MB2005
USER MANUAL

14643-C NOVEMBER 2006

Indice ***Rev.***	**Date** ***Date***	**Pages modifiées** ***Modified pages***	**Commentaires** ***Comments***
First edition-A	October 2005	Toutes / All	Création / First draft
B	January 2006	p6/p7/p8/p10/p11 p12 P9 P15 P14/15/15 P5	details MB2005 Noise Figure Consumption< 300mA Process of LVDT Adjustment Calibration Description Update of list of calibration and adjustment tools
C	November 2006	P7	Supply Voltage

NdP104-1 Ed 05

VISA / ***In charge of***	**NOM /** ***NAME***	**SIGNATURE**	**DATE**
Chef de Projet ***Project Manager***			
Responsable AQ ***QA Manager***			
Responsable Technique ***Technical Manager***			

1. TABLE OF CONTENTS

2. LIST OF ILLUSTRATIONS

FIGURES

Page

3. LIST OF CALIBRATION AND ADJUSTMENT TOOLS

LIST OF CALIBRATION AND ADJUSTMENT TOOLS

DESCRIPTION	SUPPLIER COMPANY - ADDRESS	FUNCTION
Low pressure calibrator: Pressure Manometer and equipment Air manual pump Vacuum manual pump	MARTEC	§ 6. 2.3
Barometer	MARTEC	§ 6. 2.2 § 6. 2.4
Calibrator	MARTEC	

4. INTRODUCTION

The microbarometer MB2005 was developed in order to detect an air nuclear explosion. The sensitive part is set up with an aneroid barometric bellow which warps under atmospheric pressure change; a LVDT sensor measures this deformation. This one is performant and easy to implement. The electronic noise level is 2 mPa rms, between 1 and 10 Hz.

The filtered output passband is between 0.01 Hz and 27 Hz. It can be modified. A passband of 0.001 Hz to 40 Hz has already been used by the Laboratoire de Géophysique (LDG).

The running control can be ensured by the atmospheric pressure measurement.

Digitization units, developed by LDG, are perfectly designed to use those sensors.

5. GENERAL DESCRIPTION

5.1. GENERAL (Figure 3-1)

The sensitive part is an aneroid barometric bellows (10) made of Durinval. The LVDT (Linear Variable Differential Transformer) displacement sensor (9), joined to a low noise electronics, measures the deformation of the barometric aneroid under atmospheric pressure change. The barometric aneroid displacement sensor unit of each microbarometer is temperature-calibrated to minimise its effects.

5.2. DESCRIPTION (Figure 3-1)

The microbarometer is presented as a cylinder of 15 cm diameter and 32 cm high. Its weight is 7 kg.

A 4-pin plug (5) is used to supply the sensor in 12 Volts. The signals are available on a second 7-pin plug (4).

Pin assignement of plugs

Power supply plug(5)	Signal	Comment	
Pin 1 Pin 2 internally connected	0 V		
Pin 3 Pin 4 internally connected	+12 V	Min 11.2V Max 13V	Serial Number NV5xxx Product 09415E
		Min 10V Max 16V	Serial Number after NV6xxx Product 09415F and more

Signal output plug(4)	Signal	Comment
Pin 1	Filtered OUT-	20mV/Pa
Pin 2	Filtered OUT+	
Pin 3	PA-	1mV/hPa
Pin 4	PA+	
Pin 5	PT9-	100mV/hPa
Pin 6	PT9+	
Pin 7	GND	

The low part constitutes the measurement chamber (7), it consists of the barometric aneroid (10) and the LVDT displacement sensor (9). The chamber is connected to the atmospheric pressure by four nozzles (6). Each nozzle can receive a microporous hose or other to perform an infrasound filtering network in order to minimise pressure changes due to wind effects and reduce microbarometer background noise.

The high part is watertight and receives two electronic boards:

- A power supply board (2).
- A measurement board (3).

5.3. SPECIFICATIONS

5.3.1 Microbarometric aneroid characteristics

Provided by LDG, it is made of a metal which does not vary significantly with temperature change.
It is designed to operate between 400 and 1200 hPa.
Means mechanical sensitivity: – 35 nm/Pa.
Acceleration sensitivity: vertical axis: $\simeq$ 1.5 µm/(m/s^2).

5.3.2 Characteristics of the LVDT differential transformer displacement sensor

Provided by LDG.

