MR320 Series
ZapFREE® Fiber Optic Incremental Encoder System
and
ZAPPY® Software
Technical Manual

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Revision History

Revision	Date	Notes
A	7/10/2012	• Includes updated MR320 Controller with embedded USB • Includes new MR324 Pocket Hole Sensor (IP65)
B	4/22/2013	• Includes new MR324 Pocket Hole Mode • Includes new MR325 Sensor
C	10/5/2015	Update with new Camarillo address
D	5/16/2016	• Updated per MR320 Declaration of Conformity Rev C • Added Modbus Protocol
E	6/1/2017	Updated to reflect V2.20 Firmware update • New Diagnostic variables stored in memory • New Amplifier variables can be stored and restored from EEPROM • Calibration Algorithm improved Zappy 4.01 Update Updated diagnostic screen t reflect changes to Version 2.20

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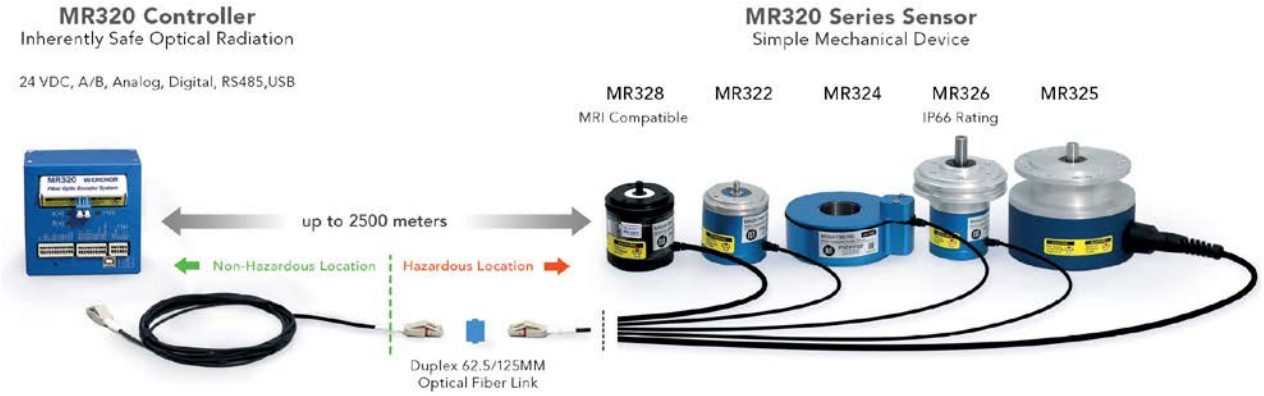
1. Product Description

The MR320 Series ZapFree® Fiber Optic Incremental Rotary Encoders are the ideal EMI-immune sensor solution for use in all manner of harsh environments and hazardous locations. The MR320 series is the second generation of Micronor's fiber optic encoders - originally released as the MR310 series in 2004 and awarded U.S. Patent 7,196,320.

The Micronor fiber optic encoder system is comprised of a passive Sensor linked via a duplex fiber optic link to the remote Controller Module. The motion control designer can count on these features:



- 100% passive optical sensor
- Immune to EMI, RFI and high voltages
- No electromagnetic emissions
- No ground loops
- Industry standard Duplex LC or harsh environment ODVA LC Duplex (IP-LC) optical interfaces
- Fiber optic link can extend to 2500 meters
- Sensor is Ex classified "Simple Mechanical Device" for safe use in all manner of hazardous locations and explosive atmospheres, including mines, gas and dust
- Controller is Ex classified “Inherently Safe Optical Radiation” for EPL Mb/Gb/Gc/Db/Dc applications
- Special non-metallic model for MRI and other applications requiring electromagnetic transparency
- Controller offers multiple built-in interfaces for maximum system compatibility, including A/B quadrature outputs, RS422/RS485, RSS232, Modbus RTU , USB and both 4-20mA and ±10V programmable analog outputs

2. Warranty Information

MICRONOR INC. warrants this product to be free from defects in material and workmanship for a period of 1 (one) year from date of shipment. During the warranty period we will, at our option, either repair or replace any product that proves to be defective. To exercise this warranty, write or call your local MICRONOR INC. representative, or contact MICRONOR INC. headquarters. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or minimum 90 days.

2.1 Limitations of Warranty

This warranty does not apply to defects resulting from unauthorized modification or misuse of any product or part. This warranty also does not apply to Fiber Optic Connector interfaces, fuses or AC line cords.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability of fitness for a particular use. MICRONOR INC. shall not be liable for any indirect, special or consequent damages.

2.2 Contact Information

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3. Specifications

3.1 MR320 Controller

Electrical Interfaces	
DIRECT Quadrature Outputs	70 kHz bandwidth maximum A/A'/B/B' RS4222 Line Driver and A/B Push-Pull outputs Contact Micronor concerning higher bandwidth requirements.
DIVIDER Quadrature Outputs	Programmable DIVIDER range is 2-9999. A/A'/B/B' RS422 Line Driver outputs (A/B push-pull available as an option)
Analog Outputs Current Output Voltage Output	Each output is independently programmable for POSITION (full scale range of 1-8,388,607 counts) or SPEED (full scale range of 10-10,000 RPM). Range: 0-24mA, Max Burden Resistance: 500Ω (24V supply) Range: ±12V; Max Current: 5mA (2kΩ load); Short Circuit <5s
RS422/485 Interface	Direct connection via J3, ISO 1745 and Modbus RTU compatible
RS232	With optional MR232-1 Converter Cable
USB Interface	Built-in, Type B receptacle. Disables RS485/Modbus interface when used.
Electrical Connectors	J1: 12-pin (WAGO QuickConnect Plug 733-112) J2: 10-pin (WAGO QuickConnect Plug 733-110) J3: 6-pin (WAGO QuickConnect Plug 733-106) USB Type B Receptacle
Power Supply	
Power Supply Input	+15VDC to +32VDC, 60mA During Power Up, the external power supply should be capable of delivering a momentary current in excess of 100mA
+5V Output	10mA maximum load (Designed for powering MR232-1 Converter Cable)
Optical Interface	
Optical Interface	LC Duplex, 62.5/125µm multimode fiber, 0.275NA, Type OM1
System Loss Budget	12.5dB
Maximum Optical Link Length	Up to 2500 meters (8300 ft) with MR320 series Sensors Consult Application Note AN118 for more information, Contact Micronor for longer distance requirements.
Laser Safety	Class 1
Explosive Atmospheres	**Inherently Safe Optical Radiation**
EX Classification	Controller shall be installed in non-hazardous location only Power supply to Controller shall be current limited to 200mA IECEX Test Report (ExTR) GB/CML/ExTR 16.0039/00
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt

Environmental Specifications	
Temperature	-5° to +55° C
Humidity	30% to 85% RH (non-condensing)
Ingress Protection	IP40
Physical Attributes	
Mounting	35mm DIN Rail
Housing	102mm W x 102mm D x 68mm H
Weight	300g (10.5oz)

Specifications subject to change without notice

3.2 MR322 Size 58mm Sensor

Measurement Parameters	
Resolution	100, 128, 256, 360 ppr (Consult Micronor for special requirements)
Max Speed	8000 RPM continuous
Mechanical Parameters	
Moment of Inertia	1.0585E-6 kg*m^2
Starting Torque	1.28E-5 N*m
Max Shaft Load	Radial = 80N (18 lbf), Axial = 40N (9 lbf)
System MTBF	L10 Bearing Life calculated at 50% of maximum radial and axial load at 2500 RPM: 1.786E+05 hours (20.3 years)
Optical Interface	
Optical Interface	LC Duplex or ODVA IP-LC, 62.5/125µm multimode fiber, 0.275NA, Type OM1
Link Length	Up to 2500 meters (8300 ft) with MR320 Controller
Optical Interface	Duplex fiber optic pigtail with Duplex LC plug ***or*** ODVA LC Duplex (IP-LC) Receptacle
Fiber Type	MM 62.5/125µm, Graded Index, 0.275NA
Maximum Fiber Link Length	See MR320 specifications for maximum distance and optical link loss range
Explosive Atmospheres	**Inherently Safe, Simple Mechanical Device**
EX Classification	Inherently Safe, Simple Mechanical Device when used with MR320 Controller. IECEX Test Report (ExTR) GB/CML/ExTR 16.0039/00,
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Environmental Specifications	
Temperature Range Standard Option Extended Option	 -40° to +80° C -60° to +150° C (Not available with D00 Option)
Humidity	0% to 95% RH (non-condensing)
Ingress Protection	IP 64
Physical Attributes	
Housing	∅ 58mm x 58mm
Weight	210g (7.25 oz)
Materials	Body: Anodized Aluminum; Shaft and Bearings: Stainless Steel

Specifications subject to change without notice

3.3 MR324 High Resolution Hollow Shaft Sensor

Measurement Parameters	
Resolution	1024 ppr
Max Speed	2,500 RPM (All MR320 functions activated) 3,000 RPM Continuous (Direct Quadrature Outputs and Analog Outputs activated ONLY)(1) 3,330 RPM short term (<1 minute, Direct Quadrature Outputs ONLY)(2) Notes: (1) At 3,000 RPM, MR324 housing temperature rises by 25° above ambient due to bearing friction. Environmental temperature must be reduced accordingly. (2) MR320 Auxiliary modes are processor-dependent functions; e.g. Divider, Multiplier, Position Counter and Analog Outputs. Unused Auxiliary functions should be turned OFF. Contact Micronor for more information about speed versus operational trade-offs.
Mechanical Parameters	
Moment of Inertia	2.06E-4 kg*m^2
Starting Torque	3.53E-3 N*m (Pocket Hole version)
System MTBF	L10 Bearing Life calculated at 2500 RPM: 2.12E+07 hours (2411 years)
Optical Interface	
Optical Interface	LC Duplex, 62.5/125µm multimode fiber, 0.275NA, Type OM1
Link Length	Up to 2500 meters (8300 ft) with MR320 Controller
Explosive Atmospheres	**Inherently Safe, Simple Mechanical Device**
EX Classification	Inherently Safe, Simple Mechanical Device when used with MR320 Controller. IECEX Test Report (ExTR) GB/CML/ExTR 16.0039/00,
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Environmental Specifications	
Temperature Range Standard Option Extended Option	 -40° to +80° C -60° to +150° C
Humidity	0% to 95% RH (non-condensing)
Ingress Protection	Through Hole=IP54, Pocket Hole=IP66
Physical Attributes	
Housing	∅ 100mm x 49mm
Weight	655g (23 oz)
Materials	Body: Anodized Aluminum; Shaft and Bearings: Stainless Steel

Specifications subject to change without notice

3.4 MR325 Size 125mm High Resolution Sensor

Measurement Parameters	
Resolution	1024 ppr
Max Speed	3600 RPM Continuous Note: MR320 Auxiliary modes are processor-dependent functions; e.g. Divider, Multiplier, Position Counter and Analog Outputs. Unused Auxiliary functions should be turned OFF. Contact Micronor for more information about speed versus operational trade-offs.
Mechanical Parameters	
Moment of Inertia	6.65E-4 kg*m^2
Starting Torque	1.79E-3 N*m
Max Shaft Load	Radial = 300N (67 lbf), Axial = 200N (22 lbf)
System MTBF	L10 Bearing Life calculated at 50% of maximum radial and axial load at 3000 RPM: 1.128E+05 hours (12.9 years)
Optical Interface	
Optical Interface	ODVA IP-LC, 62.5/125µm multimode fiber, 0.275NA, Type OM1
Link Length	Up to 2500 meters (8300 ft) with MR320 Controller
Explosive Atmospheres	**Inherently Safe, Simple Mechanical Device**
EX Classification	Inherently Safe, Simple Mechanical Device when used with MR320 Controller. IECEX Test Report (ExTR) GB/CML/ExTR 16.0039/00,
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Environmental Specifications	
Temperature	-40° to +80° C
Humidity	0% to 95% RH (non-condensing)
Ingress Protection	IP 67
Physical Attributes	
Housing Dimension	∅ 125mm x 90mm
Weight	1505 g (53 oz)
Materials	Body: Anodized Aluminum; Shaft and Bearings: Stainless Steel

Specifications subject to change without notice

3.5 MR326 Size 90mm Heavy Duty Sensor

Measurement Parameters	
Resolution	100, 128, 256 or 360 ppr (Consult Micronor for special requirements)
Max Speed	8000 RPM continuous (Direct Quadrature outputs ONLY) Note: De-rate maximum speed by 100 rpm per degree Celsius when operating above 60° C for maintaining shaft seal integrity.
Mechanical Parameters	
Moment of Inertia	2.509E-6 kg*m^2
Starting Torque	1.012E-3 N*m
Max Shaft Load	Radial = 140N (31 lbf), Axial = 70N (15 lbf)
System MTBF	L10 Bearing Life calculated at 50% of maximum radial and axial load at 2500 RPM: 8.96E+05 hours (102.3 years)
Optical Interface	
Optical Interface	LC Duplex or ODVA IP-LC, 62.5/125µm multimode fiber, 0.275NA, Type OM1
Link Length	Up to 2500 meters (8300 ft) with MR320 Controller
Explosive Atmospheres	**Inherently Safe, Simple Mechanical Device**
EX Classification	Inherently Safe, Simple Mechanical Device when used with MR320 Controller. IECEX Test Report (ExTR) GB/CML/ExTR 16.0039/00,
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Environmental Specifications	
Temperature Range Standard Option Extended Option	 -40° to +80° C -60° to +150° C
Humidity	0% to 95% RH (non-condensing)
Ingress Protection	IP66
Physical Attributes	
Housing Dimensions	∅ 90mm x 82.5mm
Weight	615g (21.5 oz)
Materials	Body: Anodized Aluminum; Shaft and Bearings: Stainless Steel

Specifications subject to change without notice

3.6 MR328 Size 58mm MRI-Compatible Sensor

Measurement Parameters	
Resolution	360 ppr
Max Speed	6000 RPM Continuous
Mechanical Parameters	
Moment of Inertia	5.455E-6 kg*m^2
Starting Torque	1.93E-4 N*m
Max Shaft Load	Radial = 60N (13.5 lbf), Axial = 30N (6.75 lbf)
System MTBF	L10 Bearing Life calculated at 50% of maximum radial and axial load at 1000 RPM: 3.01E+06 hours (343 years)
Optical Interface	
Optical Interface	LC Duplex, 62.5/125µm multimode fiber, 0.275NA, Type OM1 IMPORTANT NOTE: Fiber optic pigtail length must be long enough so that the semi-metallic Duplex LC plug is outside of the MRI environment.
Link Length	Up to 2500 meters (8300 ft) with MR320 Controller
MR Attributes	**ACR Guidance Document for Safe MR Practices**
MR Usage Zones	MR328 sensor is designed for safe use in all MR Zones I-IV
Materials	Non-metallic except for fiber optic connector end Housing: polycarbonate, Shaft: polycarbonate, Bearings: ceramic
Explosive Atmospheres	**Inherently Safe, Simple Mechanical Device**
EX Classification	Inherently Safe, Simple Mechanical Device when used with MR320 Controller. IECEX Test Report (ExTR) GB/CML/ExTR 16.0039/00,
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Environmental Specifications	
Temp Range	Ambient laboratory environment
Humidity	0% to 95% RH (non-condensing)
Ingress Protection	IP50
Physical Attributes	
Housing	∅ 58mm x 58mm
Weight	280g (9.75 oz) - With 5m Pigtail)

Specifications subject to change without notice

4. Initial Preparation

4.1 Standard Contents

MR320 Controller Module will always include:

- MR320 Module with WAGO mating connectors installed (1 each: 12-, 10- and 6-pin)
- Poly bag containing WAGO Tool (233-335) and 3x Strain Relief Plates (733-128)

MR320 Sensors will always include:

- MR320 Series Sensor

One set of the following is included with any shipment with at least one MR320 Controller:

- MR320 Series / ZAPPY™ Installation Guide (printed copy)
- MR320 Series/ZAPPY™ Software Installation and Documentation CDROM
- MR321C Fiber Optic Cleaning Kit
- MR232-3 USB Cable

4.2 Unpacking and Inspection

The unit was carefully inspected mechanically and electrically before shipment. When received, the shipping carton should contain the following items listed below. Account for and inspect each item before the carton is discarded. In the event of a damaged instrument, write or call MICRONOR INC. in Camarillo, California. Please retain the shipping container in case reshipment is required for any reason.

4.3 Damage in Shipment

If you receive a damaged instrument you should:

1) Report the damage to your shipper immediately.
2) Inform MICRONOR Inc.
3) Save all shipping cartons.

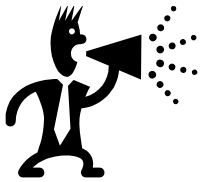
Failure to follow this procedure may affect your claim for compensation.

5. Installation Guidelines

5.1 System Planning

There are two recommended steps in designing and installing the fiber optic rotary encoder.

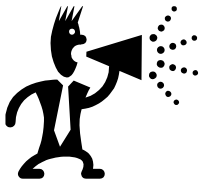
1. **Select cable and connectors which will meet performance, reliability and regulatory/contractual requirements.** Many applications operating in harsh or hazardous locations must follow industry-specific, contractual or government regulations – i.e. mines, building codes, ATEX, etc. . Connectors and cabling may need to meet flammability, radiation, temperature, corrosion resistance, altitude, shock, vibration, and/or other specific requirements.



Insertion Loss Performance Requirements

- Use only high quality, SUPER PC epoxy-and-polish terminated connectors and termini (epoxy-less or pre-terminated connectors tend to create back reflectance/return loss performance problems).
- A high-quality optical connector should have a worst case, end-of-life insertion loss of 0.5 dB over time and all environmental effects. The typical beginning-of-life (aka out-of-box) loss should be considerably less than 0.25 dB.
- Good quality mechanical splices should not exhibit insertion losses greater than 0.2 dB.
- Good fusion splicing techniques should produce insertion losses <<0.1 dB

2. **Verify that the optical link design meets optical loss budget.** The MR320 Series ZapFREE® Rotary Encoder system has a two-way loss margin of 12.5dB to cover fiber attenuation at 850nm over distance as well as losses of inline connectors and splices.



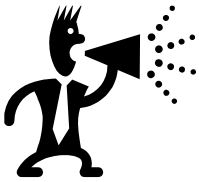
Important Considerations for Optical Loss Budget Analysis

- In the Optical Loss Budget analysis, you must also include the loss of the primary connections to the Sensor and Controller Module. That's two interconnections – typically high quality Duplex LC connectors for standard implementations.
- Since the fiber's attenuation is higher at 850nm versus 1300nm (this is a dual wavelength system), use the 850nm loss figure (typically 3dB/km) when accounting for fiber/cable losses.

EXAMPLE: Suppose that an installation will have a total link length of 1100 meters made up of two spans - 100m and 1000m. have a link length of 1100 meters consisting of a 100m and 1000m segments. Let's assume a worst case Duplex LC connection loss of 0.5dB and fiber attenuation of 3.5 dB/km at 850nm. The following table details the loss calculations to arrive at a predicted worst case loss of 10.7 dB - well below the MR320 system's 12.5 dB maximum system loss margin.

FEATURE	Input Fiber Loss (dB)	Output Fiber Loss (dB)	Total 2-Way Loss (dB)
MR320 Duplex LC Connection	0.5	0.5	1.0
100 meter Span (@ 3.5dB/km)	0.35	0.35	0.7
Duplex LC Interconnection of the two spans	0.5	0.5	1.0
1000 meter Span (@ 3.5dB/km)	3.5	3.5	7.0
MR324 Sensor Duplex LC Connection	0.5	0.5	1.0
TOTAL 2-WAY LOSS	Meets Optical Budget Requirements, < 12.5 dB System Margin		10.7

3. Follow industry-standard installation practices and trained fiber installers.



Follow Proper Installation Practices For Your Industry

- Different industries or applications may have standards related to fiber optic installations. Examples: BICSI for LAN and telecom installations, ISA or EU for hazardous locations, ARINC for civil and military air transport platforms, U.S. Navy for shipboard applications, SAE for generic aerospace applications, etc.
- Always follow best practices with regards to bend radius, flex, clamping and routing conventions. In fiber cable installations, excess bends and improper clamping produce additional losses that is not accounted for in the loss budget – and shouldn't be there anyway.
- Always place a dust cover over an open connector to prevent dirt from accumulating on the ferrule end.
- Always wipe a connector end face clean before mating.

5.2 Mounting the Solid Shaft Encoder Sensors

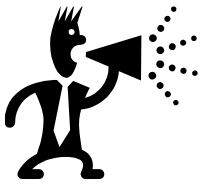
Applicable Models: MR322, MR326 and MR328 sensors

Consult reference drawing in Appendix A for most current mounting and dimensional information.

The mechanical workings of an encoder are straightforward. The rotor portion is coupled to a shaft, so that it will turn without slippage, and the encoder body is prevented from rotating so that it serves as a physical reference for the rotation of the rotor.

Here are two basic ways to mount the Shaft Encoder:

- Counter-Bored Panel Mount via Screws
- Through-Hole Panel Mount with Synchro Clamps



Important Considerations About Encoder Hook-Up

- Do not alter or modify the shaft otherwise the accuracy of the encoder and the dependability of the bearings and gaskets will be affected.
- Always use a flexible coupling between drive shaft and encoder shaft.
- Bearings are sensitive. Always handle the encoder with care when handling and mounting to the mechanism.
- The mechanical life of any encoder is mainly determined by the loading on the unit's bearings. As either the radial or axial shaft loading increases, bearing life is shortened. For this reason, the minimum amount of shaft loading or misalignment should always be the goal when installing an encoder.

5.2.1 Face Mount to Counter-Bored Panel

Consult encoder's reference drawing provided in Appendix A for most current mounting information, dimensions and tolerances.

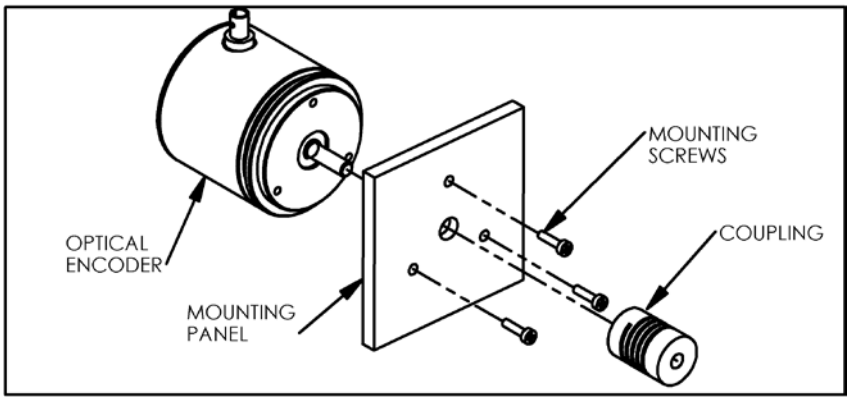


Figure 1. Shafted Encoder Face Mount via Counter-Bored Panel

Figure 1 illustrates how the encoder becomes mounted to the panel via three screws (M4 for MR322 and M6 for MR326) and to the mechanism's shaft with a flexible coupling:

STEP 1. Check that there are no burs on the mating shaft and that the set screws on the flexible coupling are backed off so they don't bind when slipped on the shaft.

STEP 2. Slide the coupling onto the mating shaft. If the mating shaft has a flat or a key way, make sure that the setscrew is aligned to land on the flat part of the shaft.

STEP 3. Mount the encoder to its bracket with screws. Do not tighten them all the way. Position the encoder shaft with the mating shaft so they are co-aligned with a gap of about 1/8-inch (3mm). Check the misalignment specifications for the coupling to ensure that it is not overstressed. Tighten the encoder mounting screws.

STEP 4. Align the flat of the encoder shaft with the flat or keyway on the mating shaft. Center the coupling over the gap between the two shafts and tighten the setscrew on the mating shaft. Wiggle the encoder shaft back and forth slightly to ensure that the coupling is not binding and it is at its free length. Now tighten the setscrew on the encoder shaft. Installation is complete.

5.2.2 Thru-Hole Panel Mount with Hold-Down (Synchro) Clamps

Consult reference drawing in Appendix A for most current mounting and dimensional information.

Figure 2 illustrates how the encoder becomes mounted to the panel via three hold-down clamps Order Micronor P/N 6099.20.651 for MR322 encoder or 6099.20.652 for MR326 encoder. Each kit is a set of 3 clamps and 3 screws. Use a flexible coupling for connecting to the mechanism's shaft.

STEP 1. Check that there are no burrs on the mating shaft and that the set screws on the flexible coupling are backed off so they don't bind when slipped on the shaft.

STEP 2. Slide the coupling onto the mating shaft. If the mating shaft has a flat or a key way, make sure that the set screw is aligned to land on the flat part of the shaft.

STEP 3. Mount the encoder to its bracket or panel with the Synchro clamps. Do not tighten them all the way. Position the encoder shaft with the mating shaft so they are co-aligned with a gap of about 1/8-inch (3mm). Check the misalignment specifications for the coupling to ensure that it is not overstressed. Tighten the encoder's synchro clamp mounting screws.

STEP 4. Align the flat of the encoder shaft with the flat or keyway on the mating shaft. Center the coupling over the gap between the two shafts and tighten the setscrew on the mating shaft. Wiggle the encoder shaft back and forth slightly to ensure that the coupling is not binding and it is at its free length. Now tighten the set screw on the encoder shaft. Installation is complete.

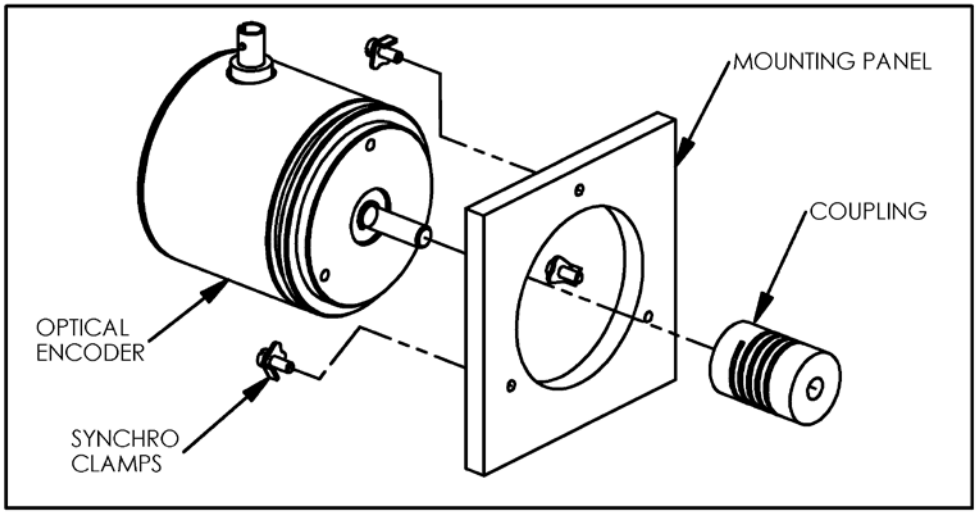


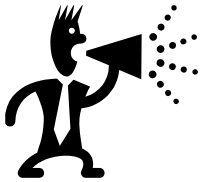
Figure 2. Shafted Encoder Mounting via Thru-Hole With Synchro Clamps

5.3 Mounting the Hollow-Shaft Rotary Encoder

Applicable Model: MR324

Like the MR322/MR326, the mechanical workings of the MR324 sensor is straightforward. The rotor portion is coupled to a hollow shaft and the encoder body is prevented from rotating via a flexible Tether arm or Spring Clip attached to the Stator.

Figure 3 shows various mounting options and hardware available for the MR324 hollow shaft encoders.



Important Considerations About Hollow Shaft Encoders

- Do not alter or modify the hollow shaft assembly otherwise the accuracy of the encoder and the dependability of the bearings and gaskets will be affected.
- Bearings are sensitive. Always handle the encoder with care when handling and mounting to the mechanism.
- Bearing degradation can occur if motor shaft currents are allowed to pass through the encoder bearings. While the fiber optic connection provides overall electrical isolation, it may be necessary to locally isolate the shaft by either use of an isolation insert or insulating the tether arm. The MR314 Tether Arm kit includes insulating bushings.
- The mechanical life of any encoder is mainly determined by the loading on the unit's bearings. As either the radial or axial shaft loading increases, bearing life is shortened. Excessive runout will cause premature bearing failure. For this reason, the minimum amount of shaft loading or misalignment should always be the goal when installing an encoder.

Consult the MR324 data sheet for detailed product description, dimensions and instructions for mounting the encoder using the optional MR314A or MR314B Mounting Kit. Generically, follow these procedures for mounting the encoder:

STEP 1. Check that there are no burs on the mating shaft and that the shaft length is correct for the encoder

STEP 2. Attach the Tether Arm to the encoder body using the supplied hardware. Slide the assembly onto the mating shaft.

STEP 3. Rotate the Tether Arm until it is at the correct orientation and align with the mounting feature on the shaft housing. Using the appropriate hardware to secure the tether arm in that position.

STEP 4. Check to make sure that the tether is still in its "unstressed" condition and then tighten the shaft clamp on the encoder. Check for excessive runout as you rotate the shaft by hand. (Excessive runout will cause premature bearing failure.) If the runout is excessive, then reinstall the encoder. Otherwise, installation is complete.

Pictures	Example of Use	Use	Pitch Circle	Order Code

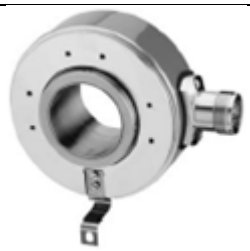
	(Shown with Hollow Shaft Optical Encoder)		Diameter	
		For applications with fastening points located on variable pitch circle	104-206 mm	MR314A
		For applications with high axial play	110 mm	MR314B (Use Long Spring and Pin)
		For applications with reduced mounting space	76 mm	MR314B (Use Short Spring and Pin)
		For applications with axial and radial plus with low dynamics for constant rotary movement	65mm	MR314B (Use Small Tether Bracket and Screw)
		Adapt smaller shafts to MR324 38mm bore	For Shaft Sizes 12mm (0.47”) 14mm (0.55”) 15mm (0.59”) 16mm (0.63”) 18mm (0.71”) 20mm (0.79”) 25mm (0.98”) 30mm (1.18”) 32mm (1.26”) 1/2” 5/8” 3/4” 1” 1 1/4”	 8.0010.4091.0000 8.0010.4027.0000 8.0010.4038.0000 8.0010.4019.0000 8.0010.4080.0000 8.0010.4011.0000 8.0010.4012.0000 8.0010.4016.0000 8.0010.4015.0000 8.0010.4013.0000 8.0010.4070.0000 8.0010.4090.0000 8.0010.4050.0000 8.0010.4060.0000

Figure 3. Hollow Shaft Encoder Mounting Options

5.4 Mounting the Controller Module

The MR320 Controller is designed to mount on a standard 35mm DIN rail, as shown in Figure 4 below.

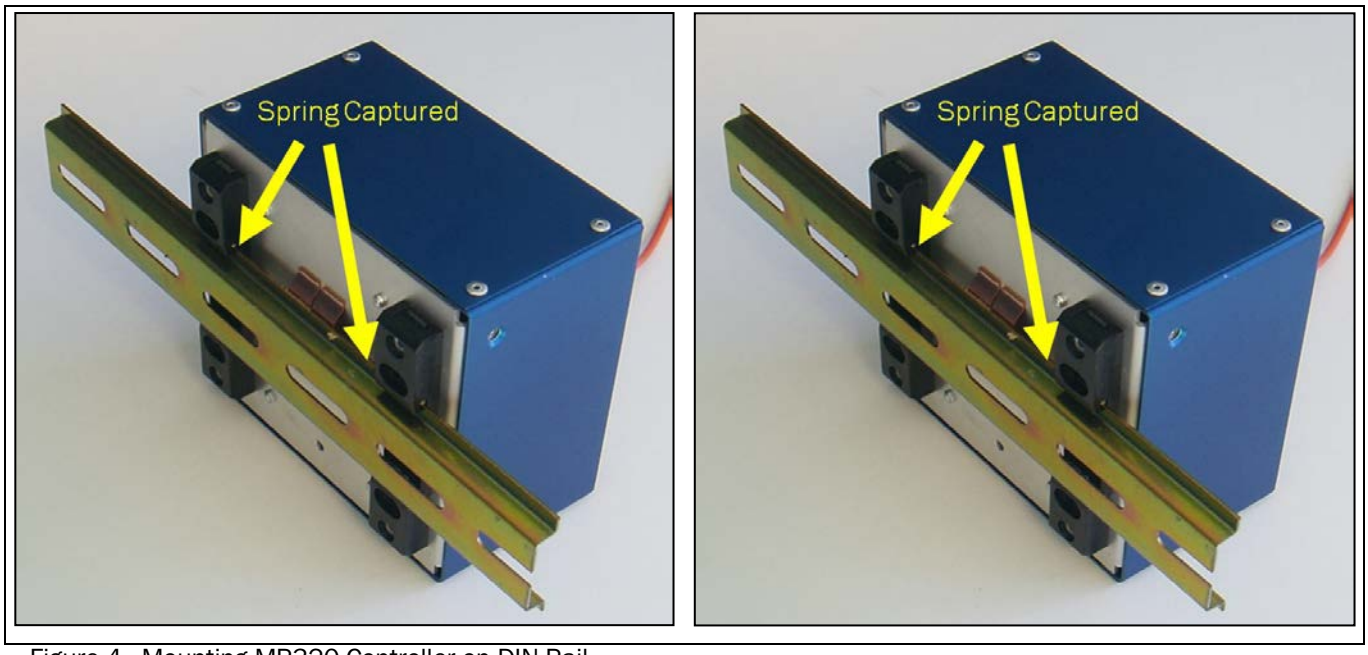


Figure 4. Mounting MR320 Controller on DIN Rail.

