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The Narrabri Temperature Controller

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Abstract

Some technical information on the Narrabri Temperature Controller is presented.

Contents

1 Introduction

A generic temperature controller has been designed and the unit was subsequently installed [1] at our station in South Africa. The Sutherland Temperature Controller was a success and as a result it has been decided to roll out similar units to the other stations within the Birmingham Solar-Oscillations Network (BiSON) as and when convenient.

As Narrabri had not been visited for a couple of years, it was decided that a station visit was in order. During the trip, the temperature controller should be upgraded as one of the main tasks.

The temperature controllers in Narrabri were replaced [2] in 2010 February. The temperature controller unit is described in BTR-321. This report details the exact configuration of the Narrabri Temperature Controller.

2 Unit Design

The Narrabri Temperature Controller like many other units is housed in a 2U 19" rack case with its own internal power supplies.

The front panel looks very similar in design to other units that are built by HiROS.

2.1 The Front Panel

The front panel of the Narrabri Temperature Controller is shown in Figure 1. There are four main elements on the front panel.

On the left there is the HiROS standard power switch. Next there are two power-LED boards showing the status of the analogue and digital power supplies respectively. Finally on the right-hand side of the front panel is the HiROS standard RS232 LED board.

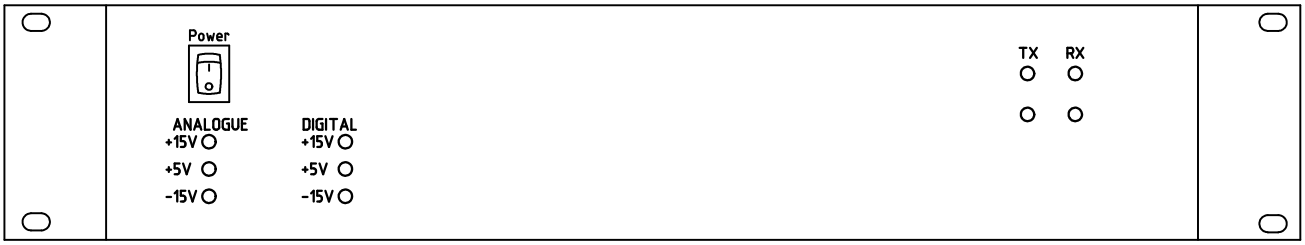

Figure 1: The Front Panel of the Narrabri Temperature Controller.

2.2 The Rear Panel

Figure 2 shows the layout of the rear panel of the Narrabri Temperature Controller. On the left of the unit is the case fan. In the centre of the rear panel are all of the D-type connectors which are used to feed temperature readings and power to the various temperature controlled components. Finally on the right-hand side are the connectors for power and the connection to the computer.

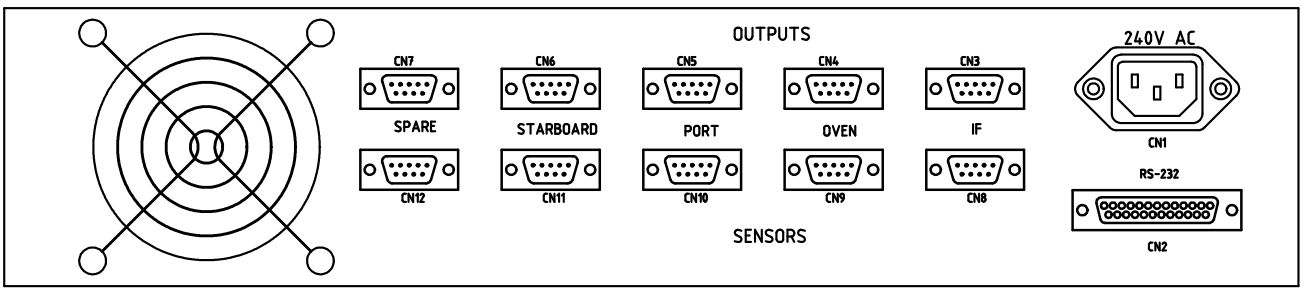

Figure 2: The Rear Panel of the Narrabri Temperature Controller.

2.3 Internal Layout

Within the Narrabri Temperature Controller there are two transformers and several printed circuit boards. Figure 3 shows the arrangement of the major components used in the unit. Note that all panel mounted components have been omitted for clarity.

There is a large digital or "dirty" transformer which provides the power to the high-current heaters/coolers and a smaller transformer for the analogue or "clean" supplies. There is also a large Main board and two smaller drive boards.

As there are two transformers that require a mains feed a terminal block connector (TB1) is used rather than splicing cables.

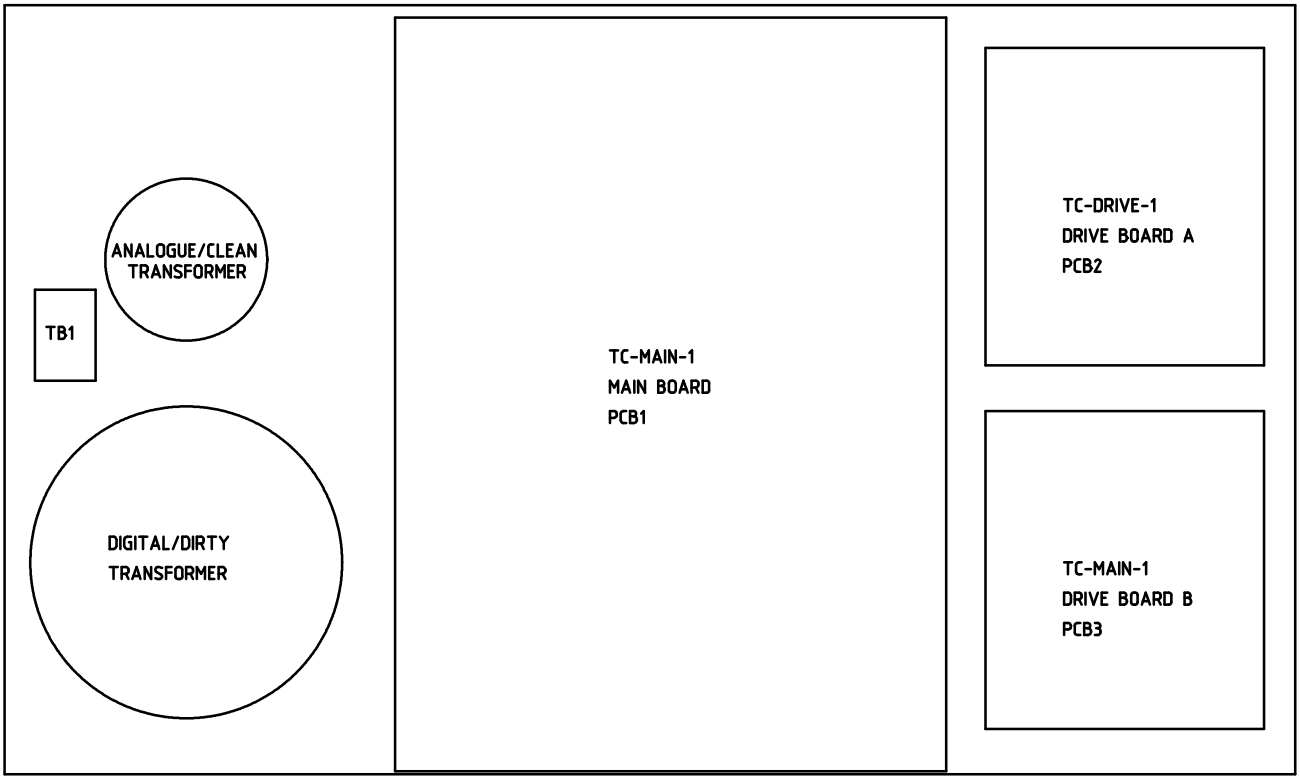

Figure 3: The Internal Layout of the Narrabri Temperature Controller.

