ECLIPSE®
700GWR

SIL Certified Safety Manual for Eclipse® Model 700-512X-XXX

Guided Wave Radar Level Transmitter

This manual complements and is intended to be used with the Magnetrol® Eclipse® Model 700 Guided Wave Radar Installation and Operating manual (Bulletin 57-660).

Safety Function

The HART® version of the Eclipse® Model 700 Guided Wave Radar (GWR) transmitter will measure level and transmit a signal proportional to that level within the stated safety accuracy of ±2% of span (or the measured error published in I/O Manual 57-660, whichever is greater). In addition, when continuous, automatic diagnostics detect that the transmitter cannot perform this function, the output will be driven to the customer-specified out-of-range signal (i.e., 3.6 mA or 22 mA).

The Model 700 is certified for use in low demand level measurement applications.

Application

The HART® version of the ECLIPSE Model 700 Guided Wave Radar level transmitter can be applied in most process or storage vessels, bridles, and bypass chambers up to the probe's rated temperature and pressure. It can be used in liquids, slurries, or solids with a dielectric constant in the range 1.4–100 to meet the safety system requirements of IEC 61508 (Edition 2.0, 2010) and IEC 61511-1.

Benefits

- SIL 3 systematic capability
- Level protection to SIL 3 as certified by exida Certification per IEC 61508/IEC 61511-1.
- Probe designs to +400 °F (+200 °C), 6250 psig (430 bar) and full vacuum.
- Cryogenic applications to -320 °F (-190 °C).
- Intrinsically safe, General Purpose, and Non-Incendive approvals.

MAGNETROL®

Eclipse® Model 700 Guided Wave Radar Level Transmitter

SIL Safety Manual for Eclipse® Model 700-512x-xxx

Table of Contents

1.0 Introduction

1.1 Product Description

The ECLIPSE Model 700 Guided Wave Radar Level Transmitter is a two-wire, loop-powered 24 VDC level transmitter based on Guided Wave Radar (GWR) technology.

NOTE: For Safety Instrumented Systems usage, it is assumed that the 4–20 mA output is used as the safety variable.

The analog output from the Model 700 meets the NAMUR NE 43 standard (3.8 mA to 20.5 mA usable). The transmitter contains self-diagnostics and is programmed to drive the output to a user-selected failure state, either low or high, upon internal detection of a diagnostic indicator. The device can be equipped with or without an optional non-interfering graphic liquid crystal display (LCD).

Table 1 indicates the version of the ECLIPSE Model 700 transmitter that has been certified for SIL 2/3 applications.

Table 1
ECLIPSE Model Numbers

1	**Transmitters:** **Model 700, 700-512*-*** (HART)** **Hardware Version (or later)** **Signal Board 030-9185 C** **Power Board 030-9187 C** **Firmware Version** **Model 700 HT 1.0aA.hex (or later)**
2	**Probes:** **Refer to I/O Manual 57-660 for complete probe offering.**

1.2 Theory of Operation

Guided Wave Radar is based upon the principle of TDR (Time Domain Reflectometry). TDR utilizes pulses of electromagnetic energy transmitted down a wave guide (probe). When a pulse reaches a liquid surface that has a higher dielectric constant than the air ($\varepsilon_r = 1$) in which it is traveling, a portion of the pulse is reflected. The transit time of the pulse is then measured via ultra high-speed timing circuitry that provides an accurate measure of the liquid level. The amplitude of the reflection depends on the dielectric constant of the product. The higher the dielectric constant, the larger the reflection.

1.3 Determining Safety Integrity Level (SIL)

Safety Instrumented System designers using the ECLIPSE Model 700 must verify their design per applicable standards, including IEC 61511-1.