5.5 Making Optical Connection to the Controller Module

Figure 9 illustrates all connections (both electrical and optical) and controls on the MR320 Controller.

A duplex fiber optic cable is used to interconnect the Sensor and Controller. The MR320 Controller incorporates a Duplex LC receptacle while the Sensor can either feature a Duplex LC optical pigtail or Harsh Environment ODVA LC Duplex receptacle. The optical link can be a direct connection between Sensor and Controller via the Sensor pigtail or multi-segment link incorporating interconnections and splices (as long as the 2-way optical loss does not exceed 12.5 dB).

Figure 5 shows the proper method of making a Duplex LC connection. Remove the dust cap from both the connector on the cable and the receptacle on the controller. Insert the LC Duplex connector as shown. There should be a positive click when the connector is engaged properly.

Figure 5. Making Duplex LC Optical Connection to MR320 Controller.

5.6 Making Electrical Connections to the Controller Module

Figure 9 illustrates all connections (both electrical and optical) and controls on the MR320 Controller.

Electrical connections to the MR320 Controller are via three WAGO Quick-Connect plugs and USB receptacle.

A set of three WAGO Quick-Connect plugs, three strain relief plates and WAGO Insertion Tool are supplied with the Controller Module to facilitate connections to J1/J2/J3 and are cross-referenced in Figure 6 below. All three Terminal Connectors are WAGO type Mini Multi Connection System with 2.5mm spacing.

WAGO Connector Part Numbers for Terminal Connectors		
Location	**MICRONOR PN**	**WAGO PN**
J1	63-733-112	733-112
J2	63-733-110	733-110
J3	63-733-106	733-106
Tool	63-233-335	233-335

Figure 6. Cross-Reference for WAGO QuickcConnect Plugs used for J1/J2/J3 Connections

These terminal connectors are non-screw connections and accept wires from AWG20 through AWG 28 or 0.5mm^2 to 0.08mm^2. The WAGO terminal blocks are a convenient way to pre-wire harnesses. To make connections, consult Figure 7 and the following steps::

1. Strip the wire approx. 0.22" (5mm to 6mm) length.
2. Insert the white operating tool into the square hole of the terminal.
3. Then insert the stripped wire all the way down and remove the operating tool.
4. When wiring completed, simply insert the WAGO plug into the appropriate interface connector (J1, J2 or J3). To remove the WAGO plug, grab top and bottom of plug and pull to disconnect

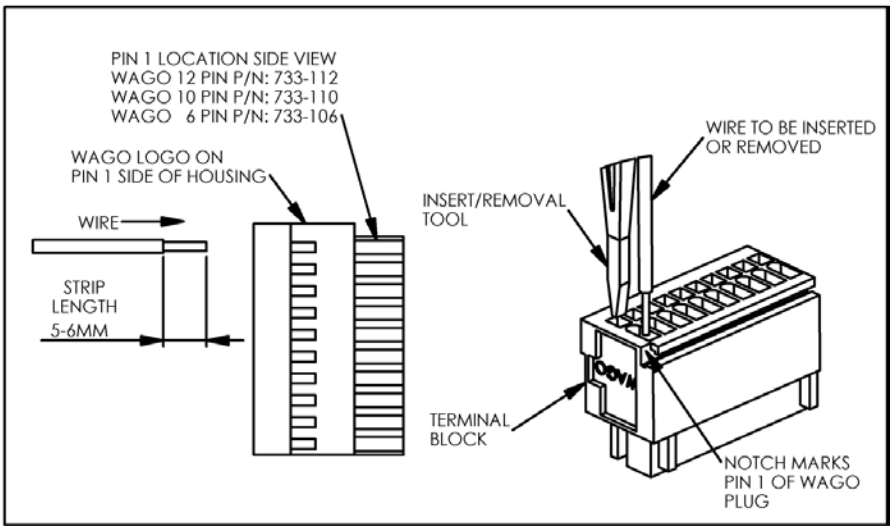


Figure 7. How To Insert and Remove Wires From the WAGO Plug

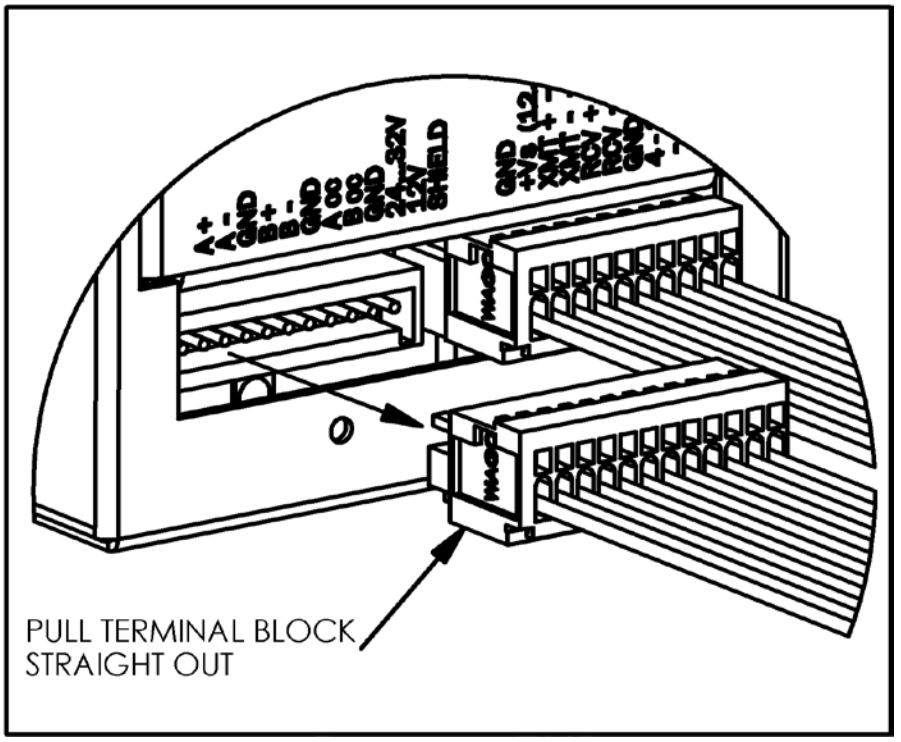
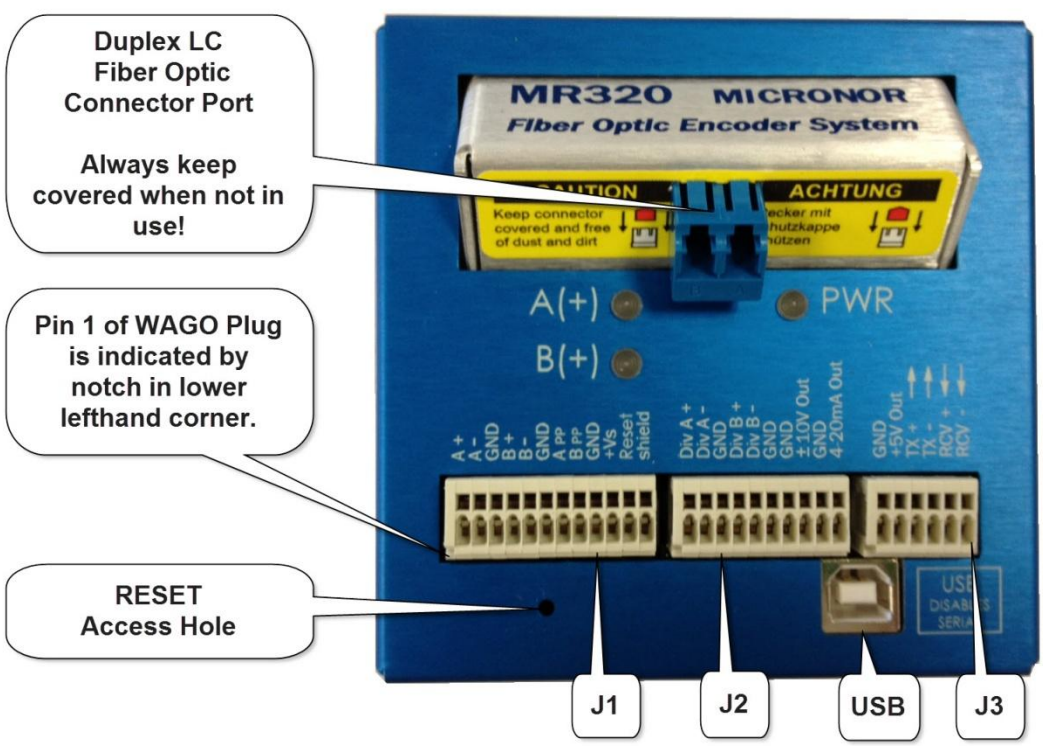


Figure 8. Inserting/Removing the WAGO Plug From The MR320 Controller Module.



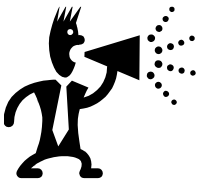
J1 Connections Real-Time Quadrature Outputs and Power Supply	
1	**A+** RS422 Line Driver (5V TTL)
2	**A-** RS422 Line Driver (5V TTL)
3	GND
4	**B+** RS422 Line Driver (5V TTL)
5	**B-** RS422 Line Driver (5V TTL)
6	GND
7	**A** Push-Pull (24V)
8	**B** Push-Pull (24V)
9	GND (power)
10	+Vs (power) (15V to +32V)
11	Counter RESET (24V Logic "1")
12	Shield

J2 Connections Divider and Analog Outputs	
1	Divider **A+** RS422 Line Driver (5V)
2	Divider **A-** Push-Pull (24V)
3	GND
4	Divider **B+** RS422 Line Driver (5V TTL)
5	Divider **B-** Push-Pull (24V)
6	GND
7	GND
8	±10V Out
9	GND
10	4-20mA Out

J3 Connections RS422/485 Serial I/O plus connection for MR232-1 series Adapter Cable	
1	GND
2	+5V Out (10mA max, power for MR232-1 Converter Cable)
3	TX+ →
4	TX- →
5	RCV+ ←
6	RCV- ←

Figure 9. Connections and controls of the MR320 Controller Module

ELECTRICAL CONNECTION	DESCRIPTION
Case Shield	Connection is made through pin 12 of J1 (12-pin plug).
Power	Power connections are made through pins 9 (GND) and 10 (+15V to +32V) of J1 (12-pin plug). Observe correct polarity!
REAT-TIME DIRECT Quadrature Outputs	These signals are the direct outputs of the ZapFREE® rotary encoder after conversion from optical to electrical signals. The A/B Push-Pull outputs are available through pins 7 and 8 of J1. The A+/A-/B+/B- RS422 Line Driver outputs are available through pins 1, 2, 4, and 5 of J1. Ancillary GND connections are available via pins 3 and 6 of J1.
DIVIDER Quadrature Outputs	These are the quadrature electrical outputs after going through the Programmable Divider function. DIV A+/B+ RS422 Line Driver outputs are available via pins 1 and 4 of J2. DIV A-/B- Push-Pull outputs are available via pins 2 and 5 of J2. Ancillary GND connections are available via pins 3 and 6 of J3.
USB Interface	Direct connection via Type B receptacle provided.
RS485 Serial Interface	Line driver signals available via pins 3, 4, 5 and 6 of J3. For RS232 serial communications, MR232-1 Converter Cable plugs into J3.
VOLTAGE Analog Output	This analog output is available on pin 8 of J2 and can be configured to represent position or speed (rpm). Voltage mode and scale are set using ZAPPY™ software or as commands issued over the serial interface
CURRENT Analog Output	This analog output is available on pin 10 of J2 and can be configured to represent position or speed (rpm). Current mode and scale are set using ZAPPY™ software or as command issued over serial interface
POSITION COUNTER RESET Input	This external control signal is available on pin 11 of J1. This signal line allows the 24-bit Internal Counter to be reset to a pre-programmed counter value when the input is changed from logic 0 to logic 1 (High, +24V). The reset value is factory preset to 0 (zero). The customer may change this reset value to any number by setting the appropriate parameter via ZAPPY™ configuration software via serial interface commands. Section 5.9 shows how to perform a manual RESET.



Important Power Connection Warnings!

- Always observe correct polarity of the power supply connections or damage to the Controller module may occur. Input range is +15 to +32VDC.
- While the Controller is protected against cross polarization of the power supply connections, the unit will ***not operate*** if wrongly connected. The unit maybe damaged by connecting a power supply to an input or output.
- There is an initial in-rush current in excess of 100mA. The power supply must be capable of handling that current.

5.7 Fiber Optic Cable, Connections and Routing

A complete and functional MR320 Series Fiber Optic Encoder System consists of a MR320 Controller and MR320Series Passive Sensor connected by an optical link. The fiber link shall be comprised of standard 62.5/125 Graded Index multimode fiber. Terminations may be either Duplex LC or ruggedized ODVA LC Duplex (IP-LC) depending on the application and expected environment.

The following figures illustrate some of the optical link configurations possible. For harsh environments, Micronor recommends the ruggedized IP66/IP67-rated ODVA LC Duplex (IP-LC) interface as shown in Figure 11. For application assistance, please contact Micronor sales and technical support.

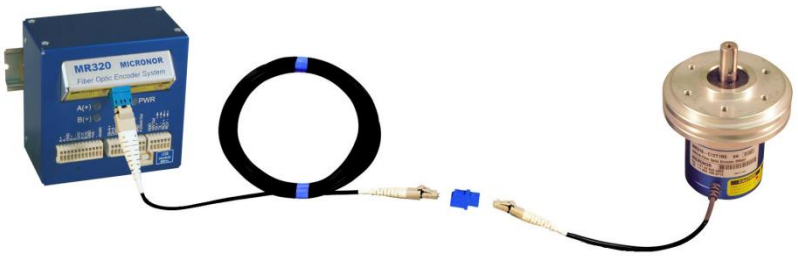


Figure 10. Typical MR320 Series Fiber Optic System connections using Sensor with Duplex LC Pigtail

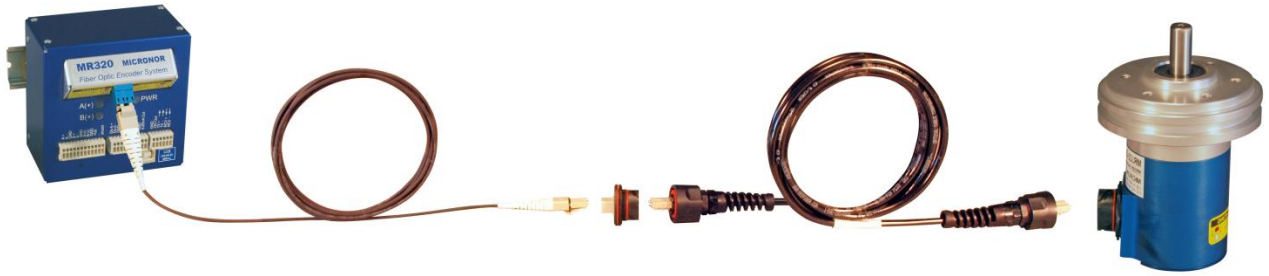
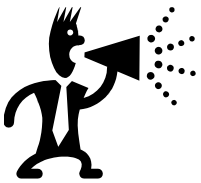


Figure 11. Typical MR320 series system using Harsh Environment ODVA LC Duplex (IP-LC) Connections



Fiber Optic Connector Optical Performance Requirements

- Always use high quality Duplex LC or ODVA IP-LC connectors and terminations. High precision single mode connectors are not much more expensive than multimode versions. "Epoxy and Polish" connectors are preferred over "hot melt" or other quick termination style connectors.
- Insertion loss < 0.5dB measured at 850nm and 1300nm
- Polished to single mode endface geometry specifications per TELCORDIA GR-326-CORE

For relatively benign industrial environments, sensors with Duplex LC optical pigtails and standard Duplex LC link assemblies are usually adequate.

For harsh environments, sensors with ODVA IP-LC receptacles and links comprised of heavy duty ODVA IP-LC environmental assemblies are recommended. Cabling should also be selected that is certified for the intended temperature range, environment and application. Sensors must be specified that have adequate shaft seals and IP rating. For example:

- Oil rig equipment must be resistant to mud oil used to lubricate drilling apparatus

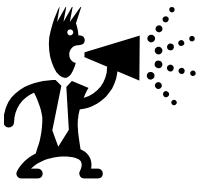
- Mining applications are typically dusty environments and may also require cabling meeting MSHA standards.
- Other industrial and process environments may require resistance to harsh and corrosive chemicals such as detergents, acids, hydraulic fluid, jet fuel, etc.

Before connecting the optical link between the Controller module and Sensor, the cable should be routed and installed such that:

- Proper bend radius specifications are not exceeded; and
- There is no pinching or other deformation of the optical cable at any point.
- Follow best installation practices which meet or exceed applicable industry standards such as the BICSI Information Transport Systems Installation Manual (for commercial datacom installations), ARINC 628 Part 6 or ARINC 806 (for avionics applications), SAE AS5088 (for aerospace), etc.

Proper functioning of a ZapFREE® Fiber Optic Rotary Encoder is very dependent on having clean optical connections. Before making any optical connections, you should make sure that:

- Connector ends have been properly cleaned and visually inspected before making connection to the ZapFREE® hardware.
- When required, thorough cleaning should be performed with reagent grade (99%) Isopropyl Alcohol (IPA) and dry lintless wipes (e.g. Kimwipes). Field portable cleaning tools such as the CLETOPS are suitable when only surface cleaning is required.
- For visual inspection, a 200x or 400x high quality fiber optic connector inspection microscope is recommended. Dirty or damaged connector ends can also damage the connector being mated to.
- Unmated connectors should always have dust caps installed to protect the polished ends from airborne contaminants or damage from mishandling.



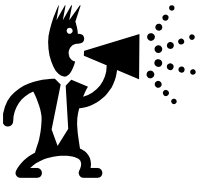
Fiber Optic Connector Cleanliness Is Important!

- Always clean and visually inspect connector ends before mating to the ZapFREE® equipment.
- Always cap unmated connectors.
- Fiber optic connectors do not require maintenance. That is, do no disconnect for the sole purpose of examining the ends. ***If it ain't broke, then don't fix it!***

5.8 First Time Start-Up

After making all conenctions to Controller and Sensor, perform the following Start-Up procedure:

- Step 1: Turn on power. PWR LED should be ON.
- Step 2: Follow the Manual Reset procedure described in Section 5.9



PWR LED Indicator and Error Code Interpretation

The Controller goes through an internal Calibration Cycle every 60 seconds. Thus, every 60 seconds a single blink of the PWR LED can be observed. If at any time, the PWR indicator blinks more than once, then count the number of blinks and consult the Error Table under the Troubleshooting section.

5.9 Manual Gain Calibration (Manual Reset)

If after operating (at a rotation of at least 50RPM), the encoder will not function properly - then a manual reset is necessary. This is not a malfunction of the unit. The issue is simply that the received optical power is currently below the detection range of the unit and the unit must recalibrate its optical gain levels. This step may only be necessary after initial installation.

To perform a Manual Reset, follow this simple procedure:

- STEP 1: Rotate input shaft of Sensor..
- STEP 2: While rotating shaft, momentarily depress the Reset button as shown in Figure 12
- STEP 3: Stop rotating.

When you press the reset switch, the POWER LED will turn OFF as long as the switch is pressed. You may press the switch as many times as you wish. However, a proper calibration will only occur when the encoder is in motion while the reset switch is being depressed.

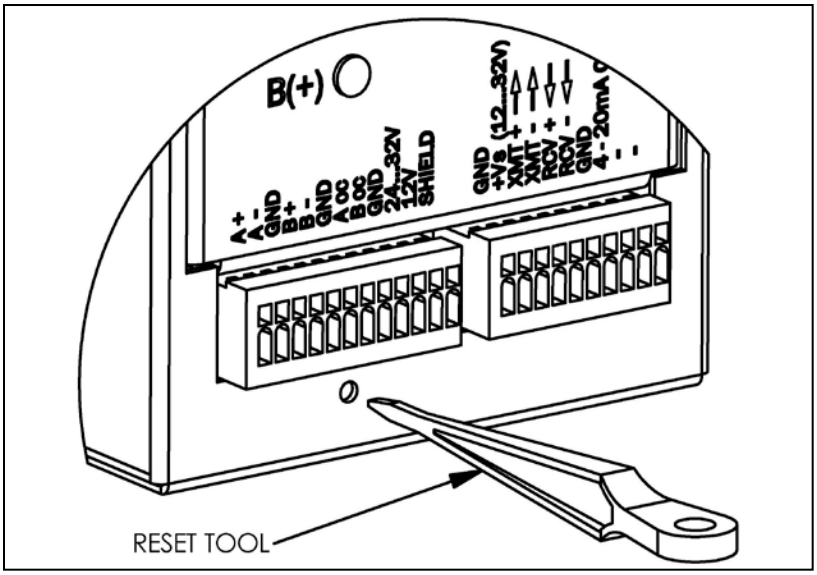


Figure 12. How to Manually Reset the Controller Module With WAGO Tool.

5.10 Manual Transmitter Power Calibration

One way to set the optical output power level is by holding down (10 seconds), the calibration button on the blue controller box. (Use the WAGO tool or small crew driver). After approx. 9 to seconds the LED blinks signaling the start of the calibration cycle. Keep holding the button until another blink is observed, which signals the end of the calibration cycle. Please note, the encoder must be rotated during the calibration cycle beween the two blinks, in order to provide meaningful peak power levels. Internally the system will set the amplifier gain to approximately 5 and then the transmitters until the right amount of light (~2.1V amplifier output) is received.

5.11 ZAPPY™ Installation and Setup Software

Micronor provides ZAPPY™ with the MR320 Controller Module – a user friendly program used to set up parameters associated with the various Auxiliary Functions (i.e. analog outputs, Divider, etc.). This information is then uploaded and stored in the non-volatile memory of the Controller.

ZAPPY™ runs on a PC running Windows (XP, Vista or 7), .net Framework and an available USB or RS232 COM port. A USB cable is provided with each system or controller order. To use an RS232 DB9 port, the optional MR232-1 Converter Cable is required

The ZAPPY™ software installs like standard PC software. If it does not start automatically when the CD is installed, then use the Windows RUN function (from the Start Menu) to find and execute the Setup.exe file. The ZAPPY™ HOME page and description of the ZAPPY™ tool bar are shown in Figure 13.

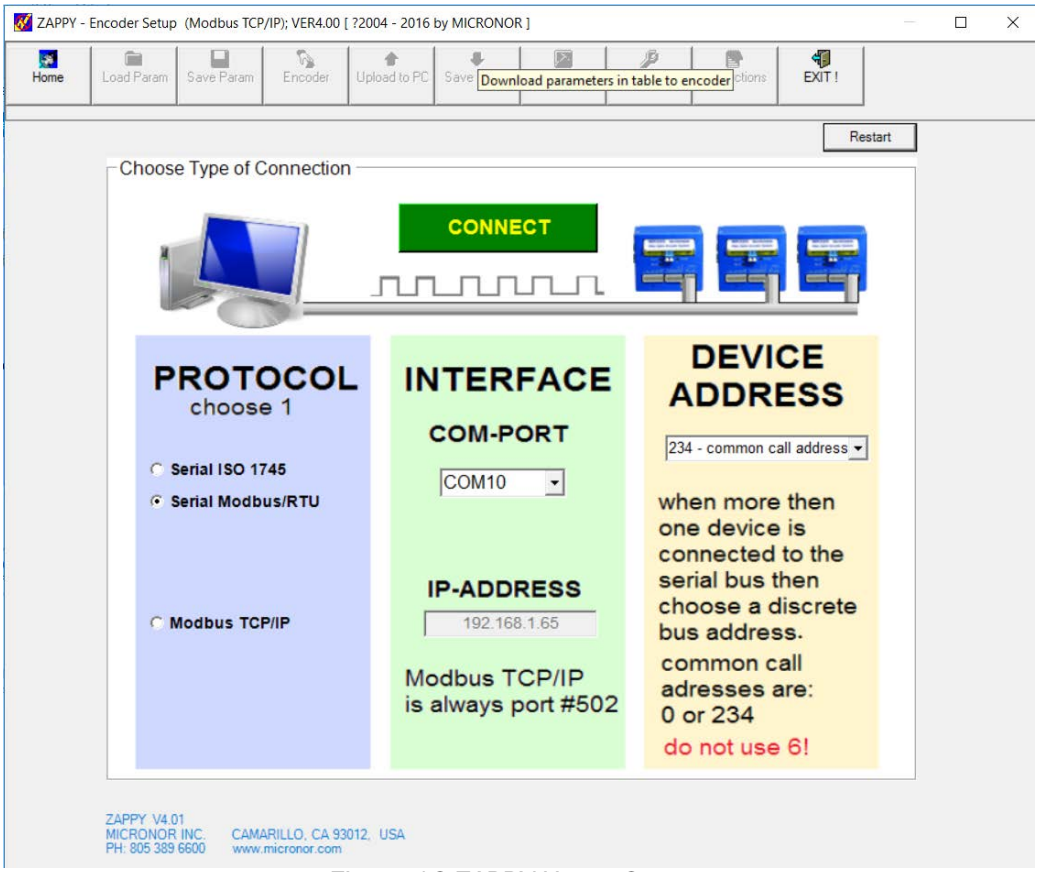


Figure 13 ZAPPY Home Screen

Select the desired format you want to communicate with. MR310 controllers must use the Serial ISO1745 protocol. Communicating via the Modbus TCP/IP requires an addional network interface. Please refer to Micronor APP Note: AN119

ZAPPY TOOLBAR MENU	DESCRIPTION
HOME	Restores ZAPPY™ HOME page with current software version information.
LOAD PARAM	Allows a pre-existing setup file of encoder parameters to be downloaded into the ENCODER table view window.
SAVE PARAM	Allows the existing ENCODER table view parameters to be saved to a file for later access via LOAD PARAM function
ENCODER	Displays encoder parameters in editable table format. From this mode, LOAD PARAM, SAVE PARAM, UPLOAD TO PC and SAVE TO MR320 functions are enabled and can be accessed.
UPLOAD TO PC	Downloads the current parameters from the connected Controller and overwrites the ENCODER parameter view.
SAVE TO UNIT	Uploads the current ENCODER parameter view to the connected MR320 Controller module.
OPERATE	Accesses the OPERATE view which displays current encoder status, including speed and position counter. This function is intended for demo use only and does not serve any other purpose
DIAGNOSTICS	Provides access to various internal controls and hardware status, including voltage test, optical source control, slit time measurements, internal DAC, and input amplifier.
INSTRUCTIONS	Short form instruction reference for the MR320 Encoder System
EXIT	Close ZAPPY™ program.

Figure 14. ZAPPY™ HOME page and Tool Bar description

5.12 Initial Performance Verification with ZAPPY™

If you are planning to use the encoder in "pure" hardware mode (that is, using the Direct Quadrature Outputs only), then using the ZAPPY™ software is not necessary – but highly recommended under these conditions:

- Performance verification upon receipt
- To take advantage of the numerous built-in Auxiliary Functions that the MR320 Controller offers.
- If the MR320 module will be used under USB or Serial Interface control - to become familiar with the various programmable functions

The ZAPPY™ software is designed for RS232 communication with the MR320 module via a PC running WINDOWS (XP, Vista or 7) and .net Framework installed and connected using either the optional MR232-1 RS422/RS485-to-RS232 Adapter Cable or USB cable.

ZAPPY™ Software installation and connection:

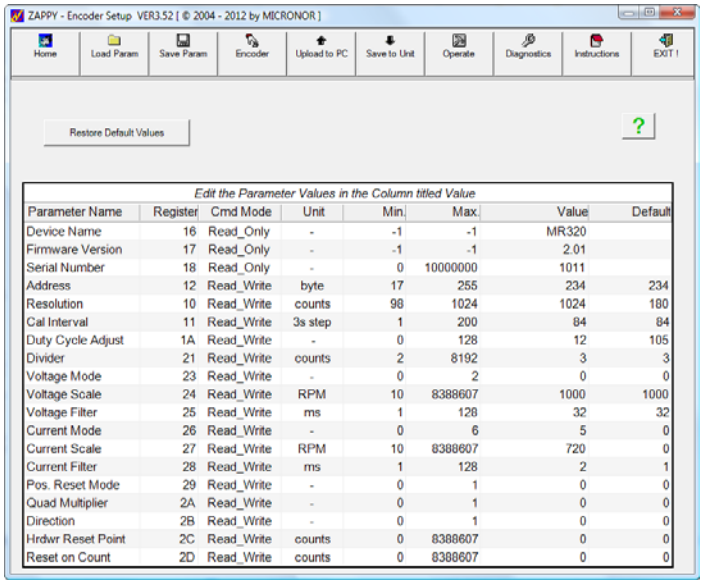
STEP 1. Install ZAPPY™ software on the target PC.

STEP 2. Connect PC to MR320 Controller via either USB cable ***or*** (2) MR232-1 cable (connecting between J3 and PC's COM1 serial port) .

STEP 3. Apply power to the MR320 and start up the ZAPPY™ software.

STEP 4. HOME page appears if PC and Controller are communicating properly. When using USB connect the USB to the PC and power up the MR320 controller prior to starting the ZAPPY software. Then select the appropriate COM-PORT (i.e. COM5, COM9..) before clicking the "Connect" button. When the communication with the MR320 controller is establish the button changes to red background color.

STEP 5 Select [UPLOAD TO PC] to load the current Encoder parameter values from the Controller into the Encoder Table View as shown in Figure 14. If there is no serial communications connection, you will experience a "Communications Timeout" and you will need to troubleshoot the serial interface per Section 7.2 Interface Problems.



Parameter Name	Register	Cmd Mode	Unit	Min.	Max.	Value	Default
Device Name	16	Read_Only	-	-1	-1	MR320	
Firmware Version	17	Read_Only	-	-1	-1	2.01	
Serial Number	18	Read_Only	-	0	10000000	1011	
Address	12	Read_Write	byte	17	255	234	234
Resolution	10	Read_Write	counts	98	1024	1024	180
Cal Interval	11	Read_Write	3s step	1	200	84	84
Duty Cycle Adjust	1A	Read_Write	-	0	128	12	105
Divider	21	Read_Write	counts	2	8192	3	3
Voltage Mode	23	Read_Write	-	0	2	0	0
Voltage Scale	24	Read_Write	RPM	10	8388607	1000	1000
Voltage Filter	25	Read_Write	ms	1	128	32	32
Current Mode	26	Read_Write	-	0	6	5	0
Current Scale	27	Read_Write	RPM	10	8388607	720	0
Current Filter	28	Read_Write	ms	1	128	2	1
Pos. Reset Mode	29	Read_Write	-	0	1	0	0
Quad Multiplier	2A	Read_Write	-	0	1	0	0
Direction	2B	Read_Write	-	0	1	0	0
Hrdwr Reset Point	2C	Read_Write	counts	0	8388607	0	0
Reset on Count	2D	Read_Write	counts	0	8388607	0	0

Figure 15. ENCODER Table View Screen.

Review the table contents and make any necessary changes to the parameter setup. Given the sample screen shown in

STEP 5. Figure 14, let's say that the existing encoder setup needs to be modified because the actual encoder has a resolution of 100 ppr. Simply type "100" followed by "↵" (ENTER) over the VALUE field for RESOLUTION.

STEP 6. If there are any parameter changes, then select [SAVE TO UNIT]. These values will be transferred to the MR320 and stored in non-volatile memory.

Next, let's test the encoder in actual – but manual – operation using the OPERATE and DIAGNOSTICS functions:

STEP 1. Select [OPERATE] mode and observe the initial static screen display similar to Figure 15. Adjust RPM METER SCALE setting as desired by writing into the field. Click on [RESET] to zero the POSITION COUNTER.