5.3.3 Characteristics of the measurement electronic board

- Quartz oscillator ultra stable in frequency and voltage.
- LVDT primary excitation frequency: 8 kHz.
- LVDT excitation level: 15.6 V peak to peak (symetrical excitation).

5.3.4 Characteristics of the microbarometer (Figure 2-1)

The sensor is designed to operate at ± 100 hPa of the atmospheric pressure, (standard 1000 hPa ± 100 hPa).
Sensitivity before filtering (DC-40 Hz band in PT9) is generally of – 1 mV/Pa, i.e. ± 10 Volts for ± 100 hPa.
Sensitivity after filtering (0.01 - 27 Hz band) is of 20 mV/Pa i.e. ± 10 Volts for ± 5 hPa.
This is the best sensitivity for 20 and 24 bits ADC use.
For 16 bits ADC, we can adjust the sentivity to 100 mV/Pa.
Typical electronic noise in the 0.01-10 Hz band is represented in figure 2.1.

5.3.5 Environment

Temperature:
Sensors are temperature-calibrated and -compensated in order to reduce their thermal sensitivity. The thermal drift after compensation is less than ± 0.1 hPa/°C.
The temperature range is - 20 to + 60°C (-4 to 140°F)

MB2005 is protected for operation in damp and dusty atmosphere IP 68

MB2005 Complies with the following EMC standards:
EN61326-1/ EN 55022/ EN61000-4-3/ EN61000-4-6/ EN61000-4-2/ EN61000-4-8

5.3.6 Power Supply

Terminal voltage: 12 Volts
Consumption < 300mA.
There is no connection between power supply input and output signals.

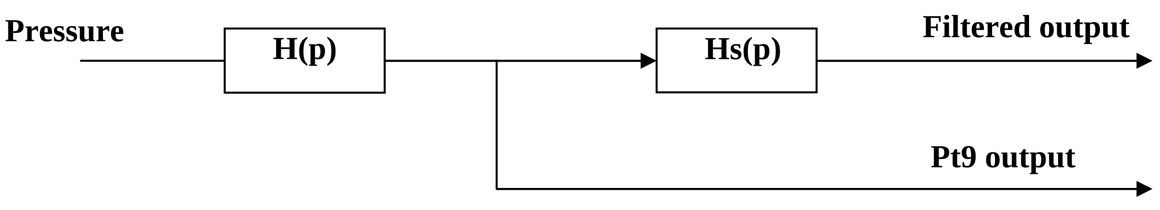
Recommended Voltage Range: 11,2V to 13V

5.4. OPERATION PRINCIPLE (Figure 2-2)

An analog oscillator set at 8 kHz is carried out from a quartz and voltage reference oscillator. The voltage hence obtained (TP3-TP4) supplies the LVDT displacement sensor primary. The voltage obtained at secondary is demodulated with analog gates controlled by a signal delivered by the 8 kHz delayed oscillator (PT5). The demodulated signal is then filtered (Low-Pass (LP) 40 Hz filter).

The sensitivity in PT9 is of – 1 mV/Pa (see § 6.3 Adjustment). Before amplification, the DC coupled signal is filtered with a 0.01 Hz high-pass filter. A second output AP measures the Atmospheric Pressure (AP) value and allows the running control of the unit.

5.5. MB2005 TRANSFERT FUNCTION



5.5.1. PT9 output

With p=jω

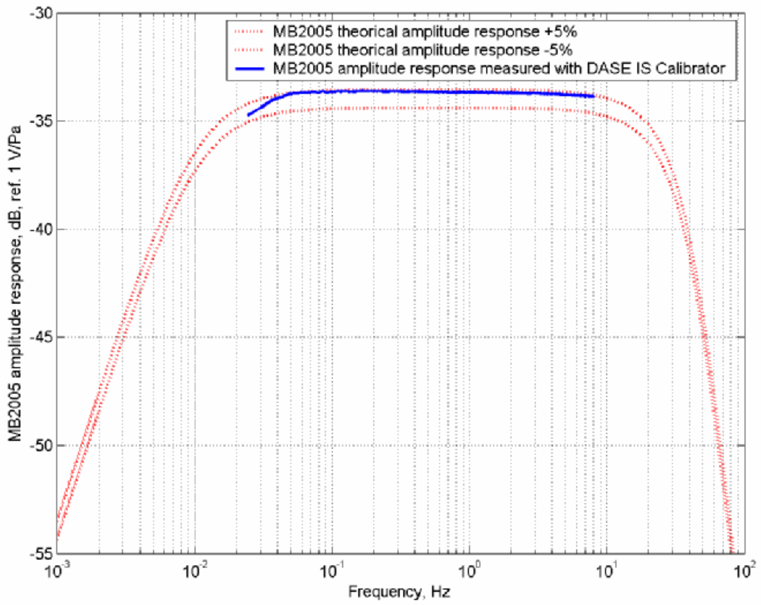
$$H(p) = \frac{b1 * p + b0}{a6 * p^6 + a5 * p^5 + a4 * p^4 + a3 * p^3 + a2 * p^2 + a1 * p + 1}$$