Three limits must be met to achieve a given SIL level:

1. The PFD_{AVG} numbers for the entire Safety Instrumented Function (SIF) must be calculated. Table 2 shows the relationship between the Safety Integrity Level (SIL) and the Probability of Failure on Demand Average (PFD_{AVG}).
2. Architecture constraints must be met for each subsystem. Table 3 can be used to determine the achievable SIL as a function of the Hardware Fault Tolerance (HFT) and the Safe Failure Fraction (SFF) for each subsystem in a safety

Table 2
SIL vs. PFDavg

Safety Integrity Level (SIL)	Target Average probability of failure on demand (PFDavg)
4	$\geq 10^{-5}$ to $<10^{-4}$
3	$\geq 10^{-4}$ to $<10^{-3}$
2	$\geq 10^{-3}$ to $<10^{-2}$
1	$\geq 10^{-2}$ to $<10^{-1}$

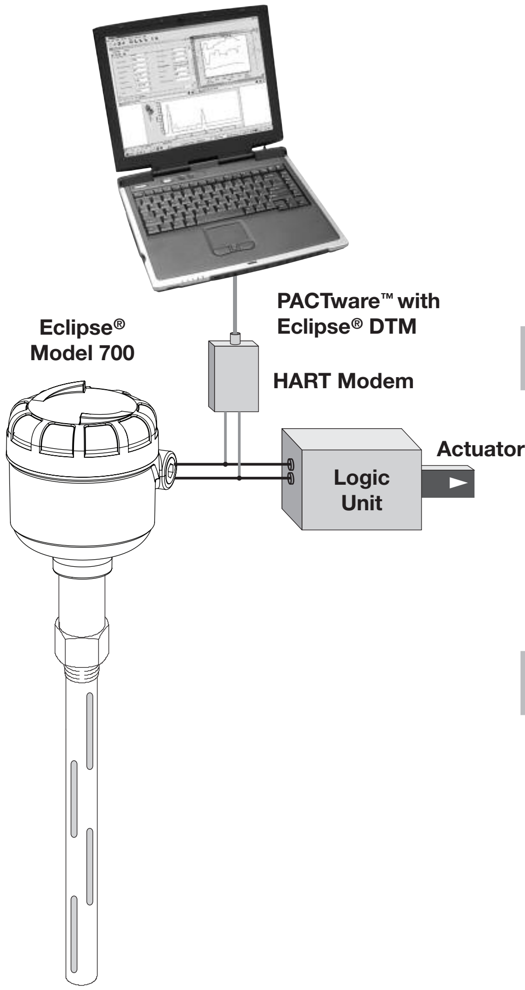
Table 3
Minimum hardware fault tolerance
Type B sensors, final elements and non-PE logic solvers

SFF	Hardware Fault Tolerance (HFT)		
	0	1	2
None: <60%	Not Allowed	SIL 1	SIL 2
Low: 60% to <90%	SIL 1	SIL 2	SIL 3
Medium: 90% to <99%	SIL 2	SIL 3	
High: ≥99%	SIL 3		

system (Type B–complex components as per IEC 61508 Part 2) of which the level transmitter is just one component.

3. All products chosen for use in the SIF must meet the requirements of IEC 61508 for the given SIL Capability level or be justified based on proven in use data collected for each job.

   The exSILentia tool from exida is recommended for design verification. This automatically checks all three limits and displays the results for any given design. The ECLIPSE Model 700 is in the exSILentia database. This tool contains all needed failure rate, failure mode, SIL Capability and common cause data as well as suggested proof test methods.



2.0 Applicable Models

This manual is only applicable to the HART versions of the ECLIPSE Model 700 transmitter shown in Table 1.

NOTE: Ensure that the Model 700 transmitter and probe are installed as a set matched by the Serial Number shown on the name plates.

3.0 Level Measuring System

The diagram at left shows the structure of a typical measuring system incorporating the ECLIPSE Model 700 transmitter. This SIL 2/3 Certified device is only available with an analog signal (4–20 mA) with HART communications; and, the measurement signal used by the logic solver can be the analog 4–20 mA signal proportional to the Level, Interface Level or Upper Layer Thickness.

