GSI General Scanning™ Optical Scanners

VM*PLUS* Motors
User's Manual

P/N: 742- 79312
Revision B

www.gs- scanners.com

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1 IMPORTANT INFORMATION

1.1 ESD WARNING

The OEM electronics that *General Scanning* manufactures - including scanner motors and servo drivers - are electrostatic discharge (ESD) sensitive. Improper handling could therefore damage these electronics. *General Scanning* has implemented procedures and precautions for handling these devices and we encourage our customers to do the same. Upon receiving your components, you should note that it is packaged in an ESD-protected container with the appropriate ESD warning labels. The equipment should remain sealed until the user is located at a proper static control station*.

Note: Any equipment returned to the factory must be shipped in anti-static packaging.

(*) A proper static control station **should** include:

1. A soft grounded conductive tabletop or grounded conductive mat on the tabletop.
2. A grounded wrist strap with the appropriate (1 Meg) series resistor connected to the tabletop mat and ground.
3. An adequate earth ground connection such as a water pipe or AC ground.
4. Conductive bags, trays, totes, racks or other containers used for storage.
5. Properly grounded power tools.
6. Personnel handling ESD items should wear ESD protective garments and ground straps.

1.2 Warranty Information

The Customer shall examine each shipment within 10 days of receipt and inform General Scanning of any shortage or damage. If no discrepancies are reported, General Scanning shall assume the shipment was delivered complete and defect free. General Scanning warrantees products against defects up to 1 year from manufacture date, barring unauthorized modifications or misuse. Repaired product is warranted 90 days after the repair is made, or one year after manufacture date - whichever is longer.

Contact Customer Service to obtain a Return Materials Authorization number *before returning any product for repair*.

All orders are subject to the General Scanning Terms and Conditions and Limited Warranty. Visit our website for the latest version of these documents and other useful information.

IMPORTANT: Optical Scanners are normally tuned, serialized and warranted as a matched set for optimized performance. Mismatched components negatively affect performance and void the warranty. A matched set typically consists of galvanometer motor, mirror load, electronic driver board and interface cable.

1.3 Customer Support

General Scanning has support services to address your questions or concerns with either the product or manual you are using. Before calling for assistance, be sure to refer to any appropriate sections in the manual that may answer your questions. Call General Scanning's Customer Service Department Monday through Friday between 8 A.M. and 5 P.M. local time (GMT –05:00 Eastern Time (US & Canada)).

The customer service personnel will be able to give you direct assistance and answers to your questions.

2 INTRODUCTION

2.1 Overview

General Scanning's advanced beam and image positioning scanner motors offer high dynamic motion along with high accuracy and instrument grade performance.

Now, The VM*PLUS* scanner motors take this performance to new levels. We combined our advanced 3Prd generation VM motor designs, which were known for low inertia, high rigidity, and low temperature characteristics, with an entirely new optical position detector. The result is VM*PLUS* Motors. These new scanner motors deliver the same speed and accuracy, with improved thermal performance and EMI resistance. And the package is significantly smaller than the previous VM motors.

Additionally, any design based on our VM series motors can perform substantially better because the VM*PLUS* Motor is a drop-in replacement. That can extend the competitive life of current designs with virtually no added engineering costs.

The VM*PLUS* Motors are fully RoHS compliant and are optimized for both large and small signal applications.

Coupled with General Scanning's innovative mirror and mount designs and servo drivers, the VM*PLUS* Motors will bring higher levels of performance to your optical scanning applications.

2.2 Configurations

The VM*PLUS* Motors are designed to work with either the Miniature Single Axis (MiniSAX) servo driver or the dual axis Low-Noise Intelligent (LN-ISD) Servo Driver.

Each motor is recommended for use with specific mirrors sizes out of our selection of standard mirrors, or within a range of load inertias.

2.3 Accessories

XY Open Frame – Flex Heads

General Scanning is an experienced component as well as sub-assembly builder. Therefore, much thought has already been put into creating two-axis systems, where mirrors and XY brackets are designed to optimize performance per aperture, maximizing speed and reducing geometric distortions. Interface drawings of the brackets are available through General Scanning's website www.gsig.com/scanners.

Please note that when using scanners in two axis configurations, some geometric phenomena, such as "pincushion effect" and "cosine distortion" will occur. (Refer to "7OM-1143 XY-Series Manual" for details).

