

Uppgjord - Telamp M.Barkell	Faktaansvarig - EAB/UKD/LK	Dokumentnr - 1551-BFD 509 08 UEN		
Dokansv/Godk - EAB/UKD/LK		Datum - 2005-02-07	Rev H	File

Fan Subrack (FSR)

1 General

This Fan Subrack (FSR) is intended for general use in BYB 501, where it is mounted as a normal low height subrack. It can be placed above or below the subrack to be cooled. It is internally built up of three fans and a control board.

FSR Product	Rack depth	Note
BFD 509 08/1	300mm	None of the below noted features. Will be phased out. LED is OFF by startup default in SERIAL mode.
BFD 509 08/2	300mm	-48V supervision. Emulates BFD50904 (3 addresses). LED is ON by startup default in SERIAL mode.
BFD 509 08/3	300mm	-48V supervision. LED is ON by startup default in SERIAL mode.
BFD 509 08/4	300mm	Larger fan motor software compatible with BFD 5908/3

(The shaded products are discontinued - RE-coded)

1.1 Changes Compared to Previous Revision

Changes in rev H, compared to rev G:

- Chapter 3.4 rewritten to refer to the newer FINFO1 and FINFO2 methods of fan unit cooperation and their descriptions in ref[5] and ref[7], instead leaving out the never implemented hardware oriented solutions to achieve the same functionality.
- Chapter 1.2 renamed from Requirements Specifications to References and using separate subsections instead. ref[7] added to the reference section.
- Chapter 3.5.3 updated with the new protocol revision used in BFD50908/4 and the addition of its FINFO1 object.
- Text in chapter 3.5.1 updated on conditions for SIMPLE mode - it only works for standalone FSRs. It was previously written for the never implemented hardware multiple FSR cooperation functionality.

1.2 References

The following documents have been used as requirement specifications for the design:

- ref[1] : TG/ML-93:140 "Strategy for fan use for AXE-N"
- ref[2]: EUA/R956187 Uen rev C "Maintenance Channel Gateway Interface"
- ref[3]: ETX/XA/M-95:229 rev B "Maintenance Channel Level 2 Interface"
- ref[4]: EUA/M951523 rev PA2 "Serial Interface of Type V.24/V.28, Medium and Physical Layer"

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ref[5]: ETX/XA/M-95:230 rev F “The Denib1 Protocol”

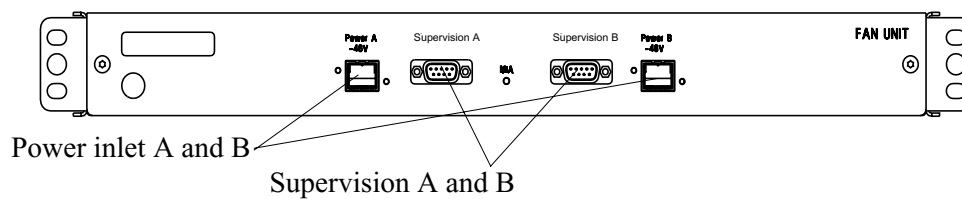
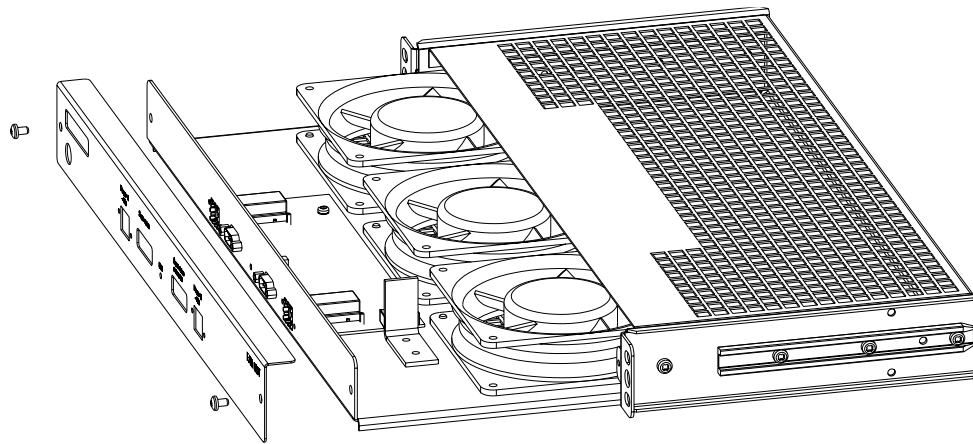
ref[6]: 1/1551-B/AXE10699 rev C “Identity for Hardware Products in AXE-10”.

