

ANNEXE 3

English version of the document:

**CCTP_A03_Annexe-1_Procedure Test Carte BPS_V03-R1(R2)-
V.02_FR Version**

SUBJECT:

**Testing and calibration procedure for the card
BPS_V03-R1-R2
V.02**

**Tender Lot n°03
BPS_V03 Electronic cards**

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1. Introduction

This document describes the procedures for verifying the functionality of the BPS_V03-R1 card, indicating the main electrical parameters to be checked. The sensor calibration procedures and their specific configurations are also described.

2. General description of the card

The card to be tested is essentially a DC power supply consisting of several DC-DC step-down and step-up converters and is designed to operate with DC input voltages in the range of 260V÷400V. A primary DC-DC converter (V375C5E50BL from VICOR Corp.), which converts the input voltage to 5V and acts as a "load point", is on board. Additional secondary step-down/step-up converters powered by the 5V line provide stabilised DC voltages of 3.3V, 2.5V, 1.8V, 1V and 12V. The 5V, 3.3V, 2.5V, 1.8V, and 1V output lines share a common ground and are galvanically isolated from the board's input line. The 12V output line is also galvanically isolated from all other lines and has its own ground line.

All low-voltage outputs are protected by current limiters that trip in the event of overcurrent or short circuit. The 5V and 12V lines are equipped with current monitoring sensors. Additional current sensors are installed on the DUL Power Line output, respectively on the +375V and 375V RETURN. The BPS_V03-R1 board is equipped with a voltage sensor to measure the voltage of the main input power line. A microprocessor on the board manages the control of the semiconductor switches of the DUL Power Line output and the reading of the current and voltage sensors. In addition, the BPS_V03-R1 connects to the DUL board, providing it with a 5V power supply and receiving digital and analogue signals.

The card accepts commands and transmits data via the standard RS232 serial communication port. Figure 1 shows the layout of the connectors on the BPS_V03-R1 card used to perform the tests.

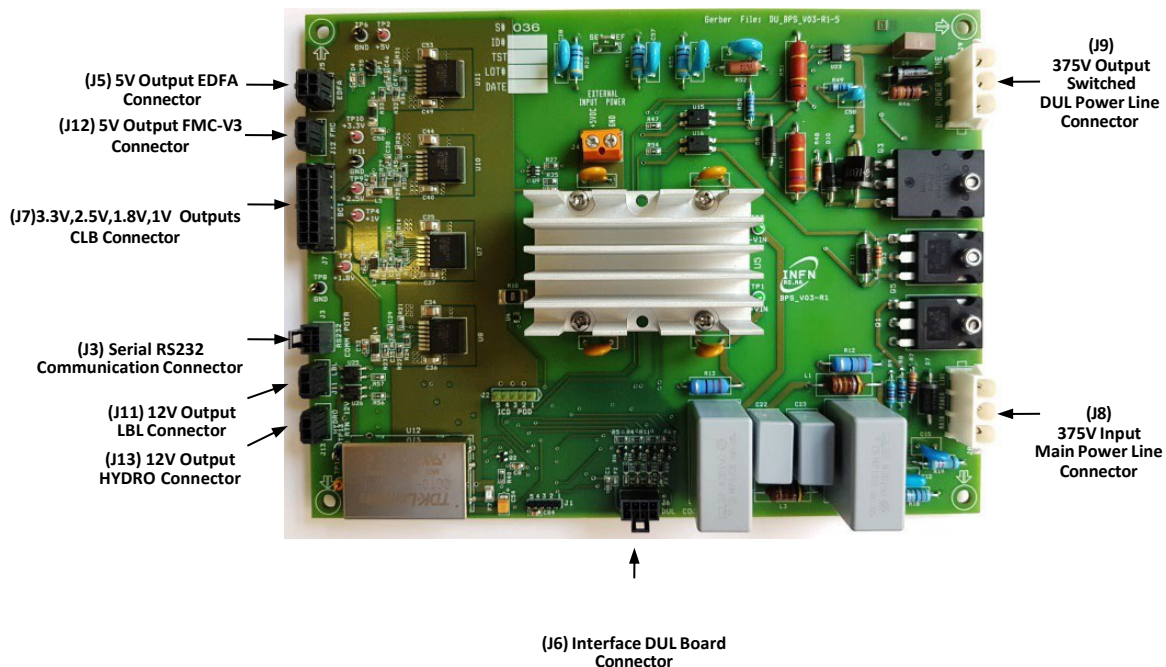


Fig. 1: BPS_V03-R1

3. Type of test

Testing operations require measurements and checks by subjecting the board to specific working conditions. The measurements are intended to verify the electrical parameters of the low-voltage outputs, the functionality of the semiconductor switches, and the characterisation of the voltage and current sensors. Specifically, the operations are divided into four categories:

a) Measures to verify low voltage outputs

- 1) Measurement and verification of output voltage values under predefined load and input supply voltage conditions.
- 2) Oscilloscope measurement and verification of the start-up timing sequence of the 3.3V, 2.5V, 1.8V, and 1V outputs.
- 3) Oscillographic measurement of the peak-to-peak value of the noise present at the 3.3V, 2.5V, 1.8V, 1V, and 12V outputs and verification of whether the maximum permitted threshold has been exceeded..

b) Verification of the functionality of the semiconductor switch

- 1) Verification of activation and deactivation of the Vout12V LBL line
- 2) Verification of activation and deactivation of the Vout12V Hydro line
- 3) Verification of activation and deactivation of the +375V line
- 4) Check the ON switch and OFF switch on line 375 RETURN.

c) Sensor calibration measures

- 1) Acquisition from the terminal of data provided by the input line voltage sensor at predetermined voltage values in the range 260V÷400V, with reporting of the corresponding data in tabular and Cartesian graph form..
- 2) Acquisition from the terminal of data provided by the current sensors of the +375V output lines and the 375V return line under predetermined load conditions, with a report of the corresponding data in tabular and Cartesian graph form..
- 3) Acquisition from the terminal of data provided by the 5V line current sensor under load conditions within the predefined range, with reporting of the relevant data in tabular and Cartesian graph form.
- 4) Acquisition from the terminal of data provided by the current sensors of the 12V_Hydro and 12V_LBL lines under load conditions within the predetermined range, with a report of the corresponding data in tabular and Cartesian graph form.

d) Checking the DUL card interface

- 1) Check the 5V voltage at connector J6.
- 2) Check that the signals from the DUL board's temperature sensors are being acquired correctly.
- 3) Check that the alarm signals are being acquired correctly.

4. Specifications for power supply and measuring instruments

The measurements described below must be carried out with the card powered by a primary power source with the following characteristics::

- Stabilised DC output voltage ($\pm 0.1\%$), adjustable from 250V to 400V
- Output voltage rise time between 1ms and 5ms
- Monotonic rise in output voltage (pseudo-constant slope without rebound)
- Output current ≥ 2.5 A

The validity of the measurements is closely linked to the electrical specifications of the primary power supply, so it is essential that these are complied with. As an example, we recommend using the TDK-Lambda power supply model: GEN-600-2.6. The board is powered by the primary power supply from connector J8 according to the pinout shown in Table 8. For oscillographic measurements, a two-channel or more isolated oscilloscope with floating ground must be used (e.g. Tektronix mod: THS720A or equivalent type with identical or better characteristics). The use of an ISO-TEC IDM 305 multimeter or equivalent type with equal or better specifications is recommended for steady-state voltage and current measurements.

Calibration operations for current sensors require the use of loads with resistance and power ratings appropriate for the current to be measured. To simplify current sensor calibration operations, it is recommended to use a "programmable DC electronic load" (e.g., B&K Precision 8622) instead of resistive loads.

To control the DUL card interface, we recommend using a square wave generator capable of providing a 1Hz TTL-compatible signal and a DC power supply with a stabilised, adjustable 0÷5V output. The card can be controlled using a computer acting as a terminal with a standard serial port and a suitable terminal emulation programme (e.g. RealTerm). The terminal's serial cable must be connected to the card's RS232 serial port. In order to communicate with the terminal and send the commands necessary to perform the tests, the dedicated firmware must first be installed on the card. The installation procedure is described in section 9. The firmware allows all test and data collection operations to be performed by sending specific commands from the terminal. Below is a list of available commands and an example of data received in response to the "C" command.

Main menu:

Y : set 375V return switch ON
H : set 375V return switch OFF

U : set 375V direct switch ON
J : set 375V direct switch OFF

I : set 12V switch ON
K : set 12V switch OFF

O : set LBL switch ON
L : set LBL switch OFF

R : set HYDRO switch ON
F : set HYDRO switch OFF

Z : read all sensors once
X : read all sensors 10 times C
: read all sensors 50 times V :
read all sensors 500 times
B : read all sensors continuously

M : read all sensors once (readable format)

Q : read timer0 call counter

- : clear screen (128 new lines)

? : show this menu

Received command: 'C'

Sensor reading

T0CALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2

2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1

2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1

.....,,,

.....,,,

2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1

2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

number of readings: 50

minimum value: 768

maximum value: 896

average value: 829.44

Stats for LBL_I_MON:

number of readings: 50

minimum value: 10688

maximum value: 11136

average value: 10935.04

Stats for HYDRO_I_MON:

number of readings: 50

minimum value: 5952

maximum value: 6400

average value: 6176.00

Stats for DU_I_MON:

number of readings: 50

minimum value: 16960

maximum value: 18560

average value: 17733.12

Stats for DU_IRTN_MON:

number of readings: 50

minimum value: 16640

maximum value: 18688

average value: 17780.48

Stats for BPS_V_MON:

number of readings: 50

minimum value: 192

maximum value: 256

average value: 252.16

Stats for THEATSNK:

number of readings: 50

minimum value: 5184

maximum value: 5248

average value: 5241.60

Stats for TBOARD:

number of readings: 50

minimum value: 4736

maximum value: 4800

average value: 4746.24

Commands are only processed by the card if they are sent in capital letters without being followed by the "enter" key.

The connection to the terminal is made via the J3 connector on the card (see Fig. 2). The terminal's serial communication port must comply with the RS232 standard with the following parameters:

Transmission speed = 115200 bits/s
Data length = 8 bits
stop bit = 1
Parity = none
Flow control = none

Table 1 shows the pinout of connector J3 for connection to the terminal.