- For fault monitoring, the logic unit must recognize both high alarms (≥ 21.5 mA) and low alarms (≤ 3.6 mA).
- If the logic solver loop uses intrinsic safety barriers, caution must be taken to ensure the loop continues to operate properly under the low alarm condition.
- The only unsafe mode is when the unit is reading an incorrect level within the 4–20 mA range (> ±2% deviation).
- MAGNETROL defines the faulted mode as one in which the 4–20 mA current is driven out of range (i.e., less than 3.6 mA or greater than 21.5 mA).
- Volume and flow are not included in the safety function for the ECLIPSE Model 700.
- The 4–20 mA output signal can be configured for over-range per NAMUR NE43.

3.1 Miscellaneous Electrical Considerations

Following are miscellaneous electrical issues to be considered in a safety system.

3.1.1 Pollution Degree 2

The ECLIPSE Model 700 transmitter is designed for use in a Category II, Pollution Degree 2 installation, which is defined by a nonconductive pollution of the sort where occasionally a temporary conductivity caused by condensation must be expected.

This is the usual pollution degree used for equipment being evaluated to IEC/EN 61010.

3.1.2 Electromagnetic Compatibility

The ECLIPSE Model 700 is designed to meet the requirements of EN 61326 and NAMUR NE21.

4.0 Mean Time To Repair (MTTR)

SIL determinations are based on a number of factors including the Mean Time To Repair (MTTR). The analysis for the ECLIPSE Model 700 is based on a MTTR of 24 hours.

5.0 Supplementary Documentation

- The ECLIPSE Model 700 Installation and Operating Manual 57-660 must be available to ensure proper installation of the transmitter.
- The following Electronic Device Description File is required if HART is used:
  - Manufacturer Code 0x56
  - Model 700 Type 0x56DC, device revision 1, DD revision 1.
- For device installations in a classified area, the relevant safety instructions and electrical codes must be followed.

6.0 General Instructions

6.1 Systematic Limitations

The following instructions must be observed to avoid systematic failures:

6.1.1 Application

Choosing the proper Guided Wave Radar (GWR) probe is the most important decision in the application process.

Coaxial and single element (rod or cable) are the two basic configurations. As the probe configuration establishes fundamental performance characteristics, the probe for use with the ECLIPSE Model 700 transmitter should be selected as appropriate for the application.

The Model 700 is designed for use in many applications in process industries. Consult factory for assistance with probe options.

Careful selection of probe design and materials for a specific application will minimize media buildup on the probe.

Refer to Installation and Operating Manual 57-660 for more information.

6.1.2 Environmental

Refer to Installation and Operating Manual 57-660 for Environmental limitations.

6.1.2.1 Operating

The operating temperature range for the Model 700 transmitter is -40 to +175 °F (-40 to +80 °C).

6.1.2.2 Storage

The device should be stored in its original shipping box and not be subjected to temperatures outside the storage temperature range of -50 to +185 °F (-46 to +85 °C).

6.2 Installation

Refer to the Model 700 Installation and Operating Manual 57-660 manual for complete installation instructions.

- Contains information on the use, changing and resetting of the password-protection function.
- Provides menu selection items for configuration of the transmitter as a level sensing device.
- Offers configuration recommendations.
- Input voltage and loop resistance must be within the safe operating area of the device.

6.3 Skill Level of Personnel

Personnel following the procedures of this safety manual should have technical expertise equal to or greater than that of a qualified Instrument Technician.

6.4 Necessary Tools

Following are the necessary tools needed to carry out the prescribed procedures:

- Open-wrenches or adjustable wrench to fit the process connection size and type.
  - Coaxial probe: 1½" (38mm)
  - Single rod probes: 1⅞" (47mm)
  - Torque wrench is highly desirable
- Flat-blade screwdriver
- Cable cutter and 3⁄32" (2.5mm) hex wrench (7y1 flexible probes only)
- Digital multimeter or digital volt/ammeter
- 24 VDC power supply, 23 mA minimum

6.5 Configuration Information

6.5.1 General

The ECLIPSE Model 700 transmitter can be configured via the local display, a HART compatible handheld terminal, or a PC using PACT*ware*™ and the associated DTM.

