User's Manual

ADMAG TI Series
AXG/AXW Magnetic Flowmeter
Safety Manual

IM 01E21A21-02EN

YOKOGAWA
Yokogawa Electric Corporation

IM 01E21A21-02EN
7th Edition

ADMAG TI Series
AXG/AXW Magnetic Flowmeter
Safety Manual

IM 01E21A21-02EN 7th Edition

Contents

1. Introduction 1

2. Safety Instrumented Systems Installation 4

2.1 Scope and Purpose 4

2.2 Using this product for an SIS Application 5

2.2.1 Safety Function 5
2.2.2 Safety Accuracy 5
2.2.3 Diagnostic Response Time 5
2.2.4 Setup 5
2.2.5 Required Parameter Setting 6
2.2.6 Proof Test 7
2.2.7 Repair and Replacement 9
2.2.8 Startup Time 9
2.2.9 Firmware Update 9
2.2.10 Reliability Data 9
2.2.11 Lifetime Limits 9
2.2.12 Environmental Limits 10
2.2.13 Application Limits 10

2.3 Definitions and Abbreviations 10

2.3.1 Definitions 10
2.3.2 Abbreviations 10

Revision Information

All right Reserved Copyright © 2017. Yokogawa Electric Corporation

1. Introduction

This manual provides the basic guidelines for Safety Instrumented Systems Installation of ADMAG TI (Total Insight) Series AXG and AXW Magnetic flowmeters.
For the items which are not covered in this manual, read the applicable user's manuals and general specifications as listed in Table 1.1. These documents can be downloaded from the website of YOKOGAWA.
To ensure correct use of the product, read these manuals thoroughly and fully understand how to operate the product before maintaining it. For method of checking the model and specifications, read the applicable general specifications in Table 1.1.
Website address: https://www.yokogawa.com/library/
These manuals can be downloaded from the website of YOKOGAWA or purchased from the YOKOGAWA representatives.

Table 1.1 Manual and General Specifications List

Model	Document Title	Document No.	Edition
AXG### AXW### AXG4A AXW4A AX01C	ADMAG TI Series AXG###, AXW###, AXG4A, AXW4A, AXG1A Magnetic Flowmeter Read Me First (Optional Code EC)	IM 01E21A11-01EN	Edition 9 or later
	ADMAG TI Series AXG/AXW Magnetic Flowmeter Read Me First	IM 01E21A21-01Z1	Edition 11 or later
	ADMAG TI Series AXG/AXW Magnetic Flowmeter Safely Manual	IM 01E21A21-02EN (this manual)	Edition 2 or later
	ADMAG TI Series AXG, AXW Magnetic Flowmeter BRAIN Communication Type	IM 01E21A02-01EN	Edition 3 or later
	ADMAG TI Series AXG, AXW Magnetic Flowmeter HART Communication Type	IM 01E21A02-02EN	Edition 3 or later
AXG### AXG4A AX01C	ADMAG TI Series AXG Magnetic Flowmeter Installation Manual	IM 01E22A01-01EN	Edition 11 or later
	ADMAG TI Series AXG Magnetic Flowmeter Maintenance Manual	IM 01E22A01-02EN	Edition 5 or later
	ADMAG TI Series AXG Magnetic Flowmeter General Specifications	GS 01E22A01-01EN	Edition 18 or later
AXW### AXW###G AXW###W AXW4A AX01C	ADMAG TI Series AXW Magnetic Flowmeter [Size: 25 to 400 mm (1 to 16 in.)] AXW Magnetic Flowmeter [Size: 25 to 450 mm (1 to 18 in.)] (Edition 13 later) Installation Manual	IM 01E24A01-01EN	Edition 7 or later
	ADMAG TI Series AXW Magnetic Flowmeter [Size: 500 to 1800 mm (20 to 72 in.)] Installation Manual	IM 01E25A01-01EN	Edition 7 or later
	ADMAG TI Series AXW Magnetic Flowmeter [Size: 25 to 1800 mm (1 to 72 in.)] Maintenance Manual	IM 01E24A01-02EN	Edition 5 or later
	ADMAG TI Series AXW Magnetic Flowmeter [Size: 25 to 400 mm (1 to 16 in.)] AXW Magnetic Flowmeter [Size: 25 to 450 mm (1 to 18 in.)] (Edition 26 later) General Specifications	GS 01E24A01-01EN	Edition 16 or later
	ADMAG TI Series AXW Magnetic Flowmeter [Size: 500 to 1800 mm (20 to 72 in.)] General Specifications	GS 01E25D11-01EN	Edition 14 or later

IMPORTANT

The combinations that can be used for safety instrumented systems are as follows.

