Safety Manual

Models MT3809G
Metal Tube Variable Area Flowmeters

BROOKS® INSTRUMENT

Beyond Measure

Contents

Section 1 Introduction
Introduction 3
Terms and Abbreviations 3
Acronyms 4
Product Support 4
Related Literature 4
Reference Standards 5

Section 2 Product Description
Product Description 6
Hardware and Software Versions 8

Section 3 Designing a SIF Using a Manufacturer Product
Safety Function 9
Environmental Limits 9
Application Limits & Restrictions 9
Design Verification 10
SIL Capability 10
Systematic Integrity 10
Random Integrity 10
Safety Parameters 11
Connection of the MT3809G w/4-20mA Output to the SIS Logic Solver 11
General Requirements 11

Section 4 Installation and Commissioning
Installation 12

Section 5 Operation and Maintenance
General 13
Proof Test Without Automatic Testing 13
Repair and Replacement 13
Useful Life 14

Warranty, Local Sales/Service Contact Information .... Back Cover

Tables
1-1 Terms and Abbreviations 3
1-2 Acronyms 4
5-1 Recommended Proof Test 13

Figures
2-1 Inductive Alarm Switches Options with SIS 7
2-2 Transmitter w/ 4-20 mA Analog Output Options with SIS 7
3-1 Low and High Flow Inductive Alarm Setting 9

Introduction

This Safety Manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) utilizing the MT3809G. This manual provides necessary user information and requirements for meeting the IEC 61508 and/or IEC 61511 functional safety standards.

Terms and Abbreviations

Table 1-1 Terms and Abbreviations

Term	Definition
Safety	Freedom from unacceptable risk of harm
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
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
Safety Assessment	The investigation to arrive at a judgment - based on evidence - of the safety achieved by safetyrelated systems
Element	part of a subsystem comprising a single component or any group of components that performs one or more element safety functions
FailSafe State	state of the process when safety is achieved; State where the output exceeds the user defined threshold.
Fail Safe	Failure that causes the MT3809G to go to the defined failsafe state without a demand from the process.
Fail Dangerous	Failure that does not permit the SIF to respond to a demand from the process (i.e. being unable to go to the defined failsafe state).
Fail Dangerous Undetected	Failure that is dangerous and that is not being diagnosed by automatic testing.
Fail Dangerous Detected	Failure that is dangerous but is detected by automatic testing.
Fail Annunciation Undetected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic and is not detected by another diagnostic.
Fail Annunciation Detected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic or false diagnostic indication.
Fail No Effect	Failure of a component that is part of the safety function but that has no effect on the safety function.
Low demand mode	Mode where the safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is no greater than one per year and no greater than twice the proof test frequency.
High demand mode	Mode where the safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is greater than one per year or greater than twice the proof test frequency.
Continuous Mode	Mode where the safety function maintains the EUC in a safe state as part of normal operation.

Acronyms

Table 1-2 Acronyms

Acronym	Definition
EUC	Equipment Under Control
FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance
MOC	Management of Change. These are specific procedures to follow for any work activities in compliance with government regulatory authorities or requirements of a standard.
PFDavg	Average Probability of Failure on Demand
PFH	Probability of Failure per Hour
SFF	Safe Failure Fraction, the fraction of the overall failure rate of an element that results in either a safe fault or a diagnosed dangerous fault.
SIF	Safety Instrumented Function, a set of equipment intended to reduce the risk due to a specific hazard (a safety loop).
SIL	Safety Integrity Level, discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems where Safety Integrity Level 4 is the highest level and Safety Integrity Level 1 is the lowest.
SIS	Safety Instrumented System – Implementation of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).

Product Support

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first-class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration. The primary standard calibration equipment to calibrate our flow products is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards. Visit www.BrooksInstrument.com to locate the service location nearest to you.

