Declaration of Conformity
As "Intrinsically Safe Simple Apparatus" Per
European Potentially Explosive Atmospheres (ATEX) Directive (94/9/EC)
By
Micronor Inc.
Newbury Park, CA USA

Affected Products: MR310 Remote Encoder Interface (REI) Module
MR312 and MR314 series Fiber Optic Rotary Encoders

Product Description: Fiber optic rotary encoder system used for monitoring rotary shaft speed, acceleration and/or angular position.

Document: 0310-ATEX
Revision: B
Dated: April 25, 2007
Number of Pages: 16

Document Outline

1. Classification

MR312 and MR314 encoders are designed to be directly installed and operated in harsh and hazardous locations in compliance with the scope of EU Directive 94/9/EC (a.k.a. ATEX Directive) as follows:

- The encoders are entirely non-electrical passive devices and qualify as "Simple Apparatus" and exempt from the ATEX Directive.

  REASON: The MR312/MR314 encoders are non-electrical, 100% optical and totally passive – thus exempt from the ATEX Directive per Chapter 1/Article I.4. In operation, the light signals entering and leaving the device are entirely sourced by the remotely located MR310 REI Module. Hence, the optical output signals of the MR310 are subject to the optical radiation requirements for hazardous locations per IEC 60079-28 (consult APPENDIX A of this document for details).

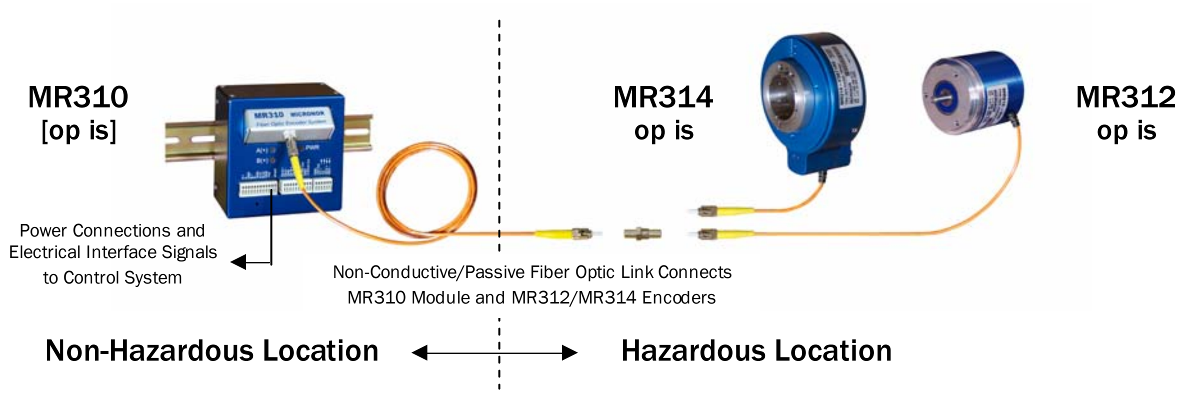
- The encoders are "intrinsically/inherently safe" apparatus and can be operated in any hazardous location up to the temperature limitations of the encoder model used:

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

- Equipment Group I (Underground Mines); All Categories (M1 and M2); All Gas/Dust Environments
- Equipment Group II; All Categories (1, 2 and 3); All Gas/Dust Environments

REASON: In either normal operation or rare malfunction, the MR310's optical output is limited by design and does not exceed the worst case "Inherently Safe" Safe Optical Power (SOP) requirements of any apparatus group/temperature class combination per Table 2 of IEC 60079-28 (consult Appendix A of this document for details)

The only known mode of failure which *might* contribute to ignition would be heat caused by bearing failure – a common issue with all rotary devices (motors, conveyors, etc.). Following instructions for proper installation and maintenance, this rare but potential mode of failure can be entirely avoided.



MR310 REI Module is the "active" remote optoelectronics interface to the passive MR312/MR314 Fiber Optic Encoders, designed to be installed only in a non-hazardous location and interconnects with an encoder via a passive, fiber optic link. The limited output of the MR310 module qualifies for the fiber optic encoder system's rating as "inherently/intrinsically safe".

- Being both "inherently safe" and designed to be purposely installed outside the hazardous area, the MR310 module is exempt from the ATEX Directive.

  REASON: The ATEX Directive only addresses equipment to be installed in hazardous locations, or ancillary equipment located outside the hazardous area – equipment which could source sufficient energy (electrical, optical or other) to cause ignition in a potentially explosive or combustible environment. The MR310 is exempt from the ATEX Directive because it is installed outside the hazardous area AND (in either in normal or rare malfunction) sources only "inherently safe optical radiation" per IEC 60079-28 (consult Annex A of this document for details).

2. Markings

All markings are consistent with the IEC 60079-28, *Electrical Apparatus For Explosive Gas Atmospheres; Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

MR310 as well as modified versions with TD series custom part numbers - are marked as follows:

- [Ex op is I/II Ga]

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

MR312/MR314 Standard Temperature models (-40/+80°C, part numbers not ending in suffix E) as well as related customer-specific versions with TDxxxx series custom part numbers – are marked as follows:

- CE Ex op is I/II 80°C/T6 Ga

MR312/MR314 Extended Temperature models (-60/+150°C, part numbers ending in suffix E) as well as related customer-specific versions with TD series custom part numbers – are marked as follows:

- CE Ex op is I/II 150°C/T3 Ga

3. Risk Assessment

MR310 Remote Encoder Interface Module is always remotely installed in a non-hazardous area.

