BiSON Birmingham Solar-Oscillations Network

The Grand Opening of the Narrabri Zoo in 2004 July

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Abstract

The zoo system is installed in Narrabri. The relay box is rewired so that it can handle the new blind motor.

1   Introduction

Brek Miller and Barry Jackson visited Narrabri in the summer of 2004. We both arrived on site on 2004 June 23. Barry left on July 6, Brek left on July 16. There were two major objectives for this visit: to fix the blind motor and to open a new zoo.

Our blind-motor problems began all the way back on 2000 February 24 when Narrabri's original blind motor failed. Brek replaced [1] this with Birmingham's original blind motor on 2000 March 17. This second motor failed on 2003 March 25.

In the mean time, Richard Bryan acquired a Parvalux motor [2] for Birmingham because the original Bodine motors are now obsolete. On 2003 April 5, George Isaak took [3] this motor to Narrabri. In Birmingham, Richard needed to make a small cut-out in one of the dome support struts in order to make the motor clear the dome when the shutter was fully open. George did not think this was a good idea in Narrabri. So instead, he left the dome in "chained mode"; that is, he left the lower wind shutter chained to the bottom of the window frame and set the software to position the shutter above the solar position. In this mode, the spectrometer looks out under the window frame.

In the mean time, Brek contacted Richard Olson from Ash Dome to find out what motor he uses on his new domes. Richard recommended a Dayton 1L550 so Brek bought two.

On 2003 July 27 Roger New and George Isaak visited [4] Narrabri. They decided it was not possible to use the Parvalux motor because the dome supports are different in Narrabri and

it would not be possible to get the Parvalux to clear the dome without cutting the whole way through the support. Instead, they put in the Dayton 1L550 and made a small cut-out in the support. No cut-out was needed in Birmingham for this motor.

George left Narrabri on 2003 August 1 with the shutter not working. On 2003 August 18, Mike Hill fixed the shutter but found the blind not working—another motor had failed. On 2003 September 21, he put in a new 1L550, but that damaged its plastic gears on 2003 October 4.

At this point, we decided to try a different motor: the Dayton 2H602. It has steel gears instead of plastic gears and it turns slower: 14 RPM instead of 35 RPM. Brek ordered two and tested them in Birmingham, then Barry put thermal cut-out switches on them, then one was sent to Narrabri.

It arrived on 2004 January 5, but Mike found that it had damaged coils. We found that the one in Birmingham also had damaged coils. It was the thermal cut-out switch.

Two more 2H602s were ordered and a working one arrived in Narrabri on 2004 February 16. Mike installed it on 2004 March 9, but it drove past the limit switch shortly afterwords. The motor did not fail this time. Mike tried many tests on the limit switch and motor. In all cases, everything worked correctly. Mike could not make the system fail. Yet when he set the system to automatic mode, it would always fail a few days later when nobody was looking. Mike put the dome back into chained mode and we asked him not to do any more work on the blind until we arrived.

At this point we suspected that the limit switch was faulty. We brought a new one with us on this trip.

2   Blind

When we arrived, the blind motor was mounted and wired up ready to go. Barry tested it and the motor and limit switch both seemed to work just fine. Barry, just like Mike, could not make it fail.

Then, during more aggressive tests, Barry noticed that if you move the manual blind control switch from *open* to *close* very quickly, the blind did not change direction. This is the heart of the problem and it will take a minute to explain. First, a small explanation of AC induction motors will be needed.

An AC motor really only needs one set of coils to operate. You apply mains across the coil, give the axle a kick to start the thing turning, and the motor will keep going. In fact, it can turn in either direction. While direction control of a DC motor is simple, changing the "polarity" on an AC motor by swapping the mains wires around will not make the motor turn the other way. Instead, the direction is determined by which way you kick the axle at start up.

Our old Bodine blind motors had two, equal-sized coils. One was connected directly to the mains and the other was connected through a "start" capacitor. The capacitor puts a delay on the voltage to one of the coils. This provides for a small kick to the axle every revolution.