- AXG Integral Type
- Combination of AXG Remote Sensor and AXG4A Remote Transmitter
- AXW Integral Type
- Combination of AXW Remote Sensor and AXW4A Remote Transmitter

Configurations other than the above (e.g., Remote Sensor and AXFA11G Remote Transmitter) cannot be used for safety instrumentation systems.

The certificate can be downloaded from the website below.
Website address : https://www.yokogawa.com/library/

NOTE

When describing the model name like AXG### in this manual, "###"means any of the following.
For AXG###:
002, 005, 010, 015, 025, 032, 040, 050, 065, 080, 100, 125, 150, 200, 250, 300, 350, 400
For AXW###:
025, 032, 040, 050, 065, 080, 100, 125, 150, 200, 250, 300, 350, 400, 450
For AXW###G or AXW###W:
500, 600, 700, 800, 900, 10L

■ Precautions Related to the Protection, Safety, and Alteration of the Product

The following safety symbol marks are used in this manual and product.



WARNING

A WARNING sign denotes a hazard. It calls attention to procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death of personnel.



CAUTION

A CAUTION sign denotes a hazard. It calls attention to procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

IMPORTANT

An IMPORTANT sign denotes that attention is required to avoid damage to the product or system failure.

NOTE

A NOTE sign denotes information necessary for essential understanding of operation and features.

The following symbols are used in the product and the manual to indicate the accompanying safety precautions:


Protective grounding terminal


Functional grounding terminal (This terminal should not be used as a protective grounding terminal.)

Alternating current

Direct current


Caution
This symbol indicates that the operator must refer to an explanation in the user's manual in order to avoid the risk of injury or death of personnel or damage to the product.

- For the protection and safe use of the product and the system in which this product is incorporated, be sure to follow the instructions and precautions on safety that is stated in user's manual as listed in Table 1.1 whenever you handle the product. Take special note that if you handle the product in a manner that violated these instructions, the protection functionality of the product may be damaged or impaired. In such cases, YOKOGAWA does not guarantee the quality, performance, function, and safety of product.
- Do not modify this product.
- The product should be disposed of in accordance with local and national legislation/regulations.

■ Regarding This User's Manual

- This manual should be provided to the end user.
- The contents of this manual are subject to change without prior notice.
- All rights reserved. No part of this manual may be reproduced in any form without YOKOGAWA's written permission.
- YOKOGAWA makes no warranty of any kind with regard to this manual, including, but not limited to, implied warranty of merchantability and fitness for a particular purpose.
- If any question arises or errors are found, or if any information is missing from this manual, inform the nearest YOKOGAWA sales office.
- The specifications covered by this manual are limited to those for the standard type under the specified model number break-down and do not cover custom-made products.
- Note that changes in the specifications, construction, or component parts of the product may not immediately be reflected in this manual at the time of change, provided that postponement of revisions will not cause difficulty to the user from a functional or performance standpoint.
- To ensure correct use, read this manual and the applicable user's manuals as listed in Table 1.1 thoroughly before starting operation. Read the general specifications as listed in Table 1.1 for its specification.

■ Trademark

- All the brands or names of Yokogawa Electric's products used in this manual are either trademarks or registered trademarks of Yokogawa Electric Corporation.
- All other company and product names mentioned in this manual are trade names, trademarks or registered trademarks of their respective companies.
- In this manual, trademarks or registered trademarks are not marked with ™ or ®.

■ For Safe Use of Product

For the protection and safe use of the product and the system in which this product is incorporated, be sure to follow the instructions and precautions on safety that is stated in user's manual as listed in Table 1.1 whenever you handle the product. Take special note that if you handle the product in a manner that violated these instructions, the protection functionality of the product may be damaged or impaired. In such cases, YOKOGAWA shall not be liable for any indirect or consequential loss incurred by either using or not being able to use the product.