Developer's Kits

An additional test / tuning kit may be purchased for each of General Scanning's drivers that will allow the user to customize the servo tuning for a specific application. These kits include a test interface board and serial interface to tuning software (where applicable). Please contact the sales representative in your area for additional information.

3 MIRRORS AND LOADS

3.1 Standard Mirrors

For best results, we recommend using standard General Scanning mirrors when possible. General Scanning offers a full line of mirrors designed specifically to optimize scanning performance and motor lifetime. All General Scanning's mirrors introduce a low inertia design (without compromising flatness or stiffness), which supports a variety of industry standard coatings.

Custom mirror coatings are available for OEM applications. Please contact the General Scanning Customer Service department for more information on available mirror coatings.

Standard mirrors and their angular specifications for each motor are listed below:

Table 1: Mirror Size and Scan Angles

Standard Mirrors (clear aperture)		**Maximum Scan Angle***
VM500+	4mm	±30º Optical
	5mm	±25º Optical
	6mm	±20º Optical
VM1000+	8mm	±20º Optical
VM2500+	10mm	±22º Optical
	12mm	±22º Optical
	15mm	±22º Optical

(*) Larger angular displacement will cause part of the beam to fall out of the mirror area.

3.2 Custom Mirror/Load Design

When designing a custom load, several factors must be considered. A common oversight is to disregard the adverse effect of an improperly balanced mirror / load. An unbalanced mirror / load can shorten the life span of the motor as it causes cross-axis excitation of the mirror-rotor assembly, leading to premature bearing failure. In the event that standard General Scanning mirrors do not meet your application's requirement, the following mirror design guidelines should be observed:

1) Mirror mass and inertia should be minimized
2) Mirror should be mounted as close as possible to the top bearing of the motor.
3) Mirror / load's center of gravity must be on the axis of rotation.
4) Principal axis of the mirror / load and mount must be aligned with the scanner axis as closely as possible.

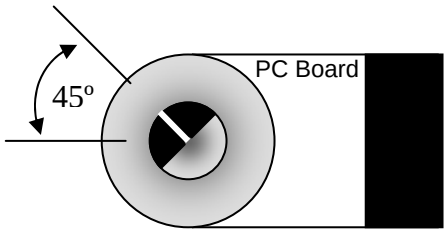
3.3 Mounting Mirror Assembly

If the VM*PLUS* Motor has already been mounted in an open frame XY bracket, this section does not apply. Do not remove or realign mirrors or mechanical stops as they have been set specifically at the factory to avoid mirror collision. If the mirror needs cleaning or is damaged please contact customer service to have the unit repaired.

If the VM*PLUS* Motor is being used in single-axis or custom multi-axis systems, this section may apply if the entire motor can only be mounted in a specific orientation.

3.3.1 VM500+ and VM1000+

Before mounting the mirror assembly to the rotor shaft, or realigning the mirror position, it is advisable to find the motor's electrical zero position to create a reference position when it is used in a system. The top of the rotor shaft on each VM500+ and VM1000+ Motor has a scribed mark. The mark is offset with a blackened half moon to give it higher visibility (see figure below).



With the mark aligned 45° from opposite the connector, the position detector is approximately in its electrical zero position. This means that when a General Scanning's servo driver connected to the motor is commanded to zero, the rotor shaft will be in the described position.

Alternatively, you may command the rotor to electrical zero by applying power and a 0 VDC command signal to the servo driver connected to the motor. This will cause the rotor to torque to its zero position as described above. **If the servo driver was factory tuned, it may be necessary to slightly de-tune the servo to avoid any destructive oscillations that may occur when the mirror is removed**. (See the servo driver user's manual for information on tuning.)

WARNING: If the motor is powered up with the rotor more than 45° (mech.) away from the above zero position, insufficient torque is available, so excessive currents might be drawn and severe damage to the motor might occur due to over-heating!

When mounting the mirror, take special precautions to prevent damage to the mirrors. If possible use latex gloves or finger cots, to avoid fingerprints on the mirror. It may be helpful to put a piece of tack-free tape over the mirror during any mounting procedures to guard against nicks and scratches. If the mirror does become dirty refer to the cleaning procedure in the following section.

Mirror mounting procedure:

1) Verify mechanical stop is in place; it can be rotated after mirror is mounted. If the stop is not in place refer to section 3.4 for insertion procedure.
2) With the rotor in its zero position, mount and align the mirror as necessary, making sure the mirror is as far down as possible, and clear from any mechanical stop interference.
3) When mirror location is as desired, tighten the screws evenly to the following torque specs: 3.25oz-in for VM500+, 14oz-in for VM1000+.
4) Once the mirror has been mounted and aligned, retune the servo driver if necessary, by following the instructions in the servo driver user's manual.

