C.S.I.R.O Australia Telescope National Facility

Australia Telescope Electronics Group

Multi Beam Correlator Racks

Manual

DRAFT

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Overview

The Multiple Beam receiver system, developed for the Parkes Telescope Neutral Hydrogen survey uses a 26 channel high resolution correlator for signal processing and archiving.

The correlator is mounted in two 39U high racks in the computer room at the Parkes telescope. The correlator racks contain 16 correlator modules and 26 ‘ S6 Multibeam Sampler’ modules, (analogue to digital convertors).

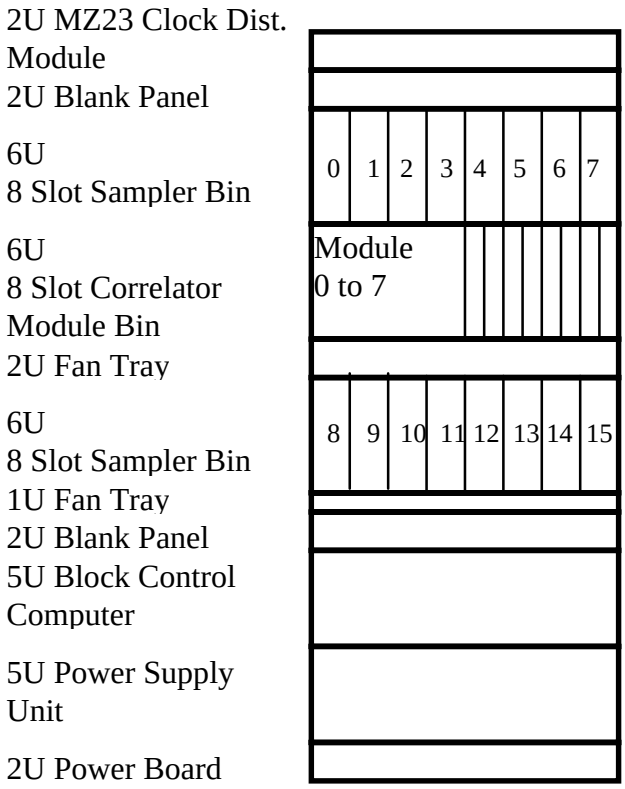
Each digital correlator module produces either two 1024 frequency channel autocorrelation products, or a single 1024 frequency channel cross correlation product.

The A to D conversion is 2 bit ‘3 level’ at 128MSamples/sec. An S6 output connects to one of two inputs on the correlator module.

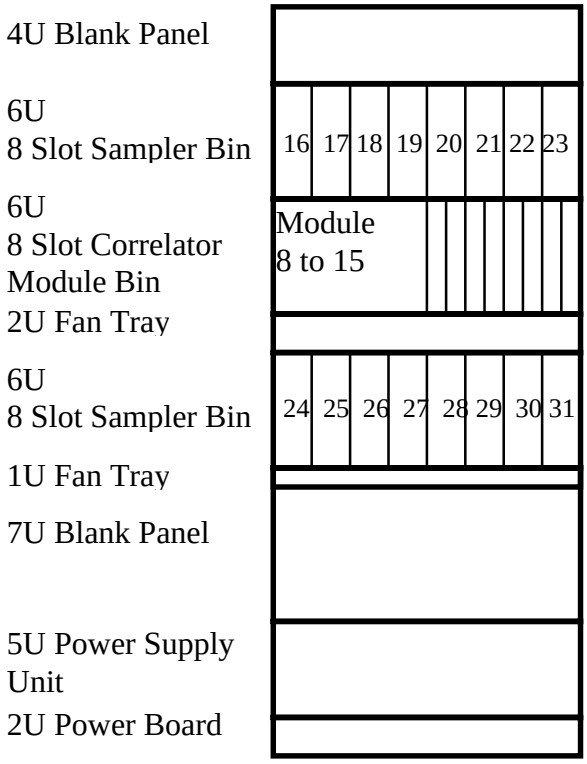
The intermediate frequency band, 128Mhz to 192MHz, is determined by filtering before the S6 module. The intermediate frequency band is down converted from an RF band of 1427MHz to1363MHz, using a Local Oscillator at 1555MHz.

