PROCESS AUTOMATION

Combustion Instrumentation

User Manual

Uvisor™ SF910i Integrated SafeFlame Scanner

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The crossed–out wheeled bin symbol on the product and accompanying documents means that used electrical and electronic equipment (WEEE) should not be mixed with general household waste. If you wish to discard electrical and electronic equipment (EEE), please contact your dealer or supplier for further information.

Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

Trademarks

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About This User Manual

Scope

This manual provides technical, maintenance, and set-up informations for the ABB Uvisor™ SF910i Integrated SafeFlame Scanner.

This manual describes the product SF910i Integrated SafeFlame Scanner itself, without considering that it is usually sold as part of a complete higher-level assembly (including fiber optic extension and/or mounting and purge air/cooling accessories).

Intended User

This instruction manual can be used by anyone responsible for the installation and operation of the SF910i.

The user must be familiar with the basic operating procedures of the boiler or furnace where the SF910i will be used.

Document Structure

This manual provides an overview of the major hardware components of the SF910i. It describes in detail the procedures to install and operate the unit.

Later sections provide details about configuration and tuning activities.

Engineering drawings are included at the end of the manual in a reduced page size. These drawings can also be provided in full size upon request.

Warning, Caution, Information, and Tip Icons

This User Manual includes **Warning**, **Caution**, and **Information** where appropriate to point out safety related or other important information. It also includes **Tip** to point out useful hints to the reader. The different icon types found in this document are presented below:

Electrical warning icon indicates the presence of a hazard that could result in *electrical shock*.

Warning potential electronstatic charging hazard - Hazard can only be cleaned with a damp cloth.

Warning icon indicates the presence of a hazard that could result in *personal injury*.

Caution icon indicates an important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard that could result in *corruption of software or damage to equipment/property*.

Information icon alerts the reader to pertinent facts and conditions.

Tip icon indicates advice on, for example, how to design the project or how to use a certain function.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, fully comply with all **Warning** and **Caution** notices.

SF910i Firmware Revisions

When this manual is reviewed, the current firmware revision of the SF910i will be B03.

If SF910i is already installed and it is working properly, the user may not need to update to newer versions. In this case, continue to refer to the previous version of this manual to operate and configure Flame Scanner.

For any doubt or question, contact the local ABB dealer to get the right suggestion or write to the tech support hot-line (see Technical Support).

Flame Explorer Software Tool Revision

When this manual is last reviewed, the current revision of the Flame Explorer software tool will be 7.0.0.

Flame Explorer 7.0.0 is used for SF910i, and is compatible with SF810INT Flame Scanner series firmware version ≥ C3.004.

Connecting Flame Explorer to SF910i devices loaded with lower firmware release index might results in mismatching data displayed.

Operating Temperatures

The operating temperature range of the SF910i is reported in Appendix A and is printed on the product label.

For units with ATEX/IECEx certification, the ATEX/IECEx label might report another temperature range, and this is not the temperature range of the whole product. It is the temperature range for which the Ex certification of the enclosure is valid.

Safety Summary

Equipment Environment

All components, whether in transportation, operation, or storage must be in a non-corrosive and static-electricity-safe environment.

Warning potential electronstatic charging hazard - Hazard can only be cleaned with a damp cloth.

Electrical Shock Hazard during Maintenance

Disconnect power or take precautions to ensure that contact with energized parts are avoided when servicing. SF910i is powered at a safe voltage ($24V_{DC}$) and has no dangerous internal voltages but the electrical connections of the relay terminal (J1) can be connected up to $50V_{AC}$ and, if exposed, present a shock hazard that can cause injury or death.

Quick Release Connector and Hazardous Area

SF910i (quick release connector versions), when installed in hazardous area, cannot be dis-connected under power. The plug is equipped with a locking allen screw that must be unscrewed before releasing the connector.

Ex certified products (Refer to datasheet *4JZZ438101A0001 SF910i Flame Scanner Uvisor* for detailed product coding) must be handled as in *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

Ex Certified Fiber Optic Versions

IECEx/ATEX certified SF910i for fiber optic versions (Refer to *EC-DOC-G018PCL402*) must be mandatorily used together with the ABB IECEx/ATEX certified fiber optic. Otherwise, the certification is invalidated.

Ex certified products (Refer to datasheet for detailed product coding) must be handled as in *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

Do not disassemble or remove the electronics from the enclosure.

It is absolutely forbidden to un-tight/remove the two screws that hold the electronic boards during operation.

There are no configurable/serviceable parts inside.

Flame Failure Response Verification

For safety reasons, the user is requested to prove the Flame Failure Response Time (FFRT) of the SF910i under any burner load/fuel conditions and under any selected file of parameters. For EN298 application, the user need to set the **DELAY DROPOUT** parameter to <= 0.9s to fulfill the requirement of EN 298 that the FFRT shall not exceed one second. If there are further adjustments of the flame detector (DELAY DROPOUT), do not cause the time to rise above one second.

Installations shall comply with the requirements of the local codes and jurisdictional authorities.

For instance, in U.S.A., the installations shall comply with the requirements of the relevant edition of the National Electrical Code (NFPA 85).

Do not open when an explosive atmosphere is present.

“Ex” certified products (Refer to datasheet for detailed product coding) in which “Ex” classified area must not be opened when an explosive atmosphere is present.

Nomenclatures, Part Numbers, and Related Documentation

The below table shows a preview of the main items related to the Uvisor™ SF910i product. For a complete list of part numbers and ordering codes (including cables, replacement parts, and so on), refer to SF910i data sheet.

Table: Nomenclatures and Part Numbers for Most Important Items

Nomenclature/Item	Description	Part Number	Related Document
Uvisor™ SF910i	Integrated SafeFlame Scanner	SF910i-xx-xx-xx-xx-xx (see Table 1.1 for the meaning of all five suffixes)	SF910i User Manual (this manual)
Flame Explorer	Software tool for configuration and monitoring	8VZZ005308	*SF910i Flame Explorer User Manual (8VZZ005308)*
LOS mounting accessories	Line Of Sight mounting accessories	Not a single part number. Refer to datasheet	See Appendix E
FOC mounting accessories	Fiber Optic Cable extension and accessories	Not a single part number. Refer to datasheet	See Appendix E

Compatibility with Previous ABB Flame Detection Products

The below table shows the compatibility issues with previous products of Uvisor™, FAU800, and DFS/SafeFlame families. The table shows, if the SF910i unit can be installed as a replacement of the system made of previous flame scanners and Flame Analysis Units/Multi-flame scanners.

Here it is considered as a replacement of an existing scanner plus its FAU800 or MFD unit with the SF910i Integrated SafeFlame Scanner. Consider that it is not a one-to-one replacement (see following note). Changes in the wiring harness are required in this case.

SF910i Integrated SafeFlame Scanner is a “single flame unit”. If the user is planning to replace one MFD and two flame scanners (or one FAU800 and two flame scanners) aimed at two different flames, then the user must use two SF910i units.

For a one-to-one replacement of an existing scanner with a SF810 (conventional) scanner, refer to SF810 User Manual.

Table: Compatibility with Previous Products

Previous Models	Part Number	Compatibility	SF910i Part Number
One UR600-IR (Line Of Sight) + MFD	Part number EC-BOM-G009HLA101 + EC-BOM-G009HLA012	Yes	SF910i -LOS-IR-X(1)_(2)_(3)
One UR600-IR (Fiber Optic Cable) + MFD	EC-BOM-G009HLA101 + 86610-S-210XXXX + EC-BOM-G009HLA012	Yes (External guide pipe is compatible, inner fiber is not)	SF910i -FOC-IR-X(1)_(2)_(3)
One UR600-UV (Line Of Sight) + MFD	EC-BOM-G009HLA102 + EC-BOM-G009HLA012	Yes	SF910i -LOS-UV-X(1)_(2)_(3)
One UR600-UVEXT (Fiber Optic Cable) + MFD	EC-BOM-G009HLA103+ 86610-S-220XXXX + EC-BOM-G009HLA012	Yes (Extended guide pipe is compatible, inner fiber is not)	SF910i -LOS-UV-X(1)_(2)_(3)
One UR450 + MFD	EC-BOM-G009HLA002 + EC-BOM-G009HLA012	Yes (Requires adapting flange)	SF910i -LOS-UV-X(1)_(2)_(3)
One UR460 (Direct View) +MFD	EC-BOM-G009HLA004 84531-S-3300000 + EC-BOM-G009HLA012	Yes (Requires adapting flange)	SF910i -LOS-UV-X(1)_(2)_(3)
One UR460 (Fiber Optic Cable) + MFD	EC-BOM-G009HLA004 84531-S-3280000 or 84531-S-3290000 + EC-BOM-G009HLA012	Yes (Extended guide pipe is compatible, inner fiber is not)	SF910i -LOS-UV-X(1)_(2)_(3)
One SafeFlame Wall-mount UV scanner, cam lock + FAU800	C10-97335 + C10-11010	Yes (Requires mechanical adapter plus change of connector in the existing cable)	SF910i -LOS-UV-X(1)_(2)_(3)
One SafeFlame IR (or full spectrum) scanner (through the wind box, cam lock, FOC) + FAU800	C10-922xxx + C10-11010	Yes (Existing guide pipe is compatible, requires flange adapter)	SF910i -FOC-IR-X(1)_(2)_(3)

(1). See Table 1.1 for the meaning of all suffixes of the part number.
(2). Owing to the change of architecture when replacing the existing scanners and analysis units with a single “integrated” unit, it requires wiring changes.
(3). Both connectorized versions need a wiring change too. The new connector is not compatible with the previous SafeFlame Scanner connector to be replaced. Refer to Table 3.2.

Technical Support

ABB provides full assistance in supporting the operation and repair of its products. Support requests must be addressed to the ABB reference office and person as indicated in the supply documentation. Technical support can be obtained via e-mail writing to CN-CI.SupportCenter@abb.com.

Spare Parts and Ordering Information

In case of need of spare parts ordering, the following informations are requested:

1. System description, part and code number, and quantity.
2. Model/version (all suffixes of the part number) and serial number.
3. Reference to the user manual and page number, where the failing device is described (if applicable).

Information and Training

ABB is running formation courses dedicated to ABB product related to operation, maintenance, and installation skills. Such training courses can be organized also at the client site on request.

Further information can be requested to ABB references at ABB offices.

Technical Documentation

Additional copies of the present manual can be ordered to ABB sales offices.

1 Introduction

1.1 Integrated SafeFlame Scanner

Uvisor™ SF910i is an instrument designed to detect and analyze flames easily and reliably. It takes advantage of the latest technologies available to make flame detection and analysis as cost-efficient as possible, while retaining ABB's rock-solid reputation for reliability.

The main characteristic of the SF910i is its "Integrated" structure. All the electronics from the sensor(s) to the wiring terminals (or quick release connector), including the processing unit, the relays, and the communication ports are contained in the scanner enclosure.

For SF910i, other important capability is its one communication line. The communication protocol is the simpler "MODBUS" protocol for greater flexibility.

SF910i is easy to install and straightforward to configure thanks its software engineering tool Flame Explorer™ and flexible to operate.

SF910i -*- PYR is the innovative approach of ABB to meet the stringent requirement of safety and the challenging demand of qualitative information for a combustion monitoring system.

SF910i -*- PYR flame scanner bases on the proven rock solid technology of the standard SF910i flame scanner series and it features the sensing element for the analysis unit to compute the flame temperature measurement in real time.

SF910i -*- PYR flame scanner offers a valuable input to improve the total NOx reduction control strategy by monitoring the local combustion process.

Flame Scanner SF910i is a simple "flame detector device" (but not an "independent flame detector device") as part of a higher-level burner control system. Flame scanners relay output will connect to customer's BMS (Burner Management System), MFT (Master Fuel Trip), or DCS/SIS systems. Inside these systems, before shutting off/driving valves, there are 3oo4 or 1oo2 voting logic between several redundancy scanners output relays.

1.2 Purpose of a Flame Detection System

ABB Flame Detection System is a crucial part of a boiler or furnace safety system.

Its primary function is to identify potentially dangerous “Flame-Out” conditions on ignition flame and on the main flame.

Because of the flame detection system importance, it must be extremely reliable and rugged.

ABB has provided reliable flame detection systems since 1966. This product is ABB’s latest offering, representing 50 years of flame detection experience.

1.3 Split (Conventional) Vs Integrated Architecture

1.3.1 Conventional

Conventional architecture is shown in Figure 1.1 and Figure 1.2.

The conventional flame scanner system is made of three parts:

– Flame Scanner head

– Processing electronics

– Cable connecting the two

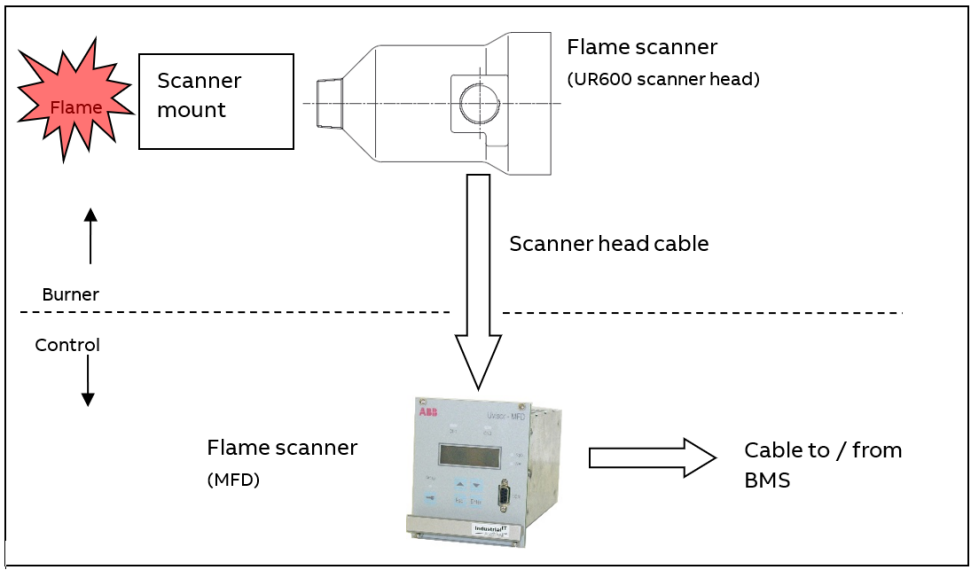


Figure 1.1: Conventional Architecture (showing ABB Uvisor™ UR600 and MFD Products)

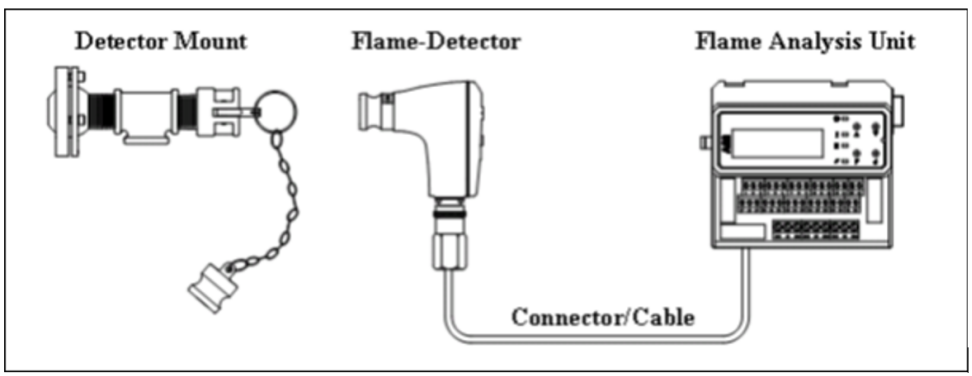


Figure 1.2: Conventional Architecture (showing ABB SafeFlame UV and FAU800 Products)

1.3.2 Integrated

Integrated architecture is shown in Figure 1.3. Flame Scanner consists of a single product, the SF910i.

Integrated architecture has several advantages over the conventional one:

- Reduced part count
- Lower system cost
- Lower installation cost
- No dedicated cabinets required in control room
- Reduced cabling
- Reduced use of natural resources

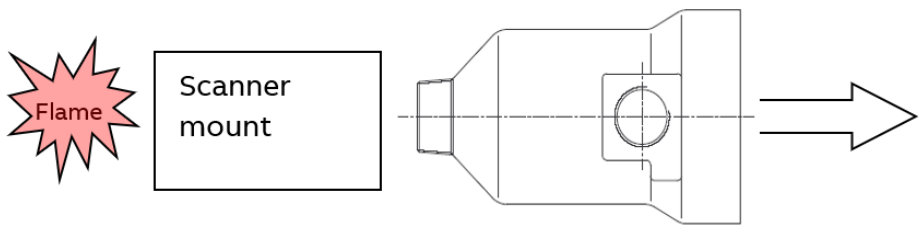


Figure 1.3: Integrated Architecture (showing ABB SF910i Integrated SafeFlame Scanner)

Scanner Mount

ABB supplies the flame scanner mounting hardware for the burner front. The mounting hardware is specifically constructed for the flame scanner and the operating environment.

Flame Scanner

Flame Scanner is mounted on the hardware on the burner/wind box. SF910i Integrated SafeFlame Scanner not only converts energy from fuel combustion to an electrical signal, but also analyzes and measures the flame. Flame safety contacts, analog output, redundant serial communication interfaces, digital input for fuel, or load switching can all be connected to the Burner Management System.

ABB offers several different Flame Scanners that are uniquely suited to specific operating environments.

Cable

A cable connects the Flame Scanner to a Burner Management System. As with the mounting hardware, ABB has the suitable cable for the flame scanner. Standard cable can also be used, see the relevant information on Appendix F.

Connector or Terminals

ABB SF910i Integrated SafeFlame Scanner comes in a variety of versions. The standard version comes with terminals. A quick-release connector version is available, as well as a connectorized cable. Refer to Table 1.1 for more details.

Block Diagram

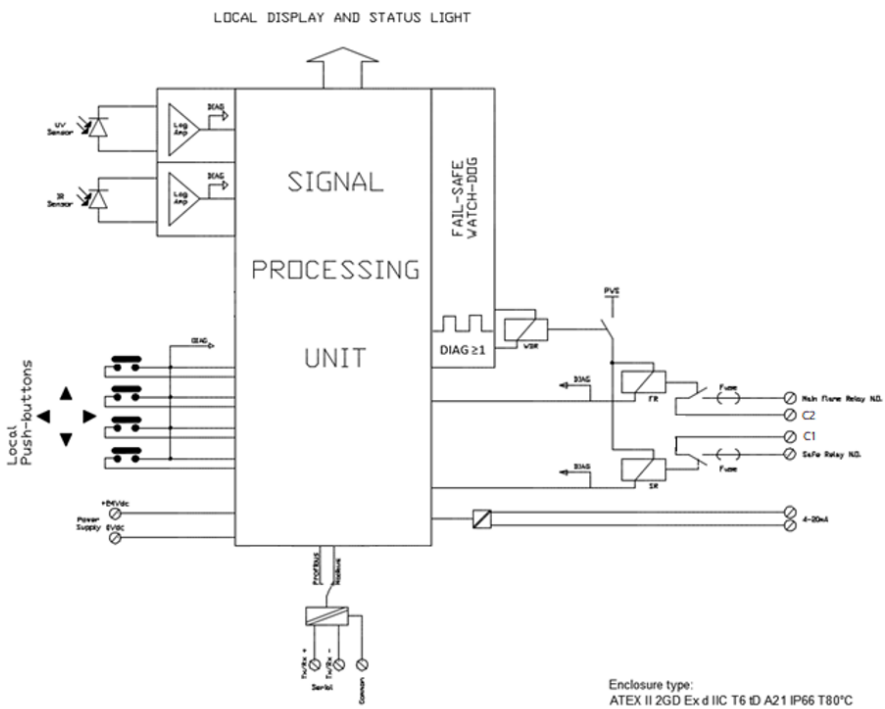


Figure 1.4: SF910i Functional Block Diagram

1.3.3 Versions

According to the fuels type and burner arrangement, Flame Scanner SF910i is assembled with diverse sensor type (IR; UV; UVIR; PYR), and mounted to the burner with different means to gather the flame:

– LOS (Line Of Sight) for direct view to the target flame.

– FOC (Fiber Optic Cable) for indirect view of the target flame through optical cable.

The wiring methods available allow for quick plug connectorized cable, versions “Q” and “QC” or for direct cable connection, version “T” and “TL”.

Refer to Table 1.1 for complete SF910i product coding.

Refer datasheet for a complete listing of ordering codes.

Table 1.1: SF910i Type Product Coding

SF910i Type Product Coding				
	x^1	x^2	x^3	x^4
SF910i	LOS (Line Of Sight) FOC (Fiber Optic Cable)	IR (Infrared Sensor) UV (Ultraviolet Sensor) UVIR (UV IR Dual Sensor) PYR (Dual IR Sensor)	T (Direct wiring - Ex) TL (Direct wiring - IP66) QC (Quick plug in - Ex) Q (Quick plug in - IP66) QE (Quick plug in) TX (Direct wiring - Ex - SS316 case)	XXXX (Reserved for other characteristics, with letters or numbers or the combination, up to 4, which are not relevant to Ex-proof protection mode. For example, “L” means lite version and “S” means sweden manufactured products)

Ex version of the FOC assemblies (that is, SF910i-FOC-X2-T or SF910i-FOC-X2-QC) must be mandatory assembled with ABB Ex certified fiber optic. Refer ABB fiber optic cable part numbers:

– EC-DWG-G041MEC020
– EC-DWG-G041MEC021
– EC-DWG-G041MEC022

The minimum length of fiber cable must be one meter.

If otherwise, the Ex product certificate is void.

1.3.4 Fiber Optics

Refer to the product data sheet for a complete listing of fiber optic assemblies and related mounting hardware. SF910i use existed SF810i fiber, aovid to re-create a sets of new fiber names.

Table 1.2: Fiber Optic Cable Assembly - Product Coding

	x^1	x^2	x^3
SF810	FOARE (Fiber optic cable and rigid external guide pipe)	IR (Infrared Sensor)	XXXX

Table 1.2: Fiber Optic Cable Assembly - Product Coding (Continued)

	x[1]	x[2]	x[3]
	FOAFE (Fiber optic cable and flexible external guide pipe) FO (Fiber optic bundle)	UV (Ultraviolet Sensor) UI (UV IR Dual Sensor) G (Glass bundle for IR sensor) Q (Quartz bundle for UV sensor) GQ (Glass and Quartz bundle for UVIR dual sensor)	(Length of the assembly. Refer to Figure 1.5 and Figure 1.6. Base length = 1500 mm) XXXX (Length of the fiber optic bundle. The minimum length of fiber cable can be one meter. Refer to Figure 1.5)

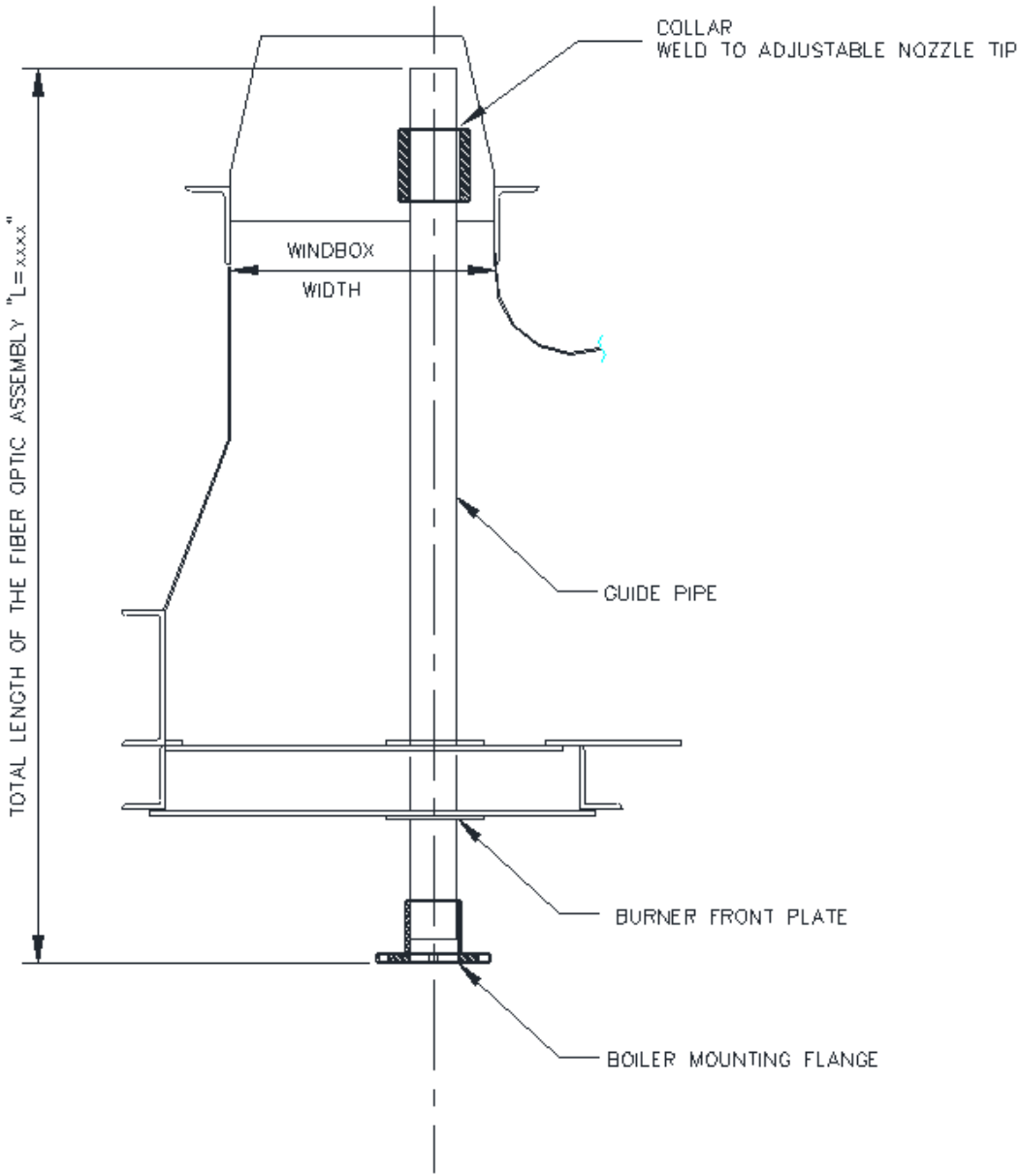


Figure 1.5: Burner Assembly with FOC Guide Pipe

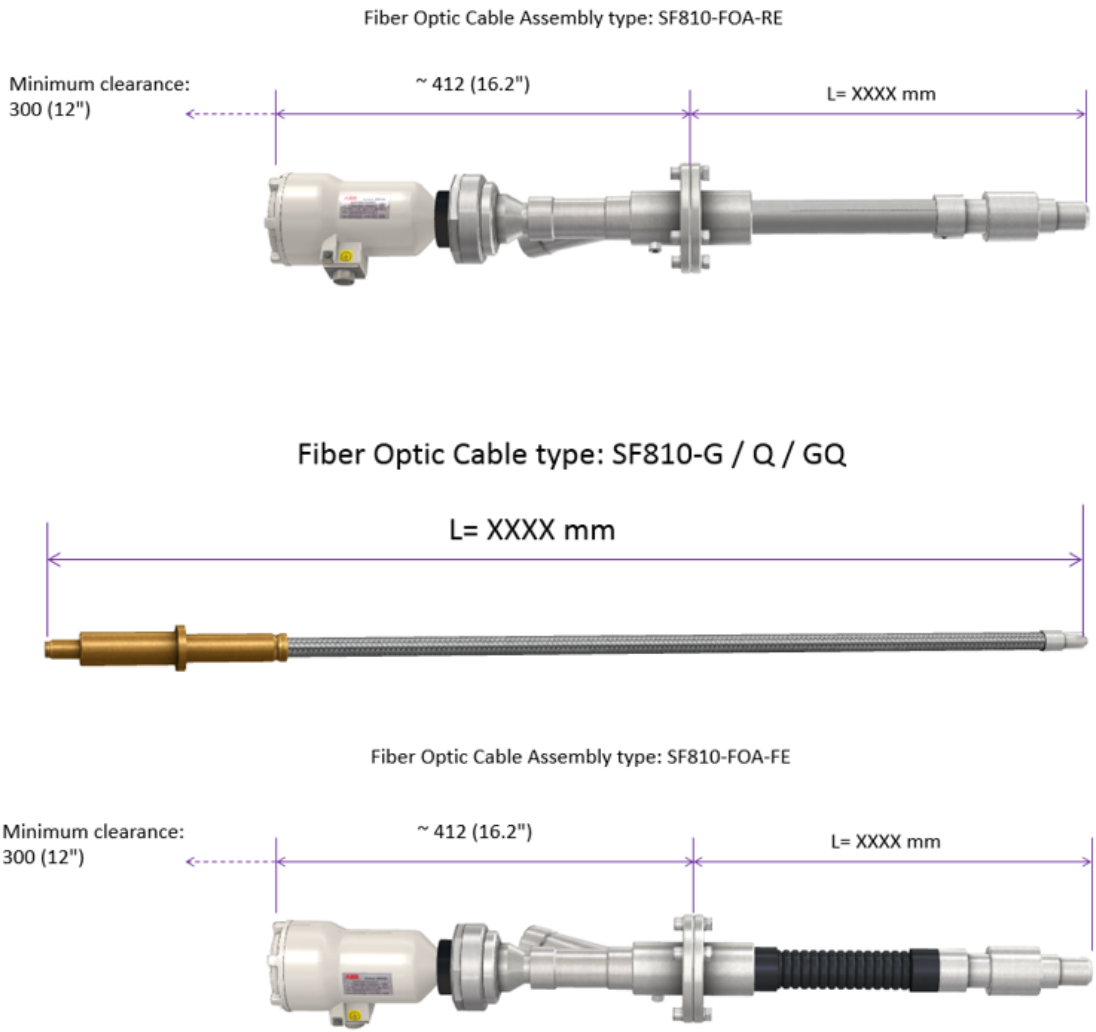


Figure 1.6: Flexible and Rigid Fiber Optic Assemblies

2 Hardware

2.1 Enclosure

SF910i has an explosion-proof (Ex certified) aluminium enclosure.

According to the installation requirements, the following enclosure types are available:

– “FOC” (Fiber Optic Cable) for installation through the burner windbox. This type of enclosure is designed to input the flame’s light signal by means of fiber optic cable.

