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Low Noise Factory

Data Sheet/User Manual

LNF-PS8

Eight Channel Low Noise HEMT Power Supply

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Contents

1. Introduction

Important: This product is ESD sensitive and shall be handled as such.
Please, read this manual thoroughly before start using this product.

The LNF-PS8 is a compact linear power supply designed for DC biasing up to eight LNF's Low Noise Amplifiers. Each drain voltage (Vd) and drain current (Id) can be set individually within a wide range by simple adjusting trimmer potentiometers on the front panel. Vd is delivered from internal constant voltage source, while, as the LNA become a part of the automatic regulation loop, the specific Id is kept constant by continuous controlling the corresponding gate voltage of the specific LNA.
There is also a remote drain voltage sense option for situations where DC bias rail(s) resistance is significant and cause a significant voltage-drop. It provides with possibility of observing Vd's on, or close to, LNA hence offers a good way to compensate for voltage drop along power rails by readjusting Vd's.
LNF-PS8 can be provided in two variants – one with eight circular five pins connectors similar to the connector used with LNF-PS3b (compliant with LNFs cable LNF-CAB_PS3b_LNA) and one with two standard d-sub 25 positions connectors each nestling four DC Bias channels.
Vd's, Id's and Vg's are displayed on 4.3" touch screen for easy individual monitoring and setup of Vd's and Id's. The graphical user interface shown on the screen is developed to be intuitive and user friendly. It also provides the user with basic user manual and quick access to information for connectors pinout.
The display can be switched off while not affecting DC Bias of LNA(s) – it is eliminating any digital noise which can be generated by the display.
LNF-PS8 is intended to be supplied preferably by LNF-PBA-HP (it can be supplied even with LNF-PBA*) or some other PSU which can provide with required +/- voltages and currents.
The LNF-PS8 is delivered with LNF-CAB_PBA_PS3b - 1.5-meter power cable to be used to connect it and the LNF-PBA-HP (or the LNF-PBA). The version of LNF-PS8 with eight circular five pins connectors use the same M12 connectors for DC Bias outputs as the LNF-PS3b to provide with back-compatibility. The version with d-sub connector requires two standard d-sub 25p cables. Regardless which version of LNF-PS8 is used the suitable cable for the DC Bias outputs should be blunt on the opposite end to get possibility for the end-users to fit their connector to mate with their system.
This instrument is meant to be used, first of all, as bench top instrument but it could be attached to e.g. wall or some other structure vertically by using four M5 self-clinching nuts attached to the bottom panel.

2. Specifications

Input					
DC Supply Voltage	**Description**	**Min**	**Nom**	**Max**	**Unit**
V^+ range	+12 V rail input voltage range	-10%	12	+10%	VDC
V^- range	-12 V rail input voltage range	-10%	-12	+10%	VDC
I(V^+=+12V)	DC current on +12V with no and maximum load of four LNAs	~260*		~785	mA
I(V-=-12V)	DC current on -12V with no and maximum load of four LNAs	~86*		~86	mA

Table 1 Power Ratings

* LNF-PBA-HP has a capacity of powering up to eight LNF-PS8 while LNF-PBA has capacity of powering up to three LNF-PS8 units.

Output					
Parameter	**Description/Conditions**	**Minimum**	**Nominal**	**Maximum**	**Unit**
Vd range		0.00		2.40	VDC
Id range		0.00		65.00	mA
Vg range		-10		+10	V
Vd noise	Drain ripple and noise		0.1	<0.5	mV_{PK-PK}
Vg noise	Gate ripple and noise		0.1	<0.5	mV_{PK-PK}

Table 2 DC Output Ratings

Environmental					
Parameter	**Description/Conditions**	**Minimum**	**Nominal**	**Maximum**	**Unit**
Storage Temperature		-40		85	°C
Operating Temperature		5		40	°C
Relative Humidity[1]	Non-Condensing	5		80	%RH

Table 3 Environment Requirements

[1] The LNF-PS8 is for indoor use only, pollution degree 2.