2. Safety Instrumented Systems Installation

WARNING

The contents are cited from exida.com safety manual on this product specifically observed for its safety purpose. When using this product for Safety Instrumented System (SIS) application, the instructions and procedures on this chapter must be strictly followed in order to preserve this product for that safety level.

2.1 Scope and Purpose

This chapter provides an overview of the user responsibilities for installation and operation of this product in order to maintain the designed safety level for SIS applications.
This chapter is described proof test, repair and replacement of the transmitter, reliability data, lifetime, environmental and application limits, and parameter settings. Functional safety is targeted for /SL option.

The following version combinations are certified as IEC 61508 products:

HART

Hardware Revision	Software Revision		
	Main	Sensor	Indicator
S1.01	R2.02.01	R1.02.01	R2.02.01
			R2.02.03
	R2.02.02	R1.02.01	R2.02.01
			R2.02.03
	R2.02.30	R1.02.01	R2.02.01
			R2.02.03
	R2.02.31	R1.02.01	R2.02.01
			R2.02.03

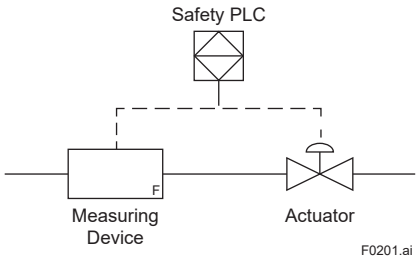
BRAIN

Hardware Revision	Software Revision		
	Main	Sensor	Indicator
S1.01	R2.02.01	R1.02.01	R2.02.01
			R2.02.03
	R2.02.02	R1.02.01	R2.02.01
			R2.02.03
	R2.02.30	R1.02.01	R2.02.01
			R2.02.03
	R2.02.31	R1.02.01	R2.02.01
			R2.02.03

2.2 Using this product for an SIS Application

2.2.1 Safety Function

This product is used as a Type B of Low demand mode in the SIS application.



This product converts Flow velocity, Volume flow, Mass flow, and Flow noise (for AXG only) to current. And it outputs “Analog Output 1” at “I/O 1” terminal as its safety functions. Other functions (display, etc…) are out of its scope. Use this “Analog Output 1” to connect the safety PLC when this product is used as a SIS.
It is necessary to set adequate parameters before starting to use this product as a SIS. Refer to Subsection 2.2.4 and Subsection 2.2.5 for details.

2.2.2 Safety Accuracy

This product has a specified safety accuracy of 2%. This means that the internal component failure are listed in the device failure rate if they will cause an error of 2% or larger.

2.2.3 Diagnostic Response Time

The period of the diagnostic test on this product is 8 seconds as its maximum. This product notifies the failure to the safety PLC as its host within 1 second by outputting the burnout (safety condition) at “Analog Output 1”. For countermeasure of its failure, read Chapter 4 in the user’s manual of applicable communication type as listed in Table 1.1.

2.2.4 Setup

Set the ranges and units via the BRAIN or HART configuration tool or Display. After configuration, make sure that they are set correctly. The calibration of this product must be carried out after parameters are set. For its parameter settings, read Chapter 4 and Chapter 5 in the user’s manual of applicable communication type as listed in Table 1.1.

2.2.5 Required Parameter Setting

The following parameters as shown in Table 2.2.1 and Table 2.2.2 are required to be set in order to preserve this product for that safety level.