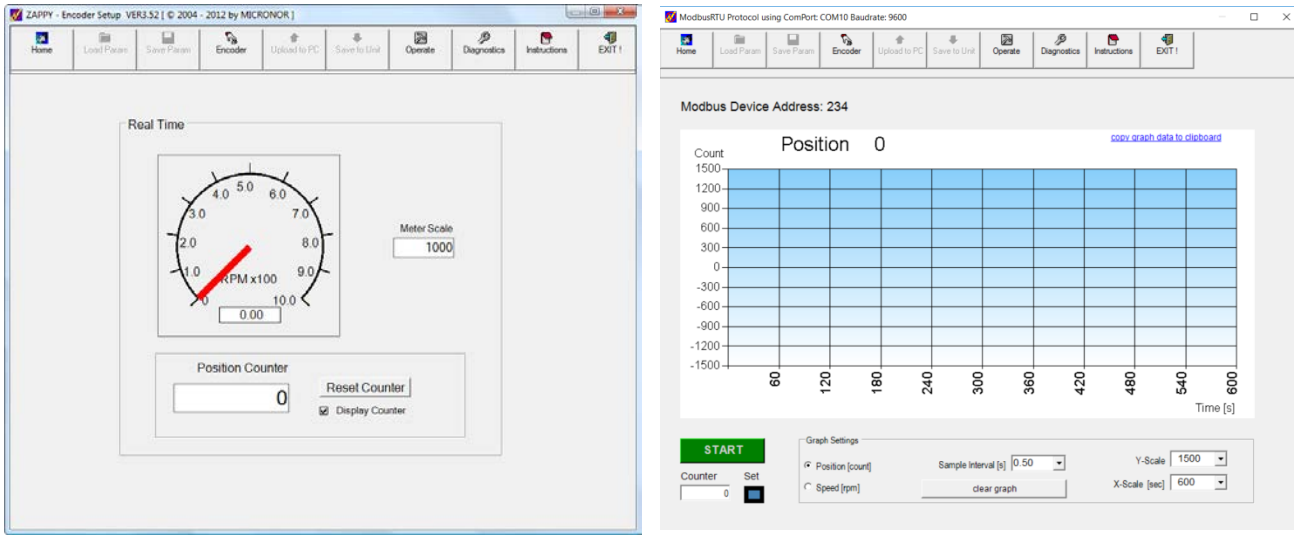


Figure 16. Initial OPERATE Screen if encoder is inactive. New Version 4.00 right

STEP 2. An initial check would be to deliberately and semi-precisely turn the encoder shaft for one revolution and note if the correct number of counts is displayed. (HINT: A little adhesive tape flag formed around the encoder shaft would provide some degree of finger control.) An active [OPERATE] screen is also shown in Figure 16.

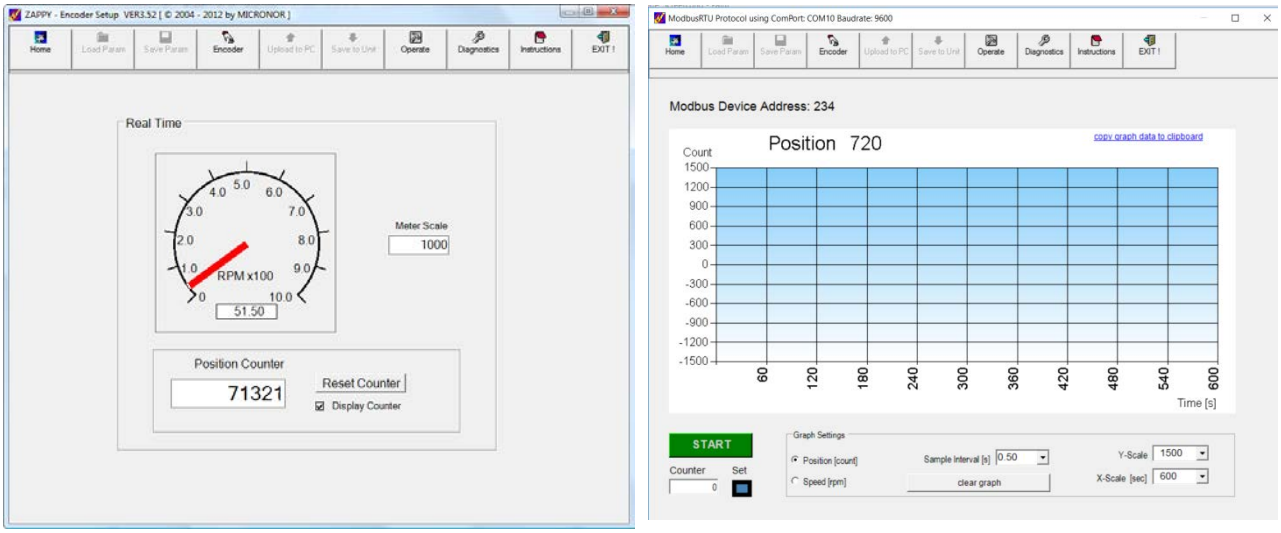


Figure 17. OPERATE Screen displays Real-time Encoder Operation. New Version 4.00 right

STEP 3. Select [DIAGNOSTICS] to view various monitoring points within the MR320. Figure 17 shows the initial screen or else when the encoder is not moving. When the encoder is still, the system cannot take a snapshot of these internal points since there is no slit-to-slit movement - hence the red-framed RPM TOO SLOW message. Depressing [DIAGNOSTICS] tab while the encoder is rotating provides a snapshot of the internal monitoring points as shown in Figure 18. Checking the "Continuous box:" will repeatable update the entire set of readings while the individual diagnostic groups (Voltage Test, Analog Outputs, get Speed are updated when clicked. A brief explanation of the relevant diagnostic fields follows on the next page.

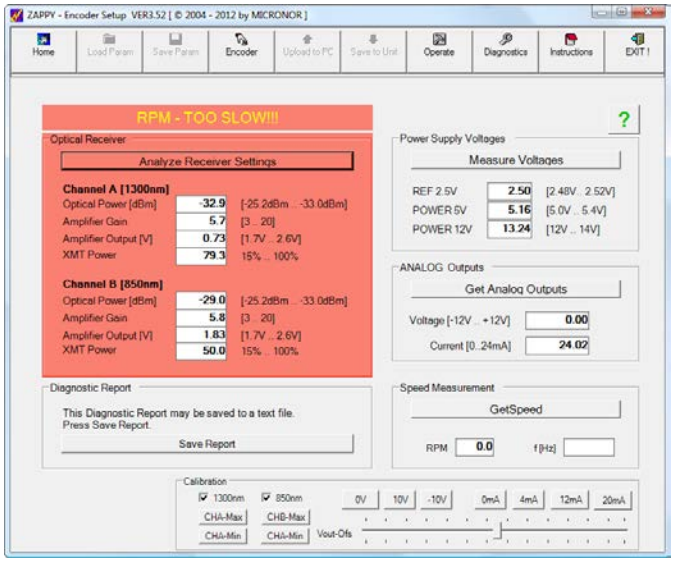
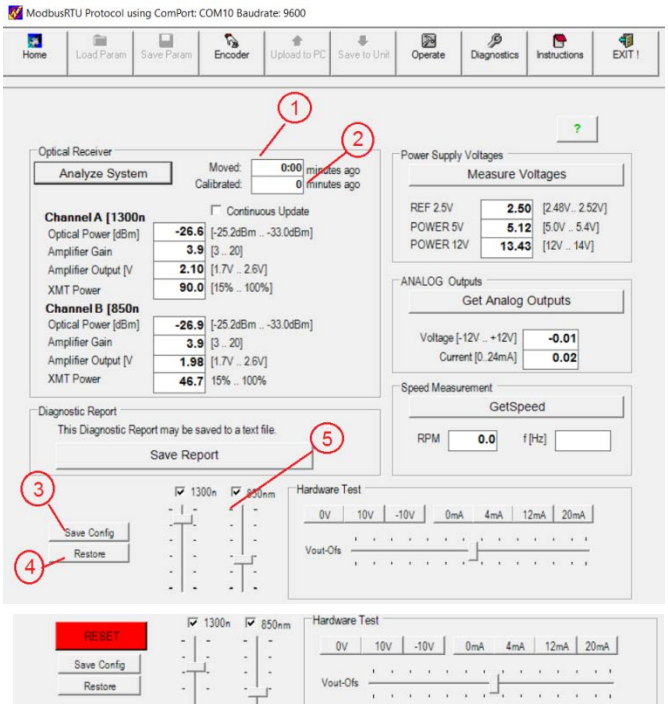


Figure 18. Initial DIAGNOSTICS Screen when encoder is inactive. MR320 Firmware Version < 2.20

Newer MR320 models (V 2.20) store the diagnostics value within their memory whenever the encoder is rotating. This allows to recall the diagnostic values even when the encoder cannot be rotated by hand.



(1) Indicates the time since the encoder has seen a movement.
Note, if the optical power levels are too low the encoder will not register a movement. Increase gain and power levels.

(2) Indicates the time since the encoder last executed an internal calibration cycle. This time is given by the Interval parameter plus the time of non movement.

(3) Once a good configuration is established use this function to save the values in the EEPROM for later restoration.

(4) Recall a "good" configuration.

(5) Use to adjust optical transmitter power levels. When these sliders are adjusted a red "RESET" button pops up. This signals tha the MR320 is now in a servicing modus. Click the "RESET" button before continuing.

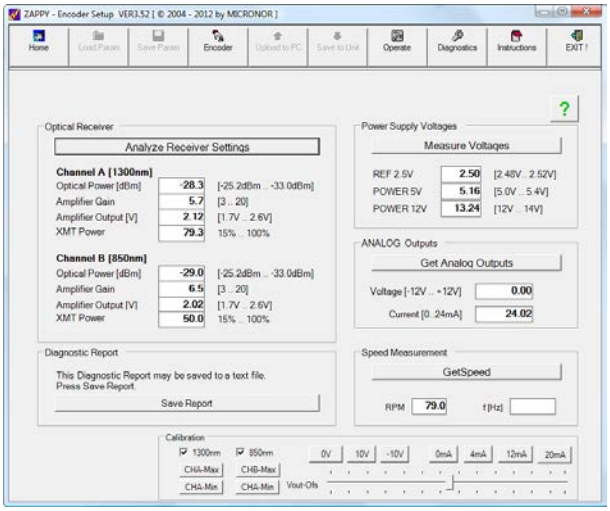
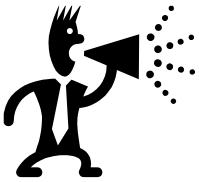


Figure 19. DIAGNOSTICS Screen displays internal operating points when encoder is active. MR320 Version < 2.20



Manual Override Of Certain Parameters In DIAGNOSTICS Mode

The [Diagnostics] view allows certain internal parameters to be overwritten for diagnostic and troubleshooting purposes – e.g. CH A/B optical sources, Analog outputs and the internal Amplifier Gain factors.

DIAGNOSTICS Field Name	DESCRIPTION
Optical Receiver	A and B quadrature signals correspond to Channels A (1300nm) and B (850nm) respectively. The internal optical receiver parameters are measured via a Peak Detector circuit. To measure properly, the encoder must be turning at least 100 rpm (same as required for CALIBRATE mode) for the measured values to be comparable to the acceptance range shown to the right. If the encoder is either not or turning too slow in this mode, you will see the red-framed [RPM - TOO SLOW] message. The Amplifier Gain and Peak optical power values are measured for each optical channel. The Gain value is modified by the periodic Calibrate mode which adjusts for any changes in optical power. Typically, the Gain values ranges from 3 to 20 and the optical power should fall within the range of -25.5 dBm to -33 dBm. "Hot" (or high power) optical transmitters are possible.
Power Supply Voltages	Measures internal voltage reference as well as internal +5V and +12 supplies.
ANALOG Outputs	The DAC output (0..4095) of both the Voltage and Current analog outputs is measured and shown. The output value will depend on the Mode, Scale and Filter settings for that analog output (see Encoder table view per Figure 14). For example, if the encoder is stationary (0 RPM), Current Mode=0 (bipolar output for 0-24mA with 12mA being mid-scale value of 0), Current Scale=100 (100 RPM), Current Filter set to any value, then the DAC output will be 2048 (half scale) and the actual current output will be 12 mA (0 RPM).
Speed Measurement	The encoder measuring speed by evaluating the real-time slit-to-slit time period. This field displays time and frequency values corresponding to current shaft speed. Manually spinning the encoder shaft by finger can

	usually achieve 50-200 RPM but results from sample to sample may vary widely.
Calibration	Both sources should normally be checked to indicate ON. CH A and CH B correspond to 1300nm and 850nm, respectively. If either of the sources is turned off, then the VOLTAGE TEST and INPUT AMPLIFIER fields for that channel will corresponding reflect its nearly zero V output state. Turning one of the sources Off will suspend normal MR320 operation as well as initiate a red button labeled [RESET HARDWARE MODE]. Clicking this button will restore the MR320 to normal operation with all sources On.
Diagnostic Report	This function allows the various monitoring points to be saved to a file. The active status information can then be forwarded to the customer's engineering group or Micronor to help troubleshoot any encoder system problems that might arise.

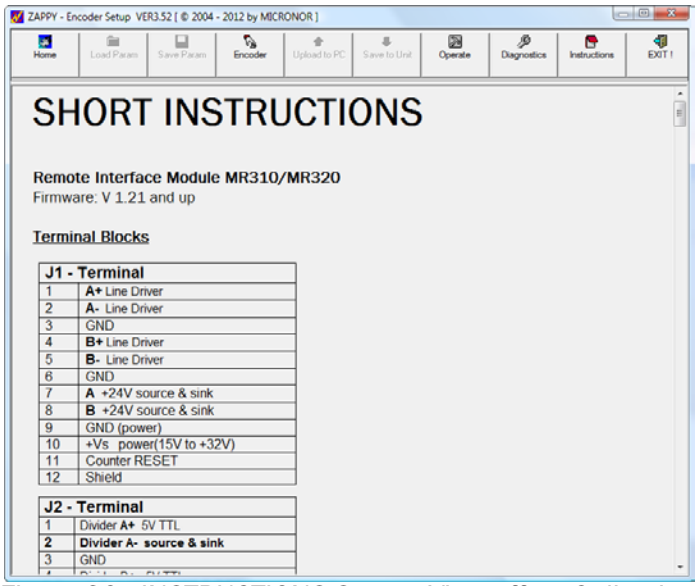


Figure 20. INSTRUCTIONS Screen View offers Online Instructions and Reference Information.

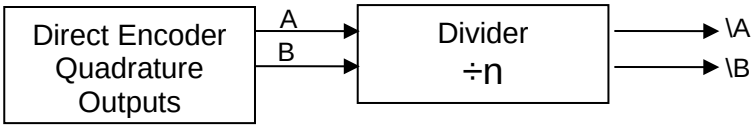
6. Operation and Description of Functions

In its most basic operating mode, the ZapFREE® Fiber Optic Encoder System simply replaces a conventional rotary encoder and provides same real-time quadrature outputs – yet offers BOTH RS422 line driver and push-pull signals in a single unit). If you plan to use the ZapFREE® Encoder System in this fashion, you may simply connect the units as described in Section 5.8 First Time Start-Up - no further setup (ZAPPY™ software set-up, etc.) is required.

The MR320 Controller Module does not face the space and environmental limitations of conventional optical rotary encoders - where all optoelectronics must be packaged into the sensor housing. Consequently, the module offers an extremely useful set of Auxiliary Functions and Auxiliary I/O that offer functionality beyond the capabilities of conventional encoders:

- **DIVIDER** function provides both A/B Line Driver and A/B push-pull quadrature outputs

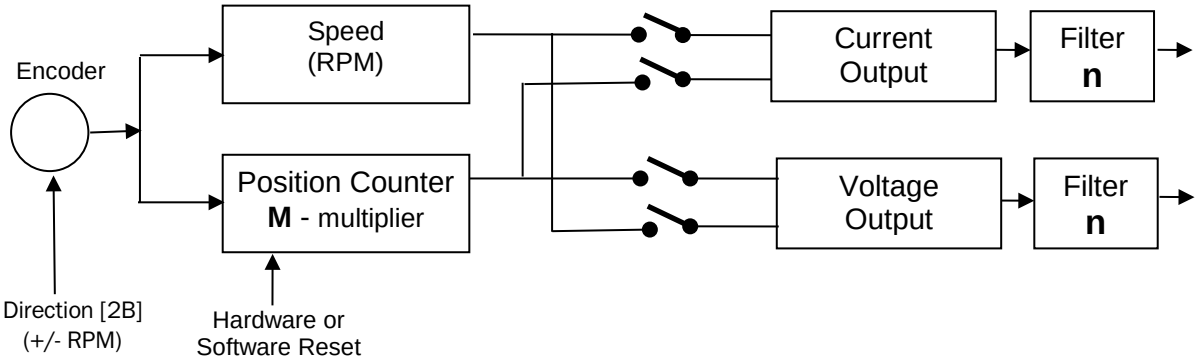
QUADRATURE DIVIDER (Reg 21) : The programmable divider output allows the user to divide the quadrature signals produced by the encoder.



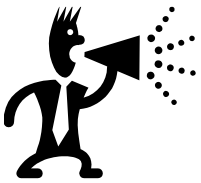
n may be any integer number from 2 to 16383. Value 0 disables this function
NOTE: It is recommend that this function be disabled if not being used.

- **ANALOG** outputs: Both fully programmable 4-20mA and ±10V outputs

Two ANALOG Outputs (Registers 23-2A): Fully Programmable 4-20mA and ±10V outputs. Independently programmable for representing Position or Speed.



Speed Limitations Of The Controller Module



The ZapFREE® encoder can operate at speeds well above 10,000 RPM (depending on model and resolution of encoder) using the Controller's Direct Quadrature outputs. However, the ***Auxiliary Functions*** (Divider and Programmable Analog Outputs) are processor limited and will shut off when the encoder frequency is higher than 50 kHz.

Auxiliary Functions can potentially be used at higher speeds with certain operational tradeoffs. Contact Micronor to discuss your application and needs.

Summary of Auxiliary Functions integrated into the MR320 controller firmware. These functions require use of ZAPPY™ software to set-up (mode, scale, etc.).

AUXLIARY Function	Features
Current Output tracking RPM	• Scalable from 10 to 10,000 RPM full scale • Up to 4mA over-range indication • Mode 0: 4mA to 12mA to 20mA (with overrange and underrange) • Mode 1: 0mA to 20mA uni-polar (with overrange) • Mode 2: 4mA to 20mA uni-polar (with overrange) • Programmable Output Low Pass Filter 2ms to 1s
Current Output tracking Position Counter	• Saleable from 1 to ±8,388,607 counts • Up to 4mA over-range indication • Mode 3: 4mA to 12mA to 20mA (with over-under-rage) • Mode 4: 4mA to 20mA uni-polar (with overrange) • Mode 5: 0mA to 20mA uni-polar (with overrange) • Mode 6 : 4mA to 20mA counter window operation
Voltage Output tracking RPM	• Scalable from 10 to 10,000 RPM full scale • ±10V with 2V over-range indication (±12V) • Drives load down to 2k Ohm • Mode 0: -10V to 0V to 10V (with 2V over-under-rage) • Mode 1: 0V to 10V uni-polar (with 2V over-range) • Programmable Output Low Pass Filter 2ms to 1s
Voltage Output tracking Position Counter	• Scalable from 1 to 8,388,607 counts • ±10V with 2V over-range indication (±12V) • Drives load down to 2k Ohm • Mode 2: -10V to 0V to 10V (with 2V over/under range)
Frequency Divided Quadrature Output	• Divider is programmable from 2 to 16,383 • Independent Line Driver Output from original Quadrature signal • Maintains full quadrature accuracy and direction information.
Real-Time Position Counter	• Maintains accurate position count • Counter depth is 24-bits (23-bits plus sign, ±8,388,607) • May be polled during operation via USB or Serial interface • Output scaleable via analog outputs
RPM Measurement	• RPM with better than 0.5% accuracy can be polled via USB or Serial Interface

6.1 Block Diagram

Explanation of System Functions:
To understand the functionality of the ZapFREE® Fiber Optic Encoder System, it is best to look at the functional block diagram shown in Figure 20.

The design philosophy emphasizes reliability and, thus, the signal path from encoder to the real-time quadrature output is implemented entirely in hardware. Even if the microprocessor malfunctions, the actual quadrature signal will still accurately track. (Of course, we do not recommend operating the unit when the microprocessor indicates an anomaly.)

The Controller emits two optical signals at differing wavelengths (850nm and 1300nm) via the Transmit fiber to the Sensor. Rotation sensing is accomplished by splitting the two optical signals into to their individual wavelength components. These two signal paths are direction- and speed-dependent modulated and sent back to the MR320 Controller via the Receive fiber. The optical receiver then separates out the two signals into their respective wavelengths and convert each to an analog electrical signal, individually representing either the A or B quadrature signal. However, the signal must first be amplified before it can be digitized.

The analog output of each channel is routed to a peak converter and thus when the encoder rotates the microprocessor can accurately determine the maximum received signal and adjust the voltage gain for each signal channel.

The power calibration inside the microprocessor determines when the power level is outside a safe range and will 'recalibrate' the gain of each input amplifier. This typically happens every one minute. This time can be set by the parameter "Calibration Interval" Register 11. However if the encoder is not rotating no gain calibration is being performed.

The analog voltage for each channel is compared to a known level and via comparators A and B the quadrature signals are digitized. Quadrature outputs are available in both RS422 line driver and push-pull electrical format.

The current output, voltage outputs are all generated by the microprocessor via the two 12 bit D/A converters. The divided output comes directly from the microprocessor and routed via the line driver buffer to the terminal. Output configuration may vary depending on application. Consult with MICRONOR service personnel.

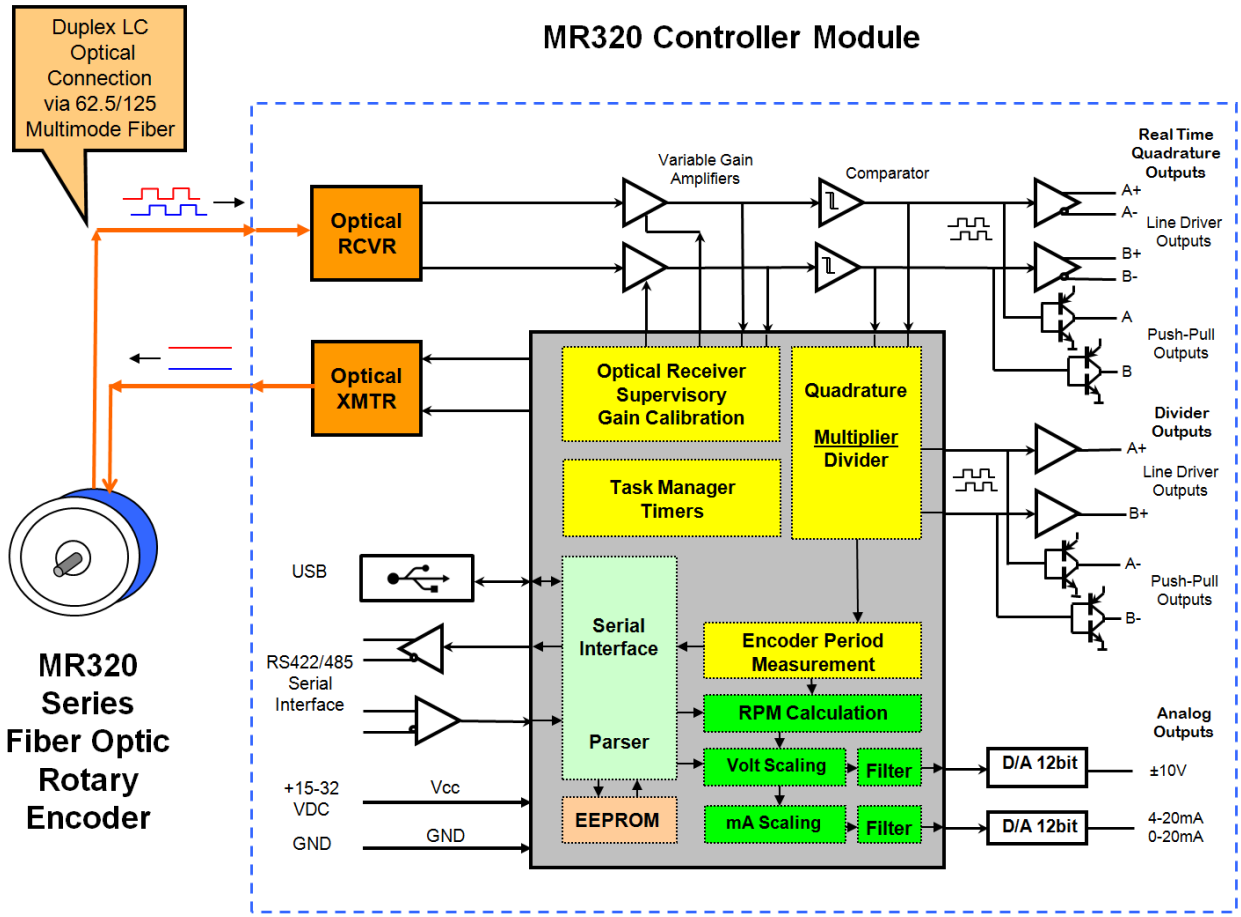


Figure 21. Block Diagram of the MR320 Series Fiber Optic Encoder System.

The microprocessor measures the Speed (RPM) by measuring the elapsed time between encoder periods. The internal timer resolution is 200ns providing accuracy to very high speeds. The encoder period is averaged over 800µs and calculated using a formula:

$$V[rpm] = 60 / (t[p] * n)$$

Where: V[rpm] = speed in revolutions per minute
t[p] = time elapsed for one period
n = number of slits in encoder wheel (256 typ.)

Note: Even though the unit can measure speed values accurately to less than 0.5RPM the analog outputs have a useful measurement range from 0.5% to 110% of the scale value as defined by the user.

Output Update Rate: Each D/A converter output is updated every 800µs. However the user must keep in mind that the speed value is derived from the elapsed time between passing slits of the encoder wheel. At slow speed the update rate can only be as fast as the time period between passing slits.

6.2 Firmware Functions and Programming

The MR320 Controller provides a host of auxiliary functions that the user may choose to use. To configure any of these special functions (such as an analog output) requires the supplied ZAPPY™ software running on an IBM Compatible PC running Windows (XP, VISTA or 7) with an available USB or RS232 serial interface port. ZAPPY™ can also be used to verify installation and proper encoder system operation as well as perform diagnostics and assist troubleshooting.

6.2.1 Serial Communications Interface Specification

At any one time, the MR320 Controller can support one of four modes of serial communications using ISO 1745 protocol specification :

- RS422/RS485
- RS232 (Requires optional MR232-1 Converter Cable and available COM Port)
- Modbus/RTU (Contact Micronor for Modbus instructions)
- USB

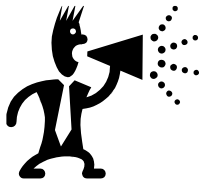
The serial interface is set up as follows:

- Full-Duplex Single addressable bus interface (Factory Address = 234)
- 9,600 baud rate
- 1 Start Bit
- 8 Data Bits
- 1 Stop Bit

Factory Standard Address is set to Hexadecimal EA (234 decimal).

The command format and responses of the MR320 Controller follows the ISO 1745 specification.

For detailed programming instructions please refer to Sections 6.3 through 6.5 in this manual.



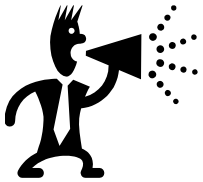
How The USB - Serial Emulator Works

The USB interface utilizes the Future Technology Devices International (FTDI) interface chip www.ftdichip.com. This chip communicates via USB, but within the PC emulates a serial COM port. When ZAPPY ™ is installed, the appropriate FTDI driver is installed on the PC and the conversion from USB to Serial is completely transparent to the user. When when communicating via USB, the MR320 Controller operates at a fixed 9600 Baud and base bus address settings.

6.2.2 Communications Protocol

The MR320 Controller incorporates a serial interface with RS422/RS485 level signals. A number of commands allow for configuring the operational parameters of the Controller while other commands are specifically meant for diagnostics used during setup, maintenance and troubleshooting. An RPM and Counter command are available to retrieve speed and position data while the encoder is running. The format for the commands and responses in general follow the ISO 1745 specification.

The MR320 implements a limited set of Modbus compatible functions. Contact Micronor for information on how to use the Modbus interface



What Is ZAPPY™ Setup Software?

ZAPPY™ is a user-friendly setup program provided free by Micronor. Typically ZAPPY™ is used one-time to configure the parameters for any MR320 Auxiliary Functions that are to be used in the customers application (analog outputs, etc.). The software runs on Windows (XP, Vista or 7) with .net Framework installed. Unless you plan to connect the MR320 to your own computer equipment for real-time digital data retrieval ,you do not need to become familiar with the Communications protocol described herein.

There are three categories of commands:

- Configuration for Parameter Setup
- Commands for retrieving operational values such as RPM Counter
- Diagnostic commands for reading and setting hardware status.

Configuration commands are those that are intended to be executed once either in the factory or during initial setup by the customer. Although these commands can be executed at any time, they generally affect system parameters that only need to be setup once.

User commands are those that are intended to be executed any time during normal system operation.

Diagnostic commands are those that are intended to be used by trained technicians for setting and trimming the hardware or troubleshooting in the field.

All commands utilize certain control characters as defined by the ISO 1745 spec. The control characters and their designations are shown below:

STX:	Control character ^B, hex 02
ETX:	Control character ^C, hex 03
EOT:	Control character ^D, hex 04
ENQ:	Control character ^E, hex 05
ACK:	Acknowledge, hex 06
NACK:	NOT Acknowledge, hex 07
BCC:	Block Check Character (an XOR sum of data)

Within each of the three categories of commands are two types of commands:

1.) Data Setup
2.) Data Request.

All commands have a Data Request type with an accompanying Data Return.
Commands that have a Data Setup type are used to establish a system operational parameter (e.g. setting the Voltage Output Scale).

The formats for each of the two command types and the data return are standard for all commands. The formats are:

Data Setup: <EOT> A <STX> r data <ETX> <BCC>

A : The MR320 address (default of EA, settable by the user)

r : Register number of the item being accessed
The Register number is really the command. i.e. number 22 is used to set the voltage scale
Data : is the parameter to be written to the register . Parameters must be within valid range to be accepted.

Data Request: **<EOT> A r <ENQ>**

A : The MR320 address (default of EA, settable by the user)
r : Register number of the item being accessed (requested)
The Register number is really the command. i.e. number 22 is used to get the voltage scale

Data returned by the MR320 :

<STX>r data <ETX> <BCC>

r : Register number of the value being returned ASCII Format and Hexadecimal.

Data : Value being returned in ASCII format

6.2.3 The Block Check Character <BCC>

The Block Check Character is used to test the transmissions for any potential errors. The <BCC> is derived by applying a bitwise eXclusive OR (XOR) over the specified transmitted bytes. The recipient must perform the same function and compare the result with the sent <BCC> value. If the values match the transmission succeeded without errors.

The string of bytes included in the <BCC> begins with the byte immediately following <STX> up to and including the <ETX> byte.

Example Transmission:
<EOT> EA <STX> 24500 <ETX> <BCC>

The corresponding Hex bytes are:

EOT	Dev. Addr.		STX	Reg. Addr.		data			ETX	BCC
04	45	41	02	**32**	**34**	**35**	**30**	**30**	**03**	30

XOR Sum Of These Bytes
Equals
<BCC>

NOTE: The shaded bytes are included in the calculation of the <BCC>. In the above example, 32.XOR.34.XOR.35.XOR.30.XOR.30.XOR.03 equals the <BCC> value of 30.

If the MR320 receives a bad <BCC>, then it will respond with a <NACK> character.

6.3 Configuration Commands and Parameters

The following three tables describe the commands recognized by the MR320.
The format for the commands as they are sent to the MR320, and the format for the data strings returned from the MR320 are the same regardless of the command. All that changes is the register number in the command and the data that is either written or read.

Each table has the following columns:

Title Description of the command function
Reg The register number needed in the command (as indicated by 'rn' above).

Read/Write Indicates whether or not the register can be read and/or written to
R/W = read and write
RD = read only
WR = write only

Range The valid range of data that can be written by a Data Setup command, or is returned in the Data Return following a Data Request.

Default The factory default setting of this particular parameter

Saved Indicates whether the data is saved in EEPROM when the save command is initiated. If this column is 'NO', the data cannot be saved to the EEPROM. In most cases any data that can actually be set by the user is saved.