– “LOS” (Line Of Sight) for installation on burner front plate. This type of enclosure is designed to input the flame’s light signal by optical lens.

– “T/TL” Electrical connection direct wiring to device’s terminal board connection.

– “Q/QC" Electrical connection wiring to device’s quick release multipin connector.

– “X” SS316L made enclosure for high corrosive.

Ex certified products (Refer the datasheet for detailed product coding) must be handled, refer to *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

Figure 2.1: Enclosure

SF910i Flame Scanner is identified with individual product labels, see Figure 2.2 to Figure 2.4 below. Non-Ex versions have only two labels, the product label and the high-level assembly revision level.

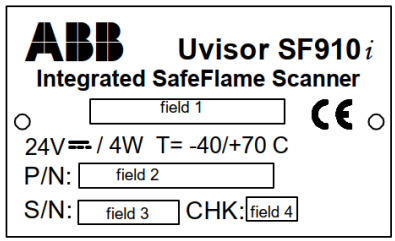


Figure 2.2: Product Label

Figure 2.3: High-Level Assembly Revision Label

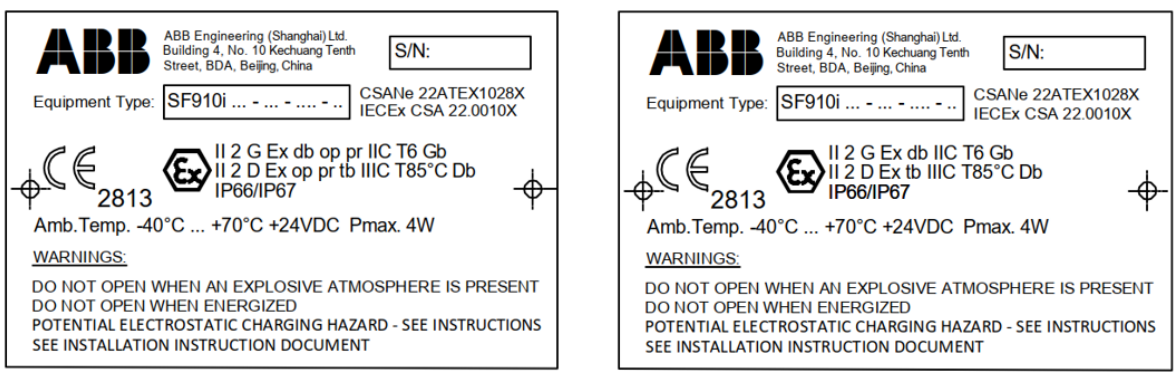


Figure 2.4: Ex Label for Ex Certified Product Only

2.2 Display and Terminations Boards

SF910i electronics is organized in four internal boards part:

- SE, Sensor Electronics, single or dual sensor (one photodiode sensible to either IR or UV)
- CPU board, Signal Processing Electronics
- TB, SF910i Terminal Board (also referred to as ‘ATB’. See Figure 2.5).

– Touchkey/LCD assembly, Touchkey and three status LEDs and LCD display board with plastic supporter

There is no need to access the internal SE and CPU boards. All the accessible parts are located on the TB board and are easily reachable once the rear cover and Touchkey/LCD assembly is unscrewed.

Figure 2.5 shows the location of connectors on the Terminal Board.

In Touchkey/LCD assembly, a LCD display and three status LEDs and four touch-buttons are available for aiming the unit to the target flame and for local setup and tuning. The user can access the touch-button while cover is screwed tightly into the enclosure, and need not to open the cover to operate the button, for example, in explosive environment that cannot allow to open cover.

Check whether the equipment is powered in hazardous area open cover is NOT ALLOWED. Setup and tuning are also available from remote through the Flame Explorer™ configuration tool.

SF910i has no jumpers and no switches to be configured.

All internal configurations are microprocessor-based. Once selected the communication station address (if needed), the configuration can be carried out either locally using the touch-buttons and display or remotely through the serial communication line.

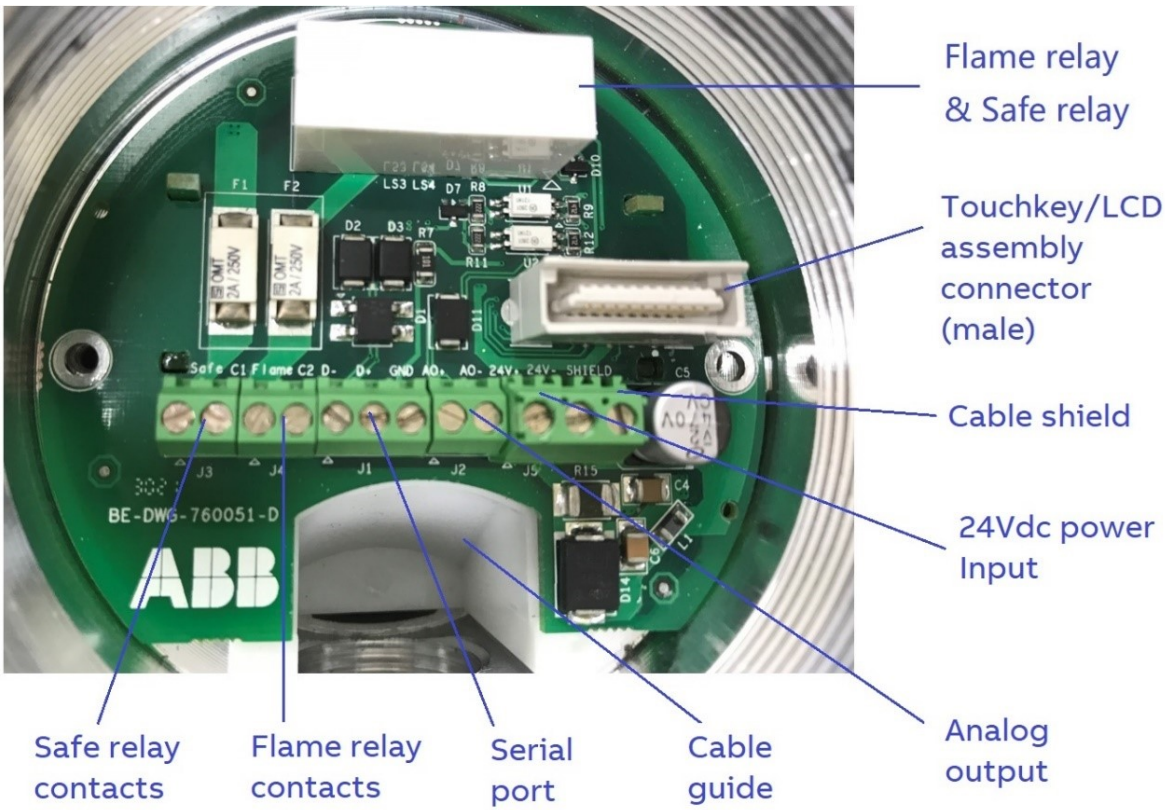


Figure 2.5: Terminal Board of SF910i

2.2.1 Connections

The minimal set of connections that are required to use the SF910i are:

– $24V_{DC}$ power

– Relay contacts

In more complete applications, the user can connect the 4-20mA analog output (and configure the SF910i to output an internal variable as, for instance, the flame quality) and the communication network (one MODBUS).

2.2.2 Power Supply

SF910i works at $24V_{DC}$. It has inrush current limiting circuits and an internal non-replaceable fuse.

Field site shall provide +24V_{DC} to SF910i through external power supply modules. Target acceptable input power supply voltage range: +24V_{DC}, <= +20%, >= -25%, as claimed in Appendix A. It shall have CE mark and fulfil the requirement of SELV/PELV according to EN 50178 1997 Electronic Equipment in Power Installations.

For SIL2 application, the customer suggest to provide the redundancy power supply, shall with power voter that will have extra 24V over-voltage protection with threshold no more than 35VDC, to ensure the maximum power input to SF910i shall not exceed 35VDC even when power supply enter critical failure mode.

For SIL2 safety, IEC 60730-1, CAN/CSA E60730-1, or EN298 application, Safe-relay need to be set into “second flame relay” condition, and needs to be serially connected with Flame-relay contacts by customer to fulfil safety redundancy output.

Despite having inrush current limitation circuits, the inrush current measured when there is a step application of 24V_{DC} peaks to a relatively high value and settles in a few ms (see Appendix A). Consider this when selecting the appropriate power distribution circuit breakers or fuses to be used with SF910i. See Appendix A for the inrush current value.

The internal non-replaceable fuse is intended to protect against internal damage in case of excess current consumption.

SF910i is protected against polarity inversion of the 24V_{DC} power supply.

Individual protection against overload or short circuit realized on external power distribution panel shall be suitably rated, with time lag. ABB suggests mounting a dedicated circuit breaker for each scanner, for instance, a thermal-magnetic circuit breaker, 1A curve “K”.

2.2.3 Relays

There are two relays in the SF910i. One is the main flame relay and the other is configurable with internal parameter, for example:

– Second flame relay
– Watch dog
– Flame quality
– Scanner case skin temperature

The relay contacts are galvanic isolated. Section 13 reports the relay assignment summary.

Flame Relay

Flame-relay is an ON/OFF switch that is energized (i.e. contact is closed - ON) when a flame is detected and de-energized (contact open - OFF) when a flame is not detected. See Appendix C for more information about flame detection.

The user can configure the SF910i to perform flame detection based on the requirements.

Flame Failure Response Time (FFRT) is programmable from Delay Dropout 0.2 to 4s in 0.1s increments, corresponding to acture FFRT time to be 0.3 – 4.2s. The difference between setting Dropout and acture FFRT time is due to the additional relay/program action delay.

For safety reasons, the user is requested to prove the FFRT of the SF910i under any burner load/fuel conditions, and under any selected file of parameters. For EN298 application, the user needs to set the **DELAY DROPOUT** parameter to <= 0.9s to fulfil the requirement of EN 298 that the FFRT shall not exceed one second. If there is a further adjustments of the flame detector (DELAY DROPOUT), it do not cause the time to rise above one second.

Safe Relay

Safe-relay is an ON/OFF switch that is energized (i.e. contact is closed - ON) when no faults are present and de-energized (contact open - OFF) when a fault is detected. This relay can be used in an alternative to its default function, to be a “second flame relay” or a “flame quality relay”. See details in the next sections of this document.

For SIL2 safety, IEC 60730-1, CAN/CSA E60730-1, or EN298 application, Safe-relay need to be set into “second flame relay” condition, and needs to be serially connected with Flame-relay contacts by customer to fulfil safety redundancy output.

Both relays go to OFF (contact open, de-energized) state, if any fault is detected (safe status).

2.2.4 4-20mA

SF910i has a galvanic isolated 4-20mA analog output (external powered, see scheme aside) that can be assigned to be proportional to one of the following flame variables:

- Intensity
- Flicker frequency
- AC-amplitude
- Quality
- Flame temperature

The output goes to the “low” value of 3.5mA in case the SF910i detects a fault in any of its internal parts.

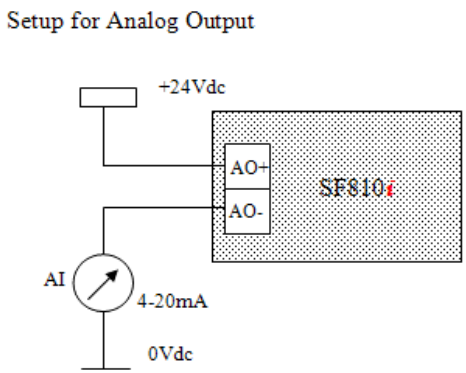


Figure 2.6: Analog Output Wiring

2.2.5 Communication Lines

For SF910i-*-L, there is one communication line: galvanic isolated, half-duplex RS-485 serial communication.

The communication lines are based on the RS-485 serial communication physical level standard. The transmission is differential; high-speed and long distance can be used on a copper cable. See Appendix A for cable length.

2.2.6 Configuration Memory

SF910i has a non-volatile internal memory that keeps configuration data indefinitely during power-down periods. The data retention circuit needs no batteries, and it is based on non-volatile memory technology.

In case of SF910i replacement, the new unit must be configured as the old one.

Easy configuration, reconfiguration, and tuning can be done with the Flame Explorer software that, among the other features, allows the user to store any unit’s configuration in a file that can be kept for reference or to reprogram a unit in case of replacement or failure.

2.3 Mounting and Orientation

SF910i can be mounted horizontally or vertically. Care must be taken to face down the cable entry thus to prevent water drops to leak in.

In wall mount application, it is advisable to install the Flame Scanner on a swivel flange, this will help optimizing the Flame Scanner aiming toward the burner flame.

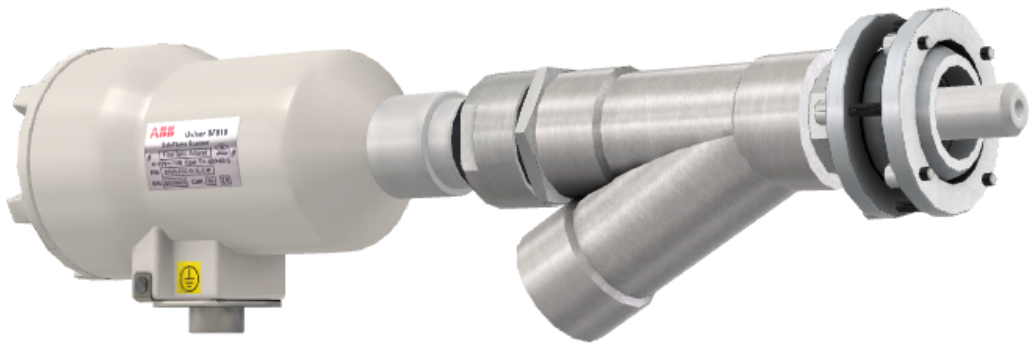


Figure 2.7: SF910i LOS Assembly

3 Installation

This section consists of three main parts:

– Site verification

– Networking preparation

– Product installation

The first two activities must be done just once for each flame detection system. The second (networking preparation) is needed only when the user is about to use the digital communication capabilities of the SF910i. The third must be repeated for each single unit to be installed.

3.1 Site Verification

This activity consists in verifying that the local environment of the physical installation location complies with the product specifications.

Not to be installed in direct sunlight.

3.2 Networking Preparation

For SF910i, there is one MODBUS based on RS-485 serial communication line that connects all units together.

First, decide whether to make use of the digital communication capabilities of the SF910i or not. In case, the user do not want this feature, just skip this activity and go to product installation.

Pointing out on this subject, that the topology of a RS485 network is a “bus”. Therefore, the network cable must be routed starting from the master station (usually a system or a DCS interface in a control room), and passing relatively close to each SF910i ending in a junction box located close to the last (most remote) unit. Both ends of the network cable must be terminated with a resistor equal to the characteristic impedance of the network. Close to each SF910i, the network must be provided with a junction box. From that junction box, a short piece (“stub”) of network cable will reach the SF910i. The maximum length of this “stub” is limited to a few meters and is strongly related to the maximum transmission speed that can be used on the network and to the total number of stubs. The shorter the stub, the higher the speed.

The above short considerations about bus network topology are enough to point out the next important concept. The topology of the network is not always (is rarely) equal to the topology of the remaining wiring needed to power-on and to interface the SF910i to the Burner Management System. The most obvious topology for all cabling except the network is a star configuration, not a bus. The center of the start is somewhere located in the control room or in the electronics cabinet room, while the points of the star are located in the junction box, above mentioned, close to each SF910i. From the junction box to the SF910i, ABB suggests using a single special cable designed for the purpose. See Appendix F for more details. The user can also use a number of standard cables readily available on the market.

Intentionally avoided to discuss the simple case of a system made of a single SF910i. In this case, the bus topology is coincident with the start topology. Of course, the user can lay-out the network and the other wiring on the same cable path.

With some restriction, and with the use of copper to fiber-optic converters, the RS-485 network can be implemented in a star topology, thus making possible to use the same cable routing paths as the rest of the wiring.

If the user connect the relay contact(s) to a circuit whose voltage is higher than $24V_{DC}$ nominal (for instance to $220V_{AC}$), then this part of the wiring must be implemented following compliance with all applicable normative.

3.3 Product Installation

The installation of the SF910i begins with the selection of station address. SF910i can be physically installed on the burner, and then it can be wired as needed. Installation terminates with the correct procedure to close the cover of the enclosure to maintain the explosion proof capability and with the preliminary operations and adjustments.

To meet EMC specifications, it is mandatory to follow the recommendations given in Appendix F.

SF910i comes from the factory already loaded with the factory-default configuration. This configuration could be not suitable to correctly discriminate the presence of the flame in the target burner. Therefore, for safety reasons, the SF910i will power-up in a safe state (First-Time Power-Up state - FTPU) in which the flame relay will never energize, even if the local display shows active signal flame algorithm vote for flame present.

SF910i exits from this first-time power-up state only after the default setting is changed or confirmed either on local or from remote through Flame Explorer.

While in FTPU state, the flame LED blinks red slowly.

3.3.1 Summary of Installation Procedure

The installation procedure refers to the actions required to install the SF910i up to the point when it can be powered, and it can begin to roughly detect a flame. Now, the user will be ready for the next phase (configuration and tuning for best performance).

Installation procedure:

- Preliminary steps (air flow, ESD precautions, special handling, unpacking, and inspection)
- Protocol and station address selection
- Physical installation
- Wiring
- Closing the enclosure

The details of the above installation steps are discussed in the following sub-sections.

3.3.2 Preliminary Steps

Air Flow

SF910i is designed to be installed in a normal ambient environment. It is absolutely forbidden to cover the enclosure with thermal insulating or any kind of material.

See Appendix A for specifications about environment of installation.

It must not be installed in direct sunlight.

ESD Precautions

Wear an anti-ESD wrist strap or equivalent system when operating with rear cover removed for installation, commissioning, and servicing an SF910i.

Special Handling

SF910i requires the care normally used to handle the electronic device (avoid mechanical stress and shocks). Observe the following steps needed to handle the electronic circuitry:

- Before opening the SF910i enclosure, wear a wrist straps connected to ground (or equivalent anti-ESD system).
- Keep the wrist strap for all the time in which the user operate with the SF910i enclosure opened.
- Handle assemblies by the enclosure, and avoid touching the semiconductors pins.

Unpacking and Inspection

- Examine the hardware immediately for shipping damage.
- Notify the nearest ABB sales office of any such damage.
- File a claim for any damage with the transportation company that handled the shipment.
- Use the original packing material and container to store the hardware.
- Store the hardware in an environment of good air quality, free from temperature and moisture extremes.

3.3.3 Station Address Selection

Before using the SF910i, even before beginning to configure it, the user must set the station address.

For MODBUS, it is 34800 baud rate initially, and can be changed later by the master. Refer to *SF910i Flame Explorer User Manual (8VZZ005308)*.

Default Initial Setting

SF910i comes from the factory already configured for MODBUS protocol, station No.1, 38400 baud.

The user can omit the protocol and station selection procedure in the following cases:

– Installing the SF910i without using the serial communication channels.

– Installing a point-to-point MODBUS serial channel (single or redundant) for each SF910i. In this case, every unit will be addressed as station 1 on its own network. This could reasonably be the case when the whole flame detection system consists of only one or two SF910i .

Station Address Selection Procedure

While the installation is in hazardous area, the user can set the station address operating while the cover is not opened, touch the button through the cover glass or remotely through Flame Explorer.

For the procedure, refer to local configuration and communication network parameters.

Physical Installation

SF910i Flame Scanner comply with the safety rules for installation in explosive atmosphere except for non-ATEX versions.

Installation, removal, assembling, and disassembling procedures shall be strictly made in accordance with the *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

To prevent moisture to drop into the enclosure, it is recommended to install the SF910i with cable inlet facing down.

SF910i - LOS (Line Of Sight Installation)

Flame Scanner SF910i - LOS is typically supplied as part of a complete higher level assembly as shown in Figure E.2.

Supply generally includes all the indicated accessories, specially designed to easy the assembly/dismantling and the aiming of the Flame Scanner.

To provide a LOS (also called direct view) installation, drill a 55 mm hole in the burner plate according to the drilling template and fit the swivel flange basement (see Figure E.2).

In case, a single scanner shall detect both the igniter and main flame, aim the scanner to the primary zone of the main burner flame in a point where the pilot flame intersect the main flame. The effect of any turbulence set by the air register must also be taken into consideration to ensure that the pilot flame involves the targeted zone of the scanner.

Connect the air flexible hose in the ¾" provision on the "Y" union (see Figure E.2).

SF910i - FOC (Fiber Optic Cable Installation)

The typical application of fiber optic extensions are:

– Flexible-extended for corner fired tilting burners

– Rigid-extended for fixed burners large wind box

The extended Flame Scanner includes both internal and external carrier. The external extension pipe (outer carrier) may be considered a semi-permanent component of the burner or relevant air box. Once mounted, it needs no care or maintenance.

Only the inner carrier, housed in the outer one, incorporates components that may need maintenance and/or replacement (optic fiber lens).

Basic premises to determine the final location of the extended Flame Scanner are:

– Define where to weld the collar in the burner bucket.

– Make sure levers or other mechanical parts do not crunch, bang, or cut the outer carrier inside the burner vane.

– Test the corner tilt within the full range and make sure that the flexible extension doesn't bend sharply.

– The end part of the outer carrier must be let free to slide inside the collar. The flexible part of the extended scanner shall work as a spring keep pressing the end part into the collar.

The extended Flame Scanner requires, in all versions, low-pressure air (preferably supplied by booster fan). This air is used for cooling and cleaning purposes. See specification for air requirement.

3.3.4 Opening Enclosure Cover and Wiring

As above stressed, when installed in hazardous area, cannot screw open the enclosure, and cannot be dis-connected under power. Ex certified products (Refer to datasheet for detailed product coding) must be handled as in *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

In non- hazardous area, it is allowed to screw open the enclosure and do the wiring.

Before to open the enclosure cover, screw out the hexagon cap in the cover.

Figure 3.1: Hexagon Cap in the Cover

When the enclosure cover is screw opened, the user can find two phillips head screws with waisted shank as shown in the below figure.

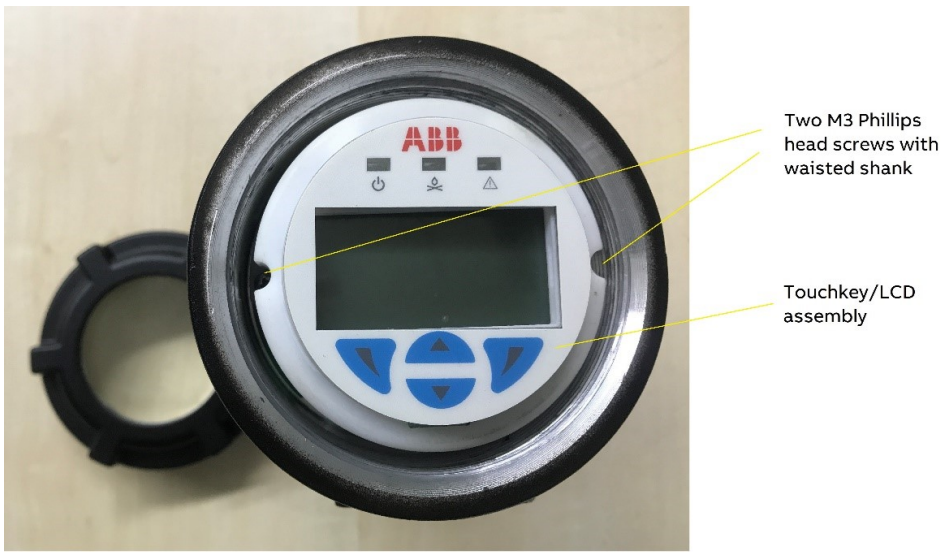


Figure 3.2: Two Phillips Head Screws with Waisted Shank

Those screws are used to fix the ATB board, Touchkey/LCD assembly, and enclosure body.

The user can use the screw driver to screw out these two screws. After that, snap the step edge of Touchkey/LCD assembly as shown in the below figure.

Figure 3.3: Snap the Step Edge of Touchkey/LCD Assembly

Pull and remove the Touchkey/LCD assembly outside from the enclosre as shown in the below figure.

Figure 3.4: Pull and Remove the Touchkey/LCD Assembly

Then, place the Touchkey/LCD assembly at hand, and notice that the two phillips head screws with waisted shank will stay on Touchkey/LCD assembly and not be dropped out.

After that, the user can find the ATB board appearance and wiring connectors, and continue to do wiring connection.

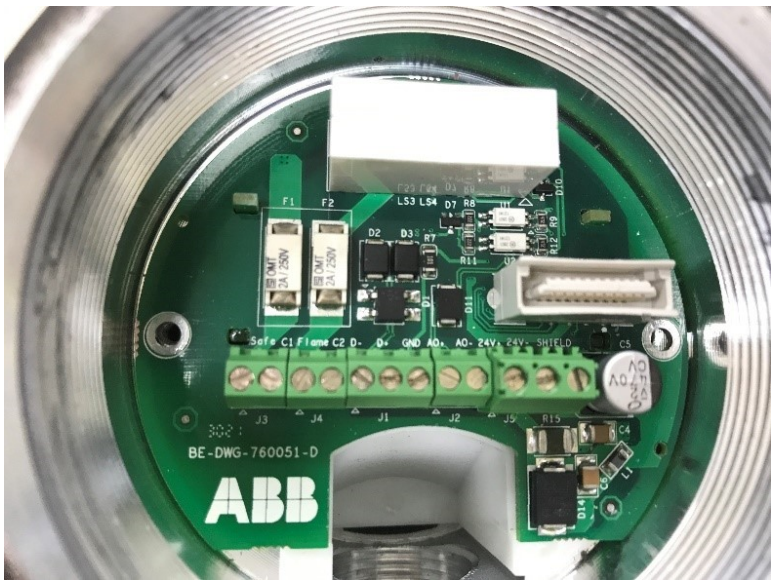


Figure 3.5: ATB Board Appearance and Wiring Connectors

To connect the SF910i to the Burner Management System, to the communication network, to its power supply and to a control system in general, depends on the type of SF910i that the user is using (whether it is equipped with terminals or connectorized), on the total number of SF910i that are needed and on the architecture of the interconnection network that the user choose.

The power supply must be distributed to the SF910i using one circuit breaker for each Flame Scanner. This will make possible to turn-off a single unit without affecting the rest of the flame detection system. As an example, a thermal-magnetic circuit breaker rated 1A nominal current and with characteristic curve “K” can be used.

For SIL2 application, the customer suggest to provide the redundancy power supply with power voter that will have extra 24V over-voltage protection with threshold no more than $35V_{DC}$, to ensure the maximum power input to SF910i shall not exceed $35V_{DC}$ even when power supply enter critical failure mode.

In hazardous area, the cabling system must comply with the applicable safety regulations. To make the cabling system compliant is outside of the purpose of this manual.

Earth

SF910i must be connected to earth by means of a suitable cable connected to the ground protection terminal available on the enclosure body (it is identified by a yellow earth symbol).

The maximum allowed length of the earth cable is three meters. See Appendix F for specifications of the earth cable.

Wiring: Terminal Equipped Version

Refer to Appendix F and Appendix A to properly select the external cable.

The multi-conductors cable must be prepared as shown in Appendix E.

Once the SF910i is physically installed in its final location, remove the rear cover.

The cable, once inserted in the cable gland, must be inserted in the cable entry hole of the SF910i enclosure.

Then, the cable gland can be screwed into place. Do not tight it on the cable.

Pull half a meter (approximately) of cable from the rear of the SF910i. This is facilitated by the presence of the cable guide that avoid hitting against the internal circuit board and facilitates the passage of the cable.

Next, connect each conductor to the corresponding terminal block and tight its screw. Terminate the cable shield, and connect it to the terminal named “SHIELD”. Now, connect each cable pin into corresponding terminal and screw it firmly, press the conductors gently to keep it separated from the threading of the cover and bottom of Touchkey/LCD assembly.

Double check of all connections, especially the connection to the relay contacts (J3/J4 terminal block) and verify that all cables are correctly inserted in the screw terminals, that all the screws are tight and that no conductors are exposed.

This is of extreme importance for two reasons:

– First, if the wires of the relay contacts become short-circuited, then the user will lose the flame-off detection, and this is a severe un-safe condition.

– Second, when the relay contacts are connected to $50V_{AC}$ or other dangerous voltages, there is an obvious risk of electric shocks or short circuits between conductor and the enclosure.

Then, the user is ready to tight the cable gland and to complete the external wiring.

To correctly identify each terminal, refer to the below figure and table.