2.4 Parts List

The parts list for the Narrabri Temperature Controller is too large to fit in a single table. Hence it has been split into several smaller tables according to component type. These tables are summarized in Table 1. A spare parts kit is also supplied.

Table 1: Narrabri Temperature Controller — Case Parts Lists

Component Type	*Table*	*Page*
Case	2	4
PCB Sub Assemblies	3	5
Spare Parts Kit	4	5

Table 2: Parts List — Case

Name	Part Number	Description (SSM)
—	RS 584-227	Rack Case 2 U × 84 HP × 254 mm
SW1	Rapid 75-0335	DPST Green Visirocker Switch
CN1	Rapid 26-1250	IEC Inlet Filter 6A
CN2	Rapid* 15-0535	25-pin Female D-Type Connector
CN3–CN7	Rapid* 15-0150	9-pin Female D-Type Connector
CN8–CN12	Rapid* 15-0100	9-pin Male D-Type Connector
TR1	Rapid 88-3403	Toroidal Transformer +15V 0.176A
TR2	Rapid 88-2638	Toroidal Transformer +15V 7.5A
TB1	FEC 117-0378	Terminal Block 2-Way Connector
FAN1	Rapid 37-0907	80mm 12-V Box Fan
—	Rapid 37-0825	80mm Fan Finger Guard
—	RS 211-0907	IEC Inlet Insulating Boot (5)
—	FEC 769-277	Heatshrink Boot 28mm
—	Rapid* 15-0365	D-type 8mm Female Screwlock Kit
—	Rapid* 33-3525	M3 × 12 Hexagonal Spacers pk25
—	Rapid* 33-4210	M3 × 6 Panhead Pozidriv Screw pk100
—	Rapid* 33-4260	M3 × 6 Pozidriv Countersunk Screw pk100
—	Rapid* 33-4200	M2.5 × 6 Pozidriv Panhead Screw pk100
—	Rapid* 33-1715	M4 Nuts pk100
—	Rapid* 33-1765	M4 Washer pk100
—	Rapid* 33-2975	M4 × 20 Pozidriv Panhead Screw pk100
—	Rapid* 33-2977	M4 × 25 Pozidriv Panhead Screw pk100

*These items are available from Physics Stores.

Table 3: Parts List — PCB Sub Assemblies

Name	Part Number	Description (SSM)
PCB1	HiROS TC-MAIN-4	Main Board Assembly
PCB2	HiROS TC-DRIVE-5	Drive Board A Assembly
PCB3	HiROS TC-DRIVE-5	Drive Board B Assembly
PCB4–PCB5	HiROS PWR-LED-4	Power-LED Board Assembly
PCB6	HiROS 232-LED-3	RS232-LED Board Assembly

Table 4: Parts List — Spare Parts Kit

Part Number	Description (SSM)
Rapid 73-3206	PIC16F877-20P Microcontroller
FEC 789-872	ADS1210 24-bit ADC
RS 225-4883	MAX536ACPE Quad 12-bit DAC
FEC 130-5157	INA114 Instrumentation Amplifier
Rapid 82-0148	MAX232CPE RS-232 Line Driver IC
Rapid 82-0066	TL084 Quad Op-amp IC
Rapid 47-0156	ZVN2106A n-channel MOSFET
Rapid 47-0174	ZVP2106A p-channel MOSFET
Rapid 47-3278	78L05 +5-V 100-mA Voltage Regulator
Rapid 47-3282	78L15 +15-V 100-mA Voltage Regulator
Rapid 47-3284	79L05 -5-V 100-mA Voltage Regulator
Rapid 47-3288	79L15 -15-V 100-mA Voltage Regulator
Rapid 82-1002	LM35DZ Temperature Sensor IC
RS 284-220	TLE2426CLP Voltage Reference
Rapid 26-0840	0.17-A Resettable Fuse
Rapid 26-0825	8-A Resettable Fuse

3 Internal Wiring

The Temperature Controller system is made up of several different PCBs and the layout within the case has already been shown in Figure 3.

Most of the electronics for the Temperature controller are contained on the Main board. The unit does require eight high-current outputs and these are provided by the two drive boards, each board having four such outputs.

Because the system contains different PCBs it means that there is a lot of interconnections that need to be made internally on the system wiring.

3.1 Internal Wiring Diagram

Table 5 summarizes the individual drawings that make up the internal wiring diagram for the Narrabri Temperature Controller.

Table 5: Internal Wiring Diagram — Common Connections

Drawing	*Figure*	*Page*
AC Power Supplies	4	7
DC Power Distribution	5	8
RS-232 Communications Interface	6	9
Spectrometer Components — Drive Board A	7	10
Spectrometer Components — Drive Board B	8	11