6.5.2 Configuration

Ensure the Model 700 transmitter has been properly configured for the application and probe. Special consideration should be given to the following configuration parameters:

Dielectric Range: Ensure this is set to "1.7–3.0" for the majority of typical hydrocarbon applications or "Below 1.7" for propane and butane applications.

Failure Alarm: DO NOT choose HOLD for this parameter as a Fault will not be annunciated on the current loop.

Blocking Distance: This value MUST be Zero for overfill applications. Consult factory prior to making any changes.

Analog Output Mode: Ensure this is set to ENABLED.

Level Threshold Mode: Set to FIXED VALUE if used in a hydrocarbon application with any possibility of water bottoms.

User Password: Must be changed to a specific value other than Zero.

6.5.3 Write Protecting / Locking

The Model 700 transmitter can be protected with a numerical password between 0 and 59,999.

NOTE: Default Password = 0 = Password disabled.

Refer to the Model 700 Installation and Operating Manual Bulletin 57-660 for additional information on password protection.

For an SIS system, it is required that, after configuration of the system is complete, a password is utilized to prevent inadvertent changes to the device.

6.6 Site Acceptance Testing

To ensure proper operation after installation and configuration, a site acceptance test should be completed. This procedure is identical to the Proof Test Procedure described in Section 7.1.4.

6.7 Recording Results

Results of Site Acceptance Testing must be recorded for future reference.

6.8 Maintenance

With no moving parts to wear out or lose tolerance, routine maintenance is not required.

6.8.1 Diagnostics and Response Times

Continuous internal diagnostics are present within the ECLIPSE Model 700 transmitter. In the event a Fault is detected, a message will appear on the LCD and the output current will be driven to 3.6 mA or 22mA depending on how the FAULT parameter is configured.

A) Start-up Time:
   a. From application of power to normal operating mode: 8 seconds
   b. From application of power to Fault mode: 29 seconds or less (Assuming a Fault is present upon start-up)

B) Diagnostic Test Interval: 15 seconds
   a. This is defined as the time from the normal operating mode to the Fault mode upon the occurrence of a fault.

C) Safety Function Response Time: 3 seconds (with Damping=0)

6.8.2 Troubleshooting

Report all failures to the MAGNETROL Technical Support Department.

Refer to the Model 700 Installation and Operating Manual Bulletin 57-660 for troubleshooting device errors.

- As there are no moving parts in this device, the only maintenance required is the SIL Proof Test.
- Firmware can only be upgraded by factory personnel.

7.0 Recurrent Function Tests

7.1 Proof Testing

7.1.1 Introduction

Following is the procedure utilized to detect Dangerous Undetected (DU) failures.

7.1.2 Interval

To maintain the appropriate Safety Integrity Level of a Safety Instrumented System, it is imperative that the entire system be tested at regular time intervals (shown as TI in the appropriate standards). The suitable SIL for the Model 700 transmitter is based on the assumption that the end user will carry out this test and inspection at least once per year.

NOTE: It is the responsibility of the owner/operator to select the type of inspection and the time period for these tests.

7.1.3 Recording Results

Results of the Proof Test should be recorded for future reference.

7.1.4 Suggested Proof Test

The suggested proof test below, in combination with the built-in automatic diagnostics, will detect 97.7% of possible DU failures in Model 700-512x-xxx.