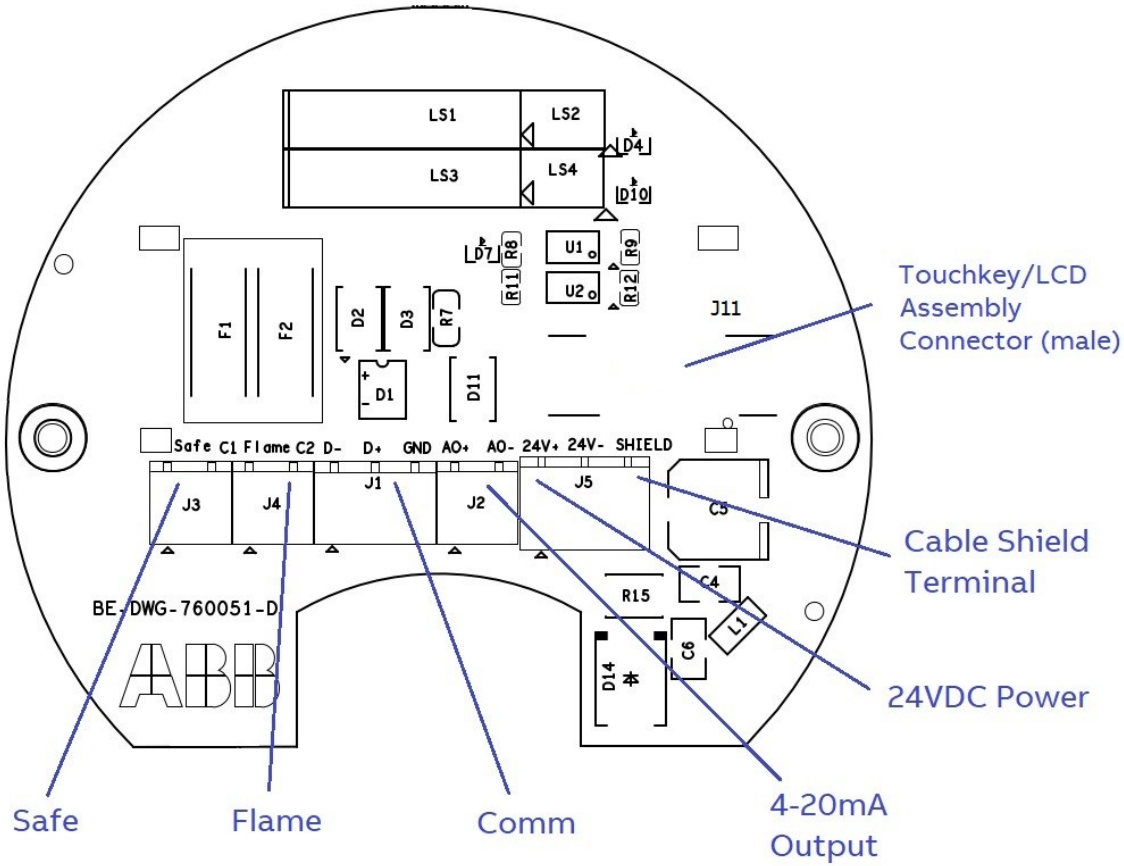


Figure 3.6: Terminals Location in SF910i

Table 3.1: Terminal Assignment

Terminal Block/Terminal	Signal Name	Description
$24V_{DC}$/+	$+24V_{DC}$	Power supply positive input
$24V_{DC}$/-	GND	Return of power supply, ground reference for all internal electronics
J2/AO+	AO+	Analog output (4-20mA) positive (externally powered)
J2/AO-	AO-	Analog output (4-20mA) negative (externally powered)
COMM/D+	D+	Serial communication port, data TX/RX, positive

Table 3.1: Terminal Assignment (Continued)

Terminal Block/Terminal	Signal Name	Description
COMM/D-	D-	Serial communication port, data TX/RX, negative
COMM/GND	GND	Ground reference for serial communication
J4/FLAME	FLAME	Flame-relay contact (NO)
J4/C2	Common 2	Common for Flame-relay contacts
J3/SAFE	SAFE	Safe-relay contact (NO)
J3/C1	Common 1	Common for Safe-relay contacts
J11	Touchkey/LCD assembly connector (male)	Connect to Touchkey/LCD assembly
SHIELD	Shield	Earth connection point for the shields of the cable(s)

Wiring: Quick-release Pin Connector

The connector versions of SF910i (third suffix = Q or QC) come with quick-release connector. The user do not need to open the SF910i enclosure for making connections. Plug the connector cable (or pigtail) into the SF910i connector and the user is ready for next step. The user must need to identify the pin-out in the socket available on the SF910i or in order to solder the external cable conductors in the connector plug, refer to the below figure and table. The pin-out in the below figure is as view from the outside of the SF810i, where the plug inserts into the socket.

Refer to Appendix F and Appendix A to properly select the external cable.

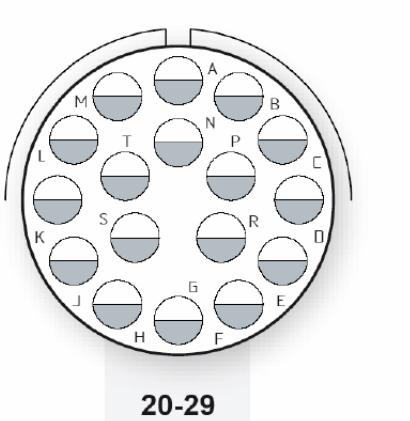


Figure 3.7: External View of Connector Pin-out (Socket) in SF910i

Table 3.2: Connector Pin Assignment and Internal Wiring for SF910i

Pin	Wire Color	Section mm^2	Signal Name	Description
K	Red	0.5	+24V_{DC}	Power supply positive input
L	Black	0.5	GND	Return of power supply, ground reference for all internal electronics
M	White/Red	0.25	AO+	Analog output (4-20mA) positive
N	White/Black	0.25	AO-	Analog output (4-20mA) negative
D	Green	0.25	D+	Serial communication port, data TX/RX, positive
E	Red	0.25	D-	Serial communication port, data TX/RX, negative
F	Green/Light blue	Tinned copper	GND	Ground ref. for serial comm. Port
A	Green	0.5	Safe-relay contact	Safe-relay contact (NO)
B	Red	0.5	Safe-relay contact	Safe-relay contact (NO)
P	Orange	0.5	Flame-relay contact	Flame-relay contact (NO)
S	Pink	0.5	Flame-relay contact	Flame-relay contact (NO)
T	Gray	Tinned copper	Shield	Earth connection point for the shields of the cable(s)

Architecture of Interconnection Network

There are several ways to build the interconnection network for the SF910i.

The simplest case is that when the user is using only one SF910i in the system. In that case, all connections are routed from the SF910i to the control system in one single cable path. (Exceptions might apply). For the convenience, the user must add a junction box along the cable path.

Systems with multiple SF910i require more complex interconnection network in which details are not the purpose of this manual. Pointing out that the communication network must be a bus structure with each station attached to the bus by means of a short stub. The cable must be terminated on its characteristic impedance at the first station of the bus (usually the master) and the last one.

The power supply can be distributed in a start topology or in a bus topology. Regarding to power, it is recommended to insert a circuit breaker for each SF910i to easily operate on one unit for servicing purpose, leaving the rest of the system unaffected.

For the maximum number of nodes and the stub length, these parameters together with the maximum total network length influence each other and have impact on the maximum attainable transmission speed. The number of stubs (nodes) and their length, for instance, limit the transmission speed. The design of the network layout is out of the purpose of this manual.

Galvanic Isolation

All the external interfaces (terminals) of the SF910i are galvanically isolated from the power supply and the internal electronics. The wiring must be done with the suitable care to keep the isolation specification. See also Appendix A.3 for isolation specifications and the below table. Error! Reference source not found for a summary of the isolation zones.

Each table entry defines the test voltage between the zone itself and all other zones and chassis connected together.

Table 3.3: Isolation Zones

CAN/CSA-E60730-1 and UL 60730-1	Test Severity Levels
Rated impulse voltage	$500V_{AC}$ between enclosure earth and all terminal blocks (except relay contacts and $+24V_{DC}$ terminal). $1500V_{AC}$ between enclosure earth and relay contacts, between relay contacts

Cables

To meet SF910i specifications and relevant certifications, it is mandatory to use cable(s) that comply with the requirement in Appendix F.

3.3.5 Close the Enclosure Cover and End of Installation

After wiring connection, the user must place back the Touchkey/LCD assembly, just reverse the steps discussed in Section 3.3.4. At first, pay attention to the upward direction, and align through the ABB LOGO and align two screws in the Touchkey/LCD assembly to the two holes in ATB/enclosure as shown in the figure below.

Figure 3.8: Align Two Screws in the Touchkey/LCD assembly to the Two Holes in ATB/Enclosure

Then, the user must press the Touchkey/LCD assembly downward till to the end. If above alignment is correct, the J11 male connector in the ATB board will be seated into the corresponding female connector in Touchkey/LCD assembly. The user will hear or feel the click sound between their connection. If there is some problem, do not continue to use brutal force, otherwise the J11 male connector in the ATB board or corresponding female connector in Touchkey/LCD assembly will be damaged. The user must snap/pull back the Touchkey/LCD assembly, and align them again to continue.

After that, screw the circular enclosure rear cover in place and secure it with the locking screw (2mm Allen-Key).

The threads of the cover must always be well lubricated with grease. Otherwise, the user will not be able to open the cover in future. In case of installation in hazardous areas, then strictly follow the instructions in *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*, even for the relatively simple action of placing the cover in place.

Some experience on the end of installation:

– After wiring, screw the circular enclosure rear cover into aluminum body. Normally, there is a designed space between the cover glass and touch button. However, if there is an abnormal, for example, flashing LCD display, it may be due to the space between the cover glass and touch button is too small. The user could have a try to screw the cover back a little (< 1mm).

– Grounding terminal of enclosure shall be connected to a good grounding point in site to ensure touch key proper detection/operation.

– After the user screw back/ahead the cover every time, suggest to re-power on/reset the SF910i, since that internal circuit will re-calibrate the touch-button identification/sensitivity after powering on.

– Suggest to use volar pad of thumb to touch ▼ or ▲ (**Downward**/**Upward**) button, especially due to that ▼ (**Downward** button) is near to the enclosure edge, using the use volar pad of thumb would increase the touching area.

– If the site of installation is not hazardous area, the unit can be powered on while the cover is still open.

4 Touch-Buttons

SF910i is equipped with four touch-buttons (UP, DOWN, LEFT, and RIGHT).

4.1 Touch-Buttons Location

The four touch-buttons are located in the bottom area of the faceplate, and is accessible when the enclosure cover is unscrewed or tightly screwed. Refer to the below figure.

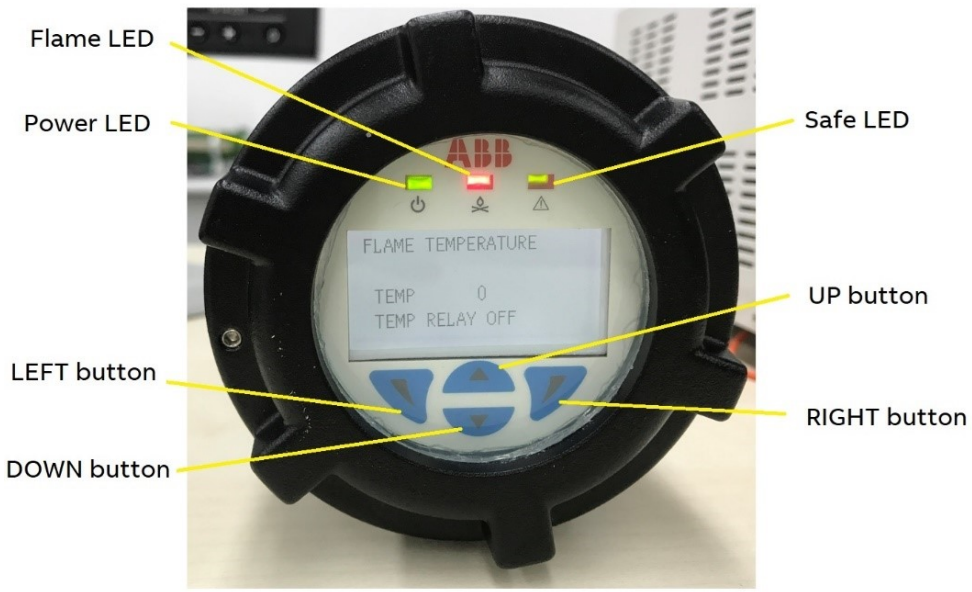


Figure 4.1: Touch-Buttons and LEDs Location of SF910i

Touch-buttons are intended to be used together with the local LCD display for local configuration.

If SF910i is installed in a hazardous area, the user can operate directly on the touch-buttons through the glass while not open the enclosure (the user cannot have the SF910i powered up while the cover is removed). In this case, the user can also provide every configuration through the serial links.

See Section 6 for information about the modes of operation.

5 LEDs

SF910i has three LEDs located on top area of the faceplate. Refer to Figure 4.1 for LEDs location. LEDs are intended as visual feedback devices to help during configuration of the SF910i (when using transparent-window rear cover), and give immediate visual feedback of the status of Safe and Flame-relay contacts.

5.1 Power LED

The left most LED is a power indicator that shows a green color when power is applied to the SF910i .

5.2 Safe LED

The right most LED is a bi-color indicator that illuminates:

– Red when the SF910i internal diagnostic and self-checking circuits determine a fault or an unsafe condition. When this LED illuminates in red, the corresponding relay (Safe-relay) will be de-energized. Flame-relay will be de-energized too for safety reasons.

– Green when the SF910i internal diagnostic and self-checking circuits detects no problems. In this case, the corresponding relay is energized.

When the Safe-relay is functioning as second Flame-relay or as Quality-relay, or as internal temperature relay, the status of this LED follows the status of its source. That is, green when the relay is energized and red when it is de-energized.

5.3 Flame LED

The centrally located LED is a bi-color indicator that illuminates:

– Green when the SF910i internal flame algorithm proves that the flame is present. In this condition, the corresponding relay (Flame-relay) is energized.

– Red when there is no flame (independently from the flame), if the internal diagnostic detects a problem (see Section 5.2 above).

– Blinking red (slow): the unit is functioning with the factory-default configuration (first-time power-up).
– Blinking red (fast): the unit has detected a noise, that means the detected frequency signal is too steady to be coming from a real flame (see Noise error paragraph in Diagnostics chapter for important information about this feature).
– Blinking green: the unit is functioning with the Flame-relay overridden. This means that, for a period of 60 minutes since the override command is issued, the unit will maintain the flame relay energized no matter what the flame algorithm proves. The normal functionality of the relay can be restored immediately using the Flame Explorer software tool.

Flame LED blinks red even in the following conditions:

– An AC-mains frequency noise is detected in the electronic boards (see Section 16).

or

– Aiming the SF910i to an AC-mains powered light source (usually a bulb or a fluorescent lamp).

6 Operational-Modes

SF910i uses three modes of operation. In each mode, the SF910i operates to provide the optimal user interface.

Operational-Modes are:

– First-time power-up mode

– Normal-Mode (Live data view)

– Configuration-Mode (Programming)

Except for the first-time power-up, the modes of operation are not mutually exclusive. For instance, when configuring, the SF910i maintaining its operability belonging to the normal mode (i.e., it continues to detect the flame, if it was in normal mode before entering the configuring mode). In other words, the SF910i is “online configurable”.

6.1 First-time Power-up Mode

When the SF910i is factory new or when the user make a complete reset of the configuration to factory defaults or when the configuration stored in non-volatile memory is not recognized as a valid one, it operates in a mode called “First-time power-up”.

The most important feature of this mode is to prevent flame-relay from energizing until authorized user performs a configuration/tuning.

In this mode:

– Flame-relay is not energized (even if the flame algorithm votes for flame-ON).

– Flame LED is blinking red (slow).

A distinction must be done at protocol level:

– Factory default and manual reset of the configuration, both bring the unit in MODBUS mode speed of 38.400 b/s, and station address equal to one.

– Reset to default configuration driven by the detection of a configuration error maintains the protocol that was active before the configuration error was.

To exit from this mode, the user must configure (either using the Flame Explorer tool or locally with touch-buttons) the SF910i.

SF910i, when used with its communication line(s) in a bus architecture, needs a basic configuration to be done before installation. This basic configuration consists in the selection of the serial line communication protocol and the assignment of the station address.

These selections must be done manually with the rear cover open and while the unit is powered. Therefore, in case the unit is to be installed in a hazardous area, these initial settings cannot be performed on the final location. The unit protocol and address must be selected before to the actual physical installation, operating on a lab bench in a non-hazardous area. The initial basic configuration requires connection to a $24V_{DC}$ power supply only.

6.2 Normal-Mode

Normal monitoring of the flame. In this mode, the flame live data view is only available. No new parameters can be entered (password protected).

6.3 Configuration-Mode

Configuration of the SF910i unit and its relays. Configuration-Mode can be entered:

– Remotely using the Flame Explorer SW Tool (running on a system connected through the serial line), and this is optional.

– Locally by the four touch-buttons on ATB.

7 Operating Display

In Normal-Mode, the SF910i provides a real-time display of operating values. Using **UP** and **DOWN** buttons, it is possible to navigate through the current values as explained below.

7.1 Measured-Values Displays

Measured-Values and their related quality values can be viewed in several different formats:

– Bar-type displays

– Numeric values

– A combination of both number and bar-type

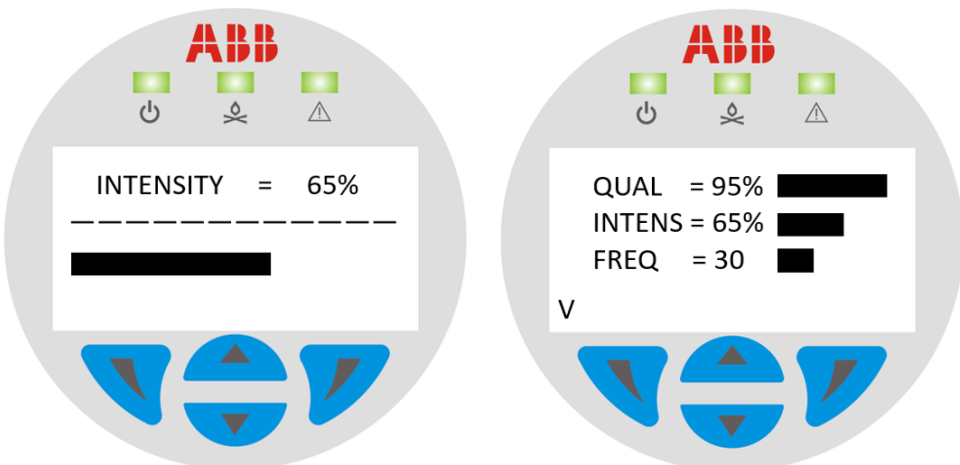


Figure 7.1: Sample Display in Normal-Mode

7.2 Current Fault Display

Pressing the **RIGHT** button displays any faults that may be present. Pressing the **LEFT** button again returns the LCD to the previous display.

7.3 Fault History Display

Fault history display shows the last three faults detected by the SF910i internal diagnostics.

This is particularly useful for tracking down the intermittent problems, such as loose field connections.

A sample fault history display is shown in the below figure.

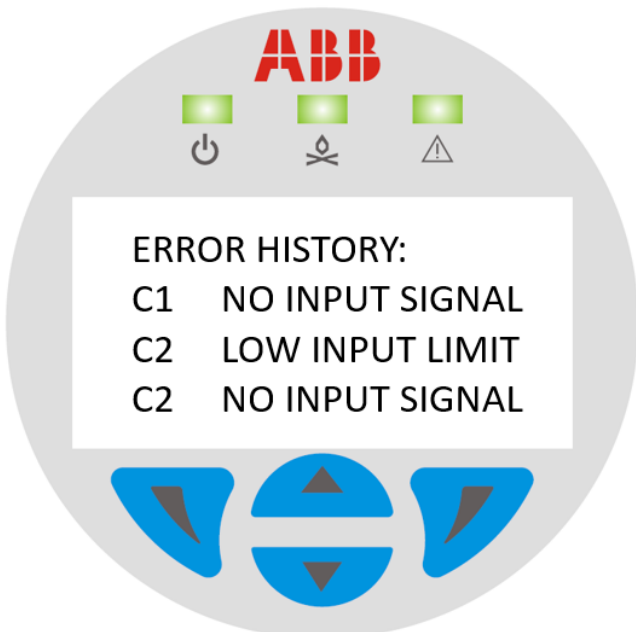


Figure 7.2: Sample Fault History Display in Normal-Mode

7.4 Tuning Display

Each channel has an associated tuning display that shows the actual Measured-Value values. The tuning display shows the highest value, the present value, and the lowest measured value. Toggling the display with either the ▼ or ▲ touch-buttons will reset the HI and LOW values. Then, the highest and lowest values will be recorded from the time of the reset.

This display is particularly useful when tuning the Flame Scanner, because it is important to know the maximum background values and the minimum operating values when selecting Flame Scanner Pull-In and Drop-Out limits.

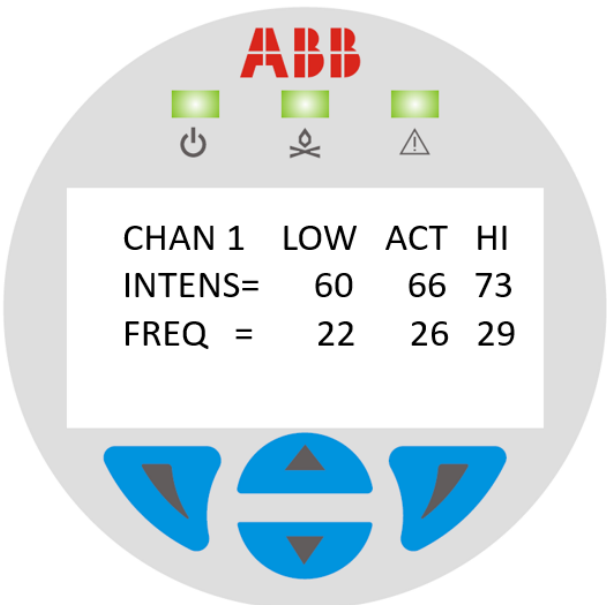


Figure 7.3: Sample Tuning Display in Operating-Mode

7.5 Version Display

When the SF910i is powered on and started, the SF910i's version information is displayed first, which is held for two seconds.

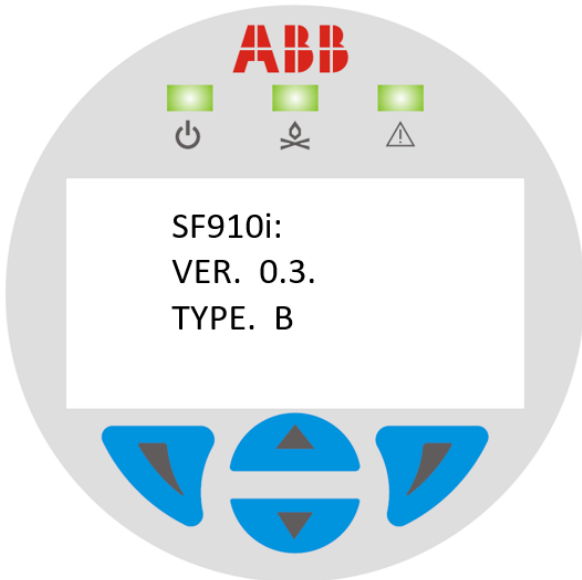


Figure 7.4: Version Display at Startup

Actual displayed FW version number value depends on the real version that is downloaded, but may be different with Figure 7.4 and Figure 7.5 display.

In Normal-Mode, use the ▼ or ▲ touch-button to toggle the display to view the version information.

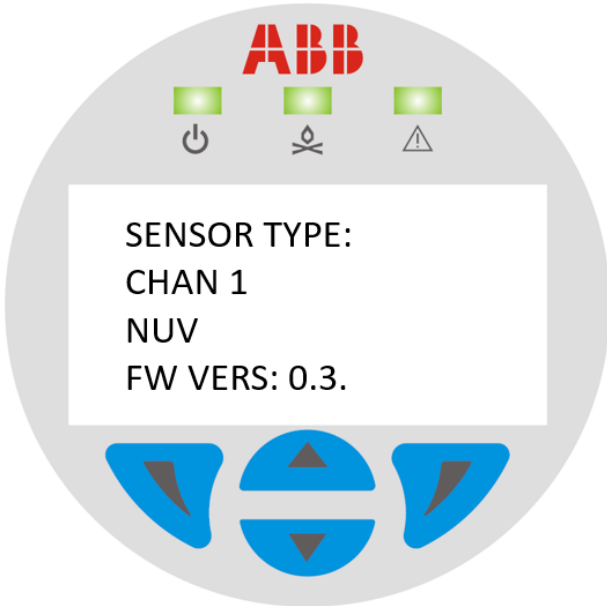


Figure 7.5: Version Display in Normal-Mode

8 Configuration-Mode

In Configuration-Mode, the LCD menu provides installation-specific information about the SF910i. Configuration settings can be changed using the four touch-buttons on the display. A complete list of the Configuration-Mode functions and their default values are found in Appendix J.

8.1 Local and Remote Configuration

There are several ways to configure the SF910i:

1. Locally by means of the display and touch-buttons (operating with open enclosure, in non-hazardous area).
2. Locally (MODBUS) by means of a system (running Flame Explorer software) connected with a short cable to one of the two serial channels of the SF910i (operating with open enclosure, in non-hazardous area).
3. Remotely (MODBUS) by means of a system (running Flame Explorer software) connected to the end of the communication network that, very likely, connects together all the SF910i of the system. Full configuration capability.

The above Step number 2 and Step number 3 are considered equivalent for the following explanations. They can be referred as MODBUS remote configuration.

8.2 General Notes

Some notes on the Configuration-Mode are as follows:

8.2.1 Several Functions only Apply to the Currently Selected Channel

To enter Configuration-Mode, hold the **P** pushbutton at the same time as the ▲ pushbutton (hold for five seconds). Use the ▼ or ▲ pushbuttons to scroll the curser up or down the main menu.

8.2.2 Exiting Configuration-Mode

Exit the Configuration-Mode by holding in the **d** pushbutton for two seconds. If there is no user activity for 20 seconds, the SF910i will automatically transfer to the Normal-Mode.

8.3 Configuration Menu Descriptions

The specific Configuration-Mode functions are described in the following sections in the order of appearance on the Configuration-Mode menu.

8.3.1 Operating-Mode

Operating-Mode can be:

– Corner

– Wall/Industrial

– Lighter

– Turbine

8.3.2 Application Select

Use High Limit

This function activates the High-Limit trip function for this channel. If the High-Limit function is activated, the SF910i will vote a Flame-Off condition when the Measured-Values exceed the programmed High-Limit values.

In most applications, the High-Limit function is OFF.

Use AC-Amplitude

This function activates the AC-Amplitude trip point for this channel. If AC-Amplitude is activated, the SF910i will vote a Flame-Off condition, if the ACAmplitude drops below the programmed Drop-Out value.

In most applications, the AC-Amplitude function is OFF.

8.3.3 Change IDS

Each unit can be uniquely identified using three category fields. Each field can have up to four alphanumeric characters. These IDs are NOT required for basic flame detection.

Channel Identifiers

- Unit ID
- Elevation ID
- Burner/Combustor/Corner/Lighter ID

The term displayed by the menu will change with “Operation-Mode” selected.

8.3.4 AO Output

Use the Analog Output function to specify the type of information that will be transmitted to the 4 to 20 analog output. This information can be related to:

- Intensity - This option will output the intensity value in a range of 4 to 20 mA = 0 - 100%.
- Frequency - This option outputs the Flicker-Frequency value which is proportional to the maximum Flicker-Frequency for the application selected.
  - For corner applications: 4 to 20 ma = 0 - 125 Hz
  - For wall/industrial applications: 4 to 20 ma = 0 - 125 Hz
  - For lighter applications: 4 to 20 ma = 0 - 125 Hz
  - For gas turbines: 4 to 20 ma = 0 -125 Hz or 0 - 250 Hz
- AC-Amplitude - This option will output the AC-Amplitude in a range of 4 to 20 mA = 0 to 100%.
- Quality (default) - This option will output the quality value in a range of 4 to 20 mA = 0 to 100%.

8.3.5 Load Default Parameters

From the local pushbuttons/display, it is possible to request to the unit to load back its factory default parameters.

In this way, all the unit parameters will be brought back to the factory default with the following exception, the active protocol will NOT change.

If the unit is MODBUS, it will remain MODBUS (but will bring back address and baud rate to 1/38.400).

8.3.6 Communication

Use this function to enter the communication protocol type, addresses, and baud rates for the serial outputs.

Network Type

The default value is “MOD” which indicates that MODBUS protocol is used.

MOD Address

Set the MODBUS address for RS-485 output to be an integer value between 1 and 254.

Each SF910i RS-485 output on a network must have a unique address.

MOD Baud Rate

Set the baud rate for the RS-485 outputs to be one of the following values:

– 9.6 = 9,600 bps
– 19.2 = 19,200 bps
– 38.4 = 38,400 bps
– 115.2 = 115,200 bps

8.3.7 Display Options

The user can customize the LCD display for the environment.

Contrast - Increase or decrease the LCD contrast setting to optimize the visibility of the display.

8.3.8 Complete Reset

The user can reload all the default values for both the program and configuration modes using the option.

The only values that are not reset with this option are Channel IDs.

9 Program-Mode

Program menus provide specific Flame Scanner tuning values that define response times and limits.

A complete list of the Program-Mode functions, their defaults, and available selections are found in Appendix K.

9.1 Notes for Program-Mode

- The values displayed or changed only apply to the currently selected Tuning Function-Set. The Channel and Tuning Function-Set selected are displayed in the upper right corner of the LCD display.
- To enter Program-Mode, press the **RIGHT** pushbutton momentarily, followed by the ▼ touch-button within two seconds.
- Exit the Program-Mode by holding in the **d** touch-button for two seconds. If there is no activity for 20 seconds, the SF910i will automatically transfer to Normal-Mode.
- The menu screens that the user see may vary depending on the configuration.
- The user cannot directly pass from Program-Mode to Configuration-Mode or vice-versa. The user must first go to Normal-Mode, then to Configuration-Mode.
- Recommended initial settings for specific applications can be found in Appendix B.
- Invalid input out of range as rules in Appendix K will not be activated, and the last value is un-changed which can be verified through re-entering and double-checking.

The specific Program-Mode functions are described in the following sections in the order of their appearance on the menu.

When the user adjust the tuning value through the ▲ touch-button and ▼ touch-button, press the **LEFT** pushbutton to cancel, and press the **RIGHT** pushbutton to confirm that the set value is effective and save.

9.2 Trip Points

Adjust the Pull-In, Drop-Out, and High-Limit values for Measured-Values with the following considerations:

– Pull-In and Drop-Out values for the AC-Amplitude will only be available for editing, if the user have enabled the AC-Amplitude in Configuration-Mode.

  See Use AC-Amplitude for more information.

– High-Limit trip values for the Measured-Values will only be available for editing, if the user have enabled the High-Limit function in the Configuration-Mode.

  See Use High Limit for more information.

– If the Pull-In value is changed, the Drop-Out value will automatically change to the same value as the Pull-In. To set a different Drop-Out value, make a manual change.

Intensity trip can be disabled and removed from the Flame-Logic only, if the Flicker-Frequency sensitivity is set to a value of 65 or greater before the intensity trip can be set to 0% (actually, in this condition the intensity trip can be set to any value between 4 and 0).

9.3 Quality Normalization

The normalization values allow the user to increase or decrease the sensitivity of the quality calculation.

– A low normalization value causes less sensitivity. This causes the quality value to rapidly change from 100% to 0%.

  This rapid change may provide very little warning of a problem before the flame proven condition is lost.

– A high normalization value causes increased sensitivity. This causes the quality value to change by small increments.

  Operators are able to detect small changes in the flame signal. They are more likely to spot combustion problems before they lead to a Flame-Off condition.

– The normalization value for AC-Amplitude will only be available for editing, if the AC-Amplitude is enabled in Configuration-Mode.

  See Use AC-Amplitude for more information.

– Since the quality value is a calculated parameter and does not impact flame detection, adjustments to the quality normalization values are not required for basic flame detection.