The following documents are referred to for further information:

ref[7]: 1/ETX/XA/M-95:230 rev A “Cooperation among Fan units with denib”

2 Mechanical Data

The following figure shows a general overview of the FSR and the location of its connectors.



Dimensions:

Parameter	min	typ	max	unit
Height		50		mm
Width		450		mm
Depth		200		mm
Weight		5		kg

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Air flow data (at various counterpressure and air temperatures):

FSR type	Conditions	min	typ	max	unit
BFD 509 08/1 to BFB 50908/3	0 Pa, t=TLOWER		240		m ³ /h
	0 Pa, t=TUPPER		480		m ³ /h
	10 Pa, t=TLOWER		225		m ³ /h
	30 Pa, t=TUPPER		360		m ³ /h
BFD 50908/4	0 Pa, t=TLOWER		100		m ³ /h
	0 Pa, t=TUPPER		750		m ³ /h
	10 Pa, t=TLOWER		690		m ³ /h
	30 Pa, t=TUPPER		600		m ³ /h

(TLOWER and TUPPER are defined in the Electrical Data chapter below).

Sound levels (at TUPPER/TLOWER air temperature):

FSR type	Condition	min	typ	max	unit
BFD 509 08/1 to BFB 50908/3	0.5m from front panel			60/45	dB(A)
BFD 50908/4	0.5m from front panel			TBD	dB(A)

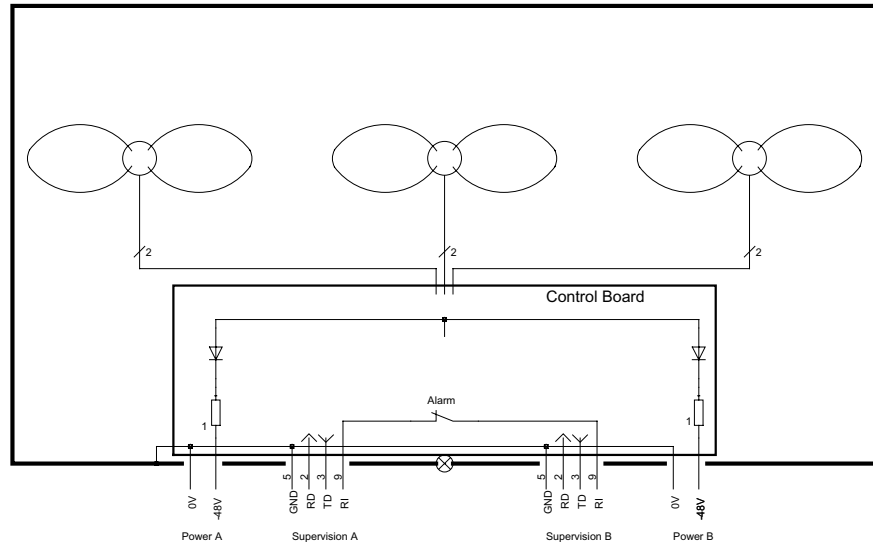
Reliability data:

Parameter	Condition	min	typ	max	unit
Operating Life Time	T _{air} = 30°C		20		years
MTBF	T _{air} = 40°C		10		years

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3 Electrical Data

The following figure shows an overview of the internal electrical connections of the FSR.



