APPLICATION NOTE

About this Document

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This document describes how to connect commercially available current sensors to HEAD*lab* modules labSG6 and labVF6-Iso II.

Target Group

The following text is intended for (potential) users of the HEADlab data acquisition system who would also like to record electrical currents, for example on electrodynamic shakers.

Questions?

Do you have questions? We look forward to your feedback!

Questions regarding the content of this document: SVP-Support@head-acoustics.com

Measuring Current Using HEAD*lab*

1. General Information

Measurement data acquisition with electronic measurement devices is usually performed using a transducer or sensor that converts a physical quantity into a voltage. For this purpose, the input of the measurement device is designed as a voltage input, followed by an analog-to-digital converter.

Figure 1: Inductive current sensors or current sense amplifiers can be used for measuring current using HEADlab modules, such as labVF6-Iso II and labSG6.

Accordingly, a current sensor outputs an electrical voltage proportional to the electrical current. The limitations of the overall system are not only dependent on the measurement frontend, but also on the properties of the current sensor. The corresponding data sheet of the sensor is to be considered accordingly.

If the current is not measured using a current sensor but directly via the voltage drop across a shunt resistor of known value, the analog part of the measurement device is at risk due to possible potential differences. For this reason, HEAD acoustics recommends using current sensors rather than shunt resistors that are not electrically isolated from the measurement frontend.

This document lists safe options for measuring current using commercially available current sensors. The examples shown can be applied to sensors with a similar design.

The following HEAD*lab* input modules are suitable:

labVF6-Iso II: measurement range up to 30 V, electric strength ±40 V, sampling rate up to 204.8 kHz, galvanically isolated inputs.

labSG6: measurement range up to ±10 V, electric strength ±35 V, sampling rate up to 48 kHz, electrically isolated inputs, built-in sensor power supply.

Detailed technical specifications for the input modules can be found in the corresponding data sheets.

2. Split-Core Current Sensors

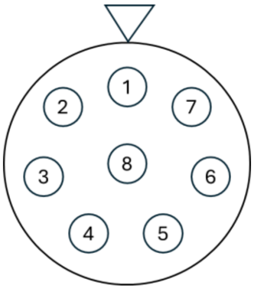
This type of inductive current sensor consists of a separable ferrite ring that is placed around the conductor through which the current to be measured flows. This allows the sensor to be applied without interrupting the circuit.

The ferrite core contains a sensor for the magnetic flux, whose signal is converted by integrated evaluation electronics and provided to the measurement device as a voltage signal. By measuring the magnetic flux, sensors of this type are capable of detecting currents with a direct component (DC). They are limited in bandwidth by the inductance of the core. The usual cut-off frequencies are 10 kHz. This information can be found in the data sheet of the sensor. The connection of a Pewatron SWL-500DC current sensor is shown below as an example.

Split Core with labSG6

The analog *lab*SG6 module provides electrically isolated inputs and can supply a bridge excitation voltage of up to ±12 V with a maximum current of 20 mA. (A maximum current of 28.6 mA is permitted up to ±7 Vand 43.8 mA up to ±2.5 V. For details, please refer to the *lab*SG6 data sheet.) This allows the sensor electronics to be powered directly from the module. (The Pewatron sensor requires about 7 mA.)

The positive supply voltage ($+V_{bridge}$) is connected to pin 1 of the 8-pin LEMO connector, the negative supply voltage ($–V_{bridge}$) to pin 6. The signal output is connected to pin 3 (In+). The signal ground for this sensor (on shield) → Pin 4 (In–)

 Pin (solder side view)	Color	Signal
1	Red	$+V_{bridge}$
3	White	In+
4	Shield	In-
6	Black	$-V_{bridge}$

Split-Core with labVF6-Iso II

As *lab*VF6-Iso II does not provide bridge excitation, the sensor must be supplied via an external power source. In the case of the Pewatron sensor, a symmetrical ±12 V supply is required that can be provided by a Meanwell GP25A power supply, for example.

In the example shown, a junction box is used to split the sensor cable into a signal cable with BNC connector and a supply cable with 5-pin DIN connector.

Figure 2: The external supply of the sensor requires a Y-cable when used with labVF6-Iso II

3. Current Sense Amplifier INA240

With INA240, Texas Instruments offers a high-precision, integrated current sense amplifier that is available with an evaluation board (INA240EVM). Different measurement ranges can be realized depending on the dimensioning of the shunt resistor used.

Figure 3: INA240 Evaluation Board with LEMO plug

First, the expected voltage drop V_{DIFF} across the shunt must be determined from the desired output voltage V_{OUT} at full scale and the gain. The gain depends on the INA240 version:

Variant	Gain
INA240A1	20 V/V
INA240A2	50 V/V
INA240A3	100 V/V
INA240A4	200 V/V

$$V_{DIFF} = \frac{V_{OUT}}{Gain}$$

Then, R_{SENSE} is calculated from the quotient of the differential voltage V_{DIFF} and the maximum current I_{MAX}.

$$R_{Sense} = \frac{V_{DIFF}}{I_{MAX}}$$

The maximum power dissipation in the shunt is:

$$P_{R_{SENSE}} = R_{SENSE} \; x \; {I_{MAX}}^2$$

Example: If the voltage at the output of the evaluation board is to be 5 V at maximum level and when using an INA240A3, the voltage drop at the shunt must be 50 mV. If this is to be the case with a current of 5 A, a shunt resistor of 10 mΩ is selected.

The sensitivity of the sensor will then be 1 V/A. At 5 A, a thermal power of 0.25 W is dissipated at the shunt. The load capacity of the resistor must be at least this high.

For more information, please refer to the INA240 data sheet.

4. Sensor Setup and Verification

In order for the voltage measured at the input of the measurement frontend to be assigned to a corresponding current, the sensitivity of the sensor must be stored in the Recorder of ArtemiS SUITE. To do so, the sensor is created in ArtemiS SUITE and added to the sensor list. The procedure depends on the version of ArtemiS SUITE used and is described in detail on the help pages of the software.

For verification purposes, a reference current can be generated by applying a known voltage across a (power) resistor of known value. The calculated current I = U/R should correspond to the measured current.