Related Literature

Hardware Documents:

- Installation-Manual-MT3809G-MT3810G – Brooks Instrument Models MT3809G and MT3810G Metal Tube Variable Area Flowmeters Instruction and Operation Manual
- Data-Sheet-MT3809G – Brooks Instrument MT3809G Series Metal Tube Variable Area Flowmeters Data Sheet

Guidelines/References

- Practical SIL Target Selection – Risk Analysis per the IEC 61511 Safety Lifecycle, ISBN 978-1-934977-03-3, exida
- Control System Safety Evaluation and Reliability, 3rd Edition, ISBN 978-1-934394-80-9, ISA
- Safety Instrumented Systems Verification, Practical Probabilistic Calculations, ISBN 1-55617-909-9, ISA

Reference Standards

Functional Safety:

- IEC 61508:2010 Functional safety of electrical/electronic/ programmable electronic safety-related systems
- IEC 61511:2016 Functional Safety – Safety Instrumented Systems for the Process Industry Sector

Product Description

The MT3809G Metal Tube Variable Area Flowmeter is an instrument used to measure the flow rate of liquids and gases. Its operation is based on the variable area principle, where flow raises a float in a tapered tube increasing the area for passage of the flow. The float will reach a stable position when the force exerted by the flowing fluid + the buoyancy equals the gravitational force. A change in flow rate upsets this force balance and will move up or down the float until it again reaches a position where the forces are in balance.

Flowrate indication is provided by means of magnetic coupling where a magnet, encapsulated in the float, is coupled to a rotatable magnet located in the rear of the indicator, thus turning the dial indicator mounted on the meter.

One or more electronic limit switches (Inductive Alarms) can be installed in the indicator housing to allow signaling or switching functions on a preset flow value. The limit switch operates as a slot initiator that is inductively actuated by a disc mounted on the pointer shaft. Any flow value can be used for setting the limit value by sliding the initiator along the indicator scale. Minimum setting distance between two limit switches is approximately 40% full scale. The position of the initiator also serves to visually indicate the signaling set value. Settings can be adjusted by removing the indicator cover, loosening, moving and retightening of the alarm indication needle, and replacement of the indicator front cover.

The 4-20mA with HART transmitter is a compact microprocessor device designed to interface directly with the MT3809G. Only the 4-20mA output signal is part of the safety function. HART communication is used for end-user configuration purposes, but it is not part of the safety function.

See Installation and Maintenance Manual for additional setup and configuration details.

Brooks Instrument Models MT3809G equipped with Safety Instrumented System (SIS) Inductive Alarm Switches are marked with code B, C, F, G, K, L, P, Q, T or U on position XV of the instrument model code. For detailed information refer to the Brooks Instrument MT3809G Series Metal Tube Variable Area Flowmeters Data Sheet.

Figure 2-1 Inductive Alarm Switches Options with SIS

XV. Electronics Configuration				
* Relay Power Supply Recommended	A	Indicator only	X	X
	B	Inductive Alarm, 1 Switch*	X	
	C	Inductive Alarm, 2 Switches*	X	
	D	Transmitter, 4-20 mA / HART compatible	X	
	E	Transmitter, 4-20 mA / HART compatible with Pulse Output & Alarm Contacts	X	
	F	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 1 Sw*	X	
	G	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 2 Sw*	X	
	H	Transmitter, 4-20 mA / HART compatible+ LOI (Digital Display)	X	
	J	Transmitter, 4-20 mA / HART compatible with Pulse Output & Alarm Contacts + LOI (Digital Display)	X	
	K	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 1 Sw + LOI (Digital Display)*	X	
	L	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 2 Sw + LOI (Digital Display)*	X	
	M	Foundation Fieldbus Transmitter	X	
	N	Fieldbus Transmitter with Pulse Output & Alarm Contacts	X	
	P	Fieldbus Transmitter with Inductive Alarm 1 Sw*	X	
	Q	Fieldbus Transmitter with Inductive Alarm 2 Sw*	X	
	R	Fieldbus Transmitter + LOI (Digial Display)	X	
	S	Fieldbus Transmitter with Pulse & Alarm Contacts + LOI (Digital Display)	X	
	T	Fieldbus Transmitter with Inductive Alarm 1 Sw + LOI (Digital Display)*	X	
	U	Fieldbus Transmitter with Inductive Alarm 2 Sw + LOI (Digital Display)*	X	

Sample Model Code

I-IV	V	VI	VII	VIII & IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
3809	G	A	B	02	B	F	C	C	3	E	4	C	0	A	B

Brooks Instrument Models MT3809G equipped with Safety Instrumented System (SIS) Transmitter w/ 4-20 mA Analog Output is marked with code D, E, F, G, H, J, K or L on position XV of the instrument model code. For detailed information refer to the Brooks Instrument MT3809G Series Metal Tube Variable Area Flowmeters Data Sheet..