Description A short explanation of the command function including information about acceptable data range. Parameter functions are described in more detail after the summary tables.

The term n/a means not applicable.

6.3.1 Configuration Commands (Registers 10-19)

These commands are used to establish system operational configuration and calibration. In general these parameters should not be changed by the user. It is possible however to do 'tricky' things. For instance the user may change the number of encoder slits and thus get fractional scaling for the analog outputs.

Title	Reg	Read/ Write	Range	Default	Saved	Description
Resolution	10	R/W	95 – 10000	180	Yes	Sets the number of slits in the encoder, used for RPM calculations.
Calibration Interval	11	R/W	1 – 200	84	Yes	Sets the time interval for performing gain calibration. The value passed is multiplied by 2.55504 seconds to determine the actual time interval.
Encoder Address	12	R/W	17 – 255	234	Yes	Sets the MR320 serial address for commands. The value is entered in decimal with this command, but is sent as hex when sending commands to the device.
Operating Params	13	R/W	1 – 5	n/a	n/a	Allows user to set or restore operational parameters. 1 = Save current parameters to EEPROM 2 = Restore Power Up parameters (from EEPROM) 3 = Restore Factory Defaults (does not save to EEPROM). Return values are 0 (if last command was a restore) or 10+ if last command was save to EEPROM. Value indicates parameter presently being saved. When a save command is issued, the device will only respond to a data request to this register. All other commands will be NACK'd until the write is complete. 4 Save Amplifier Config 5 Restore Amplifier Config
Command Status	14	RD	n/a	n/a	n/a	Returns the status of the last issued command
System Status	15	R/W	n/a	n/a	n/a	Returns the system error status, using a Setup command clears errors.
Device Name	16	RD	n/a	n/a	n/a	Returns the ASCII string device name (MR320)
Version	17	RD	n/a	n/a	n/a	Returns the ASCII string of the software version form MM.mm
Serial Number	18	RD	n/a	n/a	n/a	Returns the ASCII serial number of the device.
Reset	19	R/W	n/a	n/a	No	Causes a soft reset of the MR320
Duty Cycle Adjust	1A	R/W	80-180	105	Yes	Typically it should be left between 100 and 110, An oscilloscope is required to adjust the setting.
Diagnostic Packet	1C	RD	n/a	n/a	n/a	This command returns a string with a number of diagnostic parameters. Each parameter separated by a ":" colon.

6.3.2 User Commands (Registers 20-2A)

These commands are typical commands the user will utilize during installation or normal system operation.

Title	Reg	Read/ Write	Range	Default	Saved	Description
Counter	20	R/W	-16777215 – 1677215	n/a	No	Obtains the value in the encoder counter. This is a 32-bit value. The user can reset the counter by sending a 0 with the Data Setup Command.
Quadrature Divider	21	R/W	1 – 256	3	Yes	Sets the divide ratio for the programmatic encoder output pulses, e.g. if a value of 8 is set, each time eight quadrature input cycles occur, a single quadrature output cycle will be generated.
RPM	22	RD	0 – 10000	n/a	No	Reads the signed RPM. If the encoder is turning counter clockwise, the RPM is preceded by a minus sign '-'. If the encoder is turning clockwise, the RPM is reported as simply a number. The reported number is the actual RPM * 100.
Voltage Mode	23	R/W	0 – 1 (SPEED) 2 (POSITION)	0	Yes	Establishes the output mode of the voltage output. 0 = SPEED mode with bipolar ±12V output range 1 = SPEED mode with unipolar 0-12V output range 2 = POSITION mode with bipolar ±12V output range
Voltage Scale	24	R/W	0 – 10000 (SPEED) 0-9000000 (POSITION)	1000	Yes	Establishes the scale used for the voltage output. Regardless of Voltage Mode setting, +10V output always represents the positive VOLTAGE SCALE setting. If Voltage Mode set for SPEED, the maximum entry is 10,000. If entering a larger Scale value >10,000, the MR320 will send an error signal and reset the Scale value to 10,000. If Voltage Mode set for POSITION, the maximum entry is 9,000,000. The entered value establishes what position/counter value will produce an output ±10V (sign depends on direction).
Voltage Filter	25	R/W	0 – 256	32	Yes	Must be power of 2 (1, 2, 4, etc) If input is not power of two then parameter is accepted and converted to the next power of two.
Current Mode	26	R/W	0 – 2 (SPEED) 3 – 5 (POSITION)	0	Yes	Sets the mode of the current output. 0 = For SPEED bipolar output range 0-12-24 mA (where 12mA represents 0rpm). 1 = For SPEED unipolar output range 0 - 24mA (where 0mA represents 0rpm)

						2 = For SPEED unipolar output range 4-24mA (where 4mA represents 0rpm) 3 = For POSITION bipolar output range 0-12-24mA (where 12mA represents zero position/counter value) 4 = For POSITION unipolar 0-24mA range (where 0mA represents zero position/counter value) 5 = For POSITION unipolar 4- 24mA output range (where 4mA represents zero position/counter value) 6 = For POSITION 4- 24mA output range window mode.
Current Scale	27	R/W	0 – 10,000 (SPEED) 0-9,000,000 (POSITION)	0	Yes	Establishes the scale used for the current output. Regardless of Current Mode setting, 20mA output always represents the positive CURRENT SCALE setting. If Current Mode set for SPEED, the maximum entry is 10,000. (RPM) Valid scales are 10 to 10,000. If entering a larger Scale value >10,000, the MR320 will send an error signal and reset the Scale value to 10,000. If Current Mode set for POSITION, the maximum entry is 9,000,000 counts, The entered value establishes what position/counter value will produce an output of 20mA NOTE: 0 turns off current output.
Current Filter	28	R/W	0 – 256	1	Yes	Must be power of 2 (1, 2, 4, 8, etc) If input is not power of 2, then parameter is accepted and converted to next power of 2.
Counter Reset Mode	29	R/W	0 – 1	0	Yes	Defines how the hardware input resets the internal counter. 0 = Edge Triggered, resets the counter at the rising edge 1 = Debounced Trigger when state changes from 0 to 1 after 60ms debounce time. (used for switch or relay input)
Counter Multiplier	2A	R/W	0 - 1	0	Yes	Internal counter increments using either a full or half cycle of the quadrature signal. 0 = Full cycle counts 1 = Half cycle counts (x2 multiplier) Note: This Aux Function only affects POSITION mode operation of the analog outputs.
Encoder Direction	2B	R/W	0 - 1	0	Yes	Defines output results based on turning direction of the encoder 0 = when CW outputs are positive 1 = reversed outputs Note: quadrature outputs are not affected.
Hardware Reset Value	2C	R/W	0-9,000,000	0	Yes	Counter will be preset to this value when the hardware input changes from logic 0 to logic 1.
Reset On Count	2D	R/W	0 -9,000,000	0	Yes	Internal counter resets to 0 when this value is reached.

6.3.3 Diagnostic Commands (Registers 30-39)

These commands are used when servicing the MR320 either in the field or in-house.

Title	Reg	Setup	Range	Default	Saved	Description
ADC Read	30	R/W	0-4	n/a	No	Performs a read of the indicated ADC channel. The value is obtained by sending a Request. 0 = Channel A peak signal 1 = Channel B peak signal 2 = 2.5V channel reference voltage 3 = +5V channel 4 = +12V channel
Channel A Reading	31	No	n/a	n/a	No	Returns the most recent Channel A reading.
Channel B Reading	32	No	n/a	n/a	No	Returns the most recent Channel B reading
Pot A State	33	R/W	0 – 128	n/a	No	Writes the value to the Channel A gain pot. If a Request is issued, the current pot A value is returned, and a read of the pot initiated.
Pot B State	34	R/W	0 – 128	n/a	No	Writes the value to the Channel B gain pot. If a Request is issued, the current pot B value is returned, and a read of the pot initiated.
Encoder Period	35	RD	0 – 16,777,215	n/a	No	Reads the encoder period as detected on Channel A
Voltage DAC	36	RD	0 – DAC Range	n/a	No	Reads the actual setting of the Voltage DAC Value = 0 - 4095
Current DAC	37	RD	0 – DAC Range	n/a	No	Reads the actual setting of the Current DAC Value = 0 - 4095
Operating Mode	38	R/W	0 – 2	n/a	No	Sets the system operating mode. 0 = Normal 1 = Forces a gain pot calibration to occur (same as 'Cal' button being pressed). Following cal, mode returns to Normal. 2 = Sets the system to optical calibration mode. Refer to Section 7 Maintenance and Service for a detailed description
Optical Sources	39	R/W	0 – 3	n/a	No	Sets the two optical sources to the states indicated by the data: 0 = both A & B sources off 1 = A on, B off 2 = A off, B on 3 = both A & B source on . This command is valid only when the operating mode is '2'.

6.4 Communications/Programming Example

Make sure you have the terminal setup correctly :
9600 baud 8 data bits and 1 stop bit.

Example 1:
To retrieve the Model Number send the following Command via a serial interface.
You must send the Start Transmission Character <EOT> followed by other command information (as Human Readable ASCII characters) followed by the End Of Command <ENQ> character.

Send: **<EOT> EA16 <ENQ>**

The unit will now respond with the Model Number:

Received: **<STX> 16MR320 <ETX> <BCC>**

The number 16 is the register address and MR320 is the requested information

Example 2:
Set the Full Scale Range for the voltage output to 500RPM so that at 500RPM the output will be 10V. Use register 24 to set the value to 500.

Send: **<EOT> EA <STX> 24500 <ETX> <BCC>**

The unit will respond with:

Received: **<ACK>**

If there was a problem or the command was not received properly the unit will respond with <NACK>. Always test the return for <ACK> or <NACK>.

Note: Blank spaces in above examples are for clarity only and must NOT be included in the actual commands.

6.5 Detailed Description of Each Function

This section describes the physical outputs from the encoder monitoring circuit.

6.5.1 Counter (Register 20)

Register Address: 20

This is an internal summing counter that keeps accurate track of the full number of quadrature cycles. For the 120-256 each 360 degree rotation produces 256 counts.

The counter is relative to a given starting position. The user may reset or preset the counter to any value within a full 24 bit range.

To request the Counter value:

<EOT> EA20 <ENQ>

To Preset the Encoder Counter to value 0:

<EOT> EA <STX> 20 <counter value> <ETX> <BCC>

Range is: ± 8,388,607

The range is good for 32,768 revolutions in either direction when using a 256ppr encoder.

The (-) sign bit indicates that the encoder is turning Counter Clockwise CCW (looking at the encoder from the shaft end)

The encoder Counter is volatile and will be reset once electrical power is lost.

Example: Preset the Encoder Counter to value 0:

<EOT> EA <STX> 200 <ETX> <BCC>

Example: Preset the Encoder Counter to value 250:

<EOT> EA <STX> 20250 <ETX> <BCC>

6.5.2 Divider (Register 21)

Register Address: 21

The quadrature signal produced by the encoder can be divided down by a factor of 2 to 16,383- i.e., if you program a divide by 128, the unit will now produce 2 pulses per revolution when a 256ppr encoder is used.

☞ This function works reliably up to 52kHz encoder frequency (>3,000rpm for an MR324 encoder with 1024 slits). Consequently, users should not attempt to rely on this output if the encoder turns faster than 3000RPM (MR324).

The divided signal is externally available on connector J3.

To set the Divider to divide by 5 send:

<EOT> EA <STX> 215 <ETX> <BCC>

Range: User selectable. 0 and 2–16,383

☞ A special selection is the value 0. The value 0 turns this function OFF. This may be useful when the encoder is expected to operate at high speeds and the divided output is not required. When enabled, the divider function absorbs a significant amount of processor time and thus turning it off frees processor time for other functions such as RPM measurement and analog outputs.

☞ If the Divider function is not used, then it should be turned off by setting value to 0.

6.5.3 RPM (Register 22)

Register Address: 22

The MR320 continuously measures the elapsed time between encoder slits. This time period measurement allows accurate calculation of RPM.

The true RPM can be obtained at any time by requesting the value in register 22:

<EOT> EA22 <ENQ>

Output Format: The output is in RPM x 100 (12012 -> 120.12RPM)

Range:	Lowest RPM is 0.33 and highest is 6,000
Accuracy:	1%
Resolution:	0.1 RPM regardless of scale
I/O:	Serial Interface. See Section 6.2 for details.

6.5.4 Voltage Mode (Register 23)

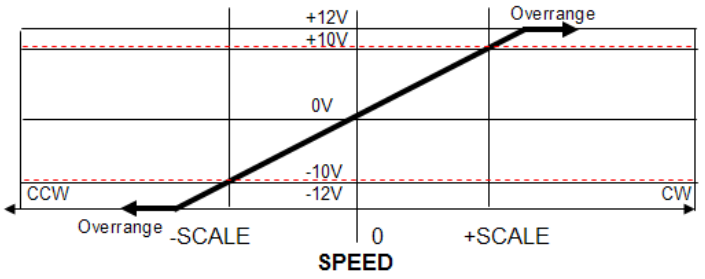
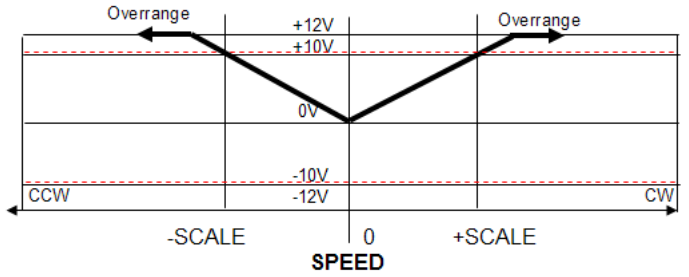
Register Address: 23

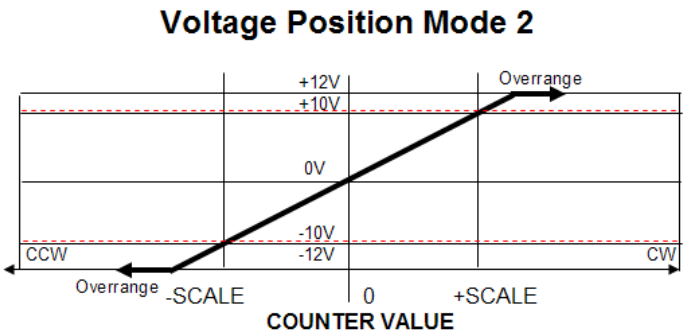
The speed in RPM will be output as analog voltage to the voltage output.

The programming string for the Voltage Mode is as follows:

<EOT> EA <STX> 23 <mode> <ETX> <BCC>

Default: SPEED Mode 0

SPEED Modes	Description
0	Output corresponds to actual RPM where CCW rotation is negative voltage. The voltage output range is 0V to +10V when the encoder rotates CW. Overrange extends from +10V up to +12V The voltage output range is 0V to -10V when the encoder rotates CCW. Overrange extends from -10V to -12V. **Voltage Speed Mode 0** 
1	Output corresponds to the absolute value of the RPM, regardless of the direction. The output is always from 0V to +10V regardless of direction of rotation. Over range extends from +10V up to +12V **Voltage Speed Mode 1** 

POSITION Modes	Description
2	The output ranges from 0V to +10V (overrange from +10V to +12V) for CW motion with +10V corresponding to the Voltage Scale setting (Register 24). The output ranges from 0V to -10V (overrange from -10V to -12V) for CCW motion with -10V corresponding to the Voltage Scale setting (Register 24). 

The programming string for the Voltage Mode is as follows:

<EOT> EA <STX> 23 <mode> <ETX> <BCC>

Default: SPEED Mode 0

6.5.5 Voltage Scale (Register 24)

Register Address: 24

Default: 1000

The voltage scale can be set by the user to track SPEED or POSITIOIN.

Example: With Voltage Mode (Register 23) set to 0, a Voltage Scale setting of 10 will provide a full scale +10V output for 10RPM (CW) or -10V output for 10RPM (CCW). Faster speeds will linearly extend from ±10V until peaking at ±12V.

The programming for the Mode is as follows:

<EOT> EA <STX> 24 <range data> <ETX> <BCC>

Range	Description
0	The value 0 turns this function OFF. This may be useful when the encoder is expected to operate at high speeds and the voltage output is not required. Disabling this function leaves processor resources for other functions such as the quadrature divider. It is recommended to

	disable the output when it is not required.
10-10,000 (SPEED)	In a SPEED mode (Register 23), a Voltage Scale setting of X establishes ±10V "full scale" value to correspond to X RPM.
1-8,388,607 (POSITION)	In a POSITION mode (Register 23), a Voltage Scale setting of X establishes ±10V "full scale" output to correspond to X Counter value.

☞ A special selection is the value 0. The value 0 turns this function OFF. This may be useful when the encoder is expected to operate at high speeds and the voltage output is not required. Disabling this function leaves processor resources for other functions such as the quadrature divider. It is recommended to disable the output when it is not required.

6.5.6 Voltage Filter (Register 25)

Register Address: 25

A user configurable low pass filter exists to allow smoothing of the calculated RPM based on user constants. It is the filtered RPM that is output to the voltage DAC. The 3dB filter point is programmable from 500Hz (no filtering) down to 1Hz

$$A_f = \frac{(A_{f\,[t-1]} * n-1) + A_{m\,[t]}}{n}$$

A_f : Filtered analog output value
$A_{f\,[t-1]}$: Previous filtered analog output value
n : filter constant in milliseconds
A_m : new analog (unfiltered) value

The programming for the Mode is as follows:

<EOT> EA <STX> 25 <filter data> <ETX> <BCC>

Range: 0 to 256
Default: 32 (equivalent to ~5Hz filter frequency)

☞ The analog output is updated every 800µs thus when setting the filter value to n an approximate time constant of n ms can be expected. The MR320 measures the period between passing slits of the code wheel. When the encoder is turning slow so that the elapsed time between slits is large then 1ms then the low pass algorithm is changed and the time constant becomes larger as the encoder turns slower. This adaptive filtering algorithm provides for a smooth output signal change.

☞ If no filtering is desired simply turn the filter OFF by setting it to value 1.

☞ When in position mode no filtering occurs regardless of the filter setting.

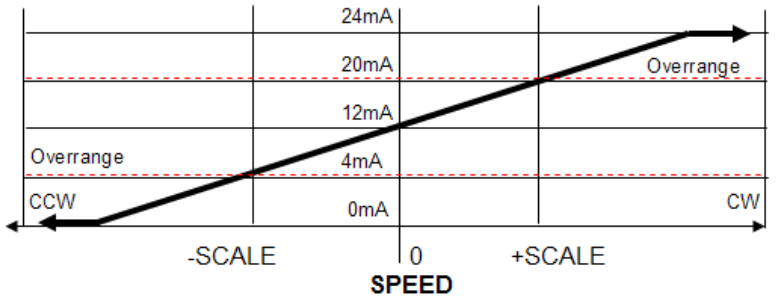
6.5.7 Current Mode (Register 26)

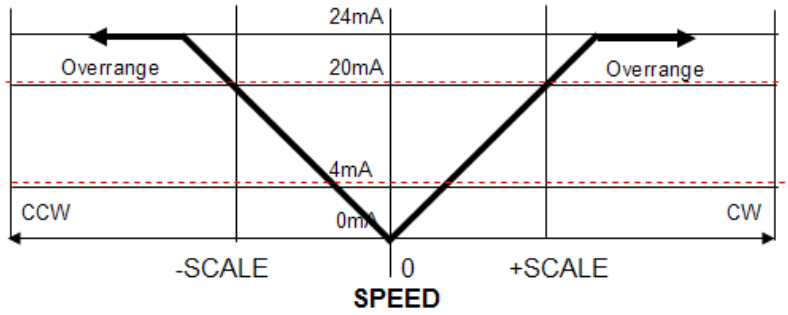
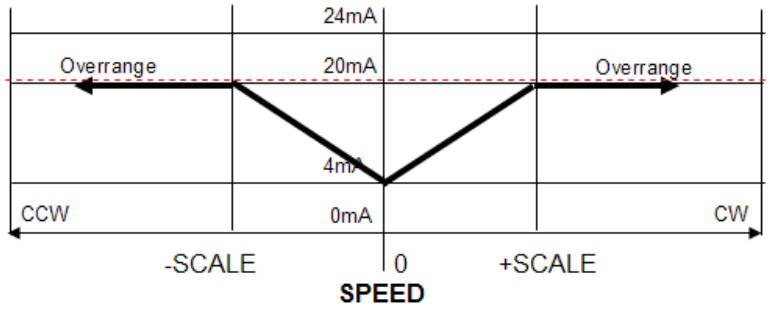
Register Address: 26
The scalable current output provides filtered RPM or POSITION analog output depending upon the chosen mode.

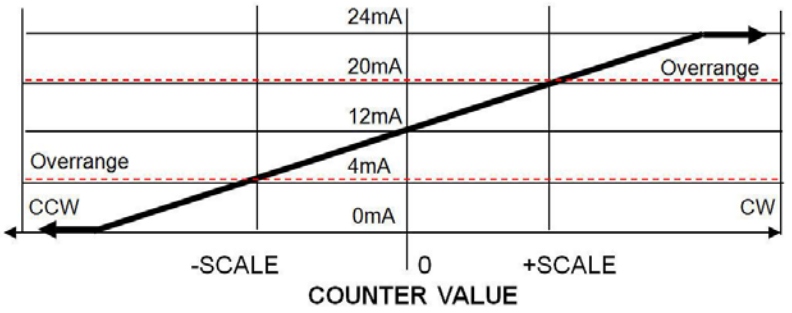
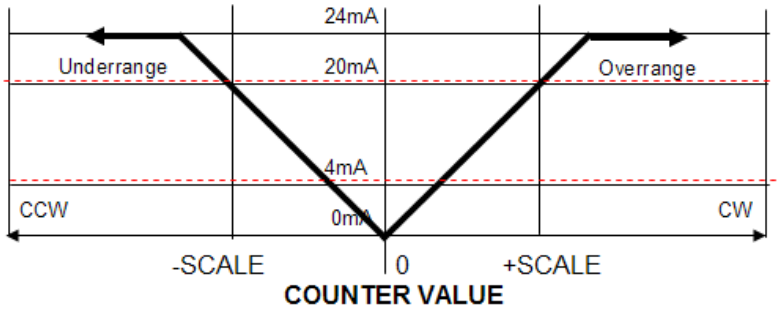
The programming for the Voltage Output Mode is as follows:

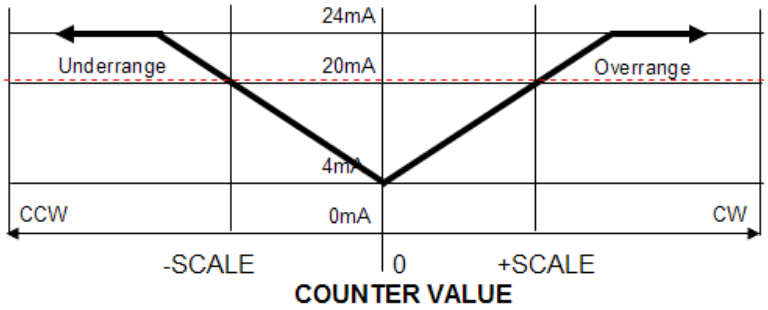
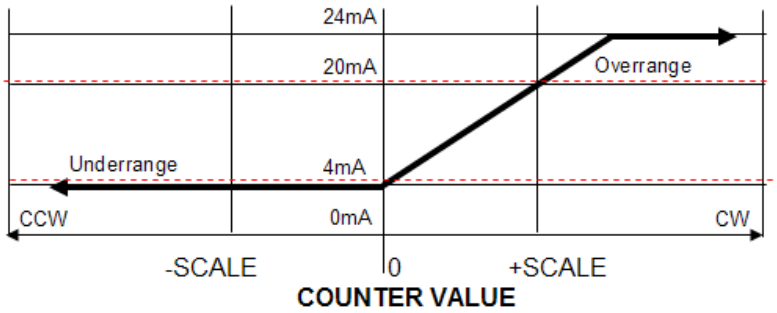
<EOT> EA <STX> 26 <mode> <ETX> <BCC>

Default: SPEED Mode 0

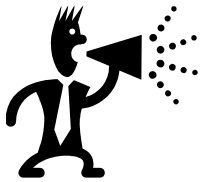
SPEED Modes	Description
0	Bipolar output over 4mA to 12mA to 20mA where 12mA is equal to 0 RPM. CW rotation from 0RPM to (Current Scale) RPM corresponds to 12mA to 20mA. Overrange extends from 20mA to 24mA (maximum) CCW rotation from 0RPM to (Current Scale) RPM corresponds to 12mA to 4mA. Overrange extends from 4mA to 0mA (minimum). **Current Speed Mode 0** 
1	Unipolar output range of 0-24mA where 0mA represents 0RPM, regardless of direction.

	Current Speed Mode 1 
2	Unipolar output range of 4-20mA where 4mA represents 0RPM, regardless of direction. **Current Speed Mode 2** 

POSITION Modes	Description
3	Bipolar output over 0mA to 12mA to 20mA where 12mA is equal to the zero position/counter value. CW rotation from 0 counter value to Current Scale (Reg 27) setting corresponds to 12mA to 20mA. Overrange extends from 20mA to 24mA (maximum) CCW rotation from 0 counter value to negative Current Scale (Reg 27) setting corresponds to 12mA to 4mA. Overrange extends from 4mA to 0mA (minimum). **Current Position Mode 3** 
4	Unipolar output range of 0-24mA representing the absolute value of the Counter. 0mA represents the zero position and 20mA corresponds to the Current Scale (Reg 27) setting (regardless of direction or sign). Overrange extends from 20 24mA (maximum). **Current Position Mode 4** 

5	Unipolar output range of 4-24mA representing the absolute value of the Counter. 4mA represents the zero position and 20mA corresponds to the Current Scale (Reg 27) setting (regardless of direction or sign). Overrange extends over 20-24mA range. **Current Position Mode 5** 
6	Window mode with Output range of 4-24mA. 4mA represents zero and negative position and 20mA corresponds to Current Scale (Reg 27). Overrange extends over 20-24mA. **Current Position Mode 6** 

In all cases there is an overrange capability of 4mA to 24mA.
Use the MODE command to select the desired output mode.



Current Output Cautions...

- Current outputs are inherently short circuit proof!
- The maximum burden resistance for the MR320 is 500 Ohm with a +24V power supply. At 24mA that represents a voltage drop of 12V.
- To minimize internal heat dissipation we recommend that the user inserts a 'burden resistance' to always assure at least 200 Ohm.

6.5.8 Current Scale (Register 27)

Register Address: 27
The programming for the Current Scale is as follows:

<EOT> EA <STX> **27 <range data> <ETX> <BCC>**

Default: 1000 RPM/full range.

Range	Description
0	The value 0 turns this function OFF. This may be useful when the encoder is expected to operate at high speeds and the voltage output is not required. Disabling this function leaves processor resources for other functions such as the quadrature divider. It is recommended to disable the output when it is not required.
10-10,000 (SPEED)	In a SPEED mode (Register 26), a Current Scale setting of X establishes 20mA as "full scale" output corresponding to X RPM.
1-8,388,607 (POSITION)	In a POSITION mode (Register 26), a Current Scale setting of X establishes 20mA as the "full scale" output when the Counter value reaches X.

☞ A special selection is the value 0. The value 0 turns this function OFF. This may be useful when the encoder is expected to operate at high speeds and the current output is not required. Disabling this function leaves processor resources for other functions such as the quadrature divider. It is recommended to disable the output when it is not required.

6.5.9 Current Filter (Register 28)

Register Address: 28
A user configurable low pass filter exists to allow smoothing of the calculated RPM based on user constants. It is the filtered RPM that is output to the voltage DAC. The 3dB filter point is programmable from 500Hz (no filtering) down to 1Hz

$$A_f = \frac{(A_{f\,[t-1]} * n\text{-}1) + A_{m\,[t]}}{n}$$

A_f : Filtered analog output value
$A_{f\,[t-1]}$: Previous filtered analog output value
n : filter constant in milliseconds
A_m : new analog (unfiltered) value

The programming for the Filter Mode is as follows:

<EOT> EA <STX> 25 <filter data> <ETX> <BCC>

Where data can be from 1 to 255ms
Default: 32 (approx. 10Hz filter frequency)

☞ The output is updated every 1.024ms thus when setting the filter value to n an approximate time constant of n ms can be expected. The MR320 measures the period between passing slits of the code wheel. When the encoder is turning slow so that the elapsed time between slits is larger then 1ms then the low pass algorithm is changed and the time constant becomes larger as the encoder turns slower. This adaptive filtering algorithm provides for a smooth output signal change at low rpm.

☞ If no filtering is desired simply turn the filter OFF by setting it to value 1.

☞ When in position mode no filtering occurs regardless of the filter setting.

6.5.10 Counter Reset (Register 29)

Register Address: 29
The internal Position Counter may be reset by applying a +5V signal to the Counter RESET Input located on pin 11 of J1.

The programming for this function is :

<EOT> EA <STX> 29 <mode> <ETX> <BCC>

Check for a <ACK> that verifies command has been accepted

Default: Mode 0 (Edge trigger)

Modes	Description
0	The RESET Input is triggered by the rising edge (first transition) from 0V to 5V. The uncertainty of this input is maximum 800µs.
1	The RESET Input is conditioned for debouncing the input signal, such as a push button or relay contact. This setting allows a debounce period of approximately 60ms.

☞ When in Debounce mode, the signal must be at least 100ms in length to be effective.

6.5.11 Counter Multiplier (Register 2A)

Register Address: 2A
The internal position counter may be multiplied by two using only one half of a quadrature cycle to increment (decrement) the internal counter.

The programming is as follows:

<EOT> EA <STX> 2A <mode> <ETX> <BCC>

Check for a <ACK> that verifies command has been accepted

Default: Mode 0 (Multiply by 1)

Modes	Description
0	Normal counting (every cycle is one count).
1	This mode effectively doubles the position resolution of the internal Counter by incrementing after every half quadrature cycle. .

☞ When in mode 1 (x2 multiplication), be sure to set the slit count to double the number of slits the encoder has. This will ensure that the speed output will be correct.

☞ Due to the inner workings of the MR320 firmware, the Controller can only be set to x2 multiplication. It is not possible to do x4 or higher multiplication.

6.5.12 Encoder Direction (Register 2B)

Register Address: 2B
This parameter defines the encoder's rotational direction. When this parameter is set to "0" (default) all outputs follow the right–hand rule convention. When the encoder turns clockwise then the speed indication is positive and the position counter increments. Analog outputs follow accordingly: i.e. a positive speed is indicated by a positive voltage.
When this direction parameter is set to "1", then all directional outputs are reversed. This may become useful when an encoder cannot be installed to turn in the CW direction within a system definition for CW being positive speed or positive position.

The programming is as follows:

<EOT> EA <STX> 2B [0,1] <ETX> <BCC>

Check for a <ACK> that verifies command has been accepted.

Default : Mode 0 (CW direction)

Modes	Description
0	Analog outputs and digital read-out follow CW direction
1	Analog outputs and digital read-out are reversed from normal CW direction

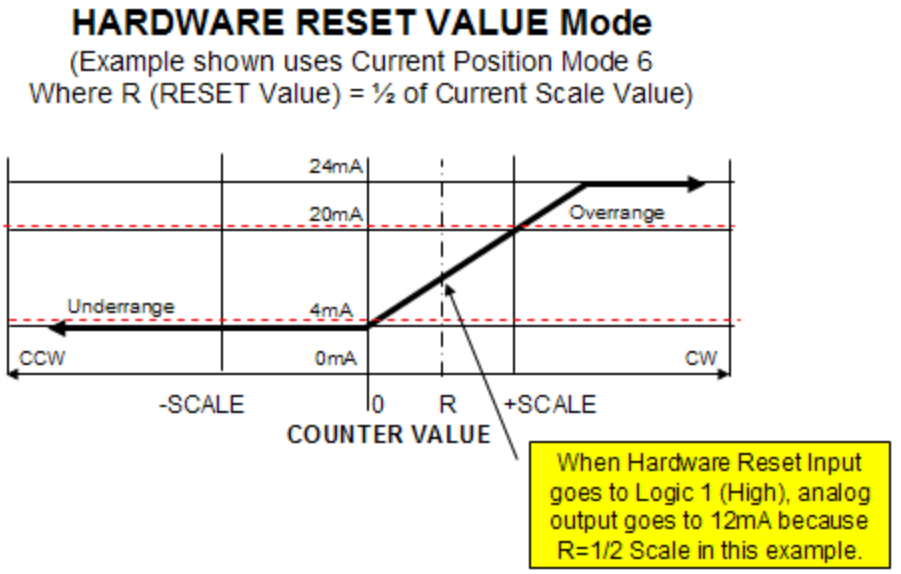
☞ Quadrature outputs A&B and divider outputs A&B are not affected by this parameter setting. The user must assure proper wiring to achieve the desired direction of an externally connected device.