Potential Ignition Souce			Measures applied to prevent the source becoming effective	Ignition protection used
Normal Operation	**Expected Malfunction**	**Rare Malfunction**		
Optical output power	Output power degradation	Not applicable	**Detailed analysis of optical output design can be found in APPENDIX A.** **Summary:** In normal operation, the combined optical power output level (both wavelengths) is set to 40μW. The optical power level of LEDs or VCSELS tend to decrease over time and temperature – never increases. In normal operation, this safely compares to the worst case Safe Optical Power limit of 15mW (of any apparatus group/temperature class combination) per requirements stated in Table 2 of IEC 60079-28. The on-board circuitry compensates for power degradation by simply adjusting the amplifier gain of the photodiodes. The user can monitor gain status via the serial interface	IEC 60079-28 (Worst case Safe Optical Power limit cannot be exceeded under any operating conditions or system failure.) and EN 13463-1 (User Instructions) and EN-13463-6 (Control of Ignition Sources "b", if monitoring function is used)
Optical output power		Optical emitter overdrive	**Detailed analysis of optical output design can be found in APPENDIX A.** **Summary:** The output power of each wavelength (850/1300nm) is adjusted to 20μW, for total output power of 40μW. The worst case optical output (if the emitters were accidentally over-driven) is 0.56mW – compared to the worst case Safe Optical Power limit of 15mW (of any apparatus group/temperature class combination) per requirements stated in Table 2 of IEC 60079-28. The user can also monitor the optical power levels and detector gain settings via the serial interface.	IEC 60079-28 (Worst case Safe Optical Power limit cannot be exceeded under any operating conditions or system failure.) and EN 13463-1 (User Instructions) and EN-13463-6 (Control of Ignition Sources "b", if monitoring function is used)

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

MR312/MR314 encoders mounted and operating in hazardous location:

Potential Ignition Source			Measures applied to prevent the source becoming effective	Ignition protection used
Normal Operation	**Expected Malfunction**	**Rare Malfunction**		
Optical signal Input/output	Loss or degradation of optical signal to/from the encoder	Optical emitter overdrive	**Detailed analysis of optical output design can be found in APPENDIX A.** **Summary:** Since the encoders are totally passive devices, the optical power entering the MR312/MR314 encoder is solely determined by the light output of the MR310 module LESS optical link losses (due to in-line fiber attenuation plus connector and splice losses). The previous MR310 optical design analysis concluded that the encoders operate well under worst case SOP or MIE thresholds under any and all conditions.	IEC 60079-28 (Worst case Safe Optical Power level or MIE thresholds cannot be exceeded under any operating conditions or system failure.)
Bearings		Not applicable	**Detailed calculations of bearing life and system MTBF can be found in APPENDIX B.** **Summary:** All bearings are lubricated by grease which is captured within the seals. MTBF calculations were performed at selected load conditions and RPM conditions. For Shafted MR312 operating at either 5000 RPM or 8000 RPM at 10% of Max Radial Load, the calculated System MTBF are 1.62E+05 hours (18.6 years) and 1.01E+05 hours (11.6 years), respectively. For Hollow Shaft MR314 operating at 2000 RPM under a 10% Radial Load, the calculated System MTBF is 1.76E+09 hours (201,000 years). Either of these numbers can vary with application, environmental factors, RPM and shaft load conditions. For high reliability ATEX applications operating under similar conditions, it is conservatively recommended that the unit be replaced after 10 years of continuous operation.	EN 13463-1 (User Instructions) and EN-13463-5 (Constructional Safety "c")
	Bearing Failure or Loss of Lubrication	Not applicable	**This is a generic discussion of bearing failure applicable to any and all equipment incorporating bearings.** **Summary:** Generically, bearing failure usually	EN 13463-1 (User Instructions) and EN-13463-6 (Control of Ignition Sources "b", if monitoring is fitted)

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

			occurs when excessive loads (combinations of radial, axial, RPM, temperature, shock, vibration, etc.) combine to cause premature bearing wear and excessive temperature rise approaching MIE. Any temperature can then be compared to normal bearing operation where the typical temperature rise is 10-50°F above ambient depending on the operating conditions. Bearing failure is rarely a catastrophic event but a gradual deterioration. For a high reliability application, the user should consider implementing one or more of the following: 1. If motor overrun could occur, the user should consider the use of torque limiting safety couplings. 2. A temperature sensor could be placed on the encoder housing closest to the bearings to monitor surface temperature relative to MIE. 3. The encoder should be examined periodically for abnormally high surface temperatures or physical signs of abnormal noise or discoloration.	

4. Control of Production

Consistent production control is achieved using trained personnel, up-to-date bill of materials and relevant assembly/test documentation. For reference, the applicable documents for each product are listed here:

Product: MR310 Module **Drawing/Document Reference**	**Description/Title**
MR310REVB-BOM	Bill of Materials
SC0310-24	Schematic Diagram
MR310	Mechanical Reference Drawing
98-MR310-41	Assembly Instructions, XMTR/RCVR
MR310-43	PCB Test Instructions
MR310-42	Final Assembly Instructions
MR310-44	Final Test Procedures

Product: MR312 Encoder **Drawing/Document Reference**	Description/Title
0312-07	Assembly Drawing/Bill of Materials
MR312	Mechanical Reference Drawing

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

Product: MR314 Encoder Drawing/Document Reference	Description/Title
0312-08	Cross-Sectional Drawing/Bill of Materials
MR314	Mechanical Reference Drawing

###

Newbury Park, California USA
30-June-2006

Micronor Inc.