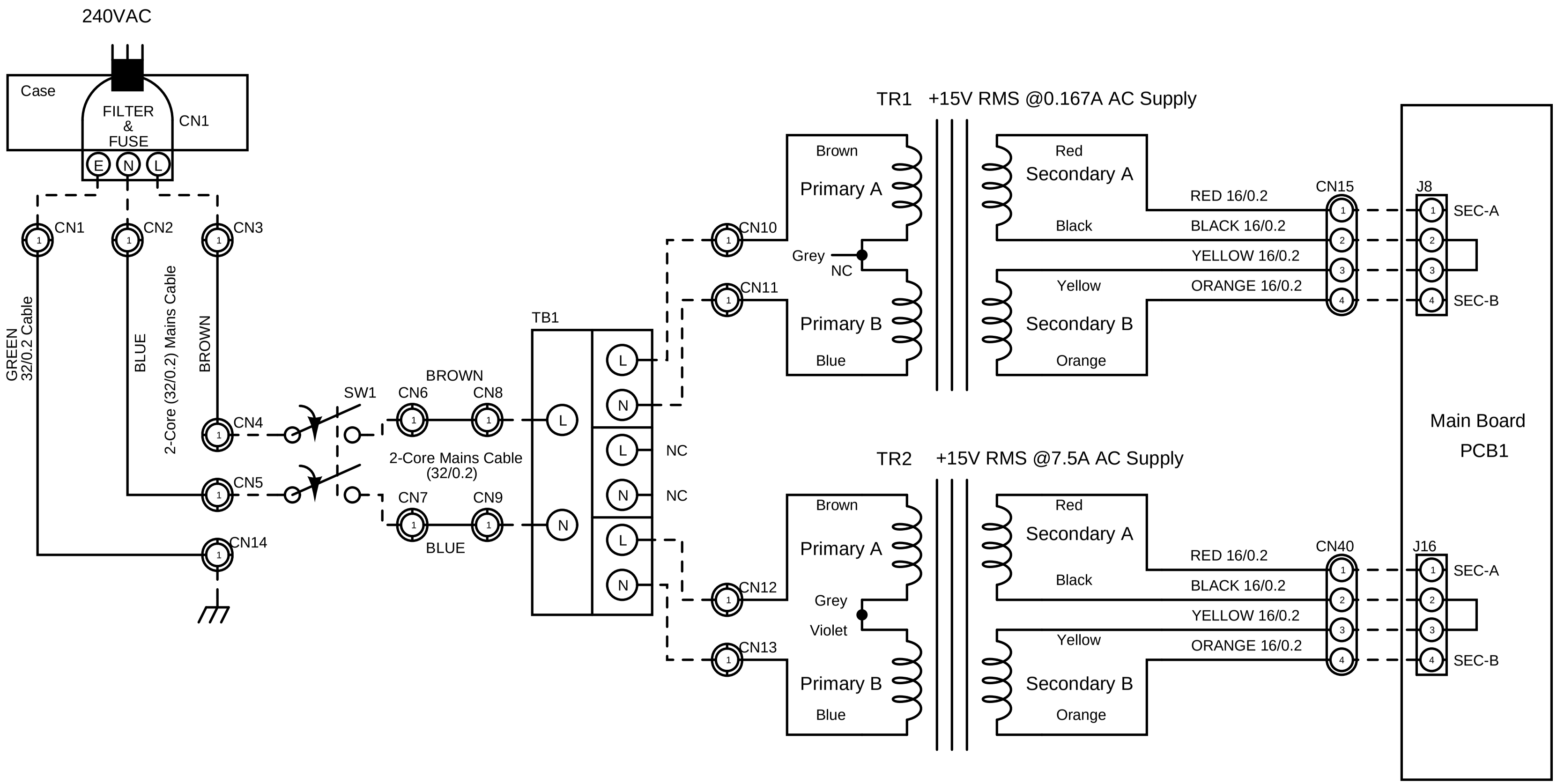

Figure 4: The Wiring Diagram for the AC Power Supplies.

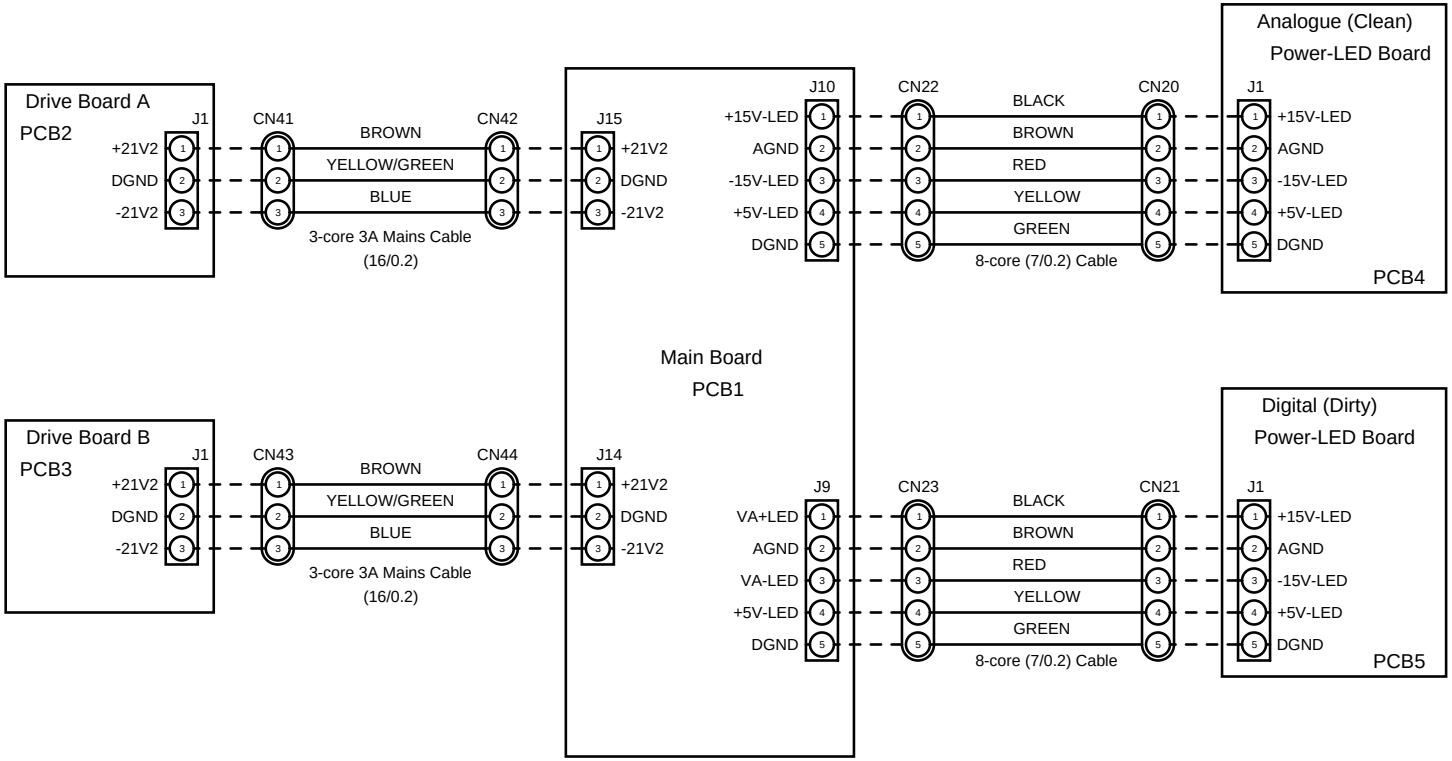

Figure 5: The DC Power Distribution.

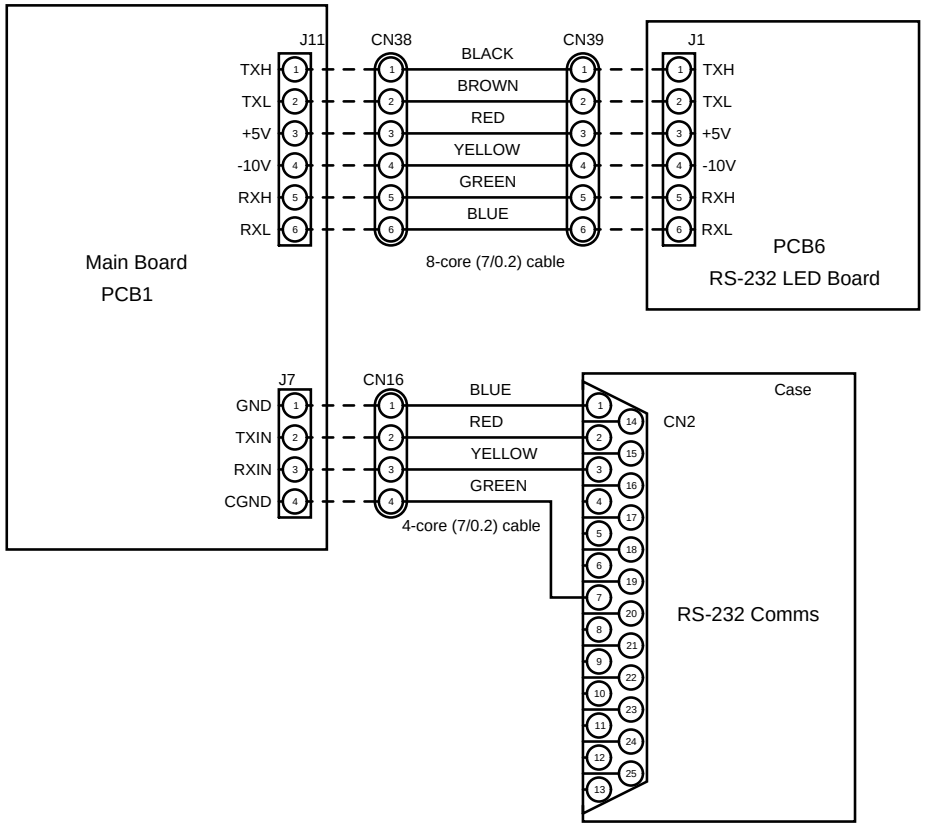

Figure 6: RS-232 Communications Interface.