Physical	
Weight	~1270 g
Dimensions	133 (W) x 47 (H) x 207 (D) millimeters

Table 4 Physical Data

3. Description

A panoramic view LNF-PS8 is shown in Figure 1:

Figure 1 LNF-PS8

The touch screen display on the top of LNF-PS8 is intended to show up the actual values of Vd, Id and Vg for each of eight connected LNAs. The top and front panels are provided with ventilation slots which may not be covered to not disturb airflow through them.

LNF-PS8 can be provided in two variants – one with eight five positions connectors (M12 size) (see Figure 2) and one with two standard 25p d-sub connectors (see Figure 3).

Figure 2 Rear panel equipped with eight female socket 5p connectors size M12.

The connectors Ch1 to Ch8 (see Figure 2) are providing with DC Outs i.e.Vd, Vg, Vd_sense+ and Vd_sense- for eight LNAs. The connector to the left (+/- 12V DC) is for powering up the LNF-PS8 from, preferably, LNF-PBA-HP

(or the LNF-PBA). The LNF-PBA-HP can power up to eight LNF-PS8 units while LNF-PBA has capacity of powering up to two LNF-PS8 units.

Figure 3 Rear panel equipped with two female socket d-sub 25p connectors.

The d-sub connectors (see Figure 3) are providing with DC Outs i.e.Vd, Vg, Vd_sense+ and Vd_sense- for eight LNAs. The connector to the left (+/- 12V DC) is for powering up the LNF-PS8 from, preferably, LNF-PBA-HP (or the LNF-PBA). Again LNF-PBA-HP can power up to eight LNF-PS8 units while LNF-PBA has capacity of powering up to two LNF-PS8 units.

Figure 4 is showing the front panel of the LNF-PS8. There are two switches - Display and Main. The Main switch is used to turn on/off LNF-PS8 completely while the Display switch is used to turn on/off the touch screen display only. (Note: The touch screen display cannot be switched on without that Main switch is on). For indication that the LNF-PS8 is running the button of the Main switch is lit.

There eight trimmer potentiometers (Vd1, Id1, .., Vd8, Id8) for manual setting Vd's and Id's individually by using a flat 2mm screwdriver.

Figure 4 Front panel

The bottom panel is provided with four rubber feet and (after April 1st 2024) even with four self-clinching M5 nuts attached from inside – see Figure 5. These self-clinching nuts are plugged with removable plugs (see Figure 5).

The self-clinching nuts are intended to offer a possibility for vertical attaching of the unit to other suitable mechanical structure in the lab.

For easy integration of the units in a larger system LNF is providing with 3D model found LNF home page (LNF-PS8 - Low Noise Factory).

Figure 5 Bottom panel – before (left) and after (right) 1 April 2024

4. Accessories

- 1 pcs of cable LNF-CAB_PBA_PS3b for DC supply of LNF-PS8

5. Before Starting Use

Warning: This unit is ESD (electrostatic discharge) sensitive and, therefore, proper ESD precautions must be taken. Exposing to high energy ESD can lead to degraded performance or even permanent damage to the unit.

Dont forget to withtake all necessary ESD precaussions.
After unpacking the unit make a visual inspection of it and make sure that there are no visible injuries. If any damage is found, please contact Low Noise Factory prior to taking it into operation.

Important:
In case that the self-clinching M5 nuts are used for fastening the unit the M5 screws absolutely **must not** go deeper than 7mm into the enclosure measured from the outher surface of the bottom panel – see Figure 6.