Figure 2-2 Transmitter w/ 4-20 mA Analog Output Options with SIS

XV. Electronics Configuration				
* Relay Power Supply Recommended	A	Indicator only	X	X
	B	Inductive Alarm, 1 Switch*	X	
	C	Inductive Alarm, 2 Switches*	X	
	D	Transmitter, 4-20 mA / HART compatible	X	
	E	Transmitter, 4-20 mA / HART compatible with Pulse Output & Alarm Contacts	X	
	F	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 1 Sw*	X	
	G	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 2 Sw*	X	
	H	Transmitter, 4-20 mA / HART compatible+ LOI (Digital Display)	X	
	J	Transmitter, 4-20 mA / HART compatible with Pulse Output & Alarm Contacts + LOI (Digital Display)	X	
	K	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 1 Sw + LOI (Digital Display)*	X	
	L	Transmitter, 4-20 mA / HART compatible with Inductive Alarm 2 Sw + LOI (Digital Display)*	X	
	M	Foundation Fieldbus Transmitter	X	
	N	Fieldbus Transmitter with Pulse Output & Alarm Contacts	X	
	P	Fieldbus Transmitter with Inductive Alarm 1 Sw*	X	
	Q	Fieldbus Transmitter with Inductive Alarm 2 Sw*	X	
	R	Fieldbus Transmitter + LOI (Digial Display)	X	
	S	Fieldbus Transmitter with Pulse & Alarm Contacts + LOI (Digital Display)	X	
	T	Fieldbus Transmitter with Inductive Alarm 1 Sw + LOI (Digital Display)*	X	
	U	Fieldbus Transmitter with Inductive Alarm 2 Sw + LOI (Digital Display)*	X	

Sample Model Code

I-IV	V	VI	VII	VIII & IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
3809	G	A	B	02	B	F	C	C	3	E	4	C	0	A	B

Hardware and Software Versions

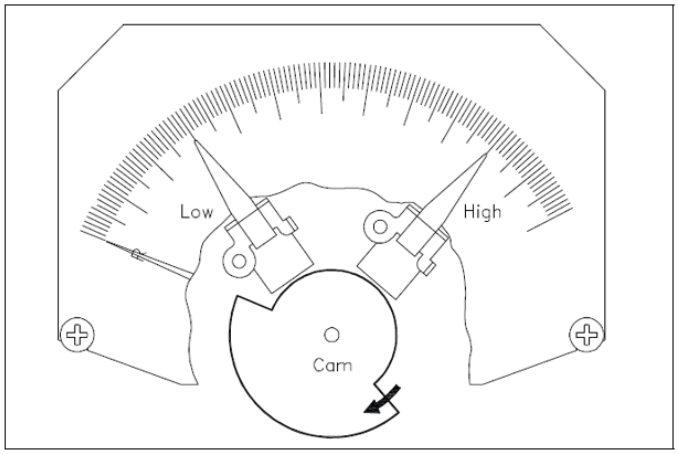
Transmitter, 4 - 20 mA / HART compatible	
Hardware	273Z938AAA Rev. T
Software/Firmware	FW Version 1.02 per Doc. No. 805A052 Rev. A
Transmitter, 4 - 20 mA / HART compatible	
Hardware	SJ3,5-SN (Pepper+Fuchs)

Safety Function

The safety function of the MT3809G Variable Area Flowmeter with Inductive Alarm provides a flowrate alarm indication when the flowrate is above or below a specified trip point within specified accuracy.

When the flow is outside a flow band set by means of the low flow- and high flow inductive alarm switches, a trip-low or trip-high signal will be provided.

Figure 3-1 Low and High Flow Inductive Alarm Setting



The safety function of the MT3809G Variable Area Flowmeter with 420mA Output shall be to provide a flowrate indication within specified accuracy.

For details, please refer to the Brooks Instrument Models MT3809G and MT3810G Metal Tube Variable Area Flowmeters Instruction and Operation Manual.

When internal dangerous faults are detected, the MT3809G Variable Area Flowmeter with 4-20mA Output moves to its fail-safe state.

The MT3809G is intended to be part of a SIF subsystem as defined per IEC 61508 and the achieved SIL level of the designed function must be verified by the designer.

