

"User Manual"



Headquarter:	Local distributor:
Corpa Rios Engineering Dorfstrasse 27A	
CH-9472 Grabs / SG Switzerland	



ORGANIZATION OF THIS MANUAL

This manual explains how to use the LFLNA-80 and is organized as follows:

1. DESCRIPTION AND SPECIFICATION

This chapter describes the LFLNA-80 and its electrical and mechanical specifications

2. OPERATION OF THE INSTRUMENT

This chapter describes preparation before use, basic operations and applied operations.

3. THEORY OF OPERATION

This chapter describes the exact function of the LFLNA-80 on schematic level

4. CERTIFICATION AND TESTING

This chapter describes how to test the LFLNA-80

5. PARTS LIST

This chapter contains the parts list of the LFLNA-80

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This document can be used for the following hardware:

Low Frequency Low Noise Amplifier 80dB	LFLNA-80	0001-0-0-00000001-00-00



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LIMITED WARRANTY

EULER PRECISION (E.P.) warrants to the original purchaser that each instrument manufactured by it will be free from defects in material and workmanship. This warranty is limited to the maintenance, repair and/or replacement of any instrument or part thereof returned to the E.P. factory for such purpose and, in addition, to the repair or replacement of all materials, except tubes, fuses, transistors and other semiconductor components, returned to the E.P. factory within ONE YEAR after shipment to the original purchaser and found to be defective upon inspection.

E.P. instruments may not be returned to the factory under the terms of this warranty without the prior authorization of the E.P. Service Department. All instruments returned to E.P. for service hereunder should be carefully packed and shipped. All transportation charges shall be paid by the purchaser.

E.P. reserves the right to discontinue instruments without notice and to make changes to any instrument at any time without incurring any obligation to so modify instruments previously sold.

This warranty is expressly in lieu of all other obligations or liabilities on the part of E.P. No other person or persons is authorized to assume in the behalf of E.P. any liability in the connection with the sale of its instruments.

<u>CAUTION:</u> The instrument you have purchased is a precision instrument manufactured under exacting standards. Any attempts to repair, modify or otherwise tamper with the instrument by anyone other than an E.P. employee or authorized representative may result in this warranty becoming void.



FACTORY SERVICE REQUEST AND AUTHORIZATION

WARRANTY SERVICE

Instruments may be returned only on prior authorization. Please obtain a RETURN AUTHORIZATION NUMBER either directly from the factory or from an authorized E.P. Representative. (See General Information below.)

CHARGEABLE REPAIRS

If requested, an estimate of charges will be submitted prior to repairs. We suggest that you request a RETURN AUTHORIZATION NUMBER to facilitate handling.

GENERAL INFORMATION

Please provide the following information in order to expedite the repair:

- 1. Indicate MODEL
- 2. Serial Number
- 3. Complete description of the trouble:

Symptoms, measurements taken, equipment used, lash-up procedures, attempted repairs, suspected location of failure and any other pertinent information.

- 4. Freight Charges must be PREPAID.
- 5. The RETURN AUTHORIZATION NUMBER should be noted on your documentation.
- 6. See Packing Suggestions (next page).



PACKING SUGGESTION

Although your E.P. instrument is built for laboratory, production environment and some field environment, it is NOT ruggedized. Therefore

- 1. Be sure the carton is STRONG enough to carry the weight of the instrument, e.g. use double wall corrugation.
- 2. Be sure the carton is LARGE enough to allow for sufficient packing material, e.g., at least 2 inches all around the instrument. The packing material should be able to be compressed and then return to its approximate original volume.
- 3. For better handling, the shipment should always be by AIR FREIGHT (expect for short distances). You might use either UPS "blue label" or common air freight carrier, second day air.

Please do not bounce it across the country in a truck. It may not hurt it, but it certainly is not going to do a laboratory instrument much good.

4. QUESTIONS? Just contact us. We will be pleased to help you.



1 DESCRIPTION AND SPECIFICATION

1.1 General Description

The LFLNA-80 is a low-noise preamplifier with a gain factor of 80dB (x10'000) and a band pass filter from 0.1Hz to 10Hz (-3dB).

The circuitry is completely solid state made of discrete and integrated circuits packaged on etched glass circuit boards (FR4). These are proven circuits, using derated components to insure long life and maximum reliability.

The instrument is a highly accurate amplifier which can be used for measuring of voltage references, semiconductor analyzing systems, analog systems, analog-to-digital converters noise, telemetry and data acquisition systems, and wherever an accurate high gain amplifier is required.

The instrument is overload and short-circuit proof, and is fully operational in normal environmental conditions.

The amplifier output will drive a short circuit indefinitely without damage to the instrument, and will recover to rated specifications after removing the short.

There are no adjustments made during normal operation.

The instrument is powered by a rechargeable battery. The running time of the instrument is approx. 100 hours.

The instrument can be charged by a simple 5V power supply, which must supply min. 800mA, within 5-6 hours.



