Bruhn 6 Constant Temperature Anemometer Notes

Stephen R. Norris for Professor Steven P. Schneider

July 29, 1996

These are very simple constant-temperature anemometers constructed at Purdue following designs developed at Caltech and later modified here.
To operate:
1) Turn the overheat ratio to zero using the potentiometer on the front panel, which shows half the operating resistance of the probe.
2) Measure the cold resistance of the probe using a low-current ohmmeter (not a hand-held, which will blow the wire with too much current).
3) Determine the operating resistance to be used for the wire or film.
4) Hook up the wire or film. Slowly increase the operating resistance by adjusting the potentiometer. The current and the output voltage should rise smoothly once you exceed the cold resistance of the probe.
5) The 'DC out' connector is the bridge output, buffered.
6) The DCF out subtracts a mean voltage (call it V1) from the DC signal and amplifies the difference by a factor of 100. For this to work, you may need to adjust V1 using a special tool to access the trimming potentiometer through the hole in the front panel. DCF is mainly useful for getting higher signal/noise ratio on small fluctuations.

For AAE520, we used to use an expensive TSI IFA100, which was shared with the undergrad labs. Since this has moved to Armstrong, and is not needed for the low frequencies studied in the wake lab, the simple Bruhn6 units built for research should be sufficient.

S.P. Schneider, 14 Jan. 2009.

1 Introduction

The Bruhn constant temperature anemometer, version 6, is the latest in a series of anemometer designs produced by Professor Steven Schneider at Purdue University in order to improve the original Bruhn design. Ten of these devices were constructed during the summer of 1996 by Stephen Norris.

Units 1-4, 5-8, and 9-10 were mounted in three different electronics boxes. Each unit was designed to keep one hot film element at a constant temperature. The resulting voltage signal was made accessible via two BNC connectors. The first connection provided the signal at 100x amplification. The second signal was amplified an additional 9x (900x total) and modified with an adjustable DC offset.

2 Configuration Notes

Some small configuration differences exist between the various boxes, as indicated in the table below.

Units	Meter	R_{cl}	C_{pl}
1-4	volt	47Ω	$100\mu F$ electrolytic
5-8	amp	10Ω	$33\mu F$ tantalum
9	amp	10Ω	$33\mu F$ tantalum
10	amp(digital)	10Ω	$33\mu F$ tantalum

Note:

- cl = current limiting
- pl = power line

Most of the components were consistent from unit to unit, including:

Component	Specification
R_{pl}	10Ω
R_{gain}	750Ω
R_d	200Ω
C_d	$1000pf$
C_1	$47pf$
single buffer caps	$1\mu F$ ceramic
double buffer caps	$10\mu F$ tantalum $\|\|$ $1\mu F$ ceramic

3 Procedure for Setting Potentiometers

The anemometer boards were usually pegged at a full-scale output when they were originally powered up. This difficulty was almost always the result of incorrect settings on the two 10K potentiometers on the circuit board. The following procedure can be used to deal with this problem:

1. Look at the DC output signal. If it is pegged at a full-scale value, go to item 2. Otherwise, go to item 3.

2. Probe the OP27 operational amplifier chip at pin 6 (output voltage). If the voltage is around ± 13 volts (pegged) then the op-amp offset must be adjusted. A tiny clip lead can be used to monitor the voltage at pin 6 while the offset pot is turned. A small positive offset is a good place to start.

3. If the OP27 output is *not* pegged and the DC output signal is *not* full-scale, then the problem is likely with the DC offset. This offset is adjusted via the other 10K potentiometer. Turn the pot clockwise to increase the DC offset, turn it counter-clockwise to decrease the DC offset. The pot should allow a ± 10 volt offset to be achieved.

4 frequency response

The frequency response of each board was affected by the OP27 offset trim which was selected with the appropriate pot. If a square wave was input while this pot was adjusted, a changing output waveform was observed.

For preliminary analysis the "frequency response" was defined to be the reciprocal of the width, in seconds, of the initial response of the DCF output to the square edge on the square wave input. The width was measured from the half-amplitude points on the increasing and decreasing legs of the initial response curve. Overshoots were ignored. These measurements were obtained by "eyeballing" the measurement cursors into their correct positions on a LeCroy digital oscilloscope. the use of the measurement cursors on a digital scope meant that there was a discrete set of possible measurements. That is, the measurement cursors jumped from one discrete data point to another, instead of providing a continuously varying measurement. This was a somewhat rough method, but was deemed to be adequate for initial adjustments.

A preliminary effort at tuning the frequency response of the anemometer boards was made. The goal of this set of adjustments was to obtain a consistent frequency response from each of the boards in a given box. This was achieved to within 10% of the units' total frequency response.

The results showed that the presence of the ammeter in the feedback loop actually *increased* the frequency response of the system as it was defined. The measured frequency responses are listed in the table below.

Unit	Freq. Response
1	8.2 (Hz)
2	8.2
3	8.2
4	8.3
5	12.5
6	12.5
7	12.5
8	13.3
9	12.5
10	11.8

sps note 6/2004: "Hz" here should be "kHz".