To change directions, you can either move the capacitor to the other coil, or reverse live and neutral on one of the two coils. In either case, the phases of the voltages change around and the kick is in the other direction.

The new 2H602 motor is different. It contains four coils, two big ones and two small ones. The extra complexity is to allow for 120-V or 240-V operation. To make things simple, let us consider only the 240-V case. For this case, the two large coils are connected in series to make one, large run coil. It is this coil that does all of the work. The two smaller coils are also connected in series along with the start capacitor. Their job is to provide the initial kick to the axle to make the motor turn in the correct direction.

Now consider the case when the 2H602 is turning full speed in one direction. Changing the arrangement of the mains to reverse the direction does change the direction of the kick from the small start coil. But because this coil is much smaller than the large run coil, its kick is quite small and is not enough to make the motor stop and change direction. The motor just keeps going in the same direction.

So, that is the explanation of what Barry observed: Changing the control switch quickly without allowing the motor to stop does not change the direction of the motor.

The computer controls the blind motor through the relay box. There is only one relay. When it is energized, the blind opens. When it is de-energized, the blind closes. There is no way for the computer to stop the blind motor. We rely on the limit switch to stop the blind when it is fully open or fully closed.

Now what happens in real life is that the dome will open at sunrise. Then a storm will move through and it will start to rain. The weather module will de-energize the relay and close the blind. Some time later it will stop raining and the weather module will energize the relay and the blind will start opening. Now it takes about two minutes for the blind to open completely. In that time, it will start raining again and the weather module will de-energize the relay. Note that in this case, the relay has changed state while the blind motor was turning. The motor does not change direction!

Now this is very bad.

When the blind is closing, the down limit switch will cut power to the motor. When the blind is opening, the up limit switch will cut power to the motor. But, when the blind is closing, the up limit switch will *not* cut power to the motor. It cannot. If it did, we would never be able to close the blind once it hit the up limit. Think about it: The blind motor must be able to drive the blind downward off the up limit.

However, in the example above, the blind is opening but the relay is in the position to close the blind. So the electrical wiring thinks the blind is closing and the down limit will cut power to the motor. But the blind does not hit the down limit. It hits the up limit, which does *not* cut power to the motor. The blind drives right through the limit switch, winds itself up tight, and keeps going around and around (until it stops raining).

When Mike was testing the blind and limit switch, he naturally waited briefly for the motor to stop before changing the direction of the control switch. Thus he could never observe the

blind or limit switch failing. But after he left the dome, without fail, the blind would work fine for three days and then miss the limit and wind itself up.

So, there you have it: We know what the problem is and it explains all of the symptoms observed by Mike over the past few months. But there was no simple solution.

We would like the computer to stop the blind briefly before changing the direction from *open* to *close*, or vice versa. However, there is only one relay for the blind in the relay box. This means that the computer can open and close the blind but it cannot stop it.

Thus we would instead like change the software so that the computer never changes the direction of the blind within three minutes of the previous change in direction. This would give the blind enough time to fully open or close. However, we cannot do this because the computer does not have sole control over the blind. The computer's instructions can be overridden by the weather module [5] which will close the blind in bad weather. This arrangement was put in place because in the early days it was felt that computers and software were unreliable.

The computer can tell when it is raining, so we might want to bypass the weather module and allow the computer to take responsibility for closing the dome in bad weather. However, we cannot do this because the weather module does not have final say in how the blind is operated. The weather module's instructions can be overridden by the relay box, which will close the blind during a power failure.

We might want to bypass the weather module and the relay box and allow the computer to take responsibility for closing the dome in bad weather and during power failures. But this is too much work to do on site and seems somewhat dangerous.

In the end, we took a completely different approach. We left the software, weather module, and UPS section of the relay box unchanged. Any one of these three actors can open and close the blind at will. To protect against rapid changes in direction, a new, time-delay relay was added to the relay box. Mains to the old blind relay now passes through the normally-closed contacts of the time-delay relay, which is itself configured to energize for five seconds after every change in the state of the blind signal. Thus, after every change in direction of the blind, power to the blind will be cut-off for five seconds. This gives the blind time to come to a stop.

