Preconfigured Optical Setups for the General Purpose Optical Bench for Frontier FT-IR Spectrometers

Introduction
The PerkinElmer® Frontier™ FT-IR instrument offers two external beams for a variety of uses. One is for use with the Spotlight™ microscope and imaging systems. The other beam provides maximum flexibility for experiments that cannot be accommodated in the standard sample compartment. The General Purpose Optical Bench (GPOB) is an accessory designed to simplify experiment setup and create customized beampaths. In addition, it is suitable for long-term use (especially convenient for those accessories with their own detector), leaving the sample compartment free for other work.
Once the hardware is installed, the Spectrum™ software can be reconfigured so that the GPOB can be selected from the Setup Instrument Beampath tab in the Setup options. Selecting the external detector will drive the mirror that directs the IR beam to the GPOB and select the detector signal from the auxiliary detector input.

Figure 2. Frontier FT-IR with GPOB, detectors (2 mm LiTa (front right), L1250463 – or 1 mm MCT (front left), L1250425) and optical elements included in optical configuration 2 (L1272500, parabolic and flat mirrors, far right).

Typical uses include:

- When using sampling accessories such as cryostats or high vacuum chambers, like those used in thin film deposition studies or holders that are too large to fit into the standard instrument sample compartment. The mechanical layout of the GPOB provides more flexibility and space than the standard sample compartment thus focusing optics which direct the beam onto the sample and subsequently onto a remote detector.

- For an additional sampling area using accessories such as fiber probes, photoacoustic detectors or to allow room for transmission work with custom integrated sphere detectors or for additional sample heating or cooling arrangements.

- For use with custom or third party sampling accessories containing optical systems not compatible with the standard sample compartment beam profile. The GPOB is supplied with a near-collimated exit beam from the interferometer which facilitates optical coupling with third-party accessories.

- For the use or characterization of custom detector systems. There is increased space to accommodate multiple custom detectors, and a number of detector signal routing options. Examples include specialized photoconductive detectors such as MCT, or helium-cooled bolometers for higher sensitivity in the far-infrared region.

**Preconfigured optical arrangements on the GPOB**

The GPOB consists of an optical bench (ca 450 mm x 300 mm) pre-drilled with fixing holes for conveniently locating optical components and assemblies. The breadboard bench is secured to the main instrument base casting by a special external bench bracket. This configuration has the necessary output steering optics and exit windows so the beam can be sent to the GPOB under software control. The system delivers a near-parallel beam ca. 40 mm diameter with ca. 3 degree half-cone angle at the exit window. The beam is centered approximately front-to-back on the baseplate to allow for custom transfer optics and/or accessories to be placed onto the baseplate where appropriate. The beam height is centered 85 mm above the optical bench. The GPOB basic system is installed by the PerkinElmer service engineer with one of the following options:

1a. LiTa part number L1250463, includes platform, LiTa detector, parabolic mirror and preamplifier, or

1b. MCT detector part number L1250425, includes platform, MCT detector, parabolic mirror and preamplifier in Optical Configuration 1 (Figure 3).

**Optical Configuration 1 includes:**

- GPOB bench
- Instrument coupling bracket
- Parabolic mirror and mounting
- 2 mm LiTa (L1250463) or 1 mm MCT Detector (L1250425)

Figure 3. Optical diagram for optical configuration 1.
Once the GPOB is installed with a MCT or LiTa detector and preamplifier by the PerkinElmer service engineer, the device can be reconfigured with a number of optical arrangements that can be supplied by PerkinElmer, or users can use their own arrangement.

The supplied preamplifier module is powered by the instrument; no separate power supply is required. If using a separate custom preamplifier, the system must operate strictly within the voltage and current limits as stated in Table 1, otherwise it should be powered by a separate power supply.

**Disclaimer:** Due to the research nature and level of customization of the GPOB elements, PerkinElmer can only guarantee the installation and performance of the optical configuration as shown in Figure 1 for configurations 1a or 1b.

**Note 1:** The connection is not swappable during operation, and the user configurable nature of this system means that PerkinElmer cannot guarantee the level of immunity to external electromagnetic interference (EMI) or the possibility that the product may itself cause interference to other nearby equipment.

### Optical Configuration 2

With the optical bench installed and tested by PerkinElmer service engineers, customers may now set up the optics provided and couple the beam to an external detector like a Bolometer. The optical set up is shown in Figure 4.

An example is shown in Figure 5. This system is supplied with a standard detector preamplifier module. While the supplied preamplifier is configurable to allow adjustment of the preamplifier gain setting and bias current over a pre-defined range, it is also possible to connect a custom preamplifier to the instrument via an external 15-way high density D-type socket located on the rear of the instrument. Table 1 details the functionality of the pins on the D-type connector.

**Note 2:** Accessories have to be removed from their original baseplate and mounted directly on the GPOB. This may require an adaptor (not provided).

### Optical Configurations 3 and 4

Optical configurations 3 and 4 mimic the beam profile of the internal sample compartment. Standard sampling accessories can be positioned at the GPOB under those optical configurations for long term use, leaving the internal compartment free for routine measurements.