Correlator Racks Front View Module Position

39U Master Rack



39 U Slave Rack



The correlator Master Rack contains the Block Control Computer and the MZ23 Correlator Clock module. The master rack is able to operate stand alone.

Each rack can handle up to 16 intermediate frequency channels. The Parkes correlator is currently configured for 26 inputs. 16 correlator modules are used to produce 26 auto-correlations and three cross correlations. Cross correlations are provided to test active noise cancellation strategies.

This manual covers ventilation, power supplies, A.C power distribution, and 128MHz clock distribution. Internal and external rack wiring are also covered.

Ventilation

The ventilation system is the same in both racks.

Adequate ventilation is required for the correlator integrated circuits to function at 128MHz. If ventilation fails damage may result to correlator integrated circuits!

Each correlator bin is ventilated by a 2U tangential blower, to minimise noise and ensure adequate ventilation. The tangential blower is powered by 240V AC mains. The up draught from the 2U blower is also ducted through the upper sampler bin.

The lower sampler bin is ventilated by a 1U fan tray. The 1U fan tray is powered by a 115V AC. The lower supply voltage ensures adequate ventilation while reducing noise. The 115V AC is provided by an auto-transformer mounted on the rear of the power supply unit.

Mains Distribution

The power supply bin MZ24 requires 240V A.C mains input. Connection is made at the rear of the bin by an IEC male chassis mounted socket. The mains input is fused by a 5A slow blow fuse.

The mains input is line filtered and connected to a I.E.C chassis mounting female socket. The unswitched outlet on the master rack is used to power the Block Control Computer. An I.E.C male to Female mains lead is required for the B.C.C power connection.

A second female chassis mounting I.E.C socket is mounted on the rear of the MZ24 bin. The second outlet active is switched by the enable switch on the front panel of the MZ24 bin. The switched outlet on the master rack is used to power the MZ23 Multi Beam Correlator Clock Distribution Module. An IEC male to female lead is required for the connection. Rack power supply modules are powered by the switched mains.

The slave rack, filtered AC and switched AC outlets are not used.

In each rack an auto-trans-former is used to provide two 115V outlets. Two round three pin sockets are mounted on the rear of each MZ24 Correlator Power Supply Bin.

Each rack has a 2U power board mounted at the base. These outlets are intended for test equipment and supplied from a separate 10A circuit.

MZ24 Correlator Power Supply

The MZ24 Correlator Power provides D.C power to the sampler and correlator bins. Both master and slave racks have an identical MZ24 power supply units. The MZ24 bin supplies +20 and +/-9 Volts to the sampler bins and .+/-5Volts to the correlator bin. In each rack the +9 and -9 Volt sampler supplies are also used to power a temperature monitor mounted in the correlator bin.

D.C Switch Mode Power Supplies Used in the Correlator Racks

Supply Voltage	Supplied to	DC Current	DC Capacity	A.C Input Current
+20V	Samplers	7.5A	150W	0.8A
+9V	Samplers	5.6A	50W	0.3A
+5V	Correlator	60A	300W	1.6A
-5	Correlator	6A	30W	0.2A
-9	Samplers	33.3A	300W	1.6A
Total			830W	4.5A

Mains power is connected from a rear panel chassis mount male IEC plug. Mains inputs line filtered and the active line is fused. The fuse holder is mounted on the rear panel of the MZ24 bin. Filtered mains is connected to a female chassis mounted IEC socket, also on the rear panel.

The filtered mains active is applied to an A.C Solid state relay. Relay outputs are connected to the switched mains plug, a chassis mounting female I.E.C plug. The Enable switch on the front panel controls the solid state relay. Switched mains are also connected to the A.C inputs of the switch mode D.C supplies.

The filtered mains connect directly to a +5 volt linear supply. The +5 volt supply is used to power an LCD Panel Meter and provides power for an enable line to a solid state relay.

All main voltages are bought out onto a tag strip mounted on the base plate of the bin.

Power supply outputs used for the samplers are line filtered. The outputs of the filters are taken to a tag strip mounted on the rear left hand side of the bin. Terminal numbers for this terminal strip have an ‘L-’ prefix.

The non-filtered supplies are bought out onto a tag strip mounted on the rear right hand side of the bin. Terminal strip numbers have an ‘R-’ prefix.