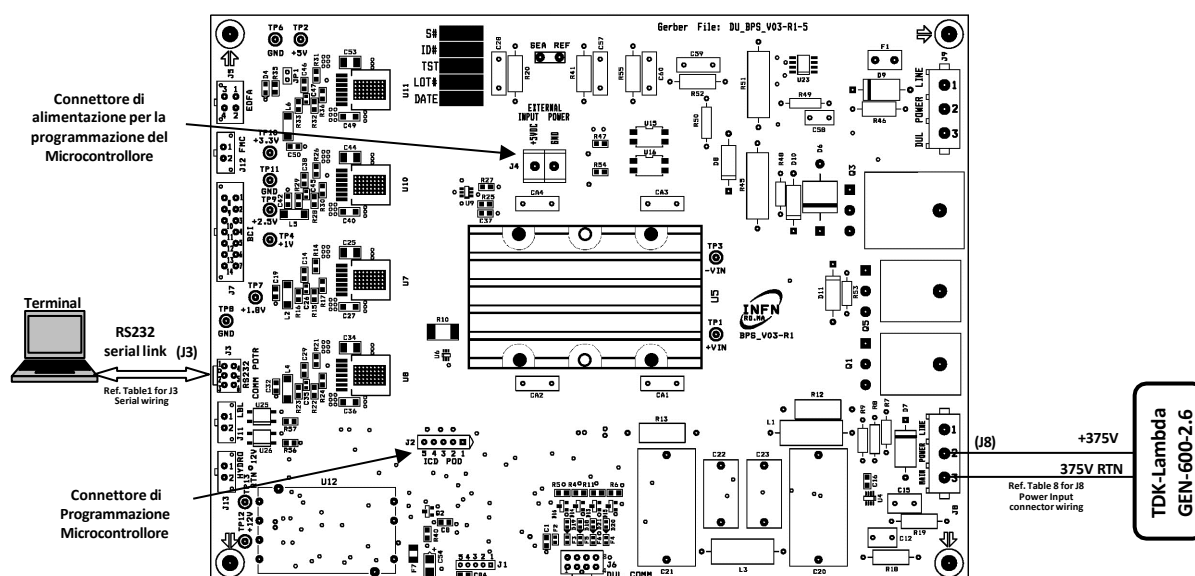


Fig. 2: Connecting the serial port to the terminal

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type
J3	Molex Nano-Fit 105310-1206	Molex Nano-Fit 105308-1206	1	N.C.	-
			2	GND	Signal return
			3	RXD	Signal in (to BPS_V03-R1)
			4	N.C.	-
			5	N.C.	-
			6	TXD	Signal out (from BPS_V03-R1)

Table 1 - Pinout of RS232 connector J3

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type
J6	Molex Nano-Fit 105310-1208	Molex Nano-Fit 105308-1208	1	ALRMNEG1	Digital Signal Input
			2	+5V	Power
			3	ALRMPOS1	Digital Signal Input
			4	TBOARD	Analog Signal Input
			5	ALRMNEG2	Digital Signal Input
			6	GND	Signal GND &Power Return
			7	ALRMPOS2	Digital Signal Input
			8	THEATSNK	Analog Signal Input

Table 2 - Pinout of the J6 DUL card interface connector

5. Measurement of electrical parameters of low-voltage outputs

The test must be performed in accordance with the configuration shown in Figure 3. All low-voltage output lines must have their resistive loads connected. Refer to Tables 3, 4, 5, 6 and Table 15 below for information on load values and connection to the respective connectors. Measurements shall be performed at input supply voltages of 260V, 330V, 375V and 400V. It is recommended to use load resistors of adequate power equipped with a heat sink to ensure stability of $\pm 1\%$ over the working temperature range.

NOTE: The board does not have a power switch, so when power is applied to the J8 input connector, the board is powered on.

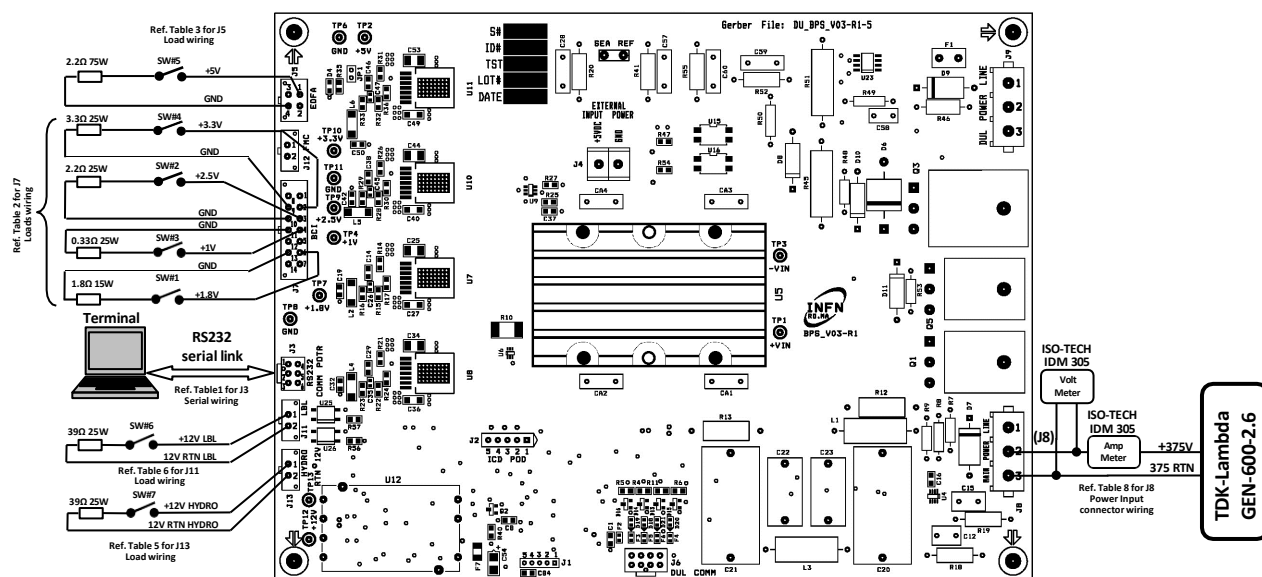


Fig. 3: Configuration for measuring input current, output voltage and start-up sequence

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Load Value
J7	Molex Micro-Fit 43045-1413	Molex Micro-Fit 43025-1400	1	5V	+5V Power	(not used)
			8	GND	GND (5V Power Return)	(not used)
			2	3.3V	+3.3V Power	3.3Ω $\pm 5\%$, 25W
			9	GND	GND (3.3V Power Return)	
			4-5	1V	+1V Power	0.33Ω $\pm 5\%$, 25W
			11,12	GND	GND (1V Power Return)	
			3	2.5V	+2.5V Power	2.2Ω $\pm 5\%$, 25W
			10	GND	GND (2.5V Power Return)	
			6	1.8V	+1.8V Power	1.8Ω $\pm 5\%$, 15W
			12	GND	GND (1.8V Power Return)	
			13	GND	GND	(not used)
			7	N.C	-	-

Table 3 - Pinout of connector J7 and resistive load values

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Load Value
J5	Molex Micro-Fit 43045-0413	Molex Micro-Fit 43025-0400	1,2	5V	+5V Power	2.2Ω $\pm 5\%$, 75W
			3,4	GND	GND (5V Power Return)	

Table 4 - Pinout of connector J5 and resistive load value

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Load Value
J11	Molex Micro-Fit 43650-0215	Molex Micro-Fit 43645-0200	1	12V	+12V Power (LBL)	39Ω ±5%, 25W
			2	RTN	12V Return (LBL)	

Table 5 - Pinout of connector J11 and resistive load value

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Load Value
J13	Molex Micro-Fit 43650-0215	Molex Micro-Fit 43645-0200	1	12V	+12V Power (Hydro)	39Ω ±5%, 25W
			2	RTN	12VReturn (Hydro)	

Table 6 - Pinout of connector J13 and resistive load value

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Load Value
J9	TE Connectivity 350789-1	TE Connectivity 350766-1	1	+375V DU Power Switched Line	Positive Power Output	150Ω ÷ 7.5KΩ
			2	N.C.	-	
			3	RTN DU Power Switched Line	Power Output Return	

Table 7 - J9 SWITCHED POWER LINE connector Pinout and resistive load value

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Connect to
J8	TE Connectivity 350789-1	TE Connectivity 350766-1	1	NC	-	TDK Lambda GEN-600-2.6 Power Supply
			2	+375V Main Power Line Input	Positive Main Power Input	
			3	RTN Main Power Line Input	Main Power Input Return	

Table 8 - Pinout of the J8 MAIN POWER LINE connector

Board Reference Connector	Board Connector P/N	Mates with Connector P/N	Pin#	Line Name	Line Type	Load Value
J12	Molex Micro-Fit 43650-0215	Molex Micro-Fit 43645-0200	1	5V	+5V Power (FMC V3)	-
			2	RTN	12V Return (FMC V3)	

Table 20 - Pinout of the J12 FMC V3 connector

5.1 Measures to verify the output voltage values of 5V, 3.3V, 2.5V, 1.8V, 1V

Required measuring instruments:

- ISO-TECH IDM 305 multimeter or equivalent with the same specifications
- TDK-Lambda power supply model: GEN-600-2.6.

The measures described in this section do not require communication with the terminal. The results must be recorded in the report in Excel format as shown in Table 9.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 260V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A..
- 3) Set switches **SW#1, SW#2, SW#3, SW#4, SW#5, SW#6, SW#7** to the closed position..
- 4) Switch on the output of the TDK-Lambda generator
- 5) Measure the voltage across the **5V** line load resistor and record the value in the column **Vout 5V** column.
- 6) Measure the voltage across the **3.3V** line load resistor and record the value in the **Vout 3.3V** column.
- 7) Measure the voltage across the **2.5V** line load resistor and record the value in the **Vout 2.5V** column.
- 8) Measure the voltage across the load resistor of the **1.8V** line and record the value in the column **Vout 1.8V**
- 9) Measure the voltage across the load resistor of the **1V** line and record the value in the column **Vout 1V** of the report.
- 10) Cut the output of the TDK-Lambda generator.

Repeat steps 4 to 9, adjusting the voltage of the primary power generator to **330V, 375V, 400V**.

5.2 Measures to check the 12V output voltage of the ON/OFF control and the input current

Required measuring instruments:

- ISO-TECH IDM 305 multimeter or equivalent with the same specifications
- TDK-Lambda power supply model: GEN-600-2.6.
- Communication terminal

The measurement results must be recorded in the report in Excel format, as shown in Table 9.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 260V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Set switches **SW#1, SW#2, SW#3, SW#4, SW#5, SW#6, SW#7** to the closed position.
- 4) Activez la sortie du générateur TDK-Lambda.
- 5) Ensure that the list of commands is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 6) Send the command "I" (set 12V switch ON) from the terminal.
- 7) Measure the voltage at the ends of the **12V line load resistor (J11)** and record the value in the **Vout12V LBL Power up** column.
- 8) Measure the voltage at the ends of the **12V line load resistor (J13)** and record the measurement value in the **Vout12V Hydro Power up** column.
- 9) Send the command "O" from the terminal (set the LBL switch to ON)
- 10) Measure the voltage at the ends of the **12V line load resistor (J11)** and record the value in the **Vout12V LBL Switch ON** column
- 11) Send the "R" command from the terminal (set the HYDRO switch to ON)
- 12) Measure the voltage across the load resistor of the **12V line (J13)** and record the value in the **Vout12V Hydro Switch ON** column
- 13) Measure the input current and record the value in the column. **Iin Current**.
- 14) Send the command "L" from the terminal (set the LBL switch to OFF).