Power supply data:

Parameter	Conditions	min	typ	max	unit
Supply Voltage		40		60	V
Supply Current	BFD 509 08/1 to 3		175	350	mA
Supply Current	BFD 509 08/4	200		800	mA
Supply Current Ripple	10Hz - 10kHz		25	50	mA _{RMS}

Fan Control BFD 50908/1 to /3:

Parameter	Name	min	typ	max	unit
Sensor Temp. Range		-20		+100	°C
Fan Voltage Lower Bkpt	ULOWER		20		V
Fan Voltage Upper Bkpt	UUPPER		48		V
Temp. at Lower Bkpt	TLOWER		35		°C
Temp. at Upper Bkpt	TUPPER		50		°C
Temp alarm limit A	TEMPERR_LO		55		°C
Temp alarm limit B	TEMPERR_HI		65		°C
Temp. Sensor Low Fail	LO_SENSEFAIL	-24			°C
Temp. Sensor High Fail	HI_SENSEFAIL		+104		°C
Temp. Sensor Diff Fail	DIF_SENSEFAIL		10		°C

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Parameter	Name	min	typ	max	unit
Fan Current for no Alarm (per fan motor)	$V_{FAN} < 22V$	0		39	mA
	$22V \leq V_{FAN} < 30V$	19		59	mA
	$30V \leq V_{FAN} < 45V$	30		102	mA
	$45V \leq V_{FAN}$	51		150	mA

Fan Control BFD 50908/4:

Parameter	Name	min	typ	max	unit
Sensor Temp. Range		-20		+100	°C
Fan Voltage Lower Bkpt	ULOWER		15		V
Fan Voltage Upper Bkpt	UUPPER		50		V
Temp. at Lower Bkpt	TLOWER		15		°C
Temp. at Upper Bkpt	TUPPER		45		°C
Temp alarm limit A	TEMPERR_LO		55		°C
Temp alarm limit B	TEMPERR_HI		65		°C
Temp. Sensor Low Fail	LO_SENSEFAIL		-24		°C
Temp. Sensor High Fail	HI_SENSEFAIL		+104		°C
Temp. Sensor Diff Fail	DIF_SENSEFAIL		10		°C

3.1 Alarm connector pin description

Pin	Function
1	NC
2	Input data
3	Output data
4	NC
5	Ground
6	NC
7	NC
8	NC
9	Relay

3.2 Fan Speed Control

Each Fan Subrack (FSR) has a temperature sensor, which is located close to the fan air stream. The FSR controls the fan motor voltage according to the temperature of this temperature sensor. If the FSR is configured to operate together with other FSRs on the same maintenance channel, (see multiple FSR cooperation below), the maximum temperature of all FSRs is instead used. For temperatures below TLOWER, the fan voltage is ULOWER. For temperatures above TLOWER, the fan voltage will increase linearly with tempera-

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ture according to a line from temperature/voltage TLOWER/ULOWER through TUPPER/UUPPER. The fan voltage is limited to the supply voltage minus approx. 2V, due to the forward voltage drop of the regulator.

The voltage regulator also acts as an active AC current filter, reducing the ripple current from the fans that would otherwise be superimposed on the input supply current.

When power is connected to the FSR, it will perform a start-up cycle, which means that it will set the fan supply voltage to 0V for two seconds, then to the full input voltage for two seconds, and then go into its normal temperature controlled fan voltage regulation.

If any of the failure flags (FFLAGS, see next chapter) is set, the FSR will run at full speed (at the full input voltage). If the FSR is configured to operate together with other FSRs on the same maintenance channel, (see multiple FSR cooperation below), all fans of all these FSRs will run at full speed if any of the failure flags are set.

3.3 Failure Detection and Response

Each Fan Subrack (FSR) senses a set of failure conditions. These are collected as flag bits in two flag registers.

FFLAGS

These flags are related to the fan motor control. All failures reported by these flags will also cause the fans to run at full speed. The names of these flags and their meaning is as follows:

TEMP_A - The temperature is above the A-alarm limit (TEMPERR_HI).

TEMP_B - The temperature is above the B-alarm limit (TEMPERR_LO).

TEMPSENSOR - The temperature sensor is out of range (below LO_SENSEFAIL or above HI_SENSEFAIL) or the temperature differs more than $\pm$ DIFF_SENSEFAIL from all cooperating FSRs. This should be considered a sensor failure.