Power supply monitor voltages derived by connecting supply outputs to resistive dividers, mounted on a p.c.b in the Block Control Computer Bin. Power supply monitor voltages are then connected to analogue inputs on a PC architecture Data Acquisition card.

Power Supply Terminal Connections

Supply Voltage	Right Hand Tag Strip	Left Hand Tag Strip
+20V	R-1	
+20V Return	R-8	
+9V	R-2,R-3	
+9V Return	R-7	
+5V		L-19,L-20
+5V Return		L-17,L-18
-5		L-23
-5V Return		L-24
-9	R4,R-5	
-9 Return	R6	

High current switch mode supplies use remote sensing. The sensing leads are connected to the either the upper sampler bin or to the correlator bin as appropriate.

Sensing lines are also connected to a 6 position dual pole break before make switch on the MZ24 Power Supply front panel. The switch wipers are connected to a LCD panel meter.

Power supplies that are not sensed have monitor lines connected at either the upper sampler bin or the correlator bin. Monitor lines are connected to the 6 position dual pole switch.

Monitor and sense lines are brought out to the left hand side rear terminal strip.

Sense/Monitor Line Terminal Strip Pin Out

Supply Voltage	**Supplied to**	**Sense Lines**	**Monitor Lines**
+20V	Samplers	L-9	L-10
20V Return	Samplers	L-8	L-7
+9V	Samplers		L-12
Supply Voltage	**Supplied to**	**Sense Lines**	**Monitor Lines**
+9V Return	Samplers		L-11
+5V	Correlator	L-16	L-15
+5V Return	Correlator	L-14	L-13

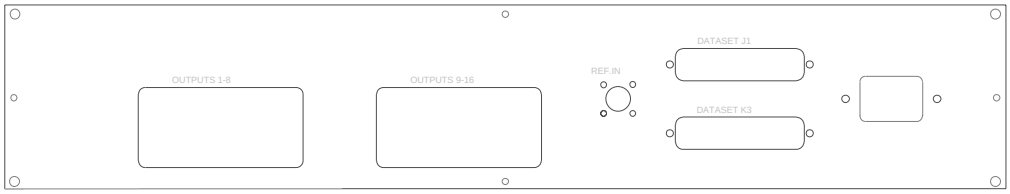
-5	Correlator		L-21
-5V Return	Correlator		L-22
-9V	Samplers	L-26	L-25
-9V Return	Samplers	L-28	L-27

MZ23 Correlator Clock Distribution Module

Correlator and sample clocks are derived from the MZ23 Multi Beam Clock Distribution Module. This module is mounted at the top of the master rack.

MZ23 Multi Beam Clock Distribution Module Front Panel

MZ23 Multi Beam Clock Distribution Module Rear Panel



Internal D.C power supplies for the module are provided by a combination of switch mode supplies and linear regulators. Power supply voltages used are +/-24Volts, + 15 Volts and +5 Volts.

Station clock of either 5 or 10MHz at a power level of 0 to -3dBm is applied from a rear panel BNC connector to the 128MHz synthesiser module.

A general purpose phase locked loop synthesiser built into a standard AT MK5 module is used for the 128MHz synthesiser. The synthesiser uses a Qualcomm Q3216 phase lock loop IC and a Mini Circuits 100-200MHz V.C.O.

The reference signal is applied to an ECL buffer 10H115. ECL logic is connected to +5V producing ‘PECL’ logic levels. The PECL reference signal is applied to the reference input of the Q3216.

Setting Reference Divisor

The mode of the Qualcomm device is set by the Q mode link, SW1. For normal usage SW1 is linked to ground.

Links R0-R3 program the reference divider. The divided reference output should equal 1MHz. The reference divisor can be determined from

Reference Divisor = (Ref Freq IN/ 1MHz) -1

Eg: If the station clock is 5MHz the reference links need to be set to the value of 4.

Reference frequency can be checked at TP2.

Setting VCO Divisor

A prescaler is used for V.C.Os with frequency higher than 300MHz. The prescaler is disabled by leaving link SW2-4 open.

VCO Divider Links

Bit	M6	M5	M4	M3	M2	M1	M0	A3	A2	A1	A0
Sw #	2-3	2-2	2-1	1-8	1-7	1-6	1-5	2-8	2-7	2-6	2-5

With the prescaler disabled the VCO divider ratio is set by 'M Register' links SW1-4 through to SW2-9. The VCO divider ratio is determined by

VCO Divider = (Required Frequency / 1MHz) -1.