Table 2.2.1 Setup by Parameters

Item	Explanation
BRAIN: G04:AO1 ALM OUT HART Menu Path: Device root menu▶Detailed setup▶ Analog output/input▶Analog output 1▶ AO1 alarm out Display Menu Path: Device setup▶Detailed setup▶ Analog out/in▶AO1▶Alarm out	This function is to output the signal through the “Analog Output 1” when this product is detected its alarm. Set the “Analog Output 1” as “> 21.6 mA” or “< 2.4 mA” when this product is used for SIS.
BRAIN: H50:SET SIL HART Menu Path: Device root menu▶Detailed setup▶ AUX calculation▶Set SIL Display Menu Path: Device setup▶Detailed setup▶ AUX calculation▶Set SIL	Set this parameter as “Yes” when this product is used for SIS. In this case, its “Analog Output 1” is fixed as “> 21.6 mA” or “< 2.4 mA” when its alarm was detected. It is able to carry out the burnout function via “Analog Output 1” without fail when this product is detected its alarm.
BRAIN: H30:DENSITY SEL HART Menu Path: Device root menu▶Detailed setup▶ Process variables▶Density▶ Density value select Display Menu Path: Device setup▶Detailed setup▶Pro var▶ Density▶Value select	Set this parameter as “Fixed value” when the “Analog Output 1” is used for mass flow measurement.
BRAIN: P22:NEW PASSWORD HART Menu Path: Device root menu ▶ Detailed setup ▶ Protection ▶ New password Display Menu Path: Device setup▶Detailed setup▶Protection▶ New password	Set a password of 8 characters (no lowercase letters allowed) to enable the software write protect function. For detailed setting instructions, please refer to the respective communication type manuals in Table 1.1. In this case, do not forget the parameters you set. When used in instrumented safety systems, at least one of the write protect switch or the software write protect function must be enabled.

Table 2.2.2 Setup by Hardware

Item	Explanation
Burnout switch	Select “High” or “Low” for the output when an internal failure was detected.
Write protect switch	Enable the write protect function by setting its switch “ON”. When used in instrumented safety systems, at least one of the write protect switch or the software write protect function must be enabled.

NOTE

Pulse output is out of the scope of the safety function. Please set the pulse output to be disabled.

NOTE

When using this instrument for Safety Instrumented System (SIS) application, The setting change of this instrument must be done by personnel should be trained in operation of SIS. Therefore, limit the number of personnel should be trained in the operation of SIS and who can set the New password or enable the write protect switch to change the setting.

2.2.6 Proof Test

A proof test is a periodic test to verify that the Safety Instrumented Function work without fails.
It is mandatory to have a proof test in order to detect any failure which is not detected by the diagnostic of the product, which prevents any action of the Safety Instrumented Function (SIF) from its intention.
The frequency of the proof tests (or the proof test interval) is to be determined in the reliability calculations for the SIFs for which this product is applied. The actual proof tests must be carried out “more frequently” or “as frequently as specified” in the calculation in order to preserve required safety integrity of the SIF.
Proof test results are required to be documented. And this documentation should be a part of the plant safety management system. Failures that are detected should be reported to YOKOGAWA.
The personnel carrying out the proof test of products should be trained in SIS operations including bypass procedures, maintenance of this product, and company management of change procedures.
Disable the write protect function before proof test. After the proof test, enable the write protect function.

Table 2.2.5 Abbreviated Proof Test

Testing method	Tool required	Expected outcome	Remarks
Loop test for “Analog output” 1. Bypass the safety PLC or take other appropriate action to avoid a false trip. 2. Make a note of the “AO1 alarm out” when the proof test is carrying out. 3. After setting the “AO1 alarm out” to “>21.6 mA” via BRAIN or HART communication or Display, actually generate an alarm and verify that the current value is above 21.6 mA. 4. After setting the “AO1 alarm out” to “<2.4 mA” via BRAIN or HART communication or Display, actually generate an alarm and verify that the current value is less than 2.4 mA. 5. Clear the all alarm. 6. Return the setting of “AO1 Alarm out” to the value you noted in Step 2. 7. Remove the bypass and otherwise restore normal operation.	For BRAIN: BRAIN configuration tool For HART: HART configuration tool	Proof Test Coverage; ADMAG TI Multi (Non-IS) Option = 68.6% ADMAG TI IS Option = 69.8%	The output needs to be monitored to assure that this product communicates the correct signal