MOTOR - The current to one of the fan motors is out of range (outside the range specified in Fan control data above). Three restart attempts have also been tried before this flag is set.

COMERR - The reporting of flags and temperatures between the FSRs has failed (two or more consecutive reports from one or more FSR are missing). This fault can appear if the FSR is configured for cooperation with other FSRs, and any of these other FSRs stop to function correctly from communication point of view.

REGERR - Fan motor voltage regulation failure. This flag indicates a FSR internal control board failure - the fan motor voltage does not properly correlate to the control signal applied.

IFLAGS

These flags relate to the maintenance channel HW interface and may be used to determine the reason for communication problems. They do not directly

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control fan speed, but are very likely to cause a COMERR failure (see above) which will do so. The names of these flags and their meaning is as follows:

A_INV - The input voltage on the A-side communication interface data input (RX) pin is not correct (acc. to RS232 specifications). This indicates a wiring failure or a failure of the data output (TX) circuitry of the next unit (supervisor or next series connected FSR).

A_CAB - The input voltage on the A-side communication interface clear to send input (CTS) pin is not correct. This indicates that the cable connecting to the next unit is not present. Circuitry for detecting this failure is not implemented in the FSR, but the bit is defined for future upgrades.

B_INV - The input voltage on the B-side communication interface data input (RX) pin is not correct (acc. to RS232 specifications). This indicates a wiring failure or a failure of the data output (TX) circuitry of the next unit.

B_CAB - The input voltage on the B-side communication interface clear to send input (CTS) pin is not correct. This indicates that the cable connecting to the next unit is not present. Circuitry for detecting this failure is not implemented in the FSR, but the bit is defined for future upgrades.

A_48V - (Implemented in BFD50908/2 and /3 only). No power is available at power inlet A. This condition is detected by voltage measurement, its threshold being -34.5V+/-2V.

B_48V - (Implemented in BFD50908/2 and /3 only). No power is available at power inlet B. This condition is detected by voltage measurement, its threshold being -34.5V+/-2V.

Common for all flags is that a logical “1” indicates the error condition and logical “0” the normal operation state. Non-implemented flags are signalled as logical “0”.

Each FSR determines its own set of FFLAGS flags, but it also collects (in table form) the FFLAGS flags from all other FSRs if it is configured for multiple FSR cooperation.

3.4 Single/Multiple FSR Operation

FSRs can cooperate in groups using two separate mechanisms when denib is used as communications protocol. Implementation of these mechanisms in the various versions are as shown in the following table:

FSR version	Cooperation Mechanism	
	OTYP_FINFO1	OTYP_FINFO2
BFD50908/3	no	yes
BFD50908/4	yes	yes

See ref[5] for a general description of these mechanisms and ref[7] more detail and how to set up and use.

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3.5 Maintenance Interface / Supervision

3.5.1 Overview

There are four possible ways to supervise the FSR, as shown in the below ta-

Supervision Method	Available in mode
Serial Denib	SERIAL
Serial Level1	SERIAL
HI/LOW	SIMPLE
Relay	any mode

ble. The change of “mode” takes place automatically, depending on whether the supervision jacks are connected to a serial interface or not. If A_INV and B_INV (see chp. 3.3) are both set, the mode is SIMPLE - otherwise it is SERIAL. Thus, for BFD50908 FSRs, SIMPLE mode can not be used with multiple FSR operation according to chapter 3.4 (since A_INV or B_INV are not active when connected to another fan). The mode change will occur within 10 seconds after the conditions above are met.

The front panel LED is in SERIAL mode controlled externally (by the supervisor), and in SIMPLE mode controlled locally (by the FSR). For more detail regarding LED handling, see the descriptions of each supervision method below.

Serial Modes

The maintenance interface is designed according to ref[3] (i.e. uses RS232/V24), which together with ref[4] describes hardware interface as well as the framing technique used to transfer messages of various software protocols. Frame size (according to ref[4]) is limited to maximum 100bytes.

