OPERATING MANUAL

80 MHz CENTER FREQUENCY
ACOUSTO-OPTIC BEAM DEFLECTOR
MODEL NUMBER:

46080-X-1.06
where x = 1, 2, or 3 mm acoustic aperture height

DOCUMENT NUMBER: 51A19604
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SECTION I

INSPECTION PROCEDURE

Examine the shipping carton for damage. If the shipping carton or packing material is damaged it should be kept for the carrier’s inspection. Notify the carrier and NEOS Technologies. Check the contents of the shipment for completeness, mechanical damage, and then test the equipment electronically. Operating procedures are contained in Section VI. If the contents are incomplete, or the equipment does not pass the electrical testing please notify NEOS Technologies.

If there is any problem with the use of this equipment, or if the equipment fails to function as expected contact NEOS Technologies, do not try to trouble shoot or repair this equipment. Consult with a NEOS service engineer. If the equipment needs repair or replacement, contact NEOS Technologies, Inc for a Return Authorization Number.
SECTION II
DESCRIPTION

The 46080-X-1.06 acousto-optic beam deflector (AOBD) is fabricated from TeO₂ crystals with LiNbO₃ longitudinal wave transducers designed to operate with 1.06 µm wavelength light. The X is the acoustic aperture height of 1, 2, or 3 mm with an aperture length of 4 mm. The deflector operates over the frequency range of 65 MHz to 95 MHz.

The AOBD can be driven by any good driver with a 50 Ω nominal output; however, it is recommended that a NEOS Technologies driver be used to drive this deflector to achieve optimum performance. The RF input power to the deflector should not exceed 2 watts CW as NEOS Technologies will not warranty damage from applying too much RF power.

The NEOS drivers available to drive the 46080-X-1.06 are as follows: The analog modulated, Voltage Controlled Oscillator: 21065-95-2AMVCO, typically used when you need to have a sweeping output beam. The analog and digital modulated Frequency Synthesizer 64020-200-2AMADFS-A, typically used when you need to randomly accessed the output position. And the analog and digital modulated Frequency Synthesizer 64040-150-.2ADMDFS-8X1, which can output up to eight beams simultaneously.
### SECTION III

**DEVICE SPECIFICATIONS**

46080-X-1.06

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SPECIFICATION</th>
</tr>
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<tr>
<td>Interaction Material</td>
<td>TeO2</td>
</tr>
<tr>
<td>Acoustic Mode</td>
<td>Longitudinal</td>
</tr>
<tr>
<td>Operating Wavelength</td>
<td>1064 nm</td>
</tr>
<tr>
<td>Static Transmission</td>
<td>&gt; 97 %</td>
</tr>
<tr>
<td>Window Configuration</td>
<td>AR coated</td>
</tr>
<tr>
<td>Operating Frequency</td>
<td>65-95 MHz</td>
</tr>
<tr>
<td>Intensity Variation</td>
<td>&lt; 2.5 dB across bandwidth</td>
</tr>
<tr>
<td>Diffraction Efficiency (midband)</td>
<td>&gt; 75 % midband with linear polarization, perpendicular to acoustic propagation,</td>
</tr>
<tr>
<td></td>
<td>&gt; 70 % midband with random polarization.</td>
</tr>
<tr>
<td>Acoustic Aperture Size</td>
<td>X = 1, 2, or 3mm high x 4 mm long</td>
</tr>
<tr>
<td>Rise Time</td>
<td>150 ns/mm beam dia.</td>
</tr>
<tr>
<td>Δ Deflection Angle</td>
<td>7.5 mrad</td>
</tr>
<tr>
<td>Deflection Angle</td>
<td>20 mrad</td>
</tr>
<tr>
<td>RF Power Level</td>
<td>&lt; 2 watts</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 ohms nominal</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt;1.5:1 across bandwidth</td>
</tr>
<tr>
<td>Package</td>
<td>53B0624 TO2</td>
</tr>
</tbody>
</table>
SECTION IV
OUTLINE DRAWING