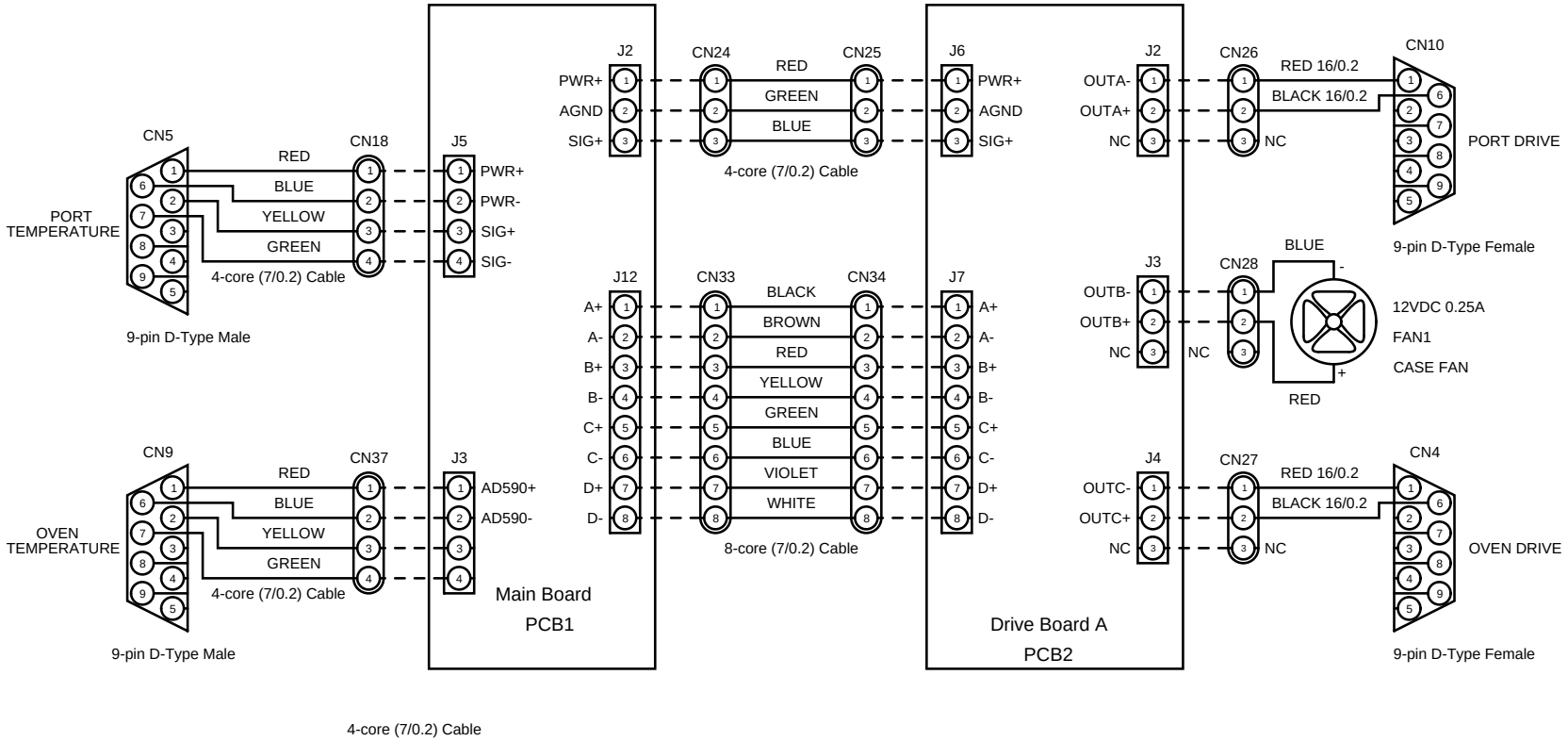

Figure 7: Spectrometer Components — Drive Board A.

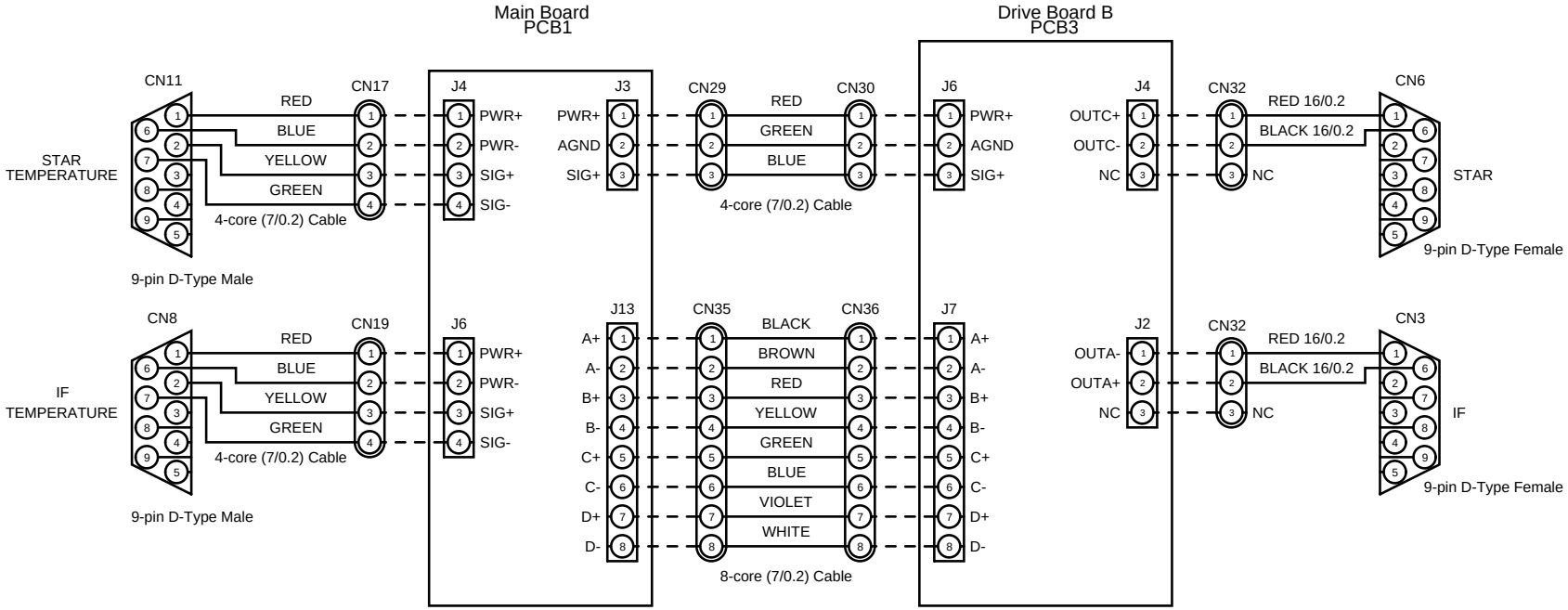

Figure 8: Spectrometer Components — Drive Board B.

3.2 Internal Wiring Parts

The parts to complete the internal wiring of the Temperature Controller have been split up into separate tables for cables and connectors.

The tables that make up the parts list for the internal wiring are summarized in Table 6.