5) Adjust the mechanical stop for the desired maximum scan angle as described in section 3.4.

3.3.2 VM2500+

The VM2500+ mirror utilizes a patented tapered-mount design, and is pre-mounted at the factory.

3.4 Mirror Mechanical Stops

The VM*PLUS* Motors use an adjustable mechanical stop to limit the maximum angular excursion of the mirror. The stop is slipped around the outer diameter of the top motor body. Should the motor become unstable during operation, or be commanded to excessively large scan angles, the mirror will hit the stop, thus preventing the rotor from spinning all the way around. The stop design provides enough friction to keep the stop in place, yet still allows the user to adjust its position relative to the mirror and therefore adjust the maximum angular peak excursion of the mirror. The stop is required in two axis applications to prevent the mirrors of an XY system from crashing into each other. In single axis applications, the stop helps keep the position detector within the necessary range of operation, for proper servo control.

VM500+ & VM1000+

VM2500+

Mechanical stop insertion procedure:

1) Remove the mirror and press the stop ring into the top of the motor so that it rests flush against the edge of the body. Be sure the ring sits as far down into the motor as possible.

2) Mount the mirror / load by carefully following the instructions in section 3.3.

3) To adjust the stop, insert a flat-head screwdriver into the slot and rotate clockwise or counterclockwise. The stop can be adjusted with or without the scanner enabled. It may be helpful to have the mirror in its zero or maximum deflection angle for reference. Recheck that the stop is still flush with the galvanometer and the mirror mount is not rubbing against it.

VM500+ & VM1000+

VM2500+

3.5 Mirror Cleaning/Maintenance

General Scanning does not recommend cleaning front surface mirrors. Mirrors damaged by cleaning are **not covered by the warranty**. The surface of these mirrors damage easily. It is difficult to prevent hard dust particles from being entrained in the process and causing scratches. In many cases, small defects in the mirror's surface may be less harmful than the surface damage resulting from continued cleaning. Cleaning requires special equipment typically not available to customers.

There are times, however, when cleaning the mirror becomes a necessity, e.g. stains such as fingerprints must be removed immediately to prevent permanent etching of the reflective surface. The information below includes general recommendations for those special occasions when mirrors must be cleaned.

- Remove lint from mirrors with a jet of low-pressure clean air or nitrogen. Blowing on front surface of mirrors with mouth, deposits moisture that may stain the finish.
- A thin overcoating of silicon monoxide protects most mirrors from oxidation. Like many optical coatings, it is easily damaged when attempts are made to clean the mirror surface with a dry tissue.
- The safest method of cleaning is to place a piece of lens tissue on the mirror surface and wet it with reagent grade (highly pure) alcohol or acetone (If you use acetone, take precautions regarding possible health and fire hazards). Grasp an overhanging corner of the tissue and gently agitate it several times, then slide the tissue off. This should remove the problem blemishes.
- If the mirror surface is still contaminated, use a highly pure solvent such as alcohol or acetone and generously wet the mirror surface with a sterile cotton swab or lens tissue. Gently wipe the dirty areas. Turn your cotton swab or tissue with each stroke so that a clean area is exposed.

4 MOUNTING CONSIDERATIONS

When designing a motor mount, the following aspects should be considered –

4.1 Mechanical

Rigidity of the mounting surface is important in minimizing vibrations and unwanted oscillations or beam movement. Rigidity becomes even more critical when operating the motor with high inertial loads. Sources of structural vibration should be investigated so that they do not include significant relative displacement between the motor and the target.

Clamping force on the motor should be tight enough to prevent the motor from moving or turning within the mounting hole. Excessive or uneven (pinching) clamping force may induce stress on the ball bearings of the motor, thus hindering performance and significantly reducing the lifetime of the motor.

4.2 Electrical

The position detector of the VM*PLUS* Motor is electrically isolated from the motor body. Performance testing of the VM*PLUS* Motor has verified minimum electrical noise to exist on the position signal when the body of the motor is well grounded to servo driver ground. Therefore to achieve optimum performance, the motors must be in good electrical contact with the servo driver ground. This may be done through the mount fixture or additional ground cabling between the scanner and servo.

