



AGV-HP(O) 2-Axis Galvo Scanner Hardware Manual

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United States (World Headquarters)	
Email: Support@aerotech.com Phone: +1-412-967-6440 Fax: +1-412-967-6870	101 Zeta Drive Pittsburgh, PA 15238-2811 www.aerotech.com
United Kingdom	China
Email: Support@aerotech.com Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649	Email: Support@aerotech.com Phone: +86 (21) 5508 6731
Germany	Taiwan
Email: Support@aerotech.com Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720	Email: Support@aerotech.com Phone: +886 (0)2 8751 6690
France	
Email: Support@aerotech.com Phone: +33 2 37 21 87 65	

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Table of Contents

AGV-HP(O) 2-Axis Galvo Scanner Hardware Manual	1
Table of Contents	3
List of Figures	4
List of Tables	5
Safety Procedures and Warnings	6
Laser Safety	7
Classes of Lasers	7
Laser Area	8
Laser Shutter	8
EU Declaration of Incorporation	10
Chapter 1: Overview	11
1.1. Environmental Specifications	16
1.2. Accuracy and Temperature Effects	17
1.2.1. Power-On Thermal Drift	17
1.3. Basic Specifications	18
1.4. Vacuum Operation	20
Chapter 2: Mechanical Specifications and Installation	21
2.1. Unpacking and Handling the Scan Head	21
2.2. Dimensions	23
2.3. Securing the Scan Head to the Mounting Surface	37
2.4. Attaching the Focal Lens to the Scan Head	39
2.5. Air Requirements	41
2.6. Water Requirements	42
Chapter 3: Electrical Specifications and Installation	43
3.1. Motor and Feedback Connectors	44
3.2. Motor and Feedback Wiring	46
3.3. Motor and Feedback Specifications	48
3.4. Limits, Marker, and Machine Direction	49
3.5. Motor and Feedback Phasing	51
Chapter 4: Maintenance	53
4.1. Service and Inspection Schedule	53
4.2. Cleaning and Lubrication	54
4.2.1. Focal Lens and Protective Glass	54
4.2.2. Turning Mirrors	56
4.3. Troubleshooting	57
Appendix A: Warranty and Field Service	59
Appendix B: Revision History	61
Index	63

List of Figures

Figure 1-1:	Functional Principle of a 2-Axis Galvanometer Scanner	11
Figure 1-2:	Standard AGV-HP	12
Figure 1-3:	Standard AGV-HPO	12
Figure 2-1:	AGV10HP-BE1 Galvanometer Scanner Dimensions	23
Figure 2-2:	AGV10HP-BE2 Galvanometer Scanner Dimensions	24
Figure 2-3:	AGV10HPO-BE1 Galvanometer Scanner Dimensions	25
Figure 2-4:	AGV10HPO-BE2 Galvanometer Scanner Dimensions	26
Figure 2-5:	AGV14HP-BE1 Galvanometer Scanner Dimensions	27
Figure 2-6:	AGV14HP-BE2 Galvanometer Scanner Dimensions	28
Figure 2-7:	AGV14HPO-BE1 Galvanometer Scanner Dimensions	29
Figure 2-8:	AGV14HPO-BE2 Galvanometer Scanner Dimensions	30
Figure 2-9:	AGV20HP-BE1 Galvanometer Scanner Dimensions	31
Figure 2-10:	AGV20HP-BE2 Galvanometer Scanner Dimensions	32
Figure 2-11:	AGV20HPO-BE1 Galvanometer Scanner Dimensions	33
Figure 2-12:	AGV20HPO-BE2 Galvanometer Scanner Dimensions	34
Figure 2-13:	AGV30HP-BE1 Galvanometer Scanner Dimensions	35
Figure 2-14:	AGV30HPO-BE1 Galvanometer Scanner Dimensions	36
Figure 2-15:	Example of F-Theta Lens (Complete Assembly)	39
Figure 2-16:	Assembly of Focal Lens to Scan Head (AGV-HP(O))	40
Figure 2-17:	Air-Cooling (-AC) Locations	41
Figure 2-18:	Water Cooling (-WC) Locations	42
Figure 3-1:	Motor and Feedback Wiring	47
Figure 3-2:	-BE1 Galvo X-Axis Machine Direction (front)	49
Figure 3-3:	-BE1 Galvo Y-Axis Machine Direction (side)	49
Figure 3-4:	-BE2 Galvo X-Axis Machine Direction (front)	50
Figure 3-5:	-BE2 Galvo Y-Axis Machine Direction (side)	50
Figure 3-6:	Analog Encoder Phasing Reference Diagram	51

List of Tables

Table 1-1: Ordering Options	13
Table 1-2: F-Theta Lens Options(1,2,3,4)	14
Table 1-3: Environmental Specifications	16
Table 1-4: AGV-HP(O) Series Specifications	18
Table 1-5: AGV-HP(O) Series Mirror Specifications	19
Table 3-1: Motor and Feedback Connector Pinouts	45
Table 3-2: Mating Connector Part Numbers for the Motor and Feedback Connector	45
Table 3-3: Aerotech Motor and Feedback Cable Part Numbers	46
Table 3-4: Wire Gauge and Insulation Specifications	46
Table 3-5: Motor and Feedback Specifications	48
Table 4-1: Troubleshooting	57

Safety Procedures and Warnings



This manual tells you how to carefully and correctly use and operate the AGV-HP(O).

- Read all parts of this manual before you install or operate the AGV-HP(O) or before you do maintenance to your system.
- To prevent injury to you and damage to the equipment, obey the precautions in this manual.



If you do not understand the information in this manual, contact Aerotech Global Technical Support.

NOTE: Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to www.aerotech.com for the most up-to-date information.



DANGER: Reduce the possibility of electrical shock, bodily injury, or death. This product contains potentially lethal voltages.



- Operators must be trained before operating this equipment.
- All service and maintenance must be performed by qualified personnel.
- Disconnect electrical power before servicing equipment.
- Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
- Restrict access to the AGV-HP(O) and component parts while the AGV-HP(O) is connected to a power source.
- All components must be properly grounded in accordance with local electrical safety requirements.
- Operator safeguarding requirements must be addressed during final integration of the product.



DANGER: Lasers.



- Wear eye protection.
- Be aware of the possibility of visible and/or invisible laser radiation. Avoid eye or skin exposure to direct or scattered radiation.



DANGER: Compressed Air.



- Wear eye protection when in the proximity of compressed air components.
- The noise from some compressed air components could be loud enough to require ear protection.



WARNING: To prevent damage to the equipment:

- Operators must be trained before operating this equipment.
- All service and maintenance must be performed by qualified personnel.
- Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.

- Use care when moving the AGV-HP(O). Lifting or transporting the AGV-HP(O) improperly can result in injury or damage to the AGV-HP(O).
- The AGV-HP(O) must be mounted securely. Improper mounting can result in injury and damage to the equipment.



WARNING: Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.



WARNING: Wear clean, powder-free gloves when you handle optical components.

Laser Safety

It is the responsibility of the user to provide the necessary conditions for safe operation of a laser system and to safeguard the surrounding area against the hazards that can be caused by laser radiation. The user must ensure compliance with all local and national regulations.


Although the scan head by itself does not emit laser radiation, the user must undertake a thorough analysis of system safety before operating the AGV-HP(O) in conjunction with a laser source. Important information for performing this analysis is presented in this manual. Additional information may be found in the corresponding documentation supplied by the manufacturer of the laser source.

Classes of Lasers

The AGV-HP(O) series scan head can be used with a variety of lasers. Each laser is assigned a particular hazard level, which is indicated by the Laser Class label that is affixed to the device near the location where laser radiation is emitted. Brief descriptions of each of the various radiation classes are presented in the table below.

Note that in addition to the dangers of radiation, lasers may pose further dangers, such as the risk of electrical shock or the generation of poisonous fumes.

Classifications of Laser Devices

	Class	Danger
	Class I	Inherently safe; no possibility of eye damage during normal operation.
	Class IIa	Requires in excess of 1000 seconds of continuous viewing to cause eye damage.
	Class II	The blink reflex will prevent eye damage, unless the person deliberately stares into the beam for an extended period of time.
	Class IIIa	Mostly dangerous in combination with optical instruments which change the beam diameter or power density. However, even without optical enhancement, direct contact for over two minutes may cause eye damage.
	Class IIIb	Direct exposures of 0.01 second or less may cause eye and skin damage.
	Class IV	Direct or scattered radiation without optical enhancement may cause eye and skin damage.

Laser Area

The area in which the maximum permitted radiation value can be exceeded is defined as the laser area. In general, a laser area is applicable to Class IIIa, IIIb and IV laser systems. A laser area may also be produced by focusing the beam of a Class I, IIa, or II laser device.

The AGV-HP(O) has the capability of aiming the laser beam over an approximately pyramidal volume. When the scan head is used in conjunction with a laser device capable of generating a sufficiently intense beam, a laser area will be produced that includes the aiming volume as well as the reflections from all objects that can be exposed to the radiation. It is important to note that even apparently diffuse surfaces can reflect laser radiation and a laser beam that has been reflected several times can still be dangerous.

The laser area must be designated by suitable warning signs or lamps and protected by appropriate shading and interlock switches.

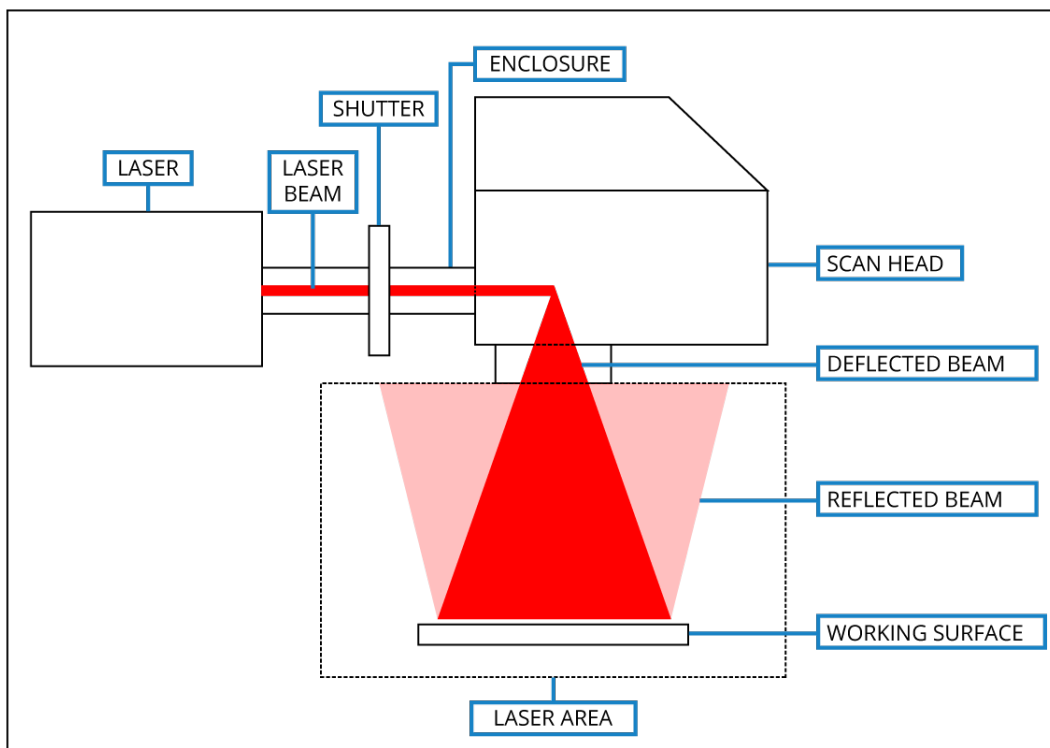


Figure 1: Laser Area of an AGV-HP(O) Scan Head

Laser Shutter

A laser attenuator (beam shutter) is a mechanical or electrical device that blocks the emission of laser radiation. It is a requirement for most classes of laser systems. The attenuator must be available for use at all times during operation of the laser system. Power switches and key controls do not satisfy the attenuator requirement.

The AGV-HP(O) scan head does not include a laser attenuator, and therefore it cannot block or weaken the laser beam. Due to the unique properties of each laser, it is the user's responsibility to incorporate an appropriate shutter as per any and all applicable regulations in order to prevent unwanted emission of the laser beam.

The beam shutter should be fitted between the laser source and the scan head (refer to [Figure 1](#)).



WARNING: Do not stare into the laser beam, place your body parts in the beam path, or expose yourself to reflections from powerful beams.



WARNING: Only a Class 1 HeNe laser is recommended for performing alignments. If this is not possible, use the lowest power setting on the available laser and employ remote beam sensing techniques.



WARNING: Wear eye protection. The danger to your eyes increases when optical instruments are used in conjunction with the scan head.

EU Declaration of Incorporation

Manufacturer: Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238-2811
USA

herewith declares that the product:
AGV-HP(O) Scan Head

is intended to be incorporated into machinery to constitute machinery covered by the Directive 2006/42/EC as amended;

and that the following harmonized European standards have been applied:

EN ISO 12100:2010

Safety of machinery - Basic concepts, general principles for design

EN 60204-1:2010

Safety of machinery - Electrical equipment of machines - Part 1: General requirements

and further more declares that

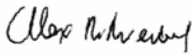
it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, for example, as a whole, including the equipment referred to in this Declaration.

This is to certify that the aforementioned product is in accordance with the applicable requirements of the following Directive(s):

EU 2015/863

RoHS 3 Directive

Authorized Representative: Simon Smith, European Director
Address: Aerotech Ltd
The Old Brick Kiln, Ramsdell, Tadley
Hampshire RG26 5PR
UK

Name  / Alex Weibel
Position Engineer Verifying Compliance
Location Pittsburgh, PA
Date 7/1/2020



Chapter 1: Overview

A 2-axis galvanometer scanner is used to deflect a laser beam in the X and Y directions. The laser can be directed to any position within the two-dimensional area, which is called the “marking field”. Deflection of the laser beam is accomplished by two mirrors, each of which is actuated by a galvano motor. Every scan head includes a beam entrance aperture, into which the laser beam is fed, and a beam exit aperture, through which the laser beam is emitted from the unit after deflection. Only suitable lasers of the appropriate wavelength, power level, beam diameter, etc., may be fed into the beam entrance aperture. Contact the factory for mirror and coating details. Depending on the options selected for the particular scan head, the beam exit aperture may be either open or fitted with a focal lens.

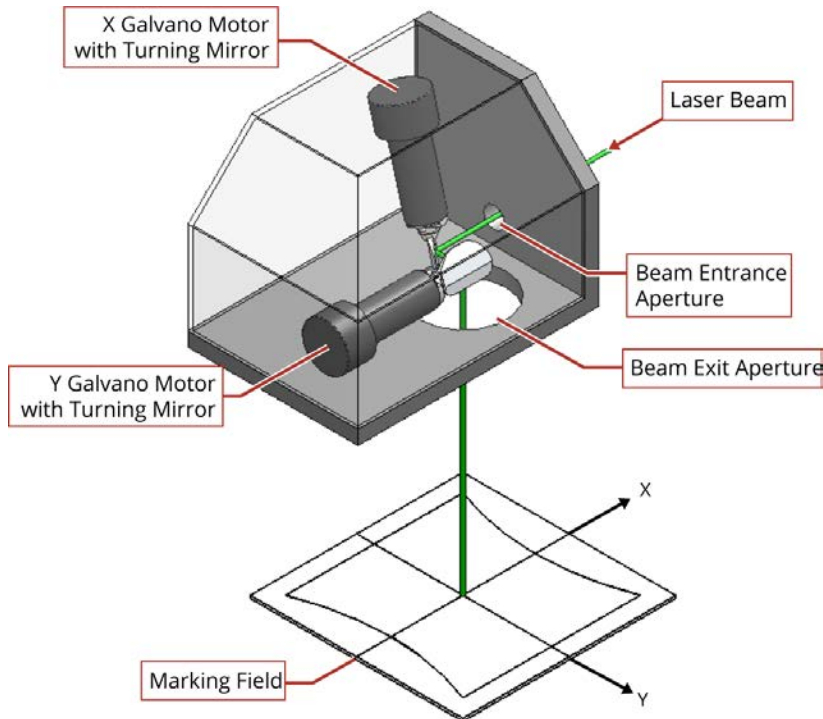


Figure 1-1: Functional Principle of a 2-Axis Galvanometer Scanner

Integration Flexibility

Most scanner control interfaces are on the same surface as the laser input aperture which can create interference problems if the laser beam path approaches the scanner from the top. The AGV-HP(O) control connections are two 25-pin D-style connectors. The scanner cables can be oriented in any direction and terminated on the machine to ensure there is no interference with beam delivery. The AGV-HPO is also available with right-side and left-side input apertures for “mirror image” machine builds or side-by-side scanner mounting with a single laser beam split to source both scanners.