6.5.13 Hardware Reset Value (Register 2C)

Register Address: 2C
The internal Position Counter will be preset to this pre-programmed value whenever the Hardware Reset input goes from logic 0 to logic 1. This is also the value stored in the position counter at power up.

This function sets the encoder to an absolute position based on an external reference switch, the Hardware Reset. When the switch is activated then the absolute position is known. This parameter tells the encoder its absolute position when the hardware signal is generated.

Sometimes this function is also called *"homing"*



The programming is as follows:

<EOT> EA <STX> 2C <preset value> <ETX> <BCC>

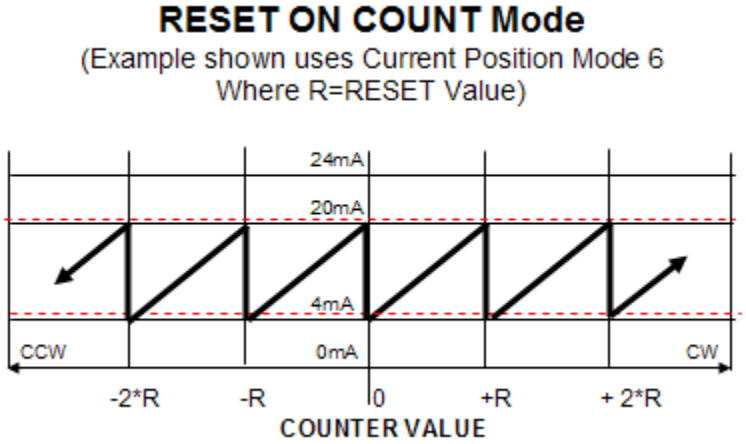
Check for a <ACK> that verifies value has been accepted.

Default value: 0

6.5.14 Reset On Count/Homing (Register 2D)

Register Address: 2C
The internal Position Counter is automatically reset to 0 whenever its absolute value matches this pre-programmed value.

This is a useful command when it is desirable to use the encoder as an absolute position indicator over the course of one or multiple turns. For instance, the MR314 encoder may be used to output a voltage from 0V to 10V corresponding to the angular position from 0° to 359.9° . In this case the Auto Reset would be set to 1024 and the voltage scale value would be set to 1024. Voltage mode setting is 2. As the encoder turns the voltage increases from 0 to 10V and as the position counter reaches 1024 it automatically resets to 0 and the output voltage naturally follows to 0V – indicating 0° angular position.
When the encoder turns CCW and passes through zero the counter resets to the maximum setting.



The programming is as follows:

<EOT> EA <STX> 2D <reset value> <ETX> <BCC>

Check for a <ACK> that verifies value has been accepted.

Default value: 0 (deactivated)

☞ Comparison is based on the absolute value of the position counter. Reset to 0 occurs when the counter reaches either the positive or the negative preset value.

6.5.15 Saving Parameters in EEPROM (Register 13)

Register Address: 13
Parameters are not automatically saved to EEPROM. The user must issue a special command to commit the parameters to EEPROM. It is highly advisable to always initiate an EEPROM commit otherwise all the stored parameters will be lost when power is removed to the MR320 unit.

In addition to checksums, all parameters are stored twice internally and when retrieved both copies are compared and only restored when there is a match or when it is determined that there is one good copy of the parameter.

To store parameters into the EEPROM Send "1" to Address 13.

The programming for the Saving parameters to EEPROM:

<EOT> EA <STX> 131 <ETX> <BCC>

Check for a <ACK> that verifies store has been completed.

☞ All parameters in EEPROM are always restored at power up. There is no special user interaction required to read parameters from the EEPROM.

6.5.16 Saving Amplifier Configuration Parameters in EEPROM (Register 13)

Register Address: 13
The optical Amplifier gain and the source transmit power values can be saved to EEPROM for purposes of restoring in case a "bad" calibration was performed.
Values stored are: Gain CHA, GAIN CHB, POWER CHA, POWER CHB

To store these configuration parameters into the EEPROM
The programming for the Saving parameters to EEPROM, Send "4" to Address 13:

<EOT> EA <STX> 134 <ETX> <BCC>

Check for a <ACK> that verifies store has been completed.

6.5.17 Restore Amplifier Configuration Parameters from EEPROM (Register 13)

Register Address: 13
Good calibration values previously stored may be recalled.
The programming for the Saving parameters to EEPROM, Send "5" to Address 13:

<EOT> EA <STX> 135 <ETX> <BCC>

Check for a <ACK> that verifies store has been completed.

6.5.18 Diagnostic String Address 1C (Version 2.20 and higher)

Register Address: 1C (This field is Read Only).

Issue a request for the full diagnostic string.

<EOT> EA1C <ENQ>

The Controller returns an ASCII string embedded into the ISO protocol. The 10 value fields are separated by a ":" colon.

#	Name	Description
0	sys_error	Status, see error tablecodes
1	gainA	Gain Channel A
2	gainB	Gain Channel B
3	adc_readA	Amp Out CHA Actual
4	adc_readB	Amp Out CHB Actual
5	amp_outA	Amp Out CHA last moved
6	amp_outB	Amp Out CHA last moved
7	timer_moved	Time since last move in 10 second interval
8	timer_cald	Time since last calibration, in 1 minute interval
9	enc_count	Position count, 16bit signed

The diagnostic values evaluate as follows:
(if possible store the values in a computer file for later analysis along with a time stamp)

a.) If Status indicates an error determine the cause based on the status/error table. A calibration error (5) indication can be remedied by sending appropriate calibration values.

b.) Evaluate the actual adc_readA and adc_readB values. If any of these two values exceed 110 counts calculate a new gain value for that channel only and send to appropriate register (either 0x310 or 0x311)
Clear the error by sending function FC05-1

c.) Check elapsed time since last movement. The elapsed time is given in 10 second intervals. If 1800 (30minutes) then the amplifier output values are fresh and do evaluate as below described in e.) If last movement is old, evaluate plausibility if indeed no movement should have occurred since the indicated time. This is application dependent – of course.

d.) Evaluate amp_outB and amp_outB. If within range nothing needs to be done. If not within range check the time elapsed since last movement and if that checks out correct then calculate enew gain and set.

e.) Evaluate time since last calibration. This time can be as long as the programmed calibration interval (0x111) plus the time of no movement. The calibration time interval is in minutes.

Acceptable Values for the Diagnostics:

Parameter	Nominal	Minimum normal warning		Maximum normal warning	
Status Byte (0x000) First byte of (0x30A)	0	value not 0x00 is a warning or error			
Gain A (0x310) Gain B (0x310)	40	4	1	105	125
Amplifier A (0x300) Amplifier B (0x301) same for values retrieved at (0x30A)	103	95	< 90	110	>110
Laser Power CH A (0x313) CH A (0x312)	127	0	n/a	127	n/a
2.5V (0x302)	123	113	< 113	133	>133
5V (0x302)	128	118	<118	128	>128
12V (0x303)	66	56	<56	76	>76

6.6 Modbus Protocol

6.6.1 Electrical Connection for Modbus Operation

The Modbus, as implemented in the MR310/MR320 Controller with software revision 1.26 or higher, operates on fixed 9600 Baud and support RTU (binary) protocol.

The connection is four wire for full duplex operation.

Physical Connection

The MR3X0 maybe connected either full duplex or half duplex

Full Duplex Wiring:

BUS Master	Wire	Slave		MR320 J3	MR320 J3-PIN#
TXD0	→	RXD0	A	RCV-	6
TXD1	→	RXD1	B	RCV+	5
RXD1	←	TXD0	A	TX-	4
RXD0	←	TXD1	B	TX+	3
GND		GND		GND	1

Baudrate	9600
Data Bits	8
Stop Bit	1
Parity	none

Bus Termination Resistor

The MR310/MR320 Controller does not have an internal Termination Resistor. If the Controller is the last device on the bus and distance exceed 5m then a suitable termination resistor should be added.

6.6.2 Device Address Selection

The MR320 comes pre-configured with Device address 33.

The MR320 always listens to address 0 (Broadcast Address). To re-program the device address, send desired address FC10 to register 010A via the broadcast address (00) and then send the appropriate "STORE" command via FC05 register 0002 (make sure the MR320 is the only device on the bus while performing this procedure)

Upon that procedure the unit will listen to the newly assigned Device Address.

EXCEPTION **Address 4 is reserved!!** Do not use address 4 and avoid any slave to respond to address 4 on the bus.

REGISTER NUMBERS VS. METER ADDRESSES
In this manual all registers are referred to by their physical address i.e. starting at 0.
Some Master devices (e.g., Modicon) require that the desired Register Number and not the Register Address be entered. Register Numbers start at 1 and therefore are always one increment higher than the Register Address. For entry to these devices, add one to the Register Address shown in the tables below.

6.6.3 Register Alignment and Register Length

In general Modbus allows a read and a write to any arbitrary register address and any number of registers without causing an error. The MR320 encoder is a real-time sensor and therefore unreasonable large bus requests could take away computing resources from the encoder unit. The MR320 safeguards against erroneous register readings or readings across several registers as follows: The MR320 will respond with error 0x03 Illegal Data Value when a register address does not match the address as specified in the function table.
The MR320 will respond with error 0x03 Illegal Data Value when the specified number of registers does not match the expected length for that specific register function.

MR320 Encoder Count Register is located at address 0x001 and length is two 16 bit registers.

Correct: Address 0x0001 Length 0x0002

Wrong: Address 0x0001 Length 0x0001
Address 0x0002 Length 0x0001
Address 0x0001 Length 0x0002

6.6.4 Listing of Functions and Registers

FUNCTION FC03 – Read Holding Registers
FUNCTION FC16 – Write Holding Registers

These Registers can also be written using Function FC16 and use identical address offset
Column 1 lists the Modbus register address.
Column 2 lists the applicable unit for which the command is valid. 1=MR320, 3=MR330
Column 3 lists the number of 16bit registers returned or sent.
Column 4 lists a descriptive name for the function/command
Column 5 lists the numeric range for which data is valid. Numbers sent outside this range generate an error
Column 6 detailed description for what the command/function does. For expanded description see also the ISO1745 command section.

Register Address	Appl Unit	Name	# regs	Range	Description
0x00	All	System Status	1	n/a	Returns the system error status, using a Setup command clears errors.
0x001	1,3	Get / Set Position	2		Set Position also valid for the MR320
0x003	3	Get Angle	2		
0x005	1	Get RPM	2		
0x100	3	Commanded Position (write) Position Offset (read)	2	-lng to +lng	Sets the position of the encoder to the commanded position. Software calculates the offset of the present reading from the commanded reading and saves that value. Reading this register returns the calculated offset.
0x104	1,3	Device Address	1	1 – 254	Sets the MR320 serial address for commands. Note that the address 4 cannot be used. A FC05 command to save EEPROM must be issued following this command.
0x105	1,3	Operating Mode	1		Sets the system operating mode. 0 = Normal 1 = Forces a gain pot calibration to occur (same as 'Cal' button being pressed). Following cal, mode returns to Normal. 2 =
0x110	1	Encoder Slits	1	95 – 10000	Sets the number of slits in the encoder,

					used for RPM calculations.
0x111	1	Calibration Interval	1	1 – 99	Sets the time interval for performing gain calibration. The value passed is multiplied by 2.55504 seconds to determine the actual time interval.
0x130	3	Video Start	1	1 – 200	
0x131	3	Target Level	1	100 - 1023	
0x132	3	Voltage Offset	1	-128 – 127	
0x133	3	Voltage Gain Pos	1	-8192 – 8192	
0x134	3	Voltage Gain Neg	1	-8192 – 8192	
0x135	3	Current Gain	1	-8192 – 8192	
0x200	1,3	Voltage Mode	1	0 – 1 (SPEED) 2 (POSITION)	Establishes the output mode of the voltage output. 0 = SPEED mode with bipolar ±12V output range 1 = SPEED mode with unipolar 0-12V output range 2 = POSITION mode with bipolar ±12V output range
0x201	1,3	Voltage Scale	2	0 – 10000 (SPEED) 0-9000000 (POSITION)	Establishes the scale used for the voltage output. Regardless of Voltage Mode setting, +10V output always represents the positive VOLTAGE SCALE setting. If Voltage Mode set for SPEED, the maximum entry is 10,000. If entering a larger Scale value >10,000, the MR320 will send an error signal and reset the Scale value to 10,000. If Voltage Mode set for POSITION, the maximum entry is 9,000,000. The entered value establishes what position/counter value will produce an output ±10V (sign depends on direction).
0x203	1,3	Voltage Filter	1	0 – 256	Must be power of 2 (1, 2, 4, etc) If input is not power of two then parameter is accepted and converted

					to the next power of two.
0x204	1,3	Current Mode	1	0 – 2 (SPEED) 3 – 5 (POSITION)	Sets the mode of the current output. 0 = For SPEED bipolar output range 0-12-24 mA (where 12mA represents 0rpm). 1 = For SPEED unipolar output range 0 - 24mA (where 0mA represents 0rpm) 2 = For SPEED unipolar output range 4-24mA (where 4mA represents 0rpm) 3 = For POSITION bipolar output range 0-12-24mA (where 12mA represents zero position/counter value) 4 = For POSITION unipolar 0-24mA range (where 0mA represents zero position/counter value) 5 = For POSITION unipolar 4- 24mA output range (where 4mA represents zero position/counter value) 6 = For POSITION 4- 24mA output range window mode.
0x205	1,3	Current Scale	2	0 – 10,000 (SPEED) 0-9,000,000 (POSITION)	Establishes the scale used for the current output. Regardless of Current Mode setting, 20mA output always represents the positive CURRENT SCALE setting. If Current Mode set for SPEED, the maximum entry is 10,000. (RPM) Valid scales are 10 to 10,000. If entering a larger Scale value >10,000, the MR320 will send an error signal and reset the Scale value to 10,000. If Current Mode set for POSITION, the maximum entry is 9,000,000 counts, The entered value establishes what position/counter value will produce an output of 20mA NOTE: 0 turns off current output.
0x207	1,3	Current Filter	1	0 – 256	Must be power of 2 (1, 2, 4, 8, etc) If input is not power of 2, then parameter is accepted and converted to next power of 2.
0x208	1	Counter Reset Mode	1	0 – 1	Defines how the hardware input resets the internal counter. 0 = Edge Triggered, resets the counter at the rising edge 1 = Debounced Trigger when state

					changes from 0 to 1 after 60ms debounce time. (used for switch or relay input)
0x209	1	Hardware Reset Value	1	0-9,000,000	Counter will be preset to this value when the hardware input changes from logic 0 to logic 1.
0x20B	1	Encoder Direction	1	0 - 1	Defines output results based on turning direction of the encoder 0 = when CW outputs are positive 1 = reversed outputs Note: quadrature outputs are not affected.
0x210	1	Quadrature Divider	1	1 – 8194	Sets the divide ratio for the programmatic encoder output pulses, e.g. if a value of 8 is set, each time eight quadrature input cycles occur, a single quadrature output cycle will be generated.
0x211	1	Counter Multiplier	1	0 - 1	Internal counter increments using either a full or half cycle of the quadrature signal. 0 = Full cycle counts 1 = Half cycle counts (x2 multiplier) Note: This Aux Function only affects POSITION mode operation of the analog outputs.
0x212	1	Reset On Count	1	0 -9,000,000	Internal counter resets to 0 when this value is reached.
0x230	3	Output 1 On	2		
0x232	3	Output 1 Off	2		
0x234	3	Output 2 On	2		
0x236	3	Output 2 Off	2		
0x300	1,3	ADC Read 1	1		0 = Channel A peak signal
0x301	1,3	ADC Read 2	1		1 = Channel B peak signal
0x302	1,3	ADC Read 3	1		2 = 2.5V channel reference voltage
0x303	1,3	ADC Read 4	1		3 = +5V channel
0x304	3	ADC Read 5	1		4 = +12V channel

0x305	3	ADC Read 6	1		
0x306	3	ADC Read 7	1		
0x307	3	ADC Read 8	1		
0x308	1,3	Voltage DAC	1	0 - 4095	actual setting of the Voltage DAC
0x309	1,3	Current DAC	1	0 - 4095	actual setting of the Current DAC
0x30A	3	Voltage output	1	0 – 10000	Target Voltage for the DAC
0x30B	3	Current output	1	0, 4000 – 20000	Target Current for the DAC
0x30A	1	Diagnostic packet	10		Returns 10 registers with diagnostic information. Must always read 10 registers.
0x310	1	Pot A State	1	0..127	value of channel A gain pot.
0x311	1	Pot B State	1	0..127	value of channel A gain pot.
0x312	1	Encoder Period	2		encoder period as detected on Channel A
0x330	1,3	DAC 1, Chan 1	1		
0x331	1,3	DAC 1, Chan 2	1		
0x332	3	DAC 1, Chan 3	1		
0x333	3	DAC 1, Chan 4	1		
0x334	3	DAC 2, Chan 1	1		
0x335	3	DAC 2, Chan 2	1		
0x336	3	DAC 2, Chan 3	1		
0x337	3	DAC 2, Chan 4	1		
0x400	1,3	Device Name	4	n/a	Returns the ASCII string device name (MR320)
0x404	1,3	Version	4	n/a	Returns the ASCII string of the software version form MM.mm.bb
0x408	1,3	Serial Number	4	n/a	Returns the serial number of the device.

FUNCTION FC05 – Write Single Coil

These commands cause an action in the system that does not have a corresponding read location.

Register Address	Appl Unit	Name	#regs	Range	Description
0x01	1,3	Device Reset	1	0x0 or 0xFF00	Cause the system to perform a software reset.
0x02	1,3	Save to EEPROM	1	0x0 or 0xFF00	Save current parameters to EEPROM
0x003	1,3	Restore From EEPROM	1	0x0 or 0xFF00	Restore Power Up parameters (from EEPROM)
0x004	1,3	Restore Factory Default	1	0x0 or 0xFF00	Restore Factory Defaults (does not save to EEPROM).
0x005	1	Save Amplifier Config	1	0x0 or 0xFF00	Save the amplifier gain and source value in EEPROM (Rev 2.20 and up)
0x06	1	Restore Amplifier Config	1	0x0 or 0xFF00	Restore the amplifier gain and source value from EEPROM (Rev 2.20 and up)
0x010	1	Source A	1	0..1	Controls source for channel A
0x011	1	Source B	1	0..1	Controls source for channel B

Exception Return Codes

Exceptions are indicated by the return of the function code with the MSB set to 1 i.e. by logically performing 0x80 or FC .

Modbus error handling is restricted to the layer one transmission protocol. It specifically does NOT mean

that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register. To test for acceptance of correct data items querry the Status register address 0x0000.

Code	Name	Description
01	ILLEGAL FUNCTION	Illegal Function was sent. This device only supports Functions 01,03,04,05,23 The function code received in the query is not an allowable action for the slave. If a Poll Program Complete command was issued, this code indicates that no program function preceded it.
02	ILLEGAL DATA ADDRESS	The address was outside the range for the given function request. The data address received in the query is not an allowable address for the slave.
03	ILLEGAL_DATA_VALUE	The number of registers requested was too long or too short for the address A value contained in the query data field is not an allowable value for the slave.
04	DEVICE FAILURE	Internal failure. An unrecoverable error occurred while the slave was attempting to perform the requested action.

05	ACKNOWLEDGE	ACKNOWLEDGE. The slave has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the master. The master can next issue a Poll Program Complete message to determine if processing is completed
06	SLAVE_DEVICE_BUSY	When device needs a delay but will deliver the response. The slave is engaged in processing a long–duration program command. The master should retransmit the message later when the slave is free.
07	NEGATIVE_ACKNOWLEDGE	The slave cannot perform the program function received in the query. This code is returned for an unsuccessful programming request using function code 13 or 14 decimal. The master should request diagnostic or error information from the slave.
08	MEMORY_PARITY_ERROR	The slave attempted to read extended memory, but detected a parity error in the memory. The master can retry the request, but service may be required on the slave device.
300	RESPONSE_TIMEOUT	Unit did not respond
301	ISCLOSED	Comm port is not available
302	CRC	CRC error
303	RESPONSE	NOT THE EXPECTED RESPONSE RECEIVED
304	BYTECOUNT	
305	QUANTITY	Quantity is out of range
306	FUNCTION	Function out of range
400	NOT_AVAILABLE	Device not available
401	WRITE	Write error
402	READ	Read Error

Message Formats

DA	= Device Address	DD	= Data to read	CRCL	= CRC Byte low
FC	= Function Code	WW	= Data to write	CRCH	= CRC byte high
RA	= Register Address	SF	= Sub Function		
NR	= Number to Read	EC	= Error Code		
NB	= Number of bytes				

FC	Action	Sync	Byte Number										
		3.5b	1	2	3	4	5	6	7	8	9	10	11
03	request	pause	DA	FC	RA	RA	NR	NR	CRL	CRH			
03	response		DA	FC	NB	DD*	DD*	CRL	CRH				
05	request	pause	DA	FC	RA	RA	DD	DD	CRL	CRH			
05	response		DA	FC	RA	RA	DD	DD	CRL	CRH			
16	request	pause	DA	FC	RA	RA	NR	NR	NB	DD*	DD*	CRL	CRH
16	response		DA	FC	RA	RA	NR	NR	CRL	CRH			

DD* = number of bytes requested or being sent

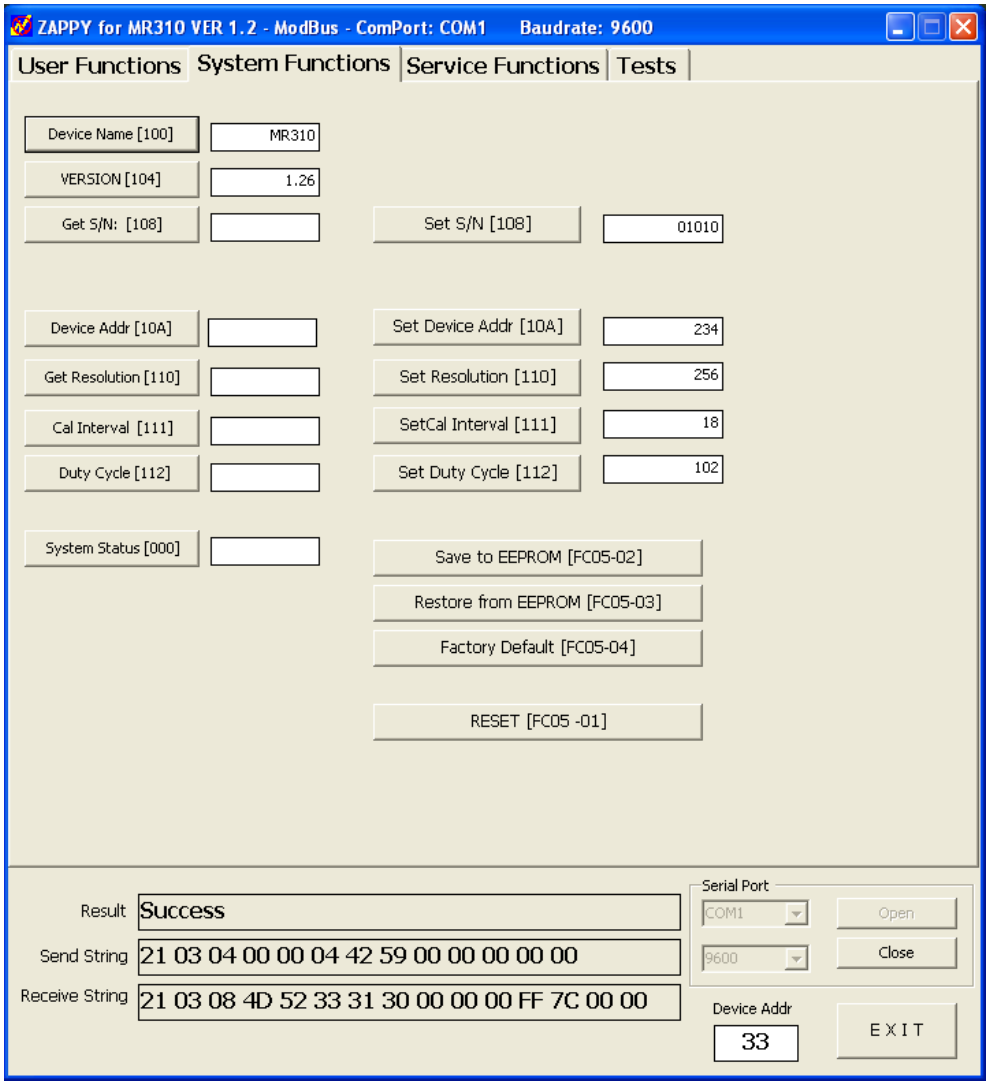
6.6.5 Modbus Test Software ZAPPY 1.20

Micronor provides a software which is intended to setup the MR320 unit. Another purpose is for the user to become familiar with the various Modbus functions.

Install the software "ZAPPY10_MOD_Setup.msi" on any PC with at least one Serial Interface port. In order to connect to the MR320 Controller, you will require an RS232 to RS422/485 interface cable, Micronor model MR232-1 which is available separately.
Alternately a USB to RS422 adapter can be utilized.

Note: This software is for engineering purposes only. It shows the bytes sent and received for the various Modbus commands.

Start the installed software and the main screen will appear.

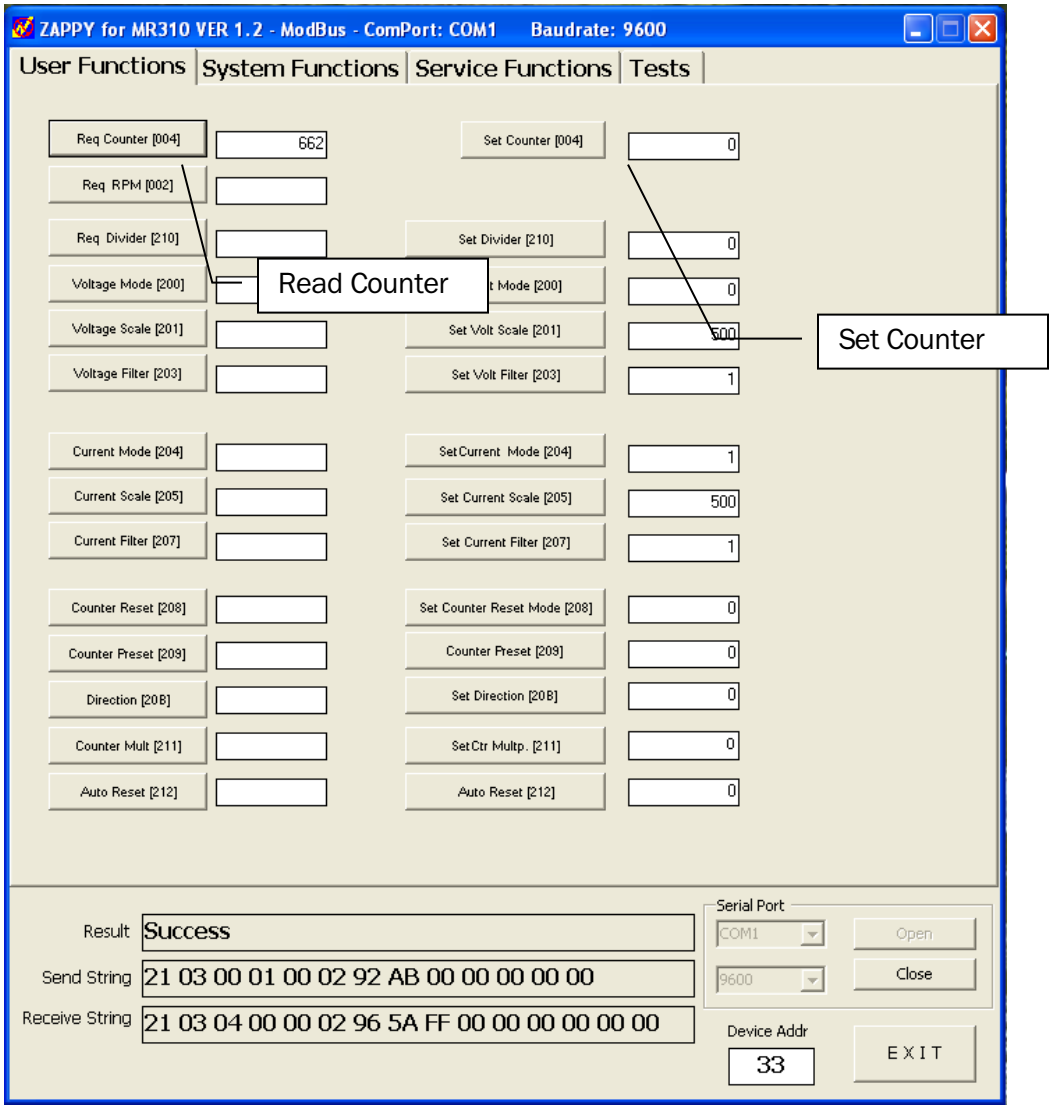


For first time start-up the software may need to be adjusted to the appropriate COM port on the computer. Click on the Close button select the Com Port where the MR320 is connected and click on Open.
The same procedure should be used to change to a different Modbus Device address.

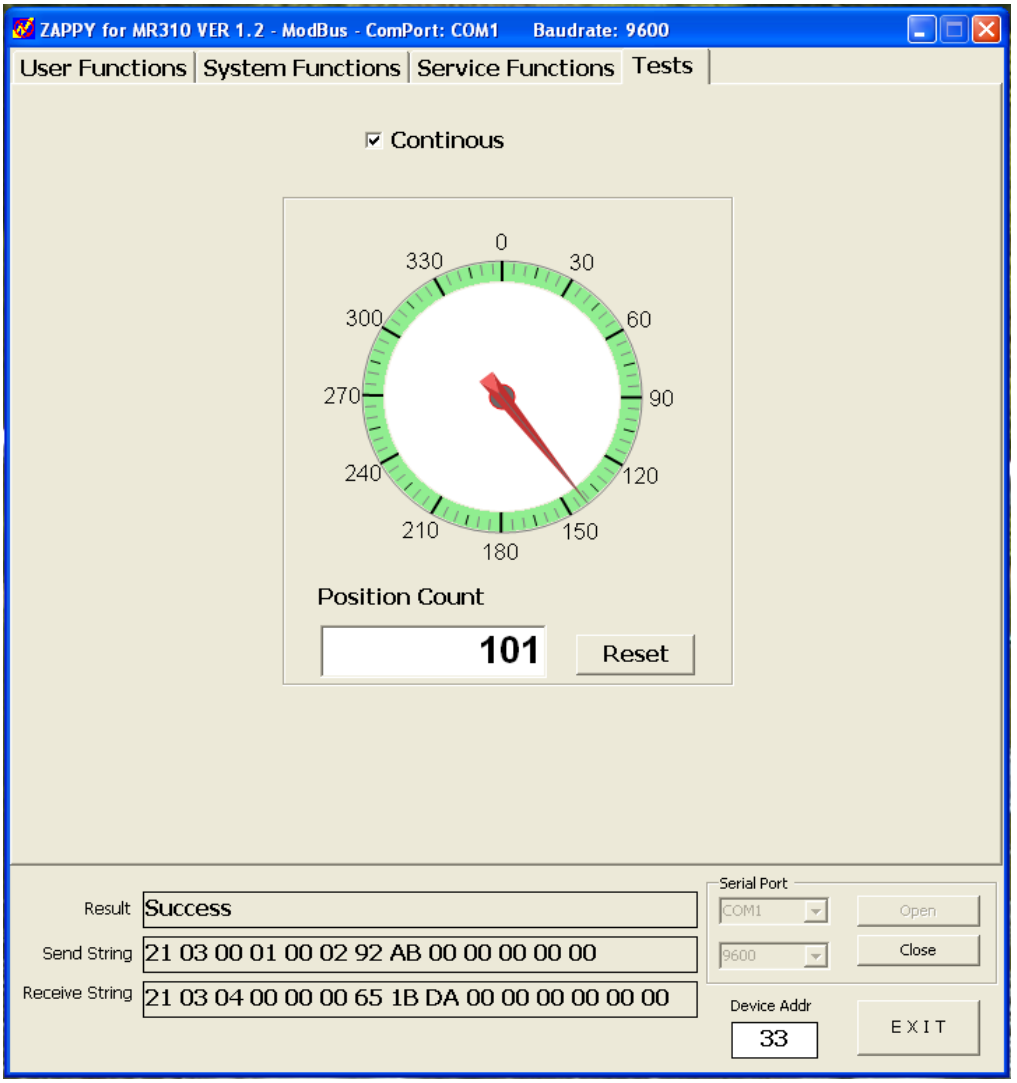
Test if the connection is good by clicking on the button “Device Name”. The MR320 should appear as shown in screenshot above.