The worst-case diagnostic interval time to complete all diagnostics is one second or less.

The MT3809G can operate in low or high demand modes.

Environmental Limits

The designer of a SIF must check that the product is rated for use within the expected environmental limits. It is very important that the Brooks Instrument MT3809G Flowmeter is installed and operated in accordance with the Brooks Instrument Models MT3809G and MT3810G Metal Tube Variable Area Flowmeters Instruction and Operation Manual. If the use of the Brooks Instrument MT3809G Flowmeter is not in compliance with these instructions and/or operated beyond limits, the SIL capability and reliability data becomes invalid.

Application Limits & Restrictions

The MT3809G Variable Area Flowmeters are rugged, all metal flowmeters offering 2% full scale accuracy. The MT3809G is constructed with stainless steel or various optional high-alloy components for measuring a variety of gas, liquid, and steam applications.

The materials of construction of the MT3809G are specified in the Data Sheet. It is especially important that the designer checks for material compatibility considering on-site chemical contaminants. If the MT3809G is used outside of the application limits or with incompatible materials, the reliability data provided becomes invalid.

Design Verification

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available from www.BrooksInstrument.com. This report details all failure rates and failure modes as well as the expected lifetime. Assumptions made during the FMEDA are listed in the FMEDA report.

The achieved Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) design must be verified by the designer via a calculation of PFDavg or PFH, considering safety architecture, proof test interval, proof test effectiveness, any automatic diagnostics and worst case fault detection interval, average repair time and the specific failure rates of all products included in the SIF. Each subsystem must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements. The exida exSILentia® tool is recommended for this purpose as it contains accurate models for the MT3809G and its failure rates.

If applicable: When using MT3809G in a redundant configuration, a common cause factor of at least 2% should be included in safety integrity calculations.

The failure rate data listed in the FMEDA report are only valid for the useful lifetime of MT3809G. The failure rates will increase sometime after this time period. Reliability calculations based on the data listed in the FMEDA report for mission times beyond the lifetime may yield results that are too optimistic, i.e. the required Safety Integrity Level will not be achieved.

An appropriate MTTR shall be selected based on plant operation and maintenance procedures.

SIL Capability

Systematic Integrity

The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 2. 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 the statement without “prior use” justification by the end user or diverse technology redundancy in the design.

Random Integrity

The MT3809G w/4-20mA Output is a Type B Element and meets the requirement for Route 2H. Therefore, the 3809G Variable Area Flowmeter meets the hardware architectural constraints for up to SIL 2 with an HFT = 0.

The MT3809G w/Inductive Alarm is a Type A Element and meets the requirement for Route 2H. Therefore, the 3809G Variable Area Flowmeter meets the hardware architectural constraints for up to SIL 2 with an HFT = 0.

When the SIF consists of many components the SIL must be verified for the entire assembly using failure rates from all components. This analysis must account for any hardware fault tolerance and architecture constraints.

Safety Parameters

For detailed failure rate information refer to the Failure Modes, Effects and Diagnostic Analysis Report (FMEDA) for the MT3809G.

See FMEDA reports below for details:

- BRO 11-06-060 R001 V1R2 3809 VA Flowmeter FMEDA, 05/24/2013
- BRO 11-06-060 R002 V1R2 3809 VA Flowmeter FMEDA, 05/24/2013

Connection of the MT3809G w/4-20mA Output to the SIS Logic Solver

The MT3809G w/4-20mA Output is connected to the safety rated logic solver and the application program in the logic solver is constructed in such a way that Fail High and Fail Low failures are detected regardless of the effect, safe or dangerous, on the safety function.

General Requirements

The system's response time shall be less than the process safety time. MT3809G w/4-20mA Output will move to its safe state in one second or less under specified conditions.

The 4-20mA output signal update time is 250ms.

All SIS components including the MT3809G must be operational before process start-up.

User shall verify that the MT3809G is suitable for use in safety applications by confirming the MT3809G's nameplate is properly marked.

Personnel using and performing maintenance and testing on the MT3809G shall be competent to do so.

Results from the proof tests shall be recorded and reviewed periodically.

The MT3809G Variable Area flowmeter is in compliance with NAMUR NE 43 Version: 03.02.2003 recommendation. See Declaration.

