector

\*\*\* maximum temperature depends on seal material (200°C with standard Viton O-rings at ambient pressure). This temperature specification is reduced at higher pressures and with alternative seal materials.

Note 1: All LFG and LFT Cells are available in modified versions for use with highly corrosive gases. Just add the suffix "C" to specify use with corrosive gases. Special features include solid nickel mirrors, modified seals, and/or welded VCR fittings.

Note 2: Most cells are available in custom lengths, and may be special ordered with non-standard construction materials, fittings and other features to suit your particular application. Please inquire for further details.

**PROPERTIES OF COMMON WINDOW MATERIALS**

<b>Materials</b>	<b>Hardness</b>	<b>Strength</b>	<b>Low Frequency Cutoff</b>	<b>Trans. (%T**)</b>	<b>Chemical Incompatibilities</b>
	<b>(kg/mm<sup>2</sup>)</b>	<b>(MPa)</b>	<b>(cm<sup>-1</sup>)</b>	<b>(uncoated, pair)</b>	
KBr	7	1	333	83	Water, alcohols, ether, humidity
CaF <sub>2</sub>	158	37	1000	89	Ammonium ions, some conc. acids
BaF <sub>2</sub>	82	27	833	87	Ammonium ions, acids
ZnSe	120	55	500	47	Acids, strong conc. bases
SiO <sub>2</sub>	461	35	3000	87	HF, strong bases
AMTIR-1	170	18	700	44	Bases, some conc. acids
ZnS (Cleartran)	160	60	950	52	Strong oxidizers, some acids
Sapphire	1370	448	2200	74	Conc. acids, bases