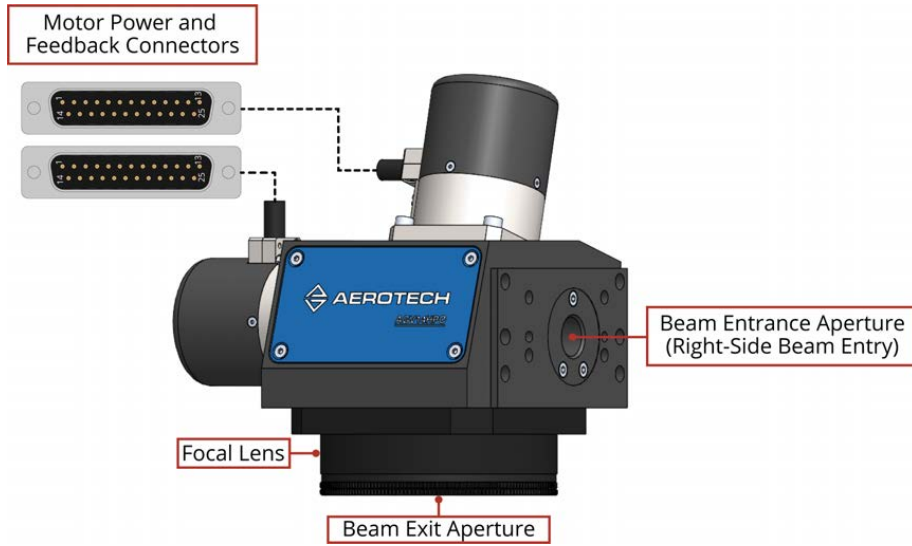


Figure 1-2: Standard AGV-HP

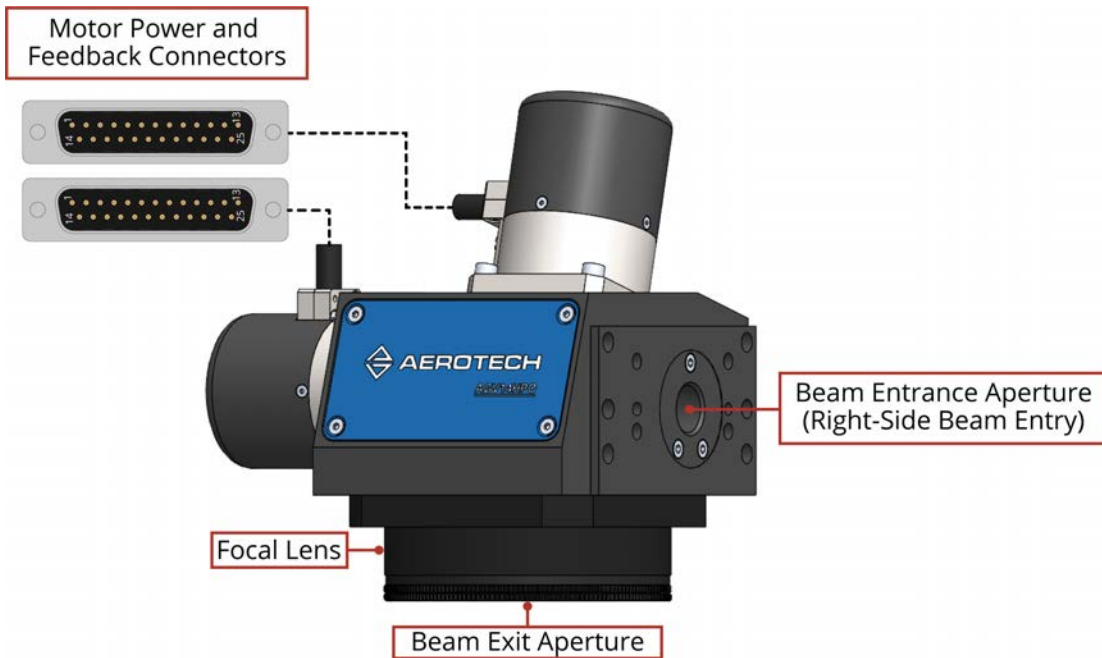


Figure 1-3: Standard AGV-HPO

Table 1-1: Ordering Options

AGV-HP(O) Series High Performance Galvanometer Scanner				
AGV10HP	2-axis galvanometer scanner with 10 mm diameter beam aperture and integral high-precision feedback			
AGV14HP	2-axis galvanometer scanner with 14 mm diameter beam aperture and integral high-precision feedback			
AGV20HP	2-axis galvanometer scanner with 20 mm diameter beam aperture and integral high-precision feedback			
AGV30HP	2-axis galvanometer scanner with 30 mm diameter beam aperture and integral high-precision feedback			
Housing Type (Required)				
-	Closed scanner housing (AGVxxHP)			
O	Open scanner housing (AGVxxHPO)			
Beam Entry Orientation (Required)				
	AGV10HP(O)	AGV14HP(O)	AGV20HP(O)	AGV30HP(O)
-BE1	Right-side (standard)	Right-side (standard)	Right-side (standard)	Right-side (standard)
-BE2	Left-side	Left-side	Left-side	N/A
Wavelength of Mirror Coating ⁽¹⁾ (Required)				
	AGV10HP(O)	AGV14HP(O)	AGV20HP(O)	AGV30HP(O)
-W001	10.6 μm			
-W002	Durable Silver (450 nm-10.6 μm)			
-W003	1552 nm			
-W004	1064 nm			
-W005	1030 nm			
-W006	532 nm			
-W007	515 nm			
-W008	355 nm			
-W009	343 nm			
-W012	9.3 μm			
NOTE: Custom coatings available. Contact factory for details.				
F-Theta Lenses Available (Optional)				
-Lxx	See Table 1-2 for standard F-Theta Lens options			
Mounting Plate (Optional)				
-MP	Mounting plate			
Air Cooling (Optional, refer to Section 2.5.)				
-AC	Air cooling			
Water Cooling (Optional, refer to Section 2.6.)				
-WC	Water cooling			

Table 1-2: F-Theta Lens Options^(1,2,3,4)

		AGV10HP(O)	AGV14HP(O)	AGV20HP(O)	AGV30HP(O)
-L1	Wavelength	1552 nm	--	10.6 μm	10.6 μm
	Focal Length	100 mm	--	100 mm	255 mm
	Design	Telecentric	--	Telecentric	--
-L2	Wavelength	1552 nm	--	10.6 μm	1064 nm
	Focal Length	163 mm	--	160 mm	200 mm
	Design	Telecentric	--	--	--
-L3	Wavelength	1064 nm	1552 nm	10.6 μm	1064 nm
	Focal Length	100 mm	100 mm	255 mm	255 mm
	Design	Telecentric	Telecentric	--	--
-L4	Wavelength	1064 nm	1552 nm	1064 nm	1064 nm
	Focal Length	100 mm	163 mm	100 mm	500 mm
	Design	Telecentric	Telecentric	Telecentric	--
-L5	Wavelength	1064 nm	1064 nm	1064 nm	--
	Focal Length	160 mm	100 mm	163 mm	--
	Design	--	--	--	--
-L6	Wavelength	1064 nm	1064 nm	1064 nm	--
	Focal Length	163 mm	100 mm	163 mm	--
	Design	Telecentric	Telecentric	Telecentric	--
-L7	Wavelength	1030 nm	1064 nm	1064 nm	--
	Focal Length	100 mm	160 mm	255 mm	--
	Design	Telecentric	--	--	--
-L8	Wavelength	1030 nm	1064 nm	532 nm	--
	Focal Length	163 mm	163 mm	255 mm	--
	Design	Telecentric	Telecentric	--	--
-L9	Wavelength	532 nm	1064 nm	--	--
	Focal Length	100 mm	170 mm	--	--
	Design	--	--	--	--
-L10	Wavelength	532 nm	1030 nm	--	--
	Focal Length	100 mm	100 mm	--	--
	Design	Telecentric	Telecentric	--	--
-L11	Wavelength	532 nm	1030 nm	--	--
	Focal Length	160 mm	163 mm	--	--
	Design	--	Telecentric	--	--
-L12	Wavelength	532 nm	532 nm	--	--
	Focal Length	163 mm	100 mm	--	--
	Design	Telecentric	Telecentric	--	--
-L13	Wavelength	515 nm	532 nm	--	--
	Focal Length	100 mm	160 mm	--	--
	Design	Telecentric	--	--	--

(1) Input beam diameter is assumed to be equal to scan head entrance aperture at $1/e^2$ Gaussian profile.

(2) Reported field-of-view (FOV) sizes are approximate and may be subject to minor variation as a function of the application's laser and optical parameters. Contact factory for details.

(3) Custom lenses available. Contact factory for details.

(4) Certain F-theta lenses are not recommended for use with short-pulse lasers (picosecond and femtosecond pulse durations).

Contact factory for alternate lens options that are compatible with short-pulse lasers.

F-Theta Lens Options (Continued) ^(1,2,3,4)

		AGV10HP(O)	AGV14HP(O)	AGV20HP(O)	AGV30HP(O)
-L14	Wavelength	515 nm	532 nm	--	--
	Focal Length	163 mm	163 mm	--	--
	Design	Telecentric	Telecentric	--	--
-L15	Wavelength	355 nm	532 nm	--	--
	Focal Length	53 mm	170 mm	--	--
	Design	Telecentric	--	--	--
-L16	Wavelength	355 nm	515 nm	--	--
	Focal Length	100 mm	100 mm	--	--
	Design	Telecentric	Telecentric	--	--
-L17	Wavelength	355 nm	515 nm	--	--
	Focal Length	160 mm	163 mm	--	--
	Design	--	Telecentric	--	--
-L18	Wavelength	355 nm	355 nm	--	--
	Focal Length	163 mm	53 mm	--	--
	Design	Telecentric	Telecentric	--	--
-L19	Wavelength	355 nm	355 nm	--	--
	Focal Length	255 mm	163 mm	--	--
	Design	--	Telecentric	--	--
-L20	Wavelength	--	355 nm	--	--
	Focal Length	--	255 mm	--	--
	Design	--	--	--	--
-L21	Wavelength	--	343 nm	--	--
	Focal Length	--	53 mm	--	--
	Design	--	Telecentric	--	--
-L22	Wavelength	--	343 nm	--	--
	Focal Length	--	163 mm	--	--
	Design	--	Telecentric	--	--
-L23	Wavelength	--	343 nm	--	--
	Focal Length	--	255 mm	--	--
	Design	--	--	--	--

(1) Input beam diameter is assumed to be equal to scan head entrance aperture at $1/e^2$ Gaussian profile.

(2) Reported field-of-view (FOV) sizes are approximate and may be subject to minor variation as a function of the application's laser and optical parameters. Contact factory for details.

(3) Custom lenses available. Contact factory for details.

(4) Certain F-theta lenses are not recommended for use with short-pulse lasers (picosecond and femtosecond pulse durations).

Contact factory for alternate lens options that are compatible with short-pulse lasers.

1.1. Environmental Specifications



WARNING: Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.

Table 1-3: Environmental Specifications

Ambient Temperature	The optimal operating temperature is 20° C ±2° C (68° F ±4° F). If at any time the operating temperature deviates from 20° C degradation in performance could occur.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
Humidity	Operating: 20% to 60% RH
	Storage: 10% to 70% RH, non-condensing in original packaging. The stage should be packaged with desiccant if it is to be stored for an extended time.
Altitude	Operating: 0 m to 2,000 m (0 ft to 6,562 ft) above sea level Contact Aerotech if your specific application involves use above 2,000 m or below sea level.
Vibration	Use the system in a low vibration environment. Excessive floor or acoustical vibration can affect system performance. Contact Aerotech for information regarding your specific application.
Protection Rating	The AGV-HP(O) has some protection from contamination due to laser marking and cutting processes. However, the scan head is not sealed. Dust and fumes generated by the laser machining process should be removed via an adequate exhaust or vacuum system. Failure to control this debris could result in damage to the scan head and the focal lens.
Use	Indoor use only

1.2. Accuracy and Temperature Effects

Aerotech products are designed for and built in a 20°C (68°F) environment. Extreme temperature changes could cause a decrease in performance or permanent damage to the AGV-HP(O). At a minimum, the environmental temperature must be controlled to within 0.25°C per 24 hours to ensure the AGV-HP(O) specifications are repeatable over an extended period of time. The severity of temperature effects on all specifications depends on many different environmental conditions, including how the AGV-HP(O) is mounted. Contact the factory for more details.

1.2.1. Power-On Thermal Drift

For the best possible accuracy and repeatability, it is recommended that the +5 V feedback power supply be connected to the galvano motors for a minimum of four hours prior to performing any critical operations with the AGV-HP(O). Application of the feedback power supply can raise the temperature of the galvano motors, resulting in a transient period of "power-on" thermal drift. Allowance for this warm-up period provides the galvano motors sufficient time to achieve thermal equilibrium.

In applications where a mark-and-measure calibration is performed to improve accuracy, it is essential that the calibration procedure not be conducted prior to completion of the warm-up period. Otherwise, the calibration may not be effective due to the change in zero offset that can result from the "power-on" thermal drift.

To minimize delays in operating the AGV-HP(O), it is recommended that the +5 V feedback power supply is continuously maintained to the galvano motors, even when they are not under servo control.

1.3. Basic Specifications

Table 1-4: AGV-HP(O) Series Specifications

	AGV10HP(O)	AGV14HP(O)	AGV20HP(O)	AGV30HP(O)
Optical Performance⁽¹⁾				
Beam Aperture	10 mm	14 mm	20 mm	30 mm
Maximum Scan Angle	±20°			
Beam Displacement	12.6 mm	16.5 mm	23.2 mm	35.7 mm
Feedback Resolution	0.012 μrad (25 bit)			
Dither ⁽²⁾ (Minimum Incremental Motion)	< 0.4 μrad _{RMS}			
Accuracy	50 μrad pk-pk			
Repeatability ⁽³⁾	0.4 μrad _{RMS}			
Gain Error	0.05 mrad			
Non-Linearity	0.005%			
Dynamic Performance				
Tracking Error	0 μsec			
Peak Acceleration ^(4,5)	288,000 m/s ²	224,000 m/s ²	80,000 m/s ²	56,000 m/s ²
Continuous Acceleration ^(4,6)	75,200 m/s ²	56,000 m/s ²	20,800 m/s ²	19,200 m/s ²
Positioning Speed ⁽⁴⁾	75 m/s	75 m/s	50 m/s	50 m/s
Marking Speed ^(4,7,8)	5 m/s			
Jump & Settle Time, 1 mm Move ^(4,9)	270 μsec	270 μsec	450 μsec	700 μsec
Stability				
Long-Term Drift ⁽³⁾	Offset	10 μrad/12 hrs		
		15 μrad/24 hrs		
	Gain	10 ppm/24 hrs		
Thermal Drift	Offset	10 μrad/°C		
	Gain	1 ppm/°C		
Mechanical Specifications				
Mass (AGV-HP)	4.1 kg	4.4 kg	5.1 kg	5.8 kg
Mass (AGV-HPO)	2.5 kg	2.6 kg	2.9 kg	3.1 kg
Material	Aluminum (Black Anodize and Blue Paint)			
Mean Time Before Failure	20,000 Hours			
<p>1. All angles are optical unless otherwise noted.</p> <p>2. Without -AC air cooling option.</p> <p>3. After initial 3 hour warm-up, ambient temperature variation < ±0.5°.</p> <p>4. Typical performance with f = 160 mm F-Theta objective.</p> <p>5. Based on maximum rated current of the motor.</p> <p>6. Based on rated rms current of the motor with -WC water cooling option; maximum continuous acceleration is 70% of this value without water cooling.</p> <p>7. Achievable with <1% velocity error over continuous velocity portion of move.</p> <p>8. Marking speed is dependent on allowable tracking error.</p> <p>9. Settled to within 1% of move distance.</p> <p>All specifications are per axis unless otherwise noted.</p>				

Table 1-5: AGV-HP(O) Series Mirror Specifications

	Cooling Option	AGV-HP(O) Size	Wavelength Coating									
			-W1	-W2	-W3	-W4	-W5	-W6	-W7	-W8	-W9	-W12
Maximum CW Laser Power (W)	No Cooling	AGV10	40	5	40	40	40	10	10	10	10	40
		AGV14	200	25	200	200	200	50	50	50	50	200
		AGV20	300	50	300	300	300	100	100	100	100	300
		AGV30	500	100	500	500	500	150	150	150	150	500
	Air Cooling	AGV10	80	10	80	80	80	20	20	20	20	80
		AGV14	400	50	400	400	400	100	100	100	100	400
		AGV20	600	100	600	600	600	200	200	200	200	600
	Air and Water Cooling	AGV30	1000	200	1000	1000	1000	300	300	300	300	1000
		AGV10	240	30	240	240	240	60	60	60	60	240
		AGV14	1200	150	1200	1200	1200	300	300	300	300	1200
		AGV20	1800	300	1800	1800	1800	600	600	600	600	1800
			AGV30	3000	600	3000	3000	3000	900	900	900	900

1.4. Vacuum Operation

Contact the factory for information regarding operation in a vacuum environment.

