

Safety Manual for Fire Control and Indicating Equipment “Solution F1” according IEC 61508

Safety Manual Solution F1 – Rev. 1.3 – 20200302

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1 Revision history

Version	Date	Modification	Author
1.0	2018-01-25	Initial version	F.Buss
1.1	2019-08-23	Content update	F.Buss
1.3	2020-02-11	Test report reference	F.Buss

2 Purpose and scope of this document

This document describes how to use the fire control panel (FCP) Solution F1 in the context of a safety-related system, specifying the hardware and software components as well as installation and operation details in order to reach the desired safety integrity level.

This document is useful to system designers willing evaluate the safety of their system embedding the FCP Solution F1.

3 Test Report

This safety manual is based on test report F177_FM001 rev.4, issued by Engineering Safety Consultants.

In the test report two versions, A and B, of the fire control panel Solution F1 are listed. Version A represents the single CPU main controller, whereas the version B includes the full redundant CPU/memory core with second CPU board F20040-11.

4 Safety system overview

Two different safety systems have been considered and evaluated. The first system is a standalone fire alarm panel (FAP) with 1 to 18 loops in modular steps by 2. In this system the monitoring of the universal functionality is possible by a dry contact relay, which will change its status in case of total power loss of the FAP or in case of a hardware system fault.

The second safety system consists of one or more FAPs or one single FAP and a remote control panel (RCP), communicating over a redundant field bus using an IEC 62280 compatible communication protocol. If the FAP stops the communication or reports any failure in the system there is an additional monitoring via RCP.

Details about the two different systems you find in table 4.1, 4.2 and 4.3 on the following pages.

4.1 Overview of achieved SIL level

Device	PFD Target (30% of SIL2 band)	PFD achieved	PFD achieved (SIL)	SFF	Type	Achieved SIL (Architecture, HFT=0)	Overall achieved SIL
Solution F1 Fire Alarm Control Panel (Version A – Using remote unit)	3.0E-03	2.9E-03	2	92%	B	2	2
Solution F1 Fire Alarm Control Panel (Version B – Using remote unit)	3.0E-03	2.8E-03	2	92%	B	2	2
Solution F1 Fire Alarm Control Panel (Version A – Without remote unit)	3.0E-03	3.6E-03	1	89%	B	1	1
Solution F1 Fire Alarm Control Panel (Version B – Without remote unit)	3.0E-03	3.4E-03	1	89%	B	1	1

Table 4.1

Version A: single CPU

Version B: redundant CPU

Remote Unit: Remot Control Panel B01500-00 or LCD Repeater Panel B01520-xx or any other SIL capable remot unit.

4.2 Safety system with remote control unit

Device Reference		Solution F1 Fire Alarm Control Panel (with remote units)	
Function Specification		To provide an audible / visual annunciation locally (or to remote connected devices) upon a fire condition detected by the field fire detection devices	
Software Configuration / Settings		Standard configuration with settings according national standards. Common fault fail safe relay configured.	
Software Version		Main controller: S040A14.22 Loop card Hochiki: S060A04.18 Loop card Apollo: S060B04.09 Conventional card: S061A01.20	
Hardware Diagram version		PSU module: Version P001-03-I date: 29.10.2015 Main board: Version P030-05-A date: 16.02.2016 CPU board: Version P040-02-A date: 11.02.2005 Loop card Hochiki Version P060-03-B date: 29.11.2011 /Apollo: Conventional card: Version P060-02-B date: 19.03.2009 LED/Keyboard: Version P090-04-C date: 04.09.2015 Zone LED board: Version P091-01-F date: 11.02.2004 Relay board: Version P121-01-C date: 30.11.2010 Network card: Version P122-02-D date: 13.10.2016	
Hardware Configuration / Settings		Highest safety level with redundant main controller CPU board and redundant CPU on loop cards.	
Failure Mode(s) Definition	Version	Version A	Version B
	Dangerous detected	Fault detected by diagnostics and indicated by specific fault alarm indication in main board	
	Dangerous undetected	Inability to provide audible/visual alarm locally or to remote unit upon detection of fire condition by field fire detection device	
	Safe	Fault results in fault alarm indication in main board	
Estimated failure rate (excluding NE failures)		5.7E-06/hr	6.0E-6/hr
Dangerous Undetected Failures (λ_{DU})		4.7E-07/hr	5.0E-07/hr
Dangerous Detected Failures (λ_{DD})		5.2E-06/hr	5.5E-06/hr
Safe Failures (λ_S)		1.9E-08/hr	1.9E-08/hr
Probability of Failure on Demand (PFD)		2.9E-03	2.8E-03
Safe Failure Fraction (SFF)		92%	92%