9.4 Frequency Sensitivity

Frequency sensitivity impacts the Flicker-Frequency measurement.

The higher the frequency sensitivity setting, the lower the measured Flicker-Frequency.

Frequency sensitivity is adjustable in increments of 1, between a low of 5 and a maximum of 100. The highest Flicker-Frequency will be measured at a setting of 5 and the lowest Flicker-Frequency at a setting of 100.

9.4.1 Accounting for Background Light

In some applications, the change in Flicker-Frequency resulting from a change in frequency sensitivity may be different for light in the background when compared to the burner flame.

In these applications, the frequency sensitivity function can be used to maximize the difference between burner ON and burner OFF (background) Flicker-Frequencies.

SF910i is then able to discriminate between the burner flame and background light.

9.4.2 Detecting Flicker-Frequency Noise

SF910i has a precision A/D converter that is capable of measuring very small Flicker-Frequency levels in the Flame Scanner input signal.

If electrical noise exists in the Flame Scanner wiring, the SF910i may detect the electrical noise if the Flicker-Frequency sensitivity is set too low.

During initial Flame Scanner tuning, the system must be checked to ensure that no electrical noise is present.

9.4.3 Check for Electrical Noise

– Darken the Flame Scanner by making sure that it is not exposed to any flame or ambient light.

– Set the Flicker-Frequency sensitivity to the minimum value expected for the application.

Flicker-Frequency displayed on the LCD must be 0 Hz. If it is not 0 Hz, the minimum Flicker-Frequency sensitivity must be raised or the electrical wiring inspected for proper shielding and installation.

This failure as well as any other fatal failure can be recovered only by cycling the power supply.

9.5 Smoothing

Smoothing filters are algorithms to smooth variations in the Measured-Value values. Smoothing provides more consistent signals for analysis. This allows for more sensitive trip points without causing unnecessary Flame-Off conditions.

There are 11 stages of smoothing available for Measured-Values.

Smoothing function values can be set to NONE, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

– A value of NONE disables smoothing filters.

– Disabling smoothing will maximize the rate of flame detection.

– A value of 1 provides the minimum amount of smoothing.

– A value of 10 provides the maximum amount of smoothing.

9.6 Delay Drop-Out

Delay Drop-Out function is a “Time-Delay on Drop-Out” feature for flame detection. If a flame proven condition exists, and one or more of the Measured-Values travel below or above their trip points, this function will provide a delay before:

– Voting a Flame-Off condition

– De-energizing Flame-Relays

This feature allows the Flame Scanner to ride through transient events.

The user can set the amount of Time-Delay from 0.2 to 2.5 seconds.

9.7 Flame Pick-Up

Flame Pick-Up function is a “Time-Delay on Pull-In” feature for flame detection. If a proven Flame-Off condition exists, and one or more of the active Measured-Values exceed the programmed Pull-In values, the SF910i will delay before:

– Providing a Flame-On signal

– Energizing the Flame-relay(s)

The user can set the amount of time for the delay, and this only allows enough time to ensure that the fuel-supply-valves clear the fully-opened limits before the SF910i proves flame.

This feature allows the Flame Scanner to ride through transient events. The user can set the amount of Time-Delay from 0.1 to 10.0 seconds.

9.8 Maximum Frequency

The user can set the value as 125 or 250. Only shows up, if the ApplicationSelected is Turbine.

10 Flame Explorer Software

Flame Explorer is an optional configuration, data trending, and historian software package that runs on a stand-alone computer. It can be used to assist in the initial setup of the SF910i and also with monitoring during routine operation.

Flame Explorer can be used on a single SF910i or on a multi-drop RS485 network where multiple SF910i can be connected. The user can use the Flame Explorer to configure all SF910i units on a MODBUS network from one location.

With the Flame Explorer, the user can monitor and trend the Measured-Values in real-time. The user can also track other information like the flame quality. Refer to below figure for a glimpse of a trend page.

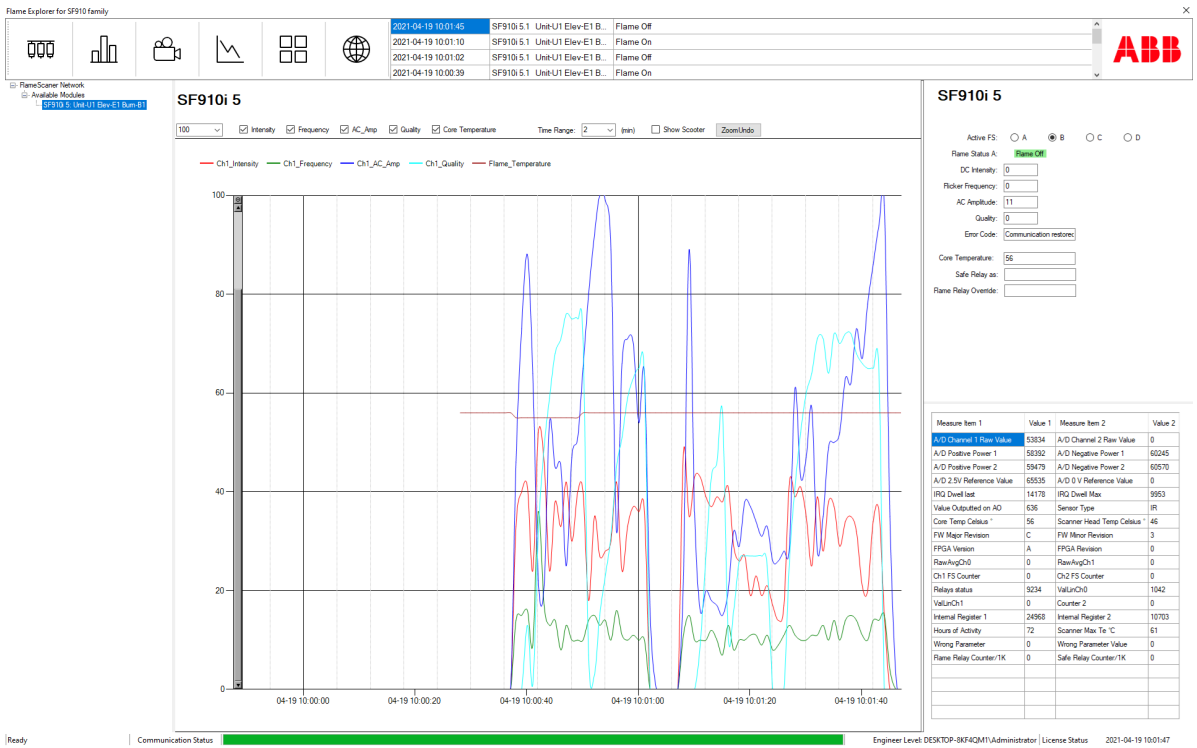


Figure 10.1: Trend Page on Flame Explorer

Up to four SF910i scanners can be displayed simultaneously on the Flame Explorer screen. Each display can be easily customized.

Data from any or all the SF910i units on a MODBUS network can be stored in an archive using a simple selection sheet.

Security is provided by Windows Authorization certification in the software, protecting the system from unauthorized use. See the *Flame Explorer for SF910i Installation and Operation Guide (8VZZ001097T0001)* for detailed information.

Flame Explorer software requires a MODBUS connection to the SF910i unit(s).

11 Configuration Parameters in Flame Explorer

There are many parameters that are combined together to form the configuration of a SF910i.

In this section, each of these parameters are described in detail.

For safety reasons, the user is requested to prove the Flame Failure Response Time (FFRT) of the SF910i under any burner load/fuel conditions and under any selected file of parameters. For EN298 application, the user need to set the **DELAY DROPOUT** parameter to <= 0.9s to fulfill the requirement of EN 298 that the FFRT shall not exceed one second. If there are further adjustments of the flame detector (DELAY DROPOUT), do not cause the time to rise above one second.

Be careful that most parameters are configurable only using the Flame Explorer tool.

A subset of parameters and basic communication setting can also be modified locally.

The main parameters page of the Flame Explorer tool for the SF910i is shown in the figure below. Note that on the left side are the parameters which normally don't change (or are very seldom changed), whilst on the right part are the parameters that can be changed more frequently (such as Pull-In and Drop-Out values).

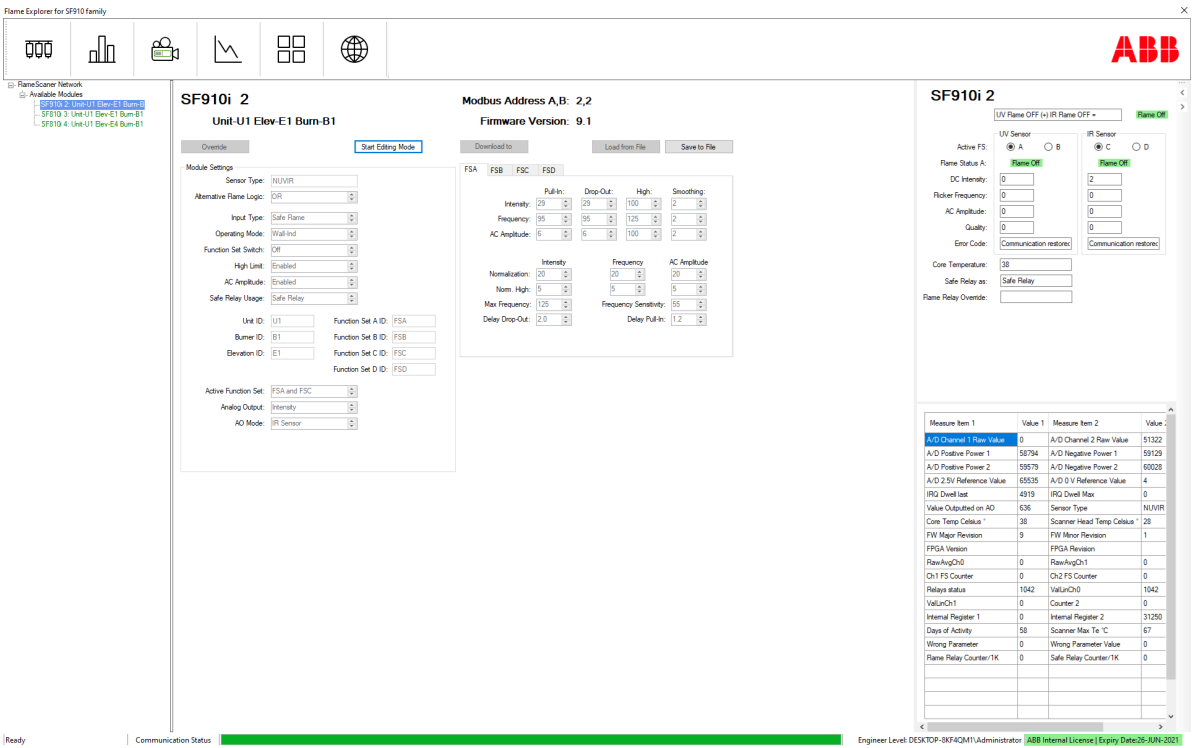


Figure 11.1: Parameters Page on Flame Explorer

Sensor Type

The sensor type can be:

- IR Infrared
- UV Ultraviolet (HW Log, installed up to HW version “E1”)
- nUV Ultraviolet (SW Log, installed from HW version “F0”)
- UVIR Dual sensor (UV HW Log + IR HW Log, installed up to HW version “E1”)
- nUVIR Dual sensor (UV SW Log + IR HW Log, installed from HW version “F0”)
- IRT Pyrometer single sensor (installed from HW version “F0”)

The configuration needs to know, if the sensor is single or dual (this information is needed to the Flame Calculation Algorithm). No details on the sensor spectral sensitivity are needed at this point. The sensor type is automatically recognized by the firmware residing on the SF910i. The sensor type can be read from the tool accessing to the unit's advanced status page (see Show Sensor Type) in this section.

Alternative Flame Logic (for DUAL Sensor Modules only)

This field is editable only, if the SF910i is working with a dual sensor. In this case, it is possible to configure the unit to vote flame conditions by calculating an OR or an AND of the flame condition detected independently by the two sources.

– Selecting OR, the unit will vote FLAME ON if at least one of the two sources detects flame presence.

– Selecting AND, the unit will vote FLAME ON if both sources detect flame presence.

Operating Mode

Operating mode can be:

– Wall Industrial (default)

– Lighter

– Turbine

– Corner

– Pyrometer

Active Function Set

This gives information about which function sets are active. "FSA" is displayed for single sensor. "FSA and FSC" are displayed for dual sensor. Other function sets are not used and could not be changed for SF910i.

Safe Relay Usage

Safe relay can be used in four different ways. Refer to Section 13 for details.

Analog Output

Use the Analog Output function to specify the type of information that will be transmitted to the 4 to 20 analog output. This information can be related to:

Intensity

This option will output the intensity value in a range of 4 to 20 mA = 0 - 100%.

Frequency

Frequency option outputs the Flicker-Frequency value which is proportional to the maximum Flicker-Frequency for the application selected.

– For corner applications: 4 to 20 ma = 0 - 125 Hz

– For wall/industrial applications: 4 to 20 ma = 0 - 125 Hz

– For lighter applications: 4 to 20 ma = 0 - 125 Hz

– For gas turbines or pyrometer: 4 to 20 ma = 0 -125 Hz or 0 - 250 Hz

AC-Amplitude

This option will output the AC-Amplitude in a range of 4 to 20 mA = 0 to 100%.

Quality (default)

This option will output the quality value in a range of 4 to 20 mA = 0 to 100%.

Core Temperature

Core temperature ranges from -60 to 110 Celsius degree. It is scaled from 0 to 100%. This option will output the core temperature value in a range of 4 to 20 mA = 0 to 100%.

Flame Temperature

Flame temperature ranges from 800 to 1800 Celsius degree. It is scaled from 0 to 100%. This option, that is available only if the used sensor type is pyrometer, and will output the flame temperature value in a range of 4 to 20 mA = 0 to 100%.

Quality Combination

This option is valid for dual sensor only. It uses higher quality value, if the alternative flame logic "OR", and lower quality value, if alternative flame logic is "AND".

This option will output the quality value in a range of 4 to 20 mA = 0 to 100%.

Load Default Parameters

From the local touch-buttons/display, it is possible to request to the unit to load back its factory default parameters.

In this way, all the unit parameters will be brought back to the factory default with the following exception the active protocol will not change:

If the unit is MODBUS, it will remain MODBUS (but will bring back address and baud rate to 1/38.400).

Show Sensor Type (Diagnostic page)

To make sure that the sensor type matches with the sensor declared on the unit's label, from the tool, access to the diagnostic page and read the sensor type field.

Measure Item 1	Value 1	Measure Item 2	Value 2
A/D Channel 1 Raw Value	0	A/D Channel 2 Raw Value	6
A/D Positive Power 1	58250	A/D Negative Power 1	58976
A/D Positive Power 2	59826		60416
A/D 2.5V Reference Value	65494	A/D 0 V Reference Value	12
IRQ Dwell last	3689	IRQ Dwell Max	0
Value Outputted on AO	636	Sensor Type	NUV
Core Temp Celsius °	36	Scanner Head Temp Celsius °	26
FW Major Revision	0	FW Minor Revision	1
FPGA Version		FPGA Revision	
RawAvgCh0	0	RawAvgCh1	0
Ch1 FS Counter	1	Ch2 FS Counter	0
Relays status	1042	ValLinCh0	1042
ValLinCh1	0	Counter 2	0
Internal Register 1	0	Internal Register 2	31250
Days of Activity	92	Scanner Max Te °C	49
Wrong Parameter	0	Wrong Parameter Value	0
Flame Relay Counter/1K	0	Safe Relay Counter/1K	0

Figure 11.2: Diagnostic Page on Flame Explorer

Show Software Version

On the parameters page, bottom-right corner, the firmware version of the unit is shown (see Figure 11.1), for instance "A.6" or "B.1" may be shown.

Recommended Initial Settings

The recommended initial settings for specific applications can be found in Appendix K. These setting allows the SF910i to operate effectively in most configurations.

The specific Program-Mode functions are described in the following sections in the order of appearance on the menu.

Function Set to Edit

Locally, it is possible to configure only the main parameters of each function set. Using the tool (in MODBUS), it is possible to modify all the parameters of each function set.

Trip Points

Adjust the Pull-In, Drop-Out, and High-Limit values for Measured-Values with the following considerations:

– AC-Amplitude trip values for the Measured-Values will only be available for editing, if the user have enabled the Use AC-Amplitude function.

– High-Limit trip values for the Measured-Values will only be available for editing, if the user have enabled the High-Limit function.

– If the Pull-In value is changed, the Drop-Out value will automatically change to the same value as the Pull-In. To set a different Drop-Out value, make a manual change.

Quality Normalization

Quality Normalization values allow the user to increase or decrease the sensitivity of the quality calculation.

– A low normalization value causes less sensitivity. This causes the quality value to rapidly change from 100% to 0%. This rapid change may provide very little warning of a problem before the Flame-Proven condition is lost.

– A high normalization value causes increased sensitivity. This causes the quality value to change by small increments. With this feature, the user can detect small changes in the flame signal. The user are more likely to spot combustion problems before they lead to a Flame-Off condition.

Quality Normalization Parameters

$$\text{Quality} = \left(\frac{\Delta F}{F_n}\right) \times \left(\frac{\Delta I}{I_n}\right) \times \left(\frac{\Delta AC}{AC_n}\right) \times 100\%$$

Where:

$\Delta F = F - F_d$

$\Delta I = I - I_d$

$\Delta AC = AC - AC_d$

And:

F_d, I_d, and AC_d are drop-out settings

F_n, I_n, and AC_n are normalized (weighted) values

Frequency Sensitivity

Frequency sensitivity impacts the Flicker-Frequency measurement. The higher the frequency sensitivity setting, the lower the measured Flicker-Frequency.

Frequency sensitivity is adjustable in increments of 1, between a low of 5 for IR sensor or 10 for UV sensor and a maximum of 100. The highest Flicker-Frequency will be measured at a setting of 5 and the lowest Flicker-Frequency at a setting of 100.

Accounting for Background Light

In some applications, the change in Flicker-Frequency resulting from a change in frequency sensitivity may be different for light in the background when compared to the burner flame.

In these cases, the frequency sensitivity function can be used to maximize the difference between burner ON and burner OFF (background) Flicker-Frequencies.

SF910i is then able to discriminate between the burner flame and background light.

On some occurrence, the background light might be too high, resulting in both, input signal saturation (alarmed by Error 35) and reduced capability to detect frequency leading to poor discrimination. This situation can be improved by interposing an orifice between the flame and the lens. The orifice is secured within the thermal isolation union with a retainer (See appendix section).

A standard kit with orifices of different diameter, including the retainer and gasket is available, Article number: **TU_KIT01**.

To choose the best size of the orifice, assure the maximum level of intensity do not exceed 85% with associated burner in operation at maximum load and remain at decent level, preferably above 40% when the associated burner is operating at the minimum rate.

Detecting Flicker-Frequency Noise

SF910i has a precision A/D converter that can measure very small Flicker-Frequency levels in the flame scanner input signal.

If electrical noise exists in the Flame Scanner wiring, the SF910i may detect the electrical noise if the Flicker-Frequency sensitivity is set too low.

During initial Flame Scanner tuning, the system must be checked to ensure that no electrical noise is present.

Check for Electrical Noise

– Darken the Flame Scanner by making sure that it is not exposed to any flame or ambient light.

– Set the Flicker-Frequency sensitivity to the minimum value expected for the application.

– Select frequency as the value to be shown on the display.

Flicker-Frequency displayed must be 0 Hz. If it is not 0 Hz, the minimum Flicker-Frequency sensitivity must be raised or the electrical wiring inspected for proper shielding and installation.

Smoothing

Smoothing filters are algorithms to smooth variations in the Measured-Value values. Smoothing provides more consistent signals for analysis. This allows for more sensitive trip points without causing unnecessary Flame-Off conditions.

There are 11 stages of smoothing available for Measured-Values.

Smoothing function values can be set from NONE to 10.

– A value of NONE disables smoothing filters.

– Disabling smoothing will maximize the speed of flame detection.

– A value of 1 provides the minimum amount of smoothing.

– A value of 10 provides the maximum amount of smoothing.

Delay Drop-Out

Delay Drop-Out function is a “Time-Delay on Drop-Out” feature for flame detection. If a Flame-Proven condition exists, and one or more of the Measured-Values are below or above the Trip Points, this function will provide a delay before:

– Voting a Flame-Off condition

– De-energizing Flame-relay(s)

This feature allows the Flame Scanner to ride through transient events. The user can set the amount of Time-Delay from 0.2 to 4.0 seconds. This parameter is also related with known FFRT (Flame Failure Response Time).

For safety reasons, the user is requested to prove the Flame Failure Response Time (FFRT) of the SF910i under any burner load/fuel conditions and under any selected file of parameters. For EN298 application, the user needs to set the **DELAY DROPOUT** parameter to <= 0.9s to fulfill the requirement of EN 298 that the FFRT shall not exceed one second. If there are further adjustments of the flame detector (DELAY DROPOUT), do not cause the time to rise above one second.

Delay Pull-In

Delay Pull-In function is a “Time-Delay on Pull-In” feature for flame detection. If a proven Flame-Off condition exists, and one or more of the active Measured-Values exceed the programmed Pull-In values, the SF910i will delay before:

– Providing a Flame-On signal

– Energizing the Flame-relay(s)

The user can set the amount of time for the delay, and this only allows enough time to ensure that the fuel-supply-valves clear the fully-opened limits before the SF910i proves flame.

This feature allows the Flame Scanner to ride through transient events. The user can set the amount of Time-Delay from 0.1 to 10.0 seconds.

Quality Threshold

Quality Threshold allows the user to specify a threshold on quality level. If the Safe-relay usage is configured as “Quality-relay”, the Safe-relay will be energized if the calculated quality is equal or above the configured threshold and will be de-energized if the calculated quality is below the configured threshold.

If the Safe-relay is not used as Quality-relay, this parameter has no effect.

12 Firmware Downloader Tool

Firmware Downloader is an optional tool that allows to download new firmware versions into the SF910i.

When a new firmware version is received, start this tool and follow the simple instructions. At the end of the download, the SF910i starts immediately to execute the newly downloaded program image.

Must something go wrong during firmware download, to force the unit to go back in download mode, power off the module, and then power it on again keeping both **UP** and **DOWN** buttons pressed at the same time. After few seconds, the module will bring itself in firmware download mode (on the display the user will see “L00”).

Note that, during firmware download, Safe-relay is kept energized, whilst Flame-relay is kept de-energized.

New firmware versions usually do not provide configuration-related issues which means that new versions will always be backwards compatible. For example, if the user have version A.4 installed on the module, and the user receive A.5, the user can safely download it without losing (or needing to change) the current configuration.

Must the user receive versions with a different letter (for example, “B.x” and the user have “A.x”) read carefully the release notes to verify whether the user have a configuration issue and proceed accordingly. If in doubt, contact ABB field service.

13 Relay Assignment

Relay Specifications

There are two relays mounted in the SF910i. Each relay has a single pole (NO - Common) contact arrangement.

Refer to Appendix A for detailed relay specifications.

Assigning Relay Use

The user can specify the purpose of each relay based on the requirements. Change relay assignments using Configuration-Mode parameters.

– Relay A - It (usually referred to as ‘flame relay’) is always assigned as the Flame-relay. It energizes when a Flame-Proven condition occurs, and no faults are detected by the diagnostic and self-checking.

– Relay B - It (usually referred to as ‘safe relay’) can be used for four different purposes depending on the needs. The options are outlined below in the table.

Table 13.1: Possible Use of Relay B

Usage of Relay B	Explanation
Safe-relay	This is the default usage. Most of applications will use Safe-relay as “Safe relay”. Safe-relay is energized when no faults or other critical conditions are detected. When a fault or critical condition is detected, it de-energizes. This event will also always de-energize relay A. For SIL2 safety, IEC 60730-1, CAN/CSA E60730-1, or EN298 application, Safe-relay needs to be set into “second flame relay” condition, and must be serially connected with Flame-relay contacts by customer to fulfill safety redundancy output
Second Flame-relay	Relay B can be also used as a second Flame-relay. It energizes when flame is proven using the alternative function set (if single sensor). It energizes when the flame is proven for the second sensor and the second sensor is logically connected to this relay. For SIL2 safety, IEC 60730-1, CAN/CSA E60730-1, or EN298 application, Safe-relay needs to be set into “second flame relay” condition, and must be serially connected with Flame-relay contacts by customer to fulfill safety redundancy output

Table 13.1: Possible Use of Relay B (Continued)

Usage of Relay B	Explanation
Quality-relay	Relay B can be used as a flame quality relay. In this case, it energizes when the calculated quality is equal or above the programmed quality threshold and de-energizes if the calculated quality is below the programmed quality
Flame Temperature-relay	Relay B can be used as flame temperature relay (for pyrometer sensor only). In this case, it needs to set a threshold above which the safe relay closes and below which it opens
Core Temperature-relay	Relay B can be used as internal temperature relay. In this case, it energizes when the temperature inside the enclosure is normal, and it de-energizes if the temperature becomes abnormally high (but the module is still safe to operate)

14 Flame Temperature Measurement

SF910i Flame Scanner can be equipped with the pyrometer sensor (coded as IRT).

In this case, although SF910i automatically configures itself to make the IRT sensor operating on module, it needs to set up some settings required for a correct measurement, as well as display of flame temperature.

Note that the IRT sensor is calibrated at factory set up time and the calibration result is downloaded into the Flame Scanner module. The result of the calibration procedure is also stored in a file (the “Te Vector” file), where, for each sensor, its own calibration characteristics are stored. Later, the calibration data file named with *.dat* must be downloaded into the SF910i through the Flame Explorer tool.

When the IRT sensor is used, the local programming facility adds automatically the new field “TEM”, where it can configure the following flame temperature settings:

– The flame temperature calculation average (SMO) (configurable from 10 to 60 seconds).

– The flame temperature scale (SCA) (configurable as either Celsius or Fahrenheit).

– The flame temperature relay threshold (TTH). This field is meaningful when the safe relay is set to be used as flame temperature relay (see Usage of Relay B par.). This parameter is the threshold value above which the safe relay closes and below which it opens. The safe LED will change from red to green when flame temperature is above the threshold.

– Opportunity to set new values for the **m** (MCF) and **q** (QCF) coefficients (used in the temperature control algorithm). The default value of **m** is 1.00, and the default value of **q** is 0.00.

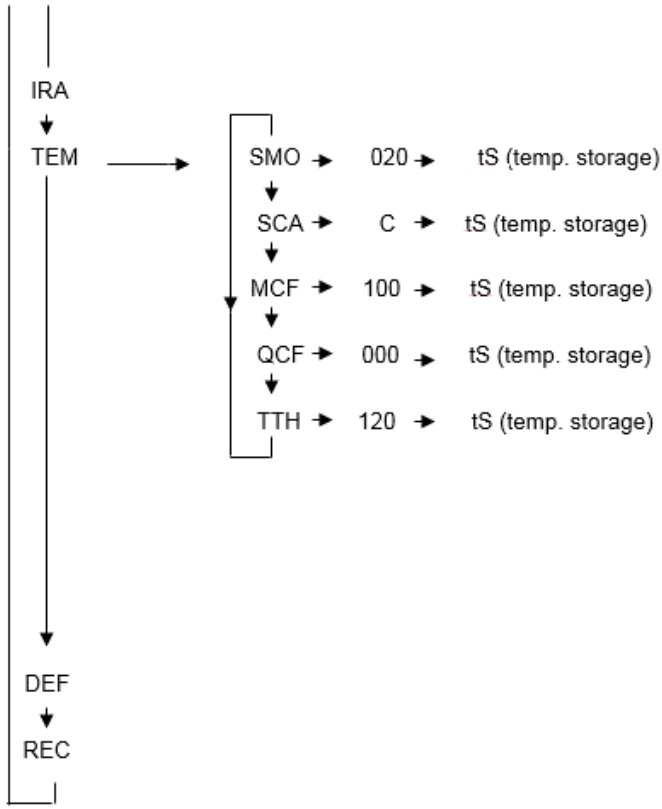


Figure 14.1: Flame Temperature Parameters Local Menu

Although the IRT sensor is calibrated and does not need further tuning, exceptionally, the **m** and **q** above items are inserted to allow to experienced staff to do additional tuning, if the current job could require it.

The default settings for the above new fields are:

1. Flame temperature calculation average set to 20 seconds.
2. Flame temperature scale set to Celsius.
3. Flame temperature relay threshold set to 1200 degrees. For local display needs, the displayed value is the real one divided by 10.

As shown below, the user can configure the flame temperature settings also using the Flame Explorer tool vers.5.5.2.

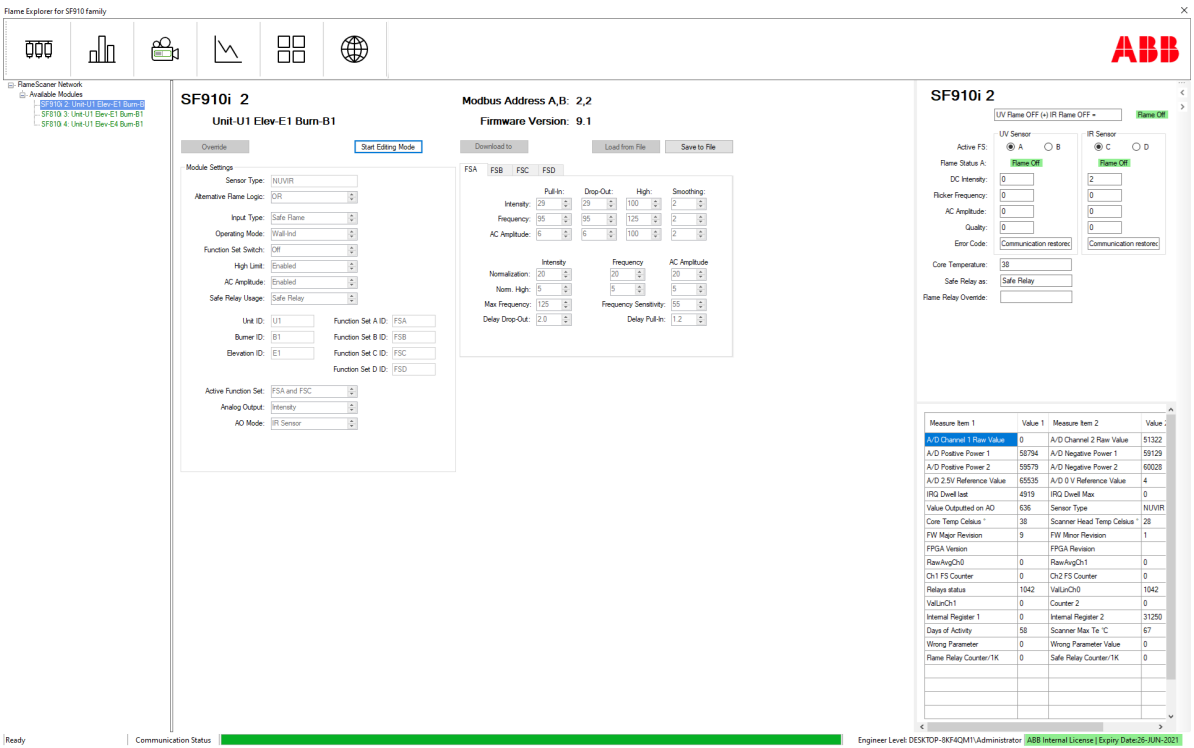


Figure 14.2: Flame Temperature Parameters Screen

15 Serial Interfaces

SF910i has one MODBUS serial communication channel. SF910i is a “slave” station, and this means that it never sends messages if not requested to do so by a master station, so it only sends replies when receives requests addressed to it. The replies are sent on the same channel over which requests are received.