Dimensions are in inches   Tolerances: Decimal:    .xx = .01       .xxx = .005
Dimensions in [ ] are in mm.        Milimeter:    .xx = .25mm        .xxx = .127mm
Angle: = ± 30°
SECTION V
CALCULATIONS

The maximum aperture of each device is $X$ millimeters high by 4 millimeters long where $X = 1, 2, \text{ or } 3\ mm$. The input laser beam diameter should fully illuminate the aperture in order to achieve the maximum number of resolvable spots. The access time ($\Delta T$) can be determined from the following:

- The access time ($\Delta T$) is equal to the Beam diameter ($d_0$) in the acoustic direction divide by the Velocity of sound ($V$) in the material.
  
  $\Delta T = \frac{d_0}{V} = \frac{4}{4.26} = 0.93 \ \mu s$

- The number of resolvable spots (TBW) for Acousto-Optic Beam Deflector is the product of $\Delta f$ and $\Delta T$
  
  Where: the RF bandwidth ($\Delta f$) of the device is $30 \ MHz$.

  $TBW = \Delta f \Delta T = 30 \ MHz \times 0.93 \mu s = 27.9$

  27 resolvable spots with no less than 5 $\mu s$ chirp time and uniform illumination of the aperture to avoid lensing effects.

- The actual number of resolvable spots ($N$) are dependent on the uniformity of the illumination of the aperture (truncation of the laser beam) and scan chirp time.

  $N = (1 - \frac{\Delta T}{T + \Delta T}) (\frac{\Delta T \Delta f}{a})$

  Where:  $T = \text{Chirp time}$
  $\Delta T = \text{process time}$
  $a = \text{A parameter for uniformity of illumination.}$

  Where:  $a = 1$ for uniform illumination.

  $a = 1.34$ for gaussian illumination clipped at the $\frac{1}{e^2}$ intensity points.

- The RF chirp applied to the AOBD causes a lensing effect as well as a deflection of the laser beam. The focal length ($F_{La}$) of the acoustic cylinder lens, lensing effect is:

  $F_{La} = V_a^2 / (\frac{df_a}{dt} \cdot \lambda)$

  Where: $\frac{df_a}{dt}$ is the slope of the frequency change vs time.

- The angle between the diffracted and the zero order beam, the deflection angle, $\varphi_d$, is defined by:

  $\varphi_d = 2 \theta_{\text{Bragg}} = \frac{\lambda f}{V} = \frac{\lambda f}{4.26\ mm/\mu\text{sec}}$

  Where: $f = \text{RF frequency in MHz}$
  $\lambda = \text{optical wavelength}$
  $\theta = \text{Bragg angle of the Acousto-Optic Beam Deflector}$

The frequencies "f" are from 65 to 95 MHz with the center frequency $= 80 \ MHz$. 
**Example Calculations for a 2 mm Circular Beam**

If using a 2 mm circular beam with a clear aperture 2 mm high by 4 millimeters long. The input laser beam diameter will not fully illuminate the aperture. Therefore, the number of resolvable spots, are reduced from the maximum available. The access time ($\Delta T$) can be determined from the following:

- The access time ($\Delta T$) is equal to the Beam diameter ($d_0$) in the acoustic direction divide by the Velocity of sound ($V$) in the material.

  \[
  \Delta T = \frac{d_0}{V} = \frac{2}{4.26} = 0.46 \, \mu s
  \]

- The number of resolvable spots (TBW) for Acousto-Optic Beam Deflector is the product of $\Delta f$ and $\Delta T$

  \[
  \text{TBW} = \Delta f \Delta T = 30 \, \text{MHz} \times 0.46 \, \mu s = 13.8
  \]

  There are 13 resolvable spots.
SECTION VI.
OPERATING PROCEDURE

Provide a RF source that will provide nominally 2 watts of CW RF power of the frequencies between 65 and 95 MHz. Preset the control voltage or input the digital control word to the device to output 80 MHz frequency. With the RF power off, connect the source to the deflector with a 50 \( \Omega \) cable.

