

H1 Very Forward Proton Spectrometer Temperature Monitor V2

Preliminary !

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Introduction

The main purpose of the (V)FPS Temperature Monitor system is to measure the temperature at different locations of the detector or its electronics and to generate in case of a temperature above a given threshold an alarm, which immediately switches off the corresponding power supply.

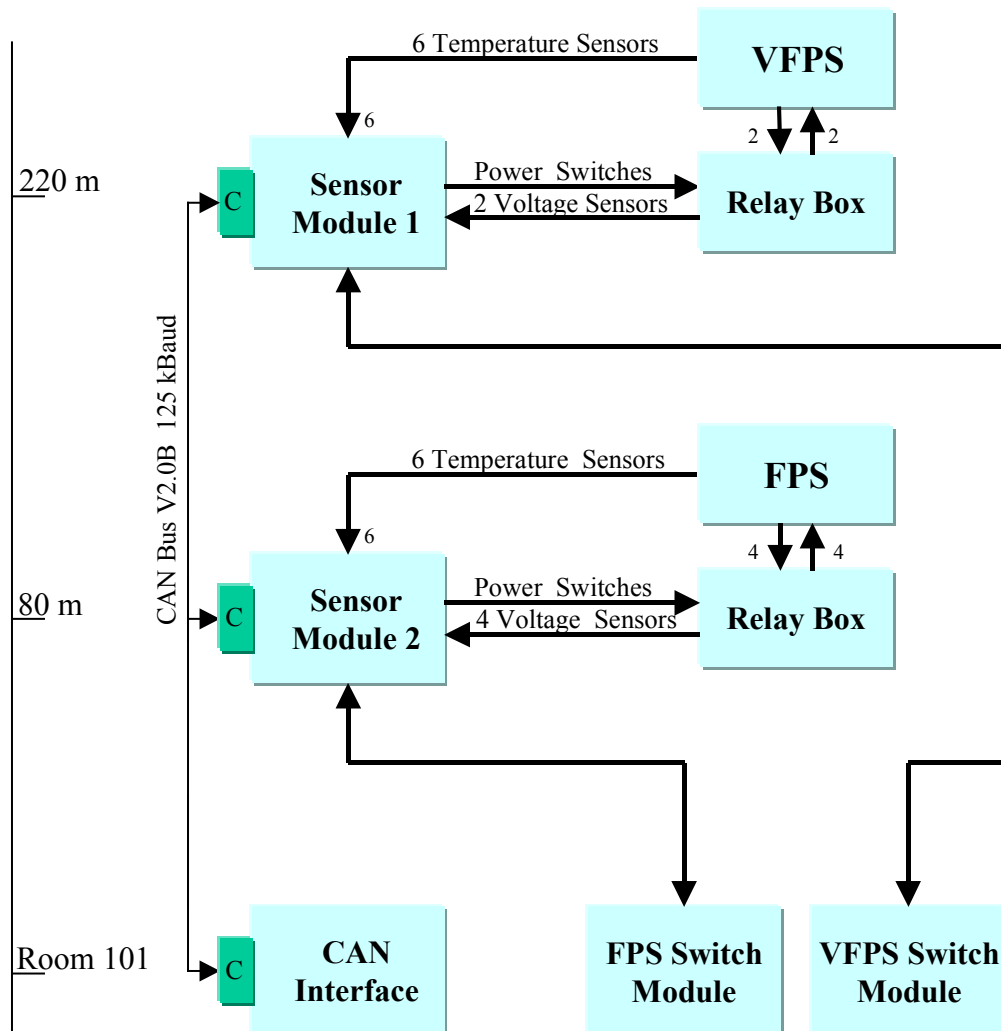


Fig. 1: (V)FPS Temperature Monitor System

For safety reasons, the alarm system is a pure hardware solution, which does not need any computer assistance. But for monitoring and data logging purposes a CAN interface

has been implemented, which provides the read-out of temperature values and status informations.

As shown in Fig.1 there are two systems, one for the FPS detectors and one for the VFPS detectors. Each system consists of a Sensor Module, a Switch Module and a Relay Box.

The heart of the system is the Sensor Module. It is located near the detectors and can operate up to six temperature sensors of two different types. For each type, a variable threshold is provided. Temperature and threshold values can be read by a 3.5 digit LCD display.