Chapter 2: Mechanical Specifications and Installation



WARNING: AGV-HP(O) installation must be in accordance to instructions provided by this manual and any accompanying documentation. Failure to follow these instructions could result in injury or damage to the equipment.



WARNING: Do not stare into the laser beam, place your body parts in the beam path, or expose yourself to reflections from powerful beams.



WARNING: Only a Class 1 HeNe laser is recommended for performing alignments. If this is not possible, use the lowest power setting on the available laser and employ remote beam sensing techniques.



WARNING: Wear eye protection. The danger to your eyes increases when optical instruments are used in conjunction with the scan head.



WARNING: Failure to use the parameter file provided by the factory may result in permanent mechanical damage to the scan head.

2.1. Unpacking and Handling the Scan Head



WARNING: To prevent the accumulation of condensation on the optical surfaces, allow the shipping case to sit at room temperature before you open it.



WARNING: It is the customer's responsibility to safely and carefully lift and move the scan head. Improper handling could adversely affect the performance of the AGV-HP(O)

- Make sure that all moving parts are secure before moving the AGV-HP(O). Unsecured moving parts may shift and cause bodily injury.
- Do not use the cables or tubing as a lift surface.
- Do not use the focal lens or exit aperture as a lift surface.
- Make certain that the lens cap is attached before moving the AGV-HP(O).
- Only put the scan head on a soft surface when it is not attached to its mounting surface to protect the optics.



WARNING: Fingerprints contain aggressive substances that can damage optical surfaces. Always wear suitable gloves when you handle the optics.

Lift only by the base of the scan head.

Carefully remove the AGV-HP(O) from its protective shipping container. Gently set the AGV-HP(O) on a smooth, flat, and clean surface.

Before operating the AGV-HP(O), it is important to let it stabilize outside of the shipping case at room temperature for at least 12 hours. Allowing it to stabilize to room temperature will ensure that all of the alignments, preloads, and tolerances are the same as they were when tested at Aerotech. Use compressed nitrogen or clean, dry, oil-less air to remove any dust or debris that has collected during shipping.

Each AGV-HP(O) has a label listing the system part number and serial number. These numbers contain information necessary for maintaining or updating system hardware and software. Locate this label and record the information for later reference.

2.2. Dimensions

NOTE: All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your Storage Device or at www.aerotech.com.

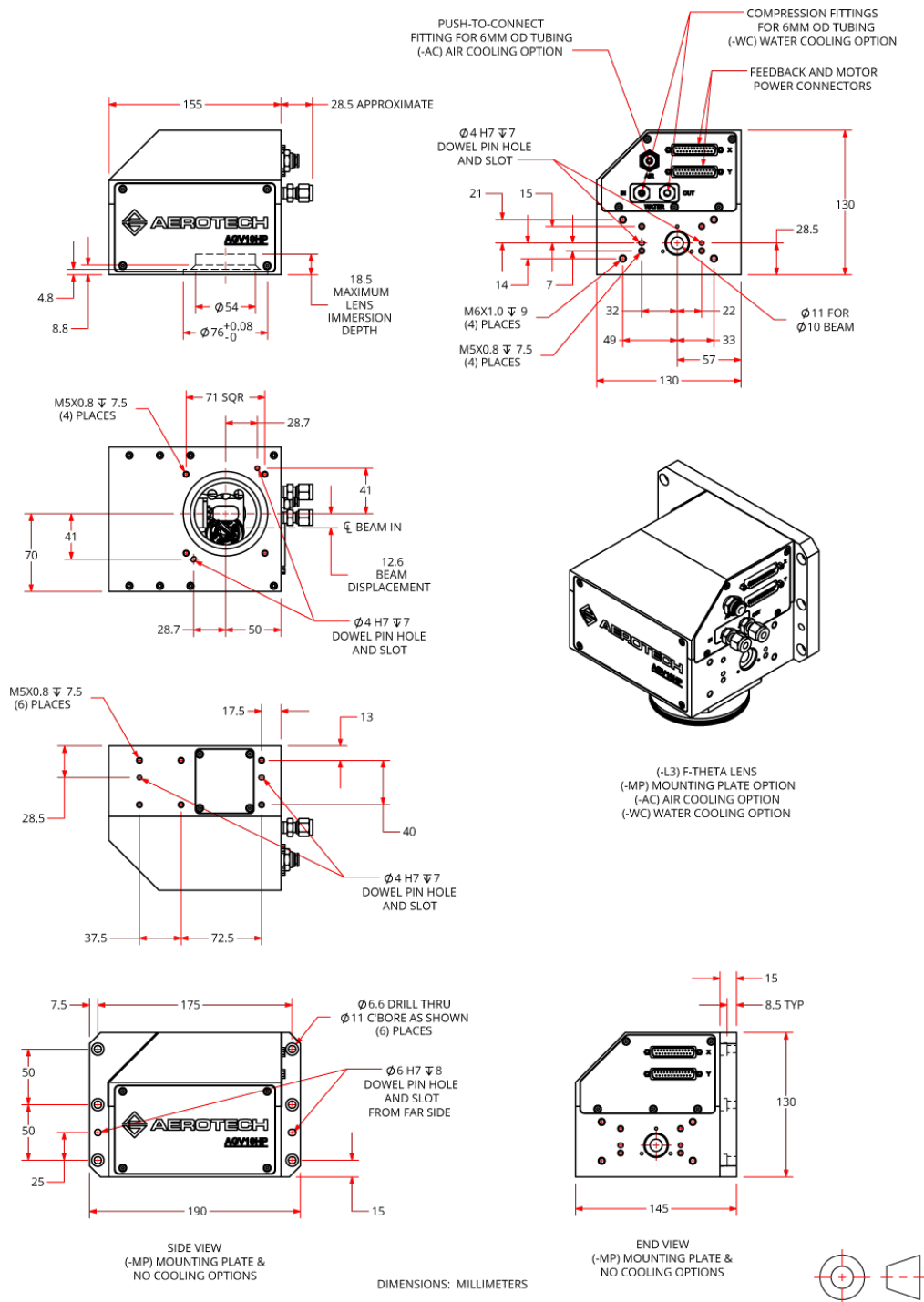


Figure 2-1: AGV10HP-BE1 Galvanometer Scanner Dimensions

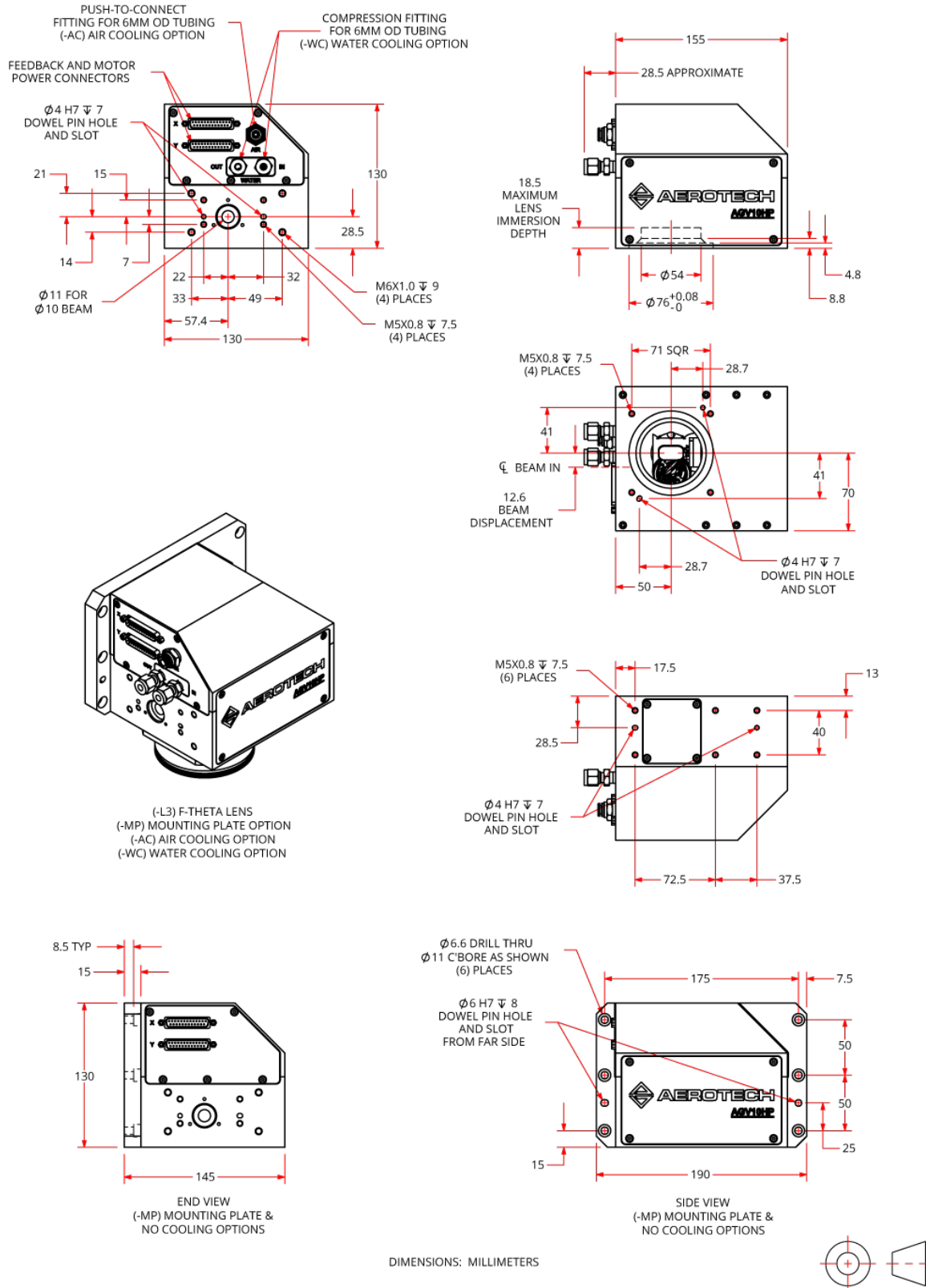


Figure 2-2: AGV10HP-BE2 Galvanometer Scanner Dimensions

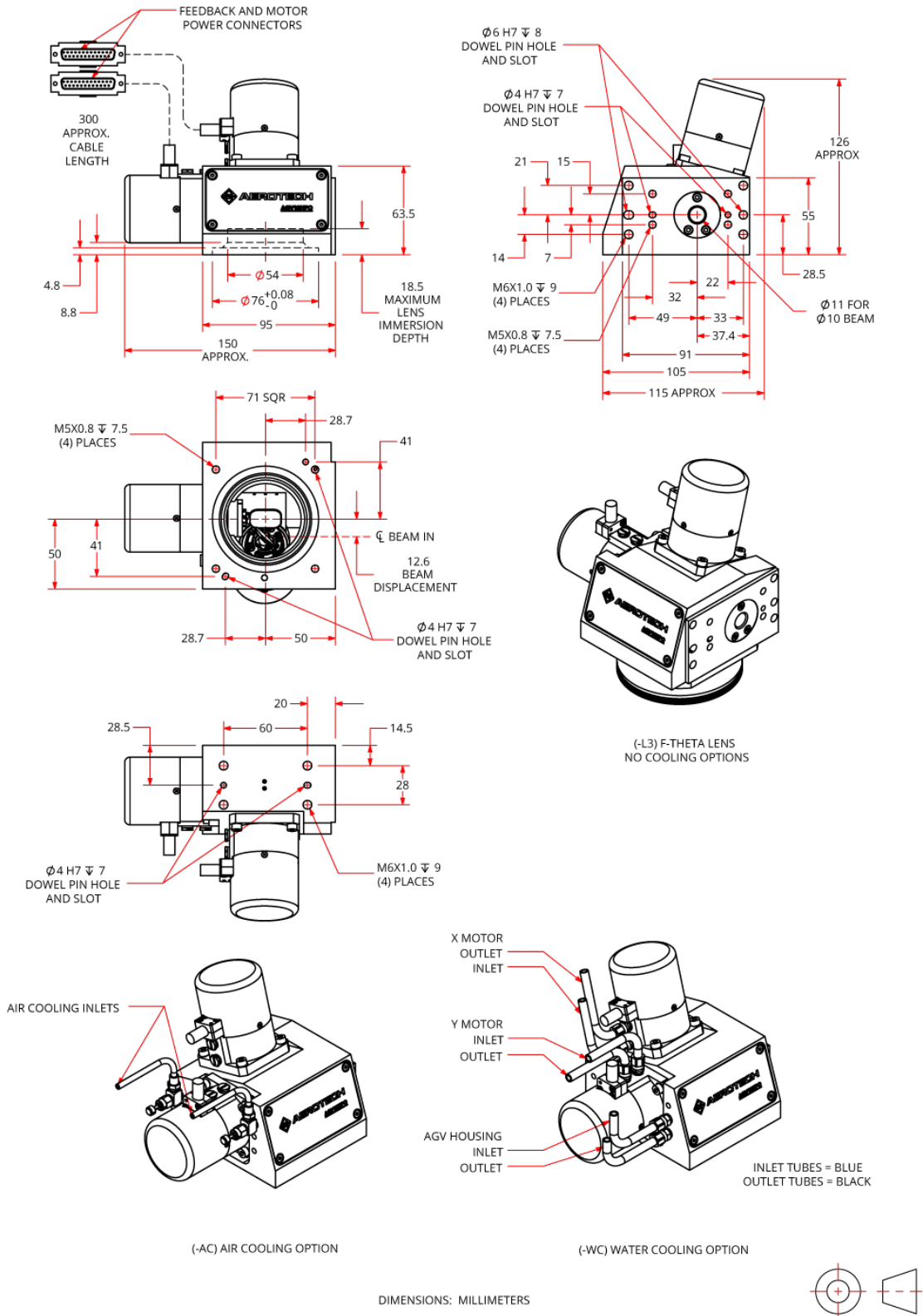
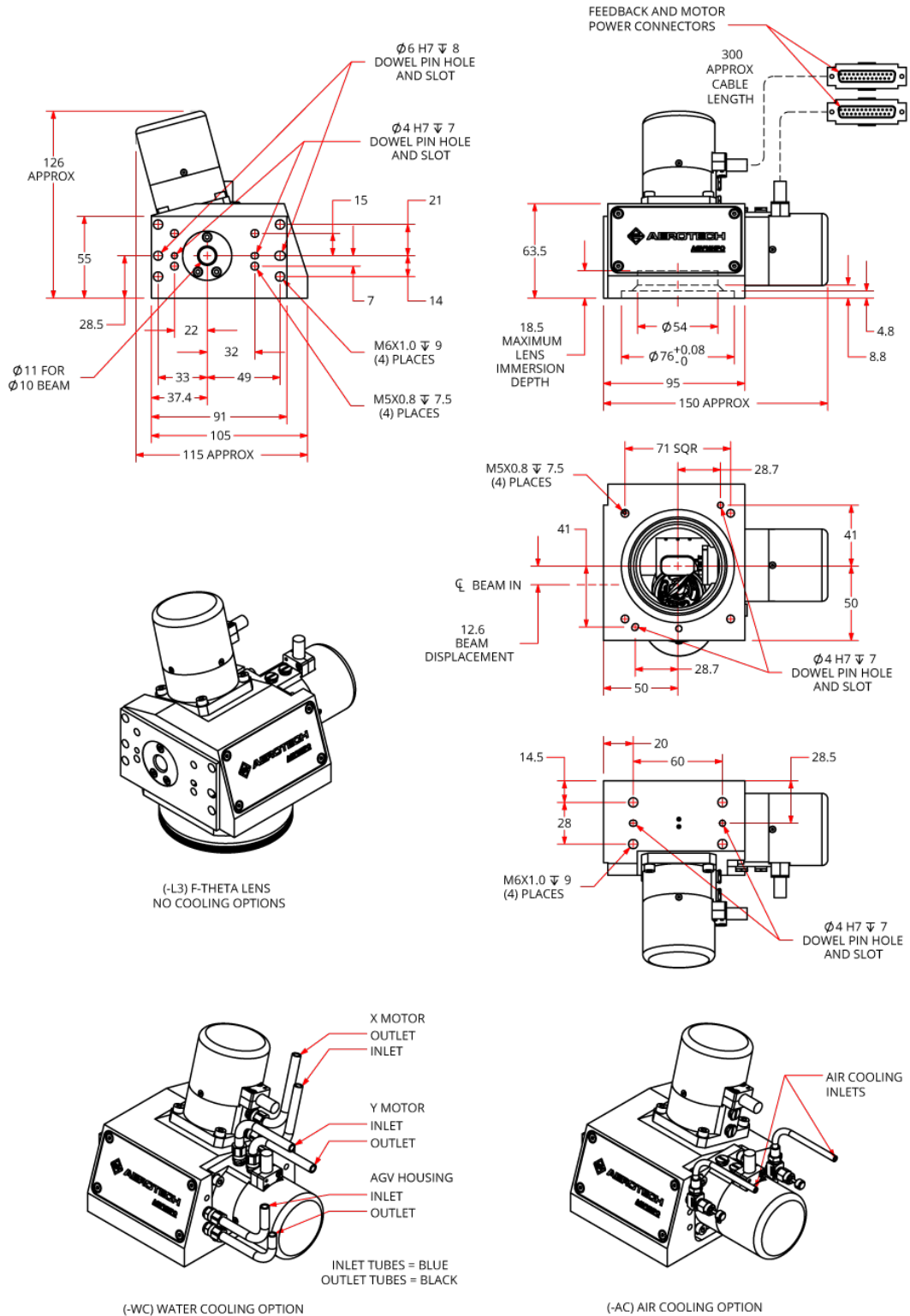