According to NAMUR NE 43 recommendation, a field device must have at least one of two current signal ranges available for failure information CA. The current signal for failure information (CA) should be $0 \leq CA \leq 3.6$mA for lower current range and $CA \geq 21.0$mA for upper current range.

Brooks 3809G Transmitter used on 3809G series meters is designed to comply with the upper current range $CA \geq 21.0$mA and hence is in compliance with NAMUR NE 43 recommendation.

The default factory setting for the failure signal is not set (the default is – continue to track signal).

The MT3809G w/4-20mA Output is connected to the safety rated logic solver and the application program in the logic solver is constructed in such a way that Fail High and Fail Low failures are detected regardless of the effect, safe or dangerous, on the safety function.

Loop Current / Current Consumption Range: 3.8 to 22.0 mA.

Installation

The MT3809G must be installed per standard practices outlined in the Installation Manual.

The environment must be checked to verify that environmental conditions do not exceed the ratings.

The MT3809G location and placement must be accessible for physical and/or visual inspection and allow for manual proof testing.

General

To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.

For details, please refer to the Brooks Instrument Models MT3809G and MT3810G Metal Tube Variable Area Flowmeters Instruction and Operation Manual.

Proof Test Without Automatic Testing

The objective of proof testing is to detect failures within MT3809G that are not detected by any automatic diagnostics of the system. Of main concern are undetected failures that prevent the safety instrumented function from performing its intended function.

The frequency of proof testing, or proof test interval, is to be determined in reliability calculations for the safety instrumented functions for which MT3809G is applied. The proof tests must be performed at least as frequently as specified in the calculation in order to maintain the required safety integrity of the safety instrumented function.

The following proof test is recommended. The results of the proof test should be recorded and any failures that are detected and that compromise functional safety should be reported to support. brooksinstrument.com.

The suggested proof test consists of a two-point calibration check per table below.

The suggested proof test will detect 92.1% of possible DU failures in the MT3809G flow meter w/Inductive Alarm configured with Trip High application and 95.0% of possible DU failures in the MT3809G flow meter w/Inductive Alarm configured with Trip Low application.

The suggested proof test will detect 68.5% of possible DU failures in the MT3809G flow meter w/4-20mA Output configured with Trip High application and 55.3% of possible DU failures in the MT3809G flow meter w/4-20mA Output configured with Trip Low application.

Table 5-1 Recommended Proof Test

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip.
2	Perform a twopoint calibration of the transmitter over the full working range.
5	Remove the bypass and otherwise restore normal operation.

The person(s) performing the proof test of a MT3809G should be trained in SIS operations, including bypass procedures, valve maintenance and company Management of Change procedures.

Repair and Replacement

Repair procedures in the MT3809G Installation, Operation and Maintenance manual must be followed.

Useful Life

The useful life of the MT3809G is 15 years.

See FMEDA reports below for details:

- BRO 11-06-060 R001 V1R2 3809 VA Flowmeter FMEDA, 05/24/2013
- BRO 11-06-060 R002 V1R2 3809 VA Flowmeter FMEDA, 05/24/2013

LIMITED WARRANTY
Visit www.BrooksInstrument.com for the terms and conditions of our limited warranty.

BROOKS SERVICE AND SUPPORT

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration. The primary standard calibration equipment to calibrate our flow products is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required.
For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

SEMINARS AND TRAINING
Brooks Instrument can provide seminars and dedicated training to engineers, end users and maintenance persons. Please contact your nearest sales representative for more details.

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

TRADEMARKS
Brooks is a trademark of Brooks Instrument, LLC
All other trademarks are the property of their respective owners.

PATENTS
Patents Pending: Please visit BrooksInstrument.com/Fieldbus for a complete list.

Safety-Manual-MT3809G-EN/541B193AAG/B/2026-11

Global Headquarters
Brooks Instrument
407 West Vine Street
Hatfield, PA
19440-0903 USA

Toll-Free (USA): 888-554-FLOW
T: 215-362-3500
Brooks-Mktg@BrooksInstrument.com

A list of all Brooks Instrument locations and contact details can be found at www.BrooksInstrument.com

©Copyright 2026 Brooks Instrument, LLC All rights reserved. Printed in U.S.A.

BROOKS® INSTRUMENT
Beyond Measure