In order to do a delayed de-energize, the time-delay relay's control logic needs another source of power. There were three choices: the mains, the UPS, or a combination of both. We could not use the mains because the relay would not energize at the point of a power failure.

We did not want to use the UPS for a more complicated reason. If the UPS fails, the relay box continues to work because it is getting power from the mains. If the time-delay relay was powered by the UPS, it would stop working during a UPS failure, but the relay box may continue to change the direction of the blind motor (unprotected).

So we had to choose the combination of mains and UPS to power the time-delay relay. There is one relay in the relay box that changes from mains to UPS when the mains fail. We used the output of this relay. Our only concern is that this output has a brief interruption in power at the point of a power failure as the relay contacts changeover from mains to UPS. It was not clear

beforehand that the time-delay relay would work properly under these conditions. However, we wired it up in this manner anyway and tested it afterwords — it seems to work.

As mentioned above, when the blind mechanism failed, the blind would wind itself up around its spool. It then just keeps on turning around and around. There is some damage to a few of the panels in the blind. We may want to consider replacing it.

To remove the blind for replacement, or just to unwind it, you need to go outside the dome and remove the hood that covers the blind. It is a fairly simple operation — you need to remove two screws and cut the seal (silicone sealant). Mike had done this a long time ago, but because there has been a long drought in Narrabri, he did not reseal the hood.

While Brek was there, it rained and the dome leaked badly. Brek resealed the hood near the end of the visit, but there was no more rain so we do not know whether or not the dome still leaks.

3   Zoo

On this visit, the old 80386-based computer was replaced by a modern AMD Athlon-based computer. At the same time, the Keithley System 570 data-acquisition system was replaced by a PCI-1753 digital I/O card. This new hardware, and the software to go with it, is known as the zoo.

Narrabri is our fourth zoo. The Birmingham Zoo is not yet fully operational and the hardware at the Izaña Zoo is substantially different to the hardware in Narrabri. However, the Narrabri upgrade was very similar to the Carnarvon upgrade, which was performed [6] in 2002 November. Because of the experienced gained in Carnarvon, it was hoped that the upgrade would proceed more smoothly here than it did in Carnarvon. Therefore, although Brek Miller was on site for the same length of time — three weeks — a more-optimistic list of jobs was planned. The extra jobs in Narrabri included the installation of a temperature-monitoring device, a network camera, and two new Pockels cells. Like Carnarvon, there was not enough time to reconnect the beam chopper or the Delta-B device. They will be dealt with on the next visit.

Also like Carnarvon, a timber rack was constructed and all of the electronics moved to it. We now have more room on the benches, the electronics are more tidy, and it is easier to get to the backs of the devices to move cables or change wire-wrap connections.

Most of the upgrade went smoothly. However, there was one major hiccup: The computer motherboard failed halfway through the visit. Fortunately there is a computer shop in town and the owner had Pentium motherboards in stock. Brek bought one of these along with a new processor (the old memory was OK) and put them into our computer. Brek had to re-install the operating system; but after that, everything worked except for the floppy disk drive.

4   Declination Gearbox Failure

On 2004 June 24, just our second day on site, the declination 90:1 gearbox failed. Because we were so near the summer solstice, the mount was very near the down limit. During light clouds, the mount strayed too far down, the declination limit switches failed to operate, and the spectrometer hit the mount. Instead of stalling the motor or skipping teeth on the worm gear, a roll pin in the 90:1 gearbox sheared off.

The workshop on site was able to provide a replacement roll pin. Barry disassembled and cleaned the gearbox, then put in the new pin and reassembled everything. We discovered that the limit switches failed to operate because the whole assembly was loose. Barry fixed this and readjusted all of the declination limit switches.

