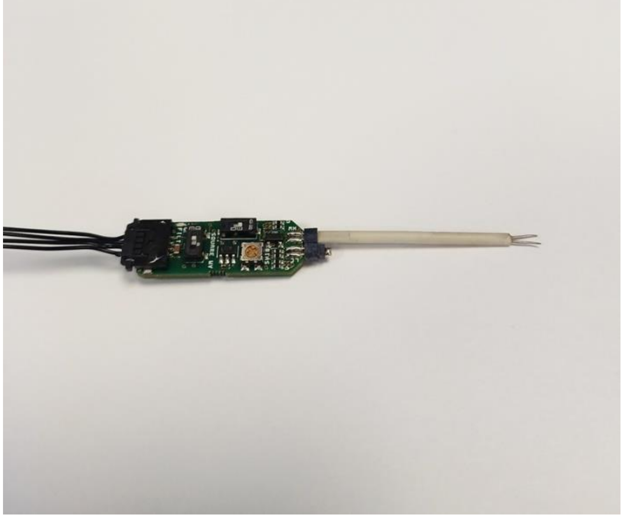
ULTRA-MINIATURE HOT WIRE ANEMOMETER SYSTEM

User Manual



WARNING

Read this document before using the product.

This is an experimental prototype, for measurement purposes only.

This system is not certified for use on aircraft.

Contents

Version Control

Version	Date	Summary of changes
1.0	01-2025	New document

1 INTRODUCTION

Principle of operation

The system consists of a compact, assembled constant-temperature hot-wire anemometry system on a printed circuit board (PCB) which can directly drive a standard third-party hot-wire probe, with miniaturized user-accessible controls. The unit is intended for mounting in an experimental model or sting.

System description

Integrated analogue hot-wire anemometry system.

System components

1x PCB	The miniature printed circuit board contains all the required user-accessible controls for the system, and mates directly with the hot-wire probe.
1x Power/signal cable assembly	Supplying power and retrieving analogue signals from the system (optional)

Additional cable extensions and probe-holding accessories are available as well. Please ensure that all the system components listed above have been supplied, and that there is no apparent damage from shipping.

System requirements

The system requires a well-regulated 5 VDC power supply rated to at least 500 mW and a compatible hot-wire probe.

2 DETAILED SPECIFICATION

Product code	MUHW-1A	
Velocity range	min. 0 m/s[1]	max 120 m/s
Maximum bandiwdth[2]	40 kHz	
Wire cold resistance range (fixed)	3.5 Ω ± 1 Ω	
Overheat ratio (fixed)	1.7	
Power requirement	min. 500 mW idle	
Supply voltage (regulated)	min. 4.5 VDC	max 5.5 VDC
Output signal range	± 5 V, including analogue amplification	
Maximum operating temperature	125 °C	
Output signal conditioning	Fixed 4th order active Butterworth low-pass filter	
Connector type (cable)	4-way Molex Pico-lock (15131-040)	
Connector type (probe)[3]	Suitable for 1 mm pitch, 0.45 mm dia. x 2 mm long straight prong leads	

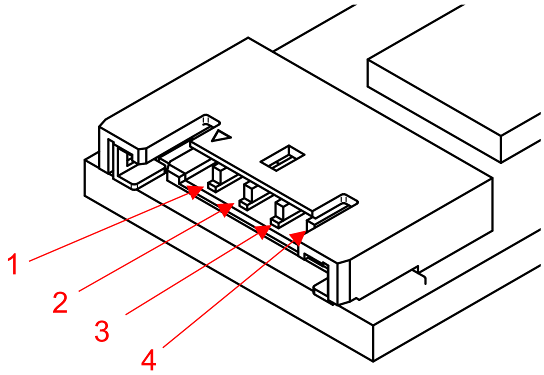
[1] Limited by buoyancy plume effects; values below 1 m/s in air may be affected. May depend on fluid and conditions.
[2] Established by square-wave test
[3] Hot-wire probe not included.

3 PHYSICAL CONNECTIONS AND CONTROLS

There are four conductor pins in the analogue connector; pin 1 is identified by a triangle recessed into the connector housing.