For up to four Roman Pots the alarm conditions are implemented by firmware. Each alarm immediately switches off the power supply of the corresponding Pot.

In case of no alarm the power supply of a certain Pot can be switched by the Switch Module, which is located in the Control Room 101. The switch command passes the Sensor Module and is sent to the Relay Box, where a relay connects the 220 V AC to the power supply. The low voltage DC then is sensed, and the Power-on status is fed back to the Sensor Module, where it is driven to the Switch Module for display.

For computer read-out the Power-on status also is available together with the switch positions and 8 temperature informations (6 sensor and 2 threshold values).

This manual provides all necessary informations for operating the system. At first the hardware of the Sensor Module is described in more detail. The next chapter deals with the computer access to the module. Finally Switch Box and Relay Box are presented.

The appendix gives informations on the actual settings for the different detectors.

Sensor Module

The Sensor Module can be operated with up to six temperature sensors **T[6..1]**, which are connected by LEMO cables to Input Nr. 6..1. The following two silicon sensor types with positive temperature coefficient of resistance are used:

KTY81 (Philips)

Input Number: 1..6
 Range: 0 .. 100 °C
 Calibration: $U = 50 * T$ [mV]

KTY84 (Philips)

Input Number: 5..6
 Range: 0 .. 300 °C
 Calibration: $U = 12 * T$ [mV]

At first a temperature to voltage conversion circuit generates for each sensor a linear voltage output (see Fig. 2). The linearisation error is of the order of 1 °C (KTY 81) and 3 °C (KTY 84) respectively.

Module inputs Nr. 1..4 are foreseen for sensor type KTY81 only. At inputs Nr. 5 and Nr. 6 type KTY81 or KTY84 can be connected. As shown in the following table, some jumpers have to be set on the module board according to the type selected:

Input Nr.	KTY81	KTY84
5	J200, J201, J403	J202, J203, J402
6	J204, J205, J405	J206, J207, J404

For jumper locations see Appendix D.

The sensor voltage outputs **U[6..1]** are sensed by six comparators with two different thresholds (**Thresh1**, **Thresh2**), one for sensor type KTY81 (comparators 1..6) and one for sensor type KTY84 (comparators 5..6). The thresholds are adjusted by potentiometers at the front panel. Threshold values and sensor values can be read by a 3.5 digit LCD display.