4.3 Thermal

4.3.1 Heatsinking

In most vector applications, power dissipation in the motor is minimal, and therefore the motor requires little heat sinking. In raster or other high duty cycle applications, optimum heat sinking is desired to maximize the scan frequency and prevent damage to the motor caused by overheating. When mounting a VM*PLUS* Motor in your system, the thermal relationship between the motor and its environment should be considered.

Caution: Insufficient heat sinking can cause irreparable damage to the motor. The internal temperature of the motor should never exceed 100ºC. When using a static heatsink, this corresponds to an external case temperature of 70°C.

To maximize heat flow from the motor case to the heat sink, the surface area of the mount should contact as much of the motor as possible. Surface finishes should not exceed 0.8um or 32 microinches

in roughness. If the mounting surface is too rough thermal grease between the two surfaces should be used.

4.3.2 Thermal Control

The VM*PLUS* Motors construction does not include thermal sensor, hence thermal control of these motors is not available.

4.3.3 Cooling Options

There is no cooling option available for the VM*PLUS* Motors.

5 APPLICATION NOTES

Motor lifetime will vary depending on many conditions, and is limited in most cases by bearing wear. Environment, command waveform, load inertia, load balance, and required resolution among other things will all play a role in dictating the number of usable cycles. Although difficult to predict, experience has provided us with some basic guidelines that can help the user maximize motor lifetime.

Maximum lifetime of the VM*PLUS* Motors *will be achieved if:*

a. The motor is operated so that it makes random moves over the full scan field. Commanding repetitive, small angle rotations of any ball bearing device will likely lower the usable lifetime because bearing lubrication is not adequately distributed.

b. Mirror / load inertia and mass are minimized.

c. Large signal commands are structured to limit acceleration and cross-axis wobble.

d. Storage and operation are in a low humidity, dust free environment. The output shaft should not be cleaned with solvents that could flow into the bearings and remove lubrication.

APPENDIX A: PRINCIPALS OF OPERATION

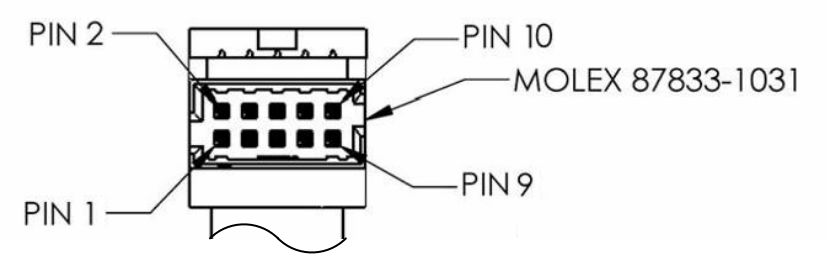
A.1 General Characteristics

General Scanning's VM*PLUS* Motors are enabled for servo control using an advanced optical detector summarized by the following characteristics:

- High current transfer ratios (up to 3 times higher than industry standards), giving superior signal to noise ratios.
- Efficient LED and excellent thermal properties of the design allow the LED to be run at 50ma with an expected lifetime of greater than 12 years.
- Very linear over a range of ±22º mechanical.
- Typical Common Mode Current is 0.8mA.
- Typical sensitivity is equal to 53µA/Degree (3.06mA/Radian).