Connector Terminal Description

There are four pins: Vout (1), aGND (2), GND (3) and V+ (4), where pin 1 is on the left with the board facing upwards.



Pin	Value	Description
1	Vout	Analogue signal output, ±5 V
2	aGND	Analogue output ground reference
3	GND	Power supply ground
4	V+	Power supply, well-regulated 5 VDC

Table 1: Pin configuration and descriptions

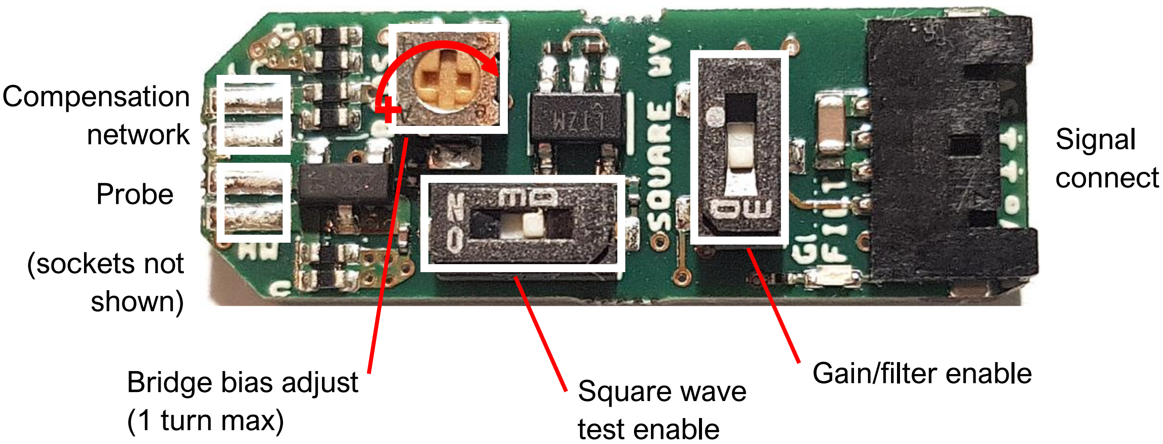


Figure 1: User controls

To insert a probe into the unit, carefully push the probe terminal pins into the socket on the narrowed side of the probe. The probe will be held in place by friction in the connector. For most applications, additional mechanical support for the probe is required.

Because the unit is fundamentally stable, connecting or disconnecting the probe when the system is powered should not cause any damage to the probe wire.

4 OPERATION

Square wave test for setting the bridge bias

Bridge bias is essential for ensuring bridge stability as well as a maximally flat frequency response. It works by providing a small bypass current path in parallel to the hot-wire that is insensitive to the flow. This has the effect of damping the feedback response while also slightly increasing the overheat ratio.

The bridge bias is adjusted with the hot-wire in the air flow at the maximum expected speed while the bridge is perturbed by a small amplitude square wave signal.

To set the bridge bias, follow this procedure:

1. Set the [SQUARE WAVE TEST ENABLE] microswitch to the ON position to enable the 1 kHz square wave injection.
2. Set the [GAIN/FILTER ENABLE] microswitch to the OFF position (away from the white dot) to bypass the gain and filter, thereby outputting the raw bridge voltage.
3. Monitor the raw voltage output on an oscilloscope of sufficiently high bandwidth (>1 MHz) with the time base set to 25 μs per division and the vertical axis set to 100 mV per division with AC coupling. Enable a rising edge trigger set to an offset of +100 mV.
4. Adjust the [BRIDGE BIAS] trimmer until the desired response is seen on the oscilloscope trace (see examples below). Note that the trimmer is very sensitive.
5. Switch to the negative going perturbation by setting the oscilloscope to trigger off a falling edge with an offset of -100 mV.
6. Adjust the [BRIDGE BIAS] again if necessary to ensure the negative perturbation is also as desired. A compromise between the two may be necessary.
7. Once satisfied with the test result, return the [GAIN/FILTER ENABLE] microswitch to the ON position (toward the white dot) and return the [SQUARE WAVE TEST ENABLE] microswitch to the OFF position.

For maximum bandwidth the correct bias setting is obtained when the bridge supply voltage signal perturbation response contains just a single undershoot. However for maximally flat frequency response the correct setting is that which provides a critically damped response (i.e. no undershoot): see figures 2 - 5.