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Hardware Fault Tolerance (HFT)	HFT=0	HFT=0 Note: Version B includes redundant P040 PCB
Classification (Type A or Type B)	B	B
Demand (Low demand or High Demand)	Low	Low
Safety Integrity Level (Hardware)	2	2
Proof Testing Procedures	Activate a fire alarm sensor and check all panel indications and output activations. Maintenance intervals and scope of proof testing are specified in national regulations like DIN 14675-1, BS5839-1 or NFPA 72.	
Installation	Indoor installation, wall mounted metal housing. Installation instructions have to be considered as well as national installation regulations like DIN 14675-1, BS5839-1, NFPA 72 or other local codes of practice.	
Average lifetime of device	15 years	
Temperature Range	-5 - +40 °C	
Systematic Safety Integrity Level	Prior Use assessment F177_FM001 rev.4 confirms suitability for safety applications requiring SIL 2 capability (max)	
Assumptions	Installation with connection to remote unit(s) and associated diagnostics	
General Notes and applicable regulations	EN54-2, EN54-4, EN54-13, national standards for installation, commissioning and maintenance of fire alarm systems, DIN 14675-1, BS5839-1 or NFPA 72. Applicable standards for environmental conditions: EN 50130-4:2011 (EMC) EN 60068-2-1:1993 (Environmental - cold) EN 60068-2-6:1995 (Environmental – sinus oscillation) EN 60068-2-47:2005 (Environmental – dynamic oscillation) EN 60068-2-75:1997 (Environmental - Impact) EN 60068-2-78:2001 (Environmental – damp heat)	
Testing requirements	Regular maintenance intervals as specified in national standards like DIN 14675-1, BS5839-1 or NFPA 72. At least once a year 100% functional testing of every automatic fire detector and every manual call point. Appropriate test equipment for smoke, heat and combined sensors has to be used. Audio and visual alarm notification has to be tested. Battery voltage has to be checked during maintenance. Battery replacement according national regulations.	

4.3 Safety system without remote control unit

Device Reference		Solution F1 Fire Alarm Control Panel (Standalone)	
Function Specification		To provide an audible / visual annunciation locally (or to remote connected devices) upon a fire condition detected by the field fire detection devices	
Software Configuration / Settings		Standard configuration with settings according national standards. Common fault fail safe relay configured.	
Software Version		Main controller: S040A14.22 Loop card Hochiki: S060A04.18 Loop card Apollo: S060B04.09 Conventional card: S061A01.20	
Hardware Diagram version		PSU module: Version P001-03-I date: 29.10.2015 Main board: Version P030-05-A date: 16.02.2016 CPU board: Version P040-02-A date: 11.02.2005 Loop card Hochiki Version P060-03-B date: 29.11.2011 /Apollo: Conventional card: Version P060-02-B date: 19.03.2009 LED/Keyboard: Version P090-04-C date: 04.09.2015 Zone LED board: Version P091-01-F date: 11.02.2004 Relay board: Version P121-01-C date: 30.11.2010 Network card: Version P122-02-D date: 13.10.2016	
Hardware Configuration / Settings		Highest safety level with redundant main controller CPU board and redundant CPU on loop cards.	
Failure Mode(s) Definition	Version	Version A	Version B
	Dangerous detected	Fault detected by diagnostics and indicated by specific fault alarm indication in main board	
	Dangerous undetected	Inability to provide audible/visual alarm locally or to remote unit upon detection of fire condition by field fire detection device	
	Safe	Fault results in fault alarm indication in main board	
Estimated failure rate (excluding NE failures)		5.7E-06/hr	6.0E-6/hr
Dangerous Undetected Failures (λ_{DU})		6.2E-07/hr	6.6E-07/hr
Dangerous Detected Failures (λ_{DD})		5.1E-06/hr	5.3E-06/hr
Safe Failures (λ_S)		1.9E-08/hr	1.9E-08/hr
Probability of Failure on Demand (PFD)		3.6E-03	3.4E-03
Safe Failure Fraction (SFF)		89%	89%