'A register' links SW2-8 to SW2-5, are ignored.

Eg:In order to program 128MHz, M should be set to 127 and A should be left open. The VCO divider output can be checked at TP1.Link SW2-4 must be left open in order to disable the prescaler.

The Q3216 uses an internal phase comparator similar to the differential phase comparator used in the Motorola device, MC4044. The differential detector outputs are filtered by a dual pole low pass filter. A notch filter follows the low pass filter to reduce the effect of reference spurs. The output of the notch filter drives the VCO.

A Phase lock indicator is bought out of the synthesiser module to an internal monitor pcb. The monitor pcb provides an open collector output which drives the P.L.L Lock indicator on the front panel. P.L.L Lock is also buffered and connected to the monitor socket on the rear panel.

Output of the synthesiser is low pass filtered to reduce the second harmonic from the synthesiser V.C.O. The filtered output is connected to a 10dB coupler, the coupled output drives a Total Power Detector on the monitor p.c.b. The Total Power Detector output is wired to the PC Data Acquisition card.

The 10dB coupler through path is amplified and connected to a clock divider module. The divider module is a binary divider, with a range of 1 to 64. The divider control bus is connected to the rear panel. The rear panel connector is connected to the Block Control Computer Bus.

A 20dB coupler is connected to the divider output, the coupled path is connected to a front panel monitor socket.

The through path of the 20dB coupler is split by a two splitter, each output of the splitter drives the input of an eight way splitter. The outputs of the eight way splitters are bought out the rear panel and are used to drive the correlator modules. The nominal power at the eight way splitter outputs is 0dBm.

The Power Amplifier D.C power is controlled by a Fet switch. The FET is controlled by a three position switch on the front panel. In REMOTE mode the Power Amplifier is controlled by a TTL signal applied to the rear panel connector. The TTL control line is normally connected to a digital output on the Data Acquisition card.

A front panel indicator P.A ON is lit when the Power Amplifier is enabled. Monitor point P.A On is also wired to the rear panel monitor connector and then connected to the p.c.b Data Acquisition card.

Though provision has been made to power an A.T data set, the option to use a data set for monitor/control has been discarded. Data set functions are now provided by the DAQ card in the BCC. The internal MZ23 power supply monitor voltages are not connected to the DAQ card.

Rear Panel MZ23 Module Pin outs

Signal	Description	Source	Rear Panel Pin
PA ON	TTL Monitor Level P.A ON	Monitor pcb	J1-19
Rem PA ON	TTL Control Turn P.A ON	Monitor pcb	J1-26
PLL Lock	TTL Monitor P.L.L Lock	Monitor pcb	J1-3
GND	Analogue GND	Monitor pcb	J1-38
Mon +24	Analogue Supply Monitor	Monitor pcb	J1-5
Mon + 15	Analogue Supply Monitor	Monitor pcb	J1-6
Mon +5	Analogue Supply Monitor	Monitor pcb	J1-7
Mon-24	Analogue Supply Monitor	Monitor pcb	J1-8
PLL Level	Analogue Supply Monitor	Monitor pcb	J1-9
BCC-D0	BCC DATA BUS	Divider	K3-1
Signal	**Description**	**Source**	**Rear Panel Pin**
BCC-D1	BCC DATA BUS	Divider	K3-34
BCC-D2	BCC DATA BUS	Divider	K3-18
BCC-D3	BCC DATA BUS	Divider	K3-2
BCC-WR	BCC DATA BUS-Write	Divider	K3-23

BCC-ACK	BCC DATA BUS-Acknoldge	Divider	K3-40
BCC-STB	BCC DATA BUS-Strobe	Divider	K3-8
DSA0	AT Dataset Address Link	Monitor pcb	J1-29
DSA1	AT Dataset Address Link	Monitor pcb	J1-12
DSA2	AT Dataset Address Link	Monitor pcb	J1-45
DSA3	AT Dataset Address Link	Monitor pcb	J1-28
DSA4	AT Dataset Address Link	Monitor pcb	J1-44
GND	Gnd	Monitor pcb	J1-11
-20V	AT Dataset Power	Supply	J1-49
+9V	AT Dataset Power	Supply	J1-17
+20V	AT Dataset Power	Supply	J1-33
GND	AT Dataset Power	Supply	J1-16

Sampler Back Plane

D.C voltages of +20 and +/-9 volts are supplied from the MZ24 Correlator Power Supply Bin. The power supply wiring is connected to the left hand side terminal strip and runs in conduit to the lower sampler backplane. A link is then made between the lower and upper sampler backplanes.