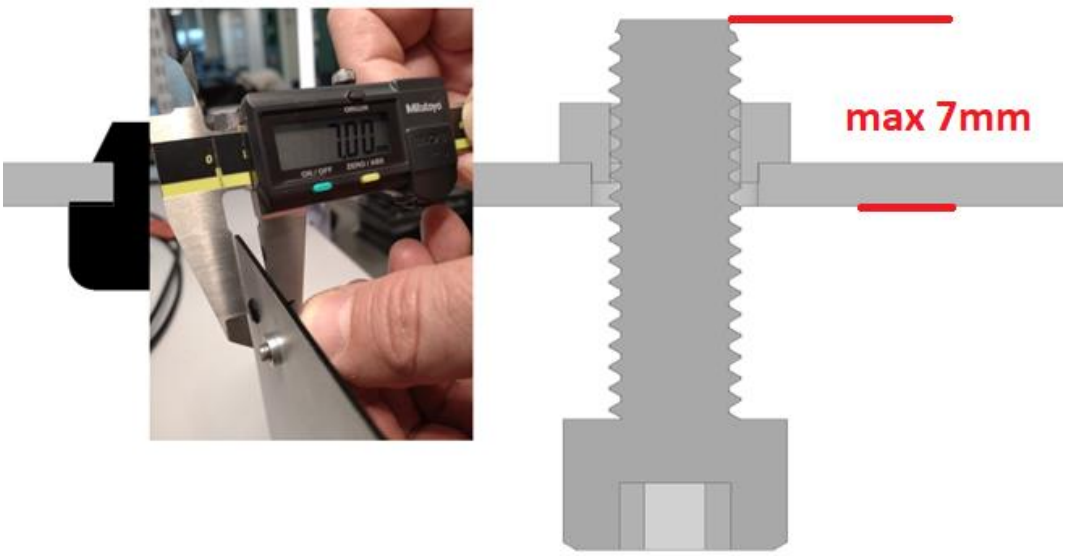

Figure 6 Maximum allowance for M5 screws

6. Pinout and Wiring

Warning: This unit must be wired as it is proposed in this section. Improper wiring can cause degradation of the performance or even fatal consequences like permanent damage of the unit.

Pinout for wiring +/-12V DC is found Table 5 and Figure 7. It is recommended to use LNF-CAB_PBA_PS3b for this purpose.

DC Power In Connector M8 – Pin Numbering	
Pin #	**Function**
1	+12 V
3	-12 V
4	GND
Shield	Earth

Table 5 Pin numbering for DC Power In Connector

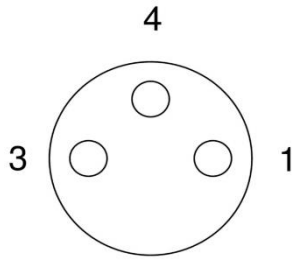

Figure 7 Pinout of M8 3p DC Power In Connector - seen from outside

Pinout for wiring cables compliant with M12 Connectors (Ch1 – Ch8) is found in Table 6Figure *8* and Figure 8. It is recommended to use LNF-CAB_PS3b_LNA cables for these purposes.

DC Bias Out Connector M12 – Pin numbering	
Pin #	**Function**
1	Vd
2	Vd_sense+
3	Vd_sense-
4	Vg
5	GND
Shield	Earth

Table 6 Pin numbering for DC Out (LNA DC Bias) M12 5p Connector

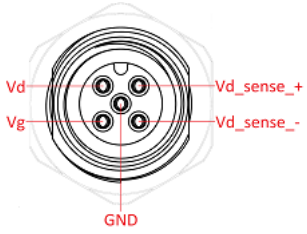

Figure 8 Pinout of M12 DC OUT Connector - seen from outside

Pinout for wiring cables compliant with d-sub connector is found in Table 7. It is recommended to use LNF- LNF-CAB_d-sub_LNA for these purposes.

As shown in Figure *3* lower d-sub connector is addressed to Ch1 - Ch4 and upper one to Ch5 - Ch8. The numbers in round brackets indicate channels in upper connector, e.g. pin 2 (Vg1(5)) on the upper connector is displayed as Vg5.

Pinout of d-sub DC Bias Out Connector			
Pin #	**Function**	**Pin #**	**Function**
1	GND	7	GND
14	Vd1(5)_sense_+	20	Vd3(7)_sense_+
2	Vg1(5)	8	Vg3(7)
15	Vd1(5)_sense_-	21	Vd3(7)_sense_-
3	Vd1(5)	9	Vd3(7)
16	GND	22	GND
4	GND	10	GND
17	Vd2(6)_sense_+	23	Vd4(8)_sense_+
5	Vg2(6)	11	Vg4(8)
18	Vd2(6)_sense_-	24	Vd4(8)_sense_-
6	Vd2(6)	12	Vd4(8)
19	GND	25	GND
		13	Not connected
		Shield	Earth

Table 7 Pin numbering for DC Out (LNA DC Bias) d-sub 25p Connectors

7. Connecting LNA to LNF-PS8

Each LNA needs to be connected to LNF-PS8 according to the schema shown in Table 8. Depending on which variant of LNF-PS8 is used you need to check in Table 6 (8x5p version) or Table 7 (d-sub version) for finding out the right pinning.