Two protocols are supported, when framed according to ref[3]:

- “Level1”. Command/Response messages according to ref[2], this protocol is below referred to as the “Level1” protocol. The functionality provided by this protocol allows full handling of the front panel LED and push-button, reading (but not writing) of the “Product Individual Data” and reading of registers. See deviation below on interpretation of address values.
- The “Denib1” protocol, as defined in ref[5]. This protocol allows the same functionality as the Level1 protocol, but also writing of the Product Individual Data and it also allows and defines the messages needed by the fan controllers to share FFLAGS and temperature information.

The maintenance interface is implemented by use of “chain controllers” in each FSR (see ref[3] for further details). The special use of pin 9 of the alarm interfaces must however be noted, see below. For further descriptions of the serial protocols, see chapters 3.5.2 and 3.5.3.

HI/LOW level supervision

The FSRs, also support a simple hardware HI/LOW alarm interface function-

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ality. This mode uses the RS232 outputs for supervision. It is further described in chapter 3.5.4 below.

Relay supervision

Pin 9 of the supervision connectors (A and B) are connected to both sides of a normally closed alarm relay. In case of any failure, this alarm contact is opened. This alarm relay functionality is independent from “supervision mode” (SERIAL or SIMPLE). These alarm pins can be chain connected over multiple FSRs to provide a simple total alarm function. It is further described in chp 3.5.5 below.

Compatibility to other Fan Subrack Families

The intention has been to introduce as little changes as possible compared to the BFD50904 fan subrack family. Still, the following differences exist:

- There is no push-button on the unit. This means the associated level1 protocol commands still are handled correctly - but the push-button will never be pushed. For the “denib1” protocol the entire “EVFLB” object named “StdPB” is removed. In SIMPLE mode (called “on/off” for BFD50904), the “LED test” is therefore of course no longer possible.
- BFD50908 is one single replacement unit, while BFD50904 contains three independently supervised replacement units. This affects the addressing when using the serial protocols (one address instead of three). The special version BFD50908/2 fully emulates BFD50904 fully in this respect.

3.5.2

Level1 Protocol Functionality

The FSR implements all commands and responses as defined in ref[2], the specification of the “Level1” protocol. Note the following deviation: **The FSR only interpret the low order 8 bits of the address** (byte 2 of the messages), the high order 8 bits are ignored. This deviation is likely to become incorporated in a new revision of ref[3].

The Level1 protocol defines messages to control the front panel LED, to read the Product Individual Data (see ref[6]), to handle a front panel push button and to read internal registers of the FSR. Not described there is however the actual contents of the data read via the ReadRegister command - it is therefore described below. Also note that there is no pushbutton on this FSR - it still implements the protocol, but the pushbutton will never “get pushed”.

Register Contents:

The FSR has four bytes of registers, arranged in the following order. The registers are all read-only.

Bit	7	6	5	4	3	2	1	0
REG[0]	FFLAGS							
REG[1]	TEMP_MSB							
REG[2]	TEMP_LSB							
REG[3]	CONF							
REG[4]	IFLAGS							

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The FFLAGS register byte uses the bits defined in chapter 3.3 above. The flags have the following bit positions within the flag byte:

r7	r6	r5	r4	r3	r2	r1	r0
0 (= not used)		REGERR	COMERR	MOTOR	TEMP- SENSOR	TEMP_B	TEMP_A

The TEMP register contains a binary coded 16-bit word stating the fan controller surrounding air temperature, in SNVT_temp format. To convert to centigrade, subtract 2740 and divide the remainder by 10.

The CONF byte tells what number of FSRs that configured together represented as a binary number. Possible values are 1 - 8. The default value (without use of the “reconfiguration set” described above) is 1. All FSRs on the same maintenance channel will return the same CONF value. The ADDRESS number range of the FSRs on the maintenance channel is 1,2, ...CONF.