Dennis Horwitz
Vice President

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

APPENDIX A: Detailed Design Analysis Of Optical Output

Reference:

IEC 60079-28, *Electrical Apparatus For Explosive Gas Atmospheres; Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*

Background:

Section 5.2 (Requirements For Inherently Safe Optical Radiation "Op Is") of IEC 60079-29 identifies the key optical requirements. Subsection 5.2.2 (Continuous Wave Radiation) provides the relevant requirements applicable to the Micronor products since the MR310 outputs CW optical signals to the encoders. Table 2 of this section (reproduced below for reference) provides the detailed Safe Optical Power (SOP) limits for the various apparatus group/temperature class combinations necessary for "op is" certification – the worst case being 15mW maximum power level given for IIC/T6.

Table 2 – Safe optical power and irradiance for hazardous locations categorized by apparatus group and temperature class

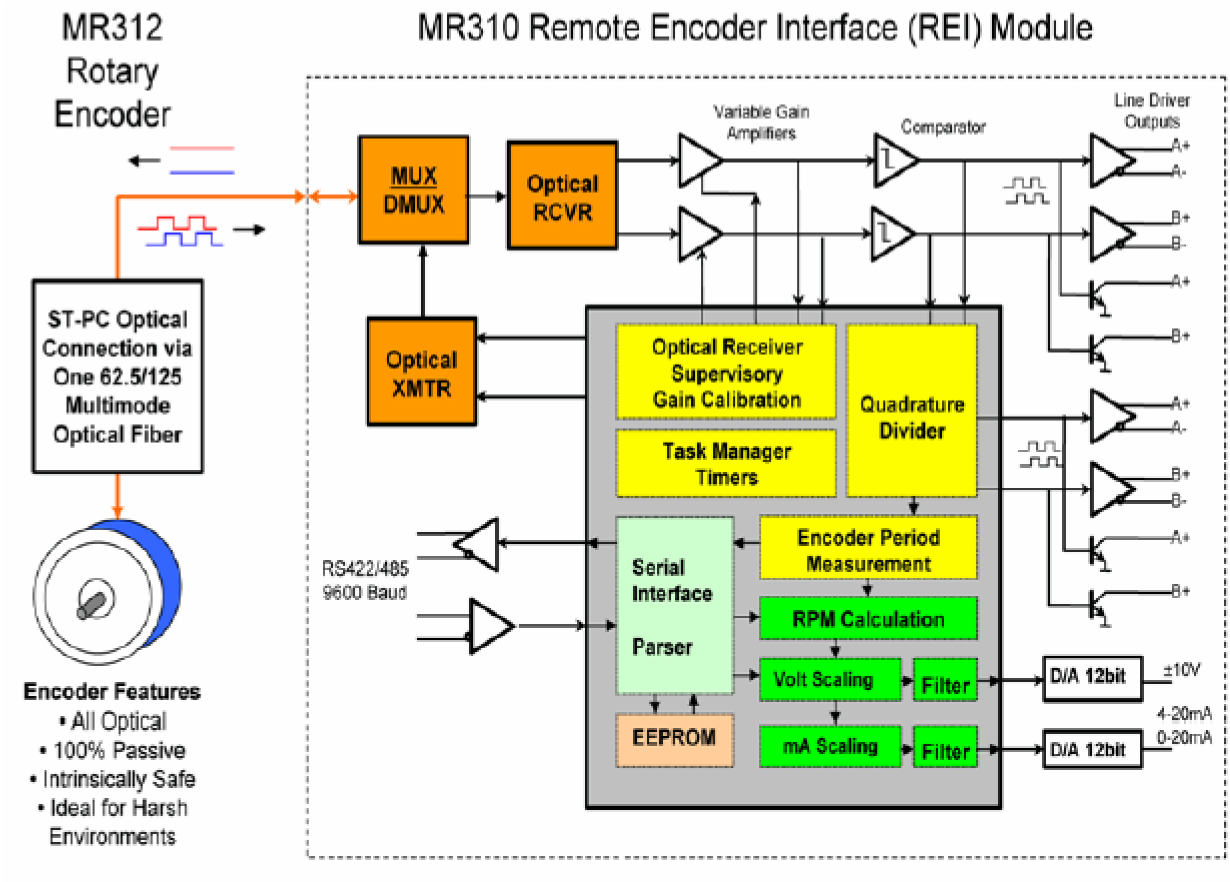
Apparatus group	I	IIA	IIA	IIB	IIC	
Temperature class		T3	T4	T4	T4	T6
Temperature class (°C)	<150	< 200	< 135	< 135	< 135	< 85
Power (mW)	150	150	35	35	35	15
Irradiance (mW/mm^2) (surface area not exceeding 400 mm^2)	20[a]	20[a]	5	5	5	5
[a] For irradiated areas greater than 30 mm^2 where combustible materials may intercept the beam, the 5 mW/mm^2 irradiance limit applies.						