Hardware Fault Tolerance (HFT)	HFT=0	HFT=0
Classification (Type A or Type B)	B	B
Demand (Low demand or High Demand)	Low	Low
Safety Integrity Level (Hardware)	1	1
Proof Testing Procedures	Activate a fire alarm sensor and check all panel indications and output activations. Maintenance intervals and scope of proof testing are specified in national regulations like DIN 14675-1 or BS5839-1.	
Installation	Indoor installation, wall mounted metal housing Installation instructions to be considered	
Average lifetime of device	15 years	
Temperature Range	-5 - +40 °C	
Systematic Safety Integrity Level	Prior Use assessment F177_FM001 rev.4 confirms suitability for safety applications requiring SIL 1 capability (max)	
Assumptions	Standalone installation without remote unit and associated diagnostics	
General Notes and applicable regulations	EN54-2, EN54-4, EN54-13, national standards for installation, commissioning and maintenance of fire alarm systems, DIN 14675-1, BS5839-1 or NFPA 72. Applicable standards for environmental conditions: EN 50130-4:2011 (EMC) EN 60068-2-1:1993 (Environmental - cold) EN 60068-2-6:1995 (Environmental – sinus oscillation) EN 60068-2-47:2005 (Environmental – dynamic oscillation) EN 60068-2-75:1997 (Environmental - Impact) EN 60068-2-78:2001 (Environmental – damp heat)	
Testing requirements	Regular maintenance intervals as specified in national standards like DIN 14675-1, BS5839-1 or NFPA 72. At least once a year 100% functional testing of every automatic fire detector and every manual call point. Appropriate test equipment for smoke, heat and combined sensors has to be used. Audio and visual alarm notification has to be tested. Battery voltage has to be checked during maintenance. Battery replacement according national regulations.	

4.4 Device Reference

The scope of this safety manual covers the fire control panel range "Solution F1" with various devices. All parts of the system are self-monitored and any abnormal function will lead to a fault indication at the control unit.

Following are the main parts of the system:

Fire control panel "Solution F1-6", part no. B01050-00



- Fire control panel with 2 – 6 loops for up to 1524 addressable devices.
- Supports Hochiki ESP and Apollo Discovery/XP95 protocol.
- Power supply 24 VDC / 4.2A included.
- Mains supply 230 VAC, 50-60 Hz
- Protection class: IP30
- Weight: 14,9 Kg (A1 housing) without batteries

Fire control panel "Solution F1-18", part no. B01060-00



- Fire control panel with 2 – 18 loops for up to 4572 addressable devices.
- Supports Hochiki ESP and Apollo Discovery/XP95 protocol.
- Power supply 24 VDC / 6.7A included.
- Mains supply 230 VAC, 50-60 Hz
- Protection class: IP30
- Weight: 19,5 Kg (B1 housing) without batteries

Additional parts of the system

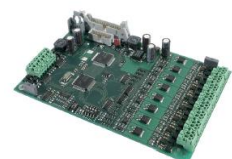
B01277-00: loop card for Apollo Discovery/XP95 protocol
(PCB = P060)



B01272-00: loop card for Hochiki ESP protocol
(PCB = P060)



B01310-00: conventional card for non-addressable fire detectors
(PCB = P061)