Table 6: Internal Wiring Parts Lists

Drawing	*Figure*	*Page*
Cables	7	12
Connectors	8	13

Table 7: Internal Wiring Parts List — Cables

Part Number	Description (SSM)
Rapid* 01-0900	16/0.2 Wire Black 100m Reel
Rapid* 01-0935	16/0.2 Wire Red 100m Reel
Rapid* 01-0925	16/0.2 Wire Orange 100m Reel
Rapid* 01-0950	16/0.2 Wire Yellow 100m Reel
Rapid* 01-1205	32/0.2 Wire Blue 100m Reel
Rapid* 01-1215	32/0.2 Wire Green 100m Reel
Rapid* 01-1210	32/0.2 Wire Brown 100m Reel
Rapid* 02-0205	8-Core Screened Cable 100m Reel
FEC* 715-232	4-Core Screened Cable 100m Reel
Rapid* 01-0230	3-Core (16/0.2) 3A Mains Cable 100m Reel

*These items are available from Physics Stores.

Table 8: Internal Wiring Parts List — Connectors

Name	Part Number	Description (SSM)
CN1–CN3	Rapid* 33-0660	Red Insulated 6.8×0.8 Female Terminal pk100
CN4–CN7	Rapid* 33-0650	Red Uninsulated 4.8×0.8 Female Terminal pk100
CN8–CN9	Rapid 33-1274	Red 1.9×12mm Pin Terminal pk100
CN10–CN13	Rapid* 33-0640	Red Uninsulated 6.8×0.8 Female Terminal pk100
CN14	Rapid 33-0605	Red Ring Terminal 3.7mm pk100
CN15–CN19, CN37	Rapid 22-0915	4-Way Molex KK Crimp Housing
CN20–CN23	Rapid 22-0920	5-Way Molex KK Crimp Housing
CN24–CN32	Rapid 22-0910	3-Way Molex KK Crimp Housing
CN33–CN36	Rapid 22-0930	8-Way Molex KK Crimp Housing
CN38–CN39	Rapid 22-0925	6-Way Molex KK Crimp Housing
CN40	Rapid 22-2510	4-Way 0.156” Crimp Housing
CN41–CN44	Rapid 22-2505	3-Way 0.156” Crimp Housing
—	Rapid 22-1098	Molex KK Crimp Terminal pk1000
—	Rapid 22-2576	0.156” Crimp Terminal pk1000

*These items are available from Physics Stores.

4 PCB Configuration

The Temperature Controller [3] is a generic device that can be configured in many different ways depending on the actual components that are present.

The spectrometer Genghis as fitted in Narrabri has the following components that require temperature control:

- Port Detector.
- Starboard Detector.
- Oven.
- Interference Filter.

4.1 Output Channel Allocation

The Narrabri Temperature Controller requires two of the drive boards to enable it to control the temperatures of components within Genghis and the ancillary outputs that are needed by the temperature controller itself.

Table 9 shows how the components have been allocated to the available output channels on the Narrabri Temperature Controller.

Table 9: Channel Allocation of the Narrabri Temperature Controller

Component	*Drive Board*	*Output Channel*
Port Detector	A	A
Case Fan	A	B
Oven	A	C
Heatsink Fan	A	D
Interference Filter (IF)	B	A
Not Used	B	B
Starboard Detector	B	C
Heatsink Fan	B	D

4.2 Output Configuration

Figure 9 shows a generic version of the output stage of the temperature controller. The drawing contains a number of components that are changed to enable the unit to control different types of component.

There are components on both the main board and on the drive board that are changed depending on the component that they are driving. LKa and LKb on the main board set the reference voltage which determines unipolar or bipolar current range.

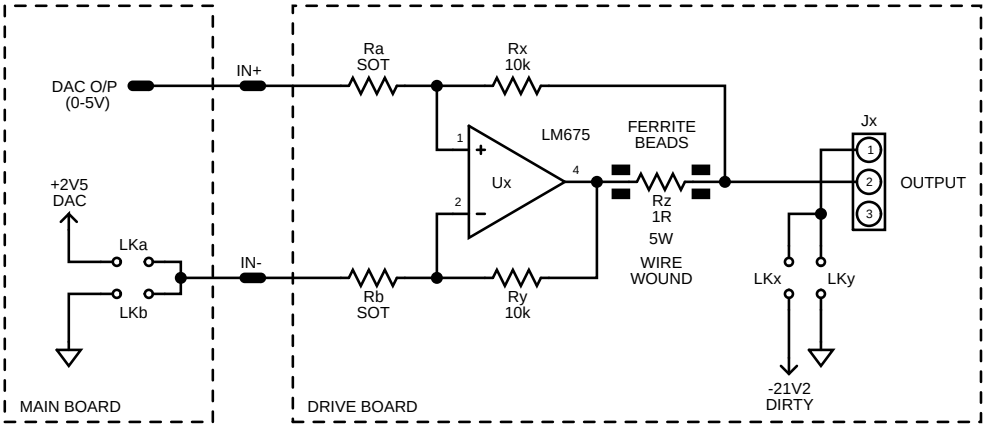

Figure 9: Temperature Controller Output Stage.

The majority of components that can be configured are on the Drive board. Ra and Rb are the gain resistors and they set the overall gain of the amplifier. Then there is the output links LKx and LKz. LKy is used in bipolar mode while LKx is used in unipolar mode.

Table 10 shows the values of the components as used on the Narrabri Temperature Controller. The gain resistors column shows the names used on the drive board for the components on the output in question. For the output link this shows which link to populate with a zero-ohm link on the drive board. The reference link shows which link to populate on the main board.

Table 10: Configuration of the Drive boards

Component	*Drive Board*	*Output Channel*	*Gain Resistors*		*Value*	*Output Link*	*Reference Link*
Port	A	A	R4	R5	47-kΩ	LK5	LK14
Case Fan	A	B	R6	R7	270-kΩ	LK2	LK3
Oven	A	C	R8	R9	24-kΩ	LK7	LK4
Heatsink Fan	A	D	R10	R11	470-kΩ	LK8	LK5
IF	B	A	R4	R5	24-kΩ	LK1	LK6
Not Used	B	B	R6	R7	—	—	—
Starboard	B	C	R8	R9	47-kΩ	LK3	LK20
Heatsink Fan	B	D	R10	R11	470-kΩ	LK8	LK9

4.3 PCB Configuration Parts

The parts to complete the PCB configuration of the Temperature Controller have been split up into separate tables. These tables are summarized in Table 11.

Table 11: PCB Configuration Parts Lists

Table 12: PCB Configuration Parts List — Drive Board A SOT Components

Name	Part Number	Description (SSM)
R4–R5	Rapid* 62-0942	47-kΩ 0.25W 1% MR25 Resistor pk100
R6–R7	Rapid* 62-0942	270-kΩ 0.25W 1% MR25 Resistor pk100
R8–R9	Rapid* 62-0924	24-kΩ 0.25W 1% MR25 Resistor pk100
LK2†, LK5, LK7, LK8	FEC 933-9027	0-Ω Link MCF Series (50)

*These items are available from Physics Stores.
†Any links in the range of LK1—LK8 not in this list are depopulated.

Table 13: PCB Configuration Parts List — Drive Board B SOT Components

Name	Part Number	Description (SSM)
R4–R5	Rapid* 62-0924	24-kΩ 0.25W 1% MR25 Resistor pk100
R6–R7	HiROS	Depopulated Resistor
R8–R9	Rapid* 62-0942	47-kΩ 0.25W 1% MR25 Resistor pk100
LK3†, LK5, LK8	FEC 933-9027	0-Ω Link MCF Series (50)

*These items are available from Physics Stores.
†Any links in the range of LK1—LK8 not in this list are depopulated.