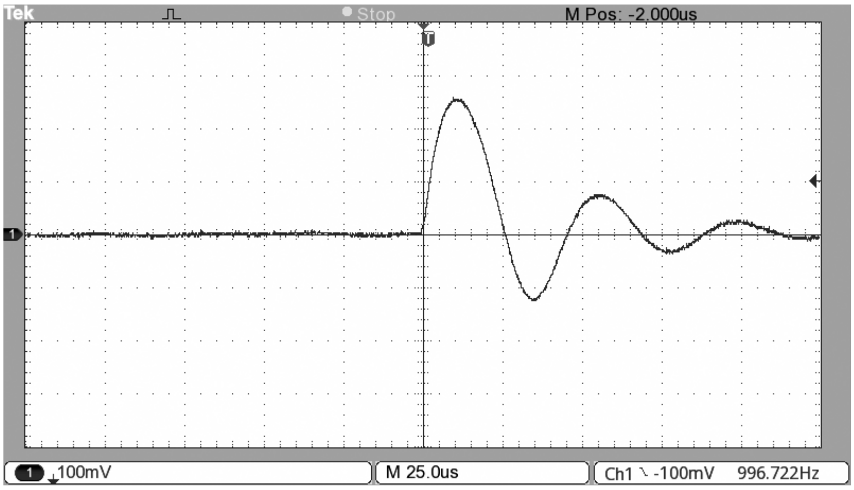


Figure 2: Underdamped response

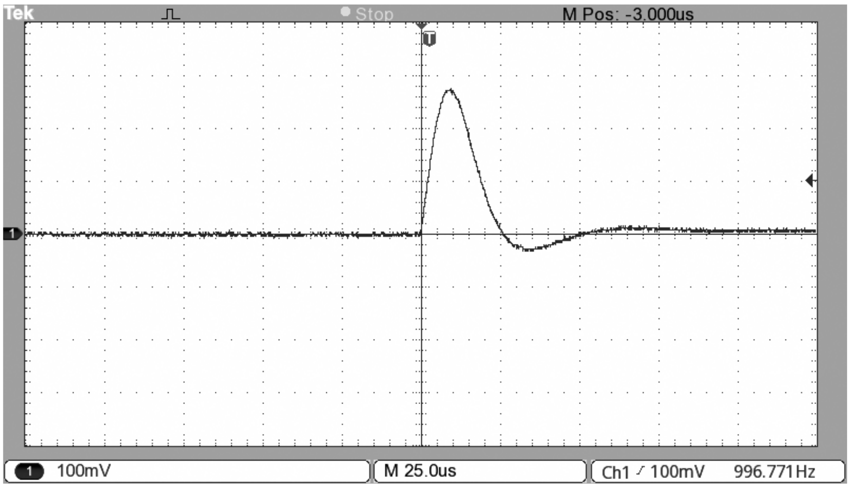


Figure 3: Single undershoot (maximum bandwidth)

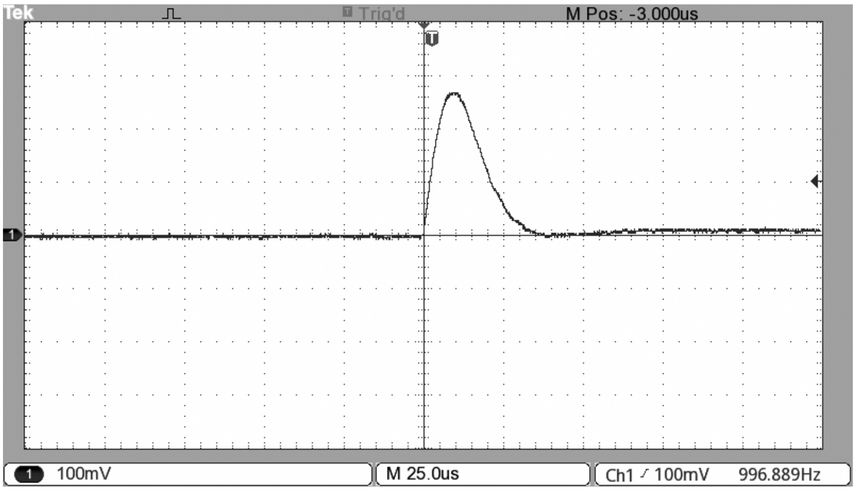


Figure 4: Critically damped (best flat-response)