DC Bias Out M12 or d-sub 25p Connector		**Connected to**	**LNA**	
Pin #	**Function**		**Pin #**	**Function**
check in Table 6 or Table 7	Vd	-->	see data sheet for used LNA	Vd
Check in Table 6 or Table 7	Vd_sense+	-->*	see data sheet for used LNA	Vd
check in Table 6 or Table 7	Vd_sense-	-->*	see data sheet for used LNA	GND
check in Table 6 or Table 7	Vg	-->	see data sheet for used LNA	Vg
check in Table 6 or Table 7	GND	-->	see data sheet for used LNA	GND
*** optional** (In the general case, the Vd sense function is not needed, but if the wiring in the cryogenic cooler is made by using high resistance wires, the sense function could come in handy to compensate for voltage drop along the wires)				

Table 8 Connecting LNA to LNF-PS8

For circular connectors (see Table *6* and Figure 8) the cable LNF-CAB_PS3b_LNA is recommended and for the version with d-sub 25p connectors a standard shielded 25p d-sub cable is recommended. Cable LNF-CAB_PS3b_LNA has a 5 pin M12 connector in one end while the other end is blunt for the end-user to attach a suitable connector for their system. If the LNA to be powered by the LNF-PS8 is for room temperature operation, solder the 9-pin nano-D connector pigtail connector directly to the open end of this cable. For cryogenic LNAs, a connector compatible with the cryo cooler should be used. It is preferred to not connect the shield at the LNA end. A similar is strategy for connecting LNA(s) is recommended when d-sub connector is used.
Usually, the Vd sense function is not needed, but if the cryo cooler is equipped with high resistance wires, the sense function could come in handy. It is recommended to keep the actual Vds at the LNA terminals to +/-0.05 V of the nominal Vds.
We can consider the example when nominal Ids and Vds are 12 mA and 0.5 V respectively and the drain and ground wire resistance in the fridge are 10Ω each. We set Vds = 0.5 V and Ids=12 mA on the LNF-PS8. The actual Vds at the LNA terminals will be:

$$V_{dsLNA} = V_{ds\_supply} - R_{drain} \times I_{ds} - R_{gnd} \times I_{ds}$$
$$V_{dsLNA} = 0.5 - 10 \times 0.012 - 10 \times 0.012$$
$$V_{dsLNA} = 0.26\,V$$

Where:
V_{dsLNA}= the actual V_{ds} at the LNA terminals

V_{ds_supply}= V_{ds} supplied by the LNF-PS8
R_{drain}= Drain wire resistance
R_{gnd}= Ground wire resistance

In this example using the Vd sense function would ensure a properly biased LNA. Note that if the power supply is not run in floating configuration, the ground return current is likely to take a different path back to the power supply than through the 10Ω ground wire. The LNA's DC-ground is connected to its chassis and the chassis likely is connected to the ground of the fridge. In this case, the voltage drop is likely to be about half of what it is in the example above.

$$R_{max} = \frac{0.05}{I_{ds}}$$

The equation above can be used as a guideline of the maximum wire resistance Rmax (sum of drain and ground resistance) allowed without having to pay special attention to compensating for the voltage drop. In the example above, the maximum resistance is 4Ω. In floating mode, this means 2Ω in each of the drain and ground wires.
If it is decided to use Vd_sense feature, the Vd_sense+ wire should be connected to the drain pin of the LNA close to the nano-D connector. The Vd_sense- wire should be connected to the ground pin of the LNA, again, close to the nano-D connector.