The following optical analysis explains how the MR3XX series Fiber Optic Encoder System operates well under the worst case SOP limits (<<15mW) and can be classified "op is". The encoders can be operated within any equipment apparatus/temperature class within the temperature specifications of the model used.

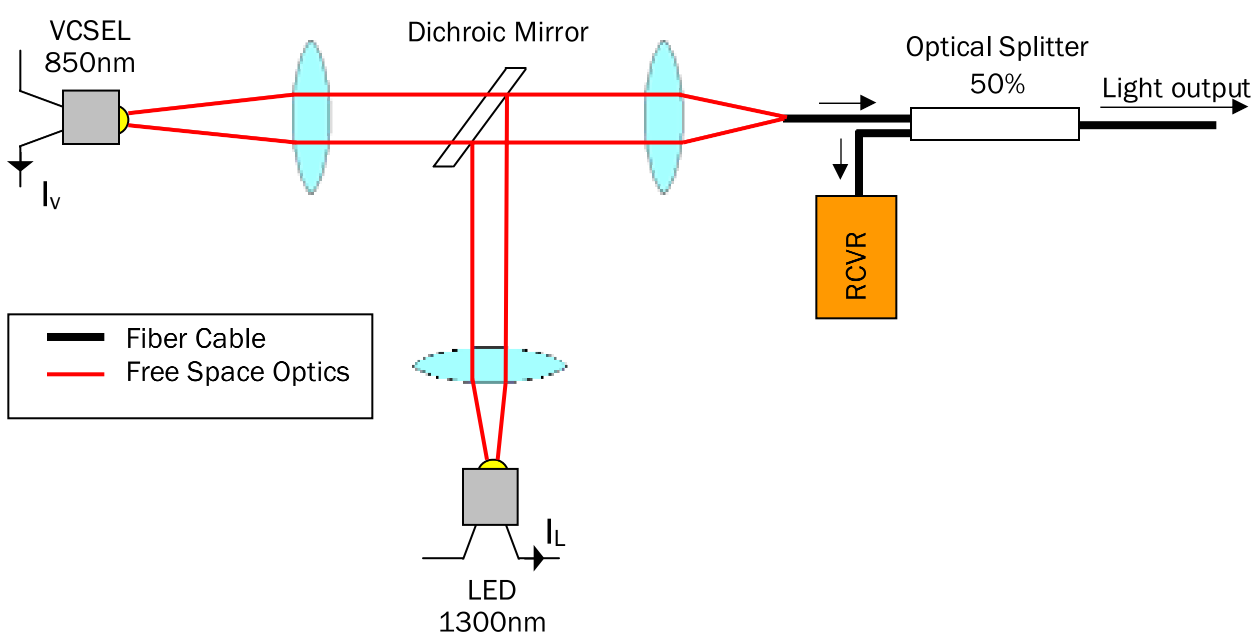
MR310 Optical Output Design Analysis:

As shown in the following block diagram for the Fiber Optic Encoder System, the MR310 incorporates two emitters: a VCSEL (vertical cavity surface emitting laser) operating at 850nm and LED (light emitting diode) operating at 1300nm. The outputs of these two optical emitters are coupled into a single fiber via a fiber optic coupler with a minimum 50% signal loss.

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com



The following detailed diagram illustrative the optical design and optical paths within the MR310:



By design, the 850nm VCSEL is driven at about 4mA forward current (with a resistive current limit by design of 6mA) to produce an output level of 20μW (after the coupler), or about 40μW before the coupler. According to

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499-0114 • FAX: (805)499-6585 • EMAIL sales@micronor.com

the manufacturer's data sheet, the VCSEL has a typical output of 200µW at 6mA or 400µW at maximum rated current of 12mA. In practice, it has been observed that the light output can reach as high as 1mW at 12mA. Let us assume that in an extreme overdrive condition that the VCSEL could output 1mW.

By design, the 1300nm LED is driven at about 30-40mA forward current (with a resistive current limit of 40mA) to produce an output level of 20µW (after the coupler), or about 40µW before the coupler. In practice, the LED could output up to 120µW at its max rated current drive of 120mA. Because source NA (numerical aperture) increases with drive current, not all of this power can be coupled into the fiber but we will use a simple analysis and assume that all of the power can be coupled into the fiber for a maximum of 120µW.

Up to this point, the design analysis has centered on the direct output of the 850nm VCSEL and 1300nm LED emitters. These outputs are then combined into a single fiber via a dichroic mirror optical combiner. Without loss, the combined output is 1.120mW. Then 50% of this light is lost via the 50/50 fiber splitter/coupler. Hence the worst case output power of the MR310 (and light into the MR312 or MR314 encoder assuming the ideal case of no inline losses) in an over-drive/runaway condition is 0.56mW (560µW).