5   Network

Some changes to our network connection were made on this visit. Brek connected [1] the dome to the Internet in 2000 March. Our link back to the control building was a 9600-baud RS-422 connection that used two twisted pairs of copper wire. We ran SLIP (serial-line internet protocol) over this link. The other end of the link was connected to a terminal server called Merry.

We originally chose 9600 baud for reliability and as a means to restrict our use of the site's overall bandwidth to the outside world of 128 kbs. Since then, their connection to the outside world has been upgraded to 512 kbs so I politely asked for our SLIP link to be increased from 9600 baud to 19,200 baud. They said, "yes," and increased the speed for me. I tested it and it worked without error.

Only one hour after this had been done, there was a knock at the door. They had brought a DSL modem and wanted to try it out. The DSL modem in the dome talks to another DSL modem in the control building over a single twisted pair of copper. It worked. The data rate from the control building to our dome is now 1 Mbs!

As before, communication between Birmingham and our dome in Narrabri must pass through the Narrabri firewall, which is set to allow all outbound traffic but it blocks all inbound traffic except for TCP port 411. This was the port we used to use to transfer data from the old computer with the **ghetto** program. We now access the new computer using **ssh** and **scp**; however, we do not use the normal ssh port 22. Instead we use port 411. To login on the Narrabri computer use:

```
% ssh -p 411 bison.atnf.csiro.au
```

or, if you are on *bison.ph.bham.ac.uk*, use the abbreviation:

```
% ssh -p 411 narrabri
```

To retrieve a data file, use a command like this:

```
% scp -P 411 narrabri:/home/zoo/Results/nayymmdd.dat .
```

More information about how to connect to zoo computers can be found in BTR-187. Some important IP addresses are shown in Table 1.

Table 1: Narrabri Network Addresses

Description	Name	IP Address
Dome computer	*bison.atnf.csiro.au*	130.155.176.126
Network camera	—	130.155.176.127
Gateway	*vlan176-fe-0-0-nar.gw.csiro.au*	130.155.176.1
Netmask		255.255.254.0
Primary nameserver	*zephir.atnf.csiro.au*	130.155.177.31
Secondary nameserver	*crux.tip.csiro.au*	130.155.194.32
Outgoing mail server	*smtp.csiro.au*	138.194.3.56
Incoming mail server	*netmon.tip.csiro.au*	130.155.192.9
NTP server	*nelle.atnf.csiro.au*	130.155.177.30

6 Network Camera

An Axis 2100 Network Camera has been installed in the dome. It is attached to the dome just to the right of the shutter and is pointed back at the mount. It moves around in azimuth with the dome but it does not move up and down with the shutter.

The network camera has been assigned its own IP address, which is 130.155.176.127. It can be accessed on port 80 (the WWW port) using any web browser. However, the Narrabri firewall blocks all access from the outside world to the camera. This is a good thing. We can still access our camera through the dome computer. You can login on the dome computer and get a single image:

```
% ssh -p 411 narrabri
user@narrabri password: ******
narrabri% cd tmp
narrabri% wget http://130.155.176.127/jpeg/image.jpg
narrabri% exit
% scp -P 411 narrabri:tmp/image.jpg .
% xv image.jpg
```

Or you can use **ssh** to setup a tunnel through the firewall and then access the network camera using a web browser on your computer:

```
% ssh -p 411 -f -N -L 2000:130.155.176.127:80
user@narrabri password: ******
% mozilla http://localhost:2000/ &
```

The network camera requires two cable connections: one for the network and one for power. In order to make the installation easier and to reduce the number of cables connecting to the dome, the power for the camera is sent upstairs on one of the unused twisted pairs inside a normal network cable. Two "wye" adaptors are used, one to put the power into the cable at the bottom and another to get the power back out again at the top next to the camera. The main camera cable is shown in Table 2. The wye adaptors are shown in Tables 3 and 4.