8. Running LNF-PS8

After connecting the LNF-PS8 (see section 7) the instrument can be switched with the Main switch on the front panel (see Figure 4) – it shall lit indicating proper DC supply and that unit is on. The next step is to switch on the Display with the Display switch (see Figure 4) – the display starts up the boot up sequence with the splash screen and after a few seconds the default start screen shall appear as shown in Figure *9*:

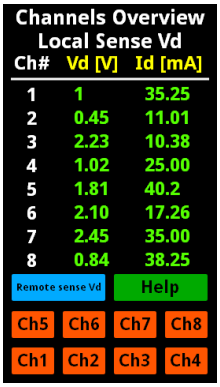

Figure 9 LNF-PS8 Default start screen – Vd sensed locally

The default start screen displays an overview of Vd's and Id's for all eight channels updated sequentially. (Note: the values show in Figure 9 are just fictive example). There is the text **Channel Overview Remote Sense Vd** at the top of the screen indicating that the measurement is done locally (inside the unit itself). At the bottom of the screen there are also two buttons, one blue: **Remote sense Vd** and dark green **Help**. By pressing **Remote sense Vd** the LNF-PS8 is reconfigured to sense Vd's on, or physically, as close as it is wired to the specific LNA. **Note**: This function is going to work **only** if the cable wiring is provided with Vd_sense+/- wires attached to the Vd and GND directly on the LNA (or close to it). The screen is also going to change to screen shown in Figure 10. (Note: the values show in Figure *10* are just fictive example).

Figure 10 LNF-PS8 Channel Overview screen – Vd sensed remotely

When the **Help** button is selected the following screen pops up – see Figure *11*.

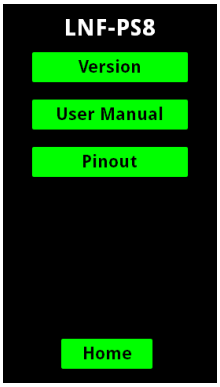

Figure 11 Help screen

Behind the **Version** button the software version information is found, **User Manual** gets the user to a brief, but, in most situation sufficient user manual and **Pinout** provides with the same pinout as that one presented in this paper. To go back to the start screen, choose the green button **Home** on the bottom of the screen.

At the bottom of the start screen Figure *9* (even Figure 10) there are four touch orange buttons **Ch1**, **..** , **Ch8**. They are used to select which DC Output Channel is to be observed in detail and shown on the screen (the white label at the top of the display is going to change to the label corresponding to the selected channel). To emphasize **which** channel **is selected** the pressed Ch? button lit **white**.

9. Graphical User Interface for Specific Channel

The touch screen display on the top of the LNF-PS8 is preprogramed to show actual values of Vd's, Id's and Vg's for specific DC Output Channel.

The default channel screen when, for example, Ch1 is selected is shown in Figure 12.

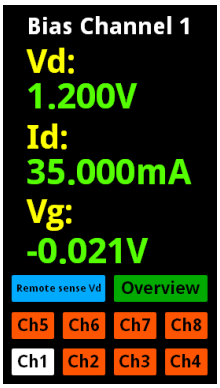

Figure 12 Channel screen

On the top of it there is a header telling which DC Output Channel is observed (in this case white label **Bias Channel 1**). Beneath it there are three yellow labels **Vd:**, **Id:**, **Vg:** and three light green numeric displays with corresponding units **V**, **mA** and **V**. At the bottom of the screen there are four touch orange buttons **Ch1**, **.. , Ch8**. They are used to select which DC Output Channel is to be observed and shown on the screen (the white label Bias Channel ? is going to change number to the number corresponding to the number of the selected channel). To emphasize **which** channel **is selected** the pressed Ch? button lit **white**.
There are also two buttons, one blue: **Remote sense Vd** and dark green **Overview**. By pressing **Remote sense Vd** the LNF-PS8 is reconfigured to sense Vd's on, or physically, as close as it is wired to the specific LNA. **Note**: This function is going to work **only** if the cable wiring is provided with Vd_sense+/- wires attached to the Vd and GND

directly on the LNA (or close to it). The screen is also going to change to screen shown in Figure 13. It is clearly visible that the yellow **Vd:** label has changed to **Vd_sense:** indicating that the LNF-PS8 is in the remote sense mode.

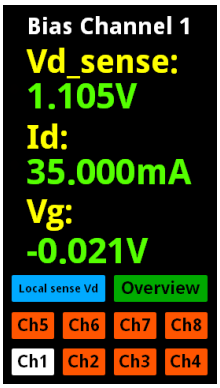

Figure 13 Screen when LNF-PS8 in remote sense mode

To get back to local (i.e., Vd sensed internally in the LNF-PS8 itself) measurement mode it is to press the blue button **Local sense of Vd**. The channel of interest is selected by choosing **Ch1, .. , Ch8** button at the bottom of the screen.