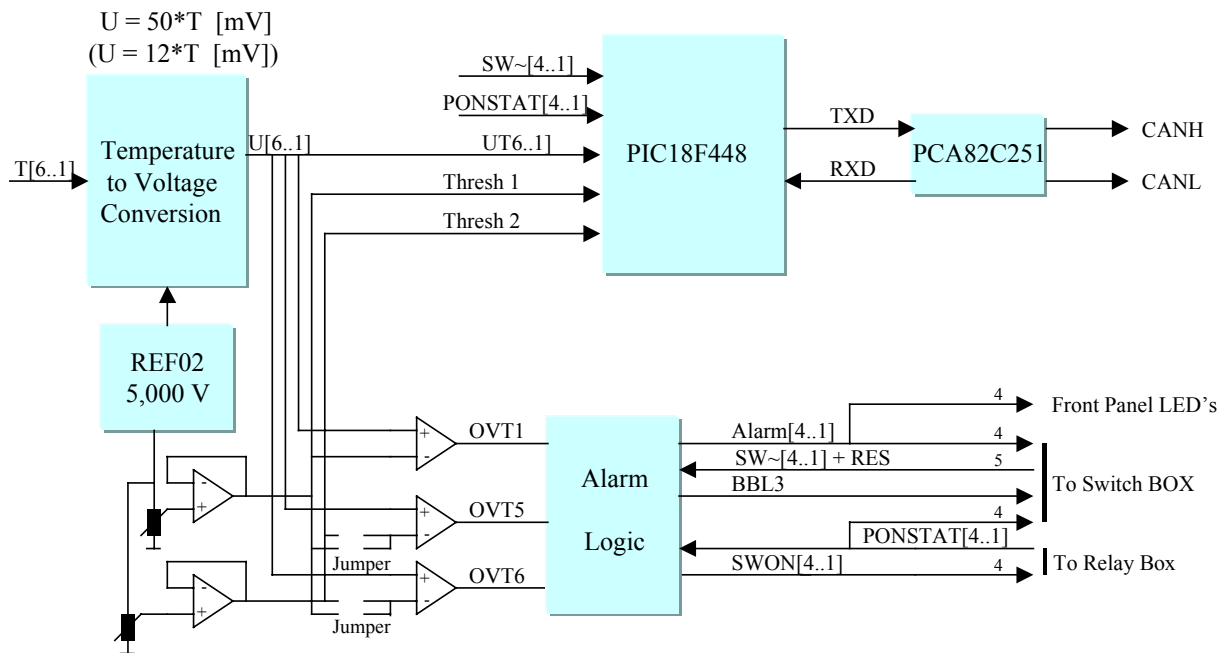


Fig. 2: Block Diagram of Sensor Module

The six comparator outputs **OVT[6..1]** are connected to a Programmable Logic Device, where the alarm logic is implemented by firmware. The logic being different for FPS and VFPS is documented in the appendix. The resulting four alarm states **Alarm[4..1]** are displayed by red LED's at the front panel of the Sensor Module and of the Switch Module. Additionally a global **BBL3** alarm is generated, which is available also at the Switch Module.

Depending on the alarm status and the switch positions **SW~[4..1]**, being delivered by the Switch Module, the alarm logic operates the power supply relays in the Relay Box, which in return provides the power-on status **PONSTAT[4..1]**, influencing the global alarm.

For computer access a CAN interface has been implemented, which is realised by a micro controller of type PIC18F448 (Microchip). It includes eight 10 bit ADC's, which are used to convert the six sensor voltages **UT[6..1]** and the two threshold voltages **THRESH[2..1]**. Additionally eight digital inputs are available, where the switch positions **SW[4..1]** and the power-on status **PONSTAT[4..1]** are connected. The read-out of these information via CAN bus is described in the following section.

Computer Access

For computer access the widely used CAN bus interface has been implemented. Devices connected to a CAN bus have to follow a so called CAN Higher Level Protocol, which includes the Baud rate and the Identifier definition. For the Sensor Module the following parameters are fixed by firmware:

- Baud Rate: 125 kHz
- Identifier: 11 Bit Standard: ID10..ID0
- Identifier Definition: Device Type: ID10..ID8
Device Instance: ID7..ID4
Device Function: ID3..ID0

The Device Type has been set to 6 by the micro controller program.
 The following Instance Numbers are implemented also by firmware:

FPS: Instance Number 0

VFPS: Instance Number 1

Two Functions are defined:

- Function Nr. 1: Read Measurements
- Function Nr. 2: Read CAN Parameter

All messages, sent to the controller, are data messages (RTR Bit = 0) with one data byte (argument), which defines the type of parameters to be read.

The controller responds to the requests by sending a data message with an identifier, containing the same Type Number and Instance Number, and the Function Number incremented by 8.

In the following the functions and the controllers response are described in more detail.

Function F1: Read Measurements

Identifier	RTR	DLC	Byte 1	Function
\$611	0	1	1	Read Digital Information and 6 Temperatures (8 Bit)
\$611	0	1	2	Read Digital Information and Temperature [1..4] (10 Bit)
\$611	0	1	3	Read Dig. Inform. and Temp[5..6], Thresh[1..2] (10 Bit)

I: Instance Number (4 Bit)

Depending on the argument, function F1 generates the following response:

F1(1) Read Digital Information and 6 Temperatures (8 Bit):

Identifier	RTR	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
\$619	0	8	1	DIG	TMP1	TMP2	TMP3	TMP4	TMP5	TMP6

DIG:

D0: 0: Power Switch of Detector 1 is in Position on
 1: Power Switch of Detector 1 is in Position off

D1: 0: Power Switch of Detector 2 is in Position on
 1: Power Switch of Detector 2 is in Position off

D2: 0: Power Switch of Detector 3 is in Position on
 1: Power Switch of Detector 3 is in Position off

D3: 0: Power Switch of Detector 4 is in Position on
 1: Power Switch of Detector 4 is in Position off

D4: 0: 5 V Power of Detector 1 is on
 1: 5 V Power of Detector 1 is off

D5: 0: 5 V Power of Detector 2 is on
 1: 5 V Power of Detector 2 is off

D6: 0: 5 V Power of Detector 3 is on
 1: 5 V Power of Detector 3 is off

D7: 0: 5 V Power of Detector 4 is on
 1: 5 V Power of Detector 5 is off

Detector Numbering of FPS and VFPS Roman Pots is listed in Appendix B.