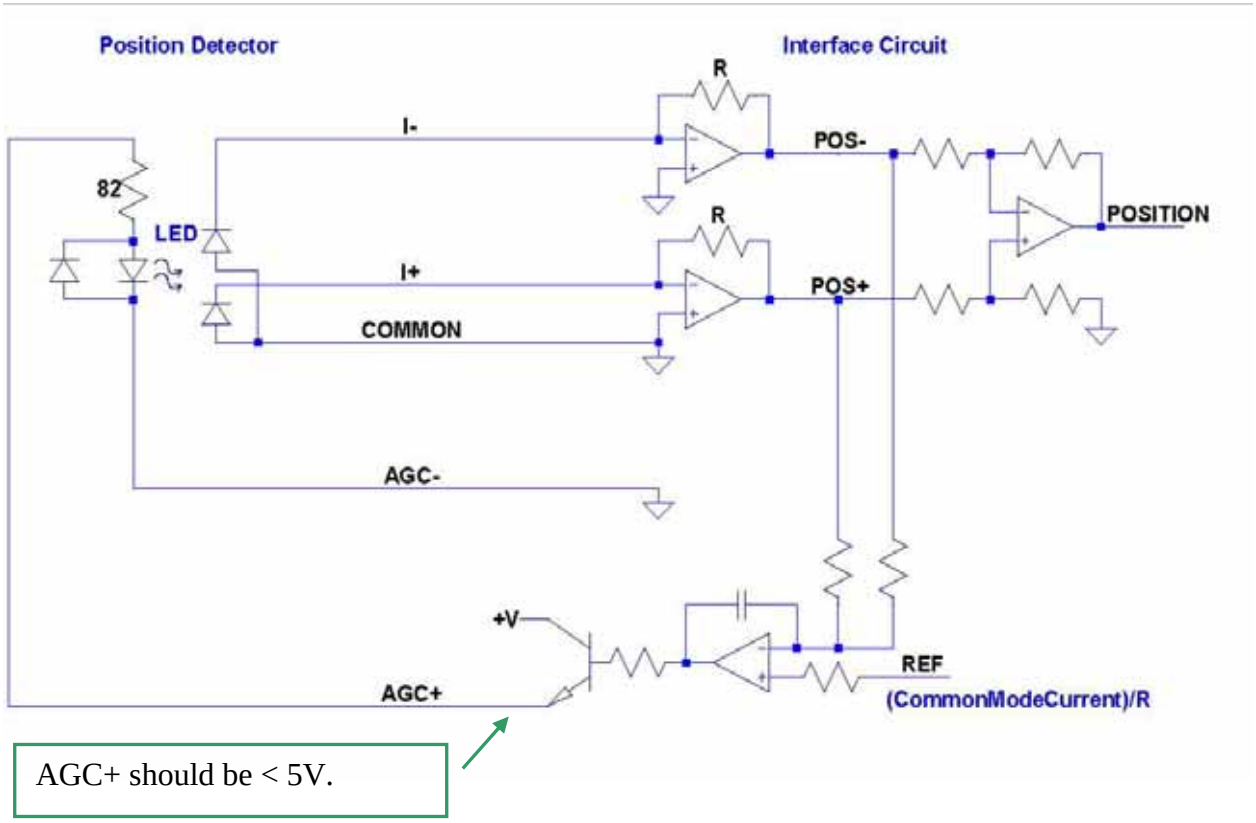
A.2 Connector Pinout

Pin #	Signal
1	I +
2	I -
3	COM
4	Shield
5	AGC +
6	AGC -
7	Motor +
8	Motor -
9	Motor +
10	Motor -



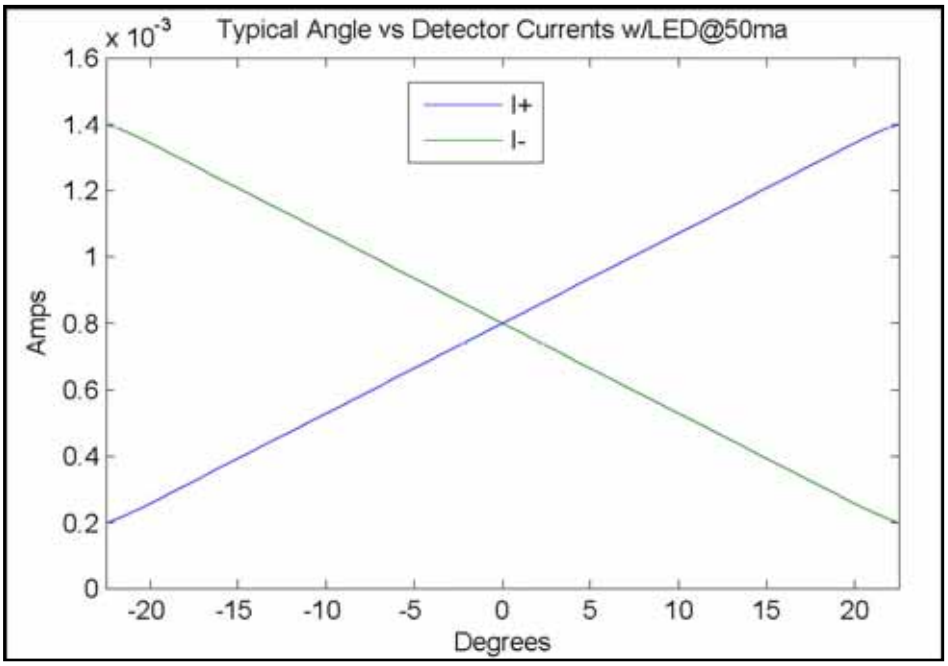
A.3 Detection Circuit

The position of the rotor indicated by the detector is equal to ((I+)-(I-))/((I+)+(I-)). If the denominator is held at a constant level, the division operation is not necessary as shown in the following simplified circuit:



The integrator controlling the **AGC+** voltage will integrate the difference between ((**POS+**)+(**POS-**)) and **REF** so that the difference approaches zero. **REF** should be set to the desired Common Mode Current divided by **R**. The Common Mode Current is defined as the average current for **I+** and **I-**. The sensitivity is defined by how much the differential current changes with respect to angle.