Figure 2-3: AGV10HPO-BE1 Galvanometer Scanner Dimensions



DIMENSIONS: MILLIMETERS

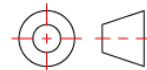


Figure 2-4: AGV10HPO-BE2 Galvanometer Scanner Dimensions

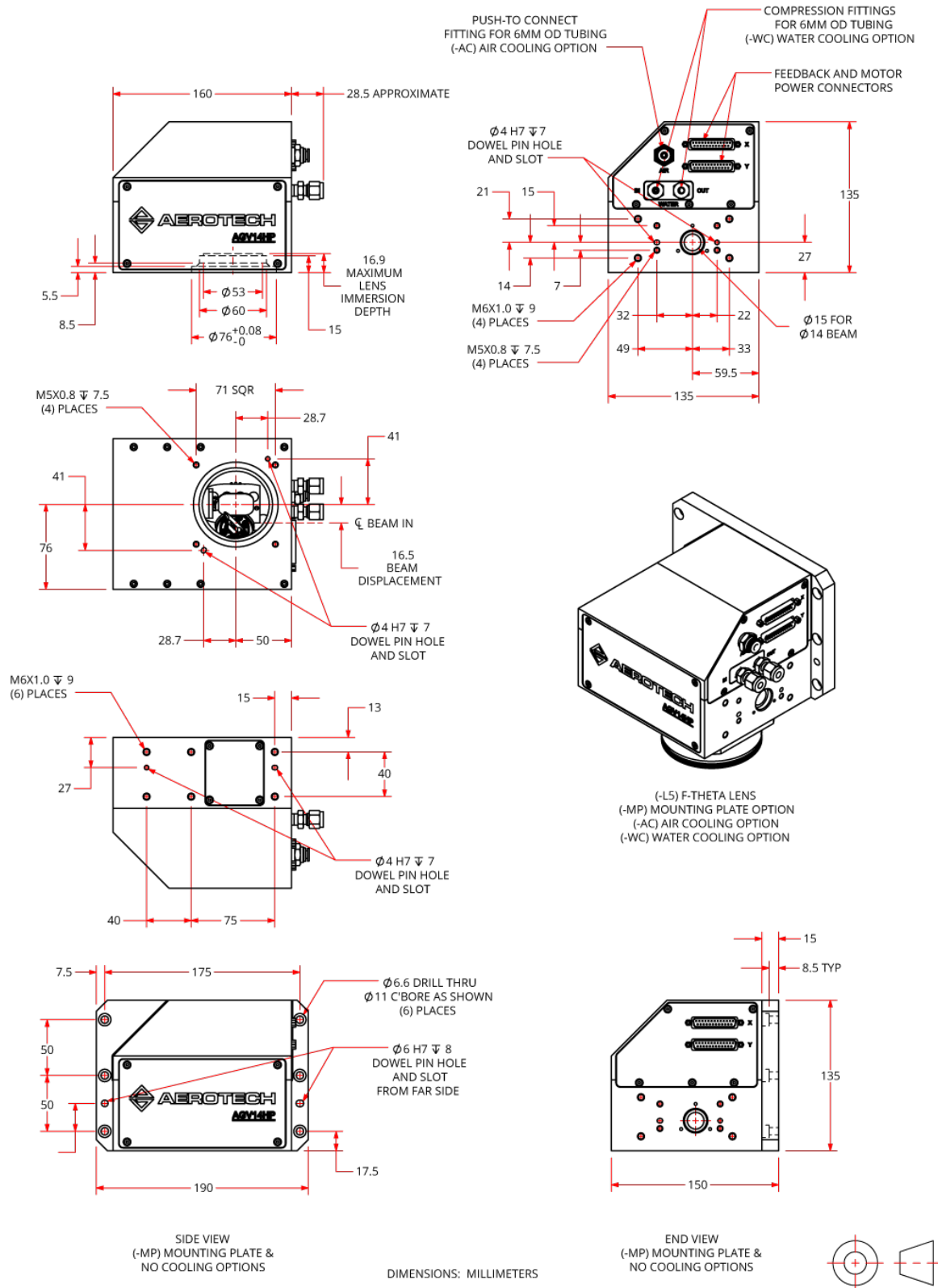
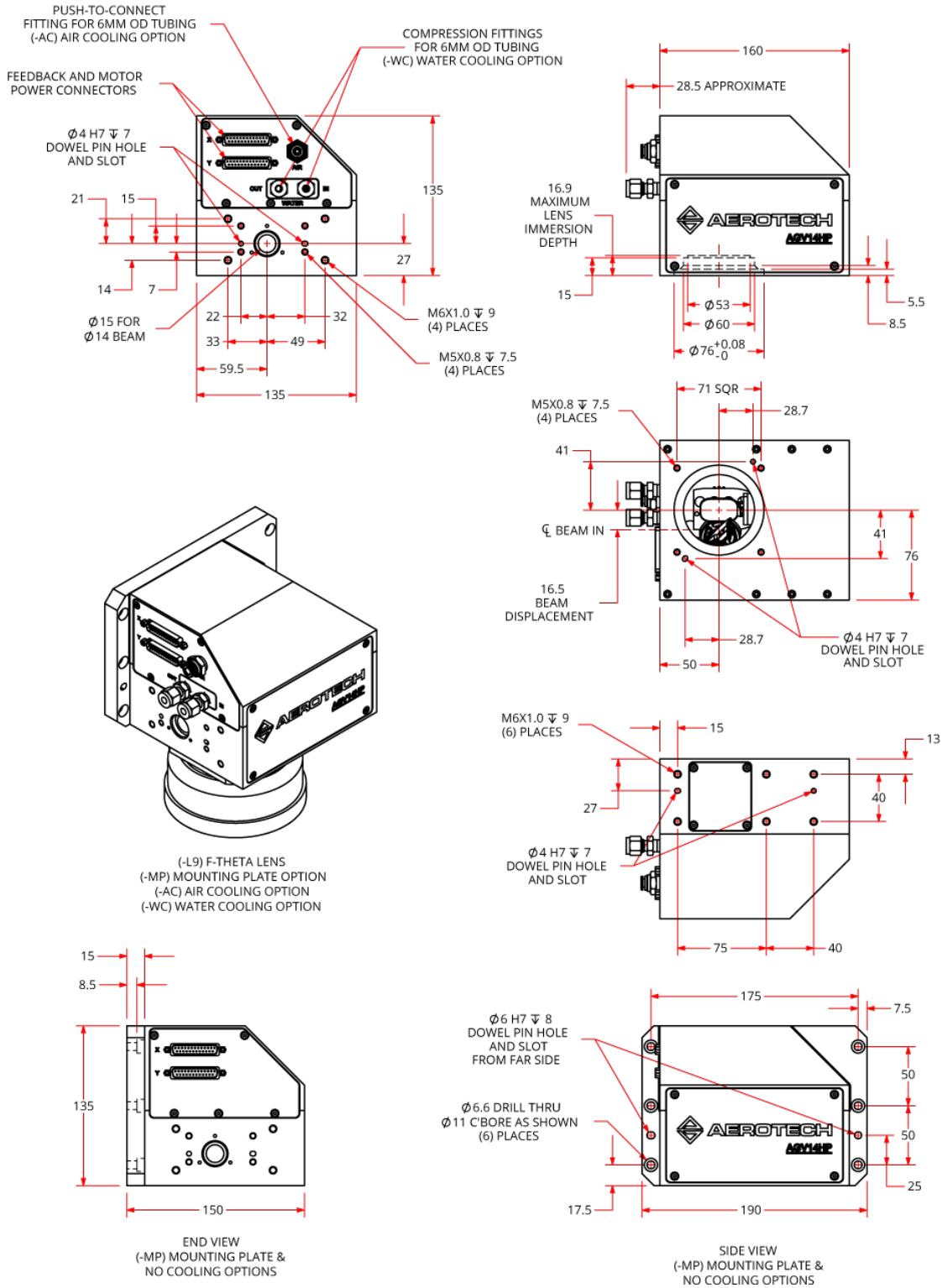