Step	Action
1	Bypass the PLC or take other action to avoid a false trip.
2	Inspect the unit in detail outside and inside for physical damage or evidence of environmental or process leaks a.) Inspect the exterior of the Unit housing. If there is any evidence of physical damage that may impact the integrity of the housing and the environmental protection, the unit should be repaired or replaced. b.) Inspect the interior of the unit. Any evidence of moisture, from process or environment, is an indication of housing damage, and the unit should be repaired or replaced.
3	Use the unit's DIAGNOSTICS menu to observe Present Status, and review EVENT HISTORY in the Event Log. Up to 10 events are stored. The events will be date and time stamped if the internal clock is set and running. It is suggested that the internal clock be set at the time of commissioning of the unit. If the clock is set at the time of the proof test, event times are calculated. a.) Choose the menu DIAGNOSTICS / Present Status. i.) Present Status should indicate OK. b.) Choose the menu DIAGNOSTICS / EVENT HISTORY/ Event Log i.) Any FAULT or WARNING messages must be investigated and understood. ii.) Corrective actions should be taken for FAULT messages.

continued on next page

Step	Action
4	Use the DIAGNOSTICS menu to perform a "CURRENT LOOP TEST". Select DIAGNOSTICS / ADVANCED DIAGNOSTICS / TRANSMITTER TESTS / Analog Output Test to change the output loop current and confirm the actual current matches the value chosen. a.) Send a HART command to the transmitter (or use the local interface) to go to the high alarm current output, 22 mA, and verify that the analog current reaches the valve. i.) This step tests for compliance voltage problems such as low supply voltage or increased wiring resistance. ii.) This also tests for current loop control circuitry and adjustment problems. b.) Send a HART command to the transmitter (or use the local interface) to go to the low alarm current output, 3.6 mA, and verify that the analog current reaches the valve. i.) This step tests for high quiescent current and supply voltage problems. ii.) This also tests for current loop control circuitry and adjustment problems. c.) Exit the "Analog Output Test" and confirm that the output returns to its original state—with the proper loop current as indicated and controlled by the unit.
5	Use the DIAGNOSTICS menu to observe the present Echo Curve. Confirm that the ECHO Waveform is normal. The echo curve is dependent on the type of probe, the installation conditions and the level of process on the probe. Comparison of the present Echo Curve to the one stored at the time of commissioning the unit gives additional confidence of the normal operation of the unit. Use of the DTM and digital communications is necessary for comparison of echo curves. a.) Select DIAGNOSTICS/ ECHO CURVE/ View Echo Curve i.) Observe the present Echo Curve, identify the characteristic portions of the waveform related to the FIDUCIAL, Process level, End of Probe and other features. ii.) Confirm that the FIDUCIAL appears acceptable. Confirm the FIDUCIAL is located where expected. iii.) Confirm that the signal from the process level appears normal and is located as expected. iv.) Verify that the baseline of the waveform is smooth and flat. v.) Compare to Echo Curve from commissioning in the FIDUCIAL area. b.) Access the Fiducial Ticks and Fiducial Strength values in the menu: DIAGNOSTICS / ADVANCES DIAGNOSTICS / INTERNAL VALUES i.) Observe and record: 1.) Fiducial Ticks _____________ 2.) Fiducial Strength _____________ ii.) Confirm that these values match the previous values. 1.) Fiducial Ticks differs within ±100 2.) Fiducial Strength differs within ±15
6	Perform two-point calibration check of the transmitter by applying level to two points on the probe and compare the transmitter display reading and the current level value to a known reference measurement.
7	If the calibration is correct the proof test is complete. Proceed to step 9.
8	If the calibration is incorrect, remove the transmitter and probe from the process. Inspect the probe for buildup or clogging. Clean the probe, if necessary. Perform a bench calibration check by shorting the probe at two points. Measure the level from the bottom of the probe to the two points and compare to the transmitter display and current level readings. a.) If the calibration is off by more than 2%, contact the factory for assistance. b.) If the calibration is correct, the proof test in complete. c.) Re-install the probe and transmitter.
9	Restore loop to full operation.
10	Remove the bypass from the safety PLC to restore normal operation.