b1=2.133 E-9
b0=1 E-3a6=1.89 E-17

a6=1.89 E-17
a5=7.03 E-15
a4=3.757 E-11
a3=1.321 E-8
a2=1.823 E-5
a1=5.645 E-3

$$Hs(p) = \frac{318.31 * p}{0.077 * p^2 + 15.92 * p + 1}$$

5.5.2. Amplitude response



Electronic noise (band 0.01 - 10 Hz).

Sensitivity : 20 mV/Pa.

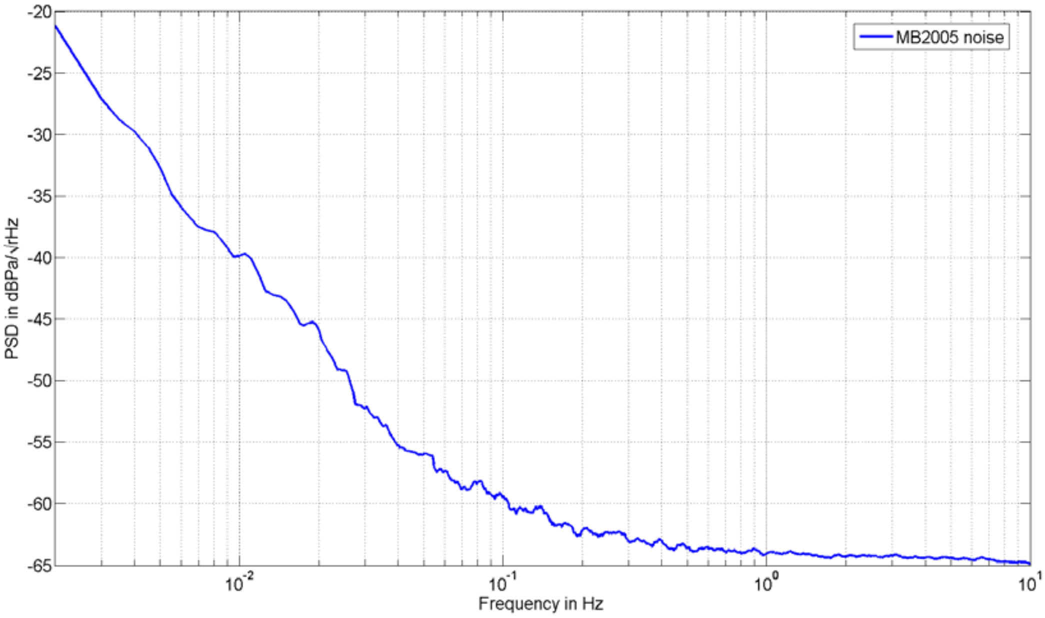


FIGURE 2-1 Electronic noise

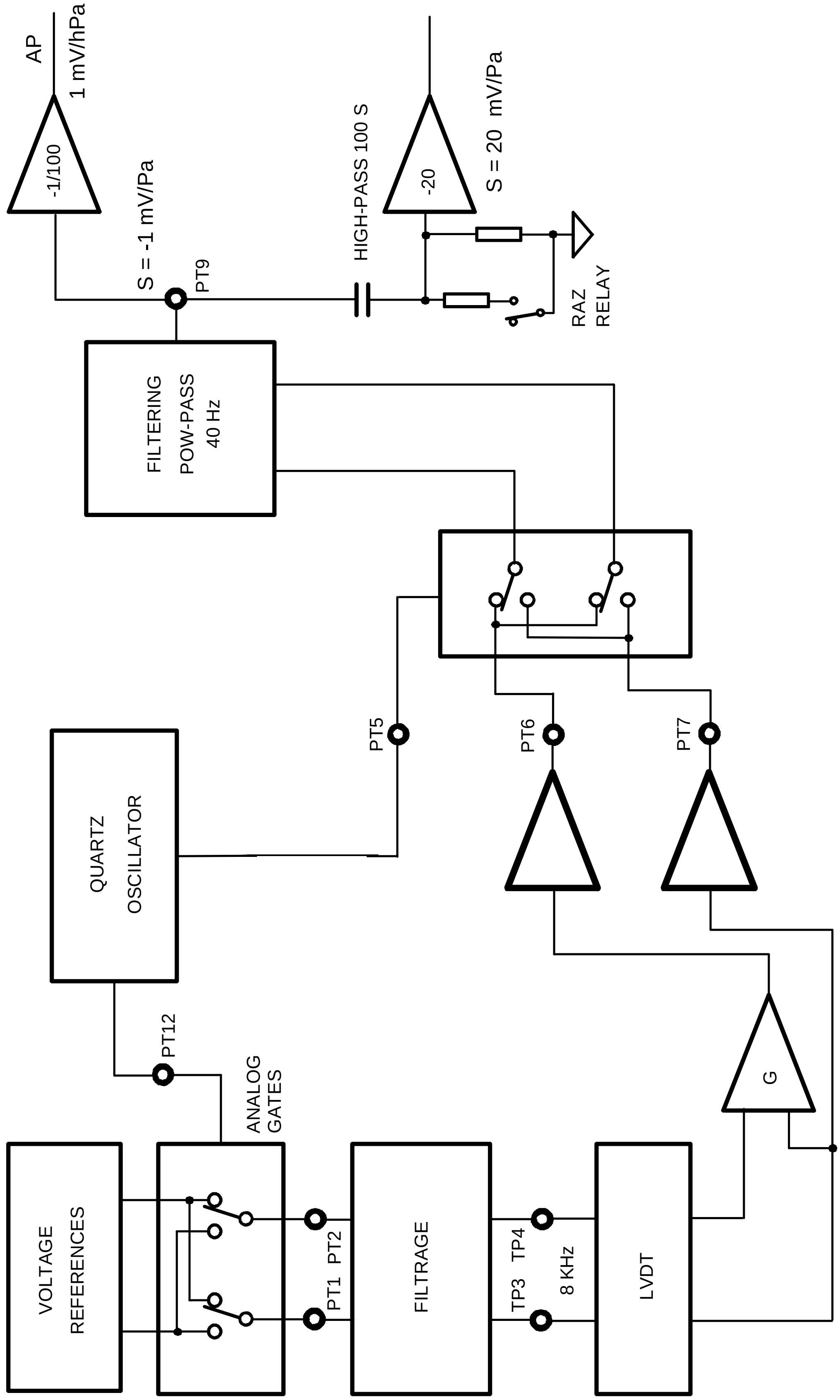


FIGURE 2-2: Synoptic-operation principle

6. OPERATION

6.1. CONNECTIONS (Figures 3-1, 3-2 and 3-3)

The sensor is supplied with + 12 volts by a 4-pins male Jupiter plug (5).

The filtered signal and the atmospheric pressure are connected to the 7-pins female Jupiter plug (4).

The wiring is presented in figures 3-2 with the digitizer unit used at LDG (AUBRAC). In this case, the signal cable is RSN53 and the supply cable is RSN29.

6.2. FILTERED OUTPUT (Figures 3-3 and figure 3-4)

The characteristics of the standard filtered output are summarised in the table figure 3-4. The characteristics of this output are compared with the Expert Group proposals. It's a symmetrical output.

6.2.1. Passeband (figure 3-4)

The standard passband is set at 0.01-27 Hz.

It is possible to modify the cut frequency of the high-pass. You need to contact MARTEC for this operation.

6.2.2. Sensitivity

The standard sensitivity is of 20 mV/Pa.

It is possible to change the sensitivity. You need to contact MARTEC for this operation.

6.3. ADJUSTMENT

6.3.1. Introduction

In factory:
The LVDT adjustment, the sensitivity adjustment of PT9 filtered and the PA output adjustment are performed in factory.
At first LVDT adjustment permits, by a mechanical adjustment of LVDT, to centred the PT9 filtered excursion of measurement around the local pressure average.
At second, the sensitivity of the atmospheric pressure dynamic range is set to +/-100hPa by a potentiometer adjustment.
At third, the Pa output offset for measurement of static output pressure is adjusted to pressure on site, by a potentiometer (1mV/hPa).