The lower part of the screen shows the modbus communication result as well as the byte by byte transmitted and receive strings. Ignore trailing 0’s after the checksum, these zeros are not part of the string.

There are four tab pages to access the various function groups. User functions are used to set parameters as well as read and set the internal position counter of the encoder.



The last screen “test” let’s you poll the MR320 continuously and it displays the position whenever the check box “continuous” is checked. This feature maybe useful to test the encoder and also to test the serial lines using an oscilloscope.



Send String: 21h = Device address of 33 decimal
03h = Function 03 -> Read Holding Register
0001h = Register Address 0x0001 -> where the position counter resides
0002h = number of registers to read
92ABh = checksum

Receive String: 21h = Device address of 33 decimal
03h = Function 03 -> Read Holding Register
04h = number of bytes. Two 16bit registers that makes 4 bytes to read.
0065h = value is 101 decimal.
651Bh = checksum

To permanently store changes to the built-in EEPROM, send the command FC05 register2. There is a button on System Commands page to invoke this command.

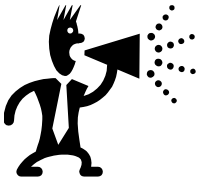
7. Maintenance and Service

7.1 Encoder Will Not Produce Quadrature Signals

If you cannot get quadrature signal output on J1, then first make sure if the A and B LEDs on the front panel light up when the encoder shaft is rotated.

7.1.1 LED's Do Light Up

If the LEDs flicker ON and OFF, then it means the encoder quadrature signals are being generated but there still might be a short or disconnect with the wiring. Make sure that you are connected to Pin 1, or 2, or 4, or 5 on J1 of the MR320 box.



Current Limit of Push-Pull Outputs
Do not exceed 15mA current!
Although the outputs are short circuit protected – avoid prolonged shorts.

7.1.2 LED's Do NOT Light Up

If one or both LED's do not light up while rotating the encoder shaft, then not enough optical power is being received, cabling problems or the MR320 input amplifiers have not been calibrated properly.

STEP 1. Calibrate the input amplifiers as described in Section 5.8 ***First Time Start-Up*** and Section 5.9 ***Manual Gain Calibration (Manual Reset)***. If that did not solve the Problem and the LED's do not light up, then most likely the fiber optic connection to the encoder is bad.

STEP 2. Check Fiber Optic Connections on both the encoder side and the controller side. Clean both connectors as described in Section 7.3 ***Fiber Optic Connector Cleaning***.

STEP 3. To check if the MR320 produces enough optical power, you must have a PC connected to the MR320 and ZAPPY™ software running and communicating with the MR320. Then disconnect the fiber optic cable from the MR320 and cover the connector interface to protect it from dust.

STEP 4. With no optical connection to the MR320, select [DIAGNOSTICS] mode and all pertinent diagnostics information will be automatically retrieved from the MR320. The INPUT AMPLIFIER field displays the gain setting of the amplifier and the calculated received optical power for each channel. Press the RESET switch on the MR320 (located just below J1) to force the ZAPPY™ Gain Setting to 20 (maximum gain due to no reflected signal from encoder). Save Diagnostic Report to File and contact Micronor Technical Support.

7.2 Interface Problems

If communications cannot be established with a PC, proceed as follows:

STEP 1. Use the ZAPPY Software from Micronor and check if you can communicate using this software.

STEP 2. Make sure you use a correct interface cable - either USB or MR232-1 for RS232 communications.

STEP 3. If ZAPPY works but your software will not communicate then make sure you have set your serial interface to the proper baudrate, start/stop bit setup, etc. as described in Section 6.2.1. If ZAPPY™ does not establish communication, then we may suspect the interface cable, MR320 module or the computer serial interface.

7.2.1 Testing The USB Interface

The basic test for the USB cable or interface is to verify that the ZAPPY™, the PC and MR320 Controller are communicating with each other. As mentioned in Section 5.10, the first installation of ZAPPY™ on a particular PC may requires 1 or 2 restarts as the appropriate Windows drivers are installed and the assigned COMx port becomes recognized by ZAPPY™.

STEP 1. First, connect USB cable and then start ZAPPY™ program. If ZAPPY cannot establish communications, then close ZAPPY™ and disconnect USB.

NOTE: There are several things that must happen in sequence so that is why is may take 2 or 3 program starts initially to get ZAPPY running and communicating to the MR320 Controller.

- FTDI driver must load
- Windows must install USB Serial Driver
- Windows assigns COMx Port to USB Serial Port
- ZAPPY finds the COMx Port and communications is complete

STEP 2. Repeat STEP 1 one or two more times. If you have further problems, please contact Micronor Technical Support.

7.2.2 Testing The Serial Cable

You may test the interface cable by converting it to a NULL Modem Cable.

STEP 3. Disconnect two wires from Pins 3 and 5 of J3 and twist the two ends together.

- *Note the colors on the cable and pin location before removing otherwise you may reconnect them in the wrong position!*
- *You must leave J3 connected to the MR320 box so that +5V power is supplied to the interface cable through PIN10.*

STEP 4. Now start up WINDOWS *Hyperterminal* on your PC. Type in any character and you should see that character being echoed back on the *Hyperterminal* screen. As shown in Figure 21, configure *Hyperterminal* with the proper communication settings - - Bits Per Second (9600), Data Bits (8), Parity (None), Stop bits (1) and Flow Control (None).

STEP 5. If the above is successful, then we know that the computer does send out and receive back signals properly through the cable. Verify again that the *Hyperterminal* communication settings (see Figure 21) have been set correctly for communicating with the MR320 because *Hyperterminal* can send and receive with any mix of settings.

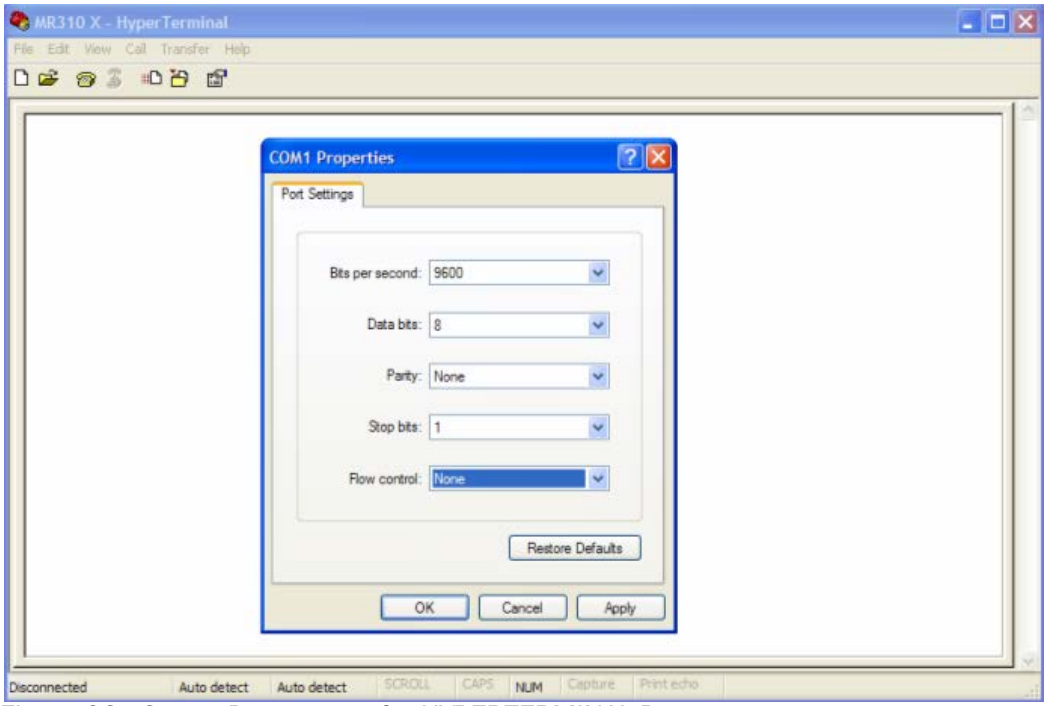


Figure 22. Set-up Parameters for HYPERTERMINAL Program.

7.3 Fiber Optic Connector Cleaning

Mating clean fiber optic connector end faces is essential to proper performance of any fiber optic-based equipment. When fiber optic connectors are not properly handled, dirt, oil and other contaminants can accumulate on the ferrule body as well as the critical tip (or end face) as shown in Figure 22. Mating of dirty connectors will result in high loss as well as potentially damaging mated end faces.

Figure 23. Dirty and Clean Fiber Optic Connector Ferrule and Endface Views.

There are two basic methods – WET and DRY - for cleaning fiber optic connectors. The method depends on the degree and spread of surface contamination.

7.3.1 WET Cleaning Method

The ***WET*** method is the most fundamental and complete (but manual) way of cleaning optical surfaces and connector endfaces. As shown in Figure 23, the consumables required are reagent-grade isopropyl alcohol (IPA) and dry lintless non-abrasive wipes or swabs (e.g. Kimwipes, TexWipe Swabs, etc.). Pre-saturated wipes (e.g. Polywater Type FO, etc.) may also be used if they also have a low non-volatile residue content. In practice, saturate the wipe with IPA (or use an approved pre-wetted wipe) and then rigorously wipe the outer and end surfaces – then dry completely with a clean dry wipe.

Figure 24. WET Cleaning Method Requires IPA & Dry Wipes *OR* Pre-Wetted Wipes & Dry Wipes.

7.3.2 DRY Cleaning Method - Micronor MR321C DRY Cleaning Kit

The ***DRY*** method is meant for surface cleaning of the ferrule endfaces only. There are several products available (e.g. CLETOPS, ReelCleaner, etc.) and they all work satisfactory and typically clean the connectors quite well. When the DRY Method does not completely remove all contaminants, then use the WET Method.

Micronor offers the MR321C Duplex LC Fiber Optic Cleaning Kits as a simple and portable DRY cleaning solution for Duplex LC plugs and receptacles. One Cleaning Kit is supplied with each

shipped lot of encoders and modules. Detailed cleaning instructions are supplied with each Cleaning Kit..

Figure 25. How To Use the MR321C Kit For Cleaning Duplex LC Optical Connectors and Interfaces.

Always visually inspect (with a fiber optic microscope) the optical plug or port (inside connector) after cleaning. If the terminated/polished end is still dirty or appears scratched, try the WET cleaning for better results. If visual inspection shows endface damage (scratches or pits in the core region), then have the connector end repolished or replaced.

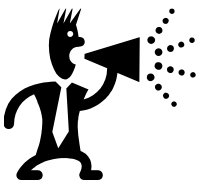
7.4 Troubleshooting

If the encoder system does not function (but lights turn on) and does not pass the ZAPPY™ Performance Verification procedure (consult Section 5.11), then it is necessary to determine where the problem exists – Controller, Sensor or fiber optic link. Be sure that you have cleaned all optical connections per Section 7.3 and verified continuity of the fiber optic link per Section 7.5.

If unable to locate the source of the problem. then contact Micronor for additional troubleshooting and fault isolation assistance.

7.5 How To Verify Visual Continuity of Fiber Optic Cable Link

Figure 25 provides detailed flow chart showing how to verify continuity of the encoder optical link using a a visual fault locator - a very basic, inexpensive and useful piece of fiber optic troubleshooting equipment.



Optical Warning
Never look directly at the output of an optical fiber with any source connected to it. Under some conditions, optical radiation can cause either temporary or permanent eye damage.

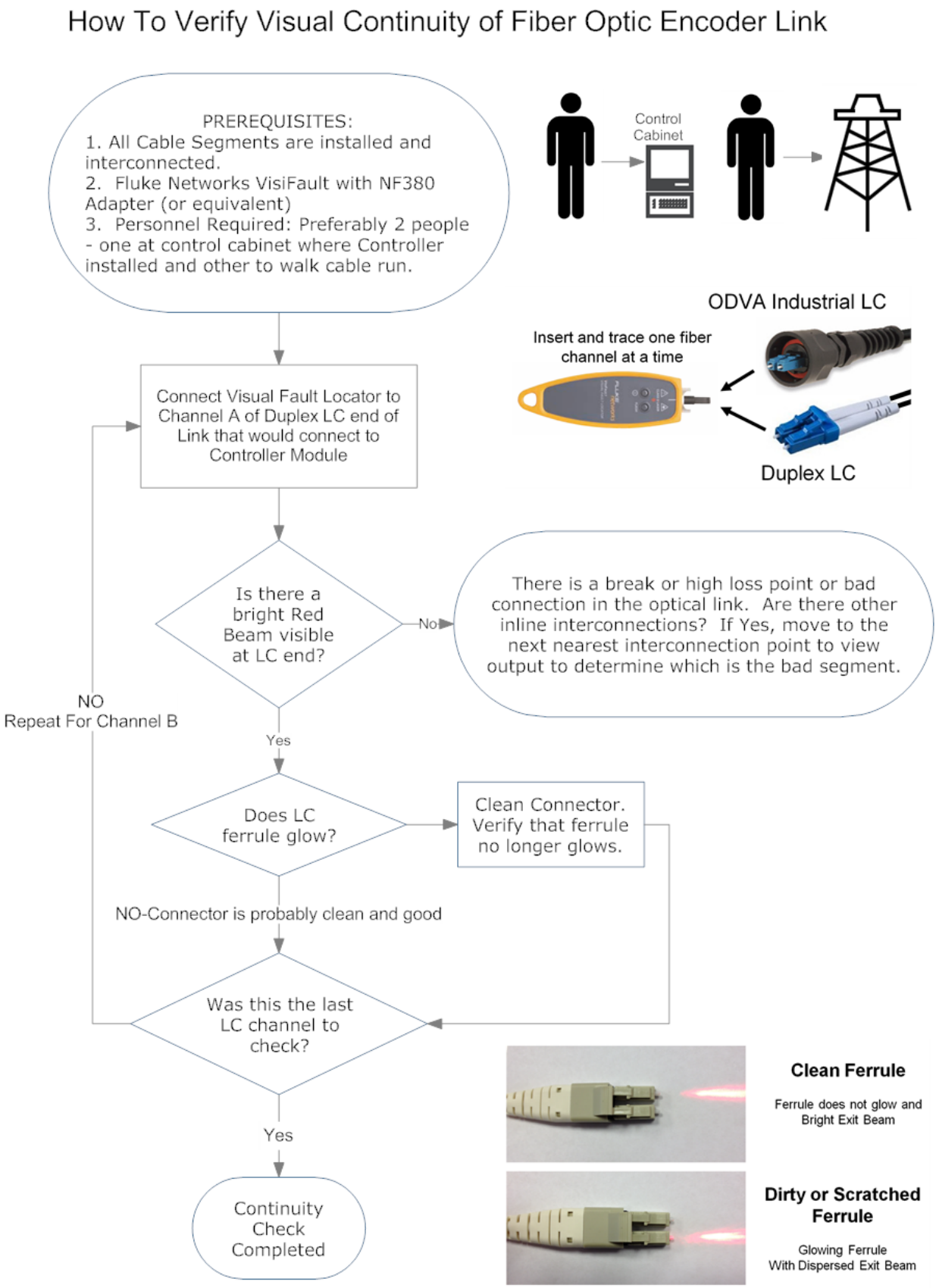


Figure 26. How To Verify Optical Continuity With A Visual Fault Locator.

7.6 Blinking Error Codes

Besides indicating Power-On, the PWR LED on the MR320 module is also used to display various problem and/or error conditions. In normal operation, the PWR indicator will behave as follows:

- Continuously ON to indicate normal operation
- Will blink off for about 150ms each time a CALIBRATION cycle occurs.

An error condition is signified by the PWR LED blinking 1-5 times in a cycle repeated every 3.3 seconds. Note the number of blinks and contact Micronor for technical support.

The PWR LED blinking error codes are:

- One (1) blink indicates an EEPROM failure.
- Two (2) blinks indicate that the internal 2.5V supply is out of tolerance.
- Three (3) blinks indicate that the internal +5V supply is out of tolerance.
- Four (4) blinks indicate that the 12V supply is out of tolerance.
- Five (5) blinks indicate that the optical encoder signal cannot be CALIBRATED correctly.

In each of these instances, the encoder system continues to run, but may not operate properly. Use the ZAPPY diagnostic tool to determine what the exact cause may be.

For instance when the +12V (4 blinks) error is indicated than use the diagnostics to evaluate if the unit must be repaired or if it is still useable. The unit is useable as long as the internal voltage is +12V to +14.5V.

Five blinks indicate that the input optical amplifier is at maximum or minimum gain range. Minimum gain is indicated when the GAIN setting of either amplifier is at 127. As long as the input voltage of that particular channel is less than 2.4V the system may still be used. If the voltage exceeds the 2.4V the unit must be sent to the factory for recalibration of the optical transmitter. When the amplifier is at maximum gain setting of 1 than there is not enough optical power the reason for this is most likely:

a.) high loss within the optical connections
b.) defective encoder
c.) defective optical transmitter unit (MR320)

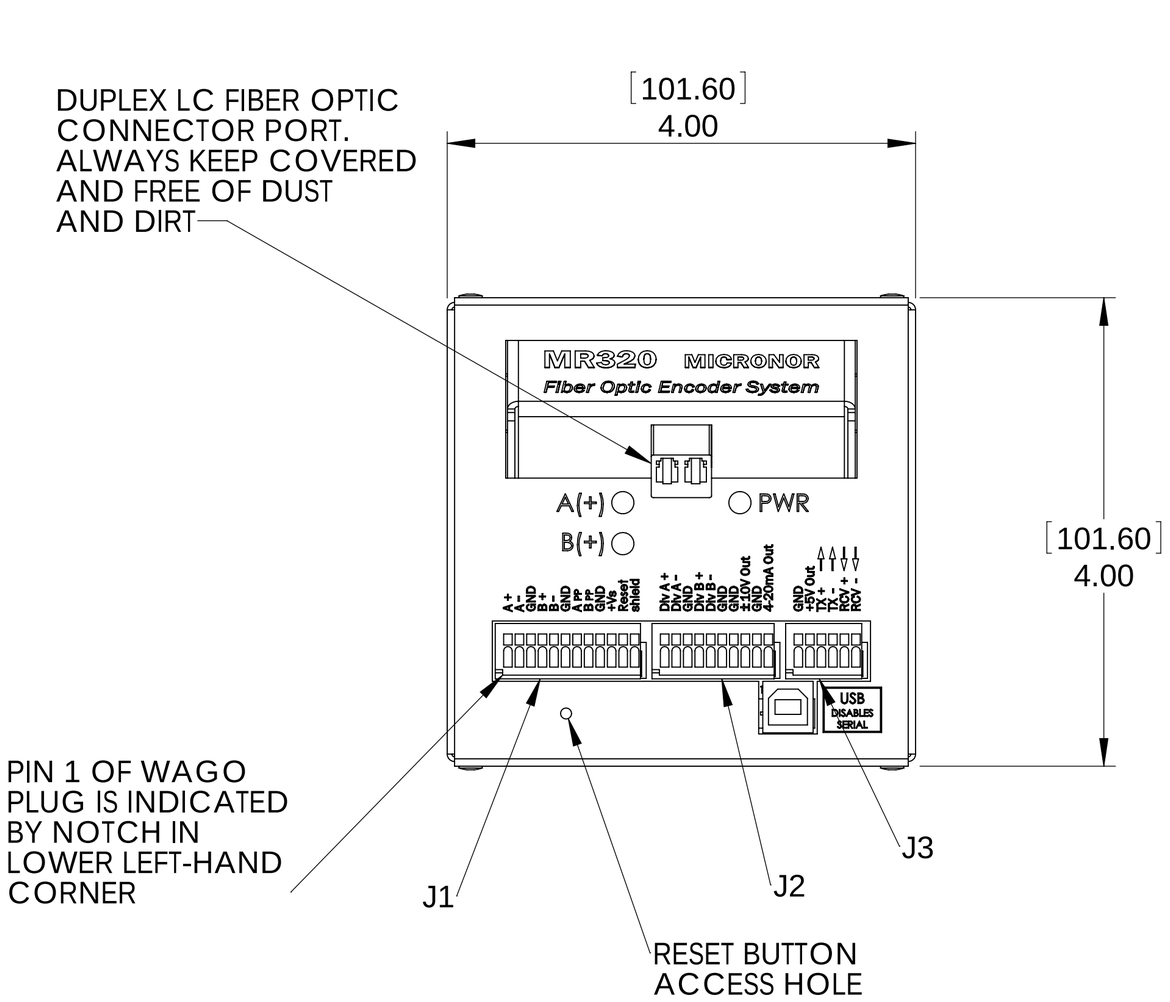
For troubleshooting the connection please refer to section 5.5 within this instruction manual.

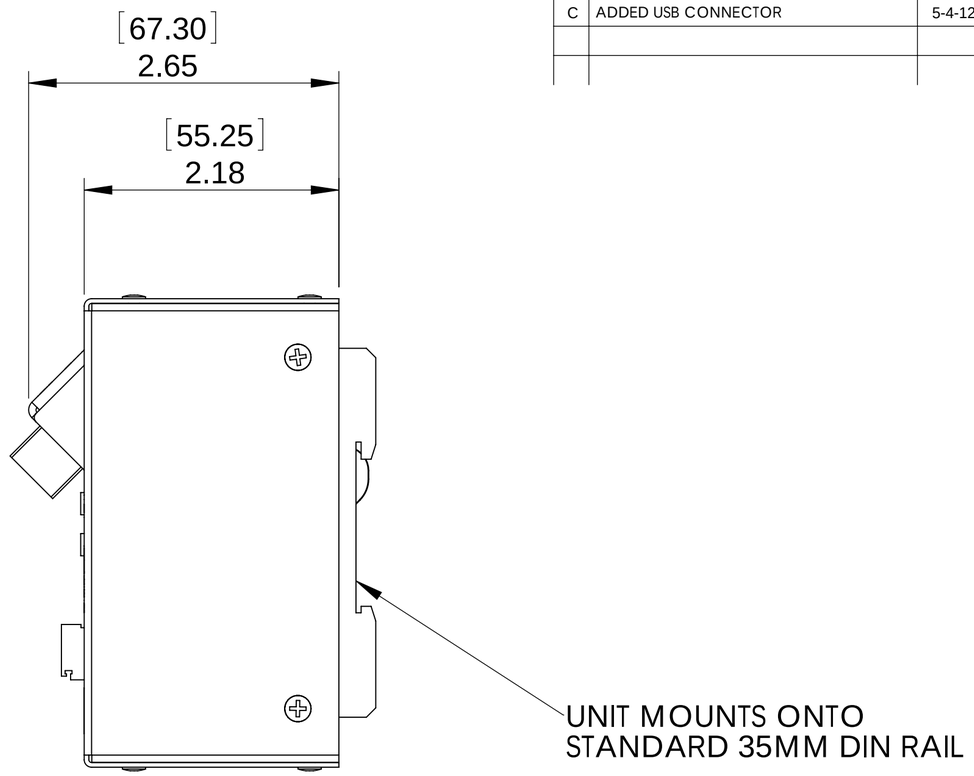
8. Reference Drawings

List of drawings which follow this page:

Micronor MR320: Controller Module Reference Drawing, 1 page
Micronor MR322: Optical Encoder Reference Drawing, 2 pages, Pigtail and ODVA versions
Micronor MR324: Optical Encoder Reference Drawing, 2 pages, Thru Bore and Pocket Hole versions
Micronor MR325: Optical Encoder Reference Drawing, 1 page
Micronor MR326: Optical Encoder Reference Drawing, 2 pages, Pigtail and ODVA versions
Micronor MR328: Optical Encoder Reference Drawing, 1 page
MR320 Series Declaration of Conformity

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
C	ADDED USB CONNECTOR	5-4-12	RGB





J1 WAGO PN: 733-112 (12 PIN TERMINAL)	
1	A+
2	A-
3	GND
4	B+
5	B-
6	GND
7	A pp
8	B pp
9	GND
10	+Vs
11	reset
12	shield

J2 WAGO PN: 733-110 (10 PIN TERMINAL)	
1	Div A+
2	Div A-
3	GND
4	Div B+
5	Div B-
6	GND
7	GND
8	±10V Out
9	GND
10	4-20mA Out

J3 WAGO PN: 733-106 (6 PIN TERMINAL)	
1	GND
2	+5V Out
3	TX+ →
4	TX- →
5	RCV+ ←
6	RCV- ←

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
ANGULAR: ± .5°
TWO PLACE DECIMAL ±.02
THREE PLACE DECIMAL ±.005
FOUR PLACE DECIMAL ±.0010
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	R BOYER	9-1-11
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

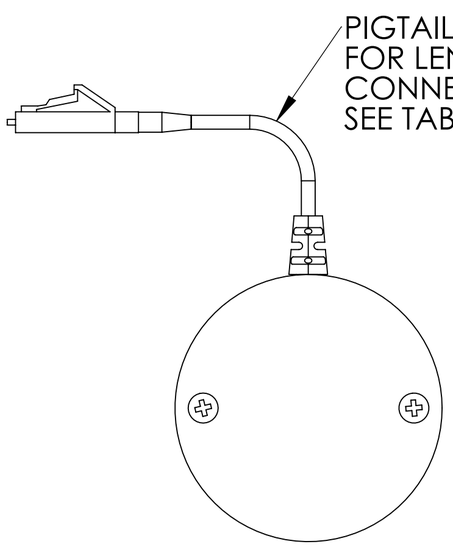
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

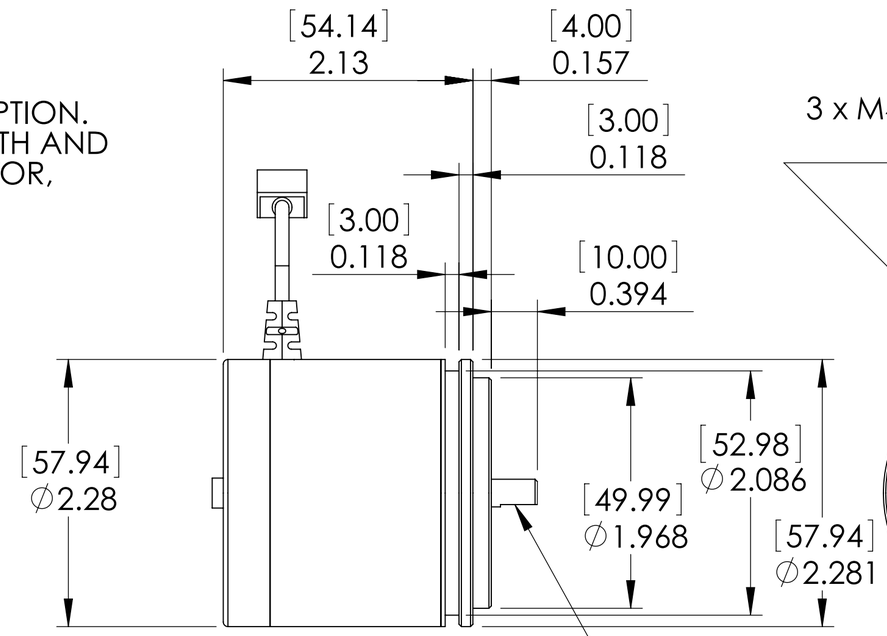
TITLE:
CONTROLLER, OPTICAL ENCODER

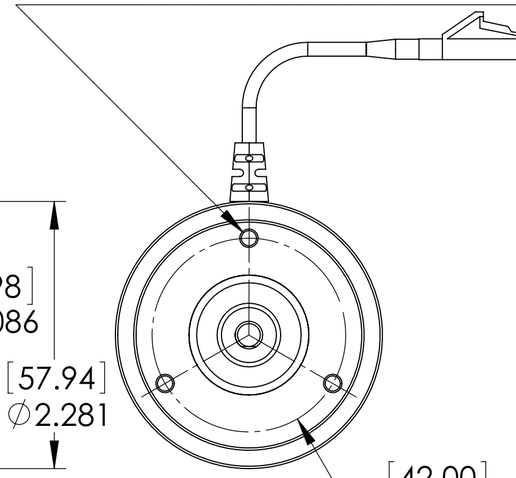
SIZE	DWG. NO.	REV
C	MR320	C

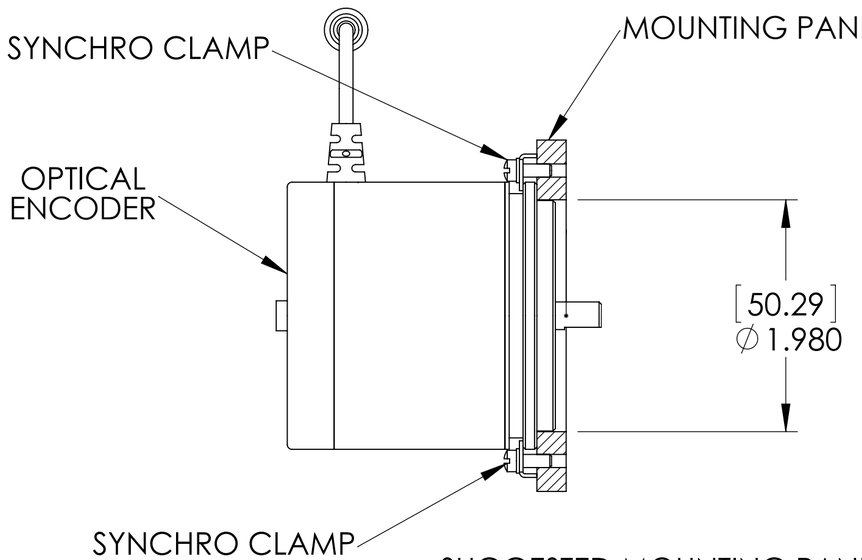
SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
B	ADD SHEET 2	4-1-13	RGB

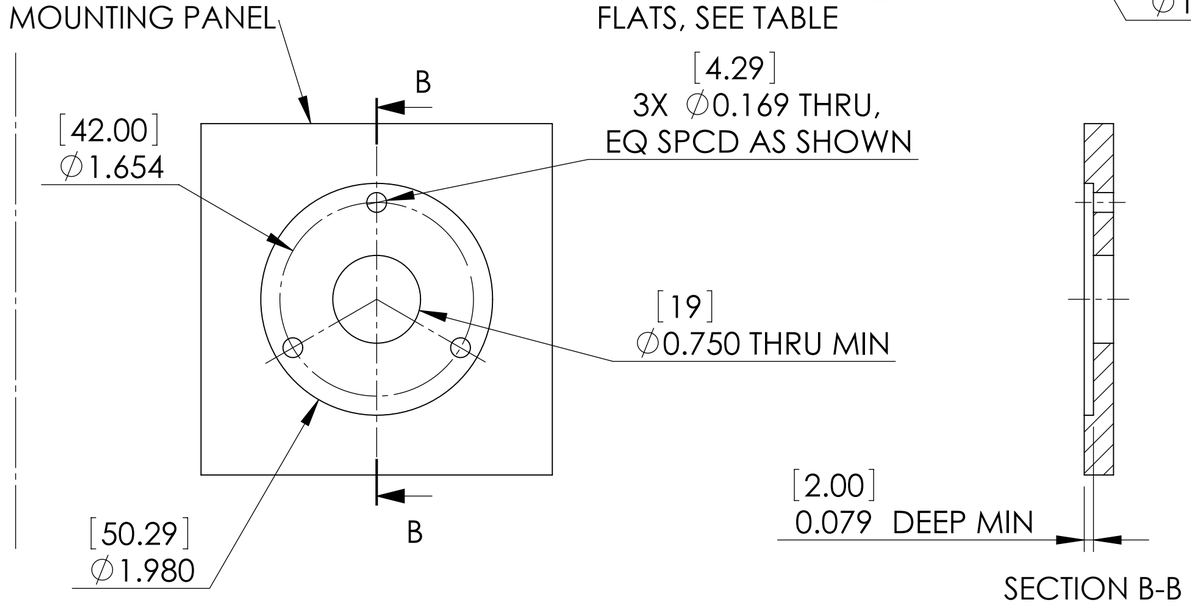








SUGGESTED MOUNTING PANEL
THRU-HOLE MOUNT WITH
SYNCHRO CLAMPS



SUGGESTED MOUNTING PANEL
COUNTER-BORED PANEL
WITH MOUNTING SCREWS

PART NUMBER ORDERING CODE

MR322 - D 06 C 1R5

RESOLUTION
A = 100
B = 128
C = 256
D = 360

SHAFT SIZE IN MILLIMETERS
6 = 6MM SHAFT
(∅0.2358 ± .0002 [5.989 ± 0.010]
WITH 0.216 [5.50 FLAT])