TMP_i: T7..T0: ADC Bits AD9..AD2 for Sensor Nr. i (i = 1..6)
 The sensor locations in the FPS and VFPS Roman Pots are given in Appendix A.

Function F1(1) provides a fast and compact overview of the most important informations. For that purpose the ADC resolution is reduced to 8 Bit. The conversion between ADC reading and measured voltage is given by the equation:

$$U = 5 * N / 255 \quad [V] \quad (N = AD[9..2])$$

F1(2) Read Digital Information and 4 Temperatures (10 Bit):

Identifier	RTR	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
\$6I9	0	7	2	DIG	TMP1	TMP2	TMP3	TMP4	TMP14

- DIG:**
- D0: 0: Power Switch of Detector 1 is in Position on
1: Power Switch of Detector 1 is in Position off
 - D1: 0: Power Switch of Detector 2 is in Position on
1: Power Switch of Detector 2 is in Position off
 - D2: 0: Power Switch of Detector 3 is in Position on
1: Power Switch of Detector 3 is in Position off
 - D3: 0: Power Switch of Detector 4 is in Position on
1: Power Switch of Detector 4 is in Position off
 - D4: 0: 5 V Power of Detector 1 is on
1: 5 V Power of Detector 1 is off
 - D5: 0: 5 V Power of Detector 2 is on
1: 5 V Power of Detector 2 is off
 - D6: 0: 5 V Power of Detector 3 is on
1: 5 V Power of Detector 3 is off
 - D7: 0: 5 V Power of Detector 4 is on
1: 5 V Power of Detector 5 is off

Detector Numbering of FPS and VFPS Roman Pots is listed in Appendix B.

- TMPi:** T7..T0: ADC Bits AD9..AD2 for Sensor Nr. i (i = 1..4)
TMP14: T0: ADC Bit AD0 for Sensor 1
T1: ADC Bit AD1 for Sensor 1
T2: ADC Bit AD0 for Sensor 2
T3: ADC Bit AD1 for Sensor 2
T4: ADC Bit AD0 for Sensor 3
T5: ADC Bit AD1 for Sensor 3
T6: ADC Bit AD0 for Sensor 4
T7: ADC Bit AD1 for Sensor 4

The sensor locations in the FPS and VFPS Roman Pots are given in Appendix A.

Function F1(2) provides besides the digital information the first four temperature measurements with full resolution.. The conversion between ADC reading and measured voltage is given by the equation:

$$U = 5 * N / 1023 \text{ [V]} \quad (N = AD[9..0])$$

F1(3) Read Digital Information, 2 Temperatures and 2 Thresholds (10 Bit):

Identifier	RTR	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
\$6I9	0	7	3	DIG	TMP5	TMP6	THR1	THR2	TMP58

- DIG:**
- D0: 0: Power Switch of Detector 1 is in Position on
1: Power Switch of Detector 1 is in Position off
 - D1: 0: Power Switch of Detector 2 is in Position on
1: Power Switch of Detector 2 is in Position off
 - D2: 0: Power Switch of Detector 3 is in Position on
1: Power Switch of Detector 3 is in Position off
 - D3: 0: Power Switch of Detector 4 is in Position on
1: Power Switch of Detector 4 is in Position off
 - D4: 0: 5 V Power of Detector 1 is on
1: 5 V Power of Detector 1 is off
 - D5: 0: 5 V Power of Detector 2 is on
1: 5 V Power of Detector 2 is off
 - D6: 0: 5 V Power of Detector 3 is on
1: 5 V Power of Detector 3 is off
 - D7: 0: 5 V Power of Detector 4 is on
1: 5 V Power of Detector 5 is off

Detector Numbering of FPS and VFPS Roman Pots are listed in Appendix B.