On site:
The atmospheric pressure is dependant on altitude. The change is about 100hPa for 1000 meters. So, the LVDT mechanical centring has to be done on site, in order to keep the pressure dynamic range well centred on the site atmospheric pressure average.
The adjustment of sensitivity is not necessary.
The Pa output adjustment has to be done in case of using this output.

6.3.2. LVDT adjustment

Tools used in order to adjust LVDT are multimeter and Allen key.
Operation is the following one:
Calculate U3 :
U3 (V) = – [AP (hPa) – APA(hPa)] x 0.1.
AP: Atmospheric pressure
APA: Atmospheric pressure average (Aproximative value)
Example: if AP = 890 hPa, U3 = – (890 – 870) x 0.1 = – 2 V.

Connect a voltmeter (on PT9 output) between pins 5 and 6 of the 7 points Jupiter output connector.
Unscrew the 3 screws.
Then move, up or down the LVDT to obtain U3 +/-0.1V on the multimeter. The voltage has to be checked after the complete screwing of the all 3 screws.
The dynamic pressure range is now well centred on the local atmospheric pressure average.

In factory, the local atmospheric average is fixed to 1000hPa.

6.3.3. Sensitivity adjustment (figure 2-2)

The sensor maximum dynamic range is set to ± 100 hPa atmospheric pressure. Use a low pressure KELLER calibrator to do calibration.

(1) Set the sensor to be calibrated + calibrator in high pressure (100 hPa) with air pump. Measure the voltage in PT9.
Adjust P1 to obtain – 10 Volts. Note the value U1.

(2) Put the unit in low pressure (– 100 hPa) with vacuum pump. Measure the voltage U2 in PT9 (it must be closed to + 10 Volts). Calculate U’2 = U2 x 20 / (│U2│+│U1│).
Adjust P1 to obtain in PT9 U’2.

(3) Put the unit in high pressure (100 hPa) with air pump. Measure the voltage U'1 in PT9
│U'2│+│U'1│ must be equal to 20 Volts +/- 100mV
Adjust P1 to obtain this result if necessary.

6.3.4. Atmospheric pressure output adjustment

The PA output (between pins 3 and 4 of the 7 pins Jupiter connector) is the conversion of the voltage in mVolt directly to the static atmospheric pressure in hPa.
If the LVDT adjust is necessary, the Pa output is no longer the right value.
So, there are 2 kinds of solution to get the value of atmospheric pressure with MB2005:

First solution: per calculation
Record the local atmospheric pressure LAP at which the LVDT was centred. The right atmospheric pressure can be calculated by adding the difference between the local atmospheric pressure setting LAP and the factory atmospheric pressure FAP (1000hPa), to the Pa output value in mV.
Right value = PA + (LAP-FAP)   each value in hPa.

Second solution: per adjustment
This adjustment needs an external reference barometer. It is necessary to adjust the value of the potentiometer P3 on the measurement board by the use of a small screwdriver.
Turn the potentiometer until the voltage value (mVolt) of the Pa output equal the local atmospheric pressure (hPa).