Power supply sense and monitoring lines are run to the upper sampler backplane. The sense lines are connected to the right hand terminal strip on the MZ24 Correlator Power Supply Bin.

Each sampler module is controlled by a data interface controlled by a correlator module. The data interface collects total power data, sets the total power prescaler, monitors loop lock indicators and reads the sampler serial number.

A correlator module generally controls two sampler modules. Address decoding links for the sampler modules are provided on the rear of the sampler backplane. At the Parkes installation links J24,J22,J20 and J18 are set to zero. Address links J23, J21, J19 and J17 are set to one.

The sampler data interface is daisy chained between two sampler connectors and on to the correlator module by a 34 pin IDC cable, note pin one is oriented to the top of the sampler backplane.

Sampler I.F inputs are connected to the rear of the sampler interface pcb at the amplifier input. The IF is connected via a BNC connector. The sampler IF inputs originate in the Multi Beam Interface Rack, and connect to Cable Equaliser outputs.

Sampler clock inputs are connected to correlator clock output connectors by RG174 coaxial-axial cables terminated in BNC connectors. Each correlator module provides clock outputs for two samplers.

The sampler data cable connects to sampler data outputs to a correlator module and is made from two multi core cables. Each multi core cable contains two shielded twisted pairs. Both cables are terminated in a 15 pin female D connector which terminates on the correlator backplane. The other cable ends connect to a sampler via a 9 pin female D connector.

Special 'three product' data cables have also been fabricated. Three product cables use four multi-core cables. Each correlator data input connects to both sampler outputs allowing either two auto-correlation products or a cross-correlation product to be formed by the correlator module.

Standard Sampler Data Cable Pin Outs

Signal	Cble 1 Core	Cble 2 Core	15 Way	9 Way #1	9 Way #2
S1 Sign+	White		9	2	
S1 Sign-	Green		2	7	
S1 Mag+	Red		3	4	
S1 Mag-	Black		11	9	
S1 Shield	Screen		1	Open	
S2 Sign+		White	13		2
S2 Sign-		Green	6		7
S2 Mag+		Red	7		4
S2 Mag-		Black	15		9
Signal	Cble 1 Core	Cble 2 Core	15 Way	9 Way #1	9 Way #2
S2 Shield	Screen		8	Open	

Three Product Sampler Data Cable Connections

Signal	Cble 1	Cble 3	Cble 2	Cbl 4	Corr #1	Corr #2	Sam #1	Sam #2
S1 Sign+	White	White			9	9	2	
Signal	**Cble 1**	**Cble 3**	**Cble 2**	**Cbl 4**	**Corr #1**	**Corr #2**	**Sam #1**	**Sam #2**
S1 Sign-	Green	Green			2	2	7	
S1 Mag+	Red	Red			3	3	4	
S1 Mag-	Black	Black			11	11	9	

S1 Shield	Screen	Screen			1	1	Open	
S2 Sign+			White	White	13	13		2
S2 Sign-			Green	Green	6	6		7
S2 Mag+			Red	Red	7	7		4
S2 Mag-			Black	Black	15	15		9
S2 Shield	Screen	Screen			8	8	Open	

Sampler and correlator module positions are detailed in figure 'Correlator Racks Front View Module Position' in the overview section. Cabling for Intermediate Frequency input, data, sampler clock and sampler control buss used in the mutlibeam correlator sampler bins are detailed below. Note Sampler slots 4,5,6,7,20 and 21 then been left as spare slots.