For the example shown on the following page, the Common Mode Current is 0.8mA. The resulting sensitivity is equal to 1.2mA/22.5 degrees or 53µAmp/degree (3.06mAmp/Radian).



A current limiting resistor and protection diode inside the position detector ensure that the diode cannot be damaged by transient events, faulty cables, or malfunctioning interface circuits.

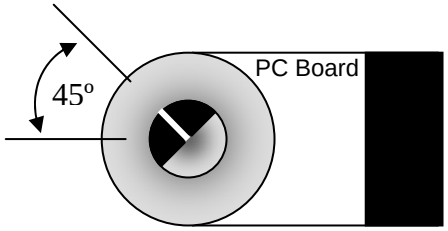
A.4 Cabling and Grounding

To minimize noise in the system, twisted pairs are recommended for the **I+ / I-, AGC+ / AGC-,** and **Motor+ /Motor-** signals. The Motor cable shield should be terminated to the Shield wire on the motor Connector and / or Chassis. The AGC and Common / I signals should be shielded with a different shield, and terminated to either the Interface circuit Ground or Chassis.

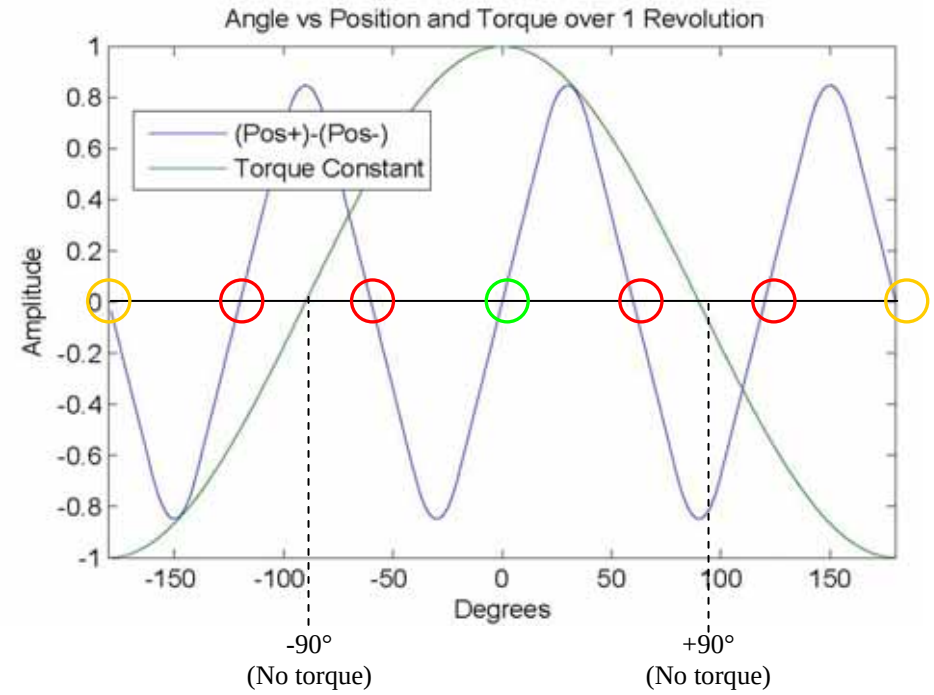
A.5 Motor Winding Alignment

The motor is aligned such that the maximum torque is at the point where the currents from both detector set are equal. The motor will move clockwise with a positive voltage. If the stops are removed and the motor is moved to a position 180 degrees from zero, the motor will be stable since both the polarity of the EMF and the slope of the detector are inverted, but will operate in the reverse direction.

The correct orientation can be verified by the marker on the shaft of the rotor. Looking at the rotor side of the motor, at zero degrees orientation, the mark on the rotor is 45 degrees clockwise away from the line of symmetry opposite to the PC board.



The Torque constant and Position signal for an entire revolution are shown in the following figure:



100% torque: Clockwise rotation

100% torque: Counter-clockwise rotation

50% Torque: Created by reversed polarity between Position and motor leads.

END OF DOCUMENT