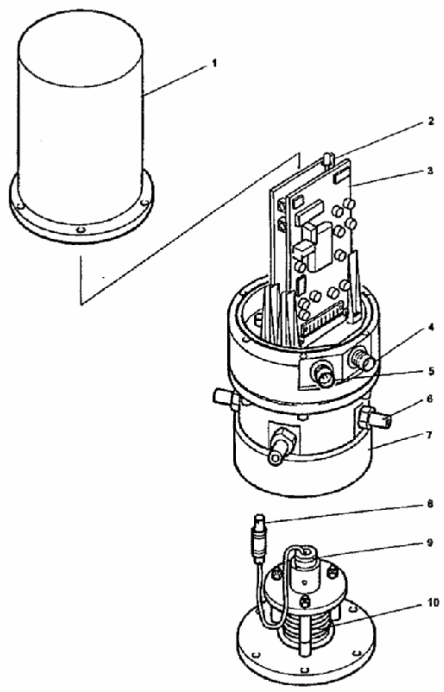


FIGURE 3-1: MB2005 Description

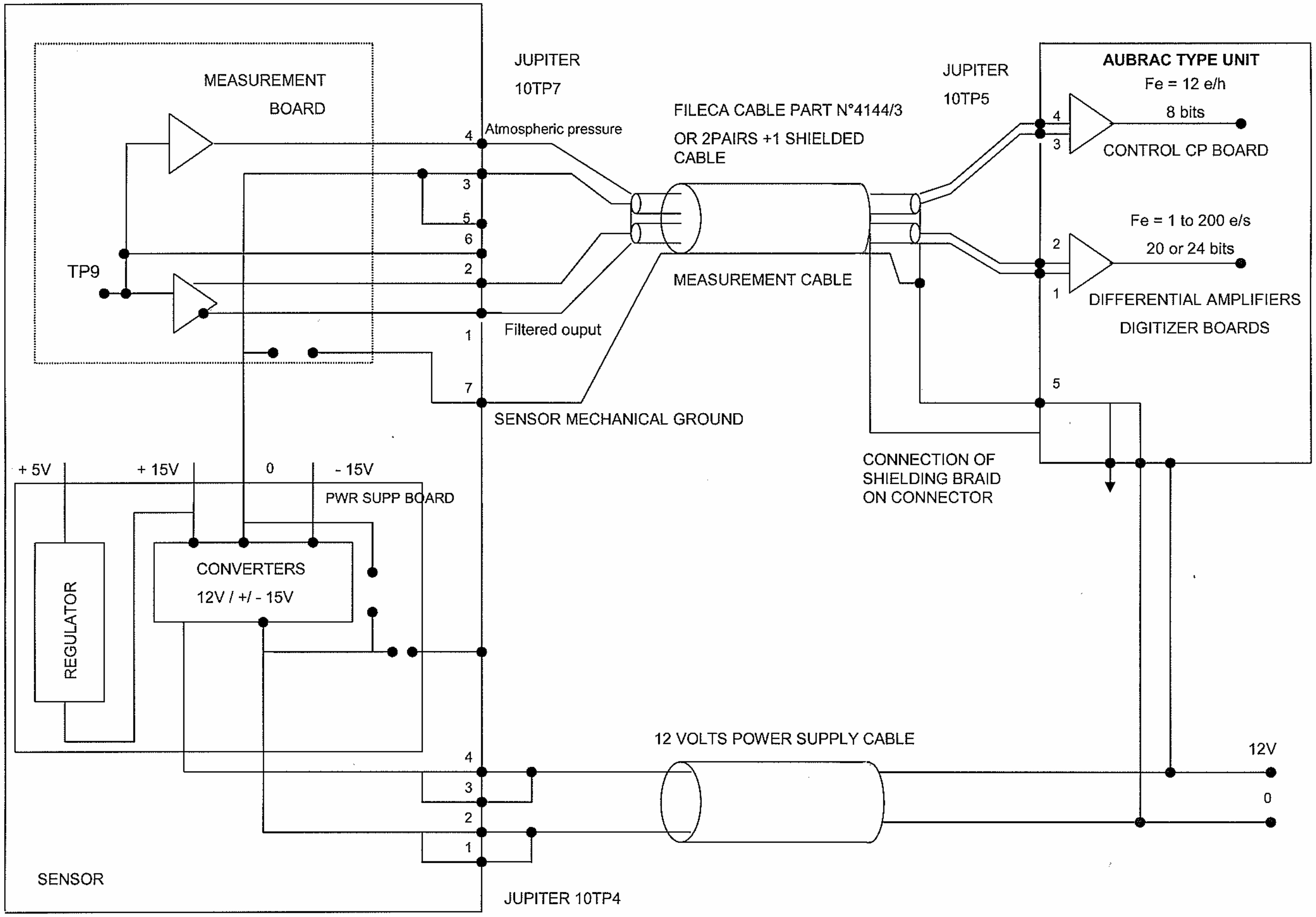


FIGURE 3-2: Connection between AUBRAC digitizer and MB2005

		MB2005 Infrasonic Sensor	Specifications CTBT/PC/II/WGB/1
MB2005 Unfilterd output	Range	200 hPa pp	
	Bandwidth (Hz)	0 – 40	
	Sensitivity	1mV / Pa	
	Electronic noise (at 1 Hz)	0.6 mPa/$\sqrt{Hz}$	$\leq$ 0.63 mPa / $\sqrt{Hz}$
	Electronic noise (0.02-4Hz)	2 mPa rms	
	Dynamic range (1)	134 dB	
	Mode/Type	Single Ended	
MB2005 Filtered output	Range	1000 Pa pp	
	Bandwidth (Hz)	0.01 – 27	0.02-4Hz
	Sensitivity	20 mV / Pa	
	Electronic noise (0.02-4Hz)	2 mPa rms	
	Dynamic range (1)	108 dB	=108dB
	Mode/Type	Differential	
MB2005 PA output	Range	200 Pa pp (within 500 to 1200hPa)	
	Sensitivity	1 mV / hPa	

(1) ½ Full scale/Noise.