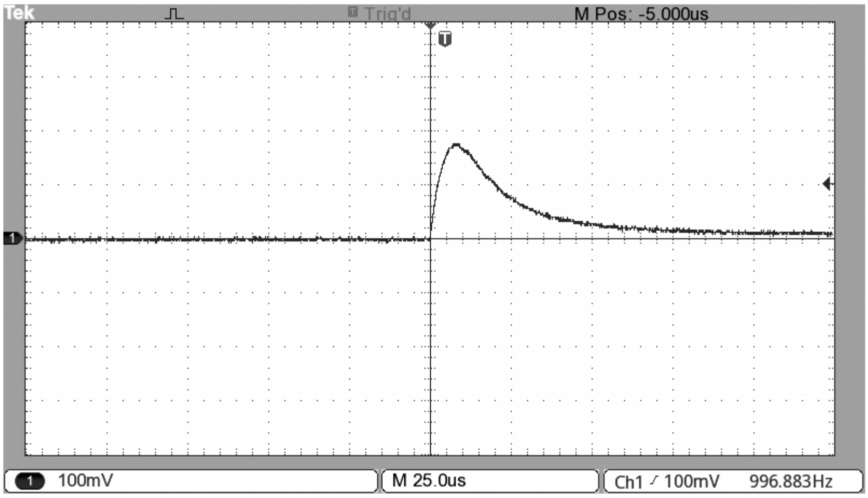


Figure 5: Overdamped response

External compensation network (optional)

With a 1:1 bridge ratio, the external compensation network can simply be an exact duplicate of any extension cable used for the hot-wire probe except with a short circuit at the end rather than a hot-wire. The compensation cable should be spatially coincident with the hot-wire probe extension cable. This will maximise rejection of induced common-mode noise while also compensating for parasitic inductance and capacitance.

If not used or if the probe is directly connected to the unit, short the [COMPENSATION NETWORK] terminals either with solder or the jumper provided.

Voltage drop across the power supply cable

Since the system idle current alone is on the order of 0.1 A, care must be taken to ensure the voltage drop across the power supply cable is not so high as to cause the supply voltage at the device to be less than the minimum of 4.5 V. If third-party cables are used, care must be take to ensure that the conductors are of sufficient cross-sectional area for their length, or that supply voltages are adjusted to ensure adequate voltage at the terminals. Supply voltage drop may cause premature signal clipping at high flow speeds.

Analogue output filter

The unit includes a fourth-order analogue output filter which can be enabled or disabled using the [GAIN/FILTER ENABLE] microswitch; the filter is enabled when the switch position is next to the white dot. The filter is factory-configured with the parameters shown in Table 2.

Parameter	**Value**
Corner frequency (-3 dB)	10 kHz (customizable)
Group delay	36 μs
Roll-off	80 dB/decade

Table 2: 4th order Butterworth output filter parameters

5 CARE AND HANDLING

WARNING: Do not allow any electrically conductive materials to come into contact with the system, or it may be permanently damaged.

- Unless specially requested, the printed circuit boards are not protected with any electrically insulating coating. Do not allow any liquid onto the board. It is recommended to wear latex or similar gloves when handling the board to prevent deposits. Sensible ESD precautions should be taken before handling.
- If not enclosed, ensure that a protective cover is placed over the system when not in use, and handle with care.
- Ensure that all electronic and mechanical connections are appropriately strain-relieved.
- Do not use the hot-wire anemometer system in wet or condensing conditions. Store in dry environment, or with desiccant pouch.
- If used in non-ambient conditions, allow the board to reach thermal equilibrium before carrying out calibration and / or measurements.

6 TECHNICAL SUPPORT

Full technical support is available for this product and its associated software.

If you experience any difficulty in installation or use, or if you need additional support in the operation of the system, please contact your Surrey Sensors Ltd. account manager or technical representative.