Table 14: PCB Configuration Parts List — Main Board SOT Components

Name	Part Number	Description (SSM)
LK3†–LK6, LK9, LK14, LK20	FEC 933-9027	0-Ω Link MCF Series (50) 0.017

†Any links in the ranges of LK2—LK9 and LK14—LK21 that are not in this list are depopulated.

5 System Design

Figure 10 shows all of the connections that are required for the Temperature Controller system.

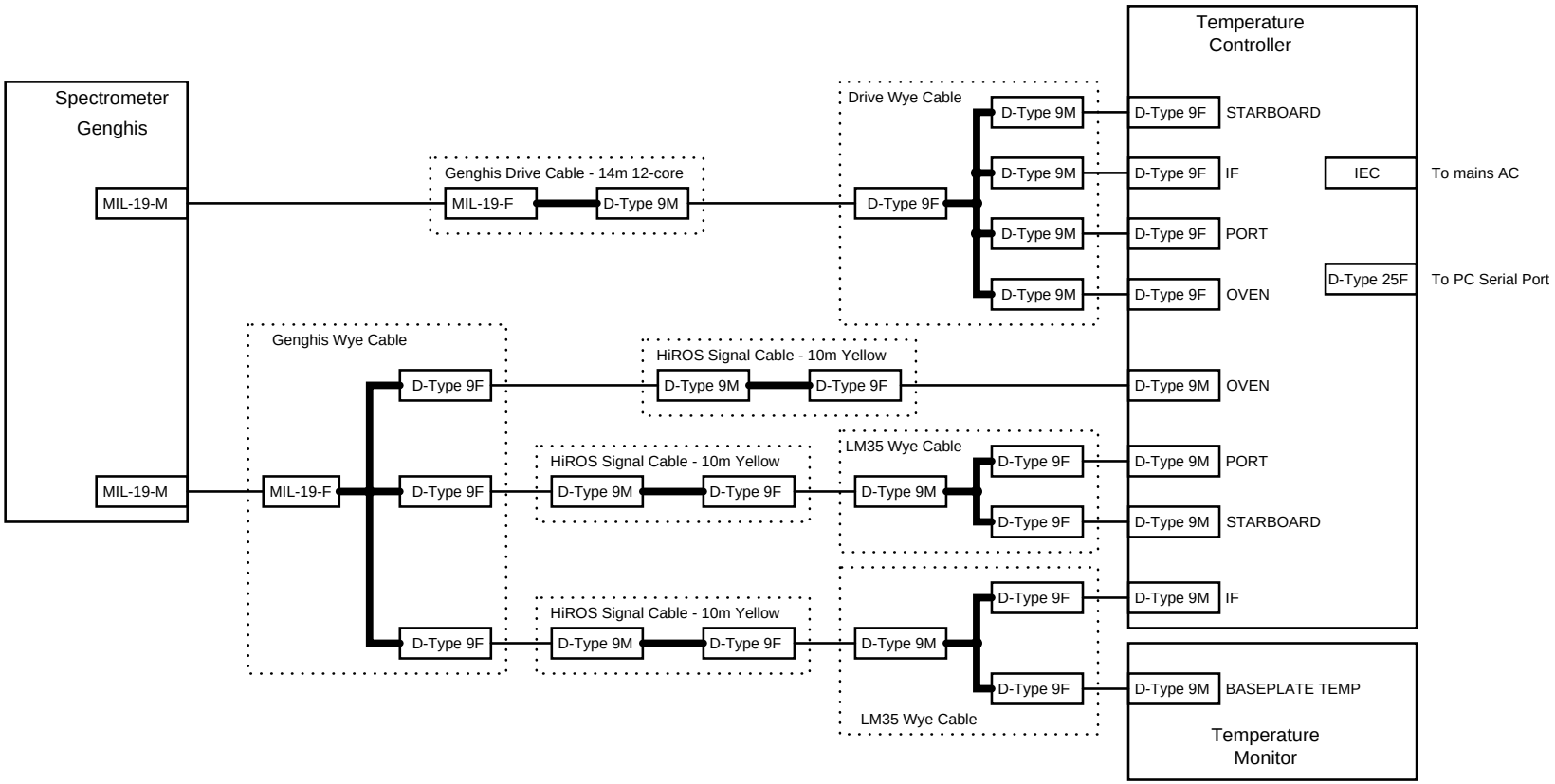

Figure 10: The Narrabri Temperature Controller System.

6 External Connections & Cable Assemblies

Figure 10 shows how all of the sensors are connected to the temperature monitor. There are basically five different types of cable assemblies that are associated with the Narrabri Temperature Monitor, these are summarized in Table 15.

Table 15: Narrabri Temperature Controller External Cable Assemblies

Drawing	*Figure*	*Page*
HiROS Signal Cable	11	19
Genghis Drive Cable	12	20
LM35 Wye Cable	13	20
Drive Wye Cable	14	21
Genghis Wye Cable	15	21

6.1 HiROS Signal Cable

The majority of signals have to travel from a remote sensor to some instrument. Because of this it was decided to adopt a standard cable that is used on any system that requires signals to travel over a considerable distance.

The HiROS signal cable is this standard cable. It is basically a network cable that has D-Type connectors fitted on each end. The cable is made up of 4 twisted pairs of 7/0.2 wires. The cables come in a variety of different lengths and several different outer sheath colours are available including yellow, blue and red.

Figure 11 shows how the cable is connected internally.

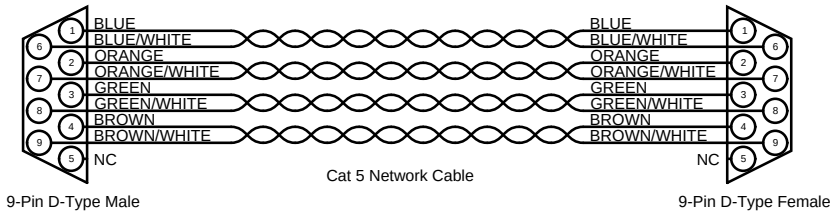

Figure 11: The HiROS Signal Cable.

6.2 Genghis Drive Cable

The Genghis drive cable carries all of the high-current power signals from the temperature controller to the spectrometer. The drive cable does not require the use of twisted pair cable and hence normal 7/0.2 cable is used instead.

Figure 12 shows how the cable is connected internally.

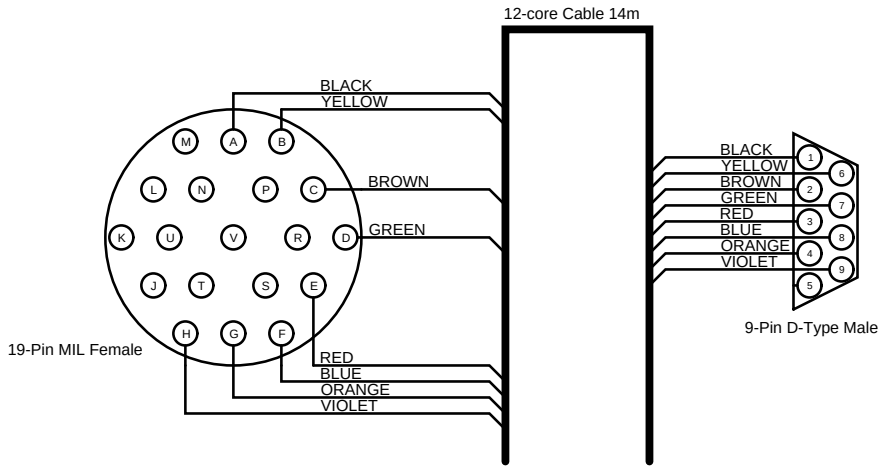

Figure 12: The Genghis Drive Cable.