Project a collimated light beam, linear polarized, perpendicular to acoustic propagation into the aperture of the AOBD. The light beam should fully fill the aperture, if the full output resolution of the deflector is desired. Rotate the AOBD Bragg angle so that the beam is normal to the input window of the Te02 crystal. Apply the RF power at 80 MHz to the AOBD. Adjust the Bragg angle as shown in figure 1 and view the output light at a distance of about 1 meter from the output side of the AOBD, as an array of spots will result when approaching the Bragg angle. Use a IR viewing card or IR viewer to see the output.

When this array of spots becomes evident, maximize the intensity of the diffracted (+) first order beam (away the BNC connector), by varying Bragg angle, the vertical and horizontal position of the AOBD. Refer to figure 1. The vertical positioning of the deflector is important to ensure that the light beam is centered in the acoustic column. In most AOBD's you may also see some diffracted light in the negative first and Positive second orders, however the intensity of these orders are generally very low when the AOBD is set at the correct Bragg angle.

Next, check the diffraction efficiency at 65 MHz and 95 MHz RF drive frequencies or sweep the RF over this 30 MHz band. Slightly adjust the three adjustments to obtain best flatness for the diffracted light intensity across the band of 65 to 95 MHz. See figure 2.

Next, the RF power should be adjusted to achieve the maximum required diffraction Efficiency*. This device has been produced and tested to meet or exceed the specifications.

*Note: The combined power of all of the frequencies applied to the deflector cannot, exceed 2 watts, NEOS will not warranty any failure resulting from the application of too much RF power. Also, when producing multiple beams, the RF power applied must be below 250 mW for each frequency in order to keep the inter-modulation frequencies from producing unwanted light between the desired beam positions.
Figure 1
AOBD Bragg Angle Adjustment

Figure 2
AOBD Field Flatness Test Setup
SECTION VII
CLEANING PROCEDURE

Periodic cleaning of the AOBD's optical windows is a normal part of maintaining an optical system. When the AOBDs are installed in an optical system, make sure that there is access to allow removal of the AOBDs and mounts from the system. When removed from the system, follow the alignment procedure in this manual to reinstall, realign and, adjust the AOBDs. Make sure that the AOBDs are reinstalled in the correct position as the devices are unidirectional.

To clean the AOBD device, remove the screws that hold the cover to the device. Caution must be used when placing a screw driver near the window opening in the cover, as it is best to protect the opening with tape or cover the opening with your finger (without touching the crystal) to protect it. NEOS will not warrant any damage or scratches caused by inserting the screwdriver into the window opening.

- Remove the protective cover.
- Blow off any visible dust with canned air. Do not use an air gun unless it is filtered and water and oil free!
- Fold (4 times) a new lens tissue into a triangle to make a cleaning tool.
- Dip the tip of the lens tissue into fresh acetone or spray fresh acetone from a squeeze bottle onto it. Then shake excess fluid out of the lens tissue. Do not handle the wet area of the tissue, as your finger oil will be absorbed and contaminate the optical surface of the crystal.
- Wipe (only once) across the crystal window in an even motion, starting near the transducer and drawing the tissue across the optical surface toward the other end. Do not damage the bond wires! Do not reuse the tissue as the mounting silver epoxy may be spread onto the window of the crystal.
- Repeat with a new tissue each time and for each surface that needs cleaning.
- Replace the AOBD mount and screws.
- Realign the AOBDs in your system and adjust the Bragg angle for maximum diffraction efficiency.

Notes:

- The lens tissue must be lint free and the best grade available.
- Only use each tissue once, for only one surface. Do not reuse the tissue, as it will redistribute the removed dust or mounting silver epoxy.
- The acetone must be electronic grade. The acetone must be fresh from a new bottle, as the acetone will absorb water from the air and cause streaks. Discard any acetone, which has been exposed to the air for more than 4 hours. If the bottle is half-empty, do not use.