According to IEC 60079-28, the governing requirement is that CW optical output power of the MR310 (which is the no-loss input power to the MR312 or MR314 encoders) shall not exceed 15mW. The MR3XX encoder system is designed to meet this requirement because:

- In normal operation, the MR310 optical output is factory adjusted for a combined output of 0.040mW (40µW)
- In a rare malfunction, the MR310 design limits combined optical output power to 0.56mW (560µW)

###

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

APPENDIX B: Detailed Design Analysis Of Bearing Life

Reference:

ANSI/AFBMA Std 9-1990, *Load Ratings and Fatigue Life for Ball Bearings*

Background (excerpt from ANSI/AFBMA 9-1990):

Bearing life is defined as the length of time, or the number of revolutions, until a fatigue spall of a specific size develops. This life depends on many different factors such as loading, speed, lubrication, fitting, setting, operating temperature, contamination, maintenance, plus many other environmental factors. Due to all these factors, the life of an individual bearing is impossible to predict precisely.

ANSI/AFBMA Std 9-1990 provides a common industry basis for estimating bearing life. L10 life is the life that 90 percent of a group of apparently identical bearings will complete or exceed before a permanent deformation of 0.0001 of the rolling diameter. General industry experience shows that a permanent deformation of this size, at the center of the most heavily loaded ball/raceway contact, can be tolerated in most bearing applications without the subsequent bearing operation being impaired. The basic static load rating is, therefore, given a magnitude such that approximately this deformation occurs when the static equivalent load is equal to the load rating.

$L_{10} = (C_r / P_r)^3$		
Where	L_{10} =	Basic rating life, in million revolutions
	C_r =	Basic dynamic radial load rating, N (lbs)
	P_r =	Dynamic equivalent load rating, N (lbs)

For many applications, it may be desirable to calculate life for a different reliability and/or for special bearing properties and operating conditions which deviate from the conventional in such a way that it is justified to take their influence into special consideration. The adjusted rating life, Ln, i.e. the basic rating life adjusted for a reliability of (100-n)% for special bearing properties and for specific operating conditions is given by:

$L_{na} = a_1 a_2 a_3 L_{10}$		
Where	L_{na} =	Adjusted life, in million revolutions L_3 = 97% reliability L_1 = 99% reliability
	a_1 =	Life adjustment factor for bearing reliability For calculating L_3, a_1 = 0.44 For calculating L_1, a_1 = 0.21
	a_2 =	Life adjustment factor for bearing materials and processing
	a_3 =	Life adjustment factor for bearing operating conditions
	L_{10} =	Basic rating life, hr

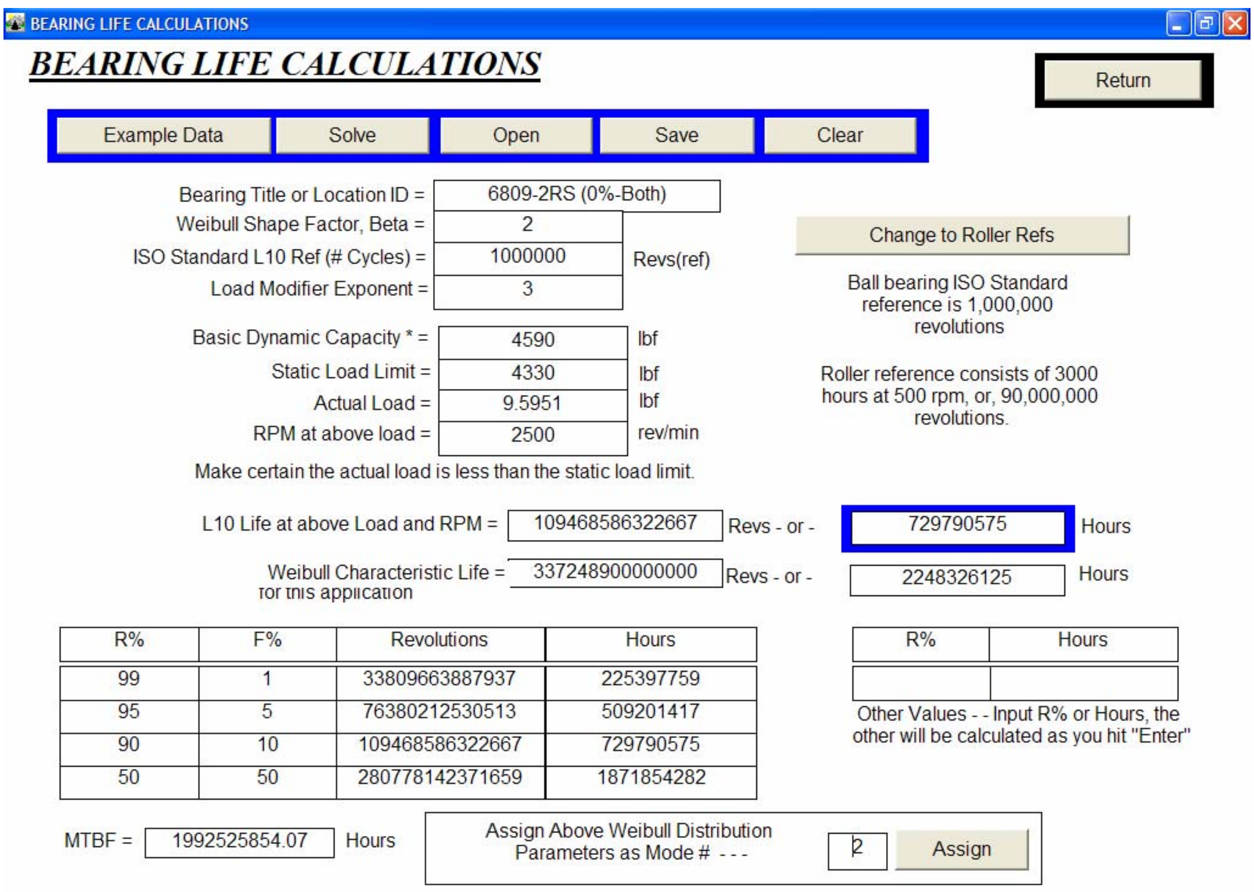
MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