Figure 2-5: AGV14HP-BE1 Galvanometer Scanner Dimensions



DIMENSIONS: MILLIMETERS



Figure 2-6: AGV14HP-BE2 Galvanometer Scanner Dimensions

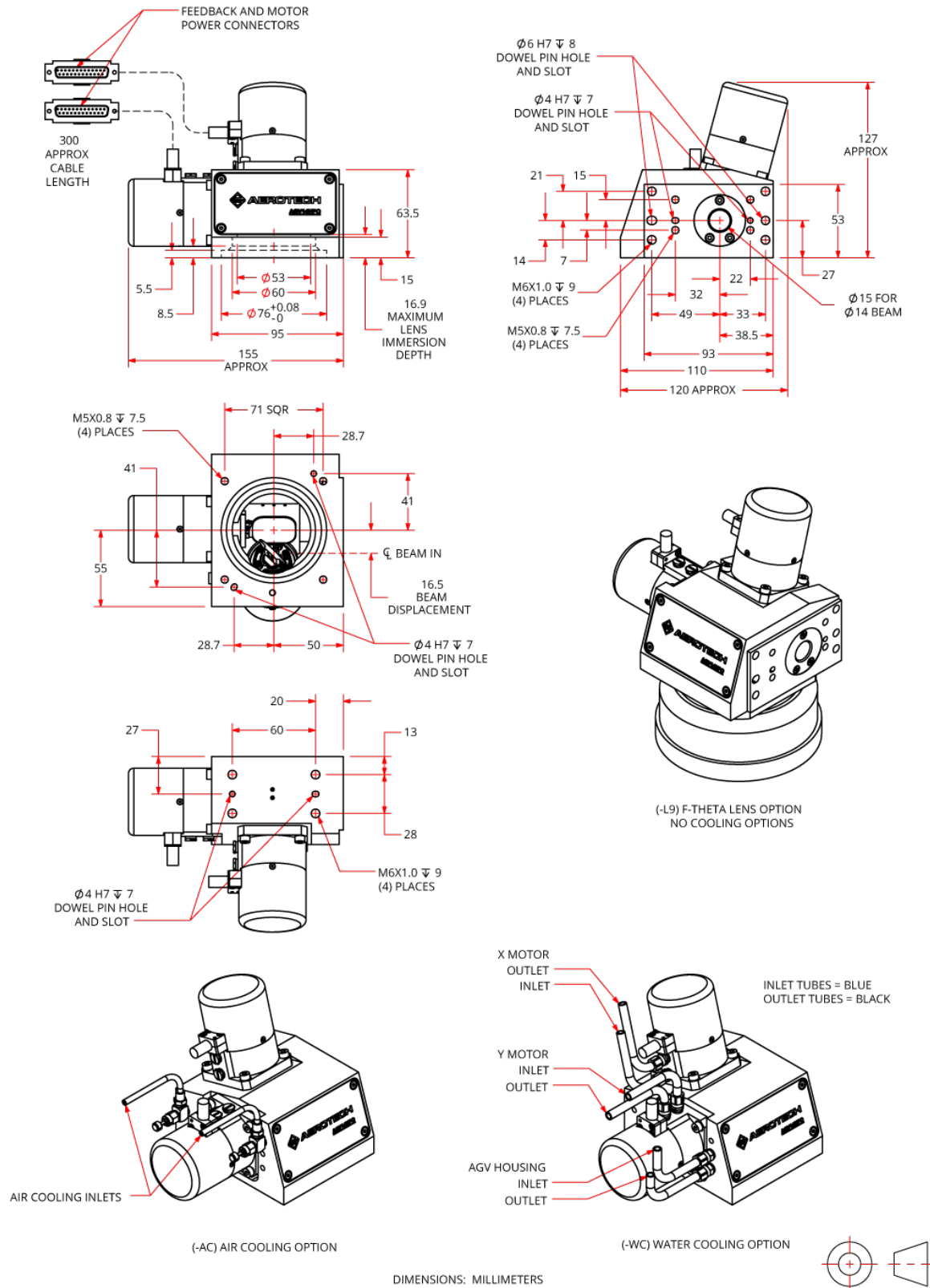


Figure 2-7: AGV14HPO-BE1 Galvanometer Scanner Dimensions

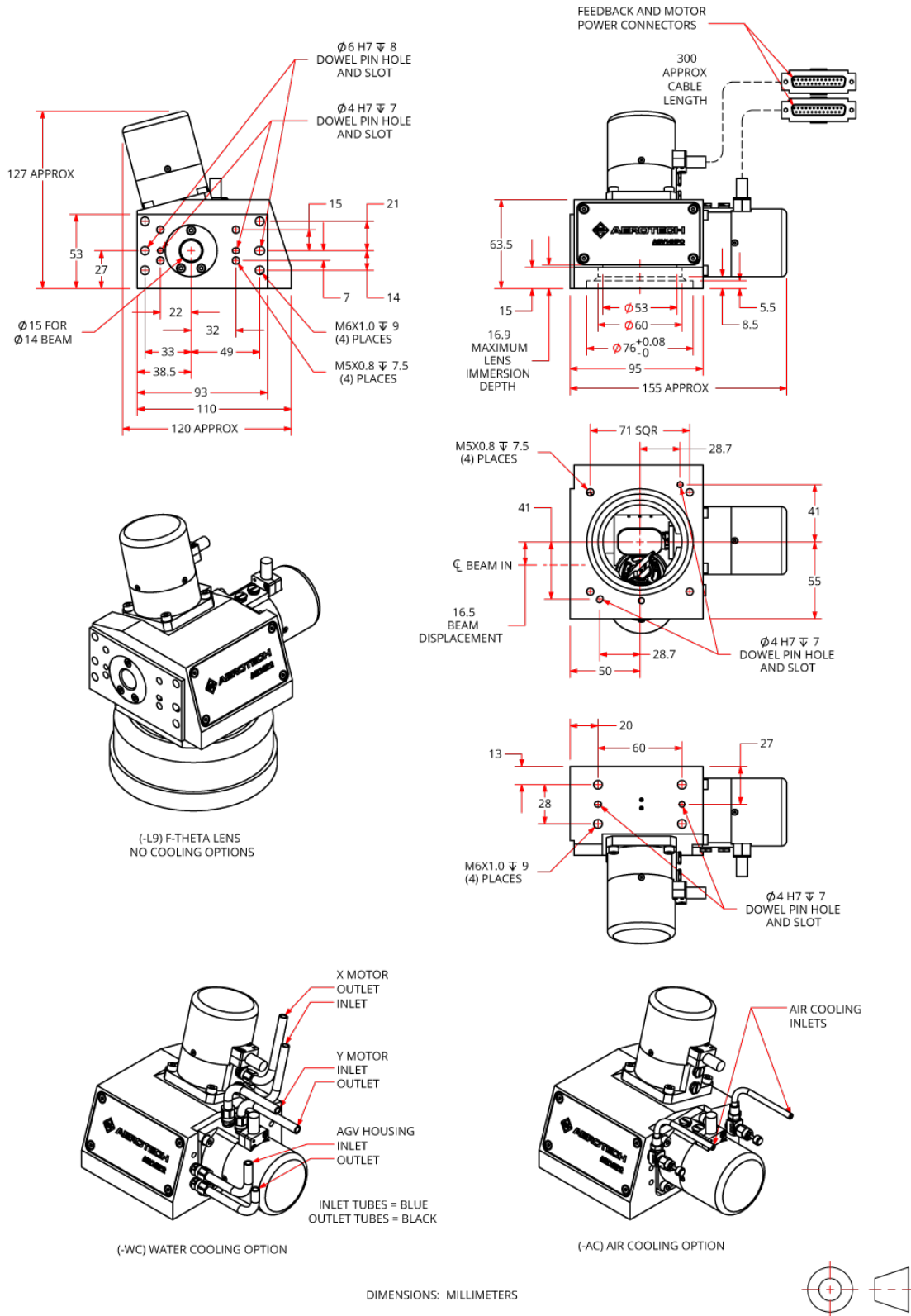


Figure 2-8: AGV14HPO-BE2 Galvanometer Scanner Dimensions

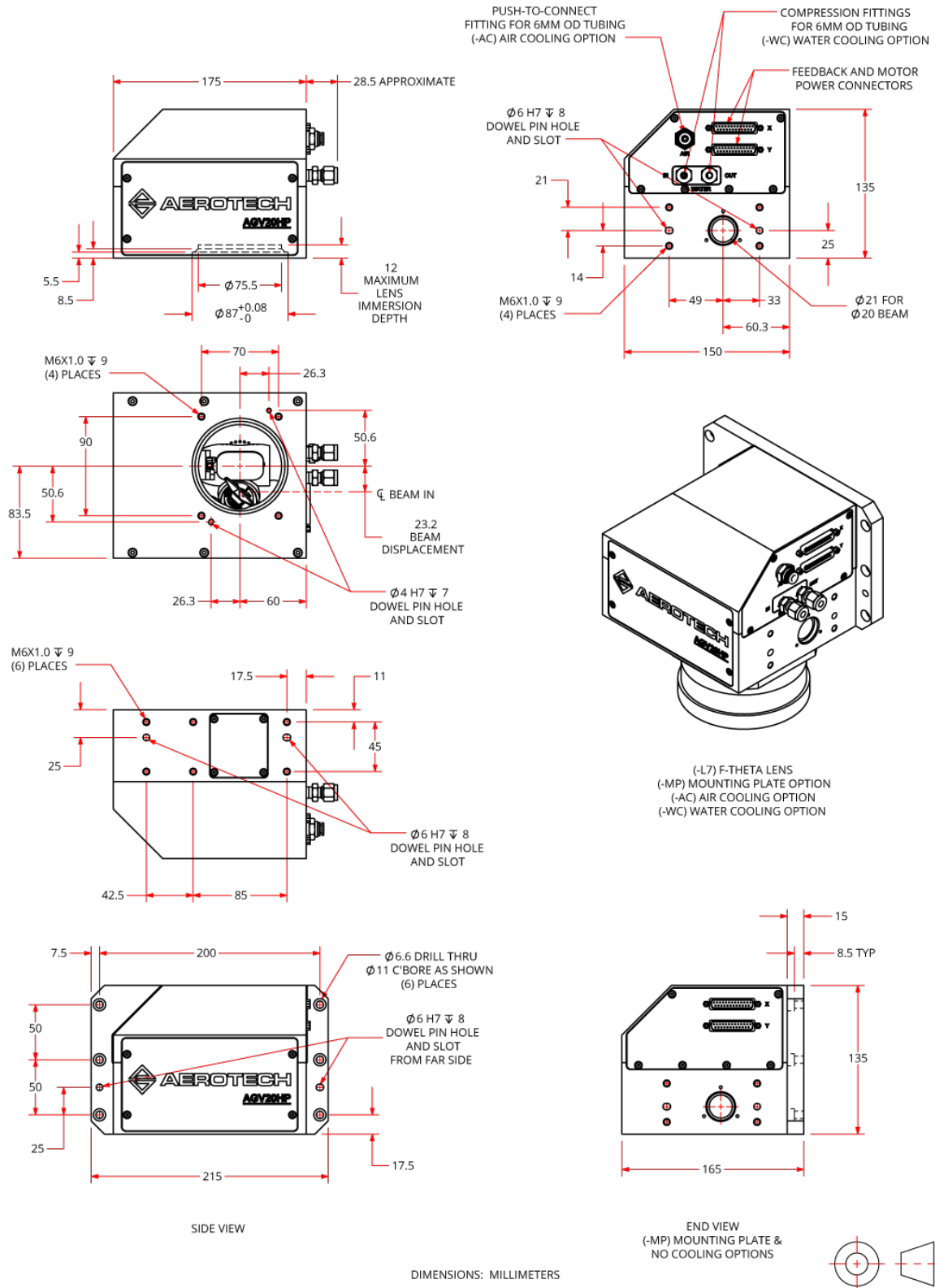


Figure 2-9: AGV20HP-BE1 Galvanometer Scanner Dimensions

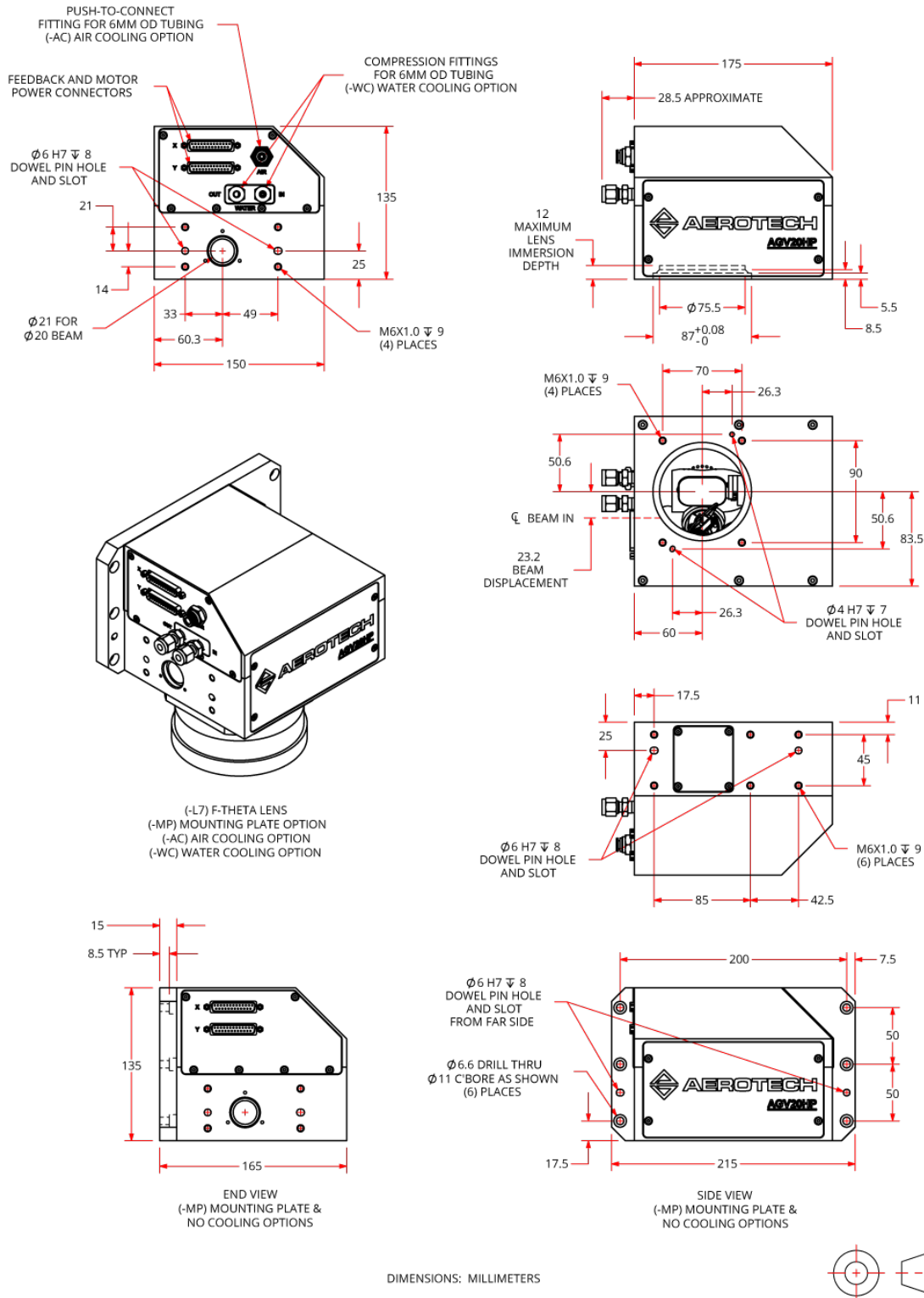


Figure 2-10: AGV20HP-BE2 Galvanometer Scanner Dimensions

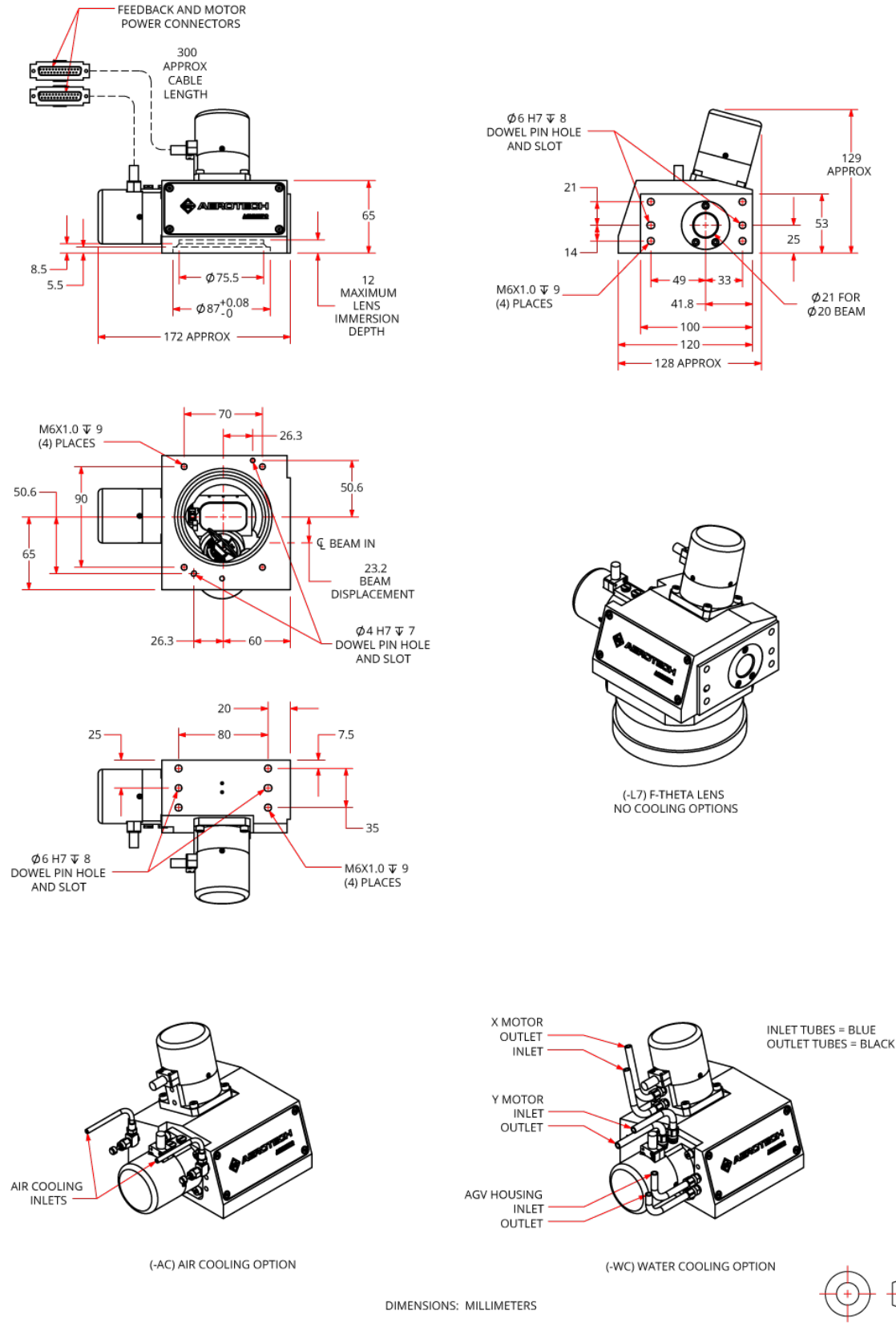


Figure 2-11: AGV20HPO-BE1 Galvanometer Scanner Dimensions

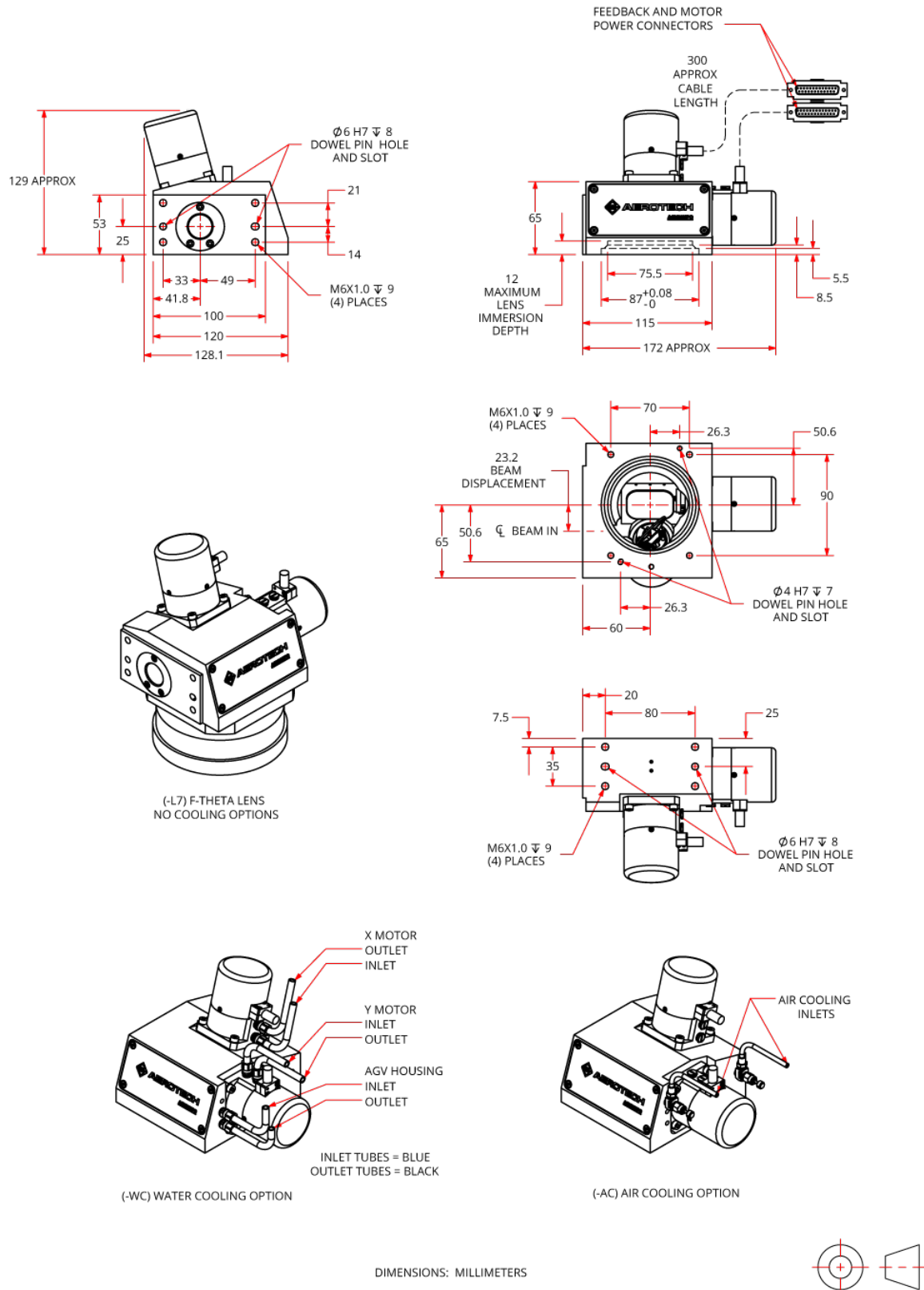


Figure 2-12: AGV20HPO-BE2 Galvanometer Scanner Dimensions

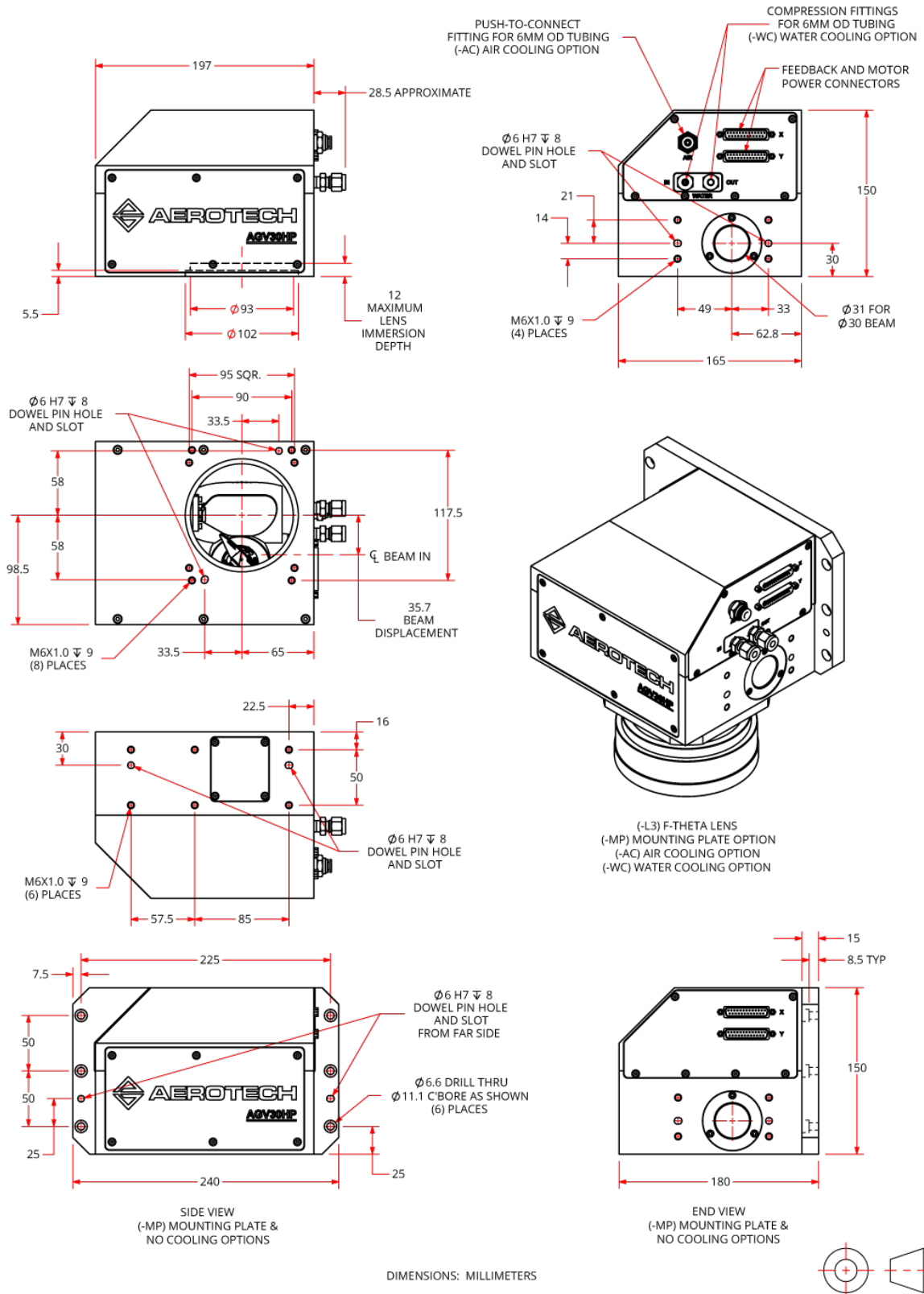


Figure 2-13: AGV30HP-BE1 Galvanometer Scanner Dimensions

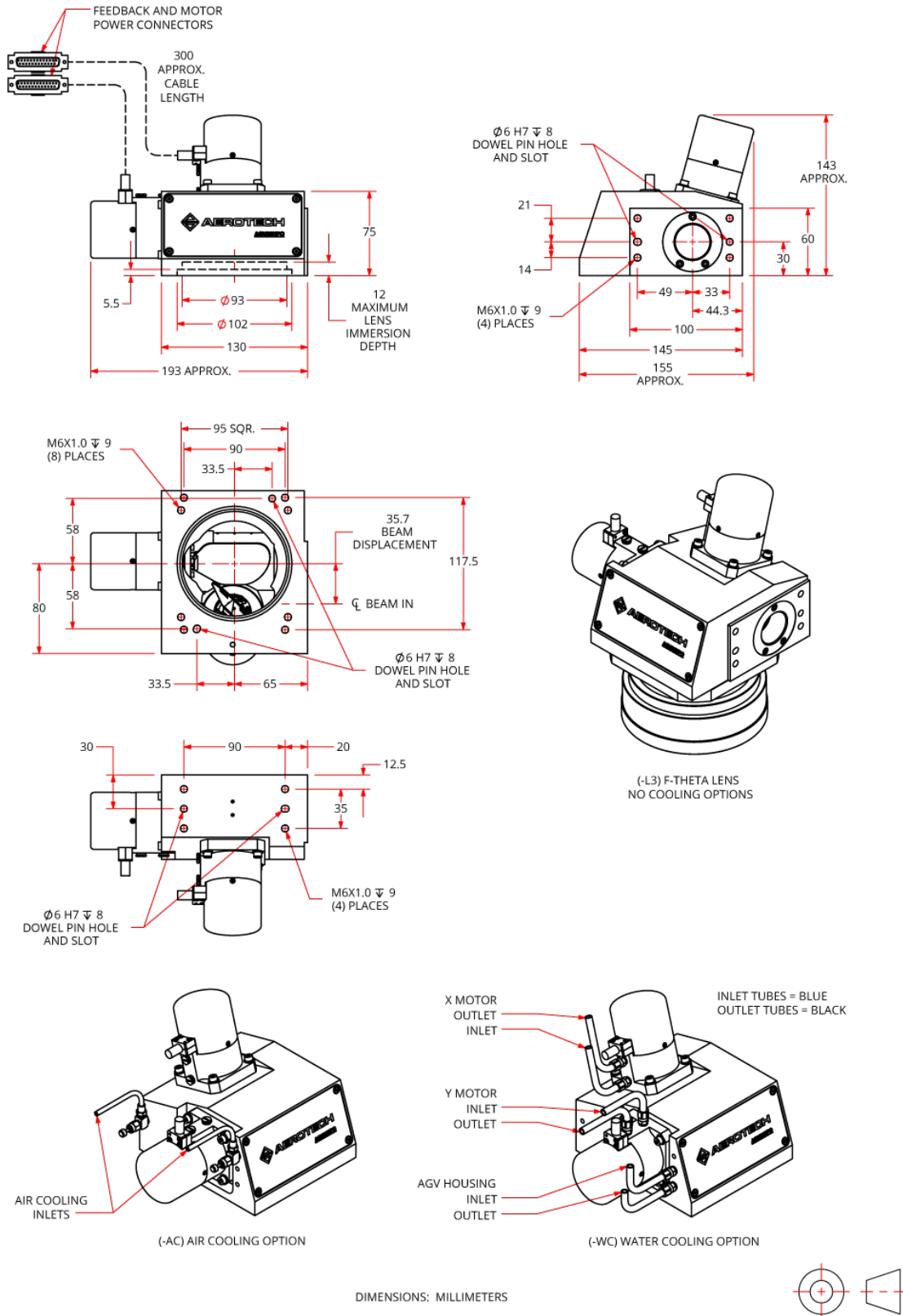


Figure 2-14: AGV30HPO-BE1 Galvanometer Scanner Dimensions

2.3. Securing the Scan Head to the Mounting Surface



WARNING : It is the customer's responsibility to safely and carefully move and mount the scan head. Improper handling could adversely affect the performance of the AGV-HP(O)

- Make sure that all moving parts are secure before moving the AGV-HP(O). Unsecured moving parts may shift and cause bodily injury.
- Make certain that the lens cap is attached before moving the AGV-HP(O).
- Put the scan head on a soft surface when it is not attached to its mounting surface to protect the optics.

The mounting surface should be flat and have adequate stiffness in order to achieve the maximum performance from the AGV-HP(O) scan head. When an AGV-HP(O) is mounted to a non-flat surface, the scan head can be distorted as the mounting screws are tightened. This distortion will affect the alignment between the galvano motors and decrease the overall accuracy of the scan head. Adjustments to the mounting surface must be made before the scan head is secured.

Inspect the mounting surface for dirt or unwanted residue and clean if necessary. Use precision flatstones on the mounting surface to remove any burrs or high spots. Clean the mounting surface with a lint-free cloth and acetone or isopropyl alcohol and allow the cleaning solvent to completely dry. Gently place the stage on the mounting surface.

NOTE : The AGV-HP(O) is precision machined and verified for flatness prior to product assembly at the factory. If machining is required to achieve the desired flatness, it should be performed on the mounting surface rather than the AGV-HP(O). Shimming should be avoided if possible. If shimming is required, it should be minimized to retain maximum rigidity of the system.

NOTE : To maintain accuracy, the mounting surface must be flat to within 3 μm per 50 mm.

There are several ways to mount the AGV-HP(O) scan head. Attaching the scan head directly with the mounting holes provided on the beam entrance plate of the head uses the least amount of hardware. Additional mounting holes are also provided on the back surface of the scan head. For applications where the scan head is to be mounted onto a bridge structure or onto the carriage of a gantry stage, the AGV-HP series scanners can be equipped with an optional mounting plate.

Refer to [Section 2.2](#) for dimensional drawings that detail the mounting hole locations, quantity, and size.

A general procedure for attaching the AGV-HP(O) scan head to a mounting flange is provided below. Note that the mounting flange must include appropriate features to match the threaded holes and the dowel holes and slots present on the AGV-HP(O) scan head.