TMP_i: T7..T0: ADC Bits AD9..AD2 for Sensor Nr. i (i = 5..6)
THR_i: T7..T0: ADC Bits AD9..AD2 for Threshold Nr. i (i = 1..2)
TMP58: T0: ADC Bit AD0 for Sensor 5
 T1: ADC Bit AD1 for Sensor 5
 T2: ADC Bit AD0 for Sensor 6
 T3: ADC Bit AD1 for Sensor 6
 T4: ADC Bit AD0 for Threshold 1
 T5: ADC Bit AD1 for Threshold 1
 T6: ADC Bit AD0 for Threshold 2
 T7: ADC Bit AD1 for Threshold 2

The sensor locations in the FPS and VFPS Roman Pots are given in Appendix A.

Function F1(3) provides besides the digital information the last two temperature measurements and the threshold values with full resolution.. The conversion between ADC reading and measured voltage is given by the equation:

$$U = 5 * N / 1023 \quad [V] \quad (N = AD[9..0])$$

Function F2: Read CAN Parameter

Identifier	RTR	DLC	Byte 1	Function
\$6I2	0	1	1	Read CAN Error Bytes
\$6I2	0	2	1	Read Firmware Version Number

I: Instance Number (4 Bit)

Function F2 generates the following response:

F2(1) Read CAN Error Bytes

Identifier	RTR	DLC	Byte 1	Byte 2	Byte 3	Byte 4
\$6IA	0	4	1	CEB	TEC	REC

CEB: C0: Error Warning Bit (C1 or C2 are set)
 C1: Receiver Warning Bit (95 < REC < 128)
 C2: Transmitter Warning Bit (95 < TEC < 128)
 C3: Receiver Bus Passive Bit (127 < REC)
 C4: Transmitter Bus Passive Bit (127 < TEC)
 C5: Transmitter Bus Off Bit (255 < TEC)
 C6: Receiver Buffer 1 Overflow Bit
 C7: Receiver Buffer 0 Overflow Bit

TEC: Transmitter Error Counter

REC: Receiver Error Counter

For more details of the CAN error handling please consult the CAN Bus Specification manual (CAN Specification, Version 2.0, Robert Bosch GmbH, 1991).

F2(2) Read Firmware Version Number:

Identifier	RTR	DLC	Byte 1	Byte 2	Byte 3
\$61A	0	3	2	VNH	VNL

VNH: MS-Byte of Version Number

VNL: LS-Byte of Version Number

Switch Module

The Switch Module is located in the Control Room and allows to switch the power supply of up to four detectors. Fig. 3 shows as an example the Switch Module for the four FPS Roman Pots.

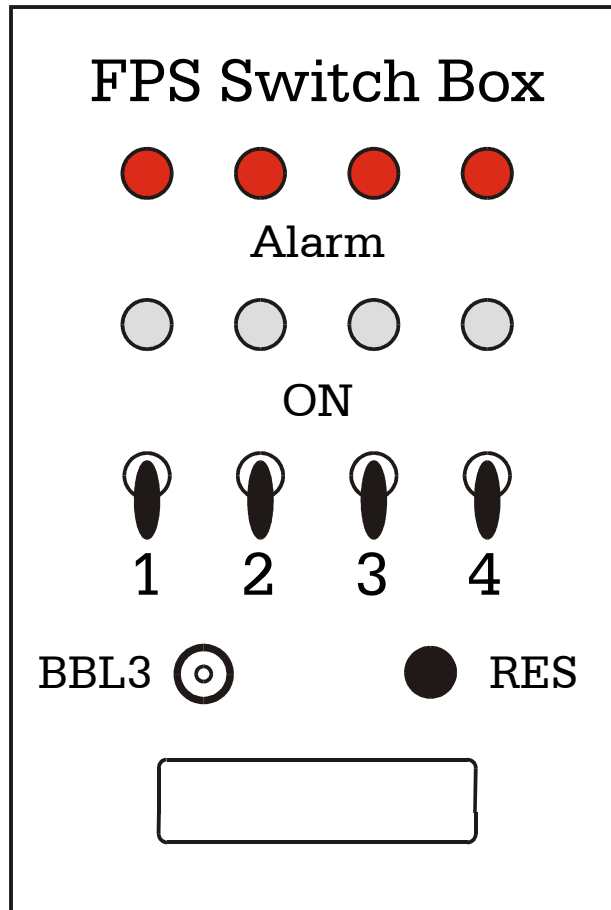


Fig. 3: FPS Switch Module

For each detector a green LED shows the Power-on status (LED on: power is on), and a red LED indicates the alarm status (LED on: alarm).