8.0 Safety Requirements

This section specifies those safety characteristics allocated to the ECLIPSE Model 700 that are conditions for its acceptance as a SIL certified device.

NOTE: This SIL evaluation has assumed that the customer will be able to acknowledge an over- or under-current condition via the Logic Solver.

8.1 System Safety Assumptions

The System Safety Assumptions provide a list of safety relevant assumptions made on the usage of the product over the safety life cycle of a user Safety Integrity Function, SIF. Magnetrol cannot directly control the user life cycle of a SIF using this product but needs to have assumptions on how the product will be used. It is important that users have full knowledge of these assumptions to ensure they are met when using the product as part of a SIF. This is to ensure the product is used in a manner consistent with the safety design.

This section only lists product specific assumptions and is not intended to specify measures required of the end user that are standard requirements for safety applications.

Assumptions for Safety
The user SIF will detect and properly handle annunciation of detected fault conditions signaled by the alarm level output according to the specific requirements of the SIF.
Proper operation of the Eclipse Model 700 is dependent on having the voltage across the transmitter terminals meet the Safe Operating Area requirements during normal operation.
A user SIF integrating the Eclipse Model 700 current loop output will detect faulted field wiring and other faults resulting in a current loop value signal outside of the specified range and take proper actions to maintain safety integrity according to the specific requirements of the SIF.
Optional Local User Interface will not be relied upon by the end user SIF during normal operation and will be considered non-interfering to the safety function.
HART communications will not be relied upon by the end user for the SIF normal operation and will be considered non-interfering to the safety function.
The impact of end user configured damping values is not included in the published safety (function) response time. (The end user must consider this as part of overall time response of the SIF.)
The end user will independently verify all changes to end user configured parameters and validate the safety functionality prior to reliance on the product for safety protection.
The end user will enable the User Password to lock out any end user modifiable configuration parameters available via the Local User Interface during normal operation.
The end user will enable the User Password to lock out any end user modifiable configuration parameters available via the HART interface during normal operation.
The end user will have proper procedures in place to ensure safe operation over the product life cycle.
The end user will ensure the device is properly installed per the product literature. The proper probe will be used for the application with the transmitter properly connected to the probe.
The end user must not select HOLD for the alarm output.
Loop Current mode must be enabled.

8.2 Safety Function Requirements

This section lists the Safety Function Requirements that specify what safety relevant functionality is to be performed for implementation of the safety integrity function and also to maintain the desired level of safety integrity. These requirements may also rule out particular functionality for SIF usage that could lead to designs that are difficult to validate for deterministic performance or safety integrity.

Safety Function Requirement
Upon application of power and successful initialization, the Eclipse Model 700 **shall** enter the Normal Mode or Faulted Mode of operation.
Upon application of power and successful initialization, the Eclipse Model 700 **shall** enter the Normal Mode operation within 8 seconds.
Upon application of power and successful initialization, the Eclipse Model 700 **shall** enter the Faulted Mode of operation in less than 29 seconds.
The Eclipse Model 700 **shall** transition to the Faulted Mode from the Normal Mode within the Diagnostic Test Interval after a diagnostic event occurs. The safety function will respond to a change from the user's process within the safety (function) response time.
The Eclipse Model 700 **shall** transition to the Faulted Mode from the Normal Mode within the Diagnostic Test Interval of 15 seconds after a diagnostic event occurs.
The safety function output of the Eclipse Model 700 **shall** respond to a change from the user's process within the safety (function) response time of 3 seconds assuming Damping is set to 0.
The Eclipse Model 700 **may** leave the Faulted Mode when all diagnostics are clear.

8.3 Safety User Programming and Configuration Requirements

The Safety User Programming and Configuration Requirements provide the requirements for field configuration of the device required to create and maintain SIF configurations. These requirements should provide the necessary guidance to ensure that the engineering environment will meet both the intended market and safety certification requirements, along with guidance and user restrictions documented in the safety manual.