1.2 Features and Applications

1.2.1 Features

1.2.1.1 Very Low Noise High Gain Amplifier

A low noise amplifier (LNA) amplifies a very low-power signal without significantly degrading its signal-tonoise ratio. When regular amplifiers amplify signals, additional noise is often introduced to the system. However, by using an electronic LNA, this additional noise can be significantly reduced.



The LFLNA-80 (DUT) input noise is = 119uVrms / 10'000 = 11.9nVrms



1.2.1.2 High Gain and Band Pass Amplifier

The LFLNA-80 is made by three stages.

- 1. The input stage: to reject any DC components.
- 2. The +80dB gain stage: to made the amplification of the input signal and
- 3. the band pass stage: with a frequency bandwidth from 0.1 Hz to 10 Hz (-3dB).

Typical frequency response:





IVIKI	пасе	A-AXIS	value	Notes
1 🗸	Gain	3.0000 Hz	79.91790651 dB	Gain@3Hz
2 🛛	Gain	107.2600 mHz	76.93357055 dB	-3dB
з 🗸	Gain	9.7757 Hz	76.90061427 dB	-3dB



1.2.1.3 Input Protection

The input of the amplifier is protected by a DC servo system against leakage currents caused by a high input voltage and the leakage of the input capacitor.

In addition, an ESD protection is attached to the amplifier input. This prevents with the internal clamping diodes a destruction of the operational amplifier inputs.

1.2.1.4 Output Protection

The output of the LFLNA-80 is protected by a serial 18k resistor. Additionally there are ESD protection elements and in charge mode a reverse polarity protection with MosFet, PTC and TVS diode.

1.2.2 Applications



1.2.2.1 "EDC MODEL 522 VOLTAGE CALIBRATOR" noise@10V



The EDC Model 522 output noise is = 2.851mVrms / 10'000 = 285.1nVrms - 11.9nVrms = 273.2nVrms



1.2.2.2 "FLUKE 332D VOLTAGE CALIBRATOR" noise@10V



The FLUKE 332D output noise is = 14.085mVrms / 10'000 = 1.4085uVrms - 11.9nVrms = 1.3966uVrms



1.2.2.3 "HP3245A Universal Source" noise @10V



The HP3245A output noise is = 18.423mVrms / 10'000 = 1.8423uVrms - 11.9nVrms = 1.8304uVrms



1.2.2.4 "FLUKE 731B DC REFERENCE STANDARD" noise @10V



The HP3245A output noise is = 2.35mVrms / 10'000 = 235nVrms - 11.9nVrms = 223.1nVrms



1.3 Specifications

1.3.1 Input Specifications

Description	Min.	Тур.	Max.	Unit
Input Impedance	0.990k	1k	1.010k	Ω
Input Capacitor		1000		uF
DC Input Voltage	-20		+20	V
Noise spectral		3.97		nV/√Hz
density				
RMS Noise		12.5		nVrms

1.3.2 Output Specifications

Description	Min.	Тур.	Max.	Unit
Dynamic Range	-78.1		+3	dBV
Output Impedance		1k//18k		Ω
Frequency Range	0.1		10	Hz (-3dB)
Noise Floor ¹		125u		Vrms (0.1Hz to 10Hz)
Output Level	-2		+2	Vp
Gain (log)		79.9572		dB@3Hz
Gain (lin)		9950.84		x1@3Hz
Phase		-43.245		°@3Hz
Settling time for 10V			120	s
input step change				

1) With flattop window and 50Ω termination resistor

1.3.3 General Specifications

Description	Min.	Typ.	Max.	Unit
Lithium Battery	2.8	3.8	4.2	V
Charging Current		600		mA
Charging Voltage ²	5	5	7	V
Power ON time ³		250		h
Ambient Temperature	0	23	55	°C
Relative Humidity			95	% at 40°C
Altitude			4570	m

2) External applied voltage on the amplifier output at charging mode for charging the internal battery3) Amplifier power ON time after a full charge (orange LED off)

1.3.4 Mechanical Specifications

Description	Min.	Тур.	Max.	Unit
Size H		35.5		mm
Size W		63.3		mm
Size D		160		mm
Weight		280		g

1.4 General Information

Mounting: For bench use only

Certification: A Certificate is issued with each new instrument **Warranty**: Full ONE YEAR warranty on parts.



2 OPERATION OF THE INSTRUMENT

2.1 Front Panel Controls, Indicators And Connectors



No.	Function
1	Charging LED This LED lights up during the charging process. When the battery is fully charged, the LED goes off.
2	Power ON indicator When the LFLNA-80 amplifier is switched on, this LED lights up.
3	BNC amplifier output
4	Power ON-OFF switch

2.2 Rear Panel Connectors



No.	Function
1	BNC amplifier input



2.2.1 Charging the LFLNA-80

To charge the LFLNA-80, it must be connected with the output (BNC) to a 5V supply. This "charger" must be able to supply at least 800mA at 5V.

The LFLNA-80 must be in the "Power-OFF" state, otherwise no charging of the unit is possible.

Here you can see the LFLNA-80 connected to a power supply and being charged.



This is signaled by a yellow LED on the front panel.



The charging process is finished when this LED goes out.