Table 2.2.6 Extended Proof Test

Testing method	Tool required	Expected outcome	Remarks
Loop test for “Analog output” 1. Bypass the safety PLC or take other appropriate action to avoid a false trip. 2. Make a note of the “AO1 alarm out” when the proof test is carrying out. 3. After setting the “AO1 alarm out” to “>21.6 mA” via BRAIN or HART communication or Display, actually generate an alarm and verify that the current value is above 21.6 mA. 4. After setting the “AO1 alarm out” to “<2.4 mA” via BRAIN or HART communication or Display, actually generate an alarm and verify that the current value is less than 2.4 mA. 5. Clear the all alarm. 6. Return the setting of “AO1 Alarm out” to the value you noted in Step 2. 7. Perform a two-point calibration in the maximum and minimum flow ranges. 8. Check current output when there is no flow in the meter. 9. Check current output when there is typical flow in the meter. 10. Remove the bypass and otherwise restore normal operation.	For BRAIN: BRAIN configuration tool For HART: HART configuration tool	Proof Test Coverage; ADMAG TI Multi (Non-IS) Option = 83.3% ADMAG TI IS Option = 83.9%	The output needs to be monitored to assure that this product communicates the correct signal

Example of generating an alarm current output;
(In case of "66:Dens cfg ERR" for BRAIN ("Density configuration error" for HART "066:Density cfg ERR" for Display));

(1) Set parameters through BRAIN or HART communication protocol in order to generate an alarm at "Analog Output 1" by making a condition of scale out at its high limit side of current value.

(a) BRAIN: G04: AO1 ALM OUT
HART Menu Path:
Device root menu▶Detailed setup▶Analog output/input▶Analog output 1▶AO1 alarm out
Display Menu Path:
Device setup▶Detailed setup▶Analog out/in▶AO1▶Alarm out

Select "> 21.6 mA" when generating an alarm for its high limit side.

(b) BRAIN: H30: DENSITY SEL
HART Menu Path:
Device root menu▶Detailed setup▶Process variables▶Density▶Density value select
Display Menu Path:
Device setup▶Detailed setup▶Pro var▶Density▶Value select
Select "Fixed value" above menu.

(c) BRAIN: H32: FIXED DENS
HART Menu Path:
Device root menu▶Detailed setup▶Process variables▶Density▶Density fixed value
Display Menu Path:
Device setup▶Detailed setup▶Pro var▶Density▶Fixed density
Set the parameter as "0.0" above menu.

(d) BRAIN: C30: PV FLOW SEL
HART Menu Path:
Device root menu▶Detailed setup▶Process variables▶PV flow select
Display Menu Path:
Device setup▶Detailed setup▶Pro var▶PV flow select
Select "Mass" above menu.

An alarm, which was set at "Analog Output 1", is generated and appeared at the result of above work.

(2) Set parameters through BRAIN or HART communication protocol in order to generate an alarm at "Analog Output 1" by making a condition of scale out at its low limit side of current value.

(a) BRAIN: G04: AO1 ALM OUT
HART Menu Path:
Device root menu▶Detailed setup▶Analog output/input▶Analog output 1▶AO1 alarm out
Display Menu Path:
Device setup▶Detailed setup▶Analog out/in▶AO1▶Alarm out

Select "< 2.4 mA" when generating an alarm for its low limit side.

(b) BRAIN: H30: DENSITY SEL
HART Menu Path:
Device root menu▶Detailed setup▶Process variables▶Density▶Density value select
Display Menu Path:
Device setup▶Detailed setup▶Pro var▶Density▶Value select
Select "Fixed value" above menu.

(c) BRAIN: H32: FIXED DENS
HART Menu Path:
Device root menu▶Detailed setup▶Process variables▶Density▶Density fixed value
Display Menu Path:
Device setup▶Detailed setup▶Pro var▶Density▶Fixed density
Set the parameter as “0.0” above menu.

(d) BRAIN: C30: PV FLOW SEL
HART Menu Path:
Device root menu▶Detailed setup▶Process variables▶PV flow select
Display Menu Path:
Device setup▶Detailed setup▶Pro var▶Density▶PV flow select
Select “Mass” above menu.

An alarm, which was set at “Analog Output 1”, is generated and appeared at the result of above work.

2.2.7 Repair and Replacement

It is necessary for user to have adequate bypass line in order to accommodate repair work of this product when process is running.
Contact YOKOGAWA for the detected failure on this product.
To replace this product, it is necessary to follow procedure described in installation manual as listed in Table 1.1.
Replacement work for this product should be done by trained personnel.