Reference data for bearings used on MR312 and MR314 rotary encoders:

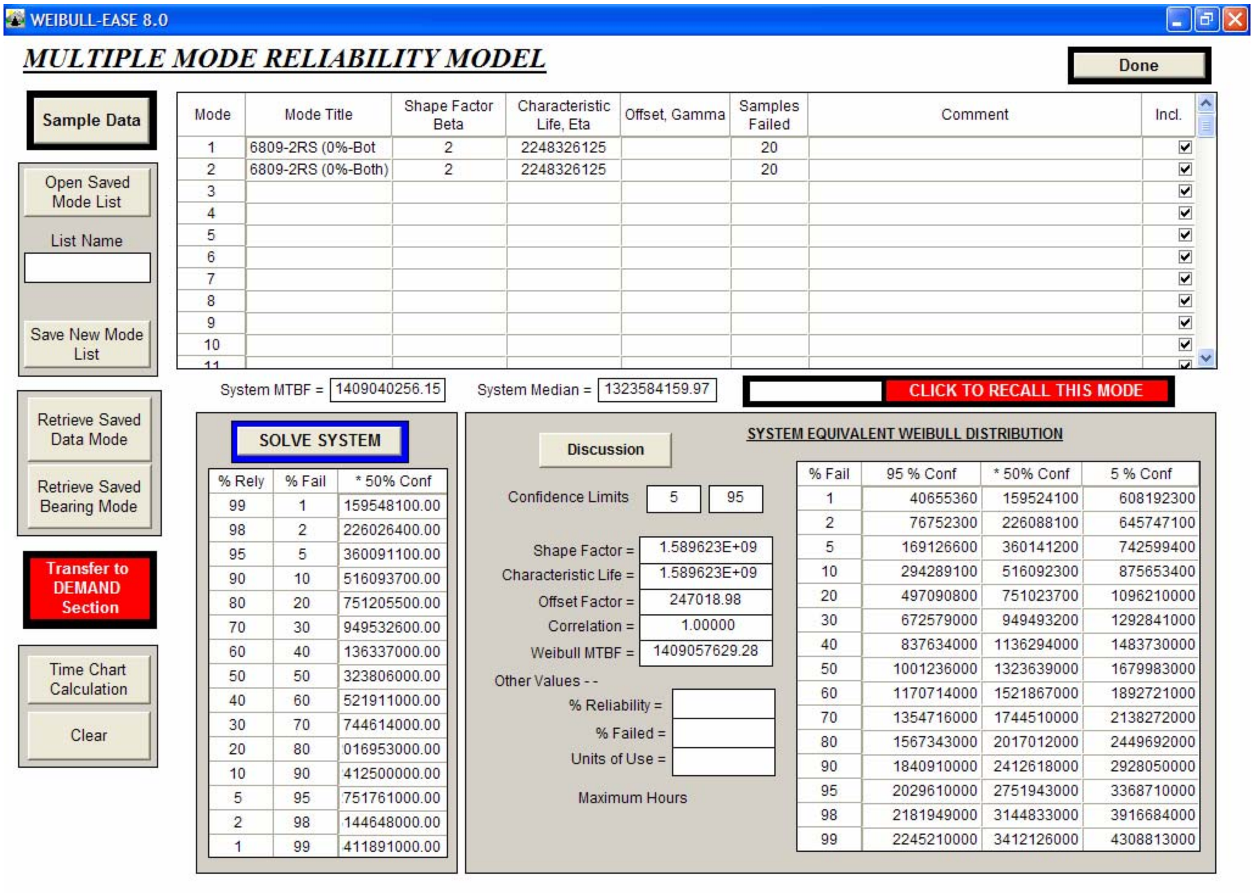
Encoder Model	BOM Designation (Qty)	C_r (Static) N (lbf)	C_{or} Dynamic N (lbf)	Maximum RPM
MR312	Item 18 (Qty 1)	4553.8N (**1023.75lbf**)	1951N (**438.75lbf**)	19,000
	Item 17 (Qty 1)	1100.9N (**247.5lbf**)	440.3N (**99lbf**)	43,000
MR314	Item 12 (Qty 2)	4590N (1031.8 lbf)	4330N (973.4 lbf)	6000

Reliability Software Used

To calculate System MTBF, Weibull reliability analysis was applied using **WEIBULL-EASE 8.0** software (www.applicationsresearch.com). First, the **BEARING CALCULATIONS** function (see sample screen below) was used to calculate L_{10} as well as the Weibull Characteristic Life – for each bearing. Next (for each bearing), the corresponding Weibull Characteristic Life with default Beta Shape Factor =2 is then transferred as a failure mode to the **CREATE/LOAD RELIABILITY MODEL** function. With the two bearings (modes) entered, the software calculates both System MTBF and Weibull MTBF. Sample screens for the MR314 bearing analysis are shown below.



MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499-0114 • FAX: (805)499-6585 • EMAIL sales@micronor.com



MR312 Bearing Analysis

Two different life cycle analyses were performed for the MR312 shafted encoder. Analysis #1 was based on loads representing 10% of the maximum Radial Load specifications and a 4 lbf Axial pre-load – at 5000 RPM (maximum continuous bandwidth/speed of standard MR310 REI module) . Analysis #2 was based on same load but at high speed of 8000 RPM (maximum continuous bandwidth/speed of Direct Quadrature Outputs of MR310.

Analysis #1 was based on shaft end load representing **10% of maximum rated Radial Load specification.** The analysis included accounting for the difference in loads on the front versus rear shaft bearings:

- 5000 RPM
- Maximum Shaft Load Specifications are Radial=80N (18 lbf) and Axial=40N (9 lbf)
- Assume fixed Axial pre-load of 4 lbf on both bearings (equivalent to 44% of Maximum Axial Load specification)
- Assume Radial load of 1.798 lbf (10% of Maximum Radial Load) centered over exposed shaft length
- Calculated Radial Load Equivalent (composite of above Radial and Axial loads) for Front Bearing is calculated to be 10.7635 lbf (using worst case factors, X=0.56 and Y=2.3) and entered as the Actual Load for the Front Bearing Life Calculations and Mode 1
- Calculated Radial Load Equivalent (composite of above Radial and Axial loads) for Rear Bearing is calculated to be 9.4643 lbf (using worst case factors, X=0.56 and Y=2.3) and entered as the Actual Load for Rear Bearing Life Calculations and Mode 2
- **Resultant calculated System MTBF is 1.62 x 10^5 hours (equivalent to 18.6 years)**

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499-0114 • FAX: (805)499-6585 • EMAIL sales@micronor.com

Analysis #2 was based on same shaft load (10**% of maximum rated Radial Load specification**) but at higher continuous running speed. The analysis included accounting for the difference in loads on the front versus rear shaft bearings:

- 8000 RPM
- Assume applied Maximum Rated Shaft Loads: Radial=80N (18 lbf) and Axial=40N (9 lbf)
- Assume fixed Axial pre-load of 4 lbf on both bearings (equivalent to 44% of Maximum Axial Load specification)
- Assume Radial load of 1.798 lbf (10% of Maximum Radial Load) centered over exposed shaft length
- Calculated Radial Load Equivalent (composite of above Radial and Axial loads) for Front Bearing is calculated to be 10.7635 lbf (using worst case factors, X=0.56 and Y=2.3) and entered as the Actual Load for the Front Bearing Life Calculations and Mode 1
- Calculated Radial Load Equivalent (composite of above Radial and Axial loads) for Rear Bearing is calculated to be 9.4643 lbf (using worst case factors, X=0.56 and Y=2.3) and entered as the Actual Load for Rear Bearing Life Calculations and Mode 2
- **Resultant calculated System MTBF is 1.02 x 10^5 hours (equivalent to 11.6 years)**

MR314 Bearing Analysis

The MR314 bearing analysis was performed and calculated as follows:

- 2000 RPM
- Radial load of 0.7055 lbf (the weight of the non-rotating portion of the encoder)
- Axial pre-load of 4.0 lbf
- Resulting Radial Load Equivalent (composite of above Radial and Axial loads) is calculated to be 9.5951 lbf (using worst case factors, X=0.56 and Y=2.3) and entered as the Actual Load for the Bearing Life Calculations and duplicated for Modes 1 & 2 of Reliability Calculations
- **Resultant calculated System MTBF is 1.76 x 10^9 hours (equivalent to 201,061 years)**

###

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

APPENDIX C: Terms and Acronyms

AFBMA	Anti-Friction Bearing Manufacturers Association. The former name of the ABMA (see separate listing).
ABMA	American Bearing Manufacturers Association. A non-profit association consisting of American manufacturers of anti-friction bearings, spherical plain bearings or major components thereof. The purpose of ABMA is to define national and international standards for bearing products and maintain bearing industry statistics. The ABMA has become the collective voice of the American bearing industry, influencing government policies and international trade. ABMA member companies manufacture 85 percent of the bearings produced in the United States.
ANSI	American National Standards Institute. A non-profit, privately funded organization that coordinates the development and use of voluntary consensus standards in the United States and represents the needs and views of U.S. stakeholders in standardization forums around the globe. The Institute is supported by over 1,000 companies, 250 technical, trade, labor and consumer organizations, and some 30 government agencies. ANSI represents the United States as a member of ISO and IEC. www.ansi.org
ATEX	Atmosphères Explosibles (Explosive Atmosphere). By ratifying the guideline 94/9/EC on 23 March 1994 the European Parliament and the Council of the European Union started to harmonize the different national legislative provisions for the operation in areas with potentially explosive atmospheres. As an acronym, ATEX generally refers to the equipment regulations and standards established by EU directive 94/9/EC.
dB	Decibels. The logarithmic ratio of optical output power to input power. A unit used to express power loss or gain in fiber optic systems. The decibel (dB) = 10 log (P_2/P_1) where P_1 and P_2 are the powers expressed in linear units such as Watts, mW, µW, etc.
dBm	Decibels referenced to 1 mW. Unlike the dimensionless dB ratio, the dBm is used in fiber optic systems to denote the absolute optical power level - referenced to 1 mW. Suppose an optical signal has a power level of P in mW units. Then the absolute power expressed in dBm units = log P. A 1 mW signal has a level of 0 dBm. Signals weaker than 1 mW have negative dBm values; signals stronger than 1 mW have positive dBm values.
IEC	International Electrotechnical Commission. IEC is the international standards commission that prepares and publishes all standards for electrical, electronic and related technologies. The worldwide organization promotes international unification of standards or norms. Its formal decisions on technical matters express, as nearly as possible, an international consensus. www.iec.ch
Inherently Safe Optical Radiation	Visible or infrared radiation that is incapable of producing sufficient energy under normal or specified fault conditions to ignite a specific hazardous atmospheric mixture. In this document, the term “intrinsically safe” is preferentially used because the industrial community is more familiar with this terminology and less familiar with the new terminology developed with the very recent release (August 2006) of IEC 60079-28 Edition 1.0.
Intrinsically Safe	According to IEC 60079-28, the term “intrinsically safe” now specifically applies to electrical circuits while “inherently safe” applies to optical radiation. The terms are used interchangeably in this document due to the user’s greater familiarity with “intrinsically safe”
Irradiance	The radiant power incident on an element of a surface divided by the area of that element. Expressed here in units of microwatts (µW) or milliwatts (mW)