- 15) Measure the voltage across the **12V line load resistor (J11)** and record the value in the **Vout12V LBL Switch OFF** column.
- 16) Send command "F" from the terminal (set the HYDRO switch to OFF).
- 17) Measure the voltage at the ends of the **12V line load resistor (J13)** and record the value in the **Vout12V Hydro Switch OFF** column.
- 18) Send the command "K" from the terminal (set the 12V switch to OFF)
- 19) Cut the output of the TDK-Lambda generator.

Repeat steps 4 to 18, setting the primary power generator voltage to 330V, 375V, 400V.

BPS_V03-R1: Mesures du courant d'entrée et des sorties basse tension													
Date:	Ambient Temperature xx °C												
Board ID#0000	Vin [V]	Iin Current [mA]	Vout 5V [V]	Vout 3.3V [V]	Vout 2.5V [V]	Vout 1.8V [V]	Vout 1V [V]	Vout12V LBL (J11) [V]			Vout 12V Hydro (J13) [V]		
								Power up	Switch ON	Switch OFF	Power up	Switch ON	Switch OFF
	260.0	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#
	330.0	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#
	375.0	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#
	400.0	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#

Table 9 - Models to be included in the report for measurements of electrical parameters of low-voltage outputs

5.3 Measurements of the low-voltage output start-up time sequence

The purpose of this test is to measure the delays in the activation sequence of the 1V, 1.8V, 2.5V, and 3.3V outputs relative to the 5V output.

The test must be performed in accordance with the configuration shown in Figure 3. All low-voltage output lines must have their loads connected. See Tables 3 and 4 for information on load values and correct connection to the respective connectors. Measurements must be performed with the board powered at 375V. Figure 5 shows the test points for connecting the oscilloscope probes. The signal from the '+5V' test point must be set as the trigger in order to measure the delay time of the ignition sequence relative to the 5V rising edge.

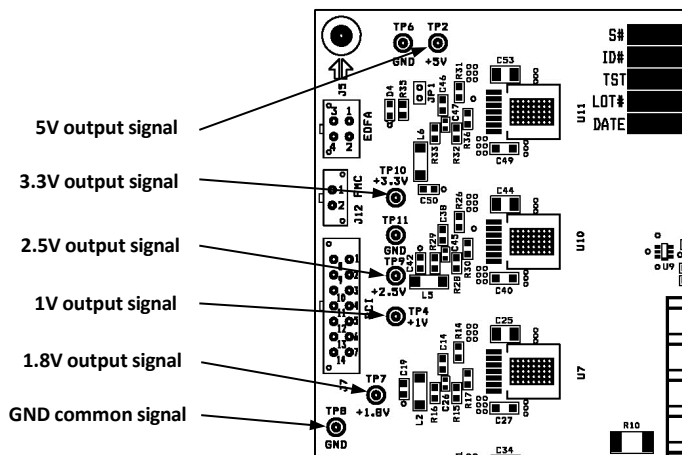


Fig. 5: Measurement points for the ignition sequence of 1V, 1.8V, 2.5V, 3.3V

Required measuring instruments:

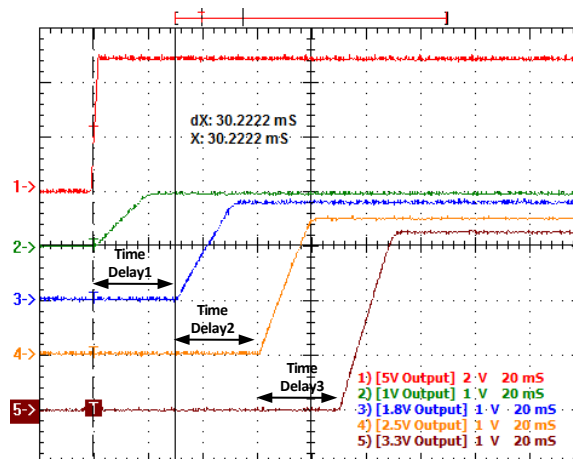
- Tektronix mod THS720A
- TDK-Lambda power supply model: GEN-600-2.6.

The measurement results must be recorded in the report in Excel format, as shown in Table 10.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to **375V**
- 2) Ensure that the output current limitation of the TDK-Lambda primary generator is set to 2.5 A.
- 3) Set switches **SW#1, SW#2, SW#3, SW#4, SW#5, SW#6, SW#7** to the closed position..
- 4) Activate the output of the TDK-Lambda generator.
- 5) Record in the report **Low Voltage Outputs Sequencer Measurements** the delay time of the low-voltage outputs relative to the rising edge of the 5V output in the respective columns by joining the acquired waveforms
- 6) Deactivate the output of the TDK-Lambda generator.

In waveforms 1, typical oscillographic measurement signals are shown for demonstration purposes..



Waveforms 1: BPS_V03-R1 Low voltage output sequence

BPS_V03-R1: Low Voltage Outputs Sequencer Measurements					
Date: gg.mm.aaa	Ambient Temperature xx °C				
Board ID#0000	Vin [V]	Time Delay 5V to 1V [ms]	Time Delay 5V to 1.8V [ms]	Time Delay 5V to 2.5V [ms]	Time Delay 5V to 3.3V [ms]
	375.0	Val.#	Val.#	Val.#	Val.#

Table 10-Template to be included in the report for measurements of the startup time sequence of low-voltage outputs

5.4 Low-voltage output noise measurements

The test must be carried out in accordance with the configuration shown in Figure 3. All low-voltage output lines must be connected to their loads. Refer to Tables 3, 4, 5, 6 and Table 15 for information on load values and correct connection to the respective connectors. Measurements must be taken with the board powered at **375V**. Figure 6 shows the connection points for the oscilloscope probes used to measure noise. As the GND of the 12V line is galvanically isolated from the rest of the GNDs of the low-voltage lines, measurements cannot be performed simultaneously with multi-channel oscilloscopes whose probes have a common ground.

It is recommended to use the oscilloscope with a floating isolated channel to earth or to measure the noise of the 12V line separately. The parameter to be evaluated from the waveforms is the peak-to-peak value of the noise signal at each output. To measure the noise, we suggest using the specific probe designed for this purpose, connected directly to the test points, setting the oscilloscope input channel to AC and limiting the bandwidth to 20MHz.

Required measuring instruments:

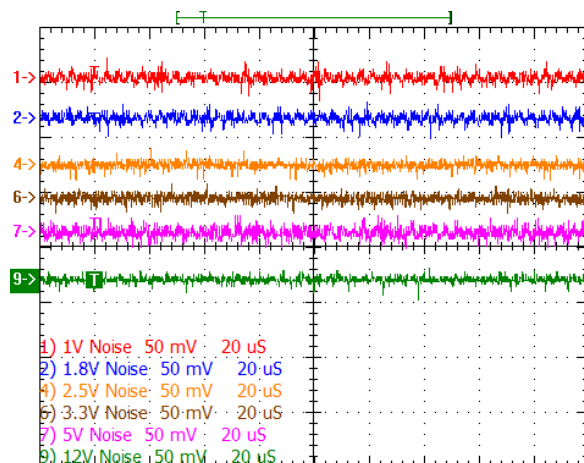
- Tektronix model THS720A
- Communication terminal
- TDK-Lambda power supply model: GEN-600-2.6

The measurement results must be recorded in the report in Excel format, as shown in Table 11.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to **375V**.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Set **switches SW#1, SW#2, SW#3, SW#4, SW#5, SW#6, SW#7** to the closed position.
- 4) Activate the output of the TDK-Lambda generator.
- 5) Ensure that the list of commands is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 6) Send the command "I" from the terminal (set the 12V switch to ON).
- 7) Send the command "R" from the terminal (set the HYDRO switch to ON).
- 8) Send the command "O" from the terminal (set the LBL switch to ON).
- 7) Record the peak-to-peak value of the noise signal in the respective low-voltage output columns in the **Outputs Noise Measurements** report and attach the acquired waveforms.
- 9) Switch off the output of the TDK-Lambda generator..

In waveforms 2, for demonstration purposes, oscilloscope signals from noise measurements are shown..



Waveforms 2: BPS_V03-R1(R2) Low voltage output noise

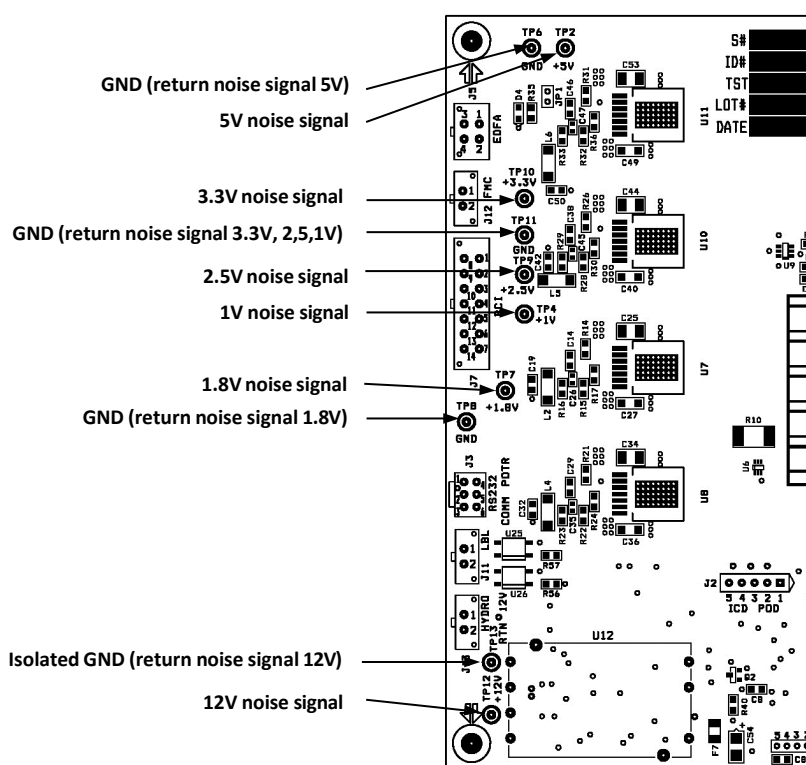


Fig. 6: Noise measurement points for outputs 1V, 1.8V, 2.5V, 3.3V, 5V, 12V

BPS_V03-R1: Outputs Noise Measurements							
Date: gg.mm.aaa	Ambient Temperature xx °C						
Board ID#0000	Vin [V]	5V Noise Voltage [mVp-p]	3.3V Noise Voltage [mVp-p]	2.5V Noise Voltage [mVp-p]	1.8V Noise Voltage [mVp-p]	1V Noise Voltage [mVp-p]	12V Noise Voltage [mVp-p]
	375.0	Val.#	Val.#	Val.#	Val.#	Val.#	Val.#

Table 11 - Models to be included in the report for low-voltage output noise measurements

6. Characterisation measurements of voltage and current sensors

The board is equipped with several voltage and current sensors. The voltage sensor measures the voltage at the input of the main power supply line, while the current sensors measure the current flowing in the output lines of the 5V, 12V and DUL power supply lines. The purpose of the test is to verify the operation of the sensors and collect data for their calibration.