Note that units 1-4 have a voltmeter outside the feedback loop, while units 5-10 have an ammeter within the feedback loop. This result suggests that the presence of some inductance in the feedback loop produced a desirable improvement in frequency response.

The reason for the high speed of circuit #8 was not clear. There may have been a different level of inductance present in the ammeter for that board. In any case, the variation in frequency response was not large.

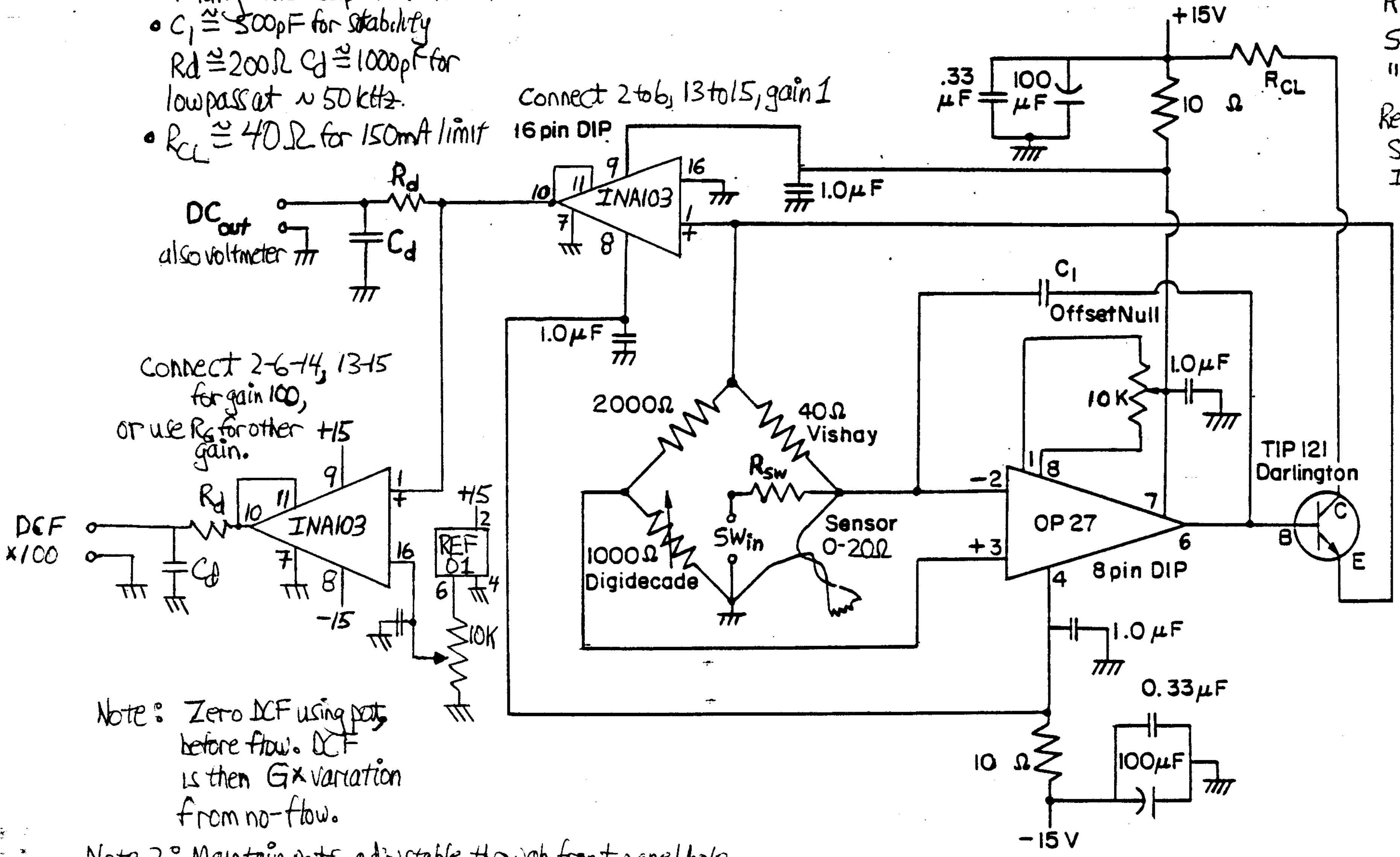
5 Warnings

If making modifications to any of these three boxes be very careful to verify that the correct power lines are connected to the correct power sources. The wire colors for ground and -15 volt lines are not consistent from box to box, and this may be a source of confusion.

HOT FILM ANEMOMETER SCHEMATIC

- Many buffer caps not shown
- $C_1 \cong 500$pF for stability
  $R_d \cong 200\Omega$ $C_d \cong 1000$pF for lowpass at ~ 50kHz.
- $R_{CL} \cong 40\Omega$ for 150mA limit

Rev. 7-15-95
S. P. Schneider
Rev. 1-1-96
S. P. Schneider (5)
"Bruhn" version
Rev. 3-5-96
S. P. Schneider
INA103 inputs were inverted. Bruhn
Rev. 6-7-96
Bruhn 6b
Add REF01.
Correct flaws



Note: Zero DCF using pot, before flow. DCF is then G× variation from no-flow.

Note 2: Maintain pots adjustable through front panel hole.