Table 2: Network Camera Cable

Station: Narrabri.
Cable: 4-pair, 7/0.2-mm, UTP, with yellow PVC sheath.
Length: 10 m

Cable Label:		Network Camera	Network Camera	
Connects to:		Network Camera Wye I	Network Camera Wye II	
Connects to Label:		Network Camera	Network Camera	
Connector:		9-pin male D	9-pin female D	
	pair 1	1	1	blue
	pair 1	6	6	white/blue
RX−	pair 2	2	2	orange
RX+	pair 2	7	7	white/orange
TX−	pair 3	3	3	green
TX+	pair 3	8	8	white/green
+15 V	pair 4	4	4	brown
gnd	pair 4	9	9	white/brown

7   Fish-Tank Heater

In 1996 August, Brek put in [8] a large-reservoir water-cooling system — the large reservoir was a wheely bin. At some point between 2000 December and 2004 June, that wheely bin was replaced

Table 3: Network Camera Wye I

Station: Narrabri.
Cable: 4-pair, 7/0.2-mm, UTP, with red PVC sheath.
Length: 1 m

Cable Label:		Network Camera	Network Camera	*None*	
Connects to:		Network Camera Cable	Hub	Power Supply	
Connects to Label:		Network Camera		*None*	
Connector:		9-pin male D	RJ-45*	2.5-mm Power Socket	
RX−	pair 1	1	4		blue
	pair 1	6	5		white/blue
	pair 2	2	2		orange
RX+	pair 2	7	1		white/orange
TX−	pair 3	3	6		green
TX+	pair 3	8	3		white/green
+15 V	pair 4	4		center	brown
gnd	pair 4	9		outer	white/brown

*The pins of an RJ-45 connector are numbered from right to left looking into the male connector with the locking tab at the bottom.

Table 4: Network Camera Wye II

Station: Narrabri.
Cable: 4-pair, 7/0.2-mm, UTP, with red PVC sheath.
Length: 1 m

Cable Label:		Network Camera	Network Camera	*None*	
Connects to:		Network Camera Cable	Network Camera	Camera Camera	
Connects to Label:		Network Camera		*None*	
Connector:		9-pin male D	RJ-45*	2.5-mm Power Plug	
	pair 1	1	4		blue
	pair 1	6	5		white/blue
RX−	pair 2	2	2		orange
RX+	pair 2	7	1		white/orange
TX−	pair 3	3	6		green
TX+	pair 3	8	3		white/green
+15 V	pair 4	4		center	brown
gnd	pair 4	9		outer	white/brown

*The pins of an RJ-45 connector are numbered from right to left looking into the male connector with the locking tab at the bottom.

by a blue, 150-l water tank. The water in the system is cooled by a car radiator that hangs in front of the air conditioner. However, there is nothing in the system to heat the water. In the southern-hemisphere winter months, the water in the tank sometimes gets too cool, making the spectrometer too cool, which prevents the interference-filter (IF) temperature controller from keeping the IF at the correct temperature.

In 2003 July, George Isaak and Roger New had a good idea — they purchased [4] a 300-W fish-tank heater. But they did not have time to try it. They left it in the dome for us. Barry tried it but found that it did not work — the heating element was broken. So we bought a new one. It worked. The manufacturer's instructions say not to turn the heater on immediately after installing it nor to raise or lower the tank temperature by more than five degrees per day. We believe that these recommendations are meant to keep us from disturbing the fish. So we ignored them.

At about the same time, Barry replaced the aging Jabsco pump with the new GE pump that Brek ordered last year. The Jabsco pump, and the Flojet pumps before it, were plastic diaphragm pumps and they seem to break after about a year of service. The GE pump that Brek bought is a sliding-vane pump and it is nearly the same pump that is used inside the Neslab CFT-33 water circulators. The new pump has better bearings though. The Neslabs are able to run more than ten years without failure so we expect a long life from this new pump.

Shortly after the new pump was installed, the system became clogged. The filter was full of blue plastic bits. The tank is blue plastic. It looked like swarf from the bottom of the tank that must have fallen in when the holes were drilled in the top of the tank when it was first installed. Barry emptied the tank, cleaned out all of the swarf, then refilled the tank and put in some algaecide.