To perform the current sensor calibration measurements, variable loads are used which are connected to the corresponding outputs and have a resistive value appropriate to the current to be measured. To obtain results within acceptable tolerance limits, it is recommended to use loads with a stability of $\pm 1\%$ over the operating temperature range. More accurate measurements of the DUL Power Line current sensor (375V and 375V Return) can be performed using the DC Electronic Load instrument indicated in paragraph 4 as the load. When the DC Electronic Load cannot be used, resistive loads of adequate power equipped with a heat sink can be used as an alternative.

6.1 Main power line input voltage sensor measurements

The test must be carried out in accordance with the configuration shown in Figure 7. Measurements for checking the operation and calibration of the voltage sensor must be carried out at input voltages between 260V and 400V in 10V increments.

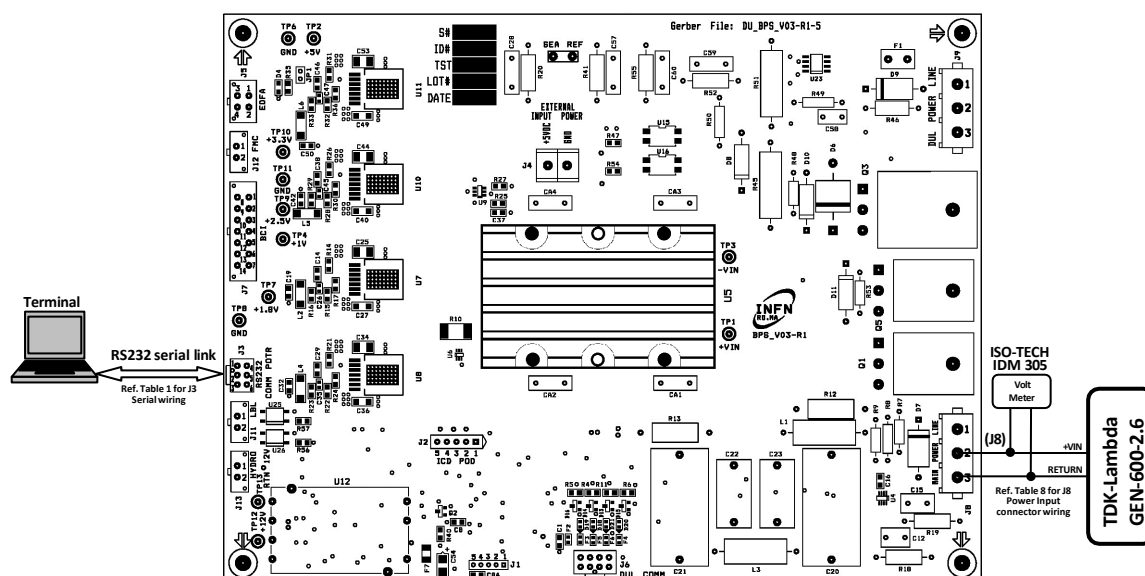


Fig. 7: Configuration for calibration measurements of the main power line input voltage sensor

Required measuring instruments:

- ISO-TECH IDM 305 multimeter or equivalent with the same specifications
- Communication terminal
- TDK-Lambda power supply mod: GEN-600-2.6

The measurement results must be recorded in the report in Excel format, as in Table 12..

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 260V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A..
- 3) Activate the output of the TDK-Lambda generator..
- 4) Ensure that the list of commands is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 5) Send command "C" (read all sensors 50 times) from the terminal. In response to command "C", the board transmits the following data screen :

Received command: 'C'

Sensor reading

```
T0CALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2
2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1
2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1
....., ....., .....
....., ....., .....
2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1
2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1
```

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

```
number of readings: 50
minimum value: 768
maximum value: 896
average value: 829.44
```

Stats for LBL_I_MON:

```
number of readings: 50
minimum value: 10688
maximum value: 11136
average value: 10935.04
```

Stats for HYDRO_I_MON:

```
number of readings: 50
minimum value: 5952
maximum value: 6400
average value: 6176.00
```

Stats for DU_I_MON:

```
number of readings: 50
minimum value: 16960
maximum value: 18560
average value: 17733.12
```

Stats for DU_IRTN_MON:

```
number of readings: 50
minimum value: 16640
maximum value: 18688
average value: 17780.48
```

Stats for BPS_V_MON:

```
number of readings: 50
minimum value: 192
maximum value: 256
average value: 252.16 <-----
```

Stats for THEATSNK:

```
number of readings: 50
minimum value: 5184
maximum value: 5248
average value: 5241.60
```

Stats for TBOARD:

number of readings: 50

minimum value: 4736

maximum value: 4800

average value: 4746.24

- 6) Record the value of the primary supply line voltage measured by the voltmeter in the **Input Voltage Voltmeter Measurement** column and the corresponding value indicated by the arrow in the received data in the **BPS_V_MON Terminal Data** column.
- 7) the corresponding value indicated by the arrow from the received data.
- 8) Increase the voltage of the TDK-Lambda primary power supply generator by 10V and repeat the procedure from step 5 until the value of 400V is reached.
- 9) Switch off the output of the TDK-Lambda generator.

BPS V03-R1 ID#0000 Input Main Powe Line Voltage Sensor Data	
Date: dd.mm.yyyy	Ambient Temperature xx °C
Input Voltage Voltmeter Measurement [V]	BPS_V_MON Terminal Data (Data average)
260	Val.#1
270	Val.#2
280	.
....	.
400	Val.#15

Table 12 - Templates to be included in the report for voltage sensor calibration measurements

6.2 Current sensor measurements of the +375V and 375V return lines of the DUL power line output

Functional testing and calibration measurements of current sensors must be performed with the board powered at 375V. For these measurements, we recommend using the DC Electronic Load instrument connected to the DUL Power Line output, which acts as a programmable load in the range of 150Ω to 7.5KΩ in order to set the current flowing through the sensor. If the DC Electronic Load instrument is not available, the measurements can be performed using 8 power resistors to be connected to the DUL Power Line output using appropriately operated switches. The connection diagram is shown in the configuration in Fig. 8. The load resistors must be selected in accordance with the stability requirements listed in paragraph 6. As an example, Table 13 below shows the specifications of the power resistors to be used.

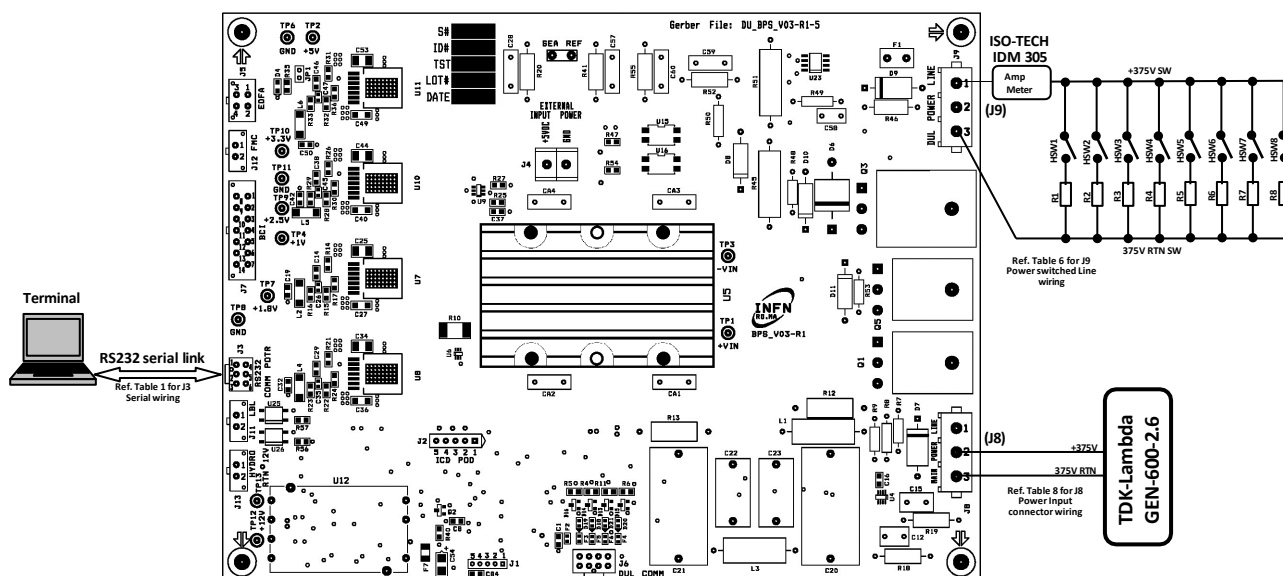


Fig. 8 : Configuration pour les mesures d'étalonnage du capteur de courant des lignes de retour +375V et 375V de la sortie DUL Power Line

DUL Power Line Resistive Load Specifications				
Fig. 8 Resistor Ref.	Resistive Load Value	Load Power	Component P/N	RS Component Code
R1	8.2k Ω	50W	HSA508K2J	807-7180
R2	5.6k Ω	50W	HS50 5K6 J	252-2877
R3	4.7k Ω	100W	RS Pro	175-2450
R4	3.3k Ω	100W	HS100 3K3 J	252-2962
R5	1k Ω	500W	RPS0500DH1001JB	789-1213
R6	470 Ω	500W	RPS0500DH4700JB	821-9959
R7	235 Ω	1KW	Voir note 1	
R8	157 Ω	1.5KW	Voir note 1	

Tableau 13 - Résistances de charge pour les mesures d'étalonnage du capteur de courant des lignes de retour +375V et 375V

Note 1: Power load R7 consists of 2 resistors R6 connected in parallel.

Note 2: Power load R8 consists of 3 resistors R6 connected in parallel.

Warning:

Due to the high power output (up to approximately 900 W), resistors R5, R6, R7, and R8 must be mounted on suitable heat sinks to prevent thermal drift effects..

Required measuring instruments:

- ISO-TECH IDM 305 multimeter or equivalent with the same specifications
- Communication terminal
- TDK-Lambda power supply mod: GEN-600-2.6
- Resistive loads according to Table 13 (or programmable DC electronic load)

The measurement results must be recorded in the report in Excel format, as shown in Table 14..