B01350-00: ARCNET network card

(PCB = P122)

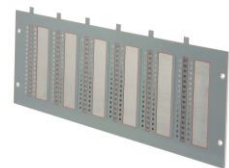


B01330-00: Relay board with 8 dry contact relays 250 VAC/5A

(PCB = P121)



B01200-00: Front plate for zone indication



B01220-00: Zone indication board alarm/fault/disabled for 32 zones

(PCB = P091)



4.5 Safety function specification

The safety function of a fire control panel could be defined as two different sections. The first section is the fire detection. This part of the process is realized by communicating with the connected fire detection devices and by evaluating the received values. As well as the fire control panel all connected devices must be capable to meet the requirements for a SIL2 safety application.

The second section of the safety function is the activation of alarm related outputs, like audio visual alarm devices, outputs, dry contacts or servicing serial interfaces to intelligent remote systems. Here again the safety integrity level of all connected devices has to be considered.

The fire control panel "Solution F1" is a modular system which can be used as a standalone fire control panel or can be connected to a variety of monitoring and control systems. The SIL capability of remote monitoring and control equipment has to be considered separately. The following connections to a remote system are possible:

- Redundant dry contact relay of 2 main board relays, configured to "common fault" function and connection to a remote monitoring station.
- Redundant connection to programmable logic controller (PLC) via serial interface
- Redundant connection to building management software (BMS) via serial interface
- Redundant connection to LCD repeater panel via serial interface
- Redundant networking to other fire control panel (FCP) or to remote control panel (RCP) via ARCNET fieldbus.

At least one of these systems has to be used as additional monitoring instrument to meet the requirements for a SIL2 safety application.

This analysis has been conducted for the fire control panel “Solution F1” unit, forming only one part of an interfacing subsystem in a very complex system. A full analysis considering the overall function including all individual sub-systems must be conducted to confirm suitability for use in the safety-related function. Please note that the fire control panel Solution F1 interface system was assessed against a maximum of 30% of the SIL 2 PFD (Probability of Failure on Demand) band and this must be considered in the overall SIL PFD calculations.

5 Software

5.1 Software Configuration / Settings

The fire control panel has to be configured by the NSC software package “FCS Tool” in the actual released version. By the “FCS Tool” all relevant settings of the system, like zone division, alarm parameters and output control can be configured. To meet SIL2 requirements at least one of the dry contact relays has to be configured to the “common fault” function. Then this relay is activated in the normal condition and will fall back in case of any fault in the system and even in case of complete loss of power this relay will indicate the fault condition. See fire control panel installer manual for configuration details.

5.2 Software Elements

The modular fire control system “Solution F1” consists of different intelligent units with various microcontrollers. The software documentation and the behavior in case of a system fault is monitored by VdS in conformity with European Standards for fire control systems. The latest software versions for microcontroller units are:

Unit	Version	PCB	History
Main controller:	S040A14.14	CPU board P040-xx	S040 Softwarehistory.doc
Loop card Hochiki:	S060A04.16	loop card P060-xx	S060_Softwarehistorie_Hochiki.doc
Loop card Apollo:	S060B04.07	loop card P060-xx	S060_Softwarehistorie_Apollo.doc
Conventional card:	S061A01.01	conventional card P061-xx	S061_Softwarehistorie.doc

To configure the fire control panel, a PC software tool is available. This software is running on Microsoft Windows computers with OS Win7 or Win10.

Unit	Version	History
FCS Tool	8.1.0.1	S040 Softwarehistory.doc

5.3 Element Configuration

Main controller:	S040A14.14	CPU board P040-xx
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IDE:

"WINIDEA" (Version 2009 Build 9.9.92) from ISystem

Toolchain :

GNU Compiler gcc Version 3.2

GNU Linker ld Version 2.40.90

GNU Assembler as Version 2.40.90

Configuration of free programmable dry contacts to function "common fault" and "common alarm". No further mandatory configurations. All further settings according application and national regulations.