Safety User Programming Requirement
Setup, configuration, and maintenance functionality for the Eclipse Model 700 **shall** be supported by the non-interfering HART communications interface.
Setup, configuration and maintenance functionality for the Eclipse Model 700 **shall** be supported by the optional Local User Interface.

9.0 Appendices

9.1 SIL Certificate

exida

The manufacturer may use the mark:

Revision 1.0 February 25, 2020
Surveillance Audit Due
July 1, 2022

Certificate / Certificat
Zertifikat / 合格証

MAG 1905028 C001

exida hereby confirms that the:

Eclipse 700GWR Level Transmitter

Magnetrol International, Inc.
Aurora, IL - USA

Has been assessed per the relevant requirements of:

IEC 61508 : 2010 Parts 1-7

and meets requirements providing a level of integrity to:

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type B Element

SIL 2 @ HFT=0; SIL 3 @ HFT = 1; Route 2_H

PFD_{AVG} and Architecture Constraints must be verified for each application

Safety Function:
The Eclipse 700GWR Level Transmitter will measure level and transmit a corresponding signal within the stated safety accuracy.

Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.

Evaluating Assessor

Certifying Assessor

ANSI ACCREDITED
ISO/IEC 17065 PRODUCT CERTIFICATION BODY #1004

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Eclipse 700GWR Level Transmitter

Certificate / Certificat / Zertifikat / 合格証

MAG 1905028 C001

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type B Element

SIL 2 @ HFT=0; SIL 3 @ HFT = 1; Route 2_H

PFD_{AVG} and Architecture Constraints must be verified for each application

Systematic Capability:
The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.
A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than stated.

Random Capability:
The SIL limit imposed by the Architectural Constraints must be met for each element. This element meets *exida* criteria for Route 2_H.

IEC 61508 Failure Rates in FIT*

Application/Device/Configuration	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}
Model 700GWR	0	63	672	60

* FIT = 1 failure / 10^9 hours

SIL Verification:
The Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) must be verified via a calculation of PFD_{avg} considering redundant architectures, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each element must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

The following documents are a mandatory part of certification:

Assessment Report:
MAG 19-05-028 R002 V1R0 Assessment Report

Safety Manual:
57-661.0 Eclipse Model 700-512X-XXX SIL Certified Safety Manual IO

exida
80 N Main St
Sellersville, PA 18960

T-002, V5R3

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9.2 FMEDA Report: exida Management Summary

Failure Modes, Effects and Diagnostic Analysis

Project:
Eclipse Model 700 GWR Level Transmitter

Company:
Magnetrol International
Aurora, IL
USA

Contract Number: Q19/05-028
Report No.: MAG 19/05-028 R001
Version V1, Revision R1, February 7, 2020
Rudolf Chalupa

Management Summary

This report summarizes the results of the hardware assessment in the form of a Failure Modes, Effects, and Diagnostic Analysis (FMEDA) of the Eclipse Model 700 GWR Level Transmitter, hardware and software revision per Section 2.5.1. A Failure Modes, Effects, and Diagnostic Analysis is one of the steps to be taken to achieve functional safety certification per IEC 61508 of a device. From the FMEDA, failure rates are determined. The FMEDA that is described in this report concerns only the hardware of the Model 700. For full functional safety certification purposes, all requirements of IEC 61508 must be considered.

Model 700-512*-*** is a loop-powered, 24 VDC level transmitter, based on Guided Wave Radar (GWR) technology. For safety instrumented systems usage it is assumed that the 4 – 20mA output is used as the primary safety variable. The analog output meets NAMUR NE 43 (3.8mA to 20.5mA usable). The transmitter contains self-diagnostics and is programmed to send its output to a specified failure state, either low or high upon internal detection of a failure (output state is programmable). The device can be equipped with or without display.

Table 1 gives an overview of the different versions that were considered in the FMEDA of the Model 700.