Procedure to follow when using resistive loads:

- 1) Set switches **HSW1, HSW2, HSW3, HSW4, HSW5, HSW6, HSW7, HSW8** to the open position..
- 2) Set the voltage value of the TDK-Lambda primary power supply generator **to 375V**.
- 3) Ensure that the output current limitation of the TDK-Lambda generator is set to 2.5 A.
- 4) Switch on the output of the TDK-Lambda generator.
- 5) Ensure that the list of commands is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 6) Send the command "Y" from the terminal (set the 375V return switch to ON)
- 7) Send the "U" command from the indicator (set the 375V direct switch to ON).
- 8) Send the "C" command from the terminal (read all sensors 50 times). In response to the "C" command, the card transmits the following data screen:

Received command: 'C'

Sensor reading

T0CALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2

2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1

2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1

.....,,

.....,,

2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1

2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

number of readings: 50

minimum value: 768

maximum value: 896

average value: 829.44

Stats for LBL_I_MON:

number of readings: 50

minimum value: 10688

maximum value: 11136

average value: 10935.04

Stats for HYDRO_I_MON:

number of readings: 50

minimum value: 5952

maximum value: 6400

average value: 6176.00

Stats for DU_I_MON:

number of readings: 50

minimum value: 16960

maximum value: 18560

average value: 17733.12 <-----

Stats for DU_IRTN_MON:

number of readings: 50

minimum value: 16640

maximum value: 18688

average value: 17780.48

Stats for BPS_V_MON:

number of readings: 50

minimum value: 192

maximum value: 256

average value: 252.16

Stats for THEATSNK:

number of readings: 50
 minimum value: 5184
 maximum value: 5248
 average value: 5241.60

Stats for TBOARD:

number of readings: 50
 minimum value: 4736
 maximum value: 4800
 average value: 4746.24

- 9) Record in the report the value of the DUL power line output current measured by the ammeter in the **375V Switched Line Ampmeter Measurement** column and the values indicated by the arrows from the data received in the respective DU_I_MON Terminal Data and **DU_IRTN_MON Terminal Data** columns.
- 10) Send the command "J" from the terminal (set the 375V direct switch to OFF)
- 11) Send the command "H" from the terminal (set the 375V return switch to OFF)
- 12) Deactivate the TDK-Lambda generator output.
- 13) Repeat the measurement from point 4, closing one switch at a time in the sequence HSW1, HSW2, HSW3, HSW4, HSW5, HSW6, HSW7, HSW8, keeping all the others open.

BPS V03-R1 ID#0000 375V Switched Line Current Sensor Data			
Date: gg.mm.aaa		Ambient Temperature xx °C	
Load Value	375V Switched Line Ampmeter Measurement [mA]	DU_I_MON Terminal Data (Data average)	DU_IRTN_MON Terminal Data (Data average)
no load (All Switch Open)	Value#1	Value#1	Value#1
8.2kΩ (Only HSW1 Closed)	Value#2	Value#2	Value#2
5.6kΩ (Only HSW2 Closed)	...	...	...
4.7kΩ (Only HSW3 Closed)	...	...	...
3.3kΩ (Only HSW4 Closed)	...	...	...
1kΩ (Only HSW5 Closed)	...	...	...
470Ω (Only HSW6 Closed)	...	...	...
235Ω (Only HSW7 Closed)	...	...	...
157Ω (Only HSW8 Closed)	Value#9	Value#9	Value#9

Table 14 - Template to be included in the report for calibration measurements of the current sensor for the +375V and 375V return lines

6.3 Measurements of the 5V low voltage line current sensor

Functional testing and calibration measurements of the 5V line current sensor must be performed with the board powered at 375V. For these measurements, 7 power resistors connected to the respective low-voltage outputs are used.

The loads are switched on one by one using switches according to the sequence indicated in the procedure. The connection diagram is shown in the setup in Fig. 9. The load resistors must meet the stability requirements listed in section 6. As an example, Table 15 below shows the specifications for the power resistors to be used.

1V, 1.8V, 2.5V, 3.3V, 5V, 12V Resistive Load Specifications				
Fig. 9 Line Output	Resistor Load Value	Resistor Load Power	Component P/N	RS Component Code
5V	2.2Ω ±5%	75W	HS75 2R2 J	309-1021
3.3V	3.3Ω ±5%	25W	HS25 3R3 J	160-708
1V	0.33Ω ±5%	25W	HS25 R33 J	160-679
2.5V	2.2Ω ±5%	25W	HS25 2R2 J	157-538
1.8V	1.8Ω ±5%	15W	HS15 1R8 J	615-0353
12V_HYDRO	39Ω	25W	HS25 39R J	107-3914
12V_LBL	39Ω	25W	HS25 39R J	107-3914

Table 15 - Load resistors for 5V line current sensor calibration measurements

The measurement results must be recorded in the report in Excel format, as shown in Table 16.

- Required measuring instruments:
- ISO-TECH IDM 305 multimeter or equivalent with the same characteristics
- Communication terminal
- TDK-Lambda power supply, model: GEN-600-2.6
- Resistive loads as per Table 15 (or alternatively Programmable DC Electronic Load)

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 375V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Open switches SW#1, SW#2, SW#3, SW#4, SW#5, SW#6, SW#7.
- 4) Activate the output of the TDK-Lambda generator.
- 5) Ensure that the command menu is displayed on the terminal. If not, check the RS232 serial line connection and/or the terminal settings.
- 6) Send the command "I" from the terminal (set the 12V switch to ON).
- 7) Send the command "O" from the terminal (set the LBL switch to ON).
- 8) Send the "R" command from the terminal (set the HYDRO switch to ON).
- 9) Send the "C" command from the terminal (read all sensors 50 times). In response to the "C" command, the board transmits the following data screen

Received command: 'C'

Sensor reading

```
TOCALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2
2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1
2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1
```

```
....., .....
....., .....
```

2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1
 2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

number of readings: 50
 minimum value: 768
 maximum value: 896
 average value: 829.44 <-----

Stats for LBL_I_MON:

number of readings: 50
 minimum value: 10688
 maximum value: 11136
 average value: 10935.04

Stats for HYDRO_I_MON:

number of readings: 50
 minimum value: 5952
 maximum value: 6400
 average value: 6176.00

Stats for DU_I_MON:

number of readings: 50
 minimum value: 16960
 maximum value: 18560
 average value: 17733.12

Stats for DU_IRTN_MON:

number of readings: 50
 minimum value: 16640
 maximum value: 18688
 average value: 17780.48

Stats for BPS_V_MON:

number of readings: 50
 minimum value: 192
 maximum value: 256
 average value: 252.16

Stats for THEATSNK:

number of readings: 50
 minimum value: 5184
 maximum value: 5248
 average value: 5241.60

Stats for TBOARD:

number of readings: 50
 minimum value: 4736
 maximum value: 4800
 average value: 4746.24

- 1) Record the voltage drop measured across resistor R10 in the R10 Voltage Drop column and the value indicated by the arrow in the 5V_I_MON Terminal Data column.
- 2) Repeat the measurement from step 9, closing one switch at a time in the sequence SW#1, SW#2, SW#3, SW#4, SW#5, SW#6, SW#7, keeping the switches that are already closed in the same position.
- 3) Switch off the output of the TDK-Lambda generator.

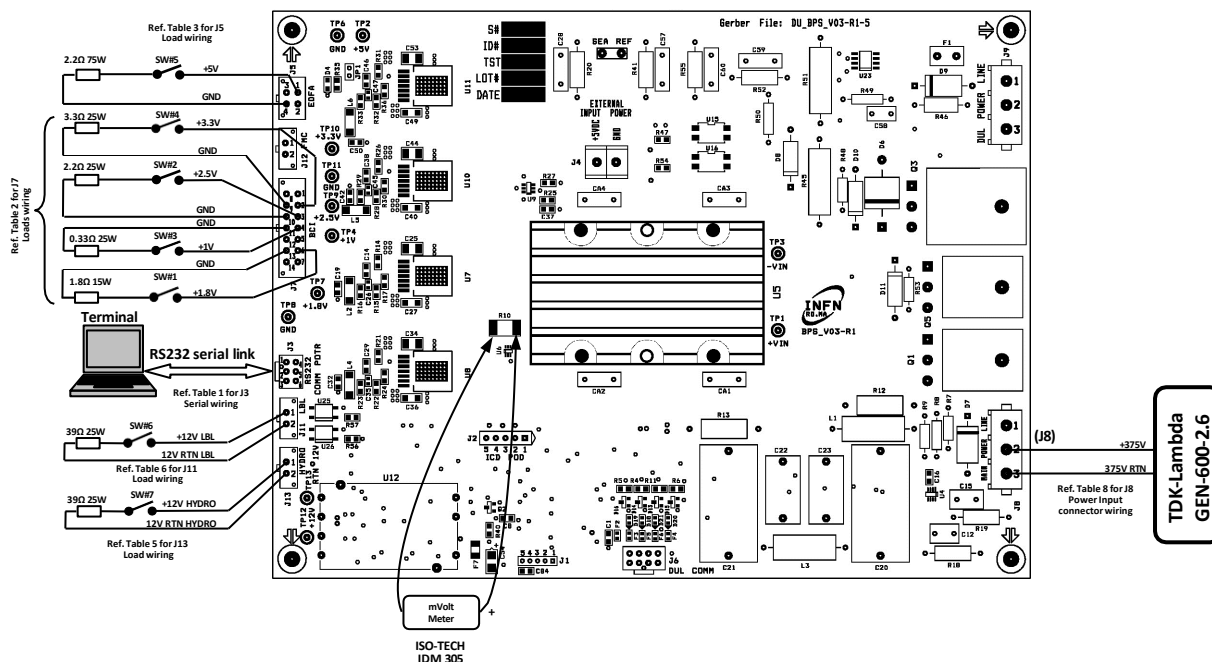


Fig. 9: Configuration for calibration measurements of the 5V line current sensor

BPS V03-R1 ID#XX 5V Current Sensor Data			
Date: gg.mm.aaa			Ambient Temperature xx °C
Switch conditions		R10 Voltage Drop [mV]	5V_I_MON Terminal Data (Data average)
closed	open		
-	All Switch open	Val.#1	Val.#1
SW#1	SW#2-SW#3 SW#4-SW#5 SW#6-SW#7	Val.#2	Val.#2
SW#1-SW#2	SW#3-SW#4 SW#5-SW#6 SW#7	...	...
SW#1-SW#2 SW#3	SW#4-SW#5 SW#6-SW#7	...	...
SW#1-SW#2 SW#3-SW#4	SW#5-SW#6 SW#7	...	...
SW#1-SW#2 SW#3-SW#4 SW#5	SW#6-SW#7	...	...
SW#1-SW#2 SW#3-SW#4 SW#5- SW#6	SW#7	Val.#7	Val.#7
All Switch closed	-	Val.#8	Val.#8

Table 16 - Models to be included in the report for current 5V sensor calibration measurements

6.4 Current sensor measurements 12V HYDRO line

The operational verification and calibration measurements of the 12V HYDRO line current sensor must be performed with the board powered at 375V. For these measurements, five 100Ω 16W power resistors are used as a variable load connected to the 12V HYDRO line, activated by the switches according to the sequence indicated in the procedure. The connection diagram is shown in Fig. 10.

Load resistors must meet the stability requirements listed in section 6. For example, power resistors with the following reference number may be used: HSA10100RJ Code RS720-4925.

The measurement results must be recorded in the report in Excel format, as shown in Table 17.