Loop card Hochiki/Apollo:	S060A04.16	loop card P060-xx
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IDE:

High-performance Embedded Workshop

Copyright (C)2009 Renesas Technology Corp.

Copyright (C)2009 Renesas Solutions Corp.

Copyright (C)2009 Renesas Technology Europe Ltd.

Version 4.06.00.047

Toolchain:

H8S,H8/300 Standard Toolchain (V.6.2.1.0)

H8S,H8/300 C/C++ Library Generator (V.2.02.01)

H8S,H8/300 C/C++ Compiler (V.6.02.01)

H8S,H8/300 Assembler (V.6.02.01)

Optimizing Linkage Editor (V.9.04.01)

System Tools:

E8a Emulator Software

V.1.00 Release 00

Configuration of card address via DIP switch according wiring diagram necessary.

Conventional card:	S061A01.01	conventional card P061-xx
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IDE:

Hitachi Embedded Workshop

(c) 2001 Hitachi Micro Systems Europe.

(c) 2001 Hitachi Ltd.

Version 2.0 (release 9)

Die Entwicklungsumgebung beinhaltet die folgenden Einzelwerkzeuge:

Toolchain:

Hitachi H8 Tiny/SLP Standard Toolchain (Ver. 1.0.0.0)

Hitachi Tiny/SLP C/C++ Library Generator (Ver. 1.0.00)

Hitachi Tiny/SLP C/C++ Compiler (Ver. 1.0.00)

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Hitachi Tiny/SLP Assembler (Ver. 1.0.00)
Hitachi Tiny/SLP Optimizing Linkage Editor (Ver. 1.0.00)

System Tools:

Hitachi Debugging Interface Version 5.02
LEM3664 SYSTEM Ver. 1.04

Toolchain:

H8S,H8/300 Standard Toolchain (V.6.2.1.0)
H8S,H8/300 C/C++ Library Generator (V.2.02.01)
H8S,H8/300 C/C++ Compiler (V.6.02.01)
H8S,H8/300 Assembler (V.6.02.01)
Optimizing Linkage Editor (V.9.04.01)

System Tools:

E8a Emulator Software V.1.00 Release 00

Configuration of card address via DIP switch according wiring diagram necessary.

5.4 Competence

The integrator has to attend NSC training following courses:

Name of course	Content	Duration
FCS Solution F1/F2 basic	system overview, wiring, software tool and configuration, workshop	3 Days
FCS Solution F1/F2 professional	remote accessories, networking, interface protocols	2 Days
BMS integration	configuration of building management software, connection to Solution F1/F2 system	3 Days

All elements passed VdS software approval process and are certified according EN54-2 software requirements. Special degree of reliance is reached by methods for dead-lock prevention, memory and program sequence monitoring, hard- and software watchdog and definition of safety operating status in case of software corruption.

Software updates will be done by software tools and are documented in special update manual for each element. Software download is monitored and error reported.

All reasons for release are documented in the software history and are explained individually. All releases are distributed to the installer base by email information system.

A software compatibility list gives information about backward compatibility for each element.

Certain compatibility requirements to other systems are explicitly mentioned in the software history and in the release note for each element.

Pre-existing elements are listed in the software history of each element.

Change request could be initiated directly by call of technical support hotline or by sending an email to support@nsc-sicherheit.de. Change requests are documented in a ticket system under categorization of priority and with a detailed description of the change request demands.

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Design safe state is specified in the software documentation and satisfies the requirements of EN54-2 chapter 13: **Additional requirements for software controlled fire alarm systems**. Highest attention has been paid to the detection of a system fault and the definition of the safe state. The safe state is defined as a system restart with audio and visual indication of the system fault message. A system fault message can't be reset by the normal operator.

Possible interface constraints are specified in the various "Operating and Installation manuals", available for the panels but also for special applications and accessory Modules.