1. Remove the plug from the beam entrance aperture of the scan head.

NOTE: After removing the plug, retain it for future use. In the event that the scan head should require service at the factory, the plug may be reinstalled to ensure that the scan head ships safely.

2. Prepare the mounting flange and the mating surface of the scan head by stoning with precision flatstones to remove any burrs or high spots.
3. Clean the mounting flange and the mating surface of the scan head with the appropriate cleaners (isopropyl alcohol for the scan head).
4. Line up the dowel hole and slot features of AGV-HP(O) scan head with the dowel pins protruding from the mounting flange.
5. Install the scan head onto the pins.
6. Insert the appropriate hardware into the holes of the mounting flange. The screw length must be long enough to provide at least 1.0x diameter thread engagement.
7. Using an appropriate wrench, tighten the hardware. Alternate tightening of the screws so that the AGV-HP(O) scan head comes together evenly on the mounting flange.

2.4. Attaching the Focal Lens to the Scan Head

The procedure outlined in this section is provided as a general reference for installing and removing focal lenses (F-Theta lenses). A lens adapter is required to attach the focal lens to the AGV-HP(O) series scan head. This lens adapter is supplied with optics configurations that include a focal lens. For AGV-HP(O) scan heads that are provided without a focal lens, the user is responsible for supplying both the F-Theta lens and the necessary lens adapter. Contact the factory for assistance with the design of an appropriate lens adapter if necessary.

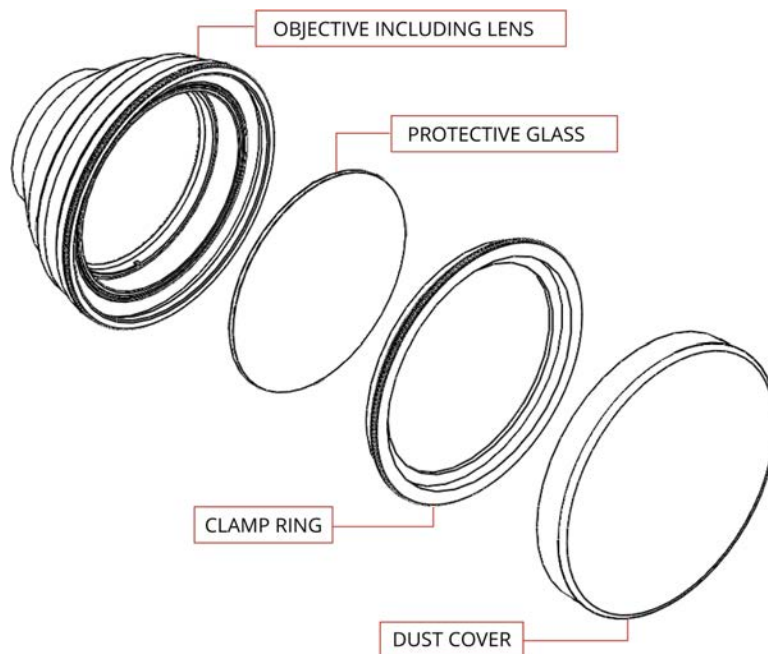


Figure 2-15: Example of F-Theta Lens (Complete Assembly)



WARNING: Before performing any inspections of the focal lens, verify that the laser is switched off and secured against accidentally being switched on.



WARNING: Fingerprints contain aggressive substances that can damage optical surfaces. Always wear suitable gloves when you handle the optics.

1. Before assembling the focal lens into the scan head, remove the dust cover(s) and inspect the lens elements and protective glass for dirt, scratches or cracks. Any lens component with a scratch or a crack must be replaced.
2. If the optics are dirty, clean them using the procedure outlined in [Section 4.2](#).
3. If necessary, install the protective glass over the front of the lens using the clamp ring. Place the dust cover over the front of the lens.
4. Remove the plug from the beam exit aperture on the bottom of the scan head.
5. Making sure that the dowel pin in the lens adapter is aligned with the reference slot in the scan head, attach the lens adapter to the scan head using the appropriate hardware. The screw length must be long enough to provide at least 1.0x diameter thread engagement.
6. Screw the focal lens into the lens adapter until it seats and is positioned securely. Be careful not to cross-thread the housing of the lens assembly when installing.
7. Remove the dust cover from the front of the focal lens.

To remove the focal lens, reverse the procedure outlined above.

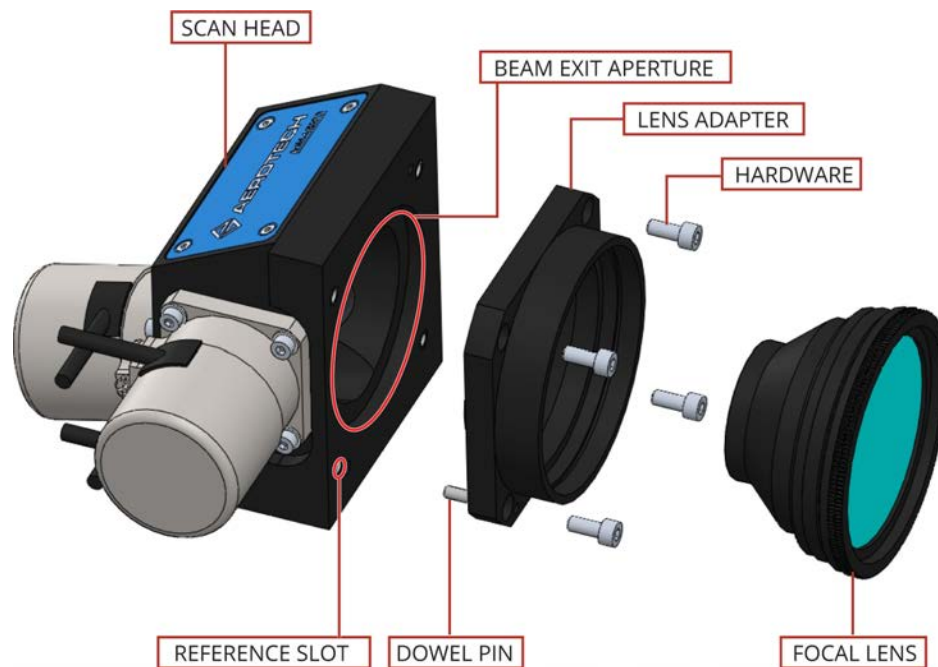


Figure 2-16: Assembly of Focal Lens to Scan Head (AGV-HP(O))

2.5. Air Requirements

An air supply is needed for AGV-HP(O) models equipped with the -AC air cooling option. A gas supply pressure of 517 kPa to 586 kPa (75 psi to 85 psi) is required when using this feature. Gas must be delivered through a polyurethane air hose with an outer diameter of 4 mm. Unless otherwise specified, a gas flow rate of 20 SLPM (standard liters per minute) at 550 kPa (80 psi) should be observed.