Required measuring instruments:

- ISO-TECH IDM 305 multimeter or equivalent with equivalent specifications
- Communication terminal
- TDK-Lambda power supply mod: GEN-600-2.6

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 375V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Open switches SW#8, SW#9, SW#10, SW#11, and SW#12.
- 4) Activate the output of the TDK-Lambda generator.
- 5) Ensure that the command menu is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 6) Send the command "I" (set the 12V switch to ON) from the terminal.
- 7) Send the command "R" from the terminal (set the HYDRO switch to ON).
- 8) Send the command "C" from the terminal (read all sensors 50 times). In response to the command "C", the card transmits the following data screen

Received command: 'C'

Sensor reading

```

T0CALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2
2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1
2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1
....., ....., .....
....., ....., .....
2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1
2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1

```

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

```

number of readings: 50
minimum value: 768
maximum value: 896
average value: 829.44

```

Stats for LBL_I_MON:

```

number of readings: 50
minimum value: 10688
maximum value: 11136
average value: 10935.04

```

Stats for HYDRO_I_MON:

```

number of readings: 50
minimum value: 5952
maximum value: 6400
average value: 6176.00 <-----

```

Stats for DU_I_MON:
 number of readings: 50
 minimum value: 16960
 maximum value: 18560
 average value: 17733.12

Stats for DU_IRTN_MON:
 number of readings: 50
 minimum value: 16640
 maximum value: 18688
 average value: 17780.48

Stats for BPS_V_MON:
 number of readings: 50
 minimum value: 192
 maximum value: 256
 average value: 252.16

Stats for THEATSNK:
 number of readings: 50
 minimum value: 5184
 maximum value: 5248
 average value: 5241.60

Stats for TBOARD:
 number of readings: 50
 minimum value: 4736
 maximum value: 4800
 average value: 4746.24

- 9) Record in the report the value of the current measured in the 12V HYDRO Current Ampmeter Measurement column and the value indicated by the arrow in the 12V_I_MON_HYD Terminal Data column.
- 10) Repeat the measurement from step 8, closing one switch at a time in the sequence SW#8, SW#9, SW#10, SW#11, SW#12, keeping the switches already closed in the same position.
- 11) Switch off the output of the TDK-Lambda generator.

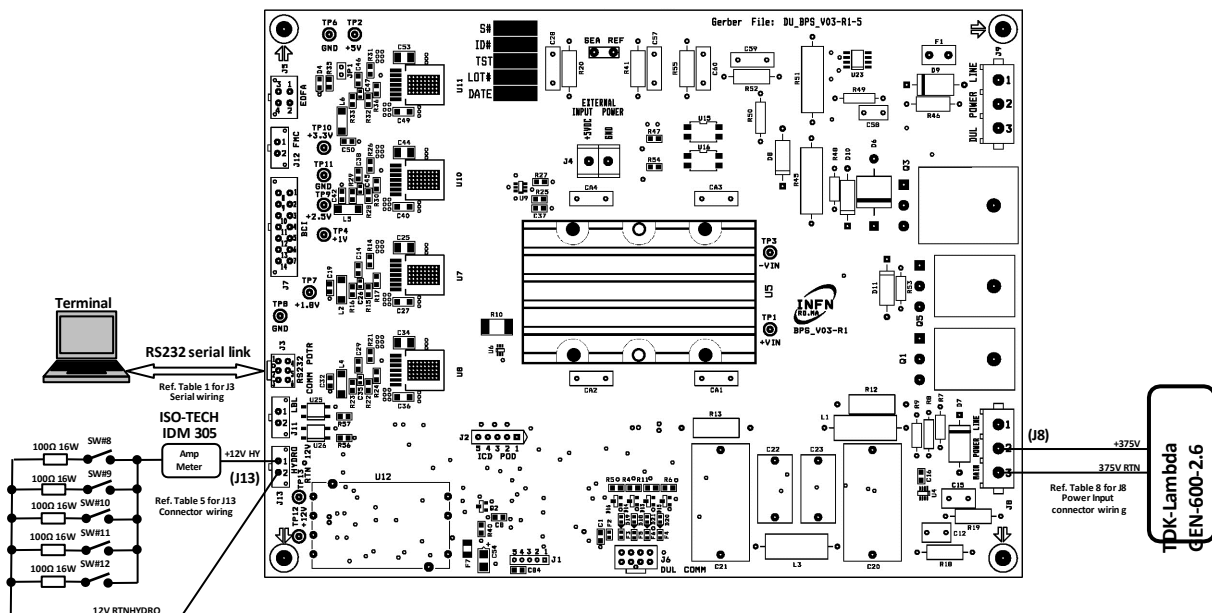


Fig. 10: Configuration for calibration measurements of the 12V line current sensor

BPS V03-R1 ID#0000 12V HYDRO Current Sensor Data		
Date: gg.mm.aaa		Ambient Temperature xx °C
12V Output Line load [Ω]	12V HYDRO Current Ampmeter Measuremet [mA]	12V_I_MON_HYD Terminal Data (Data average)
Unloaded	Val.#1	Val.#1
100	Val.#2	Val.#2
50	...	...
33.3	...	...
25	...	...
12.5	Val.#6	Val.#6

Table 17 - Templates to be included in the report for calibration measurements of the 12V HYDRO line current sensor

6.5 12V LBL line current sensor measurements

The operational check and calibration measurements of the 12V LBL line current sensor must be performed with the board powered at 375V using the same loads as those used for the 12V HYDRO line current sensor. The circuit consisting of the 5 resistors, switches and ammeter must be disconnected from connector J13 and connected to the adjacent connector J11. The measuring instruments are identical to those used for measuring the 12V HYDRO line current sensor described in the previous paragraph.

The measurement results must be recorded in the report in Excel format as shown in Table 18.

BPS V03-R1 ID#0000 12V LBL Current Sensor Data		
Date: gg.mm.aaa		Ambient Temperature xx °C
12V Output Line load [Ω]	12V LBL Current Ampmeter Measuremet [mA]	12V_I_MON_LBL Terminal Data (Data average)
Unloaded	Val.#1	Val.#1
100	Val.#2	Val.#2
50	...	...
33.3	...	...
25	...	...
12.5	Val.#6	Val.#6

Table 18 - Templates to be included in the report for 12V LBL current sensor calibration measurements

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 375V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A..
- 3) Set switches **SW#8, SW#9, SW#10, SW#11, SW#12** to the open position.

- 4) Activate the output of the TDK-Lambda generator..
- 5) Ensure that the command menu is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 6) Send the command "I" from the terminal (set the 12V switch to ON)
- 7) Send the command "O" from the terminal (set the LBL switch to ON).
- 8) Send the command "C" from the terminal (read all sensors 50 times). In response to the command "C", the board transmits the following data screen

Received command: 'C'

Sensor reading

```

TDCALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2
2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1
2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1
....., ....., .....
....., ....., .....
2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1
2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1

```

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

```

number of readings: 50
minimum value: 768
maximum value: 896
average value: 829.44

```

Stats for LBL_I_MON:

```

number of readings: 50
minimum value: 10688
maximum value: 11136
average value: 10935.04 <-----

```

Stats for HYDRO_I_MON:

```

number of readings: 50
minimum value: 5952
maximum value: 6400
average value: 6176.00

```

Stats for DU_I_MON:

```

number of readings: 50
minimum value: 16960
maximum value: 18560
average value: 17733.12

```

Stats for DU_IRTN_MON:

```

number of readings: 50
minimum value: 16640
maximum value: 18688
average value: 17780.48

```

Stats for BPS_V_MON:

```

number of readings: 50
minimum value: 192
maximum value: 256
average value: 252.16

```

Stats for THEATSNK:

```

number of readings: 50
minimum value: 5184
maximum value: 5248
average value: 5241.60

```

Stats for TBOARD:

number of readings: 50
 minimum value: 4736
 maximum value: 4800
 average value: 4746.24

- 9) Record in the report the value of the current measured in the 12V Current Ampmeter Measurement column and the value indicated by the arrow in the 12V_I_MON_LBL Terminal Data column.
- 10) Repeat the measurement from step 8, closing one switch at a time in the sequence SW#8, SW#9, SW#10, SW#11, SW#12, keeping the switches already closed in the same position..
- 11) Switch off the output of the TDK-Lambda generator.

7. Control measures for the DUL card interface

The BPS_V03-R1 is connected to the DUL board via connector J6. Through this connection, the BPS_V03-R1 supplies 5V power, receives analogue signals from the temperature sensor and digital alarm signals (TTL compatible). The purpose of this test is to verify the supply voltage and the correct acquisition of signals from the temperature sensor and the alarm. To perform the test, a square wave generator (TTL output) is used to generate the alarm signals, and a DC power supply is used to provide the temperature sensor signals. The test for checking the DUL board interface must be performed with the BPS_V03-R1 powered at 375V.

7.1 Checking the power supply to the DUL card

The test must be carried out according to the diagram in Figure 11.

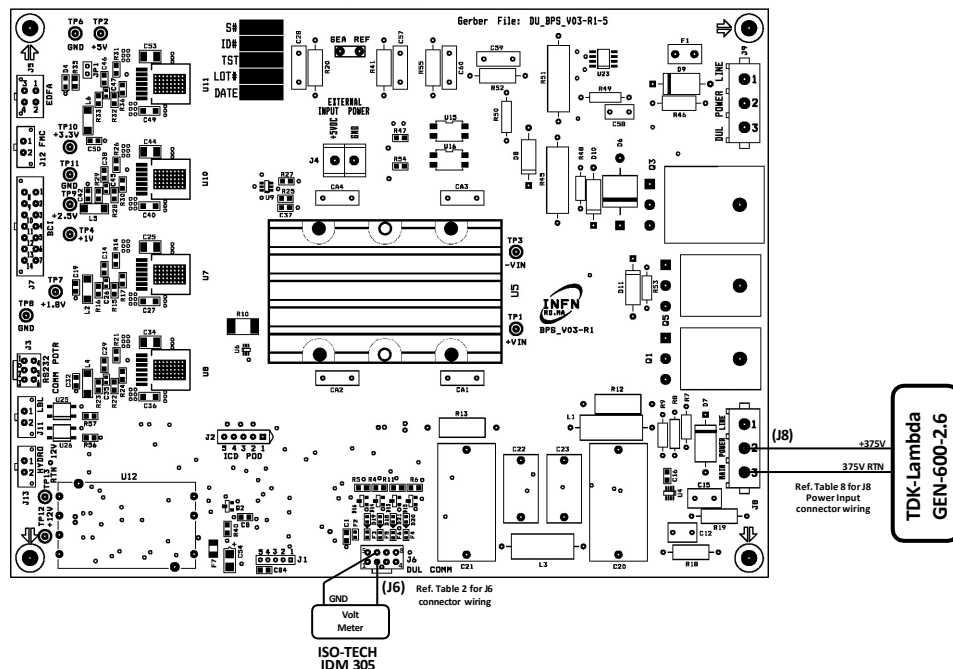


Fig. 11: Configuration for checking the supply voltage of the DUL board

Required measuring instruments:

- ISO-TECH IDM 305 multimeter or equivalent with the same specifications
- TDK-Lambda power supply mod: GEN-600-2.6.