CONNECTOR TYPE
C = DUPLEX LC

PIGTAIL LENGTH IN METERS
(R = DECIMAL POINT)
1R5 = 1.5 METER

OTHER SHAFT OPTIONS ARE AVAILABLE

3. WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

2. WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

1. ALWAYS USE FLEXIBLE COUPLING WHEN MOUNTING SHAFT TO EXTERNAL EQUIPMENT.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES [MM]	DRAWN	R BOYER	9-1-11
TOLERANCES: ANGULAR: ± .5°	CHECKED		
TWO PLACE DECIMAL ±.02	ENG APPR.		
THREE PLACE DECIMAL ±.005	MFG APPR.		
FOUR PLACE DECIMAL ±.0010	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

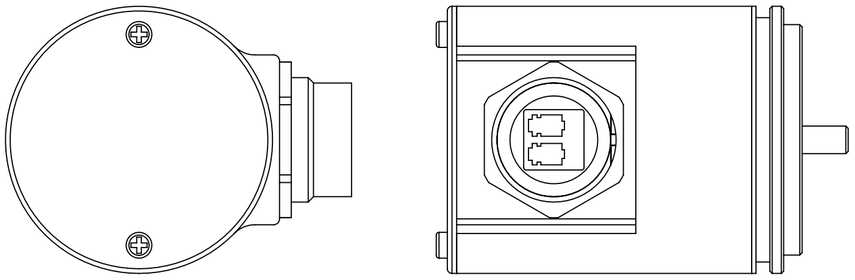
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

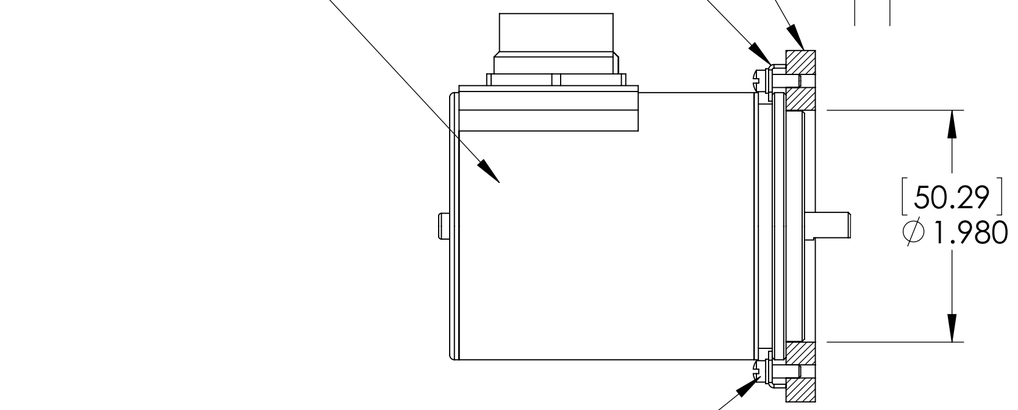
TITLE:
OPTICAL ENCODER
DUPLEX LC PIGTAIL

SIZE	DWG. NO.	REV
C	MR322-CXX	B

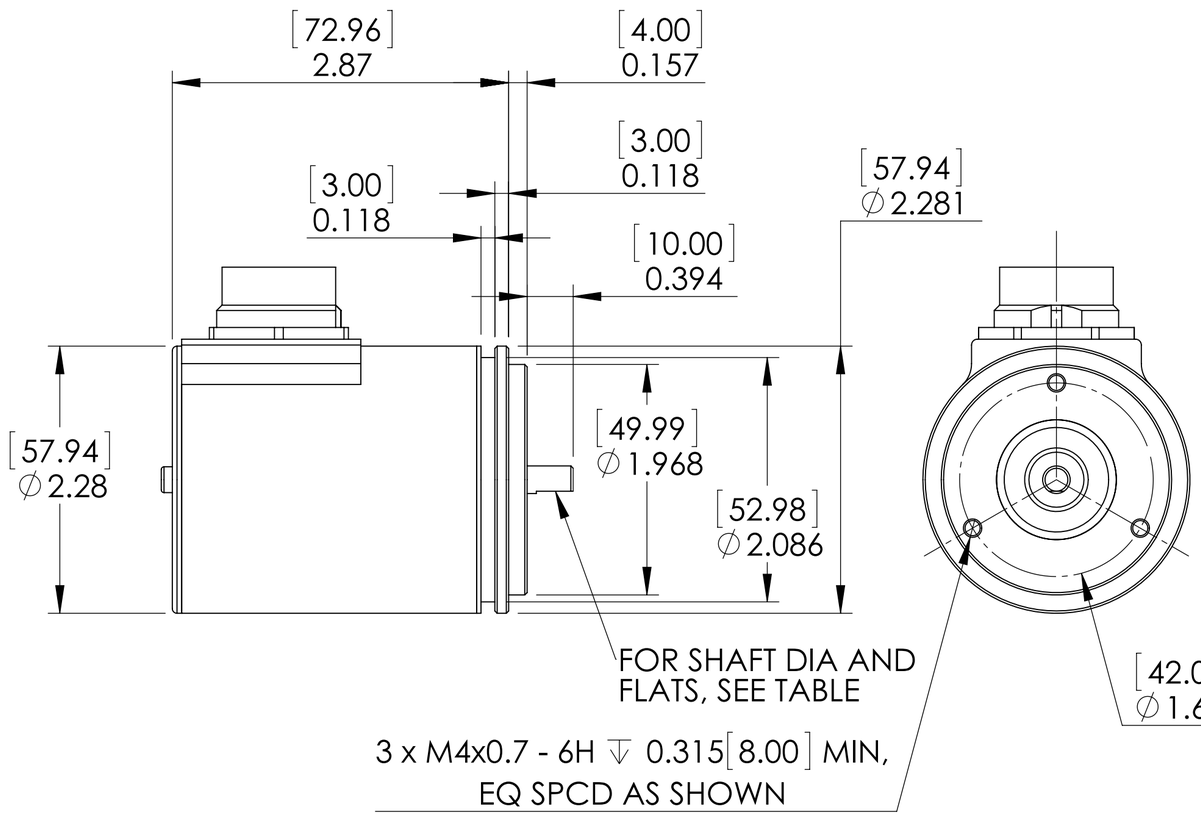
SCALE: 1:1 | WEIGHT: | SHEET 1 OF 2

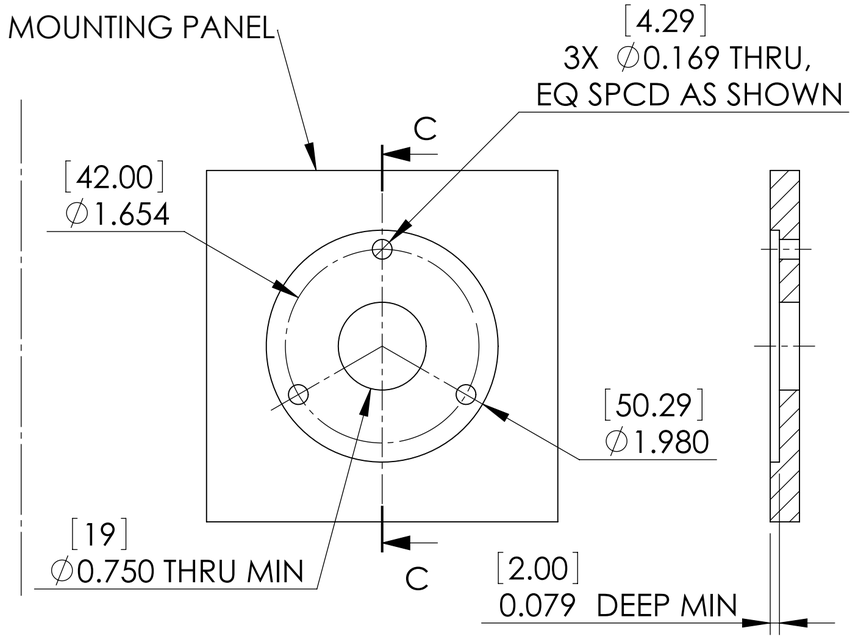
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
B	ADD SHEET 2	4-1-13	RGB





SUGGESTED MOUNTING PANEL
THRU-HOLE MOUNT WITH
SYNCHRO CLAMPS





SUGGESTED MOUNTING PANEL
COUNTER-BORED PANEL
WITH MOUNTING SCREWS

SECTION C-C

3. WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

2. WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

1. ALWAYS USE FLEXIBLE COUPLING WHEN MOUNTING SHAFT TO EXTERNAL EQUIPMENT.

NOTES: UNLESS OTHERWISE SPECIFIED

PART NUMBER ORDERING CODE

MR322 - D 06 D00

RESOLUTION
A = 100
B = 128
C = 256
D = 360

SHAFT SIZE IN MILLIMETERS
6 = 6MM SHAFT
(∅0.2358 ±.0002 [5.989 ±0.010]
WITH 0.216 [5.50 FLAT])

OPTICAL CONNECTOR
D00 = ODVA INDUSTRIAL LC
DUPLEX CONNECTOR

OTHER SHAFT OPTIONS ARE AVAILABLE

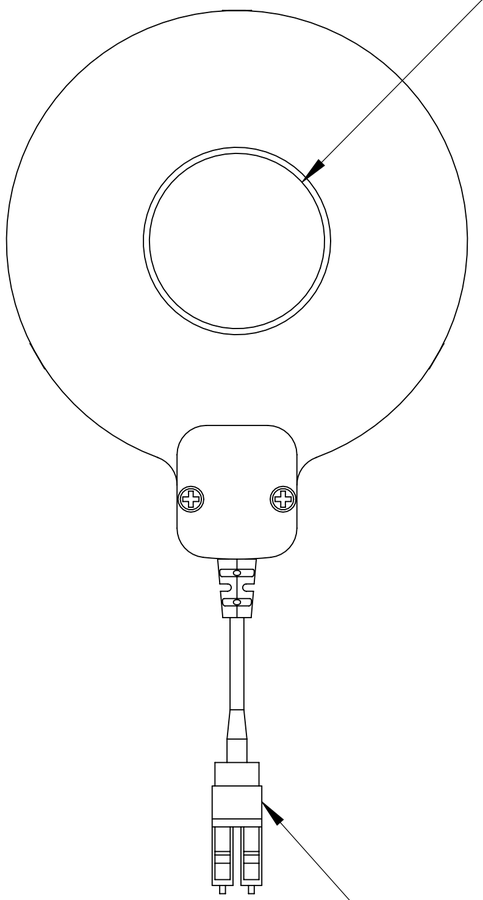
UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ± .5° TWO PLACE DECIMAL ±.02 THREE PLACE DECIMAL ±.005 FOUR PLACE DECIMAL ±.0010	DRAWN	R BOYER	4-1-13
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
MATERIAL SEE NOTES	COMMENTS:		
FINISH SEE NOTES			
DO NOT SCALE DRAWING			

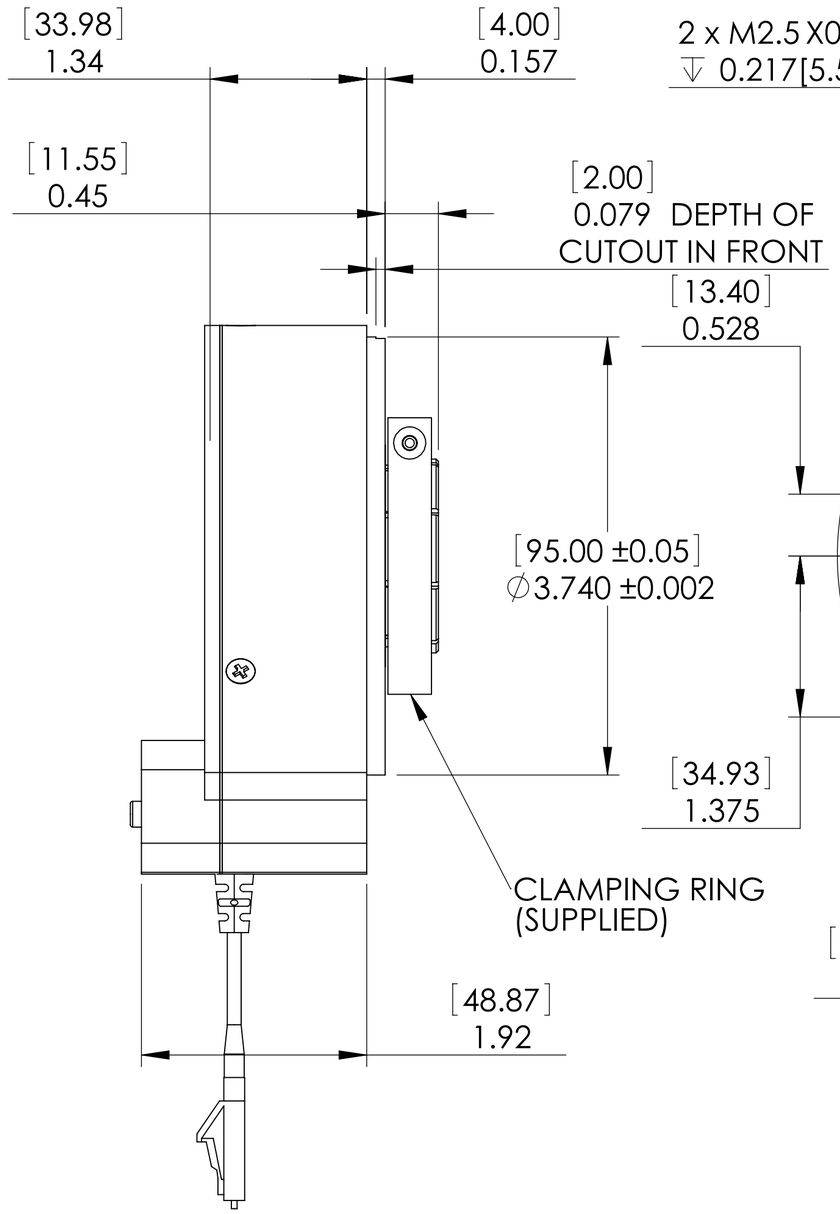
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

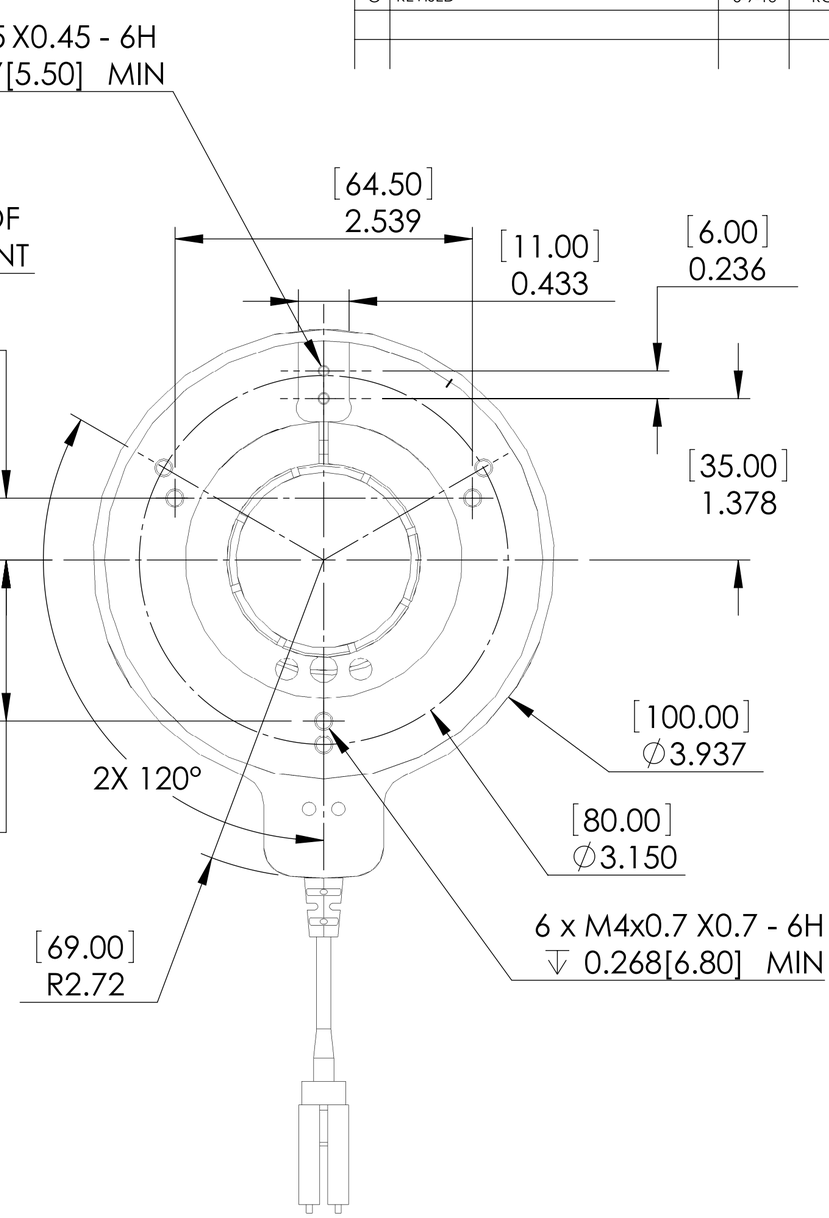
TITLE:
OPTICAL ENCODER
ODVA LC

SIZE	DWG. NO.	REV
C	MR322-D00	B
SCALE: 1:1	WEIGHT:	SHEET 2 OF 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
C	REVISED	5-9-13	RGB







PART NUMBER ORDERING CODE

MR324- F 38 C 1R5

TEMPERATURE OPTION
(BLANK) = STANDARD, -40°C TO +80°C
E = EXTENDED, -60°C TO +150°C

RESOLUTION
F = 1024

HOLLOW SHAFT BORE IN MILLIMETERS
38 = 38MM HOLLOW SHAFT THRU HOLE IP54
[∅38.026 ±0.013]
∅1.4971 ±0.0005

CONNECTOR TYPE
C = DUPLEX LC

PIGTAIL LENGTH IN METERS
(R = DECIMAL POINT)
1R5 = 1.5 METER

2. WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

1. WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

NOTES: UNLESS OTHERWISE SPECIFIED

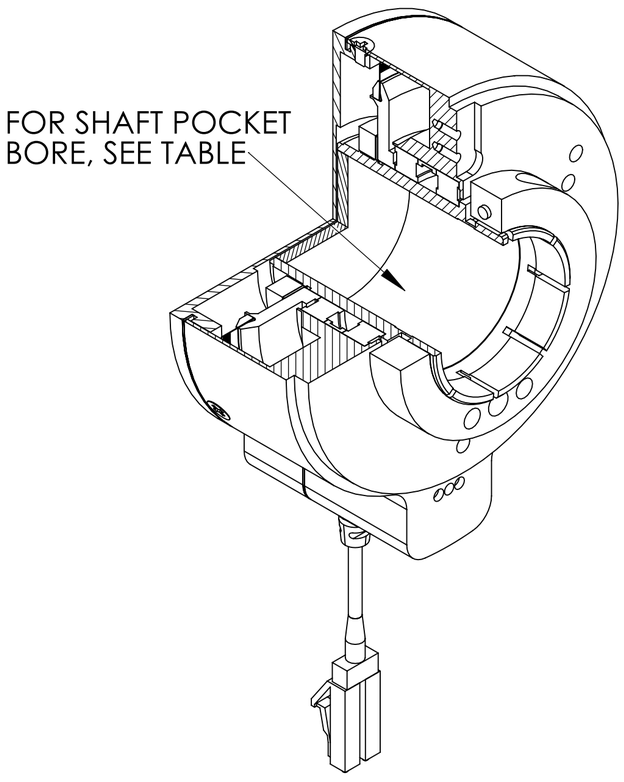
UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ± .5° TWO PLACE DECIMAL ±.02 THREE PLACE DECIMAL ±.005 FOUR PLACE DECIMAL ±.0010	DRAWN	R BOYER	9-1-11
	CHECKED		
	ENG APPR.		
	MFG APPR.		
	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

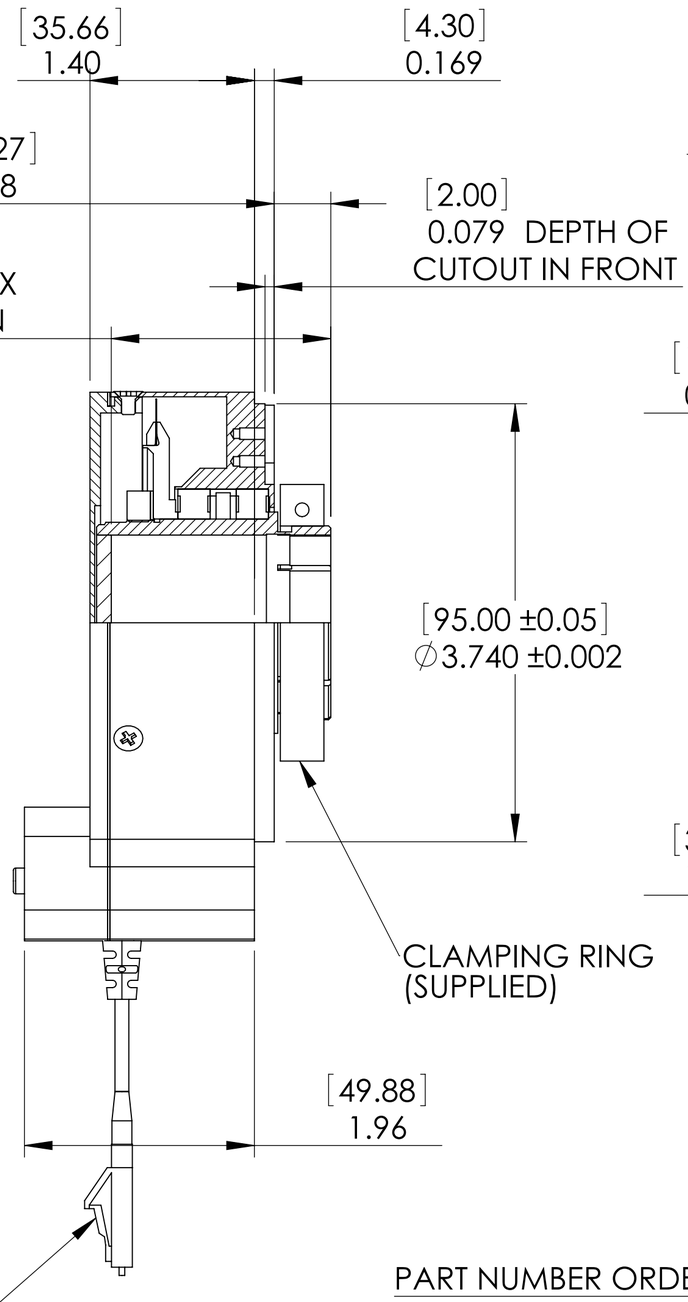
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

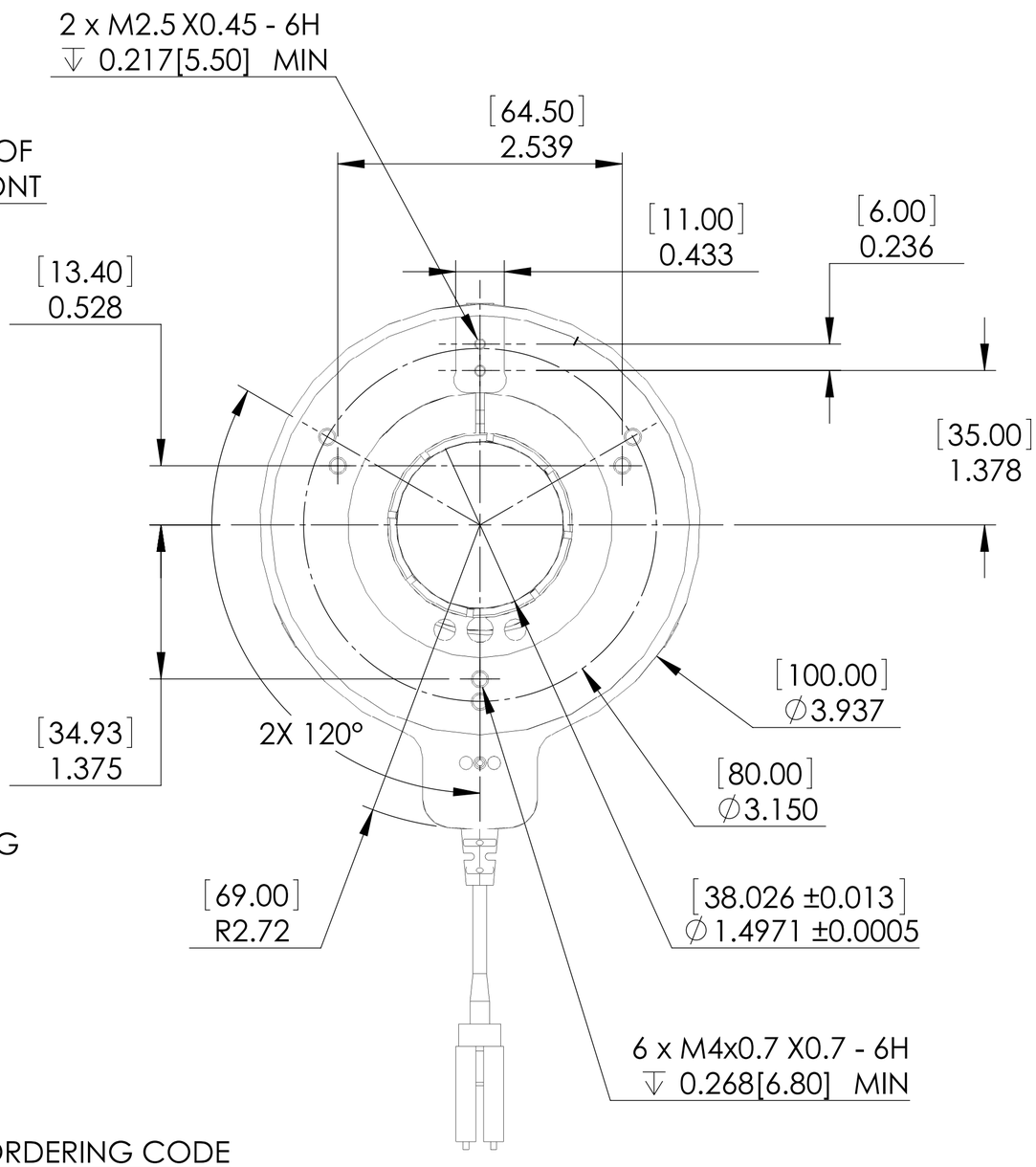
TITLE:
OPTICAL ENCODER
DUPLEX LC

SIZE	DWG. NO.	REV
C	MR324	C
SCALE: 1:2	WEIGHT:	SHEET 1 OF 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
C	REVISED	5-9-13	RGB







DUPLEX LC CONNECTOR
ON PIGTAIL, 1.5 METER LG

PART NUMBER ORDERING CODE

MR324- F 38P C 1R5

TEMPERATURE OPTION
(BLANK) = STANDARD, -40˚C TO +80˚C
E = EXTENDED, -60˚C TO +150˚C

RESOLUTION
F = 1024

PIGTAIL LENGTH IN METERS
(R = DECIMAL POINT)
1R5 = 1.5 METER

SHAFT POCKET BORE IN MILLIMETERS
38P = 38MM CLOSED END
SHAFT POCKET IP66
[∅38.026 ±0.013]
∅1.4971 ±0.0005

CONNECTOR TYPE
C = DUPLEX LC

2. WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

1. WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
ANGULAR: ± .5°
TWO PLACE DECIMAL ±.02
THREE PLACE DECIMAL ±.005
FOUR PLACE DECIMAL ±.0010
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL: SEE NOTES
FINISH: SEE NOTES
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	R BOYER	4-5-13
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

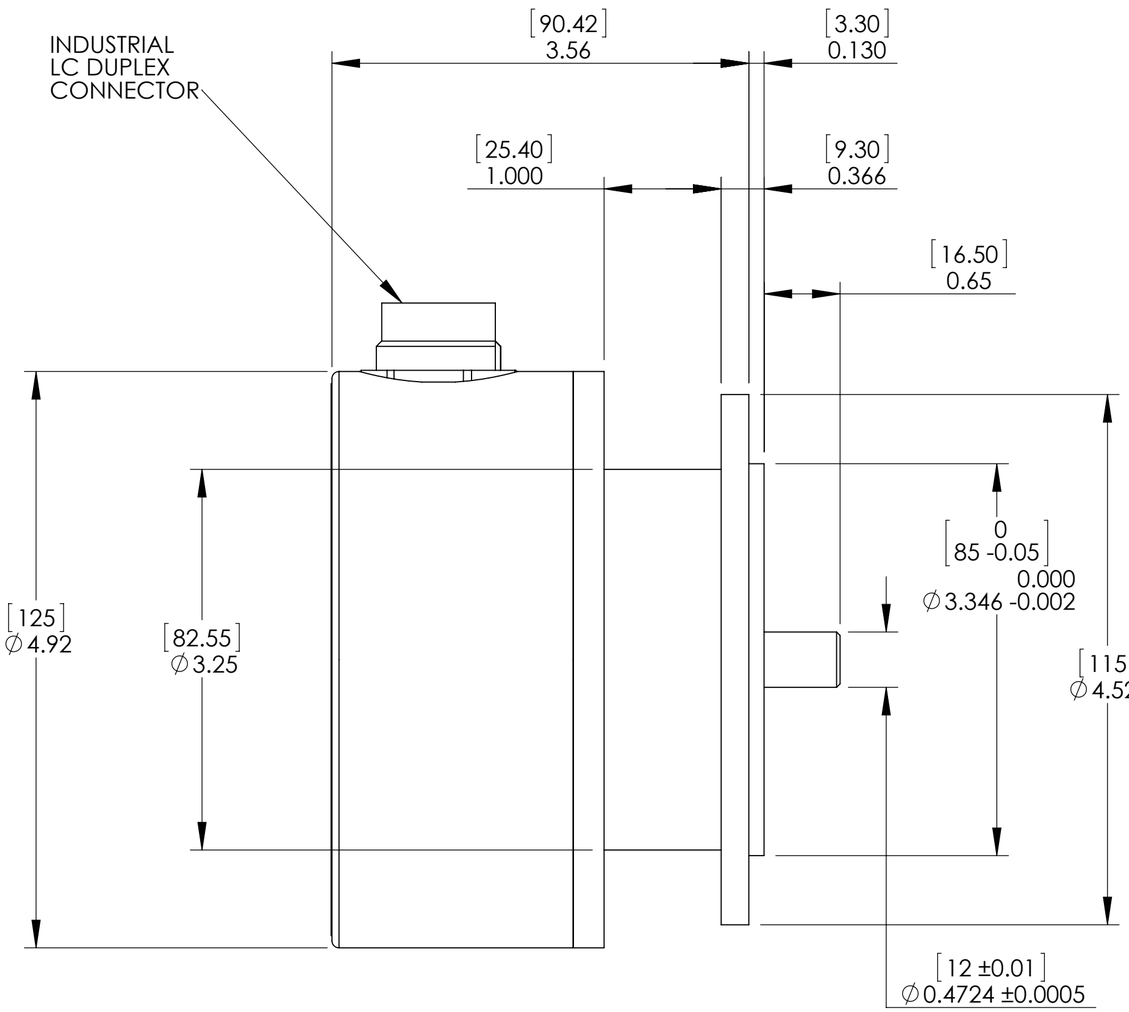
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