- If compressed air is used, it must be filtered to 0.25 microns, dry to 0° F dew point, and oil free.
- If nitrogen is used, it must be 99.99% pure and filtered to 0.25 microns.

The filtration requirement is necessary to prevent particles from damaging the optical surfaces of the turning mirrors.



WARNING: To prevent damage to the AGV-HP(O), do not attach a water hose to an air fitting or an air hose to a water fitting.



WARNING: Wear eye protection when you are close to compressed air components.

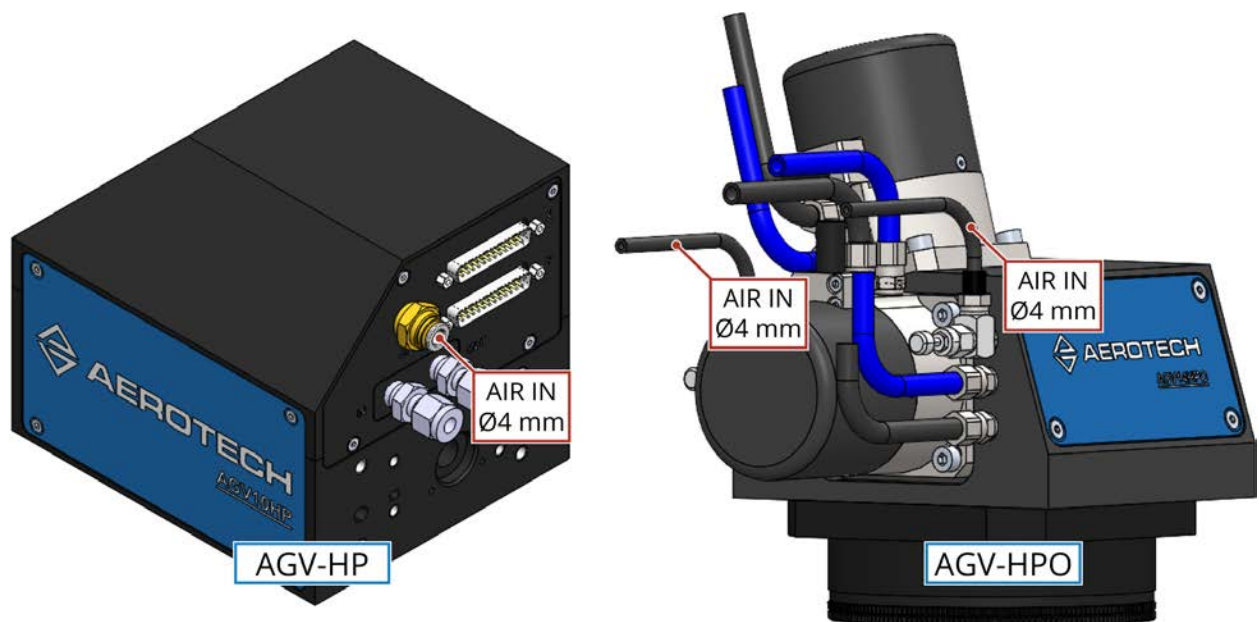


Figure 2-17: Air-Cooling (-AC) Locations

2.6. Water Requirements

A supply of coolant is necessary for AGV-HP(O) models furnished with the -WC water cooling option. This feature requires a source of distilled, temperature-controlled water. You could use a corrosion inhibitor additive meant for multi-metal cooling channels to help increase the life of components in the water cooling circuit. Aerotech recommends using an appropriately sized chiller capable of delivering 0.35 GPM (gallons per minute) at 60 psid. The coolant must be delivered and retrieved from the scan head via appropriate hoses with outer diameters of 6 mm.



WARNING: Use distilled water with the AGV-HP(O) water cooling system. The use of deionized water, un-distilled water, or other coolants could lead to corrosion and failure of certain water cooling system components. Any anti-corrosion additive must be compatible with nickel and stainless steel, as well as any other materials found in the cooling circuit. If distilled water cannot be used, contact the factory to discuss the specifics of your application.



WARNING: To prevent damage to the AGV-HP(O), do not attach a water hose to an air fitting or an air hose to a water fitting.

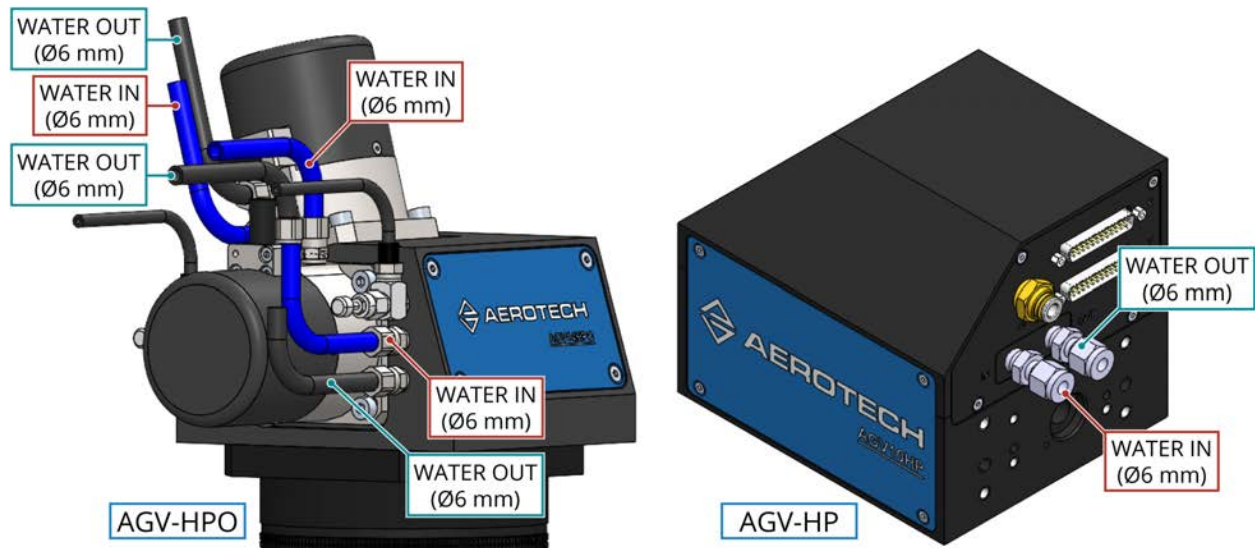


Figure 2-18: Water Cooling (-WC) Locations

Chapter 3: Electrical Specifications and Installation



WARNING: Electrical installation must be performed by properly qualified personnel.

Electrical installation requirements will vary depending on product options. Installation instructions in this section are for AGV-HP(O) stages equipped with standard Aerotech motors intended for use with an Aerotech motion control system. Contact Aerotech for further information regarding products that are otherwise configured.

Aerotech motion control systems are adjusted at the factory for optimum performance. When the AGV-HP(O) is part of a complete Aerotech motion control system, setup usually involves connecting the AGV-HP(O) to the appropriate drive chassis with the cables provided. Labels on the system components usually indicate the appropriate connections.

If system level integration was purchased, an electrical drawing showing system interconnects has been supplied with the system (separate from this documentation).

The electrical wiring from the motor and encoder are integrated at the factory. Refer to the sections that follow for standard motor wiring and connector pinouts.



WARNING: Applications that require access to the AGV-HP(O) must be restricted to qualified and trained personnel. The system integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements when they integrate the AGV-HP(O) into a completed system.



DANGER: Remove power before connecting or disconnecting electrical components or cables. Failure to do so could cause electric shock or damage to the equipment.



WARNING: Operator access to the base and tabletop must be restricted while connected to a power source. Failure to do so could expose the operator to electrical shock or mechanical dangers.

3.1. Motor and Feedback Connectors



DANGER: Remove power before connecting or disconnecting electrical components or cables. Failure to do so could cause electric shock or damage to the equipment.

Stages equipped with standard motors and encoders come from the factory completely wired and assembled.

The AGV scan heads contain galvano motors with dual analog encoder feedback. Both the primary and secondary position feedback signals of each galvano motor must be tuned for optimal performance. Each channel's gain, offset, and phase balance should be adjusted using the Feedback Tuning tab of the A3200 Digital Scope utility. Refer to the Nmark GCL or GL4 Controller Hardware Manual and the A3200 Help for more information.

The protective ground connection of the AGV-HP(O) provides motor frame ground protection only. Additional grounding and safety precautions are required for applications requiring access to the stage while it is energized. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.



WARNING: The protective ground connection must be properly installed to minimize the possibility of electric shock.



WARNING: Operator access to the base and tabletop must be restricted while connected to a power source. Failure to do so could expose the operator to electrical shock or mechanical dangers.



CAUTION: The stage controller must provide over-current and over-speed protection. Failure to do so could cause electric shock or damage to the equipment..

Table 3-1: Motor and Feedback Connector Pinouts

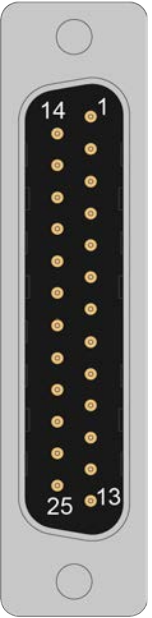
Pin	Description	Connector
Case	Cable Shield	
1	Sine 1+	
2	Cosine 1+	
3	5V Common Ground	
4	Sine 2+	
5	Cosine 2+	
6	Signal indicating maximum travel produced by positive/CW mirror direction (CW/+LIMIT).	
7	Marker +	
8	Encoder 5V Supply Input	
9	Reserved	
10	Reserved	
11	Frame Ground	
12	Motor +	
13	Motor +	
14	Sine 1-	
15	Cosine 1-	
16	5V Common Ground	
17	Sine 2-	
18	Cosine 2-	
19	Signal indicating maximum travel produced by negative/CCW mirror direction (CCW/-LIMIT).	
20	Marker -	
21	5V Common Ground	
22	5V Common Ground	
23	Frame Ground	
24	Motor -	
25	Motor -	

Table 3-2: Mating Connector Part Numbers for the Motor and Feedback Connector

Mating Connector	Aerotech P/N	Third Party P/N
Backshell	ECK00656	Amphenol #17E-1726-2
Connector	ECK00300	FCI DB25S064TLF

3.2. Motor and Feedback Wiring

AGV-HP(O) scan heads come from the factory fully wired and assembled.

NOTE: Refer to the other documentation accompanying your Aerotech equipment. Call your Aerotech representative if there are any questions on system configuration.

The protective ground connection of the AGV-HP(O) provides motor frame ground protection only. Additional grounding and safety safeguards are required for applications requiring access to the stage while it is energized. The System Integrator or qualified installer is responsible for determining and meeting all safety and compliance requirements necessary for the integration of this stage into the final application.

For cable drawings, refer to the documentation that shipped with your system.

Table 3-3: Aerotech Motor and Feedback Cable Part Numbers

Aerotech Controller	Nmark GCL or GL4	
Cable Application	Standard	Hi-Flex
Interface Cable Part Number	C23680-xxx	C23690-xxx
NOTES:		
<ul style="list-style-type: none"> -xxx = Cable Length in Decimeters (1 Decimeter = 3.937 inches) Contact factory for standard & custom cable lengths 		

Table 3-4: Wire Gauge and Insulation Specifications

	Current	Wire Gauge: mm ² (AWG)	Minimum Recommended Insulation Voltage (V)
AGV10HP(O)	7.1	1.3 (16)	60
AGV14HP(O)	7.1	1.3 (16)	60
AGV20HP(O)	7.1	1.3 (16)	60
AGV30HP(O)	5.6	1.3 (16)	60



DANGER: Remove power before connecting or disconnecting electrical components or cables. Failure to do so could cause electric shock or damage to the equipment.



WARNING: The protective ground connection must be properly installed to minimize the possibility of electric shock.

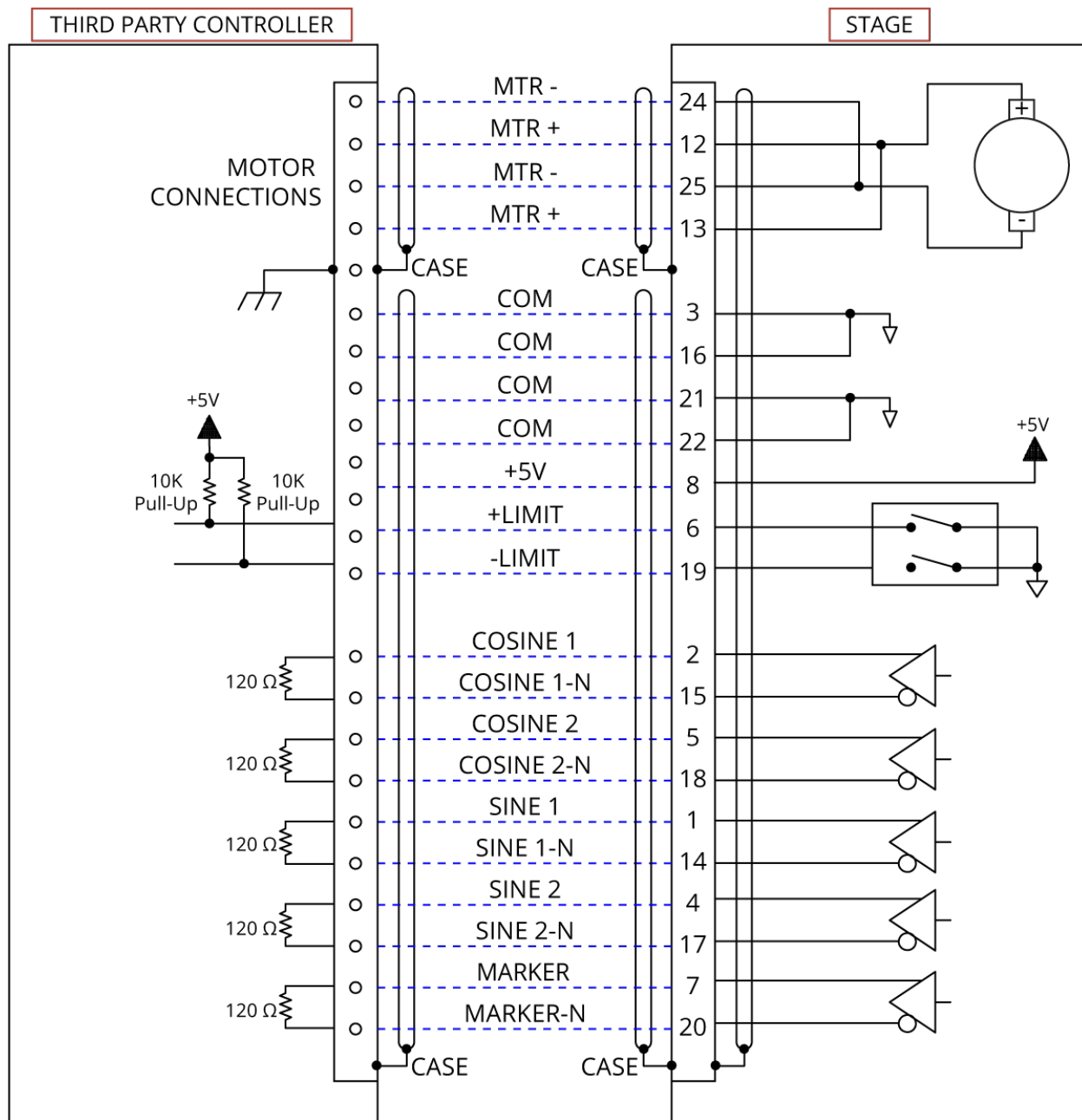


Figure 3-1: Motor and Feedback Wiring

3.3. Motor and Feedback Specifications

Table 3-5: Motor and Feedback Specifications

Feedback Specifications		
	AGV10HP(O), AGV14HP(O), AGV20HP(O)	AGV30HP(O)
Supply Voltage	5 V	
Supply Current	250 mA	
Output Signals	Sinusoidal Type (Incremental Encoder): 1 V _{pk-pk} into 120 Ω Load (differential signals SIN+, SIN-, COS+, COS- are .5 V _{pk-pk} relative to ground.)	
Encoder Resolution	4096 lines/revolution	
Motor Specifications		
	AGV10HP(O), AGV14HP(O), AGV20HP(O)	AGV30HP(O)
BEMF Constant	1.4 V/krpm	4.3 V/krpm
Max Current	5 A	5 A
Resistance	1.5 ohms	3.1 ohms
Inductance	170 μH	675 μH
Maximum Bus Voltage	80 V	80 V
Number of Poles	2	2

3.4. Limits, Marker, and Machine Direction

Aerotech stages are configured to have positive and negative "machine" directions. The machine direction defines the phasing of the feedback and motor signals and is dictated by the stage wiring (refer to [Section 3.5](#) for Motor and Feedback phasing information). Programming direction of a stage is set by the controller that is used to move the stage. The galvo motors for each axis have internal electrical limits for both positive and negative machine direction motion. Programming direction is typically selectable in the controller, while machine direction is hardwired in the stage.