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

LED	Light Emitting Diode. A device used in a transmitter to convert information from electrical to optical form. It typically has a large spectral width. A semiconductor device that emits light when forward biased.
MIE	Minimum (optical) Ignition Energy. The lowest energy which is sufficient to effect ignition of the most ignitable explosive atmosphere under specified test conditions. The MIE levels for various combustibles are given in Figure 1/Figure B.1 of IEC 60079-28.
MMF	Multimode Fiber. In the case of the MR3XX Fiber Optic Encoder System, the fiber type employed is a glass-based graded index multimode fiber with a core diameter of 62.5 microns, cladding diameter of 125 microns and a numerical aperture (NA) of 0.275.
MTBF	Mean Time Between Failure. A statistical calculation of the amount of time before 50% of the units of interest will have failed; used as a measure of the time a user might reasonably expect a device or system to work before a fault or failure occurs.
Optical Power	The time rate of flow of radiant energy with time. Expressed here in terms of mW/mm^2
Radiant Energy	Energy that is emitted, transmitted or received via electromagnetic waves
Simple Apparatus	As defined in the EC ATEX Guidelines, simple apparatuses (exclusions to the Directive) are "equipment and protective systems where the explosion hazard results exclusively from the presence of explosive substances or unstable chemical substances." In other words, under intended use and fault condition, the equipment have no known effective source of ignition.
SOP	Safe Optical Power. The SOP levels for various apparatus groups/temperature class combinations are provided in Table 2 of IEC 60079-28. By design, the MR310 CW optical output never exceeds the worst case SOP level.
VCSEL	Vertical-Cavity Surface-Emitting Laser. A type of semiconductor laser with laser beam emission perpendicular to the chip surface, contrary to conventional edge-emitting semiconductor lasers (also in-plane lasers) where laser light is emitted at one or two edges.

###

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com

APPENDIX D: References

Normative References

ATEX Directive: *Directive 94/9/EC Consolidated Text, Approximation Of The Laws Of The Member States Concerning Equipment And Protective Systems Intended For Use In Potentially Explosive Atmospheres (ATEX)*, 1994L0009-20/11/2003, Office for Official Publications of the European Communites (EUR OP), ec.europa.eu

ATEX Guidelines (Second Edition): *Guidelines On The Application Of Council Directive 95/9/EC Of 23 March 1994 On The Approximation Of The Laws Of The Member States Concerning Equipment And Protective Systems Intended For Use In Potentially Explosive Atmospheres (ATEX)*, July 2005, ec.europa.eu

EN 13463-1: 2001, *Non-Electrical Equipment For PotentiallyExplosive Atmospheres; Part 1: Basic Method And Requirement*, 2001, Comité Européen de Normalisation (CEN), Belgium, www.cenorm.be

EN 13463-5: 2003, *Non-Electrical Equipment For PotentiallyExplosive Atmospheres; Part 5: Protection By Constructional Safety 'C'*, 2003, Comité Européen de Normalisation (CEN), Belgium, www.cenorm.be

EN 13463-6: 2003, *Non-Electrical Equipment For PotentiallyExplosive Atmospheres; Part 6: Control Of Ignition Sources 'B'*, 2003, Comité Européen de Normalisation (CEN), Belgium, www.cenorm.be

IEC 60079-28, *Electrical Apparatus For Explosive Gas Atmospheres; Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation* , International Electotechnical Commission, Switzerland, Edition 1.0 published August 2006, www.iec.ch

Informative References

Machinery's Handbook, 27th Edition, 2004, Industrial Press Inc., New York-NY USA, www.industrialpress.com , New York, NY.

WEIBULL-EASE V8.0 (Reliability Analysis Software), Applications Research Inc., Golden Valley-MN USA, www.applicationsresearch.com

###

MICRONOR INC.
3483 OLD CONEJO ROAD SUITE 203 • NEWBURY PARK CALIFORNIA • 91320
PHONE: (805)499–0114 • FAX: (805)499–6585 • EMAIL sales@micronor.com