15.1 Physical Level of Communication

The serial communication channels are implemented in hardware using the RS-485 industry de-facto standard. It is a pair of copper wires that carry differential signals (D+ and D-) plus a shield and a GND reference. Usually, the bus must be terminated with its characteristic impedance (120 Ohm).

15.2 MODBUS Protocol

The master to successfully communicate with a SF910i configured with the default parameters must be configured.

Table 15.1: RS-485 Serial Interface Default Settings for MODBUS Protocol

Parameter	Value
Baud rate	38400 bps
Parity	Even
Stop bits	1
Data bits	8
Addresses	1 to 254

Baud rate on the SF910i must be changed through the local display and touch-buttons. Stop bits, parity, and data bits are fixed and cannot be modified.

The device address can be changed through Flame Explorer.

15.2.1 MODBUS Registers

Coil Status Registers

The coil status registers provide access to the SF910i relay values. These values are read using MODBUS function code 1.

This information can be read by any MODBUS master conveniently configured.

Table 15.2: Coil Status Registers (MODBUS)

Coil Status	Register Address
Flame status (0 = no flame and 1 = flame)	3000
Flame status for second sensor (if dual)	3001
FSA is used for Flame Calculation Algorithm on Flame-relay	3002
FSB is used for Flame Calculation Algorithm on Flame-relay	3003
FSC is used for Flame Calculation Algorithm (single sensor, dual sensor, or Safe-relay as second Flame-relay)	3004
FSD is used for Flame Calculation Algorithm (single sensor, dual sensor, or Safe-relay as second Flame-relay)	3005
Combined Unit Fault Status (0 = no fault and 1 = fault)	3006
Scanner Fault (0 = no Scanner-Fault and 1 = Scanner-Fault)	3007
Sensor 1 Fault (0 = no fault and 1 = fault)	3008
Sensor 2 Fault (0 = no fault and 1 = fault) If dual sensor only	3009
The scanner is using the factory default configuration (0= no, normal condition and 1 = yes, the module must be configured)	3010
The flame relay is currently overridden (1 = no and 1 = yes)	3011
The scanner is executing an Auto Tune procedure (0 = no and 1 = yes)	3012
Flame status for second Function Set (if single and Safe-relay as second Flame-relay (0 = no flame and 1 = flame)	3013
The safe relay is closed (meaningful is safe relay used as quality or temperature relay)	3014
Spare	3015

Input Registers (Process Values)

The input registers provide the ability to read the scanner process values to a MODBUS master. These values are read using MODBUS function code 4. MODBUS master cannot write to these values. The process values use the following MODBUS registers, including spare registers provided for future expansion.

These registers are 16-bits long. Since all the informations contained in this table is no longer than 8 bits, information is packed into two values every 1 bits to make the data transfer faster.

This information can be read by any MODBUS master conveniently configured.

Table 15.3: Process Value Registers (MODBUS)

Scanner Process Values	Register Addresses (decimal)
Flame status (0 = no flame and 1 = flame) Flame status for second sensor, if dual (0 = no flame and 1 = flame)	5100 Lo 5100 Hi
Flame status for second flame relay, if single (0 = no flame and 1 = flame) Spare	5101 Lo 5101 Hi
Active Function Set for Flame-relay Active Function Set for dual sensor of Safe-relay as second Flame-relay	5102 Lo 5102 Hi
Composed scanner fault Combined scanner fault	5103 Lo 5103 Hi
Fault on sensor 1 (0 = no fault) Fault on sensor 2 (0 = no fault)	5104 Lo 5104 Hi
Program change status (counter of the times configuration are changed, between 0 and 100, then rolls to zero) Spare	5105 Lo 5105 Hi
Intensity for sensor 1 Flicker-Frequency for sensor 1	5106 Lo 5106 Hi
AC-Amplitude for sensor 1 Quality for sensor 1	5107 Lo 5107 Hi
Combustion index for sensor 1 (not supported) Spare	5108 Lo 5108 Hi
Intensity for sensor 2 Flicker-Frequency for sensor 2	5109 Lo 5109 Hi
AC-Amplitude for sensor 2 Quality for sensor 2	5110 Lo 5110 Hi

Table 15.3: Process Value Registers (MODBUS) (Continued)

Scanner Process Values	Register Addresses (decimal)
Flame temperature high byte Flame temperature low byte	5111 Lo 5111 Hi
Intensity for sensor 1, if safe as second Flame-relay Flicker-Frequency for sensor 1, if safe as second Flame-relay	5112 Lo 5112 Hi
AC-Amplitude for sensor 1, if safe as second Flame-relay Quality for sensor 1, if safe as second Flame-relay	5113 Lo 5113 Hi
Collected data can be sent to FEX (0 = no, 1 = yes, and 2 = stop) Spare	5114 Lo 5114 Hi
DTC version flag (0x0a = Rev 04L and 0x0e = Rev 004) Spare	5115 Lo 5115 Hi
Spare (also spares 5116 and 5117) Sensor type (IR, UV, and DUAL)	5118 Lo 5118 Hi

Holding Registers (Programmable Parameter Registers)

The holding registers provide the ability to read/set the scanner parameter values to/from a MODBUS master.

Change these values only using the Flame Explorer tool. There is an automatic procedure that performs safety operations in the Flame Explorer tool. This cannot be replicated (and MUST not be replicated) on a generic MODBUS master.

Table 15.4: Channel Configuration Parameter Registers (MODBUS)

Scanner Configuration Parameters	Register Addresses
Reserved for ABB	4000-4004
MODBUS address on serial #1	4005
MODBUS address on serial #2	4006
Sensor type (single or dual)	4007
Flame logic on dual sensor (OR/AND)	4008
Flame-relay usage (Safe-relay, second Flame-relay, Quality-relay, and Temperature-relay)	4009
Operating mode	4010

Table 15.4: Channel Configuration Parameter Registers (MODBUS) (Continued)

Scanner Configuration Parameters	Register Addresses
Function Set Switch (Off, through Serial Line, and through Digital Inputs)	4011
Enable High Limit (NO/YES)	4012
Enable AC Amplitude (NO/YES)	4013
Unit ID	4014-4017
Elevation ID	4018-4021
Burner ID	4022-4025
Function-set ID A	4026-2029
Function-set ID B	4030-4033
AO Output mode	4034
AO Output source (Intensity, Frequency, AC-Amplitude, Quality.CI)	4035
Spares	4036-4056
Function-set ID C	4056-4059
Function-set ID D	4060-4063

These values are read using MODBUS function code 3 and written to using MODBUS function code 6 or 16.

The parameters require 64 MODBUS registers for the scanner configuration (including spare registers provided for future expansion), and 40 registers for each of the four function-sets (including spare registers). This is a total of 230 registers per scanner. This means that two MODBUS requests are required to access all the parameters for one SF910i scanner.

The user must update an entire Tuning Function-Set in one MODBUS request to ensure that all the parameters are consistent and that all are accepted or all are rejected.

Table 15.5: Tuning Function-Set Parameter Registers (MODBUS)

Tuning Function-Set Parameters	Register Addresses
Function-set A	
Intensity Trip Point Pull-In (IP)	4070
Intensity Trip Point Drop-Out (ID)	4071
Intensity Trip Point High (IH)	4072
Intensity Normalization (IN)	4073

Table 15.5: Tuning Function-Set Parameter Registers (MODBUS) (Continued)

Tuning Function-Set Parameters	Register Addresses
Intensity Normalization High (INH)	4074
Intensity Filter Select	4075
Frequency Trip Point Pull-In (FP)	4076
Frequency Trip Point Drop-Out (FD)	4077
Frequency Trip Point High (FH)	4078
Frequency Normalization (FN)	4079
Frequency Normalization High (FNH)	4080
Frequency Filter Select	4081
AC-Amplitude Trip Point Pull-In (AP)	4082
AC-Amplitude Trip Point Drop-Out (AD)	4083
AC-Amplitude Trip Point High (AH)	4084
AC-Amplitude Normalization (AN)	4085
AC-Amplitude Normalization High (ANH)	4086
AC-Amplitude Filter Select	4087
Maximum Frequency	4088
Flame-relay Trip Time	4089
Pull-In Delay Time	4090
Frequency Sensitivity	4091
Quality threshold	4092
Function-Set B	4110-4132
Function-Set C	4150-4172
Function-Set D	4190-4212

Program Enable Register

SF910i requires a degree of procedural security to allow scanner configuring and tuning. This is obtained through the exchange of a set of MODBUS commands between Flame Explorer and SF910i before configuration can be changed. This exchange is proprietary ABB and is not described here.

16 Troubleshooting

This section addresses the troubleshooting of SF910i in two parts. The first applies to the Line-Of-Sight version (LOS) also called “Direct View”, and the second applies to the Fiber Optic Cable (FOC) version.

16.1 Troubleshooting LOS

Table 16.1: Troubleshooting LOS

Problem	Possible Causes	Corrective Actions
SF910i does not sense the flame	Scanner is not aimed on the target flame Combustion is bad Wrong wiring to the scanner Lens is dirty Electronics boards failure	Loose the swivel flange and aim the scanner properly Ask for the authorized personnel to take actions Check wiring Make sure that the cooling/purging air matches the requirements, and follow the maintenance instruction for cleaning Replace the unit
Flame is detected but the flame relay does not energize	Device is in “First Time Power Up” Wrong wiring to the scanner Flame-relay contact failure	Change or confirm the factory default setting and store it Check wiring Replace the device
Error code on display	Hardware failure (?)	Find out the error code in Section 17 Cycle SF910i power -OFF and then -ON. If the error recurs, then decide if the unit needs to be replaced or if the cause can be external
SF910i device does not exchange data with Flame Explorer	Rx/Tx +/- polarity reversed on ATB or RS485 line converter RS232/RS485 serial line converter driver not installed or not compatible with the PC-WIN OS running Flame Explorer	Review SF910i connection earlier on this manual and make wiring congruent with serial converter outputs

Table 16.1: Troubleshooting LOS (Continued)

Problem	Possible Causes	Corrective Actions
	Flame Explorer network not initialized Wrong communication protocol	Search for the original manufacturer driver, make sure it complies with the PC Win-OS running Flame Explorer and execute the installation wizard Refer to Section 8.3.6 for COM parameters setting

16.2 Troubleshooting FOC

Table 16.2: Troubleshooting FOC

Problem	Possible Causes	Corrective Actions
SF910i does not sense the flame	Combustion is bad Lens at the hot side is dirty Wrong wiring to the scanner Fiber optic bundle is damaged Electronics board failure	Ask for the authorized personnel to take actions Make sure that the cooling/purging air matches the requirements, and follow the maintenance instruction for cleaning Check wiring Replace the fiber optic bundle and make sure no levers or mechanical bodies bangs or bends sharply the outer carrier Replace the unit
Flame is detected but the flame relay does not energize	Device is in “First Time Power Up” Wrong wiring to the scanner Flame-relay contact failure	Change or confirm the factory default setting and store it Check wiring Replace the device
Error code on display	Hardware failure (?)	Find out the error code in Section 17

Table 16.2: Troubleshooting FOC (Continued)

Problem	Possible Causes	Corrective Actions
		Cycle SF910i power -OFF and then -ON. If the error recurs, then decide if the unit needs to be replaced or if the cause can be external
SF910i device does not exchange data with Flame Explorer	Rx/Tx +/- polarity reversed on ATB or RS485 line converter RS232/RS485 serial line converter driver not installed or not compatible with the PC-WIN OS running Flame Explorer Flame Explorer network not initialized Wrong communication protocol	Review SF910i connection earlier on this manual and make wiring congruent with serial converter outputs Search for the original manufacturer driver, make sure it complies with the PC Win-OS running Flame Explorer and execute the installation wizard Refer to Section 8.3.6 for COM parameters setting

17 Diagnostics

SF910i runs internal self-checking diagnostic routines for every 0.125 seconds. The list of error codes and related descriptions are shown in the tables of this section.

The error information is shown on the LCD display. When non-fatal, it is reported through the serial communication channels (MODBUS).

When using MODBUS, the errors can be seen in the relevant Flame Explorer Software screen (refer to *SF910i Flame Explorer User Manual (8VZZ005308)*).

Due to safety reasons, only a small set of errors leaves the SF910i in operation. Most errors bring the SF910i to a HALT mode in safe condition (no more program execution, all outputs into a safe state, both relays de-energized).

For the dual-sensor version, if a “Sensor-Fault” occurs, then the associated Flame-relay is de-energized, and the associated LED becomes solid red.

Safety mode for outputs. When a fault is detected, the SF910i, before stopping execution, brings the values of outputs to the safety values listed below in the table.

Table 17.1: Safety Outputs

Output Source	Safety Value
Safe-relay	OFF (de-energized)
Flame-relay	OFF (de-energized)
Analog output	3.5 mA
Safe LED	Red
Flame LED	Red
Power LED	Green
Display	Error code (see tables)
Comm lines(1)	Disabled

(1). In this way, the transmitter is disabled, and communication between master and the other SF910i on a multi-drop line will not be affected.

17.1 Failures Detected by On-board Diagnostic Routines

17.1.1 Fatal Errors

Error messages (if possible) will be shown on the local display.

Table 17.2: Program Monitoring Error Message

Program Monitoring Error Message	Description
TASK MONITORING FAILURE	At least one major software task is not executing timely
TIME SLOT MONITORING FAILURE	Time slot monitoring of interrupt routines fail (no interrupts or interrupts too frequent)
CTRL FLOW FAILURE	Check control flow failed
DEAD MAN TIMER FAILURE	Background diagnostic functions not executed
MAIN PROGRAM MONITORING FAILURE	Main program execution time frame failure

Table 17.3: Instruction Execution Error Message

Instruction Decoding Error Message	Description
CPU INSTRUCTION FAILURE	CPU's instruction set failure

Table 17.4: Memory Error Message

Memory Error Message	Description
FLASH CRC FAILURE	Program memory failure
STACK OVERFLOW FAILURE	Stack(s) overflow and/or underflow
FRAM CRC FAILURE	Check for setup data (parameters) fail
WRONG FW DOWNLOAD	RAM variables for firmware download are OK, but in flash it is no exist
RAM TEST FAILURE	RAM test

Table 17.5: Hardware Circuitry Error Messages

Hardware Circuitry Error Messages	Description
POWER FAILURE	24V power level reached a value over 28.8V or below 15V
VRELAY ERROR	Check VRELAY signal failed
LOCAL KEYBOARD FAILURE	At least one local button is shorted

Table 17.5: Hardware Circuitry Error Messages (Continued)

Hardware Circuitry Error Messages	Description
OVERTEMPERATURE	Over temperature
FLAME RELAY FAILURE	Flame-relay 1 driving failure
SAFE RELAY FAILURE	Flame-relay 2 driving failure
SENSORS VALUES TOO HIGH	The input signal of both sensors are higher than 2.45V
SENSOR TYPE UNKNOWN	Sensor type unknown
SENSOR SHORT FAILURE	Check internal sensor short fault
INPUT SIGNAL TOO HIGH	Input signal too high
FRAM DEADLOCK	EEPROM is no longer responding to read/write requests
A/D CONVERSION FAILURE	Analog input wrong conversion
REFERENCE VOLTAGE FAILURE	2.5V reference voltage failure
ZERO VOLTAGE FAILURE	0V reference voltage failure
CHANNEL 1 VOLTAGE FAILURE	Sensor 1 voltage fail
CHANNEL 2 VOLTAGE FAILURE	Sensor 2 voltage fail
CLOCK TEST FAILURE	Wrong frequency: there is a discrepancy between the CPU oscillator

17.1.2 Non-Fatal Errors

Error messages for non-fatal errors are reported through the serial communication channels, and stored in the Fault History field of the local display.

Table 17.6: Faults Messages and Description

Error Message	Description
NO INPUT SIGNAL	Low-voltage input and low Flicker-Frequency (less than 5 Hz) [Safe Flame only]
HIGH INPUT LIMIT	High voltage limit reached [Safe Flame, 4 to 20 ma]
FREQUENCY HIGH	Low intensity and high Flicker-Frequency error, based on the three following conditions: – If Intensity Drop-Out is > 3 AND – Current Intensity is <= 3 AND – Frequency > 98

Table 17.6: Faults Messages and Description (Continued)

Error Message	Description
RAMS INVALID PARAMS	Occurs when parameters are invalid at startup, and input types have changed since the last startup or software version has changed since the last startup (this error will automatically switch the product over to First-Time Power up Mode)
EEPROM WRITE	Occurs when parameters cannot be saved to the EEPROM (this error will automatically switch the product over to initial startup menu)
EEPROM READ	Occurs when parameters cannot be saved to the EEPROM (this error will automatically switch the product over to initial startup menu)

If a Channel-Fault occurs, the Flame-relay associated with the channel will be de-energized.

1. The associated Channel LEDs will blink red.
2. The Fault-relay LED will blink red.

If a Product-Fault occurs, all LEDs will blink red.

17.2 Noise Error on Flame Channel

SF910i features a continuous self-check on the incoming flame signal(s) to prevent any electrical value deemed inconsistent with “real” flame, from being processed as such thus to lead to unsafe operation.

Electrical signals that are in the same frequency and intensity range of the flame are:

– Electrical noises

– Fault of the sensor board

– AC lights, and so on

For example, SF910i can detect the frequency values that are too stable to be generated by a flame and associate them with an error that is called ‘noise detected’. This error is reported if, for instance, the user point the sensor towards a fixed light source such as the neon light in the room. Since any flame cannot have a ‘constant’ frequency, the detection of a constant frequency may also be related to an error in the sensor electronics.

Whenever any of the above condition is met:

– SF910i stops program execution and shows on the display as the error code “noise detected”.

– All outputs are brought in safe state:

  • SF910i sends the noise detected fault message over the serial line.

  • The associated flame relay will be de-energized.

  • The associated channel LED will blink red.

  • The Fault-relay LED will blink red.

For safety reasons, the Flame Scanner normal operations after a fatal error code are triggered, can only be recovered by cycling the power supply.

18 Maintenance/Cleaning/Inspection

18.1 Maintenance

There is no periodic maintenance of the SF910i and its related mounting accessories. Only a periodical cleaning is required.

For FOC versions, the fiber optic assembly, instead, can be disassembled for replacement, cleaning, re-alignment of the focal distances.

All repair/replacement operations must be executed by trained and authorized personnel only.

Dangerous voltage (up to $50V_{AC}$) can be present on the relay terminals. Verify and disconnect any dangerous voltage before proceeding.

Operating temperature of the enclosure is close to 80°C (176°F) when operating in 70°C ambient (158°F).

The unit under maintenance can be covered by ash and carbon particles.

Use protective clothing, gloves, and glasses.

SF910i (Ex certified versions) complies with the safety rules for installation in explosive atmosphere. Assembling and disassembling procedures shall be made strictly in accordance with the *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

18.2 Cleaning

Cleaning of the SF910i is limited to a periodic removal of ashes, carbon particles, and other dusts and oils that might be deposited on the external surface of the enclosure.

Cleaning is needed to avoid excessive buildup of ashes and carbon particles that might prevent an efficient thermal dissipation to ambient air.

Since it strongly depend on the general cleanness of the environment, no cleaning schedule is given here.

Version equipped with a lens (Line Of Sight versions) might require a cleaning of the lens itself in the following cases:

– The purging air is not clean.

– The purging air system is non-working for a period of time.

Proceed with the following steps:

1. Read all the warnings at the beginning of this section, refer to *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.
2. Turn-off the power supply.
3. Close the manual isolating valve (where provided).
4. Loose the thermal union and remove the unit.
5. Clean the scanner lens. Use degreases liquid. Do not use abrasive tools. Let it dry.
6. Relocate the unit to the mounting (thermal union).
7. Open the manual isolating valve.
8. Turn-on power supply.

18.3 Fiber Optic Maintenance

Maintenance of the fiber optic assembly when present is given in the following procedures:

1. Read all the warnings at the beginning of this section, refer to *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.
2. Turn-off the power supply (optional).
3. Loose the locking ferrule and remove the unit.
4. Withdraw the inner carrier.
5. In case, the fiber optic needs replacement or focal length adjustments, follow Section 19.2 next.
6. Clean the lens. Use degreaser liquid. Do not use abrasive tools/substances. Let it dry.

7. Check the color of the lens holder tip (hot terminal), and it must be light-gray. Darker colors (like brown or violet) reveal the fiber optic has operated above the allowed maximum temperature. In this case, investigate the following:
   – Cooling air pressure (see requirements in Appendix B)
   – Cooling air hose (avoid sharp bend)
   – Burner throat or diffuser
8. Re-insert the inner carrier.
9. Relocate the unit to the mounting (thermal union).
10. If power supply was turned-off, then turn it on.

18.4 Inspection

Even if the SF910i has a powerful self-test capability, a small number of failures, not related to safety are not automatically detected by the self-test. They are:

– Failure of the display
– Failure of LEDs
– Failure of the 4-20mA analog output (can be detected by the system that is connected to it)
– Failure of one communication line (can be automatically detected by the master of the network)

A periodic inspection of the above items can be scheduled at, for instance, 1 year period.

19 Repair and Replacement

This section contains the detailed procedures to replace the SF910i (if it is a Fiber Optic Cable (FOC) version) to repair or replace the fiber optic assembly.

In case, the user need to replace the whole SF910i, follow the procedures given in this section.

It is not possible to repair the internal parts of the SF910i.

All repair/replacement operations must be executed by trained and authorized personnel only.

Dangerous voltage (up to $50V_{AC}$) can be present on the relay terminals. Verify and disconnect any dangerous voltage before proceeding.

Operating temperature of the enclosure is close to 80°C (176°F) when operating in 70°C ambient (158°F).

The unit under maintenance can be covered by ash and carbon particles.

Use protective clothing, gloves, and glasses.

SF910i complies with the safety rules for installation in explosive atmosphere. Assembling and disassembling procedures shall be made strictly in accordance with the *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

19.1 Whole Unit Replacement

19.1.1 Versions with Removable Terminals

1. Read all the warnings at the beginning of this section, refer to *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.
2. Initially power-on the replacement unit on a work-bench in a safe area, and configure its protocol (MODBUS) and its node address as the unit to be replaced. Refer to communication network parameters.
3. Turn-off the power supply.
4. Wear the anti-static wrist strap or equivalent system.
5. Loose the locking screw on the cover (requires an allen wrench).
6. Unscrew the cover.
7. Unplug all the removable connectors and “shield” terminal from the round board after taking note of the assignment.
8. Loose the cable gland and unscrew it from the enclosure.
9. Carefully remove the cable harness from the enclosure.
10. Unscrew the whole enclosure from the mechanical adapter that holds it at the light entrance port.
11. If an optical fiber is present, clean its cold terminal before proceeding.
12. Mount the new unit in place.
13. Insert the cable harness in the cable entry bore.
14. Re-install the cable gland.
15. Plug all the connectors and “shield” terminal in the respective sockets in the round board.
16. Re-install the cover and tight the locking screw. Follow the requirement as in *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

No tightening tool is required. Hand turning is recommended up to complete closure (minimum 6 turns). Socket head screw must be tightened to prevent the lid from loosen.

19.1.2 Connector Versions

1. Read all the warnings at the beginning of this section, refer to *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.
2. If the unit to be replaced is connected to a data communication network, initially power-on the replacement unit on a work-bench in a safe area, and configure its protocol (MODBUS) and its node address as the unit to be replaced. Refer to communication network parameters.
3. Turn-off the power supply.
4. Disconnect the quick release connector.
5. Disconnect the earthling cable, and make sure not to lose the screw and washer.
6. Unscrew the whole enclosure from the mechanical adapter that holds it at the light entrance port.
7. If an optical fiber is present, clean its cold terminal before proceeding.
8. Mount the new unit in place.
9. Re-connect the earthling cable with its screw and washer.
10. Reconnect the quick release connector.
11. Make a final check against the requirements of the *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

19.2 Fiber Optic Replacement

All repair/replacement operations must be executed by trained and authorized personnel only.

Dangerous voltage (up to $50V_{AC}$) can be present on the relay terminals. Verify and disconnect any dangerous voltage before proceeding.

The temperature of the hot terminal is 350°C or higher (662°F).

The unit under maintenance can be covered by ash and carbon particles.

Use protective clothing, gloves, and glasses.

SF910i complies with the safety rules for installation in explosive atmosphere. Assembling and disassembling procedures shall be made strictly in accordance with the *SF910i Safety Instruction Manual (EC-DOC-G041MAN033)*.

The fiber optic assemblys brass plug must be protected against impact, cut, and abrasion. Failing to do the above will affect the safety behavior in Ex-environment.

1. Remove the SF910i inner assembly by losing the ring nut.

Figure 19.1: FOC Assembly - Losing Ring Nut

2. Pull gently the fiber optic assembly out of the inner guide pipe.

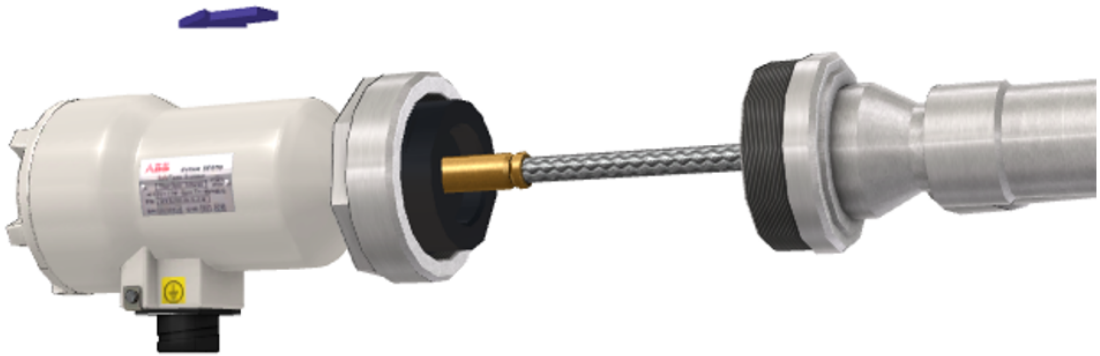


Figure 19.2: FOC Assembly - Pulling Fiber Optic Bundle

3. Remove the SF910i enclosure.

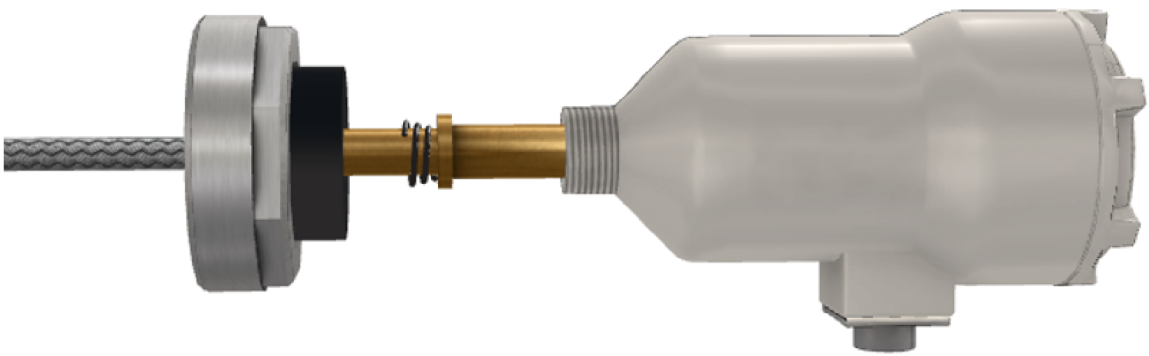


Figure 19.3: FOC Assembly - Release the Enclosure

4. Free the fiber optic bundle from the lens barrel hot side.

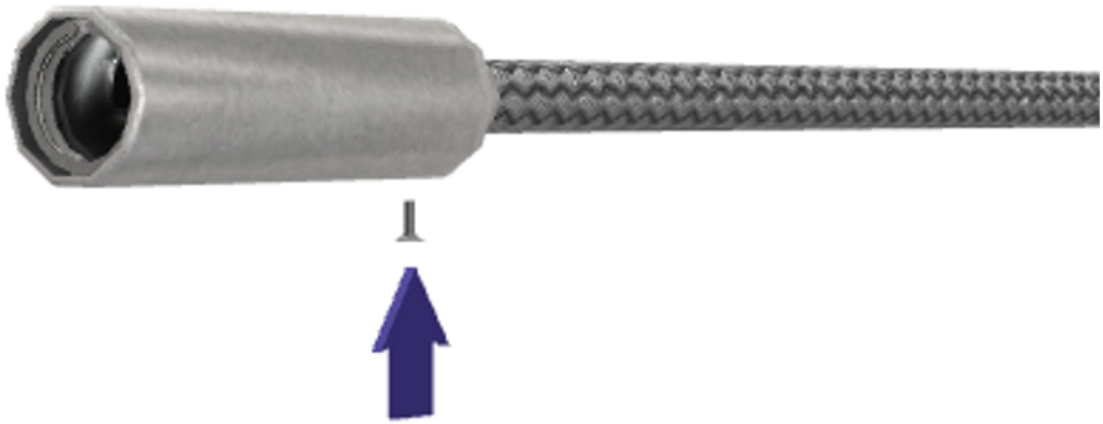


Figure 19.4: FOC Assembly - Release the Lens Barrel

5. Replace the fiber optic bundle.

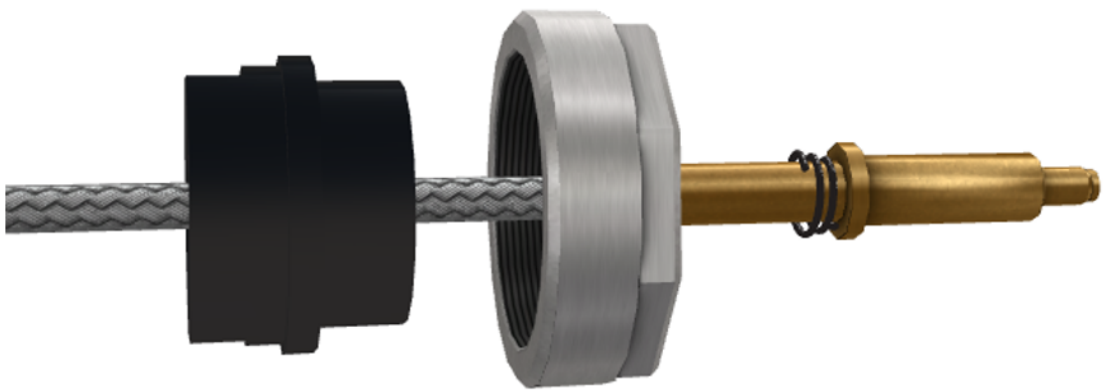


Figure 19.5: FOC Assembly - Replace the Fiber Optic Bundle

6. Plug the fiber optic hot end side into the lens barrel seat and secure it with the allen head screw.
7. Push gently the fiber optic assembly all the way into the guide tube. A spare length of about 30 to 40 mm (1 ½”) is acceptable and can be hosted in the guide tube.