The IFLAGS register byte contains flags related to the maintenance channel HW interface, described “Failure Detection and Response” chapter above. The flags have the following bit positions within the flag byte:

r7	r6	r5	r4	r3	r2	r1	r0
0 (= not used)		B_48V	A_48V	B_CAB	B_INV	A_CAB	A_INV

The fan controller responds REG_ADD values of 0, 1, 3 and 4 only. Depending on REG_LENGTH, the following is returned:

REG_ADD	REG_LENGTH	returned data (in order stated)
0	1...8	FFLAGS
0	9...24	FFLAGS, TEMP_MSB, TEMP_LSB
0	25...32	FFLAGS, TEMP_MSB, TEMP_LSB, CONF
0	33...40	FFLAGS, TEMP_MSB, TEMP_LSB, CONF, IFLAGS
1	1...16	TEMP_MSB, TEMP_LSB
1	17...24	TEMP_MSB, TEMP_LSB, CONF
1	25...32	TEMP_MSB, TEMP_LSB, CONF, IFLAGS
3	1...8	CONF
	9...16	CONF, IFLAGS
4	1...8	IFLAGS

FLAGS are the entire flags register byte, TEMP_MSB is the temperature register entire most significant byte, TEMP_LSB is its entire least significant byte and CONF is the configuration byte.

The recommended system level handling of the FFLAGS is:

TEMP_A (r0): Immediate action, replacement or other service is required.

Others (r1..r5): Needs replacement, but normal service interval is accepta-

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The recommended system level handling of the temperature register is for information. Examples of its use could be to limit traffic or capacity at high temperatures.

3.5.3 Denib1 Protocol Functionality

The following named standard data objects according to this protocol are implemented:

Denib-Type	Nr	Name	States		Bits		
			State	Name	Mask (hex)	Name	Rec. alarm priority
CONTR	0	Fan					
NVSTR	0	ProdIndivData					
4STCTL	0	StdLED	0	Off			
			1	SlowFlash			
			2	FastFlash			
			3	On			
ROFLB	0	FFLAGS			01	Temp65	A
					02	Temp55	B
					04	TempSensor	B
					08	Motor	B
					10	Comerr	B
					20	Regerr	B
ROFLB	1	IFLAGS			01	A_INV	-
					02	A_CAB	-
					04	B_INV	-
					08	B_CAB	-
					10	A_48V	-
					20	B_48V	-
8ROSAN	0	AirTemp					
FINFO1	0						
FINFO2	0						

The protocol revision is “D” for BFD50908/3 and “F” for BFD50908/4. The FINFO1 object is currently not implemented in BFD50908/3.

The ProdIndivData size is 100 bytes. The first byte of ProdIndivData determines the length that will be returned as a response to the Level1 protocol Read Product Individual Data command, the following bytes are the same in both protocols.

The “Temp65” bit directly corresponds to the Level1 protocol FFLAGS register TEMP_A bit, and the “Temp55” bit directly corresponds to the TEMP_B bit.

3.5.4 HI/LOW Alarm Functionality

This functionality is activated in SIMPLE mode (see chp. 3.5.1).

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Alarm interface using HI/LOW

In SIMPLE mode of operation, the output pins (pin 3, TxD) of the supervision A and B interfaces will both act as electrical voltage level outputs, where:

- low level acc. to RS232 (voltage below approx. -3V) indicates no fault.
- high level acc. to RS232 (voltage above approx. +3V) indicates alarm.

Conditions that cause an alarm in SIMPLE mode are:

- Any bit in the FFLAGS registers of all cooperating FSRs is set, or
- Any of the A_48V or B_48V bits of the IFLAGS register (of this FSR).

LED behaviour in SIMPLE mode

In this mode, the LED is fully controlled by the FSR faults. Any conditions that cause an alarm in SIMPLE mode (as defined in the paragraph above) will cause the LED to flash at 1Hz, 60% duty cycle.

3.5.5

Relay Supervision

The FSR is also equipped with an alarm relay contact, series connected between pin 9 in each of the supervision connectors A and B. It is normally closed, but opened in case of alarm. Conditions that cause an alarm are any bits of the FFLAGS register except COMERR (see chp. 3.3), or the IFLAGS A_48V or B_48V bits. This means that this relay alarm is has the same alarm conditions as in SIMPLE mode - but regardless of mode.

The LED behaviour only depends on SIMPLE/SERIAL mode. Since relay supervision normally uses SIMPLE mode, the LED will indicate the relay status. For LED behaviour in SIMPLE mode, see chp 3.5.4.