An alarm has to be reset by the **RES** button, after the alarm condition has disappeared.

The global BBL3 alarm information is provided at the LEMO connector. It is realised by a relay, which is normally closed and opened by the alarm.

The Switch Module is connected to the Sensor Module by a 20-fold flat cable.

Relay Box

The Relay Box located near the Sensor Module switches the power supplies for up to four Roman Pots.

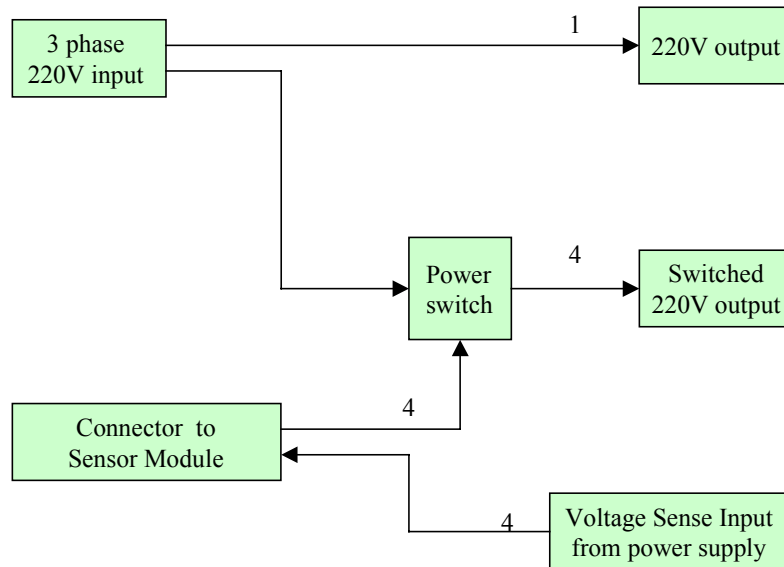


Fig. 4: Block Diagram of the Relay Box

It is connected to the Sensor Module by means of a 16-fold flat cable. The Block Diagram in fig. 4 shows, that four signals, provided by the Sensor Module, are controlling the relays, which are connecting the 220 V input to the four switched outputs. There is an additional not switched 220 V output, which is used for the power supply of the NIM Crate housing the Sensor Module.

For each of the power supplies a voltage sense input has been provided. These Power-on status flags are fed back to the Sensor module via the cable connection.

Appendix

A. Sensor Location

FPS				VFPS			
Input	Type	Detector	Location	Input	Type	Detector	Location
1	KTY81	P90V	Electronic Box	1	KTY81	P220	Electronic Box
2	KTY81	P80V	Electronic Box	2	KTY81	P220	Electronic Crate
3	KTY81	P80H	Electronic Box	3	KTY81	P224	Electronic Box
4	KTY81	P64H	Electronic Box	4	KTY81	P224	Electronic Crate
5	KTY81	P80H	Electronic Crate	5	KTY84	P220	Roman Pot
6	KTY81	P64H	Electronic Crate	6	KTY84	P224	Roman Pot

B. Detector Numbering

FPS		VFPS	
Nr	Detector	Nr	Detector
1	P90V	1	P220
2	P80V	2	P224
3	P80H		
4	P64H		

C. Alarm Logic

Nomenclature:

Alarm[n]: Alarm Status for Detector Nr. n

OVT[n]: Temperature is above Threshold for Sensor Nr. n

POFF[n]: Power is 'off' on Detector Nr. n

SWON[n]: Switch position is 'on' on Detector Nr. n

FPS:

Alarm[1] = OVT[1]

Alarm[2] = OVT[2]

Alarm[3] = OVT[3] or OVT[5]

Alarm[4] = OVT[4] or OVT[6]

BBL3 = (Alarm[1] or POFF[1]) and SWON[1]

or (Alarm[2] or POFF[2]) and SWON[2]

or (Alarm[3] or POFF[3]) and SWON[3]

or (Alarm[4] or POFF[4]) and SWON[4]

VFPS:

Alarm[1] = OVT[1] or OVT[2] or OVT[5]

Alarm[2] = OVT[3] or OVT[4] or OVT[6]

BBL3 = (Alarm[1] or POFF[1]) and SWON[1]

or (Alarm[2] or POFF[2]) and SWON[2]