8. Fit in place the SF910i Flame Scanner.

20 End of Product Life Cycle

SF910i is manufactured using materials that do not require special treatments. It does not contain radioactive materials.

SF910i does not contain batteries.

Local regulations might apply to the disposal of electronic assemblies.

21 Cyber Security Deployment

Cyber security measures need be taken to protect the reliability, integrity, and availability of power and automation technologies against unauthorized access or attack. ABB recognizes the importance of cyber security in control-based products/systems and solutions for infrastructure and industry, and is working closely with the customers to address the new challenges.

Below measures are strongly suggested:

– **On physical access**: The device local configuration can only be done manually by workers near the device and through touch key buttons, where the products are located near the burners, where is physically protected area in customer site (including commissioning, configuration, maintenance phase, and so on), and only authorized workers can access it, which is the trust boundary.

– **On interacting with the products**: The touch key buttons could only be operated by human finger with certain keying speed using specific buttons-combination that are accepted to avoid wrongly pressing, and specific configuration value rules are applied to avoid wrong value setting.

– **On ATB/CPU board**: Not open/disassemble the ATB + CPU + SE board. Do not touch or operate the CPU programming interfaces in the CPU board located inside the enclosure/beneath the ATB (termination board) PCBA, which are sealed and not allowed customer to access through warranty paper (anti-tear sticker). Otherwise, the warranty is also lost.

– **On Modbus communication**: Secure the Modbus RS485 communiation lines are not attacked/destroyed/interfered/traced/spoofed by outsiders, for example, through physics restriction on related wiring/looping area. And plant management engineers shall strictly manage the MODBUS/RTU network and ensure that all other devices connected to the network are fully trusted.

– **On Modbus host**: As stated in *SF910i Flame Explorer User Manual (8VZZ005308)*.

Appendix A Specifications

A.1 Technical Specifications

Table A.1: Technical Specifications

Property	Value
Optical spectrum	IR versions: 320 -1100 nm peak sensitivity @ 920 nm UV versions: 210 - 360 nm peak sensitivity @ 280 nm UVIR versions: Combination of above IR and UV sensitivities PYR: Dual colors IR
Optical sensor technology	IR versions: Si photodiode UV versions: SiC photodiode UVIR versions: One Si and one SiC photodiodes PYR: Si Photodiode
Power supply voltage	$24V_{DC}$ (-25%, +20% = 18 - $29V_{DC}$)
Power supply current	150mA typical
Power consumption	3.6W typical and 4W maximum
Inrush current	6A peak and 2ms settling time
Hot insertion/removal	Allowed
Flame-relay Safe-relay	Contacts: 1 NO, for each relay 50 V_{AC}/1.5A cycles 100,000 48 V_{DC}/300 mA 30 V_{DC}/1.5A Minimum load 10mA, $5V_{DC}$
Flame-relay drop-out time	0.2s to 4.0s at 0.1s increments (configurable setting) 2s default
Flame-relay pull-in time	0.2s to 10s at 0.1s increments (configurable setting) 2s default
Analog output (4-20mA)	4 - 20 mA (R load <= 500) Galvanically isolated

Table A.1: Technical Specifications (Continued)

Property	Value
	Precision: +/-5% f.s. Externally powered
Communication ports	One RS-485 serial channels configurable in MODBUS protocols MODBUS speed: Selectable 9600, 19200, 38400, or 115200 baud The serial line(s) cable(s) must not be in the same tray as the relay contact wiring. The relay contact(s) is (are) wired to a circuit whose voltage is higher than 50V (AC or DC).
Local configuration interface	4 touch-buttons (UP, DOWN , LEFT, and RIGHT) LCD display
Air source for lens cleaning	From clean ambient air
Air flow for lens cleaning	LOS (Line Of Sight) versions: 115 l/min (4 SCFM) Excessive contaminants might require a flow up to 400l/min (14 SCFM) FOC (Fiber Optic Cable) versions: 400 l/min (14 SCFM)
Minimum cleaning air pressure	LOS (Line Of Sight) versions: 20mm H_2O (1” W.C.) above the maximum wind box pressure measured at the “Y” connection inlet. FOC (Fiber Optic Cable) versions: 400mm H_2O (12” W.C.) above the maximum wind box pressure measured at the “Y” connection inlet
Maximum fiber optic continuous operating temperature	Quartz fiber: 350°C (662°F) Glass fiber: 482°C (900°F)
Mounting thread	1” NPT male
Cable entry thread	¾ “ NPT female (N/A for connectorized versions)
Electrical connections (terminal versions)	Allowable cable sections: 0.05÷2mm^2 for 24V_{DC} Power and SHIELD (J5 terminal block) 0.08÷1.4mm^2 for all other terminal blocks
Enclosure earth connection	Standard yellow-green earth cable 4mm^2 minimum section 3m maximum length
Maximum length of electrical connections (by function)	– Power supply: Not specified – COMM (MODBUS): Depends on transmission speed – Analog Output (4-20mA): Not specified

Table A.1: Technical Specifications (Continued)

Property	Value
	– Relay contacts: Not specified
Mounting orientation	Any, provided that the cable entry (or quick-release connector) is facing down

A.2 Environmental Specifications

Table A.2: Environmental Specifications

Property	Characteristic/Value/Standard/Regulation
Insulation specifications	IEC 60664-1
Over voltage category Pollution degree Protection (EN 60529)	II 2 IP66/IP67 (all versions)
Ambient Operating temperature (EN/IEC 60068-2-1/2/14)	-40° to 70°C (-40° to 158°F) Below -20°C, the LCD may be blank, but all other work OK including the safety relay function. -20° to 70°C (-4° to 158 °F) with quick connector Ex models "QC" Must not be installed in direct sunlight.
Ambient Storage and transportation temperature (EN/IEC 60068-2-1/2/14)	-40°C/85°C (-40°F/185°F)
Relative humidity (EN/IEC 60068-2-78)	5 - 95% non-condensing
Vibration sinusoidal operating (EN/IEC 60068-2-6)	Frequency range: 5 - 200 Hz Acceleration: 20m/s^2 peak (2 G) Displacement: 0.15 mm peak
Shock operating (IEC 60068-2-27)	Acceleration: 15G – Duration of pulses: 11 ms duration (half sine wave) – Three shocks in each direction (six pulses in each axis)

A.3 Galvanic Isolation Specifications

Table A.3: Galvanic Isolation Specifications

CAN/CSA-E60730-1 and UL 60730-1	Test Severity levels
Rated impulse voltage	$500V_{AC}$ between enclosure earth and all terminal blocks (except relay contacts and $+24V_{DC}$ terminal). $1500V_{AC}$ between enclosure earth and relay contacts and between relay contacts

A.4 EMC Specifications

Follow the below standards:

– IEC 61000-6-2
– IEC 61000-6-4
– IEC 61000-4-29
– IEC 61326-3-1
– IEC 60730-1/CAN/CSA E60730-1
– EN 298 and EN 13611

Table A.4: EMC Specifications - 1

Category/Purpose	Standards	Design Level/Acceptance Criteria
Electro Static Discharge (ESD) Immunity	IEC 61000-4-2 IEC 61326-3-1 EN 13611	± 8 KV contact discharge ± 15 KV air discharge
Radiated, Radio-Frequency, and Electromagnetic Field Immunity	IEC 61000-4-3 IEC 61326-3-1 EN 13611	80 - 1000MHz 20V/m 1400 - 6000MHz 10V/m 80% Amplitude Modulated (1 KHz, sin.)
Electrical Fast Transient (Burst) Immunity	IEC 61000-4-4 IEC 61326-3-1 EN 13611	Relay contacts: 3 kV (5/50ns, 5 kHz) Others and Earth: 2 kV (5/50ns, 5 kHz)
Surge Immunity	IEC 61000-4-5 IEC 61326-3-1	Relay contacts: 2 kV (line to line)

Table A.4: EMC Specifications - 1 (Continued)

Category/Purpose	Standards	Design Level/Acceptance Criteria
	EN 13611	4 kV (line to ground) Others: 2 kV (line to ground)
Conducted Disturbances Immunity, induced by radio-frequency fields	IEC 61000-4-6 IEC 61326-3-1 EN 13611	10 V (150 kHz to 80 MHz, 1 kHz (80 % AM))
Magnetic Field Immunity	IEC 61000-4-8 EN 13611	30 A/m cont., 300 A/m for 1s

Table A.5: EMC Specifications - 2

Category/Purpose	Standards	Design Level/Acceptance Criteria
Conducted, Common Mode Disturbances Immunity	IEC 61000-4-16 IEC 61326-3-1	Severity Level 3 1 V to 10 V, 20 dB/Decade (1,5 kHz to 15 kHz) 10 V (15 kHz to 150 kHz) 10 V (DC, 16 2/3 Hz, 50/60 Hz and 150/180 Hz) 100 V short duration (1s, DC, 16 2/3 Hz and 50/60 Hz)
Voltage Dips and Interruptions Immunity	IEC 61000-4-29 IEC 61326-3-1 EN13611	Voltage dips: 40% and 70% UT for 10ms Short interruption: 0% UT for 10ms and 20ms 0V and Recorded Voltage to 10%
Radiated Emission and Conducted Emissions	IEC 61000-6-4	CISPR 11:2015/AMD1:2016 CISPR 16-1-1:2015 Group1, Class A, ISM Equipment

A.5 Mechanical Specifications

Table A.6: Mechanical Specifications

Property	Value
Dimensions	Diameter 95 mm maximum Overall length:180mm approximately
Weight	1.3 Kg approximately
Degree of protection	IP66/IP67 (CEI EN 60529)
Corrosion resistance	Aluminum alloy coated with Epoxy Polyester Powder. Thickness minimum 60µm, maximum 200 µm, typical 100 µm INOX versions AISI 316L available

Appendix B Proposed Initial Setting

Notes on the Proposed Initial Settings

Important values for flame detection that must be set before initial start-up are shown in bold.

Other values that can be changed, but are not critical for flame detection are shown in plain text.

Using Flame Explorer tool, the user can load from a file the predefined and default values for a wide range of standard applications. Refer to *SF910i Flame Explorer User Manual (8VZZ005308)* for details, and for a list of the pre-defined configurations that are available.

For safety reasons, the user is requested to prove the Flame Failure Response Time (FFRT) of the SF910i under any burner load/fuel conditions and under any selected file of parameters. For EN298 application, the user need to set the **DELAY DROPOUT** parameter to <= 0.9s to fulfill the requirement of EN 298 that the FFRT shall not exceed one second. If there are further adjustments of the flame detector (DELAY DROPOUT), do not cause the time to rise above one second.

B.1 Corner Applications

Table B.1: Proposed Initial Settings for Corner Applications

Application Description	Tangential-Coal w/oil Warm-up Discriminate	Tangential-Coal	Tangential-Gas only	Tangential-Oil only	Tangential-Gas and Oil
Flame Sensor Type	Visible Light Fiber Optic Scanner	Visible Light Fiber Optic Scanner	UV Fiber Optic Scanner	Visible Light Fiber Optic Scanner	VL or UV Fibre Optic Scanner
Fuel/Load Switching	On	Off	Off	On	On
Application Select	Corner	Corner	Corner	Corner	Corner
Hi Limits	Off	Off	Off	Off	Off
AC Amplitude	Off	Off	Off	Off	Off

Table B.1: Proposed Initial Settings for Corner Applications (Continued)

Application Description	Tangential-Coal w/oil Warm-up Discriminate		Tangential-Coal		Tangential-Gas only		Tangential-Oil only		Tangential-Gas and Oil	
Function Set	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Function Identifier	Coal	Oil	Coal		Gas		Low	Hi	Gas	Oil
Intensity Pickup	30	20	30		10		55	65	30	20
Intensity Dropout	30	20	30		10		55	65	30	20
Intensity Hi										
Frequency Pickup	5	30	5		20		20	15	10	30
Frequency Dropout	5	30	5		20		20	15	10	30
Frequency Hi										
AC Pickup										
AC Dropout										
AC Hi										
Quality Norm Intensity	20	20	20		20		20	20	20	20
Quality Norm Intensity Hi										
Quality Norm Frequency	15	15	15		15		15	15	15	15
Quality Norm Frequency Hi										
Quality Norm AC										
Quality Norm Frequency AC										
Frequency Sensitivity	55	60	55		30		58	58	30	60
Intensity Smoothing	5	5	5		5		5	5	5	5
Frequency Smoothing	8	8	8		5		8	8	5	8
AC Smoothing										
Delay on Dropout	2	2	2		1		2	2	1	2
Delay on Pickup										
Maximum Frequency	125	125	125		125		125	125	125	125

B.2 Wall Fired Applications

Table B.2: Proposed Initial Settings for Wall Fired Applications

Application Description	**Opposed Wall Coal with or without Oil Lighters**		**Gas Lighters on Opposed Wall Coal**		**Opposed Wall Gas with or without Oil**		**Front (or Rear) Wall Gas with or without Oil**	
Flame Sensor Type	Visible Light or IR with or w/o Fibre Optic Scanner		UV Wall Mount Scanner		UV Wall Mount Scanner		UV Wall Mount Scanner	
Fuel/Load Switching	On		Off		On		On	
Application Select	Wall/Industrial		Wall/Industrial		Wall/Industrial		Wall/Industrial	
Hi Limits	Off		Off		Off		Off	
AC Amplitude	Off		Off		Off		Off	
Function Set	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Function Identifier	Low	Hi	Gas		Low	Hi	Gas	Oil
Intensity Pickup	30	30	5		0	10	10	20
Intensity Dropout	30	30	5		0	10	10	20
Intensity Hi								
Frequency Pickup	10	5	15		15	25	15	15
Frequency Dropout	10	5	15		15	25	15	15
Frequency Hi								
AC Pickup								
AC Dropout								
AC Hi								
Quality Norm Intensity	20	20	15		15	15	15	15
Quality Norm Intensity Hi								
Quality Norm Frequency	15	15	15		15	15	15	15
Quality Norm Frequency Hi								
Quality Norm AC								

Table B.2: Proposed Initial Settings for Wall Fired Applications (Continued)

Application Description	Opposed Wall Coal with or without Oil Lighters		Gas Lighters on Opposed Wall Coal		Opposed Wall Gas with or without Oil		Front (or Rear) Wall Gas with or without Oil	
Quality Norm Frequency AC								
Frequency Sensitivity	58	58	75		75	75	55	75
Intensity Smooting	5	5	5		5	5	5	5
Frequency Smoothing	8	8	5		5	5	5	5
AC Smoothing								
Delay on Dropout	2	2	1		1	1	1	2
Delay on Pickup								
Maximum Frequency	125	125	125		125	125	125	125

B.3 Cyclone Applications

Table B.3: Proposed Initial Settings for Cyclone Applications

Application Description	Cyclone Coal and/or Oil Lighter		Cyclone Gas Lighter only	
Flame Sensor Type	Visible Light Scanner		UV Scanner	
Fule/Load switching	Off		Off	
Application Select	Wall/Industrial		Lighter	
Hi Limits	Off		Off	
AC Amplitude	Off		Off	
Function Set	**A**	**B**	**A**	**B**
Function Identifier	Coal		Gas	
Intensity Pickup	30		10	
Intensity Dropout	30		10	
Intensity Hi				
Frequency Pickup	15		25	

Table B.3: Proposed Initial Settings for Cyclone Applications (Continued)

Application Description	Cyclone Coal and/or Oil Lighter		Cyclone Gas Lighter only	
Frequency Dropout	15		20	
Frequency Hi				
AC Pickup				
AC Dropout				
AC Hi				
Quality Norm Intensity	20		20	
Quality Norm Intensity Hi				
Quality Norm Frequency	20		20	
Quality Norm Frequency Hi				
Quality Norm AC				
Quality Norm Frequency AC				
Frequency Sensitivity	60		60	
Intensity Smoothing	5		5	
Frequency Smoothing	8		5	
AC Smoothing				
Delay on Dropout	2		2	
Delay On Pickup				
Maximum Frequency	125		125	

B.4 GT and Side Igniter Applications

Table B.4: Proposed Initial Settings for GT and Side Igniter Applications

Application Description	Gas Turbine	Side Ignitor
Flame Sensor Type	IR or UV Remote Fibre Optic Scanner	Visible Light Scanner
Fuel/Load Switching	Off	Off
Application Select	Turbine	Lighter
Hi Limits	Off	Off

Table B.4: Proposed Initial Settings for GT and Side Igniter Applications (Continued)

Application Description	Gas Turbine		Side Ignitor	
AC Amplitude	Off		Off	
Function Set	**A**	**B**	**A**	**B**
Function Identifier	GT		IGN	
Intensity Pickup	5		10	
Intensity Dropout	5		10	
Intsensity Hi				
Frequency Pickup	5		15	
Frequency Dropout	5		15	
Frequency Hi				
AC Pickup				
AC Dropout				
AC Hi				
Quality Norm Intensity	20		15	
Quality Norm Intensity Hi				
Quality Norm Frequency	20		15	
Quality Norm Frequency Hi				
Quality Norm AC				
Quality Norm Frequency AC				
Frequency Sensitivity	55		55	
Intensity Smoothing	0		5	
Frequency Smoothing	0		8	
AC Smoothing				
Delay on Dropout	0		2	
Delay on Pickup				
Maximum Frequency	125		125	

Appendix C Flame Detection Theory

C.1 Basic Flame Detection

Flame Scanner located on the igniter or main burner measures the instantaneous energy produced from the combustion of the fuel.

SF910i digitizes the flame signal 2,000 times per second, then measures the flame characteristics using proprietary analysis algorithms as shown in the figure below.

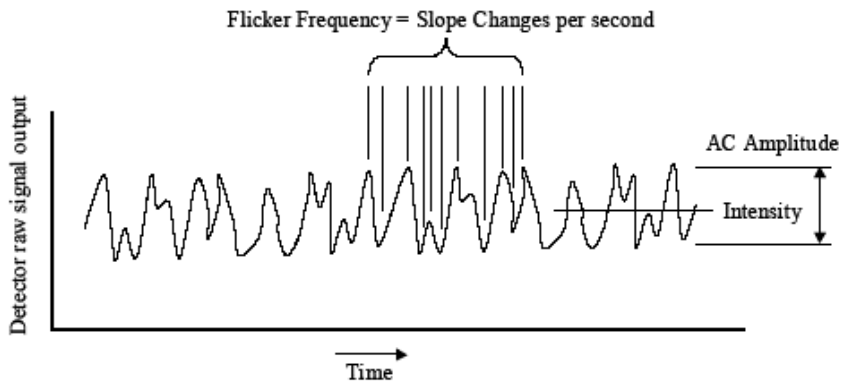


Figure C.1: Intensity, Flicker-Frequency, and AC-Amplitude

C.2 Measured-Values

Measured-Values are the energy characteristics that can be measured with the SF910i . They include:

- Intensity
- Flicker-Frequency
- AC-Amplitude
- Flame Quality

– Flame Temperature

These values are compared to Pull-In and Drop-Out limits that the user set during the tuning process.

If Measured-Values exceed the programmed Pull-In limits, the SF910i will:

– Vote a Flame-On condition in the program Flame-Logic.

– Energize the Flame-relay.

– Provide a Flame-Proven signal on the redundant serial ports.

If Measured-Values fall below the programmed Drop-Out limits, the SF910i will:

– Vote a Flame-Off condition in the Flame-Logic.

– De-energize the Flame-relay.

– Provide a Flame-Off signal on the redundant serial ports.

Figure C.2 shows an example of the Pull-In and Drop-Out settings for Flicker-Frequency.

Measured-Values are Application Dependent

Depending on the application (flame, burner, and fuel) and/or the spectral range (IR, UV, IR+UV, and so on), certain Measured-Values may be low in strength or may vary greatly with the operation of the burner.

Under that conditions, these Measured-Values are not reliable for flame detection and may be removed from the Flame-Logic.

Flame Detection using High-Limits

In rare instances, more robust operation can be achieved by also applying a High-Limit to Measured-Values.

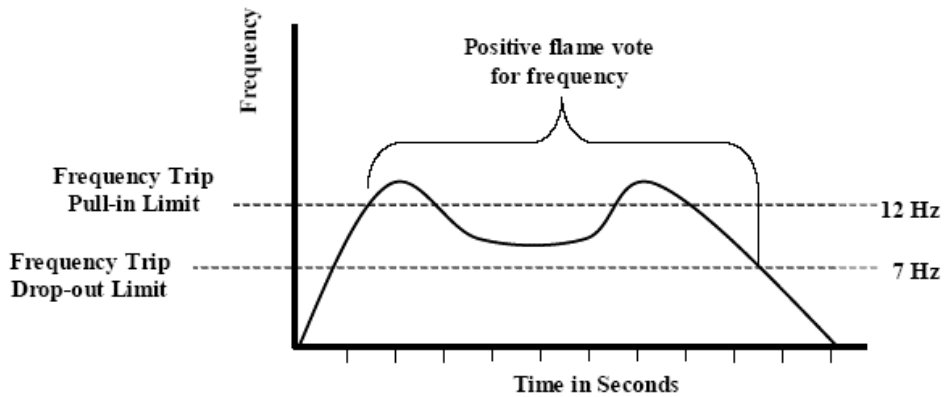


Figure C.2: Flicker-Frequency Trip Points

When the High-Limit feature is enabled, the SF910i will vote a Flame-Off condition whenever one or more of the active parameters are above the programmed High-Limit values.

The default condition for the High-Limit feature is OFF, so that the user must enable this Flame-Logic.

C.3 Smoothing and Time-Delays

Since rapid changes can occur in any combustion system, special features are included to minimize the chance of false readings due to transient conditions. Smoothing filters (rolling averages) can be applied to the Measured-Values to reduce the impact of sudden changes.

C.4 Fuel/Load Switching

In some combustion firing systems, the flame characteristics may change with fuel or load changes. Under these circumstances, the ideal trip, sensitivity, and Time-Delay settings may be different for the different fuels or load.

Use the Fuel/Load Switching feature through serial line to more precisely determine the flame characteristics under these conditions.

C.5 Flame Quality

Quality is a measure of how close the SF910i is voting a Flame-Off condition. Quality value can range from zero to 100%.

Any drop in the quality value from the top 100% level indicates that one or more of the Measured-Values values are approaching a trip point. The user can use this information to take preventative actions before a trip occurs.

Quality Calculation does not pinpoint the source of a burner problem. It only informs the user about the general state of flame detection. Quality Calculation does not affect the Flame-Logic algorithm.

Appendix D Glossary

Table D.1: Glossary

Term	Description
AC-Amplitude	AC-Amplitude is defined as a measurement of the intensity of the flicker or pulsation of the flame. It is one of the Measured-Values
SF910i	Uvisor™ Integrated SafeFlame Scanner
ATB	Terminal board for the SF910i
Ex	Atmosphere explosive
BMS	Burner Management System
Channel	Channel is a connection to a Flame Scanner. SF910i includes two channels. Each channel can be independently connected and operated by the SF910i
Configuration-Mode	SF910i is in Configuration-Mode when it is enabled to modify configuration functions
Control System	Used as synonymous of BMS
Conventional	Flame Scanner made of three parts namely a scanner head, a separate electronic unit, and a cable connecting the two
Drop-Out	Drop-Out occurs when a Measured-Value goes below the Drop-Out value
DW	Direct View, see LOS
ESD	Electro Static Discharge
Safe-relay	Safe-relay is an ON/OFF switch that is energized when no faults are present, and de-energized when faults are detected
FFRT	Flame Failure Response Time, the time period from flame-off (absence of a flame) to the flame-relay off (contact open)
First-Time Power up	First-Time Power up is a mode of operation that the SF910i automatically enters when it is factory new or when a complete reset of the configuration performed
Flame Explorer	Software tool for configuration and monitoring
Flame Scanner	Flame Scanner is a unit that detects changes in a light source
Flame-Logic	Flame-Logic is the program code that determines when a flame is considered ON (Flame-On) or OFF (Flame-Off). This Flame-Logic can be customized using SF910i menus

Table D.1: Glossary
(Continued)

Term	Description
Flame-Off	The absence of a flame as calculated by the Flame-Logic
Flame-On	The presence of a flame as calculated by the Flame-Logic
Flame-Proven	Flame-Proven condition occurs when the Flame-Logic determines that all the requirements are in Flame-Proven condition will continue to exist until the Flame-Logic votes a Flame-Off condition
Flame-relay	Flame-relay is an ON/OFF switch that is energized when a flame is detected, and de-energized when a flame is not present
FOC	Fiber Optic Cable
High-Limit	A Measured-Value must remain at or below the High-Limit value or else the Flame-Logic will vote a Flame-Off condition
Intensity	For SafeFlame applications, the intensity is defined as the brightness of light energy. It is one of the Measured-Values
IR	Infra-Red, electromagnetic wave whose wavelength is from 750 to 2000nm and longer (approximately)
LOS	Line Of Sight
Measured-Values	Measured-Values are the energy characteristics that can be measured with the SF910i
MODBUS	Widely used and well-known serial communication protocol used in SF910i application to exchange working parameters and configuration data
Normalization	A method of setting the sensitivity of the quality calculation. The normalization values can be modified to account for the boiler environment
Normal-Mode	SF910i is in Normal-Mode when it is not in Configuration-Mode or Parameter-Mode. In this mode, the SF910i will display the flame monitoring information
PCB	Printed Circuit Board
Program-Mode	SF910i is in Program-Mode when it is enabled to modify the program functions
Pull-In	Pull-In occurs when a Measured-Value goes from zero to a value that matches or exceeds the Pull-in Limit value
Quality	Quality is a measure of how close the SF910i is voting a Flame-Off condition. Quality value serves as an indicator of the general state of flame detection
RS-485	A de-facto industrial standard that specify the signal type, level and other basic parameters of a differential communication line on copper cable
SafeFlame™	SafeFlame™ is an ABB trademarked name for a series for Flame Scanners that operate by measuring the flame energy with photo-diode sensors. These sensors convert light energy into electronic signals
SE	Sensor Electronic - SF910i sensor board

Table D.1: Glossary
(Continued)

Term	Description
Single-Relay	A mode that enables a single relay for use on a channel
SPE	Signal Processing Electronics - SF910i processing board
TB	See ATB
UV	Ultra-Violet, electromagnetic wave whose wavelength is from 100 to 400nm (approximately)
Uvisor™	ABB family of flame scanners and analysis products
VL	Visible Light, electromagnetic wave whose wavelength is from 400 to 750nm (approximately)