When the **Overview** button is selected, depending on in which mode local/remote the measurements are run the display will jump back to overview display local/remote as shown in Figure 9 and Figure 10.

10. Adjusting LNA Bias and Understanding Alarms

The trimmer potentiometers on the front panel are used to adjust Vd's and Id's. Each of them can be adjusted and observed individually by selecting DC Bias channel by pressing corresponding orange button on the touch screen.

The LNF-PS8 is intended to provide with the nominal values shown in Table 2, i.e. Vd up to 2.4V and Id up to 65mA. In reality it is capable to deliver Vd=~2.5V and Id=~70mA but they shall not be assumed as nominal. To be able to trim **Vd** to ~2.5V is done intentionally to provide with capability to compensate for voltage drop along wires when the LNA is used close to its recommendable max Vd (but still far enough from its absolute maximum) i.e. 2.4V. The colour of the numbers representing value of Vd and Id value are going to swap to **red** when you are trimming them over 2.4V and Id over 65mA. It is an **alarm** telling you that settled values are approaching the LNAs limits but it is still far enough from the absolute max values for LNAs. User shall try to avoid running LNA while any of Vd or Id is lit red.

The typical situation when Vd turns red can arise when you adjust Vd to 2.4V while observing it remotely, i.e. directly over the LNA and then press the blue button **Return to local measurements of Vd** and reconfigure LNF-PS8 to sense Vd internally in the LNF-PS8 itself. The locally sensed Vd is always somewhat higher than that on the LNA and that difference can cause that Vd locally can be higher than 2.4V and turn red.

Using the Instrument

To power up this instrument you need preferably LNF-PBA-HP or the LNF-PBA or some other PSU which can provide with volatges and current values shown in Table 1.
Once the wiring is done according to sections 7 and 8 , the instrument can be taken into operation.
Do not forget to withtake all necessary ESD precaussions.

FIRST TIME POWER UP

1. Connect the LNF-PS8 to the LNF-PBA-HP- use the included cable LNF-CAB_PBA_PS3b.
2. Ensure the LNF-PBA-HP (or the LNF-PBA) is in non-floating mode by installing the jumper plug between earth and common.
3. Switch on the LNF-PBA-HP (or the LNF-PBA).
4. Switch on the LNF-PS8 by using the Main switch – it shall lit.
5. If not yet, switch on the Display switch.
6. Select the DC Bias channel by pressing corresponding button at the bottom of the touch screen panel.
7. Set Vds to nominal value of the LNA using corresponding trimmer potentiometer (Vd's) on the front panel of the LNF-PS8.
8. Repeat step 5 and 6 for each used DC Bias channel.
9. Switch off LNF-PS8 – use the Main switch.
10. Connect the LNF-PS8 to the LNA(s).
11. Switch on the LNF-PS8 – use the Main switch.
12. If floating mode is desired, remove the jumper plug from the LNF-PBA-HP (or the LNF-PBA).
13. Adjust Ids to nominal value of each LNA by selecting propper DC Bias Channel and using corresponding trimmer potentiometer (Id's) on the front panel.
14. If the Vdsense function is used, press **Remote sense Vd button** – the blue one. The display will now show the actual Vds over the LNA and you can readjust it to compensate for voltage drop in the wires.

POWER DOWN

1. Ensure the jumper plug is installed on the LNF-PBA-HP (or the LNF-PBA).
2. Switch off the LNF-PS8 using the Main switch.
3. Switch off the LNF-PBA-HP (or the LNF-PBA) using the its main switch on its raar panel.

SECOND TIME POWER UP

This procedure assumes everything is connected and voltages and currents set to nominal value of the LNA.

1. Ensure the jumper plug is installed on the LNF-PBA-HP (or the LNF-PBA).
2. Switch on the LNF-PBA-HP (or the LNF-PBA) using the main power switch on its rear panel.
3. Switch on the LNF-PS using the Main switch.
4. If not yet, turn on the display using the Display switch.
5. Remove the jumper plug from the LNF-PBA-HP (LNF-PBA) if floating mode is desired.