Optical Configuration 3 is for those accessories such as a photoacoustic detector or an integrating sphere with a built-in detector or a detector like a bolometer. Configuration 4 uses the detector provided with the GPOB and a set of additional optics, providing a means of fully duplicating the internal sampling area.

**Note 2:** Accessories have to be removed from their original baseplate and mounted directly on the GPOB. This may require an adaptor (not provided).
Summary

The GPOB is a multifunctional platform for the Frontier FT-IR spectrometer to expand the system capabilities well beyond the standard configurations. It offers the customer unique opportunities in terms of flexibility of the optical design. In addition, it introduces previously unmatched solutions for researchers such as the capacity to couple accessories on the side of the instrument without losing sampling capabilities.

Figure 7. Optical diagram for optical configuration 4.

Appendix

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Function</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Accessory Bus Reset</td>
<td>System reset, normally 5 V but 0 V pulse on spectrometer power up. Output.</td>
</tr>
<tr>
<td>2</td>
<td>0 VL</td>
<td>0 V return for digital circuitry</td>
</tr>
<tr>
<td>3</td>
<td>Accessory Bus Clock</td>
<td>307200 Hz TTL compatible signal for Accessory Bus microcontroller clock drive. Do not pull more than ±2 mA from this pin. Output.</td>
</tr>
<tr>
<td>4</td>
<td>Accessory Bus Abort</td>
<td>Accessory abort to prematurely finish Accessory Bus command. Output.</td>
</tr>
<tr>
<td>5</td>
<td>Accessory Bus serial transmit (from spectrometer to external)</td>
<td>TTL compatible serial signal running at 4800, n, 8, 1. Output.</td>
</tr>
<tr>
<td>6</td>
<td>Accessory Bus serial receive (from external to spectrometer)</td>
<td>TTL compatible serial signal running at 4800, n, 8, 1. Input.</td>
</tr>
<tr>
<td>7</td>
<td>0 VL</td>
<td>0 V return for digital circuitry</td>
</tr>
<tr>
<td>8</td>
<td>5 VL</td>
<td>5 V supply for digital circuitry. Do not pull more than 1 A from this pin. Output.</td>
</tr>
<tr>
<td>9</td>
<td>0 VA</td>
<td>0 V analog return for analog circuitry.</td>
</tr>
<tr>
<td>10</td>
<td>EXTDET+</td>
<td>External differential positive analog detector signal. ±11 V full scale. Input. See Note 1.</td>
</tr>
<tr>
<td>11</td>
<td>EXTDET−</td>
<td>External differential negative analog detector signal. ±11 V full scale. Input. See Note 1.</td>
</tr>
<tr>
<td>12</td>
<td>0 VA</td>
<td>0 V analog return for analog circuitry.</td>
</tr>
<tr>
<td>13</td>
<td>+12 VA</td>
<td>+12 V analog for any analog circuitry. Do not pull more than 100 mA from this pin.</td>
</tr>
<tr>
<td>14</td>
<td>−12 VA</td>
<td>−12 V analog for any analog circuitry. Do not sink more than 100 mA into this pin.</td>
</tr>
</tbody>
</table>

Note 1. The differential input signal has a maximum positive value when EXTDET+ is at +11 V and EXTDET− is at −11 V. It has a maximum negative value when EXTDET+ is at −11 V and EXTDET− is at +11 V. The input impedance is 100 KΩ on each input with reference to 0 VA.
<table>
<thead>
<tr>
<th>Optical Configuration</th>
<th>Elements Included</th>
<th>Spot Size of Beam</th>
<th>Focal Distance to Detector</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1a – LiTa (L1250463)  | • GPOB  
• Coupling bracket  
• Parabolic mirror (40 mm focal length) and mounting  
• LiTa detector                                                                                                                                       | 2 mm              | 40 mm                       | Basic setup, only one installed by PerkinElmer.                                               |
| 1b – MCT (L1250425)   | As above but with MCT detector, preamp and cable instead of LiTa detector                                                                                                                                          | 2 mm              | 40 mm                       |                                                                                              |
| 2 – L1272500          | • Parabolic mirror (100 mm focal length)  
• Flat mirror  
• Mountings for attaching mirrors onto optical bench                                                                                                  | 8 mm              | 100 mm                      | Optimized for external detectors like a bolometer                                            |
| 3 – L1272501          | • Parabolic mirror (150 mm focal length)  
• Flat mirror  
• Mountings for attaching mirrors onto optical bench                                                                                                  | 12 mm             | 150 mm                      | Reproduces sampling compartment beam, ideal for 3rd party accessories with their own detector |
| 4 – L1272502          | • Parabolic mirror (2 x 150 mm focal length)  
• Flat mirror  
• Mountings for attaching mirrors onto optical bench optics                                                                                         | 2 mm              | 40 mm                       | Reproduces sampling compartment beam, ideal for 3rd party accessories without detector        |