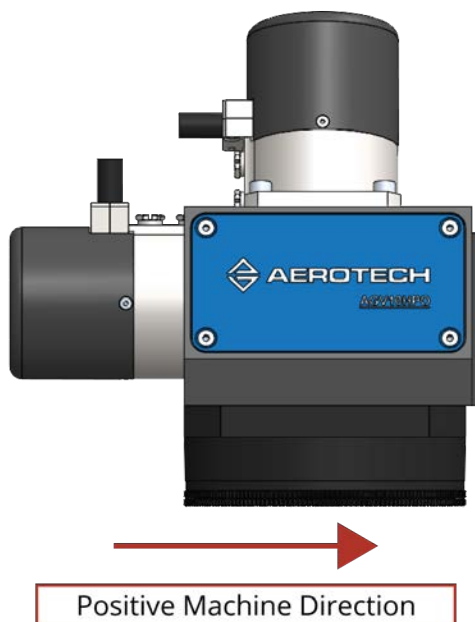


Figure 3-2: -BE1 Galvo X-Axis Machine Direction (front)

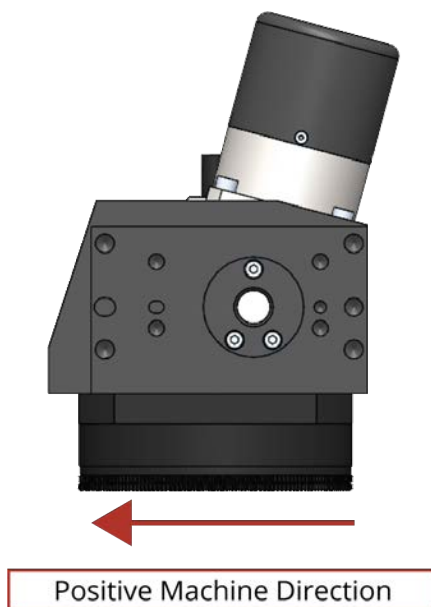


Figure 3-3: -BE1 Galvo Y-Axis Machine Direction (side)

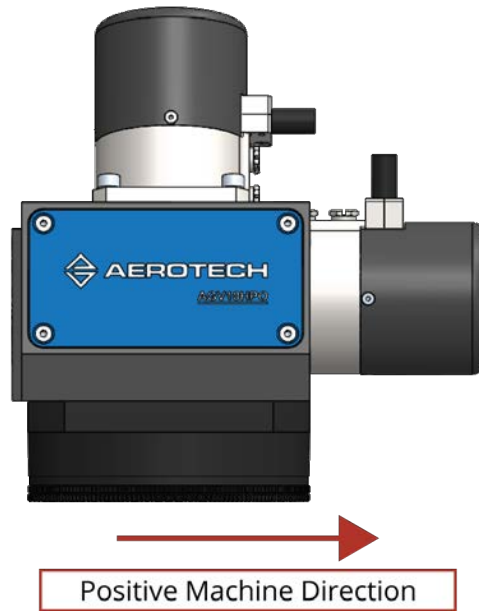


Figure 3-4: -BE2 Galvo X-Axis Machine Direction (front)

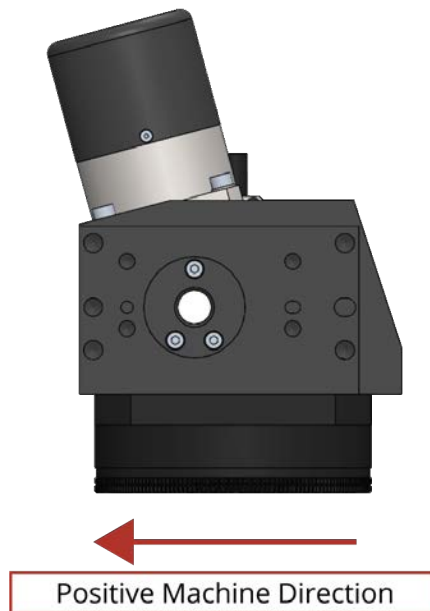


Figure 3-5: -BE2 Galvo Y-Axis Machine Direction (side)

3.5. Motor and Feedback Phasing

Motor phase voltage is measured relative to the virtual wye common point.

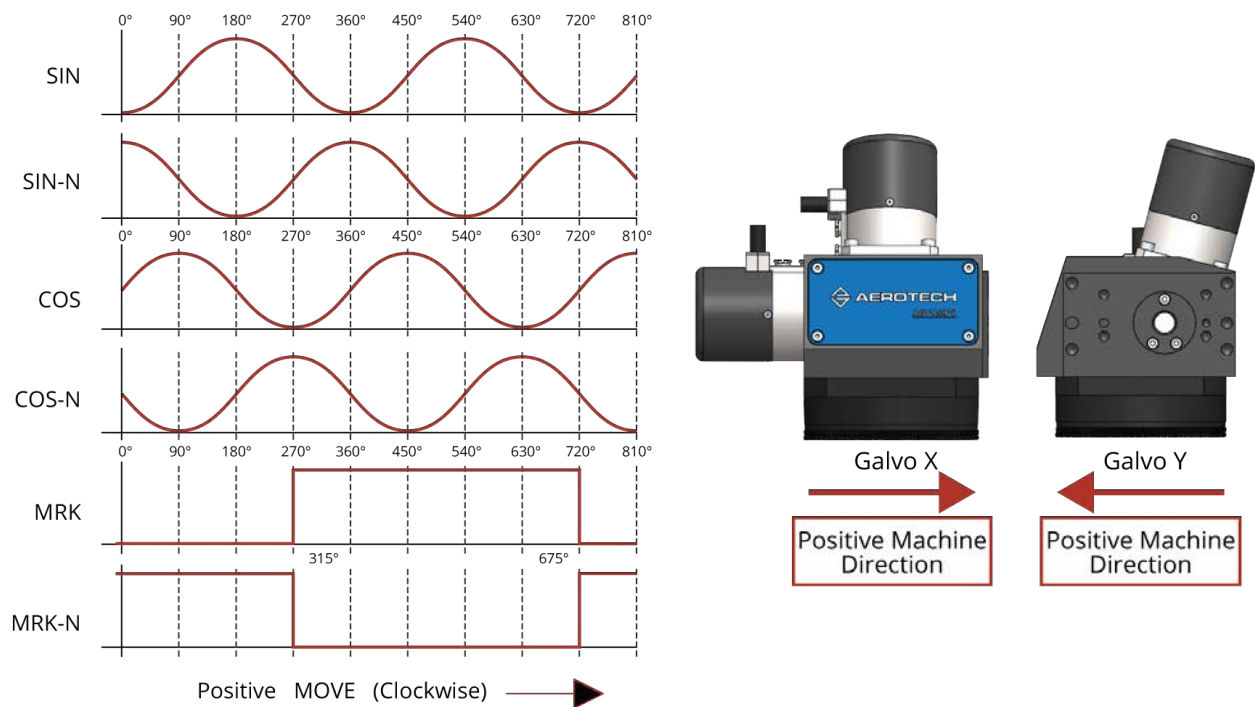


Figure 3-6: Analog Encoder Phasing Reference Diagram

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Chapter 4: Maintenance

The AGV-HP(O) series scan head is designed to be dust resistant except at the beam entrance and beam exit apertures. The scan head does not require any maintenance other than periodic cleaning. Included in this chapter are recommended cleaning solvents.

NOTE: The scan head must be kept free of foreign matter and moisture; otherwise, the performance and life expectancy of the scan head will be reduced.

4.1. Service and Inspection Schedule



DANGER: To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.

Inspect the AGV-HP(O) at least once per month. A longer or shorter inspection interval may be required depending on the application and conditions, such as the duty cycle, speed, and environment.

Monthly inspections should include but not be limited to:

- Visually inspect the stage and cables.
- Re-tighten loose connectors.
- Replace or repair damaged cables.
- Clean the AGV-HP(O) and any components and cables as needed.
- Repair any damage before operating the AGV-HP(O).
- Inspect and perform an operational check on all safeguards and protective devices.

In general, repair and/or replacement of damaged or malfunctioning components by Aerotech field service personnel is not possible. Repair typically requires that the unit be returned to the factory. Please contact Aerotech Global Technical Support for more information.

4.2. Cleaning and Lubrication

There are no elements on AGV-HP(O) stages that require lubrication.

Before using a cleaning solvent on any part of the AGV-HP(O), blow away small particles and dust with nitrogen or, less preferably, clean, dry, compressed air.

Any external metal surface of the AGV-HP(O) can be cleaned with isopropyl alcohol on a lint-free cloth.

4.2.1. Focal Lens and Protective Glass

Optical surfaces that are contaminated with dirt and debris result in increased absorption of laser radiation. Over time, this contamination can cause the optical surfaces to absorb enough heat to cause permanent burn damage. There are several different kinds of optical surface contamination:

- Airborne particles in the ambient atmosphere – dust, grease, etc.
- Products from the laser process – vapors, back spatter, burned-in particles, etc.
- Organic contamination – particles produced by talking, coughing, or sneezing near the optical surfaces.

Wherever possible, protect the exposed optics to avoid contamination. However, since contamination cannot be completely avoided, you will have to periodically clean the optical system. Regularly inspect and clean the optical surfaces to help prevent permanent damage.



WARNING: Contamination from the laser process can cause irreversible damage to the optical surfaces. To help minimize contamination, use a disposable protective glass window and/or an exhaust or vacuum system.

Optical materials and coatings are relatively soft substances and incorrect cleaning techniques will result in surface damage and drastically reduced component lifetime. The cleaning procedure for the AGV-HP(O) is intended to help prolong the component lifetime.



WARNING: Fingerprints contain aggressive substances that can damage optical surfaces. Always wear suitable gloves when you handle the optics.



WARNING: Before performing any inspections of the focal lens, verify that the laser is switched off and secured against accidentally being switched on.



WARNING: Take extra care when cleaning a focal lens that does not have a protective glass window.

Cleaning Procedure

1. Use compressed nitrogen or clean, dry, oil-less air to remove any loose particles from the surface.
2. Moisten an appropriate lint-free lens cleaning cloth with isopropyl alcohol.
3. Fold the cloth over such that one folded (straight) edge will serve as the leading edge during the wiping motion.
4. Place the folded (straight) edge of the cloth onto one end of the optical surface. Applying very minimal pressure, slowly move the cloth over the optical component to the opposite end. Never bear down hard, scrub, or wipe in a circular motion when cleaning an optical surface.
5. Remove any liquid residue with a dry lint-free lens cleaning cloth or by blow it off in one direction with compressed nitrogen or clean, dry, oil-less air.
6. Repeat this procedure, using a new lint-free lens cleaning cloth for each repetition, until the surface is completely clean.

4.2.2. Turning Mirrors



WARNING: Never touch the reflective surface of a turning mirror. Turning mirror surfaces are extremely delicate and can be easily damaged.



WARNING: Fingerprints contain aggressive substances that can damage optical surfaces. Always wear suitable gloves when you handle the optics.

The reflective surfaces of the turning mirrors are extremely sensitive and should only be cleaned when it is absolutely necessary and only by experienced personnel. In many cases, minor imperfections in the surface of the mirror can be less harmful than the surface damage caused by repeated cleaning.

When cleaning the turning mirrors becomes an absolute necessity (to remove fingerprints from the reflective surfaces, for example), carefully follow the same procedure outlined in [Section 4.2.1](#).

4.3. Troubleshooting

This section provides some information regarding typical problems.

Table 4-1: Troubleshooting

Symptom	Possible Cause	Possible Solution
Scanners will not move.	Controller trap or fault.	See Controller documentation to clear fault.
	Motor and Feedback connections	See Section 3.1. , Section 3.2. , and Controller documentation
Scanners move uncontrollably	Gains not optimized	See Controller documentation for tuning instructions
	Encoder signals not optimized	See Section . and Controller documentation for encoder tuning instructions
	Motor and Feedback connections	See Section 3.1. , Section 3.2. , and Controller documentation
Scanners oscillate or squeal	Gains not optimized	See Controller documentation for tuning instructions
	Encoder signals not optimized	See Section . and Controller documentation for encoder tuning instructions
Reduction in power as the laser beam passes through the scan head	Optical surfaces contaminated with dirt and debris	See Section 4.2. for cleaning instructions
	Optical surfaces damaged	Contact Aerotech service and/or a lens supplier
AGV-HP(O) scanner does not find marker during homing cycle.	Motor and Feedback connections	See Section 3.1. , Section 3.2. , and Controller documentation
	Mechanical stops have shifted	Contact Aerotech service

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Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from harmful defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale, or use of any of its products shall in no event exceed the selling price of the unit.

THE EXPRESS WARRANTY SET FORTH HEREIN IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL AEROTECH BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES.

Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within thirty (30) days of shipment of incorrect material. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. A "Return Materials Authorization (RMA)" number must accompany any returned product(s). The RMA number may be obtained by calling an Aerotech service center or by submitting the appropriate request available on our website (www.aerotech.com). Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than thirty (30) days after the issuance of a return authorization number will be subject to review.

Visit <https://www.aerotech.com/global-technical-support.aspx> for the location of your nearest Aerotech Service center.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an expedited method of return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Fixed Fee Repairs - Products having fixed-fee pricing will require a valid purchase order or credit card particulars before any service work can begin.

All Other Repairs - After Aerotech's evaluation, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within thirty (30) days of notification will result in the product(s) being returned as is, at the buyer's expense.

Repair work is warranted for ninety (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-site Non-Warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Service Locations

<http://www.aerotech.com/contact-sales.aspx?mapState=showMap>

USA, CANADA, MEXICO	CHINA	GERMANY
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720
TAIWAN	UNITED KINGDOM	
Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690	Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649	

Have your customer order number ready before calling.

Appendix B: Revision History

Revision	Description
1.05.00	Updated Chapter 3 with new motor specifications.
1.04.00	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
1.03.00	
1.02.00	
1.01.00	
1.00.00	

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Index

	2		cleaning the turning mirrors	56
2006/42/EC		10	compressed air	41
	A		coolant	42
Accuracy and Temperature Effects		17	D	
air			Dimensions	23
compressed		41	Directive 2006/42/EC	10
nitrogen		41	E	
Air Requirements		41	Electrical Installation	43
Altitude		16	EN 60204-1 2010	10
Ambient Temperature		16	EN ISO 12100 2010	10
Attaching the Focal Lens to the Scan Head		39	F	
attenuator		8	Feedback Specifications	48
	B		field service	53
Basic Specifications		18	Focal Lens	39,54
Beam Entry Orientation		13	G	
beam shutter		8	Global Technical Support	2
	C		H	
Cable Part Numbers		46	Handling the Scan Head	21
chiller		42	Housing Type	13
Class I		7	Humidity	16
Class II		7	I	
Class IIa		7	Inspection	53
Class IIIa		7	Inspection Schedule	53
Class IIIb		7	isopropyl alcohol	54
Class IV		7	L	
Classes of Lasers		7	label	22
cleaning			Laser Area	8
mounting surface		37	Laser Safety	7
solvents		54	Laser Shutter	8
Cleaning		54	lubrication	54
Cleaning Solvents			Lubrication	54
Recommended		54	M	
			Maintenance	53

maximum permitted radiation value	8	W	
Motor Specifications	48	Warranty and Field Service	59
mounting surface		Water Requirements	42
cleaning	37		
		N	
nitrogen	41		
		O	
Optical surfaces contaminated	54		
Ordering Options	13		
		P	
part number	22		
Protection Rating	16		
Protective Glass	54		
protective ground connection	44		
		S	
Securing the Scan Head to the Mounting Surface	37		
serial number	22		
Service and Inspection Schedule	53		
shimming	37		
solvents	54		
stabilizing stage	22		
stage			
stabilizing	22		
Support	2		
		T	
Technical Support	2		
Temperature Effects	17		
Turning Mirrors	56		
		U	
Unpacking and Handling the Scan Head	21		
		V	
Vacuum Operation	20		
Vibration	16		