Appendix E Drawings

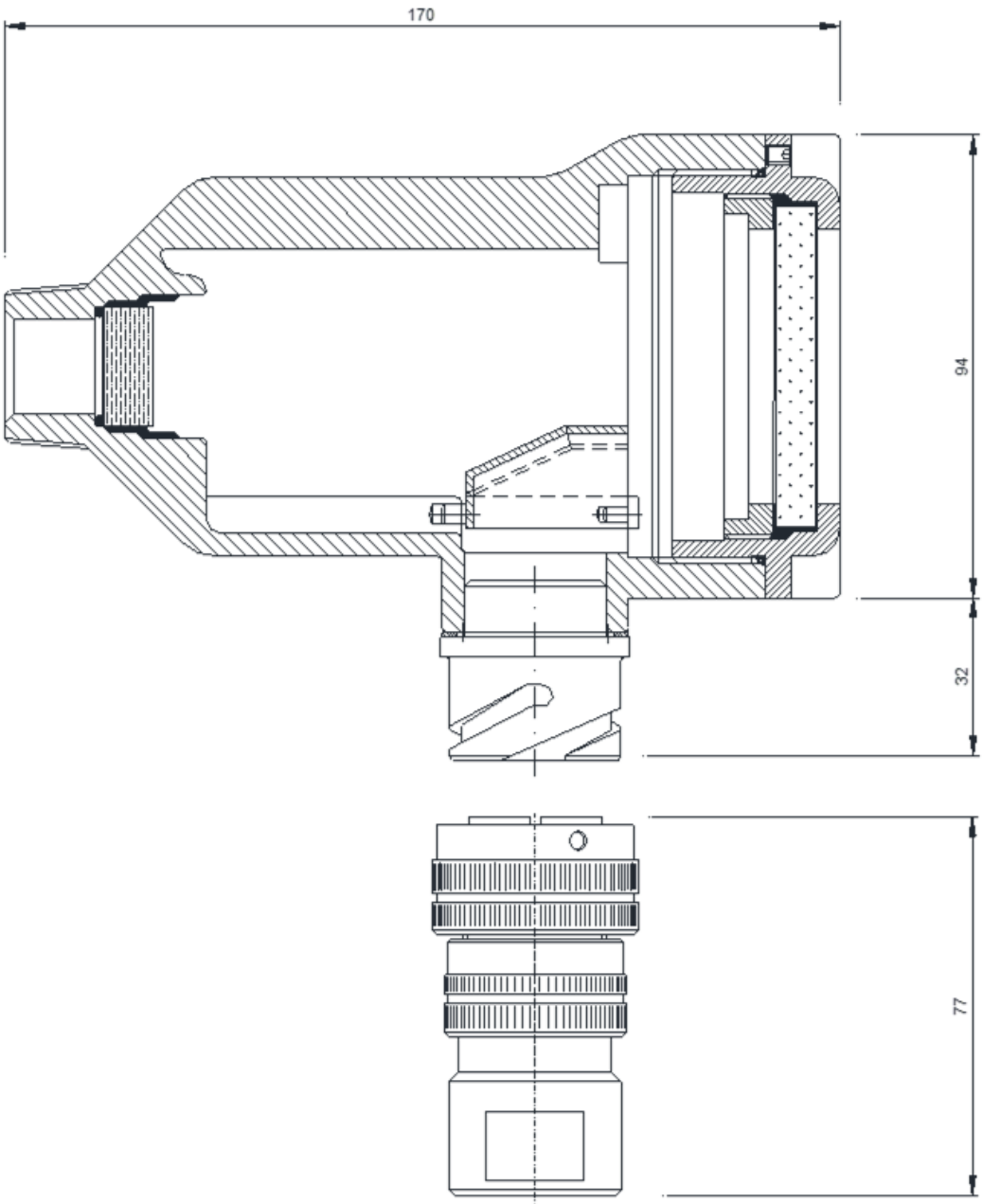


Figure E.1: Enclosure, Quick Release Connector, and Version LOS

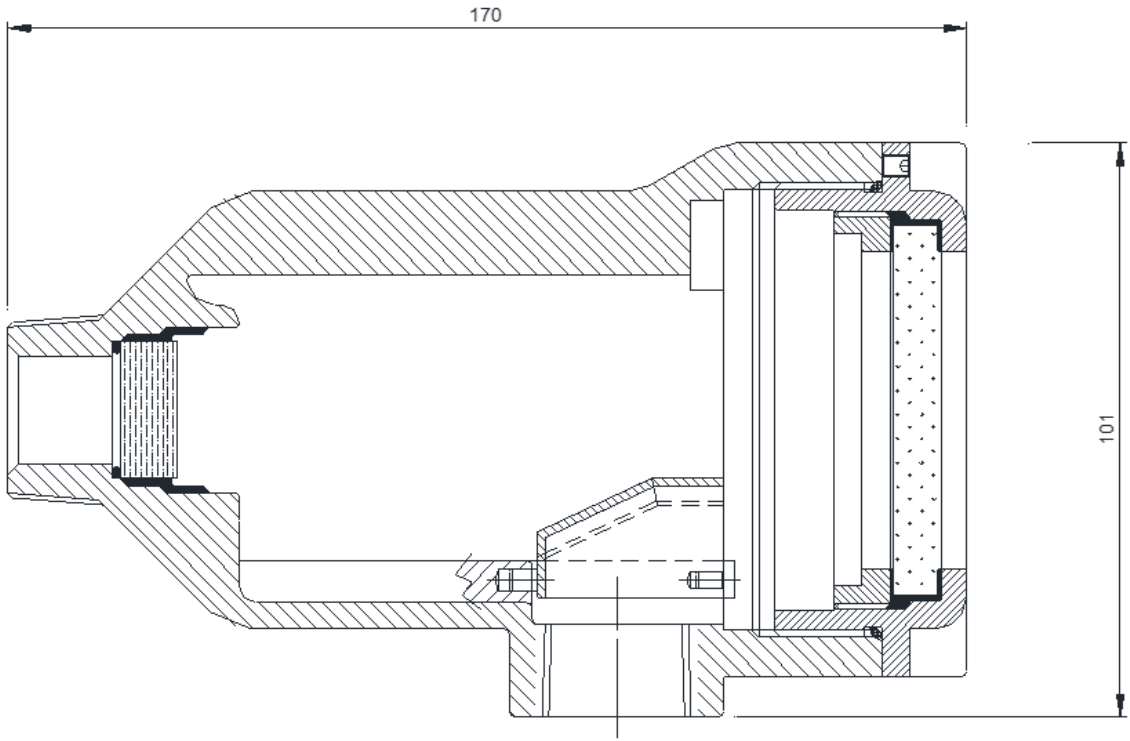


Figure E.2: Enclosure, ¾" NPT Cable Inlet, and Version LOS

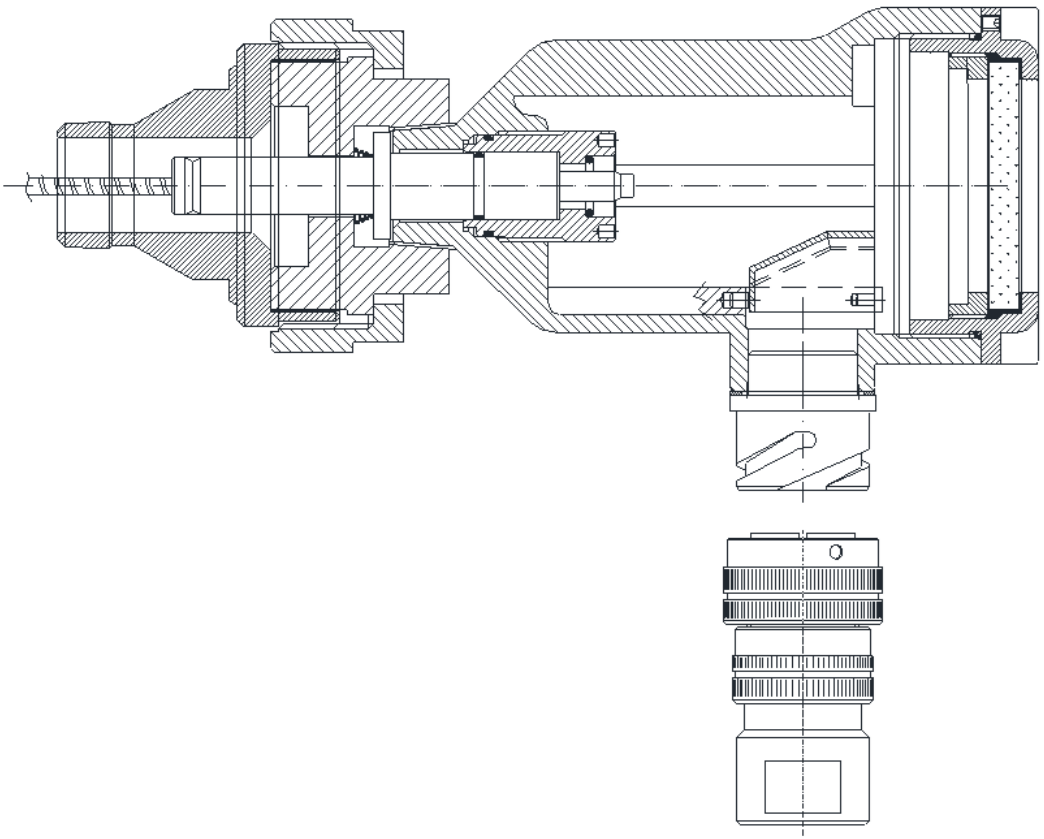


Figure E.3: Enclosure, Quick Release Connector, and Version FOC

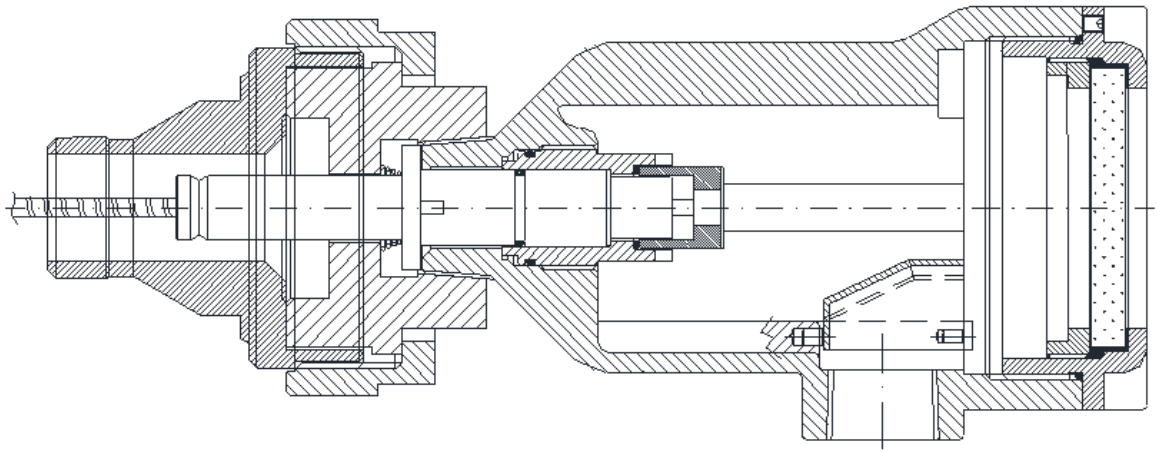
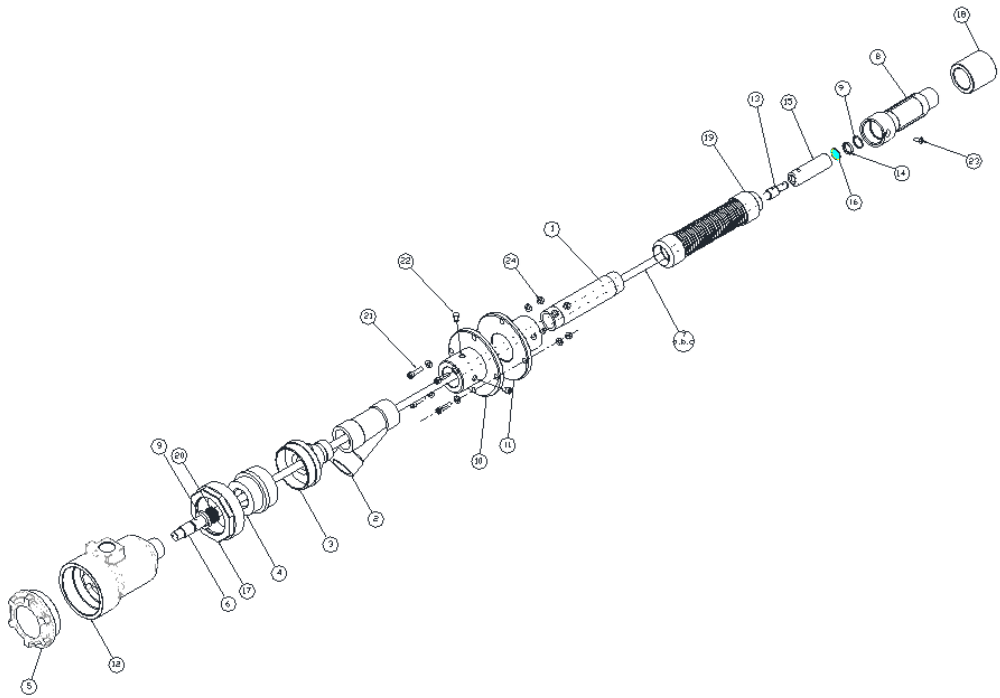
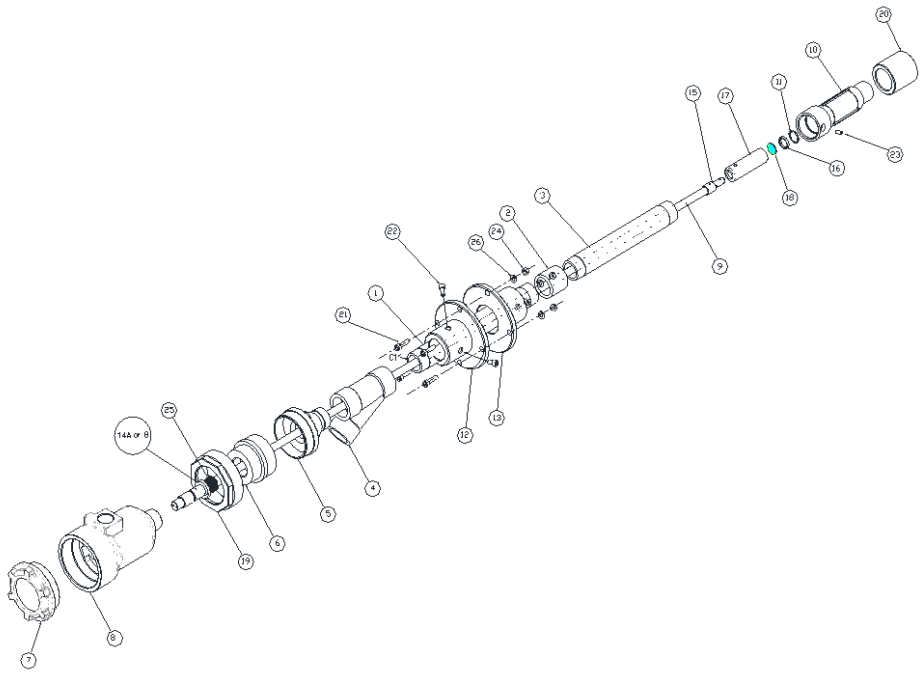


Figure E.4: Enclosure, ¾" NPT Cable Inlet, and Version FOC



ITEM	DESCRIPTION	PART NUMBER	MATERIAL	NOTE	Q.ty
1	1" RIGID MAIN PIPE	EC-DWG-G041MEC019-A	Steel UNI EN 10240		1
2	COOLING AIR MANIFOLD 1" NPTF	EC-DWG-G041MEC010-A	Cast Alluminum Alloy		1
3	MANIFOLD ADAPTER	EC-DWG-G041MEC011-A	Alluminum Alloy		1
4	THERMAL ISOLATOR	EC-DWG-G018MEC761-B	AISI 321		1
5	UVISOR SF810/SF810i FLAME SCANNER		Cast Alluminum Alloy	WINDOWED HOUSING COVER	1
6	FIBER OPTIC TERMINAL-COLD SIDE				1
7a	FIBER OPTIC CABLE	EC-DWG-G041MEC020-C	AISI 321	SINGLE SENSOR IR	1
7b	FIBER OPTIC CABLE	EC-DWG-G041MEC021-C	AISI 321	SINGLE SENSOR UV	1
7c	FIBER OPTIC CABLE	EC-DWG-G041MEC022-C	AISI 321	DUAL SENSOR UVIR	1
8	EXTERNAL GUIDE PIPE TERMINAL	EC-DWG-G041MEC012-B	AISI 304		1
9	SEEGER RING			Inner 20mm UNI3654-7437	1
10	BOILER MOUNTING FLANGE	EC-DWG-G041MEC015-A	Fe 360 Galvanized		1
11	BOILER MOUNTING COUNTER FLANGE	EC-DWG-G041MEC014-A	Fe 360 Galvanized		1
12	UVISOR SF810/SF810i FLAME SCANNER		Cast Alluminum Alloy	SCANNER HOUSING	1
13	FIBER OPTIC TERMINAL - HOT SIDE	EC-DWG-G041MEC017-B	AISI 304		1
14	LENS RETAINER	EC-DWG-G041MEC008-A			1
15	LENS HOLDER	EC-DWG-G041MEC005-C	AISI 304		1
16	LENS	EC-DWG-G041MEC006-A			1
17	LOCKING RING NUT	EC-DWG-G041MEC024-A	Alluminum alloy anticorodal		1
18	GUIDE COLLAR	EC-DWG-G041MEC016-B	AISI 304		1
19	FLEXIBLE HOSE	EC-DWG-G041MEC013-B	AISI 321	Standard length = 1100mm (43.3")	1
20	LOADING SPRING	EC-DWG-G018MEC771-B			1
21	VEI_M8X35			SCREW HEXAGON SOCKET. M8 x 35	4
22	VEI_M8X10			SCREW HEXAGON SOCKET. M8 x 10	2
23	V5-8--_-_U7688_PZ			SCREW TSP.CR PZ UNI 7688 M 5X8	1
24	NUT_M8-Z			NUT M8 UNI 5588	4

Figure E.5: FOC Flexible Assembly



ITEM	DESCRIIPTION	PART NUMBER	MATERIAL	NOTE	Q.ty
1	1" RIGID GUIDE PIPE	EC-DWG-G041MEC019-B	Steel UNI EN 10240	Ref.: EC-DWG-G041MEC019-B for assembly details	1
2	1" RIGID PIPE JOINT	EC-DWG-G041MEC026-A	Steel UNI EN 10241	Ref.: EC-DWG-G041MEC019-B for assembly details	1
3	1" RIGID GUIDE PIPE EXTENSION	EC-DWG-G041MEC027-A	Steel UNI EN 10240	Ref.: EC-DWG-G041MEC019-B for assembly details	1
4	COOLING AIR MANIFOLD 1" NPTF	EC-DWG-G041MEC010-A	Cast Alluminum Alloy		1
5	MANIFOLD ADAPTER	EC-DWG-G041MEC011-A	Alluminum Alloy Anticorodal		1
6	THERMAL ISOLATOR	EC-DWG-G018MEC761-B	AISI 321		1
7	UVISOR SF810/SF810i FLAME SCANNER		Cast Alluminum Alloy	WINDOWED HOUSING COVER	1
8	UVISOR SF810/SF810i FLAME SCANNER		Cast Alluminum Alloy	SCANNER HOUSING	1
9	FIBER OPTIC CABLE	EC-DWG-G041MEC020 / 022	AISI 321		
10	EXTERNAL GUIDE PIPE TERMINAL	EC-DWG-G041MEC012-B	AISI 304		1
11	SEEGER RING		UNI X35CRMO17	Inner 20mm UNI3654-7437	1
12	BOILER MOUNTING FLANGE	EC-DWG-G041MEC015-A	Fe 360 Galvanized		1
13	BOILER MOUNTING COUNTER FLANGE	EC-DWG-G041MEC014-A	Fe 360 Galvanized		1
14a	FIBER OPTIC TERMINAL-COLD SIDE	EC-DWG-G041MEC023-D	BRASS UNI EN 12164	SINGLE SENSOR (IR or UV)	1
14b	FIBER OPTIC TERMINAL-COLD SIDE	EC-DWG-G018MEC787-D	BRASS UNI EN 12164	DUAL SENSOR (UV1R)	1
15	FIBER OPTIC TERMINAL - HOT SIDE	EC-DWG-G041MEC017-B	AISI 304		1
16	LENS RETAINER	EC-DWG-G041MEC008-A	AISI 304		1
17	LENS HOLDER	EC-DWG-G041MEC005-C	AISI 304		1
18	LENS	EC-DWG-G041MEC006-A	SUPRASIL		1
19	LOCKING RING NUT	EC-DWG-G041MEC024-A	Alluminum alloy anticorodal		1
20	GUIDE COLLAR	EC-DWG-G041MEC016-B	AISI 304		1
21	VEI_M8X30			Bolt or Socket Hex. Screw M8x30	4
22	VEI_M8X16			Bolt or Socket Hex. Screw M8x16	2
23	V5-5			HEX SET SCREW M5x5	1
24	NUT_M8-Z			NUT M8 UNI 5588	4
25	LOADING SPRING	EC-DWG-G041MEC771-B	Steel		1
26	GROWER (UNI 1751 B) for M8				4

Figure E.6: FOC Rigid Assembly

This option provides the user with a convenient solution to upgrade an existing DFS Flame Scanner installation, relieving from the external guide tube replacement with all that involves (Major boiler shutdown, scaffolding, cut, and welding).

SF910i-FOC final equipment selection is based on the specific customer and application needs. They use the same fiber part number as SF810i did. Ref. Assembly part number: EC-DWG-G041MEC115 and Article number: SF810-FOACE-IR (UV; UVIR).

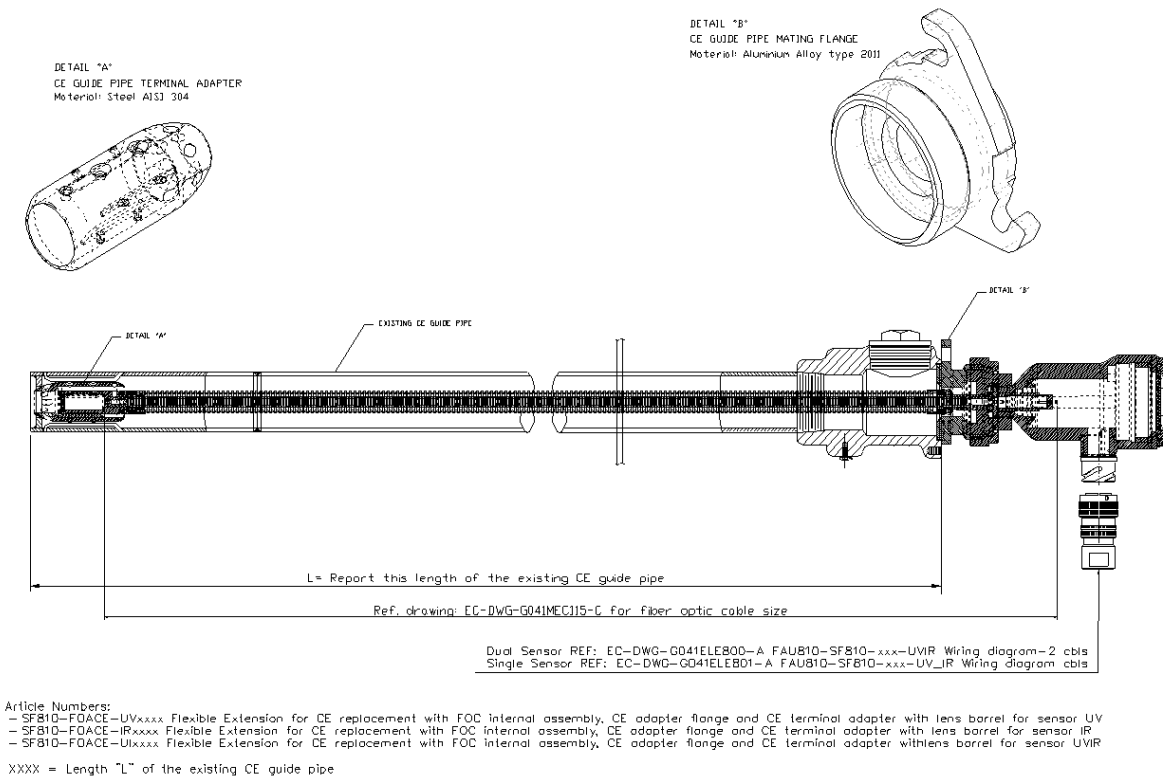


Figure E.7: DFS/CE Standard Replacement - Final Assembly with CE Guide Pipe

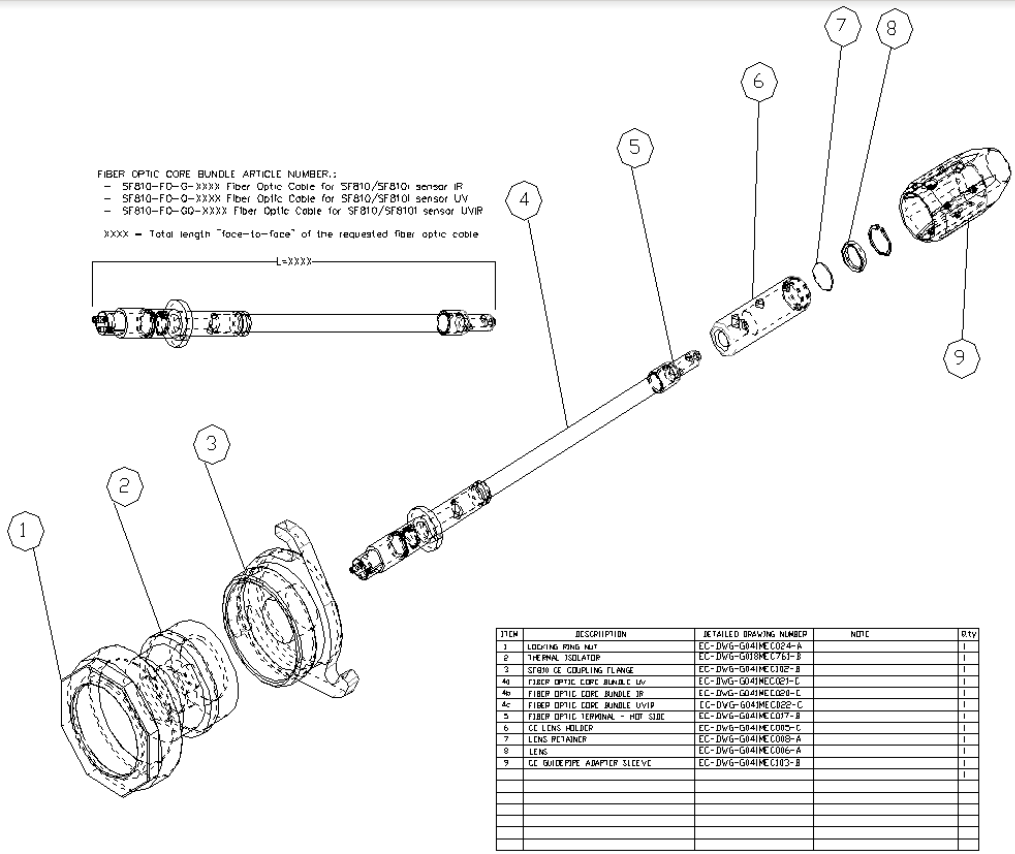


Figure E.8: DFS/CE Standard Replacement - Internal Assembly

This option provides the user with a convenient solution to upgrade an existing Bailey FlameON flame series UM...UW...Flame Scanner with flexible fiber optic design or reflecting tube.

SF910i-FOC final equipment selection is based on the specific customer and application needs.

Refer to the assembly part number: EC-DWG-G041MEC119.

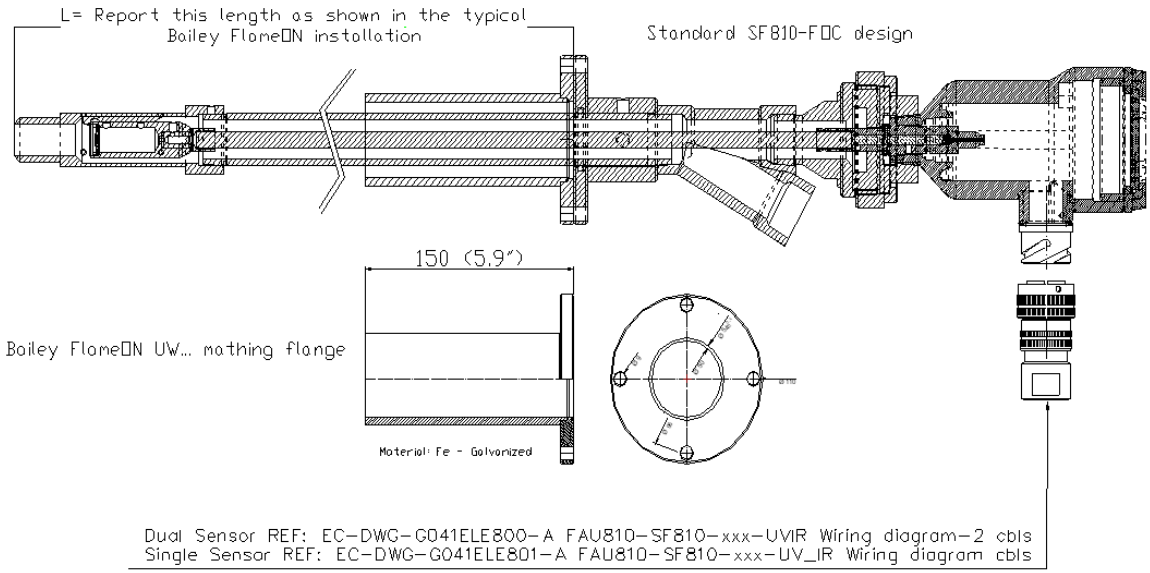


Figure E.9: Bailey Flame ON Standard Replacement

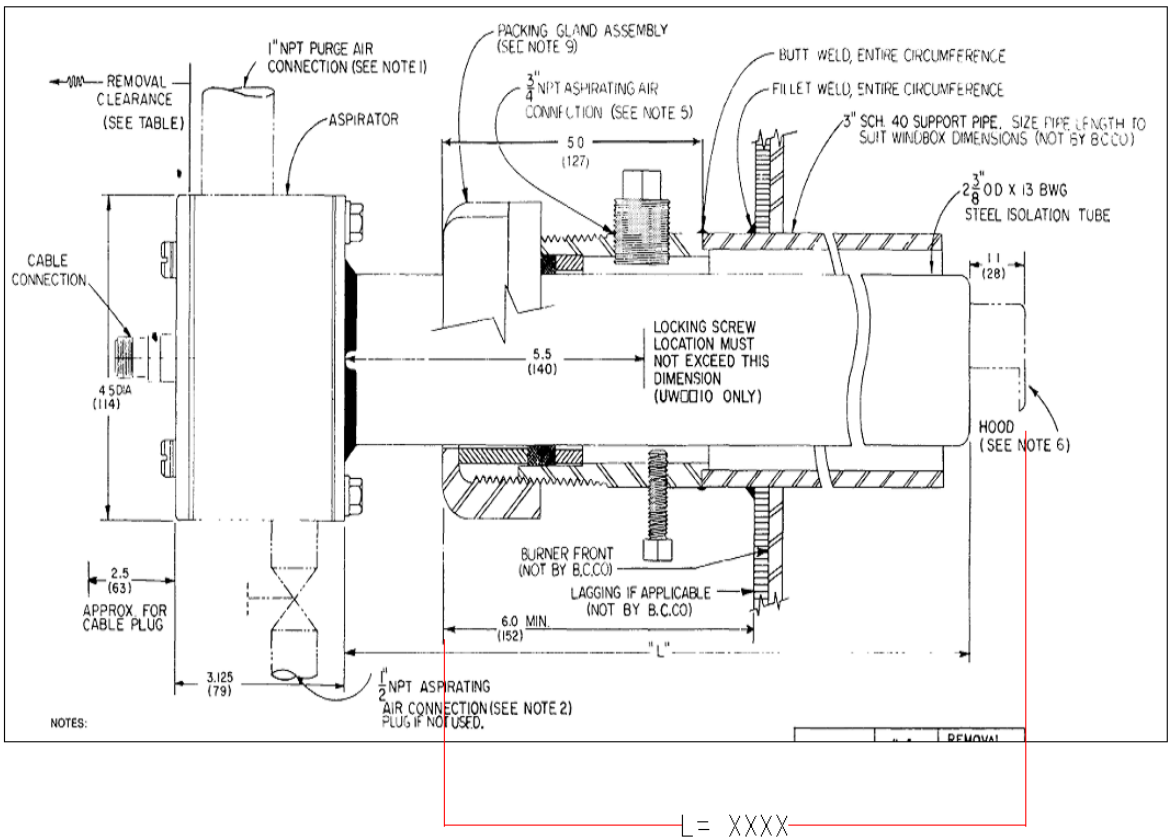


Figure E.10: Typical Bailey Flame ON Installation

Appendix F Cables

All the equipment are supplied without permanently connected cable(s), field wiring, and grounding are on the users scope.