Table 1 Version Overview

Variant/Model	Hardware Version		Software Version
700-512x-xxx (HART)	SIGNAL PC BOARD	030-9185-001 Rev. C	Model 700 HT 1.0aA.hex
	POWER PC BOARD	030-9187-001 Rev. C	

The Model 700 is classified as a Type B[1] element according to IEC 61508, having a hardware fault tolerance of 0.

The failure rate data used for this analysis meet the *exida* criteria for Route 2_H (see Section 5.2). Therefore, the Model 700 meets the hardware architectural constraints for up to SIL 2 at HFT=0 (or SIL 3 @ HFT=1) when the listed failure rates are used.

Based on the assumptions listed in 4.3, the failure rates for the Model 700 are listed in section 4.4.

These failure rates are valid for the useful lifetime of the product, see Appendix A.

The failure rates listed in this report are based on over 350 billion-unit operating hours of process industry field failure data. The failure rate predictions reflect realistic failures and include site specific failures due to human events for the specified Site Safety Index (SSI), see section 4.2.2.

A user of the Model 700 can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL).

[1] Type B element: "Complex" element (using micro controllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2, ed2, 2010.

9.3 Specific Model 700 Values

Product	ECLIPSE Model 700-512x-xxx
SIL	SIL 2
HFT	0
SFF	92.4%
PFD_{avg}	Refer to FMEDA report

9.4 Report: Lifetime of Critical Components

According to section 7.4.9.5 of IEC 61508-2, a useful lifetime, based on experience, should be assumed.

Although a constant failure rate is assumed by probabilistic estimation method, this only applies provided that the useful lifetime of components is not exceeded. Beyond their useful lifetime the result of the probabilistic calculation method is therefore meaningless, as the probability of failure significantly increases with time. The useful lifetime is highly dependent on the subsystem itself and its operating conditions.

The assumption of a constant failure rate is based on the bathtub curve. Therefore it is obvious that the PFDavg calculation is only valid for components that have this constant domain and that the validity of the calculation is limited to the useful lifetime of each component.

The expected useful life of ECLIPSE Model 700-512x-xxx is at least 50 years.

It is the responsibility of the end user to maintain and operate the Model 700-512x-xxx per manufacturer's instructions. Furthermore, regular inspection should indicate that all components are clean and free from damage.

When plant experience indicates a shorter lifetime than indicated here, the number based on plant experience should be used.

References

- IEC 61508 Edition 2.0,2010 "Functional Safety of Electrical/Electronic/ Programmable Electronic Safety Related Systems"
- ANSI/ISA-84.00.01-2004 Part 1 (IEC 61511-1Mod) "Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 1 Hardware and Software Requirements"
- ANSI/ISA-84.00.01-2004 Part 2 (IEC 61511-2Mod) "Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 2 Guidelines for the Application of ANSI/ISA84.00.01-2004 Part 1 (IEC 61511-1 Mod) – Informative"
- ANSI/ISA-84.00.01-2004 Part 3 (IEC 61511-3Mod) "Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 3 Guidance for the Determination of the Required Safety Integrity Levels – Informative"
- ANSI/ISA-TR84.00.04 Part 1 (IEC 61511 Mod) "Guideline on the Implementation of ANSI/ISA-84.00.01-2004"

Disclaimer

The SIL values in this document are based on an FMEDA analysis using exida's SILVER Tool. MAGNETROL accepts no liability whatsoever for the use of these numbers or for the correctness of the standards on which the general calculation methods are based.

ASSURED QUALITY & SERVICE COST LESS

Service Policy

Owners of MAGNETROL controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by prepaid transportation. MAGNETROL will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory prior to the material's return. This is available through a MAGNETROL local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

ECLIPSE Guided Wave Radar transmitters may be protected by one or more of the following U.S. Patent Nos. US 6,626,038; US 6,640,629; US 6,642,807; US 6867729; US 6879282; US 6906662. Other patents pending.

MAGNETROL®

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