8   Dome Foam Insulation

Several pieces of the dome foam had fallen off or were about to fall off. Although it is the good foam that we currently use, it was glued to the dome using some sort of caulk-type adhesive. Barry re-attached the foam using a heat-resistant contact adhesive purchased in town.

The white foam on the sides of the spectrometer is now deteriorating badly. The optics get covered in fine, white dust every time the spectrometer cover is removed. On the next visit, this foam should be replaced.

9   Temperature Monitor

The temperatures in Narrabri are now monitored by the Narrabri Temperature-Monitoring Thingy [9]. This is a PIC-based device that sends the temperature information to the computer over an RS-232 connection. The new zoo software logs the temperature data to temperature

Table 5: Narrabri Temperature Files

Column	Description
0	Time (hours UT)
1	Interference Filter
2	Oven bottom
3	Starboard detector
4	Port detector
5	Spectrometer
6	Ambient
7	Control Room
8	Test Point

files in much the same way as the old software used to do. The temperature information in each column of these temperature files is shown in Table 5.

Seven temperature signals are output from the Narrabri Temperature Controllers [10] on one 9-pin D-connector. The new Narrabri Temperature-Monitoring Thingy accepts these signals as differential inputs on two 9-pin D-connectors. A small wye adaptor was needed and is shown in Table 6.

The Narrabri Temperature Controllers also accept input from three LM35 temperature-sensing ICs. They amplify these signals so that their scale is $110\,\mathrm{mV}/{}^\circ\mathrm{C}$. These signals are then sent to the Narrabri Temperature-Monitoring Thingy along with the other temperature signals.

The first LM35 is attached to the spectrometer baseplate on the inside. The second LM35 is positioned upstairs behind the mount and hopefully monitors the outside air temperature. The third LM35 is sitting next to the Narrabri Temperature-Monitoring Thingy and is monitoring the control-room air temperature.

All three LM35 inputs are on a single nine-pin, female D-connector. Before this visit, the cables from the LM35s joined together at the input connector. During this visit, Brek made a small wye adaptor. This allows the LM35s to be disconnected separately. The connections in this wye are shown in Table 7.

There is a problem with the combination of the output impedance of the Narrabri Temperature Controllers and the input impedance of the Narrabri Temperature-Monitoring Thingy. The situation for a single channel is shown schematically in Figure 1. The monitor badly loads the controller outputs. The situation is further complicated by the large output capacitor in the controller and the switching nature of the monitor inputs.

The input switching means that only one controller output is loaded at a time. The large output capacitor means that it takes a long time for the load to take effect. The monitor sweeps through the channels once every thirty seconds. It does this quite quickly so the effects of loading are minimal, except on the one channel where the monitor "rests" for thirty seconds between sweeps. To avoid any problems, the monitor has been programmed to rest on channel 15, which is unused.

Table 6: Temperature Monitor Wye

Station: Narrabri.
Cable: 4-Pair, 7/0.2-mm, Unshielded with Red PVC Sheath.
Length: 3 in.

Cable Label:	Output	Temperatures A	Temperatures B	
Connects to:	Temperature Controller	Narrabri Temperature-Monitoring Thingy	Narrabri Temperature-Monitoring Thingy	
Connects to Label:	Output	Temperatures A	Temperatures B	
Connector:	9-pin male D	9-pin female D	9-pin female D	
IFTEMP+ OVENTEMP+ PORTTEMP+ STARTEMP+	2 3 4 5	1 2 3 4		blue orange green brown
IFTEMP− OVENTEMP− PORTTEMP− STARTEMP−	1 1 1 1	6 7 8 9		white/blue white/orange white/green white/brown
SPECTEMP+ AMBTEMP+ AMB2TEMP+ TESTP+	6 7 8 9		1 2 3 4	blue orange green brown
SPECTEMP− AMBTEMP− AMB2TEMP− TESTP−	1 1 1 1		6 7 8 9	white/blue white/orange white/green white/brown