6.3 LM35 Wye Cable

The LM35 Wye cable is used to separate the signals from two LM35 temperature sensors that have been grouped together for transmission down a HiROS signal cable.

Figure 13 shows how the cable is connected internally.

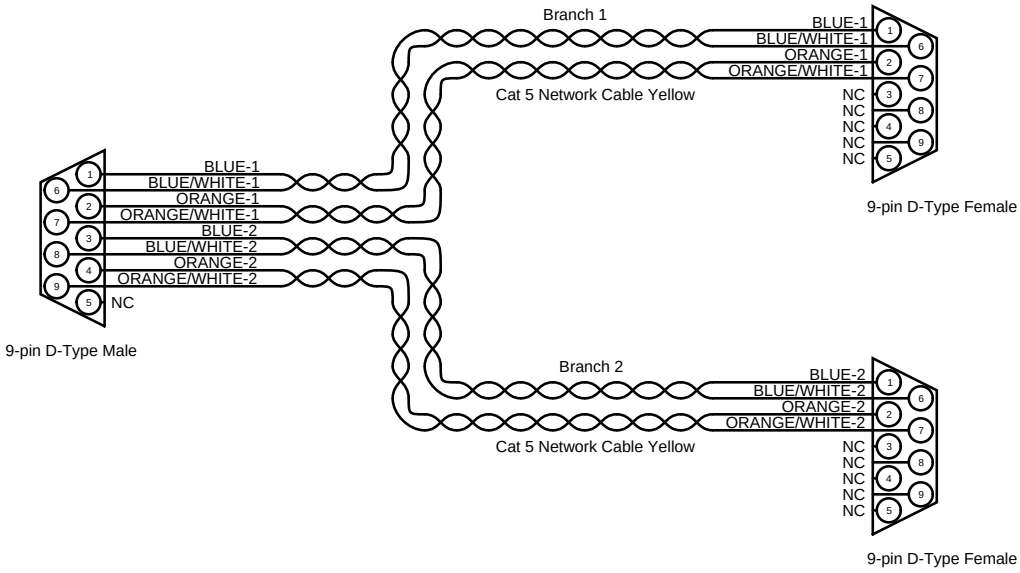

Figure 13: The LM35 Wye Cable.

6.4 Drive Wye Cable

The Drive Wye cable is used to combine the four drive signals so that they can be transmitted to the spectrometer over a single twisted pair network cable

Figure 14 shows how the cable is connected internally.

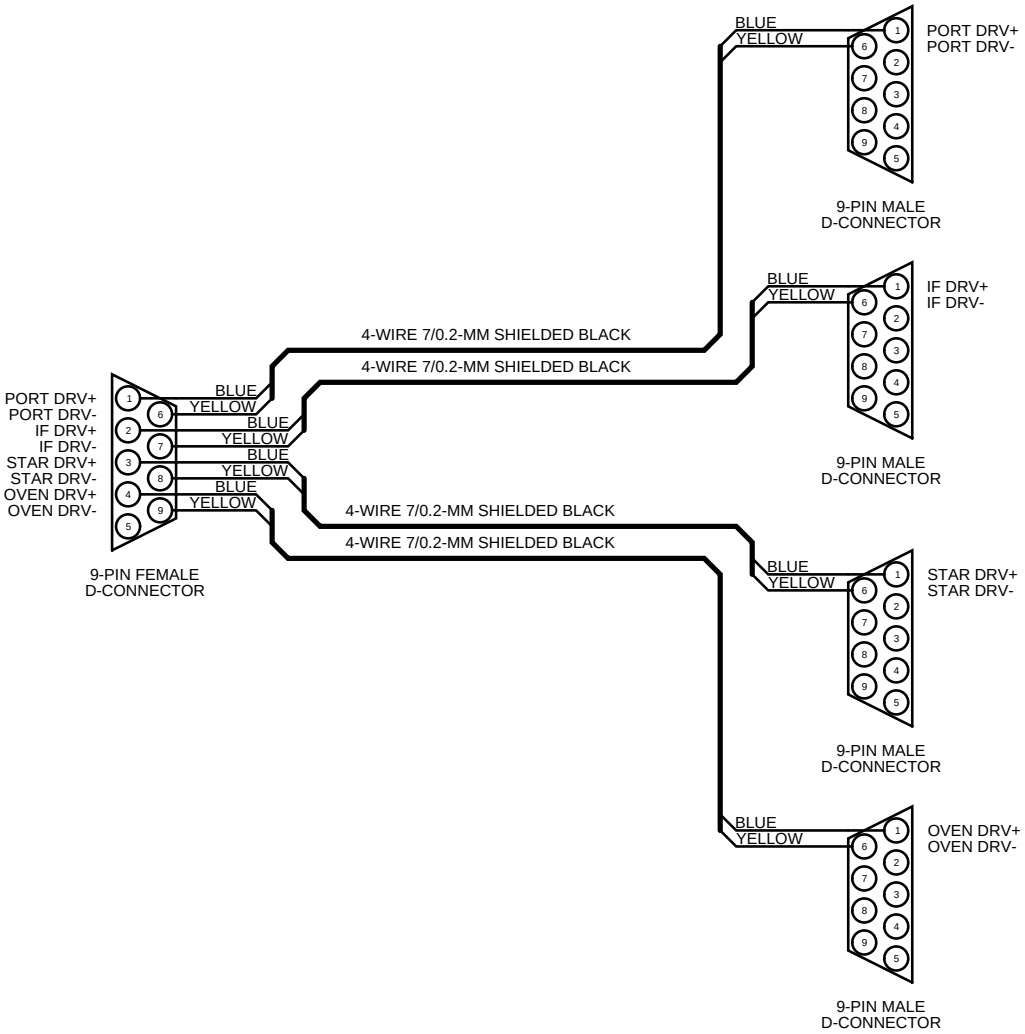

Figure 14: The Drive Wye Cable.