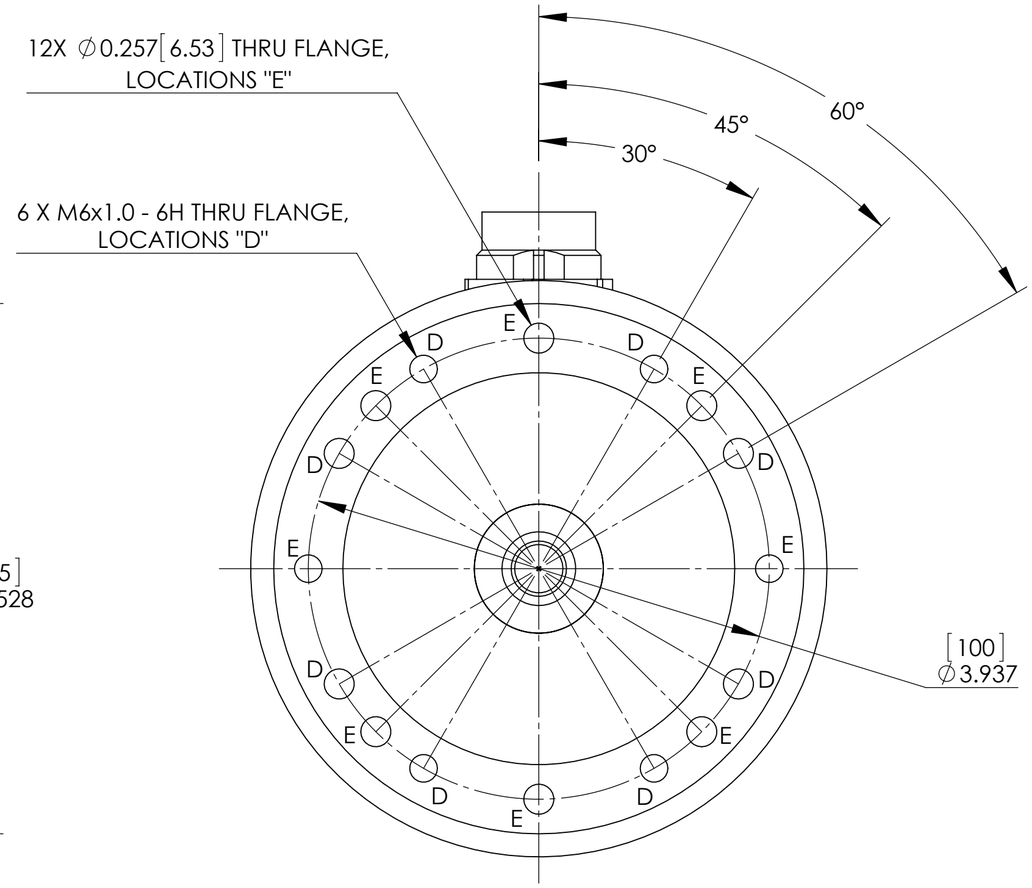
TITLE:
OPTICAL ENCODER
POCKET HOLE VERSION

SIZE	DWG. NO.	REV
C	MR324	C

SCALE: 1:2 WEIGHT: SHEET 2 OF 2

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	NEW RELEASE	6-28-12	RGB





PART NUMBER ORDERING CODE

MR325 - F 12 D00 ____

RESOLUTION (PPR)
F = 1024

SHAFT SIZE IN MILLIMETERS
12 = 12 MM SHAFT

OPTICAL CONNECTOR
D00 = INDUSTRIAL LC DUPLEX CONNECTOR

TEMPERATURE RANGE
(BLANK) = STANDARD
(-40°C TO +80°C)

3 WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

2 WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

1 ALWAYS USE FLEXIBLE COUPLING WHEN MOUNTING SHAFT TO EXTERNAL EQUIPMENT.

NOTES: UNLESS OTHERWISE SPECIFIED

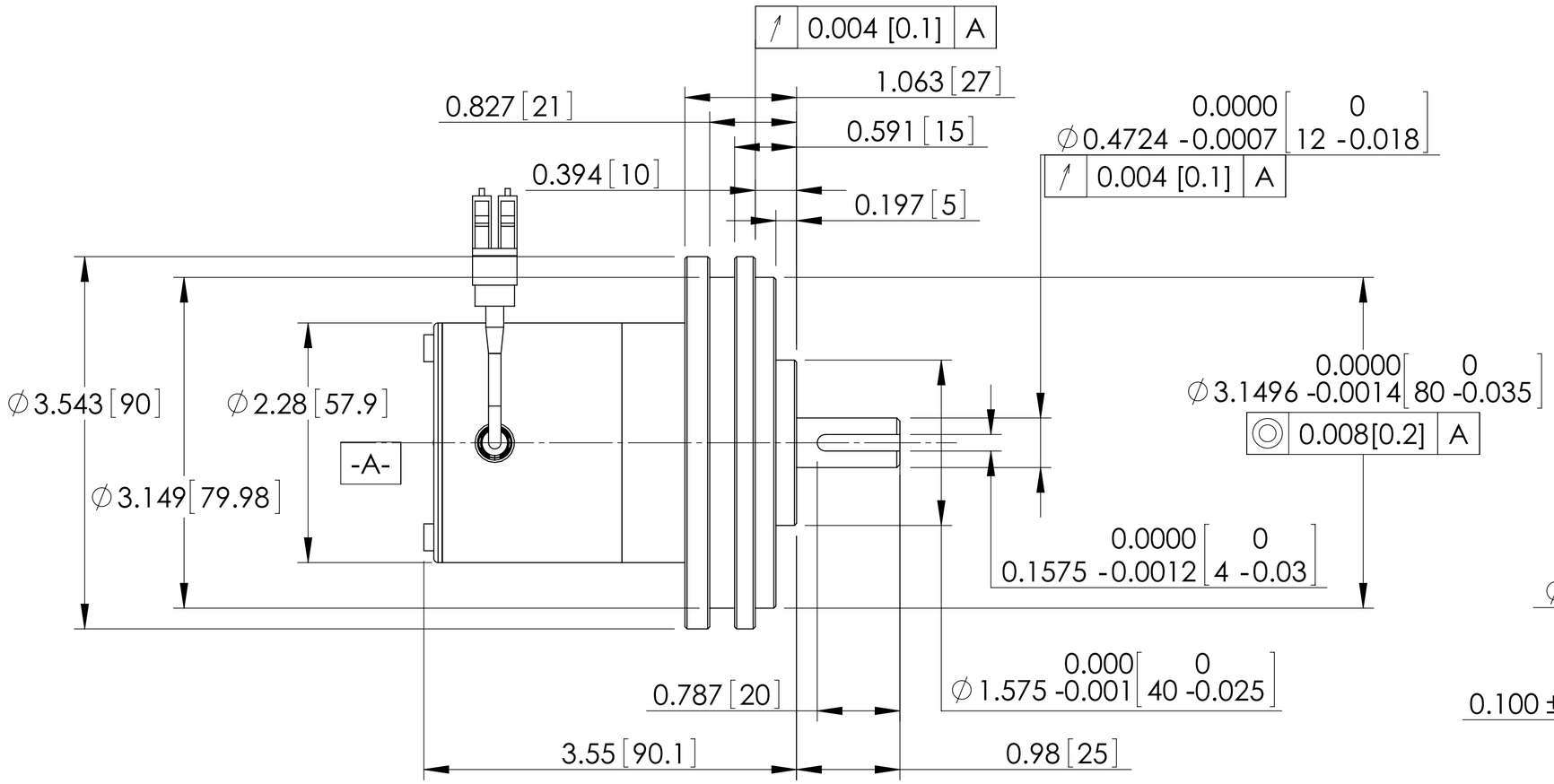
UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ± .5° TWO PLACE DECIMAL ±.02 THREE PLACE DECIMAL ±.005 FOUR PLACE DECIMAL ±.0010	DRAWN	R BOYER	6-28-12
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
MATERIAL	COMMENTS:		
FINISH			
DO NOT SCALE DRAWING			

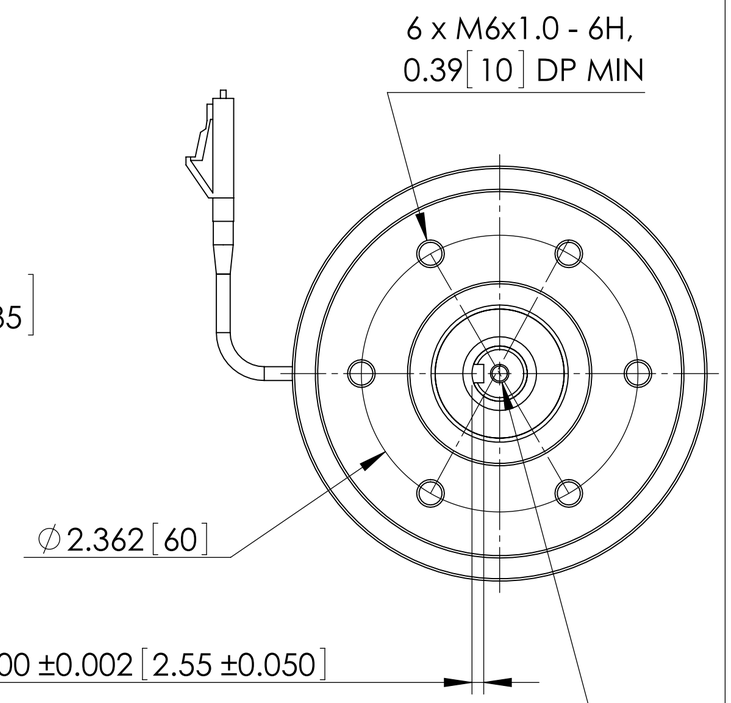
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

TITLE:
INCREMENTAL ENCODER

SIZE	DWG. NO.	REV
C	MR325-F12D00	A
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
B	REVISED	6-28-12	RGB





PART NUMBER ORDERING CODE

MR326 - C 12 C 1R5

RESOLUTION
C = 256

SHAFT SIZE IN MILLIMETERS
12 = 12MM SHAFT
OTHER SHAFT OPTIONS
ARE AVAILABLE

CONNECTOR TYPE
C = DUPLEX LC

PIGTAIL LENGTH IN METERS
(R = DECIMAL POINT)
1R5 = 1.5 METER

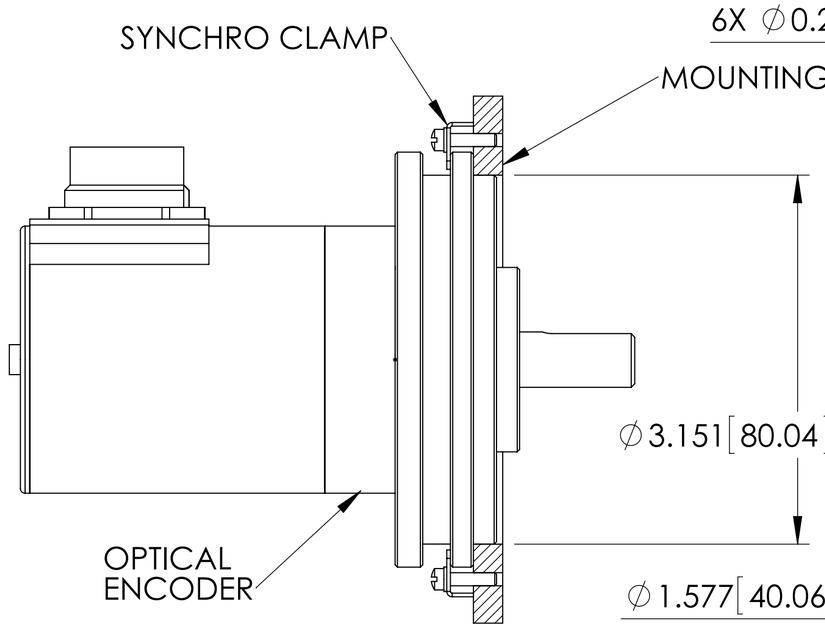
TEMPERATURE RANGE
(BLANK) = STANDARD
(-40°C TO +80°C)

3 WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

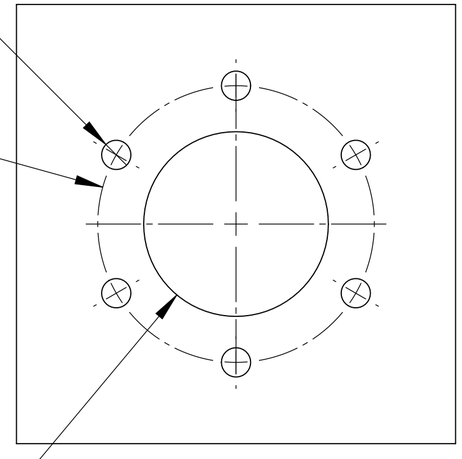
2 WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

1 ALWAYS USE FLEXIBLE COUPLING WHEN MOUNTING SHAFT TO EXTERNAL EQUIPMENT.

NOTES: UNLESS OTHERWISE SPECIFIED



SUGGESTED MOUNTING PANEL
WITH SERVO CLAMPS



SUGGESTED MOUNTING PANEL
WITH MOUNTING SCREWS

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
ANGULAR: ± .5°
TWO PLACE DECIMAL ±.02
THREE PLACE DECIMAL ±.005
FOUR PLACE DECIMAL ±.0010
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL SEE NOTES
FINISH SEE NOTES
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	R BOYER	6-21-05
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

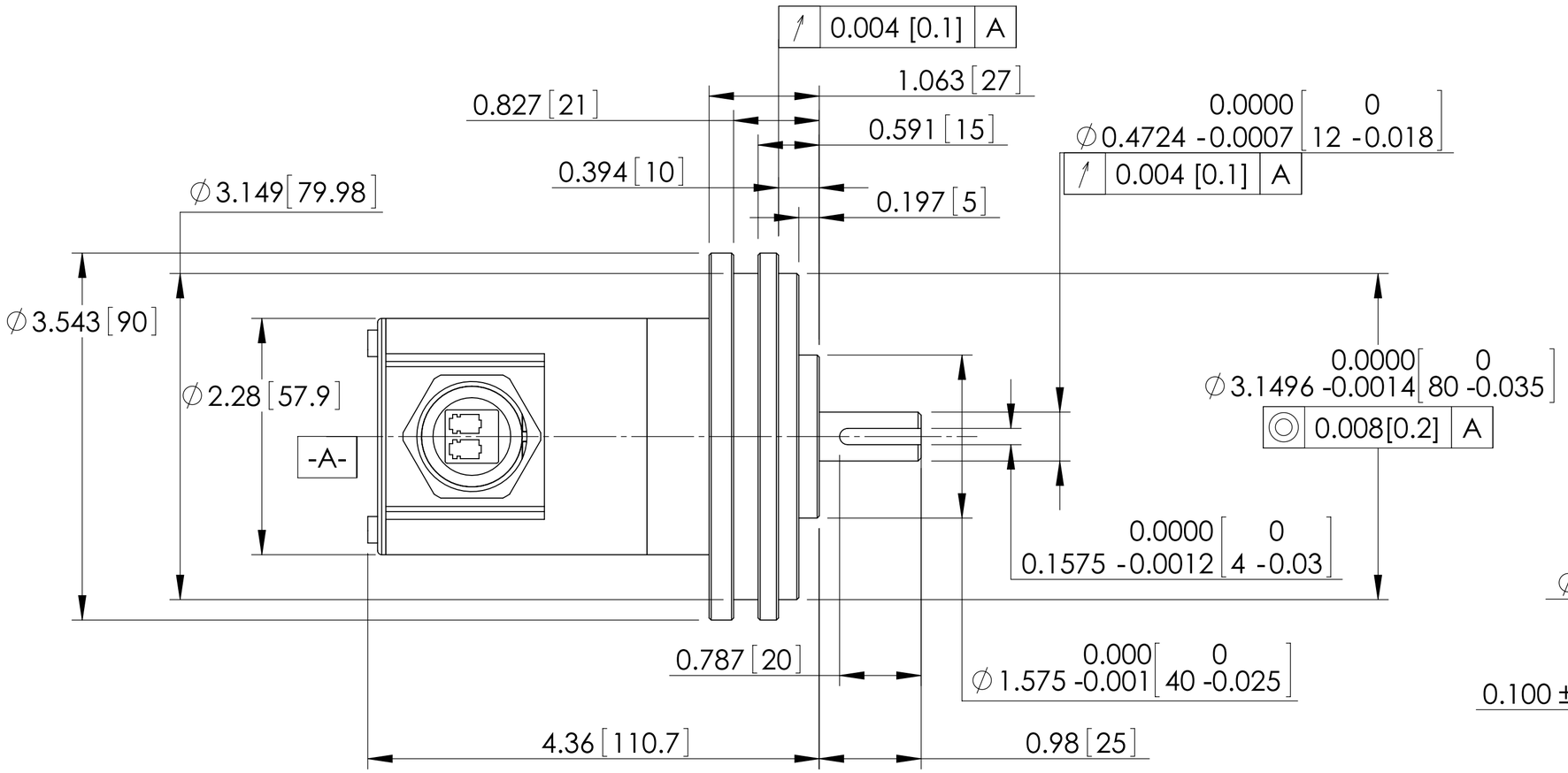
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

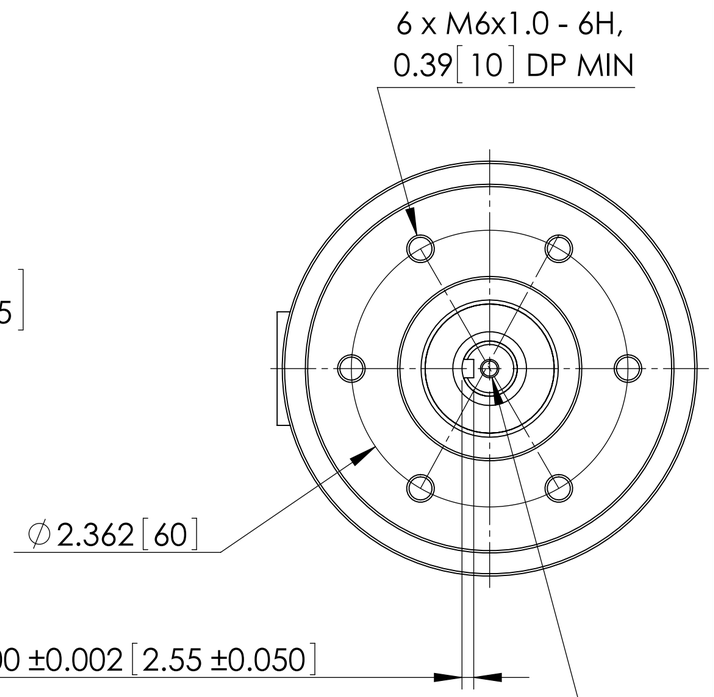
TITLE:
SENSOR, 90MM,
DUPLEX LC

SIZE	DWG. NO.	REV
C	MR326-CXXCXXX	B

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	NEW RELEASE	6-28-12	RGB

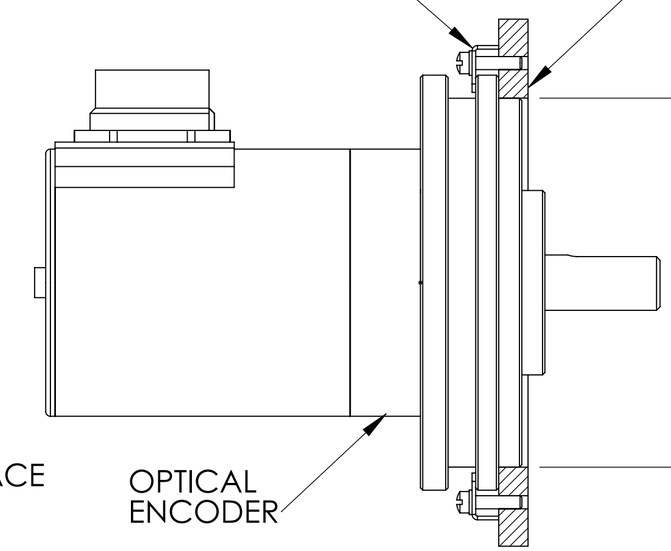




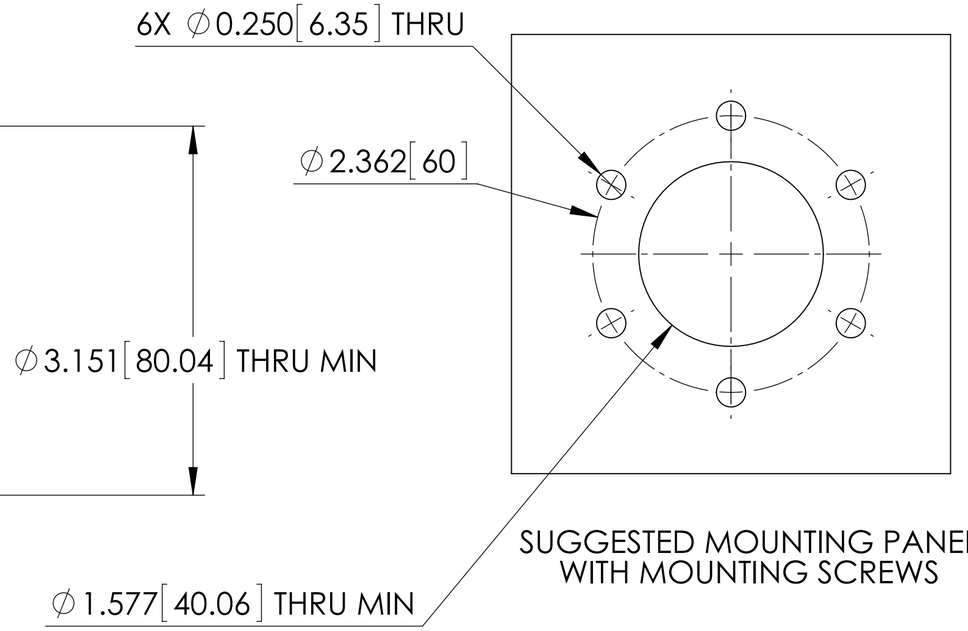
PART NUMBER ORDERING CODE

MR326 - C 12 D00

- RESOLUTION
  C = 256
- SHAFT SIZE IN MILLIMETERS
  12 = 12MM SHAFT
- OPTICAL CONNECTOR
  D00 = INDUSTRIAL LC DUPLEX CONNECTOR
- TEMPERATURE RANGE
  (BLANK) = STANDARD (-40°C TO +80°C)



SUGGESTED MOUNTING PANEL WITH SERVO CLAMPS



SUGGESTED MOUNTING PANEL WITH MOUNTING SCREWS

3 WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

2 WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

1 ALWAYS USE FLEXIBLE COUPLING WHEN MOUNTING SHAFT TO EXTERNAL EQUIPMENT.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ± .5° TWO PLACE DECIMAL ±.02 THREE PLACE DECIMAL ±.005 FOUR PLACE DECIMAL ±.0010	DRAWN	R BOYER	6-28-12
	CHECKED		
	ENG APPR.		
	MFG APPR.		
	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL SEE NOTES			
FINISH SEE NOTES			
DO NOT SCALE DRAWING			

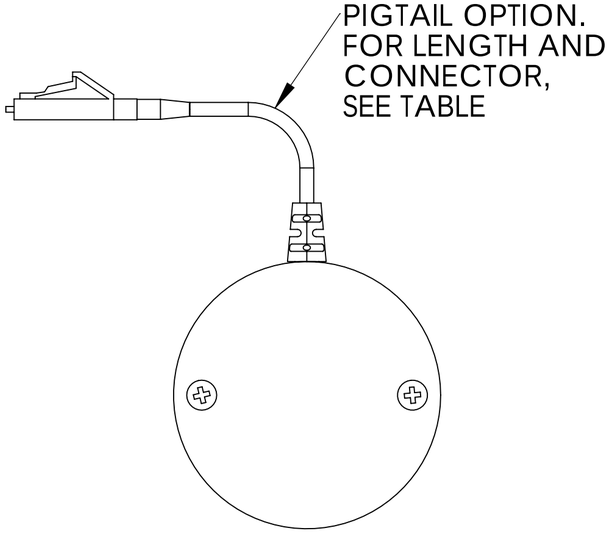
MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

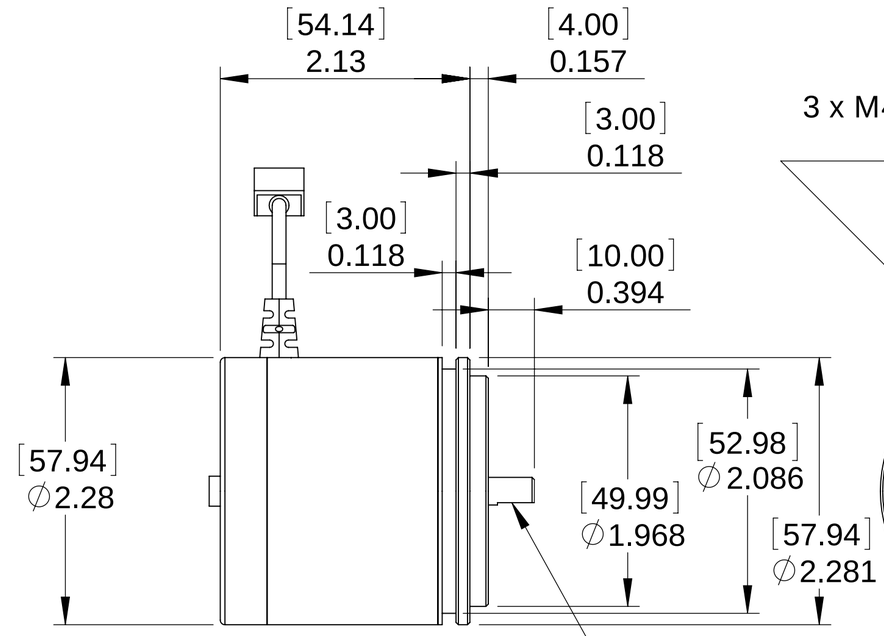
TITLE:
SENSOR, INDUSTRIAL, 90MM, LC DUPLEX

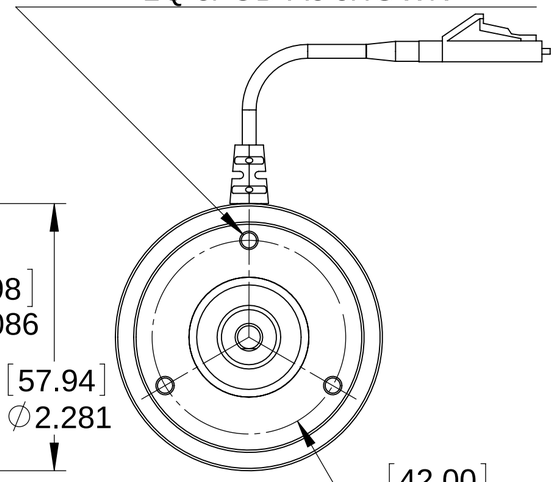
SIZE	DWG. NO.	REV
C	MR326-C12D00	A

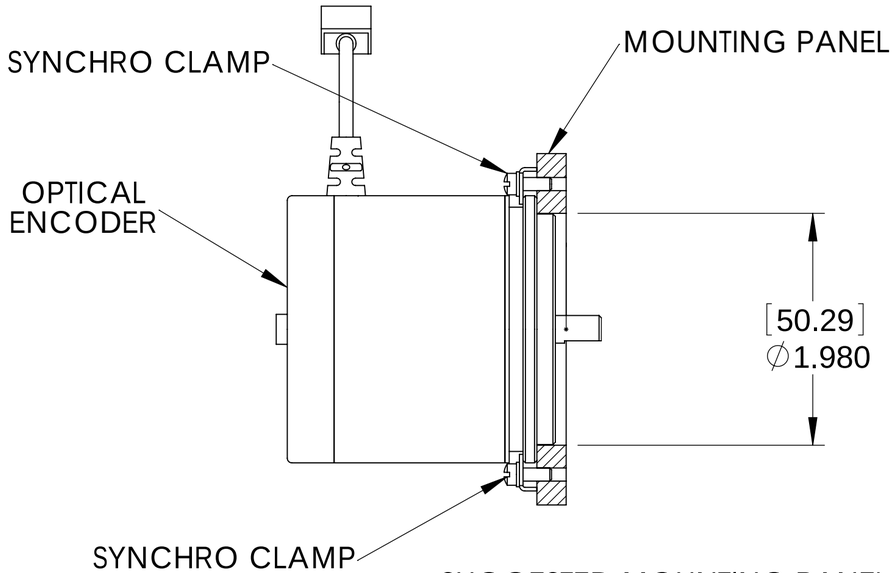
SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	NEW RELEASE	9-1-11	RGB

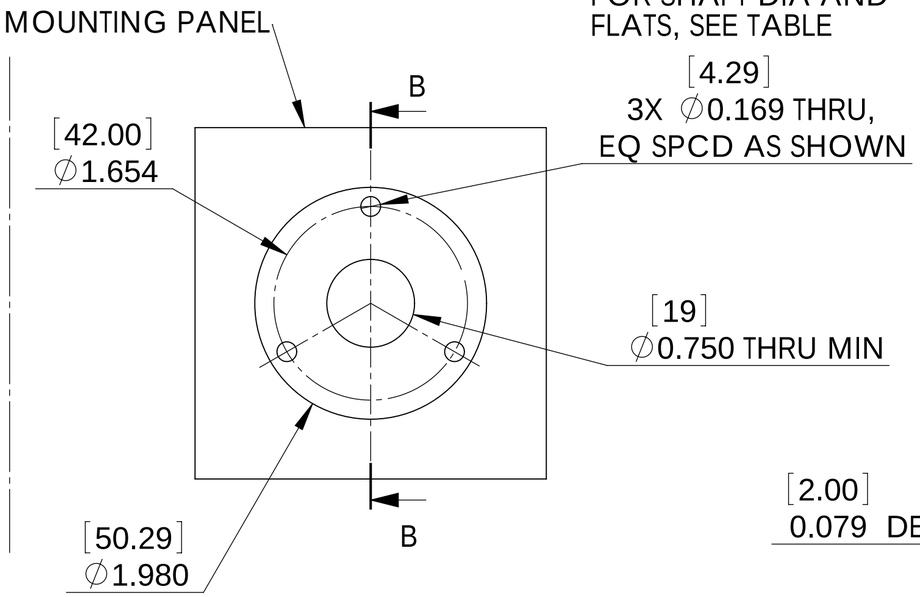


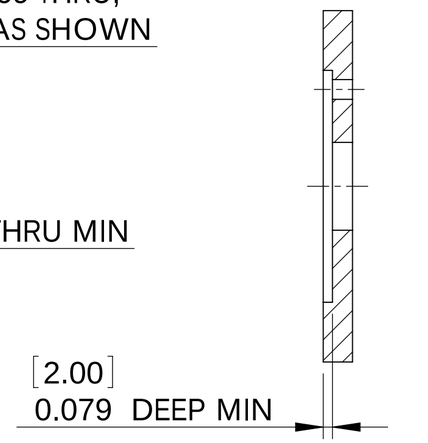






SUGGESTED MOUNTING PANEL
THRU-HOLE MOUNT WITH
SYNCHRO CLAMPS





SUGGESTED MOUNTING PANEL
COUNTER-BORED PANEL
WITH MOUNTING SCREWS

PART NUMBER ORDERING CODE

MR328 - D 06 C 05

- RESOLUTION: D = 360
- SHAFT SIZE IN MILLIMETERS: 6 = 6MM SHAFT (∅0.2358 ±.0002 [5.989 ±0.010] WITH 0.216 [5.50 FLAT])
- CONNECTOR TYPE: C = DUPLEX LC
- PIGTAIL LENGTH IN METERS: 05 = 5 METERS, 10 = 10 METERS

OTHER SHAFT OPTIONS ARE AVAILABLE

3. WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

2. WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

1. ALWAYS USE FLEXIBLE COUPLING WHEN MOUNTING SHAFT TO EXTERNAL EQUIPMENT.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES [MM]	DRAWN	R BOYER	9-1-11
TOLERANCES: ANGULAR: ± .5°	CHECKED		
TWO PLACE DECIMAL ±.02	ENG APPR.		
THREE PLACE DECIMAL ±.005	MFG APPR.		
FOUR PLACE DECIMAL ±.0010	Q.A.		
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

TITLE:
MRI COMPATIBLE
OPTICAL ENCODER

SIZE	DWG. NO.	REV
C	MR328	A
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

900 Calle Plano, Suite K
Camarillo, CA 93012 USA
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F +1-805-389-6605
www.micronor.com

Declaration of Conformity

We

Micronor Inc.
900 Calle Plano, Suite K, Camarillo, CA 93012, USA

declare that the product

Fiber Optic Incremental Encoder System	**Item Code(s)**
Controller Module	**MR320**
Sensors	**MR322, MR324, MR325, MR326**

Country of Origin: Camarillo, CA USA

to which this declaration relates in conformity with the following standards, normative documents and/or customer requirements:

Requirement	MR320 Controller	MR320 Sensors
1. Laser Safety	Class 1 laser device per IEC 60825	Exempt
2. ATEX Directive	Sensor and Controller are exempt: Not considered to have an independent source of ignition. (a) Optical sources which meet the Class I limits are considered suitable for use in locations with an EPL of Mb, Gb, Gc, Db or Dc as per Clause 1 (3) of IEC 60079-28:2015 Ed 2. IECEx GB/CML/ExTR 16.0039/00, Evaluated by Notified Body 2503, Certification Management Limited, Unit 1 Newport Business Park, New Port Road, Ellesmere Port, CH65 4LZ, United Kingdom	
3. Low Voltage Directive	Exempt	Exempt
4. EMC Directive	Exempt	Exempt
5. CE Mark	Applicable	Applicable

Place: Camarillo, CA, USA
Date of Issue: 27-April-2016

Dennis Horwitz
Micronor Inc.
Vice President, Sales and Marketing
dennis@micronor.com

Ref: N:\Declaration of Conformity\MR320_DOC\MR320 DoC RevC March-2016\MICRONOR_98-0320-20_MR320 Declaration of Conformity RevC released 27-April-2016.docx