Table 7: Temperature Sensors Wye

Station: Narrabri.
Cable: 4-Wire, 7/0.2-mm, Unshielded with Black PVC Sheath.
Length: 3 in.

|	Aux Sensors	Spectrometer Sensor	Ambient Sensor	Room-Temperature Sensor
Cable Label:	Aux Sensors	Spectrometer Sensor	Ambient Sensor	Room-Temperature Sensor
Connects to:	Temperature Controller	Spectrometer Sensor Cable	Ambient Sensor Cable	Room-Temperature Sensor Cable
Connects to Label:	Aux Sensors	Spectrometer Sensor	Ambient Sensor	Room-Temperature Sensor
Connector:	9-pin male D	9-pin female D	9-pin female D	9-pin female D
Ground Output (10mV/°C) Power	1 2 3	1 2 3		
Ground Output (10mV/°C) Power	4 5 6		1 2 3	
Ground Output (10mV/°C) Power	7 8 9			1 2 3
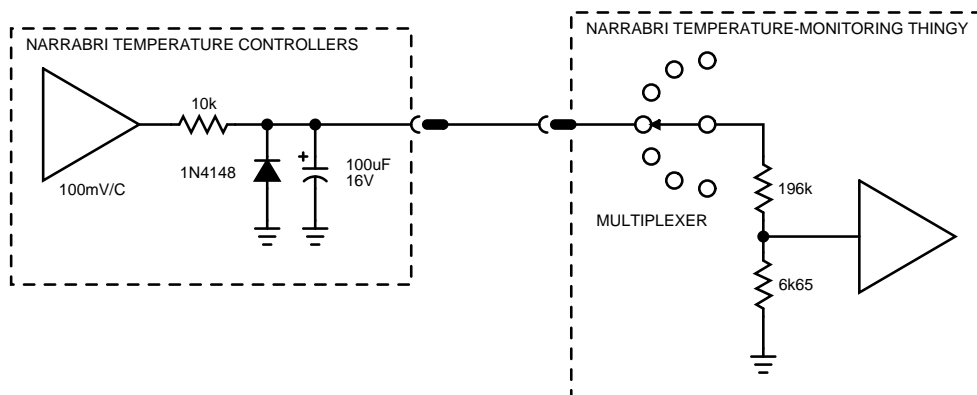
Figure 1: One temperature channel.

10 Pockels Cells

On their previous visit [4], George and Roger took with them two new Leysop Pockels cells (L7 and L12) in new mounts [11] made by Barry Jackson. However, problems with one of the old Malcolm Andrews Pockels-cell drivers prevented the re-implementation of magnetic measurements. George and Roger removed Pockels cell L2 from Spectrometer G and put in Pockels cell L7 instead.

On this trip we took a new Richard Lines dual Pockels-cell driver [12] and two new Leysop Pockels cells (L17 and L18). The transformers and a few other useful components were scavenged from both of the old Malcolm Andrews Pockels-cell drivers. The new Pockels-cell driver was installed, Pockels cell L17 was put in the magnetic position, L18 was put in the velocity position, and Pockels cells L2, L7, and L12 were returned to Birmingham.

Barry Jackson made two new mounts for cells L17 and L18. These mounts hold the cells so that the SHV connectors are symmetric and pointing downwards. The mounts for L7 and L12 put the connectors pointing upwards and put them at non-symmetric angles. In this position, the cables were very close to the lid and it was easy to move the cells accidentally when the lid was taken off and put on.

Now that the connectors angles are symmetric, the fast axes of the cells are no longer at 45°. The polarizer now has to be set at 30° instead of 0°. Brek tried aligning the cells between crossed polarizers, but he was unable to see the Haidinger brush pattern.

Finally, in order to get both Pockels cells to fit inside the spectrometer at the same time, Brek had to remove the interference-filter position encoder from the IF mount. We have never used this in Narrabri, so we probably will not miss it.

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