The measurements described in this section do not require communication with the terminal. The results must be recorded in the report in Excel format as shown in Table 19.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 375V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Switch on the output of the TDK-Lambda generator.
- 4) Check that the value measured by the voltmeter between contacts 6 and 2 of J6 is $5V \pm 2\%$.
- 5) Record in the report in the column Check 5V on pin no. 2 J6 OK if positive or NO OK if negative.
- 6) Switch off the output of the TDK-Lambda generator.

7.2 Verifying the acquisition of the temperature sensor signal from the DUL board

The test must be carried out according to the setup shown in Figure 12. The signals from the two temperature sensors are reproduced by the DC power supply set to provide a voltage of 0.7 V for the "TBOARD" sensor and 2.9 V for the "THEATSNK" sensor.

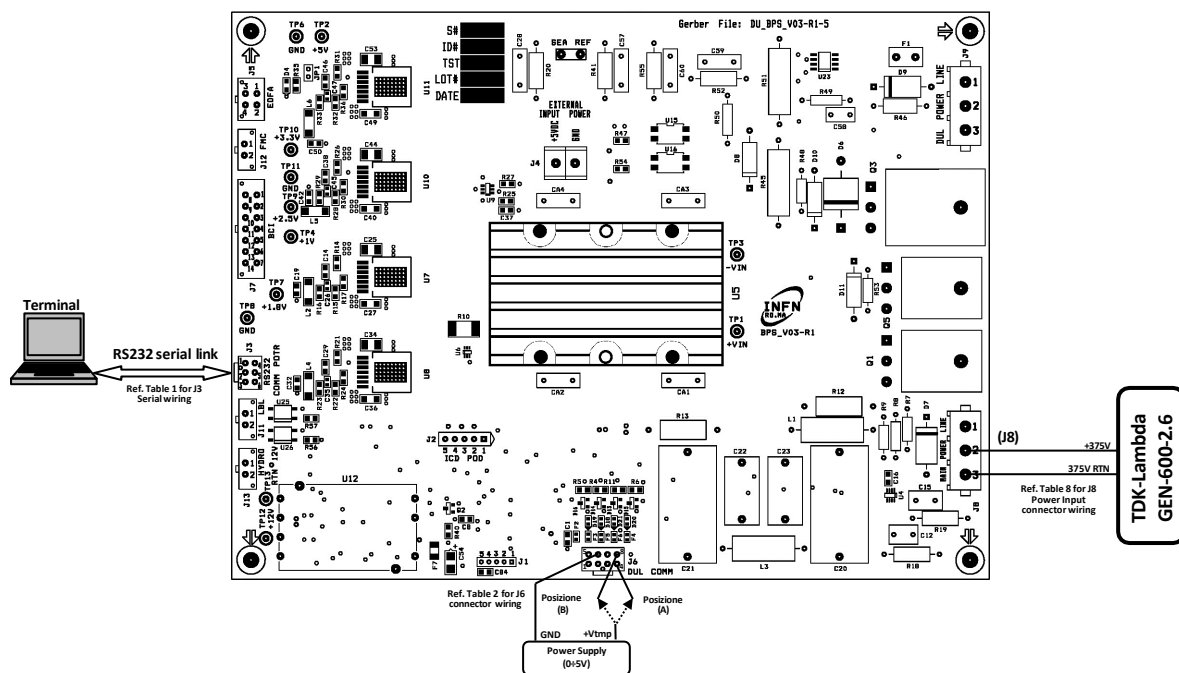


Fig. 12: Configuration for verifying temperature sensor signal acquisition

Required measuring instruments:

- Stabilised DC power supply with adjustable output 0÷5V
- Communication terminal
- TDK-Lambda power supply mod: GEN-600-2.6.

The results must be recorded in the report in Excel format, as shown in Table 19.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 375V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Switch on the output of the TDK-Lambda generator.
- 4) Ensure that the command menu is displayed on the terminal. If this is not the case, check the RS232 serial line connection and/or the terminal settings.
- 5) Apply a voltage of +0.7V between pin 6 (GND) and pin 4 of connector J6 (see Fig. 12 Position A).
- 6) Send the command "C" from the terminal (read all sensors 50 times). In response to the command "C", the card transmits the following data screen

Received command: 'C'

Sensor reading

T0CALLS, 5V_I_MON, LBL_I_MON, HYDRO_I_MON, DU_I_MON, DU_IRTN_MON, BPS_V_MON, THEATSNK, TBOARD, ALRMNEG1, ALRMNEG2, ALRMPOS1, ALRMPOS2

2408734, 832, 10816, 6272, 16960, 18112, 256, 5248, 4736, 1, 1, 1, 1

2408960, 832, 11136, 6080, 17984, 17664, 256, 5184, 4736, 1, 1, 1, 1

.....,,

.....,,

2419397, 832, 10944, 6208, 17216, 17984, 256, 5248, 4736, 1, 1, 1, 1

2419619, 832, 10880, 6080, 17728, 18432, 256, 5248, 4800, 1, 1, 1, 1

Measurement statistics over 50 readings:

Stats for 5V_I_MON:

number of readings: 50

minimum value: 768

maximum value: 896

average value: 829.44

Stats for LBL_I_MON:

number of readings: 50

minimum value: 10688

maximum value: 11136

average value: 10935.04

Stats for HYDRO_I_MON:

number of readings: 50

minimum value: 5952

maximum value: 6400

average value: 6176.00

Stats for DU_I_MON:

number of readings: 50

minimum value: 16960

maximum value: 18560

average value: 17733.12

Stats for DU_IRTN_MON:

number of readings: 50

minimum value: 16640

maximum value: 18688
average value: 17780.48

Stats for BPS_V_MON:

number of readings: 50
minimum value: 192
maximum value: 256
average value: 252.16

Stats for THEATSNK:

number of readings: 50
minimum value: 5184
maximum value: 5248
average value: 5241.60

Stats for TBOARD:

number of readings: 50
minimum value: 4736
maximum value: 4800
average value: 4746.24 <-----

- 1) Enregistrez dans le rapport la valeur de la tension appliquée dans la colonne Tension du signal d'entrée du capteur de température et la valeur indiquée par la flèche dans la colonne TBOARD.
- 2) Appliquer une tension de +2,9V entre le contact 6 (GND) et 8 du connecteur J6 (voir Fig. 12 Position B).
- 3) Envoyer la commande "C" depuis le terminal (lire tous les capteurs 50 fois). En réponse à la commande "C", la carte transmet l'écran de données suivant:

.....

.....

Stats for THEATSNK:

number of readings: 50
minimum value: 5184
maximum value: 5248
average value: 5241.60 <-----

Stats for TBOARD:

number of readings: 50
minimum value: 4736
maximum value: 4800
average value: 4746.24

- 4) Record the value of the applied voltage in the Input Signal Voltage column of the temperature sensor and the value indicated by the arrow in the THEATSNK column in the report..

7.3 Verifying the acquisition of the alarm signal from the DUL card

The test shall be carried out in accordance with the configuration shown in Figure 13. Alarm signals shall be provided by the square wave generator set to emit a 1 Hz TTL-compatible signal.

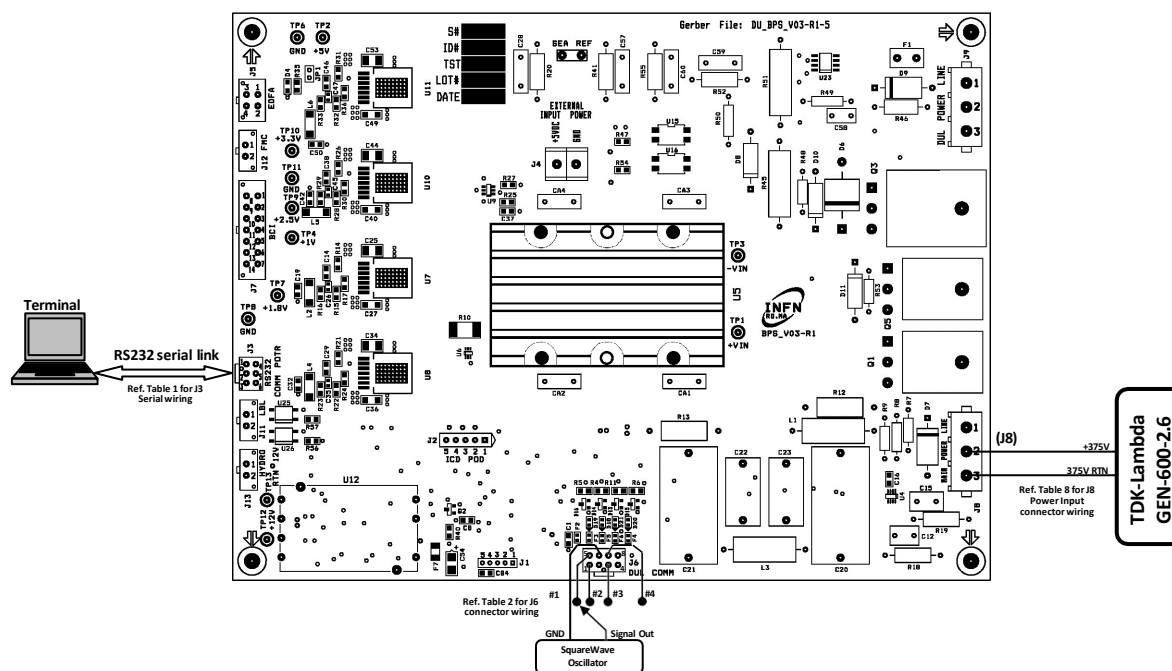


Fig. 13: Configuration for alarm signal acquisition control

Required measuring instruments:

- Stabilised DC power supply with adjustable output 0÷5V
- Communication terminal
- TDK-Lambda power supply mod: GEN-600-2.6.

The results must be recorded in the report in Excel format, as shown in Table 19.