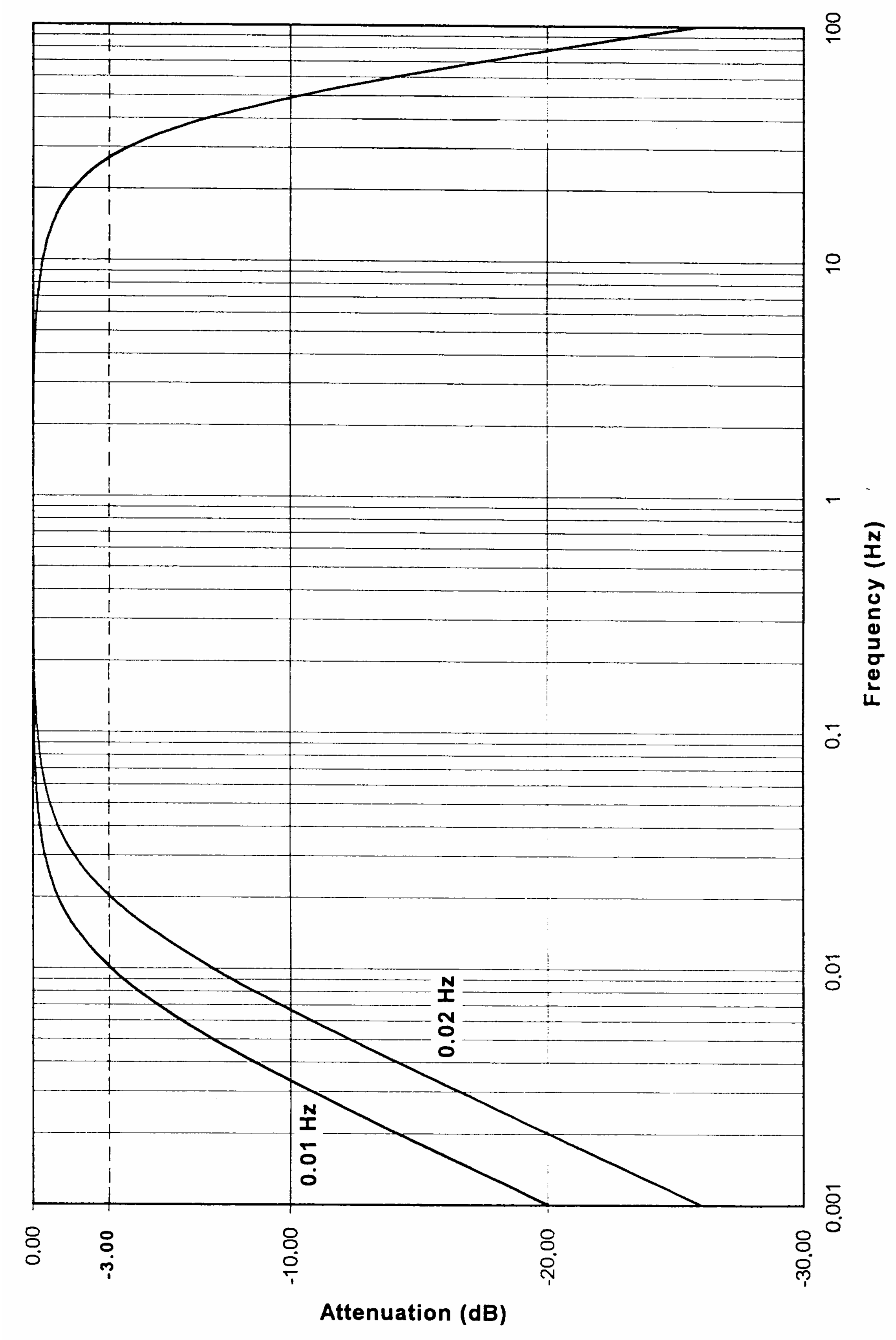


FIGURE 3-4: Frequency Band