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MEDTEQ
Medical Device
Test Equipment
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MEDTEQ IPB Sensor Step Response Jig (SRJ) – short instructions

Overview

This equipment allows the user to monitor the step response of an IBP sensor, to support an alternate method for the frequency response test in IEC 60601-2-34.

Most IBP systems (monitor plus sensor) have a fairly low frequency response, therefore the 10Hz/3dB frequency response in IEC 60601-2-34 is reasonable test. However, the test is reported to be difficult: creating a mechanical sine wave pressure simulator at 1Hz and 10Hz while maintaining reasonably low harmonic distortion.

In practice a typical IBP sensor has a frequency response of least 250Hz, which is sufficiently above the limit in IEC 60601-2-34 as to be considered negligible. The reduced frequency response is usually the result of fairly heavy analogue or digital filtering which is needed to remove noise, noting a typical signal is just 25µV (0.000025V) per 1mmHg.

If it can be shown that the response of the sensor is sufficiently high as to be negligible, the monitor can be tested separately using electronic simulation (such as using the MEDTEQ IBPS). This eliminates the need for mechanical simulation of sine waves[1].

In principle the frequency response (bandwidth) of a simple first order system can be approximated using the relationship BW = 0.35/t, where t is the 10-90% rise or fall time in response to a step change.

The following waveform is taken from a IBP pressure sensor where step response is stored pressure is quickly released by taking a finger away from an open T-joint in a typical IBP circuit to create a sudden drop in pressure[2]:

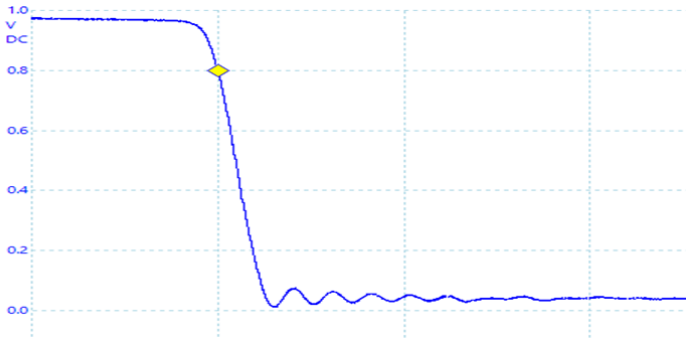

Figure 1: step reduction in pressure (1V = 100mmHg; 5ms/division)

Using the automatic “fall time” function on the oscilloscope yielded a 90-10% drop of 1.3ms, which using BW = 0.35/t = 269Hz. This is a rough estimate only, but the point is to show the frequency response is far above the 10Hz limit in the standard.

[1] It is permitted in ISO 17025 to use alternate test methods provided they are verified / validated as being appropriate. As such, it is possible to formally declare a “Pass” result even though a different method is used.
[2] Opening the T-joint by rotating the stop cock is needs some practice. The volume of air in sensor should be as small as possible, i.e. a T joint on either side (no long tubing in the circuit).

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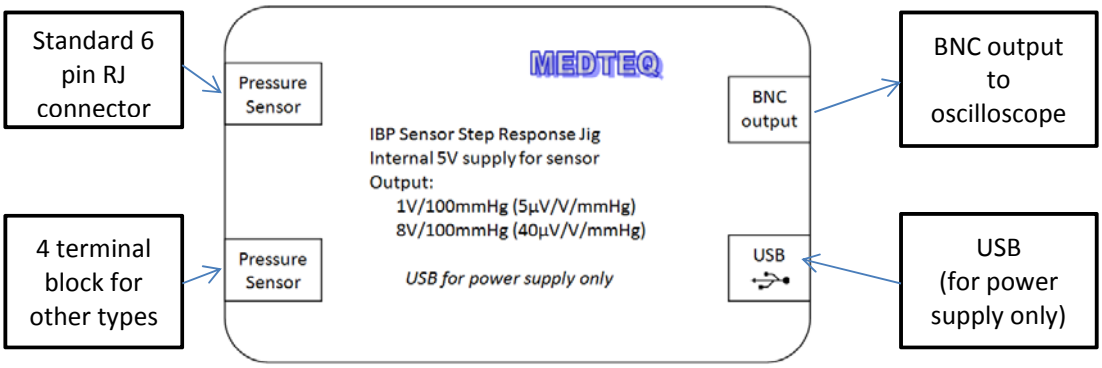
The equipment has the following inputs/outputs:



The equipment uses a standard USB to power the internal electronics and to create 5.00V±1% for the sensor (independent but not isolated from the USB supply).

An internal differential amplifier provides a gain of 400 for the sensor output. This means that with a 5V supply, the output is 1V/100mmHg for 5µV/V/mmHg sensors (and 8V/V/mmHg for 40µV/V/mmHg).

The BNC output has a 560Ω series resistor with no output filter.

Instructions for use (brief)

- Connect the equipment to a USB supply (or USB charger, or any device which can provide a 5V supply)
- Connect the equipment BNC output to an oscilloscope
- If the sensor is a standard 4 pin telephone type (RJ connector), use the connector provided.
- If the sensor is not compatible, cut the sensor and determine the 4 wires as below:
    - V+ (sensor supply, usually +5.00V)
    - D+ (sensor differential output, +)
    - D- (sensor differential output, -)
    - V- (sensor ground, 0V)
- Connect these four wires to four terminals provided, in the same order above from top to bottom.
- Pressure the sensor to about 100mmHg (1V output for 5µV/V/mmHg sensor)
- Release the pressure as fast as possible
- Record the step response (use single shot, negative slope, ~0.5V trigger)

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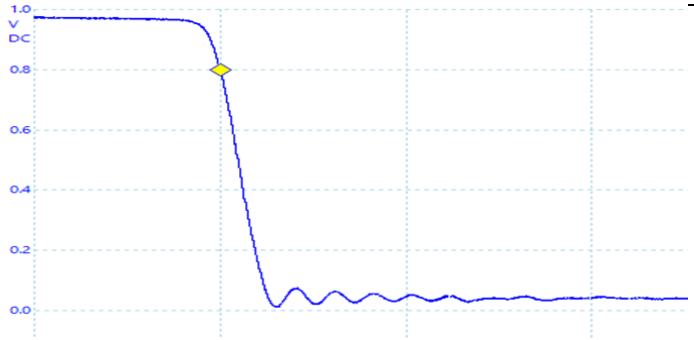
Shipping test (example)

The results below are taken from a typical shipping tests. Note his equipment is designed to provide step response, so the actual values are not required to be accurate. However they are recorded for information.

Item	Inspection point / details	Measured results	Verdict
1.	Serial No.	2014-xxx	-
2.	Shipping location	- - -	-
3.	Tests by / location	Peter Selvey / MEDTEQ, Ise Japan	-
4.	Room conditions	26°C / 54% RH	-
5.	Date of test	13 June 2014	-
6.	Sensor supply voltage (5.00V±1%)	4.960V	Pass
7.	Output noise (<10mVac)	0.5mV	Pass
8.	Output offset, no pressure applied (<70mV)	53mV	Pass
9.	Output with 100mmHg applied (5uV/V/mmHg sensor), 1V±2%)	Step of 100mmg = 0.991V (with offset applied)	Pass
10.	Step response test result (with 5uV/V/mmHg sensor)	 Oscilloscope set to 5ms/div. Pressure step function implemented by finger over an open T joint, which is removed to create a fast pressure drop. Response time (90-10%) measured by automatic oscilloscope function was 1.3ms. Using the relationship BW = 0.35/ t_r , the bandwidth of the sensor is estimated to be around 269Hz. If the sensor has a bandwidth of more than 70Hz, is considered to have negligible impact on the test in IEC 60601-2-34, thus allowing the use of an electrical simulator to test the monitor side for frequency response.	Pass