Procedure:

- 1) Set the voltage value of the TDK-Lambda primary power supply generator to 375V.
- 2) Ensure that the output current limitation of the TDK-Lambda primary power supply generator is set to 2.5 A.
- 3) Switch on the output of the TDK-Lambda generator.
- 4) Ensure that the command menu is displayed on the terminal. If not, check the RS232 serial line connection and/or the terminal settings.
- 5) Apply the 1Hz signal (ALRMNEG1 signal) between contact 6 (GND) and 1 of J6.
- 6) Send the "B" command (continuous reading of all sensors) from the terminal. In response to the "B" command, the card transmits the following data continuously:

```

.....
6347289, 768, 320, 17984, 18112, 256, 9984, 10048 0, 1, 1, 1
6347494, 896, 320, 17664, 17280, 256, 9984, 10048 0, 1, 1, 1
6347700, 896, 320, 18304, 17216, 256, 9984, 10048 0, 1, 1, 1
6347906, 832, 320, 17792, 17344, 256, 9984, 10048 1, 1, 1, 1
6348111, 768, 320, 18112, 18048, 256, 9984, 10048 1, 1, 1, 1
.....
6351604, 832, 320, 18944, 18432, 256, 9984, 10048 1, 1, 1, 1
6352632, 896, 320, 17600, 17792, 256, 9984, 10112 1, 1, 1, 1
6352837, 768, 320, 17216, 18240, 256, 9984, 10048 0, 1, 1, 1
6353043, 832, 320, 17472, 18048, 256, 9984, 10048 0, 1, 1, 1
6353248, 768, 320, 17472, 17856, 256, 9984, 10048 0, 1, 1, 1
.....

```

- 7) Check that the data in the highlighted column changes status (1.0).
- 8) Record in the report in the Check AlarmNeg1 column OK if the result is positive or NO OK if it is negative.
- 9) Interrupt the acquisition process by sending the command ' ?
- 10) Apply the 1Hz signal (ALRMNEG2 signal) between contact 6 (GND) and 5 of J6.
- 11) Send the command "B" (continuous reading of all sensors) from the terminal. In response to the command 'B', the card continuously transmits the following data:

```

.....
6347289, 768, 320, 17984, 18112, 256, 9984, 10048, 1, 0, 1, 1
6347494, 896, 320, 17664, 17280, 256, 9984, 10048, 1, 0, 1, 1
6347700, 896, 320, 18304, 17216, 256, 9984, 10048, 1, 0, 1, 1
6347906, 832, 320, 17792, 17344, 256, 9984, 10048, 1, 1, 1, 1
6348111, 768, 320, 18112, 18048, 256, 9984, 10048, 1, 1, 1, 1
.....
6351604, 832, 320, 18944, 18432, 256, 9984, 10048, 1, 1, 1, 1
6352632, 896, 320, 17600, 17792, 256, 9984, 10112, 1, 1, 1, 1
6352837, 768, 320, 17216, 18240, 256, 9984, 10048, 1, 0, 1, 1
6353043, 832, 320, 17472, 18048, 256, 9984, 10048, 1, 0, 1, 1
6353248, 768, 320, 17472, 17856, 256, 9984, 10048, 1, 0, 1, 1
.....

```

- 12) Verify that the data in the highlighted column changes status (1.0).
- 13) Record in the report in the Check AlarmNeg2 column OK if the result is positive or NO OK if negative.
- 14) Interrupt the acquisition process by sending the command ' ?
- 15) Apply the 1Hz signal (ALRMPOS1 signal) between contact 6 (GND) and 3 of J6.
- 16) Send the command "B" (continuous reading of all sensors) from the terminal. In response to the command "B", the card continuously transmits the following data:

```

.....
6347289, 768, 320, 17984, 18112, 256, 9984, 10048, 1, 1, 0, 1
6347494, 896, 320, 17664, 17280, 256, 9984, 10048, 1, 1, 0, 1
6347700, 896, 320, 18304, 17216, 256, 9984, 10048, 1, 1, 0, 1
6347906, 832, 320, 17792, 17344, 256, 9984, 10048, 1, 1, 1, 1
6348111, 768, 320, 18112, 18048, 256, 9984, 10048, 1, 1, 1, 1
.....

```

```

.....
6351604, 832, 320, 18944, 18432, 256, 9984, 10048, 1, 1, 1, 1
6352632, 896, 320, 17600, 17792, 256, 9984, 10112, 1, 1, 1, 1
6352837, 768, 320, 17216, 18240, 256, 9984, 10048, 1, 1, 0, 1
6353043, 832, 320, 17472, 18048, 256, 9984, 10048, 1, 1, 0, 1
6353248, 768, 320, 17472, 17856, 256, 9984, 10048, 1, 1, 1, 1
.....

```

- 17) Verify that the data in the highlighted column changes status (1.0).
- 18) Record in the report in the Check AlarmPos1 column OK if the result is positive or NO OK if it is negative.
- 19) Interrupt the acquisition process by sending the command ' ? '
- 20) Apply the 1Hz signal (ALRMPOS2 signal) between contact 6 (GND) and 7 of J6.
- 21) Send command "B" (continuous reading of all sensors) from the terminal. In response to command 'B', the card transmits the following data continuously:

```

.....
6347289, 768, 320, 17984, 18112, 256, 9984, 10048, 1, 1, 1, 0
6347494, 896, 320, 17664, 17280, 256, 9984, 10048, 1, 1, 1, 0
6347700, 896, 320, 18304, 17216, 256, 9984, 10048, 1, 1, 1, 0
6347906, 832, 320, 17792, 17344, 256, 9984, 10048, 1, 1, 1, 1
6348111, 768, 320, 18112, 18048, 256, 9984, 10048, 1, 1, 1, 1
.....

```

```

.....
6351604, 832, 320, 18944, 18432, 256, 9984, 10048, 1, 1, 1, 1
6352632, 896, 320, 17600, 17792, 256, 9984, 10112, 1, 1, 1, 1
6352837, 768, 320, 17216, 18240, 256, 9984, 10048, 1, 1, 1, 0
6353043, 832, 320, 17472, 18048, 256, 9984, 10048, 1, 1, 1, 0
6353248, 768, 320, 17472, 17856, 256, 9984, 10048, 1, 1, 1, 0
.....

```

- 22) Verify that the data in the highlighted column changes status (1.0).
- 23) Record in the report in the Check AlarmPos2 column OK if positive or NO OK if negative.
- 24) Switch off the output of the TDK-Lambda generator.

BPS_V03-R1: DUL Interface Check

Date:	Temperature Sensor Data Measurements			Power & Alarm Signal Check				
	Temp Sensor (ppm) Signal Voltage [V]	TBOARD [Count]	THEATSNK [Count]	Check 5V on pin# 2 J6	Check AlarmNeg1	Check AlarmNeg2	Check AlarmPos1	Check AlarmPos2
Board ID#0000	0,7	Val.#1	-	OK	OK	OK	OK	OK
	2,9	-	Val.#2					

Table 19 - Templates to be included in the DUL card interface control report

8. Programming the microcontroller with firmware for testing

On board is the PIC18F26K22-I/SO microcontroller manufactured by MICROCHIP, which acquires sensor data, controls output lines, and manages communication with the terminal. To perform the tests, it is necessary to program the microcontroller with the "bpsV3_pic18f_testbench.X.production.hex" firmware, which has been specially written for this purpose and is provided with this document.

The microcontroller must be programmed using the appropriate programming tool for the specific microcontroller. There are various programming tools available on the market for the PIC18F26K22-I/SO; the procedure is described below using the ICD3 programming module and MPLAB IDE software as the development environment, both supplied by MICROCHIP. More detailed information on using this programming tool is available on the official MICROCHIP website:

<https://www.microchip.com/developmenttools/ProductDetails/dv164035>.

To program the PIC18F26K22-I/SO using the ICD3 module, it must be connected with a special cable to the J2 ICD-POD connector on the BPS_V03-R1 board (see Fig. 2).

The connection cable must be terminated on the ICD3 side with the RJ11 PLUG 6P6C UNSHIELDED connector and on the BPS_V03-R1 side with the HE13/HE14 connector, female, 5 contacts, 1 row, pitch 2.54mm P/N 281838-5.

Fig. 18 and Fig. 19 show the wiring diagram and technical details of the connectors for cable assembly.

J2 BPS_V03-R1 to RJ11 ICD3 Interconnection Cable

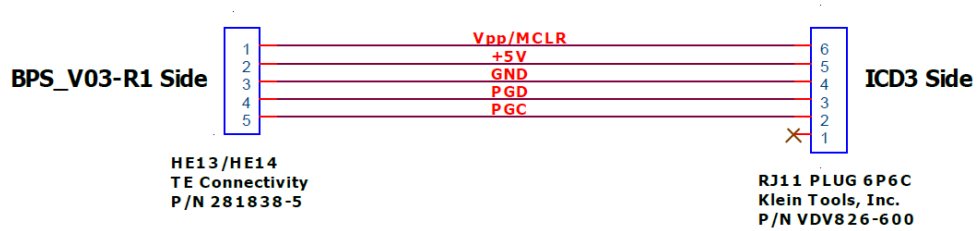
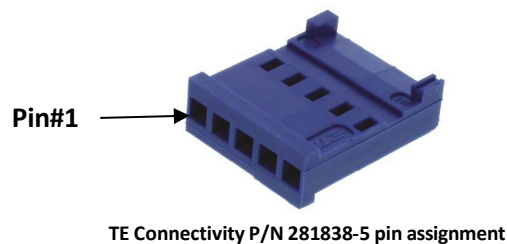


Fig. 18 Wiring diagram for programming cable



Side ICD3 Cable Header Connector P/N	Pin#	Line Name
Klein Tools, Inc. VDV826-600	1	NC
	2	PGC
	3	PGD
	4	GND
	5	+5V
	6	Vpp/MCLR

Side ICD3 RJ11 PLUG 6P6C UNSHIELDED Connector Pin-out



Fig. 19: Pinout of the programming cable connector

To perform programming, the board must be powered by the dedicated J4 connector with an external power supply at a voltage of 5V @1A. Figure 20 shows a diagram of the interconnections required for programming the microcontroller.

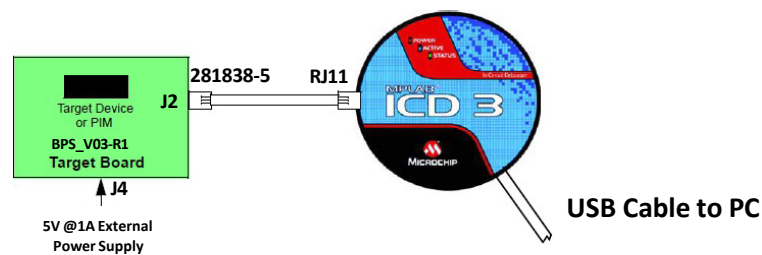


Fig. 20: Configuration for programming the PIC18F26K22-I/SO microcontroller

9. Test results report

Each card has a unique four-digit identification code. This code is printed on the top of the printed circuit board (see fig. 1). For each card, a report must be drawn up containing its identification number, the values of the electrical parameters measured and, where applicable, the corresponding oscilloscope waveforms. The report should preferably be in digital format. As an example, an Excel file summarising the results of all the tests described is attached to this document.

10. Validation criteria

If it is verified that one or more values of the measured electrical parameters are not within the tolerance limits specified in the reference table, the sheet is classified as "non-compliant" and must therefore be discarded. The test sheet for the card classified as non-compliant must be marked **"TEST FAILED"**, highlighting the value(s) that exceed the tolerance limits.

If all measured values are within the tolerance range defined in the reference table, the card is classified as "compliant" and the words **"TEST PASSED"** are written on its test sheet.