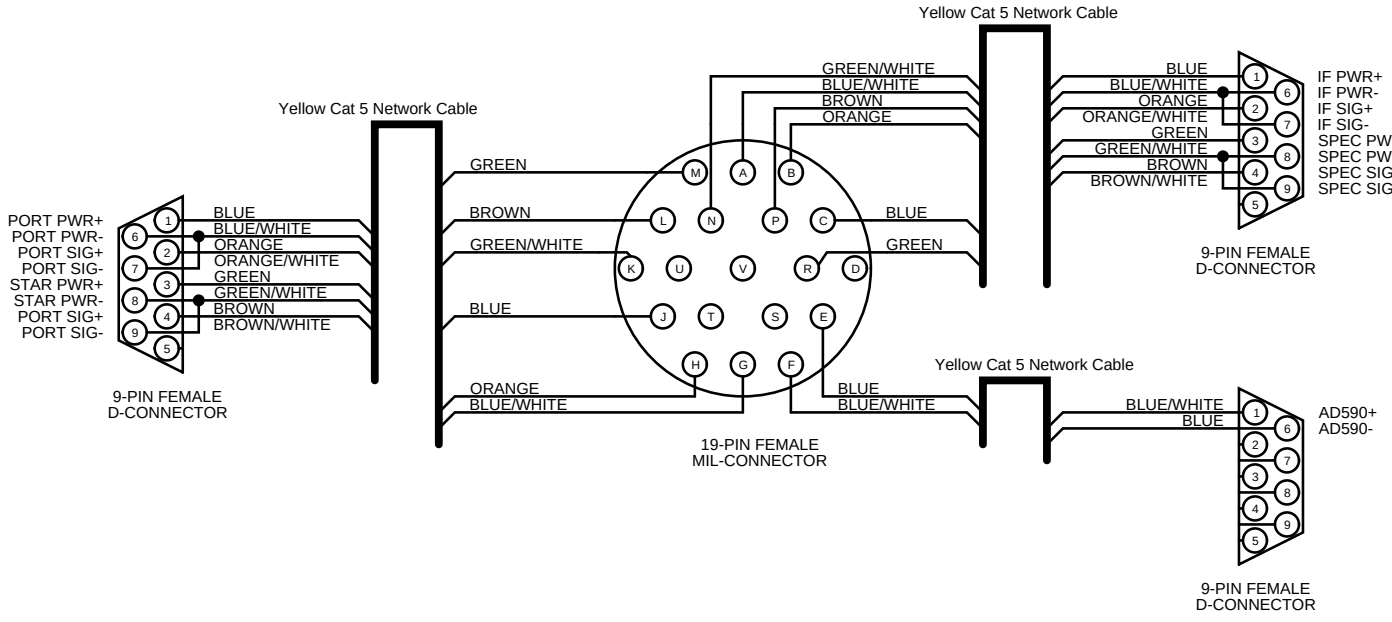

Figure 15: The Genghis Wye Cable.

6.5 Genghis Wye Cable

Figure 15 shows how the cable is connected internally.

6.6 Parts List

All of the parts that are needed to manufacture the cable assemblies used in the external connections are listed in Table 16.

Table 16: External Connections — Parts List

Part Number	Description (SSM)
RS 442-2044	19-Pin MIL Male Connector
RS 442-2123	19-Pin MIL Female Connector
Rapid* 15-0525	9-Pin Female D-Type Connector
Rapid* 15-0500	9-Pin Male D-Type Connector
RS 544-3402	D-Type Connector Hood 9-Pin (10)
Rapid* 19-4424	Yellow 10-meter Network Cable
FEC* 119-0267	12-Core (7/0.2) Screened Black Cable 100m Reel
FEC* 119-0255	4-Core (7/0.2) Screened Black Cable 100m Reel

*These items are available from Physics Stores.

7 Mechanical Drawings

There are two mechanical drawings that are associated with the Narrabri Temperature Controller and these are summarized in Table 17.

Table 17: Mechanical Drawings

Drawing	*Figure*	*Page*
Front Panel	16	24
Rear Panel	17	25

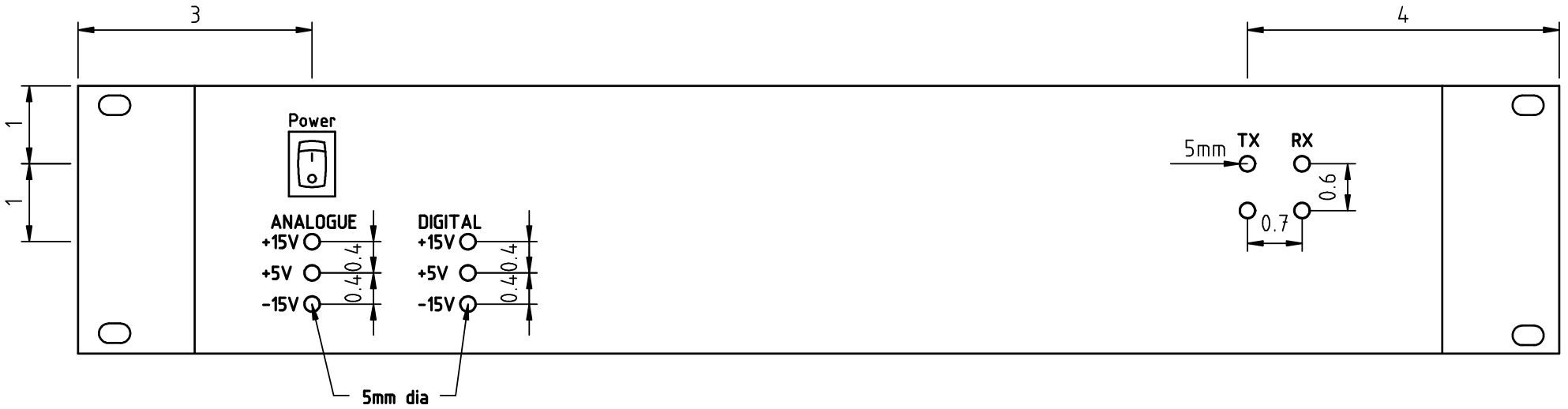

Figure 16: The Front Panel of the Narrabri Temperature Controller.

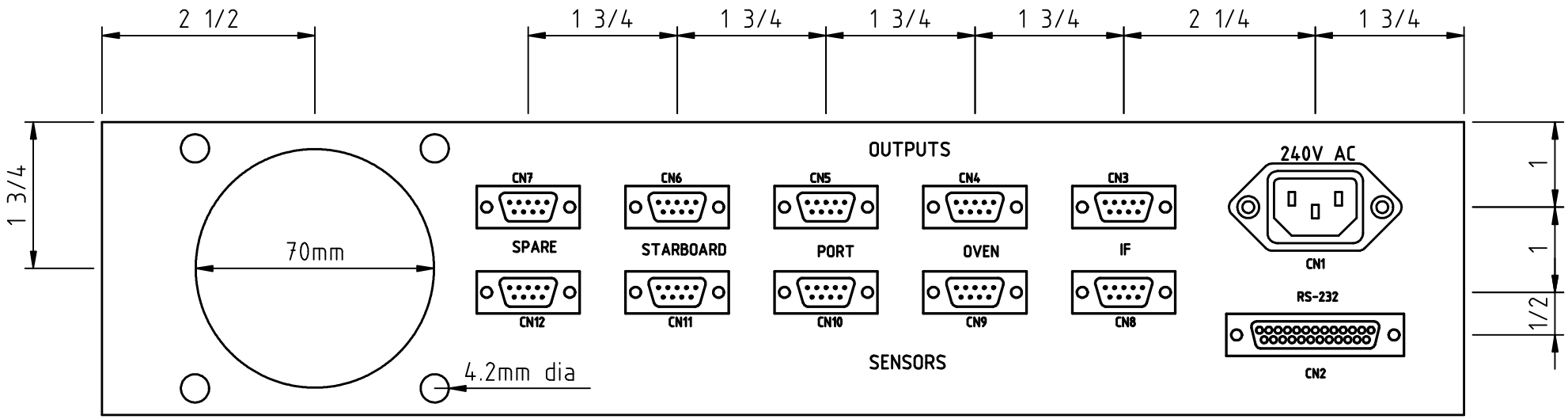

Figure 17: The Rear Panel of the Narrabri Temperature Controller.

References

[1] Ian Barnes. The installation of the Sutherland Temperature Controllers in 2007 August. *BISON Technical Report Series,* Number 294, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, January 2008.

[2] Ian Barnes and Steven J. Hale. The installation of new temperature controllers at Narrabri in 2010 February. *BISON Technical Report Series,* Number 332, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, November 2010.

[3] Ian Barnes and Brek A. Miller. A computer-controlled temperature controller. *BISON Technical Report Series,* Number 321, High-Resolution Optical-Spectroscopy Group, Birmingham, United Kingdom, June 2009.