2.2.8 Startup Time

This product generates a valid signal within 3 seconds when its damping time constant is set as 0.1 seconds.

2.2.9 Firmware Update

The user will not be required to carry out any firmware updates.
When its updates work is required, it must be carried out at YOKOGAWA.

2.2.10 Reliability Data

Refer to the FMEDA report (YEC 16/03-009 R002 V3R3) for failure rates and failure modes. The FMEDA Report can be downloaded from the website below.
Website address: https://www.yokogawa.com/library/

The device is capable of applying up to SIL 3 in a redundant configuration (HFT=1, 2) (PFDavg calculation of the entire safety instrumentation function according to the SIL to be applied is required).

When using the transmitter of this flowmeter in a redundant configuration, the use of a common cause factor (β-factor) of 5% is suggested.
If the owner-operator of the plant would institute common cause failure training and more detailed maintenance procedures for avoiding common cause failure, the β-factor of 2% would be applicable.

2.2.11 Lifetime Limits

The expected lifetime of this product is 10 years. The reliability data listed the FMEDA report is only valid for this period. The failure rates of this product may increase sometime after this period. Reliability calculations based on the data listed in the FMEDA report for its lifetimes beyond 10 years may yield results that are too optimistic. Product use can continue at the user's responsibility, but the calculated SIL may not be achieved.

2.2.12 Environmental Limits

The environmental limits on this product are specified in the general specifications as listed in Table 1.1.

2.2.13 Application Limits

The application limits on this product are specified in this manual. If it is used outside of the application limits, the reliability data listed in Subsection 2.2.10 becomes invalid.

2.3 Definitions and Abbreviations

2.3.1 Definitions

● Safety

Definition	Contents
Safety	Freedom from unacceptable risk of harm.
Functional Safety	The ability of a system to carry out the actions necessary to achieve or to maintain a defined safe state for the equipment/machinery/plant/apparatus under control of the system.
Basic Safety	The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition.

● Verification

Definition	Contents
Verification	The demonstration for each phase of the life-cycle that the (output) deliverables of the phase meet the objectives and requirements specified by the inputs to the phase. The verification is usually executed by analysis and/or testing.
Validation	The demonstration that the safety-related system(s) or the combination of safety-related system(s) and external risk reduction facilities meet, in all respects, the Safety Requirements Specification. The validation is usually executed by testing.
Safety Assessment	The investigation to arrive at a judgment based on evidence of the safety achieved by safety-related systems.

Further definitions of terms used for safety techniques and measures and the description of safety-related systems are given in IEC 61508-4.

2.3.2 Abbreviations

Definition	Contents
FMEDA	Failure Mode, Effects and Diagnostic Analysis
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SLC	Safety Lifecycle

Revision Information

- Title : ADMAG TI Series AXG/AXW Magnetic Flowmeter Safety Manual
- Manual No. : IM 01E21A21-02EN

Edition	Date	Page	Revised Item
1st	June 2017	—	New publication
2nd	Feb. 2022	1 2 5 6 8 —	Revise Table 1.1 Document title and No. Add IMPORTANT 2.2.5 Add and Revise the explanation 2.2.6 Add and Revise the explanation 2.2.7, 2.2.10 and 2.2.11 Add and Revise the explanation Delete SIL declaration and FMEDA report
3rd	Mar. 2023	1 4	Add edition number toTable 1.1 Update the Version List for Hardware and Software
4th	Jun. 2023	8	Changed FMEDA Report
5th	Mar. 2024	4 5 5 6 9	2.1 Add Indicator Revision 2.2.4 Add the explanation Table 2.2.1 Add Display menu path 2.2.6 Add the explanation 2.2.10 Changed FMEDA Report
6th	Feb.2025	4 6 7 9	2.1 Add Main Revision 2.2.5 Add the Note 2.2.6 Change Proof Test Coverage 2.2.10 Changed FMEDA Report
7th	Jan. 2026	1 2 4 9	Table 1.1 Add Document title Note Add Nominal size 450 mm 2.1 Add Main Revision 2.2.10 Changed FMEDA Report