F.1 Earth Connection Cable

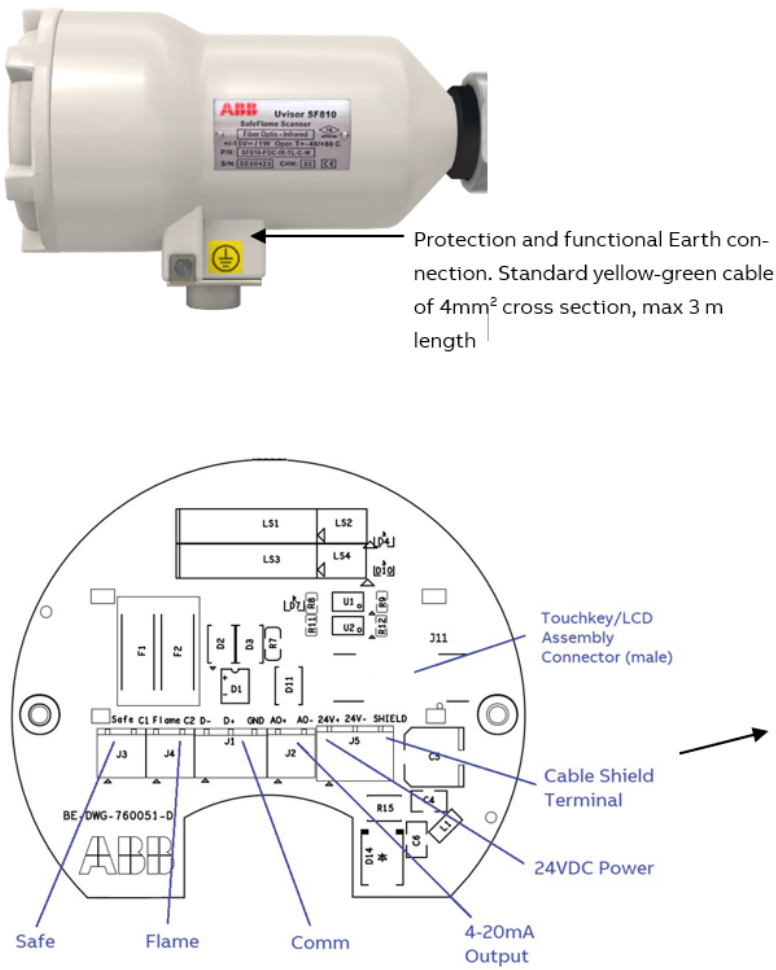


Figure F.1: Earth Connections

F.2 Cabling

SF910i can be wired to external devices using standard cables available on the market.

The following tables specifies the technical requirement for the SF910i cables except SF910i-L.

Note that in this case, ABB does not specify mechanical properties, global cross sections, fire resistance properties, and so on. The following are the minimum electrical requirements.

Table F.1: 24 V_{DC} Power Supply

Type	Pair
Conductor(s) section	1 mm^2 each
Conductor(s) material	Copper
Colors	Conductor 1: red Conductor 2: black
Shield	Not required
Conductor resistance	<= 20 Ohm/Km (at 20ºC)
Isolation resistance	>= 1000 MOhm x Km (at 20ºC)
Working voltage	< $50V_{DC}$

Table F.2: Relays Contacts

Type	Three Conductors
Conductor(s) section	0.5mm^2 each
Conductor(s) material	Copper
Colors	Conductor 1: Orange Conductor 2: Light-blue Conductor 3: Pink
Shield	Not required
Conductor resistance	<= 20 Ohm/Km (at 20ºC)
Isolation resistance	>= 1000 MOhm x Km (at 20ºC)
Working voltage	Up to $50V_{AC}$

Table F.3: Communication Line(s)

Type	Shielded Twisted Pair
Conductor(s) section	0.34mm^2 22 AWG
Conductor(s) material	Copper
Colors	Conductor 1: red Conductor 2: green
Shield	Aluminum ribbon/polyester; aluminum is in continuous contact with a 24/7AWG drain wire plus a copper shield
Conductor resistance	Loop resistance <110 Ohm/km
Isolation resistance	>= 1000 MOhm x Km (at 20ºC)
Capacitance (1KHz)	<30pF/m
Impedance	135-165 Ohm
Working voltage	< 50V_{DC}

Table F.4: Digital Inputs

Type	Three Conductors
Conductor(s) section	0.5mm^2 each
Conductor(s) material	Copper
Colors	Conductor 1: yellow/red Conductor 2: yellow/blue Conductor 3: yellow/brown
Shield	Not required
Conductor resistance	<= 40 Ohm/Km (at 20ºC)
Isolation resistance	>= 1000 MOhm x Km (at 20ºC)
Working voltage	< 50V_{DC}

Table F.5: Analog Output

Type	Shielded Twisted Pair
Conductor(s) section	0.22mm^2 each (AWG24/7)
Conductor(s) material	Copper
Colors	Conductor 1: white/red

Table F.5: Analog Output (Continued)

Type	Shielded Twisted Pair
	Conductor 2: white/black
Shield	Yes
Conductor resistance	<= 88.6 Ohm/Km (at 20ºC)
Isolation resistance	>= 1000 MOhm x Km (at 20ºC)
Working voltage	< $50V_{DC}$

F.3 ABB Special Cables

The number of conductors required for wiring the SF910i to the associated external devices are dependent on the functions utilized by the scanner.

All SF910i products use ABB standard cable part number: SF910i-CBL16, which is made up of 16+1 (Sh) conductors grouped according to the functional feature of the Flame Scanner. The table below reports individual conductor size, color, circular connector pin, SF910i TB connection, and relevant signal.

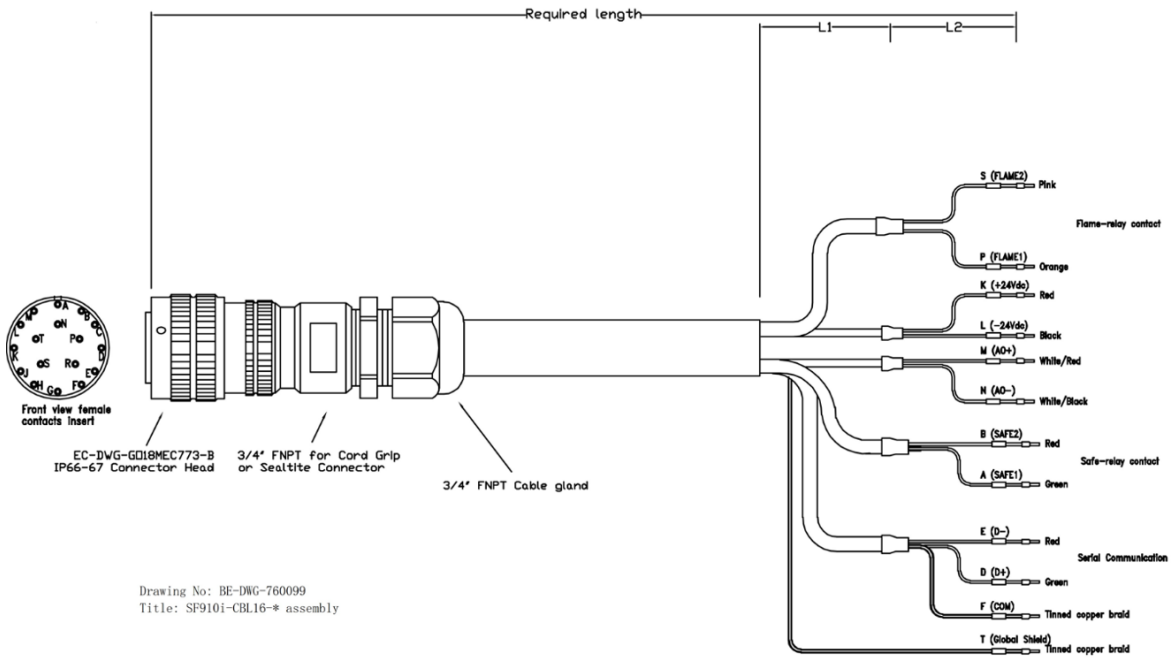


Figure F.2: ABB Standard Tail Cable for SF910i

PIN	Wire Color	Section mm^2	Signal Name	Description
K	Red	0.5	+24V_{DC}	Power supply positive input
L	Black	0.5	GND	Return of power supply and ground reference for all internal electronics
M	White/Red	0.25	AO$^+$	Analog output (4-20mA) positive
N	White/Black	0.25	AO$_-$	Analog output (4-20mA) negative
D	Green	0.25	D$^+$	Serial communication port, data TX/RX, and positive
E	Red	0.25	D$_-$	Serial communication port, data TX/RX, and negative
F	Green/Light blue	Tinned copper	GND	Ground reference for serial communication port

PIN	Wire Color	Section mm^2	Signal Name	Description
A	Green	0.5	Safe-relay contact	Safe-relay contact (NO)
B	Red	0.5	Safe-relay contact	Safe-relay contact (NO)
P	Orange	0.5	Flame-relay contact	Flame-relay contact (NO)
S	Pink	0.5	Flame-relay contact	Flame-relay contact (NO)
T	Gray	Tinned copper	Shield	Earth connection point for the shields of the cable(s)

Related ABB SF910i standard cable can be supplied:

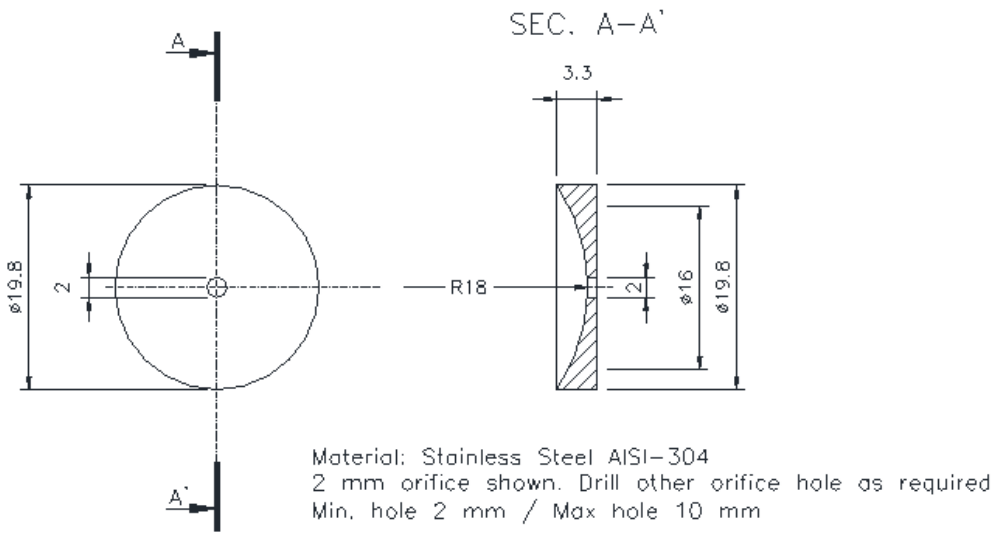
– As lose item, Article number: SF910i-CBL16-YYY (YYY = cable length in meter).

– Pre-assembled on multipin IP66/IP67 quick connector, Article number: SF910i-CBL16-Q-YYY (YYY = cable length in meter).

– Pre-assembled on multipin Ex quick connector, Article number: SF910i-CBL16-QC-YYY (YYY = cable length in meter).

Appendix G Fittings

G.1 TU_KIT03 Set of Diaphragms for SF910i FOC



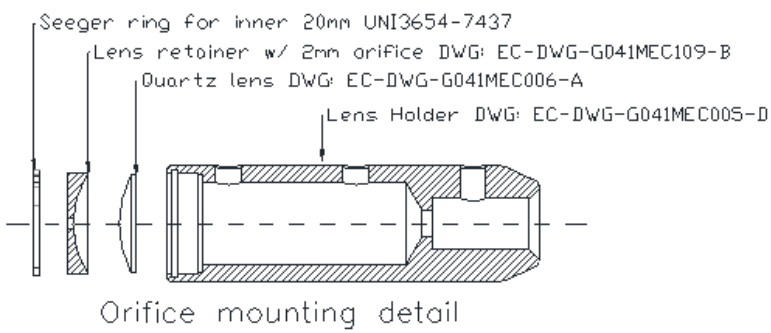


Figure G.1: Diaphragm for SF910i FOC Scanner

TU_KIT03 includes only Nos.5 orifices AISI-304.

G.2 SWF-1NPTM Swivel Mounting Flange

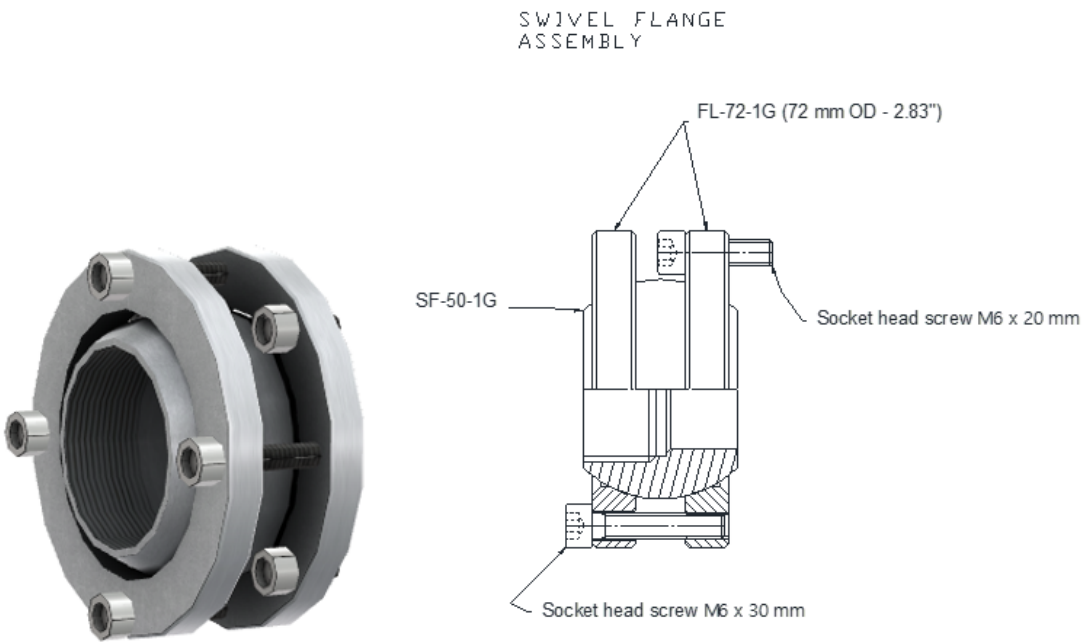


Figure G.2: Swivel Mounting Flange

G.3 THU-1NPTMF 1” NPTM/1” NPTF Thermal Isolation Union

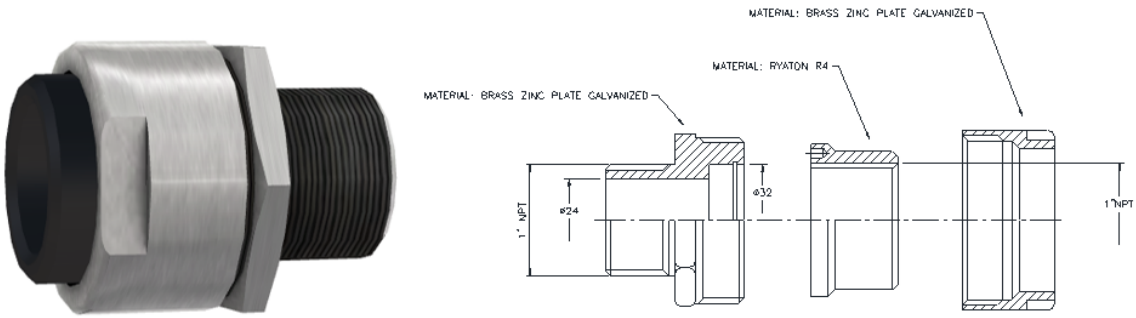
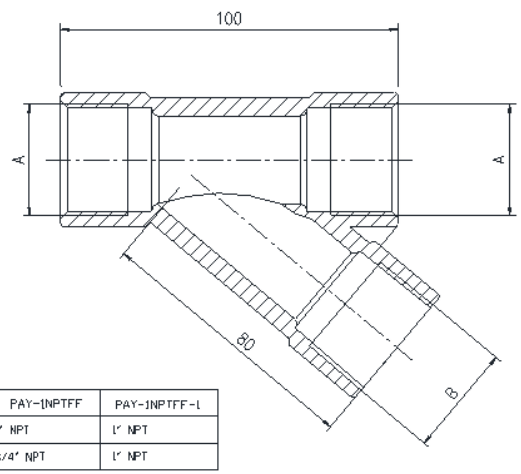


Figure G.3: 1” NPTM/1” NPTF Thermal Isolation Union

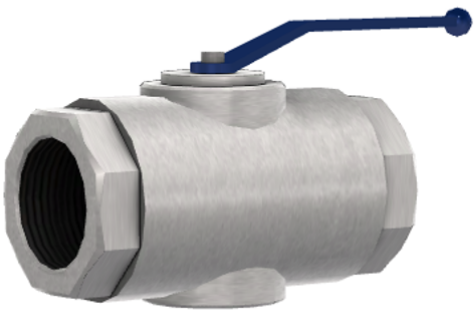
G.4 PAY-1NPTFF Purging Air “Y” NPTF/NPTF Inlet



Diameter	PAY-1NPTFF	PAY-1NPTFF-L
A	1" NPT	1" NPT
B	3/4" NPT	1" NPT

Figure G.4: Purging Air “Y” NPTF/NPTF Inlet

G.5 IV-1NPTF Isolating Valve 1” NPTF/1” NPTF



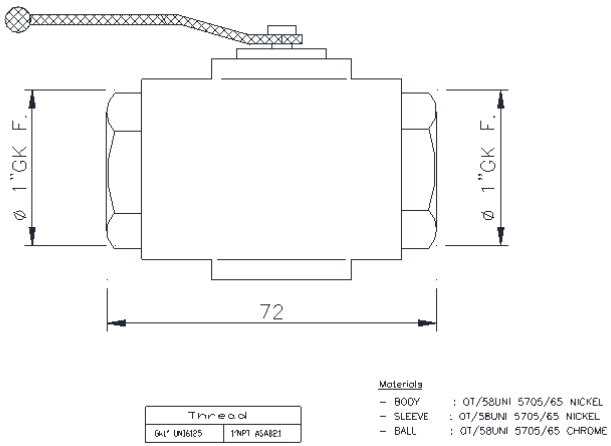


Figure G.5: Isolating Valve

G.6 SF910i-CBL16-Q-YYY for SF910i with Multipin Connector

Figure G.6: Tail Cable with Connector for SF910i

The 16 core ABB tail cable SF910i-CBL16-YYY is available with the following codes:

– 16 core cable only, Article number: SF910i-CBL16-YYY.

– 16 core cable pre-assembled on multipin connector IP66, Article number: SF910i-CBL16-Q-YYY.

– 16 core cable pre-assembled on multipin connector IP66-Ex, Article number: SF910i-CBL16-QC-YYY.

G.7 Counter Flange

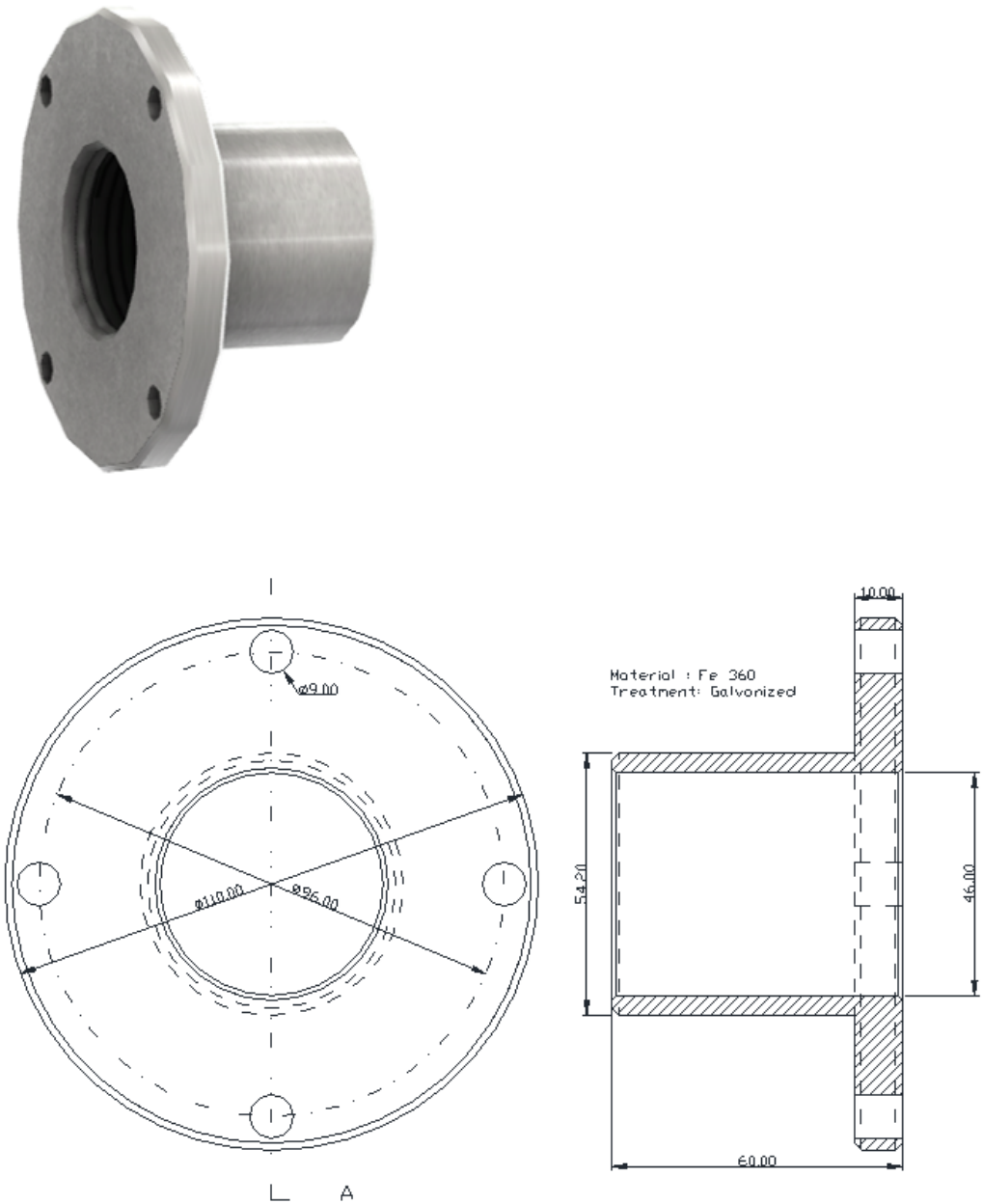


Figure G.7: Boiler Mounting Counter Flange for FOC Installation

Boiler mounting counter flange for FOC external guide pipe, Article number: 84410-S-0400002.

Appendix H Tools

Conventional maintenance tools are generally all that is necessary to perform installation and basic measurements for diagnostic purposes. A suitable “allen” wrench is needed to remove the cover looking screw.

Anti-ESD wrist strap is needed when operating with the rear cover removed.

This section is intended to describe the tools needed to install and service the SF910i product itself, not considering the mechanical tools, welding station, and accessories that are needed to physically mount the fiber optic external guide pipe, flanges and generically speaking all mounting accessories (among them: purge air pipe, swivel flange, valves, and so on).

H.1 Tools

- Allen wrench (2mm) for the cover locking screw
- Allen wrench (3mm) for unlocking the quick-release connector
- Only for SF910i-XX-XX-QC-type
- One small flat-blade screwdriver (2÷2.5mm) for the removable terminal screws
- One medium/large flat-blade screwdriver (5mm) for the earth connection screw
- Cutter
- Anti-ESD wrist strap or other equivalent system
- DMM (not strictly mandatory; could be useful to check the wiring of power supply, digital inputs, and analog output 4÷20mA)
- Silicone grease (to add to the rear cover thread before reinstalling it). A copper-based lubricating paste can be used, for instance, Product code 8160 from AREXONS, MISAL AREXONS SpA, Via Antica di Cassano, 23, Cernusco S/N (MI) Italy, Phone: (+39) 02 924361

- RS-485/USB converter for interfacing the SF910i with the system running the local configuration Flame Explorer SW tool. In order to keep the system isolated from the cables that reach the boiler area from the control room, it is better if it features galvanic isolation. Easy available on the market
- Serial cable for RS-485
- Flashlight

H.2 Personal Safety

ABB suggests to use the following items pertaining to personal safety:

- Safety glasses
- Protective gloves
- Protective clothing/working suit
- Respiratory mask with filter for ash, smoke, and carbon particles

Local plant regulations might apply when working in the area surrounding the burner/boiler.

Appendix I Configuration Form

In case, the SF910i is installed without making use of the serial communication lines, photo-copies of the following form can be helpful to write down and archive the configuration data.

Table I.1: Configuration Form

Type Property	Configured Value	Notes
Burner/pilot flame identification		
SF910i Serial number		
Light ingress (LOS or FOC)		
Spectral sensitivity (IR, UV)		
Function set A: Intensity pull-in Intensity drop-out Frequency pull-in Frequency drop-out AC-amplitude pull-in AC-amplitude drop-out Frequency sensitivity Delay drop-out		
Function set B: Intensity pull-in Intensity drop-out Frequency pull-in Frequency drop-out AC-amplitude pull-in AC-amplitude drop-out Frequency sensitivity Delay drop-out		
Function set C: Intensity pull-in		

Table I.1: Configuration Form (Continued)

Type Property	Configured Value	Notes
Intensity drop-out Frequency pull-in Frequency drop-out AC-amplitude pull-in AC-amplitude drop-out Frequency sensitivity Delay drop-out		
Function set D: Intensity pull-in Intensity drop-out Frequency pull-in Frequency drop-out AC-amplitude pull-in AC-amplitude drop-out Frequency sensitivity Delay drop-out		

AC-amplitude, pull-in, and drop-out can be locally configured using touch-buttons only, if they are enabled. Currently, the only way to enable them is using the Flame Explorer software connected through the serial port.

Appendix J Configuration-Mode Fucntions

Table J.1: Configuration-Mode Functions

Configuration Function	Level	Default Value	Values Available
Application select	Application	Wall/Industrial for applications	Corner Wall/Industrial Lighter Turbine
	Use Hi limit	Off	On or Off
	Use AC-Amplitude	Off for applications	On or Off
Change IDs	Unit ID	U1 or U2 (new start-up only)	Any 4 alphanumeric characters *+,-./:; < = > ? 0 to 9 and A to Z
	Elevation ID	E1 or E2 (new start-up only)	Any 4 alphanumeric characters *+,-./:; < = > ? 0 to 9 and A to Z
	Application specific: Burner (for wall) Corner (for corner) Combustor (for turbine) Lighter (for lighter)	B1 or B2 (new start-up only)	Any 4 alphanumeric characters *+,-./:; < = > ? 0 to 9 and A to Z
AO output	AO mode	Auto	Auto Channel 1 Channel 2
	AO source	Quality	Quality Intensity Frequency AC-Amplitude Core Temperature Flame Temperature Quality Comb

Table J.1: Configuration-Mode Functions (Continued)

Configuration Function	Level	Default Value	Values Available
Load default parameters	Parameters F Set All	N/A	Touch-button **RIGHT** to accept or **LEFT** to exit
FS switch sel	N/A	Off	Off On through Digital Inputs On through Serial Line
Communications	Network type		
	MOD address	1	1 to 254
	MOD baud rate	38400	9600, 19200,38400, and 15200 bps
	Show status	N/A	N/A
	Communication reset	N/A	N/A
Display	Contrast	5	0 to 10
Complete reset	Delete all the parameters except 4 to 20 mA calibration and IDs (Brings module to original start-up state)		Touch-button **RIGHT** to accept or **LEFT** to exit

Appendix K Program-Mode Fucntions

Table K.1: Program-Mode Functions

Program Function	Level		Default Value	Values Available
CH FSET TO EDIT	Function Set to Edit		FSA	FSA FSB (if used) FSC (if used) FSD if used)
Trip Points	Intensity	Pull-In	30	5 to 80
		Drop-Out	30	Pull-In - 6 maximum
		High Limit	100	100 to Pull-In + 10
	Frequency	Pull-In	5	5 to 100 or 5 to 225 for turbine
		Drop-Out	5	Pull-In - 6 maximum
		High Limit	125	125 to Pull-In + 10 or 250 to Pull-In + 10 for turbine
	AC-Amplitude	Pull-In	0	0 to 80
		Drop-Out	0	Pull-In - 6 maximum
		High Limit	100	100 to Pull-In + 10
Qulaity normalization	Intensity		20	1 to 100
	Intensity high		5	1 to 100
	Frequency		20	1 to 100
	Frequency high		5	1 to 100
	AC-Amplitude		20	1 to 100
	AC-Amplitude high		5	5 to 100
Frequency sensitive	N/A		55	5 to 100
Smoothing (Rolling Average)	Intensity		None	None, 1 - 10
	Frequency		2	None, 1 - 10

Table K.1: Program-Mode Functions (Continued)

Program Function	Level	Default Value	Values Available
	AC-Amplitude	2	None, 1 - 10
Delay drop-out	N/A	2.0	1 to 2.5 seconds
Flame pick-up	N/A	2.0	0 to 5.0 seconds
Maximum frequency	Only shows up, if the application selected is turbine	125	125 or 250

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