There are actual no threats listed. All monitored inputs and outputs, like loop wires, transmission or alarming outputs and interfaces to other systems are permanently monitored and any interference or abnormality will be detected and indicated as a fault message. Unauthorized access is inhibited by several password protected access levels.

All configurable elements are explained in detail in the "Operating and Installation manuals". Additionally tutorial videos will be supplied to the integrators for further explanation. "Help" functions in the PC configuration software will support the integrator to configure the system properly. Training courses are mandatory before receiving the configuration software tool.

5.5 Justification of claims

Compliance of items is justified by following meanings:

- Test reports

Issued by	Name	Scope	Date
VdS	121695-AU01+UCE01-PB01	Environmental and EMC	2016-06-30
VdS	121695-AU01+BZA02-PB01	Functional testing	2016-08-26
VdS	BMA 10133	PSU testing	2010-11-30
VdS	121695-AU01+SW01-PB01	Software	2016-05-02
VdS	160159-AU01+BZA03-PB01	System compatibility	2018-11-06
EMC Test NRW	P19-Z-00047-002	EMC	2019-05-03
RST Rail system Testing GmbH	P50-14-0085_1	Environmental according DIN EN 50155	2014-11-17
RS Schwarze GmbH	2014181	EMC EN50121-3-2:2006	2014-11-11

- suppliers documentation

Issued by	Name	Date
NSC	[B01050-00_B01060-00] End User Manual Solution F1 V14.20 20190115.pdf	2019-01-15
NSC	[B01050-00_B01060-00] F1 mounting instructions.pdf	2014-05-07
NSC	[B01050-00_B01060-00] Installer Startup Protocol F1 20130910.pdf	2013-09-10
NSC	[B01050-00_B01060-00] maintenance manual Solution F1 2014.pdf	2014-06-30

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NSC	[B01050-00_B01060-00] Operating Installation Manual Solution F1 V14.22 20190603.pdf	2019-06-03
NSC	[B01050-00_B01060-00] Solution F1 wiring english 2014.pdf	2014-12-17
NSC	[B01050-00_B01060-00_B01500-00] Network Installer manual Solution F1 01-2019.pdf	2019-01-29

- records of repair under warranty items and statistical evaluation

Issued by	Name	Date
NSC	Statistical evaluation from ERP software	anual

- production process monitoring

Issued by	Name	Scope	Date
NSC	MP BMZ F1-6 B01050-00 Version7.doc	Assembly and test protocol	2019-01-15
NSC	MP BMZ F1-18 B01060-00 Version9.doc	Assembly and test protocol	2014-05-07
NSC	[B01050-00_B01060-00] Installer Startup Protocol F1 20130910.pdf		2013-09-10
NSC	[B01050-00_B01060-00] maintenance manual Solution F1 2014.pdf		2014-06-30
NSC	[B01050-00_B01060-00] Operating Installation Manual Solution F1 V14.22 20190603.pdf		2019-06-03
NSC	[B01050-00_B01060-00] Solution F1 wiring english 2014.pdf		2014-12-17
NSC	[B01050-00_B01060-00_B01500-00] Network Installer manual Solution F1 01-2019.pdf		2019-01-29

- approved quality management system according ISO 9001

Issued by	Name	Scope	Date
VdS	ISO-Zertifikat-S803114 GB.pdf	DIN EN 9001:2015	2017-12-12

Zertifikat Certificate



Certificate No.:	No. of pages:	Valid from:	Valid to:
S 803114	1	12.12.2017	11.12.2020

Development, production and sales of products for fire and intrusion detection as well as video surveillance and access control technology

Any advertising with this VdS approved quality management system shall reflect the correct contents of the certificate and shall not violate the competition regulations.

DIN EN ISO 9001
Quality management systems
Requirements
Edition September 2015
Management documentation of the approval holder

Köln (Cologne), 12.12.2017



Rich

Dr. Reinermann
Managing Director

Mr. C.

i.V. Edel
Head of the VdS Certification Body

Accredited for the certification of
quality management systems by the
DAkkS - Deutsche
Akkreditierungsstelle GmbH