2.2.2 Connecting the DUT to the LFLNA-80

2.2.2.1 Typical application for measuring the noise.



The connection to the DUT is made via a 50Ω BNC connector. The shorter this connection is, the better the measurement result.



3 THEORY OF OPERATION

3.1 Introduction

A low-noise amplifier (LNA) is an electronic amplifier that amplifies a very low-power signal without significantly degrading its signal-to-noise ratio. An amplifier will increase the power of both the signal and the noise present at its input, but the amplifier will also introduce some additional noise. LNAs are designed to minimize that additional noise.

Our LNA has a gain of 80dB (10'00) and a bandwidth of 0.1Hz to 10Hz.

In addition, special circuit techniques have been used to:

- 1. Minimize the noise of the amplifier
- 2. Eliminate the leakage current of the input capacitor.

The entire amplifier circuitry has been designed using SMD technology to minimize the distances between components and thus minimize interference from external noise sources.

3.1.1 Input Amplifier (Schematic)



The input amplifier is made by 5 very low noise operational amplifiers mounted in parallel. Each of the amplifiers has a gain of 80dB, which is set by 0.1% resistors.



3.1.2 Output Amplifier / Filtering (Schematic)



The output amplifier (filter) was realized by a 4-pole low-pass filter.



The filter curve up to the frequency of 0.1Hz is determined by the DC servo part and the input capacitor.

3.1.3 Internal Power Supply (Schematic)



Since we have no +/- voltage available in our circuit, we simply set the GND potential to half the battery voltage and thus obtain a +/-1.6V supply voltage.



3.1.4 Battery Charging (Schematic)

E	Battery Protection Opens when Vbat < 3.08 V		Lithium-ion charging			
© Q401	Q402 0 S13483DDV 0 BAT A BO		Charging cut-off: 4.20 V	CHG_FET	Q403 00 S13483DDV 01	
		CHG_OUT C401 10u	2 prog	R401 CHG_LEDA IK	C402 ~~	D401
-vcc	2 VDD JIK C403 RST 2 100n	-VCC	LEMP GND	CHG_LEDK	-vcc -vcc	-vcc
	MAX810T-3.08V	IK	-VCC			

The TC4056A is a complete lithium-ion battery with a linear constant current/constant voltage charger. As a result of the internal PMOSFET architecture coupled with anti-down charging circuitry, no external blocking diode is required. In addition, thermal feedback is incorporated to automatically adjust the charge current and limit the chip temperature at high power or high ambient temperatures.

The charging voltage is fixed at 4.2 V. The charging current can be adjusted via an external resistor. If the charging current drops to 1/10 after reaching the float voltage the charging cycle is automatically terminated.



4 CERTIFICATION AND TESTING

4.1 Recommended Equipment

- HP 3562A Dynamic Signal Analyzer
- 50Ω Input Termination Resistor
- High Quality BNC Cables
- 80dB Precision Attenuator (DC to 1kHz)

4.2 Calibration Procedure

4.2.1 Noise test

4.2.1.1 LFLNA-80 connection for noise test



4.2.1.2 HP3562A settings for noise test:

Log Resolution					
MEASURE:	CHAN 1 Power Spec		CHAN 2 Power Spec		
AVERAGE:	TYPE Stable	# AVGS 4	OVERLAP 0%	OVFL REJ Off	
FREQ:	START 100mHz	STOP 100 Hz	SPAN 3 Dec	RESOLUTION 240 Pts	
	REC LGTH 13.3 Min				
INPUT: CH 1 CH 2	RANGE AutoRng AutoRng	ENG UNITS 1.0 V/EU 1.0 V/EU	COUPLING DC (Gnd) DC (Flt)		
SOURCE:	TYPE Rndm Nois	e	LEVEL 0.0 Vpk	OFFSET 0.0 Vpk	

Noise test setup



4.2.2 Frequency / Gain Test

4.2.2.1 LFLNA-80 connection for frequency / gain test

Gain test setup



4.2.2.2 HP3562A settings for frequency / gain test

Swept Sine					
AVERAGE:	INTGRT TIME 50.0ms		# A∨GS 1		
FREQ: Start Stop	10.014 mHz 100 Hz		SPAN Resltn	4.0 Dec 50.0 Pt/Dc	
SWEEP:	TYPE Log	DIR Up	EST TIME 1.52 Min	EST RATE 22.8 S/Dc	
AU GAIN:	Off				
INPUT: CH 1 CH 2	RANGE AutoRng↑ AutoRng↑	ENG UNITS 1.0 V/EU 1.0 V/EU	COUPLING DC (F1t) DC (F1t)		
SOURCE:	TYPE Off		LEVEL 300mVrms	OFFSET 0.0 Vpk	



5 PARTS LIST

5.1 Replacement Parts for Model LFLNA-80





No.	Part-No.	Description
1		Hammond 1457C1201 milled watertight extruded aluminum enclosure 1.22x2.32x4.72
2		LFLNA-80 populated PCB (0001-P-0-00000001-00-00)
3		Battery Panasonic NCR18650B