Sampler Bin I.F Input, Data Bus, Clock and Data Connections

Sampler Position No.	**IF IN**	**Sam Data to Corr Mod #**	**Corr Mod Data Buss**	**Corr Mod Clk Source**	**Sam Address**
0	1	0 and 1	0	0	0
1	2	0 and 1	0	0	1
4	3	2 and 3	2	2	0
5	4	2 and 3	2	2	1
8	5	4	3	3	0
9	6	4	3	3	1
10	7	5	5	5	0
11	8	5	5	5	1
12	9	6	6	6	0
13	10	6	6	6	1
14	11	7	7	7	0
15	12	7	7	7	1
16	13	8	8	8	0
17	14	8	8	8	1
18	15	9 and 10	9	9	0
19	16	9 and 10	9	9	1
22	17	11	11	11	0
23	18	11	11	11	1
Sampler Position No.	**IF IN**	**Sam Data to Corr Mod #**	**Corr Mod Data Buss**	**Corr Mod Clk Source**	**Sam Address**
24	19	12	12	12	0
25	20	12	12	12	1
26	21	13	13	13	0
27	22	13	13	13	1

28	23	14	14	14	0
29	24	14	14	14	1
30	25	15	15	15	0
31	26	15	15	15	1

Correlator Back Plane

Sampler data cables, sampler clock outputs and sampler control buss connectors connect to the correlator back planes.

In addition the correlator backplane provides connections for a 32 and 24 bit DMA buss, connections to a Block Control Computer Buss, and an Event Generator Buss. Inputs from the MZ23 Correlator Clock Distribution Module are also terminated on the correlator backplane.

Each correlator backplane is given a unique address for decoding DMA data. The address is set by SW1 mounted on the rear of backplane. The Master rack backplane has address 0x4200 and is identifired as Block 2. The slave rack has address 0x4300 and is identified as Block 3. Blocks 0 and 1 are two blocks of A.T compact array correlator.

A 32 bit DMA buss is used for the Parkes Multi Beam correlator. The DMA buss originates in a DMA interface card is at the DEC Alpha computer. The DMA buss is terminated at the Alpha end.

Two cables connect to the interface a 60 way ‘twist and flat’ IDC connector and a 16 way IDC connector. The 16 way cable carries data bits D24 to D31. A 60 way IDC ‘twist and flat’ and a 16 way ‘twist and flat’ cable are used for the connections.

The 16 way cable is connected to a 40 way IDC connector at pins 9 through 24 on the Block 2. Backplane. The 60 way IDC cable terminates in a 60 way IDC connector on Block 2. The 60 way IDC and the 16 way IDC cable are then diasy chained onto Block 3.

Correlator Block 2 is connected to the BCC external Buss port 0. Correlator Block 1 is connected to BCC external Buss Port 1. Connections are made by 50 way IDC cables.

The PC Event Generator Buss is connected via a 34 way ‘twist and flat’ IDC cable. The cable connects to the output port on the BCC Event Generator Card and then daisy chains between Block 2 and Block 3.

Event 15 is connects via a switching box to the Alpha. Event 15 is used as an interrupt to Alpha control program. The switching box is used to switch between an interrupt generated by AT compact array correlator and the Multi-beam correlator interrupt.

Event 3 is used as the SYNC signal for the Total Power Noise Measurement system. Event 3 drives an optical modem, the modem then control the noise diode on the receiver package.

Block Control Computer

The multi beam correlator block control computer consists of a ISA passive back plane a 486 ISA bus PC card, an Ether-net adaptor, an AT Event generator, an AT External Buss card and a Data Acquisition card.

The Ether-net adaptor is used to communicate between the BCC and the Alpha process control computer.

The Event generator synchronises system timing from an external 'BAT' time signal. The event generator outputs pre-programmed time specific TTL 'event' signals.

The AT External Buss provides a flexible addressed data buss interface for control and monitoring of remote peripherals. The external buss card has three separate output busses.

The Block Control Computer is given an address by an Identity board mounted on the front mounting BCC interface panel in the Block control computer bin. The BCC interface panel has a BCC power on indicator and a BCC external bus strobe activity indicator.

Multi Beam Block Control Computer Details

Name	Address	I.P Number
PKBCC02	0x42	192.207.157.163

The upper byte value 0x40 of the BCC identifier address is unique to the Parkes site.

The Data Acquisition card is used to control and monitor the MZ23 Clock Distribution Module, correlator bin ambient temperatures and the MZ24 Correlator Power Supply bins.

Monitor and Control Points Interfaced to Data Acquisition Card

Signal	Type	Source	Divider In	Divider Out	Tag Strip	Monitor Card	Monitor Sig
+20R1	S.E Analogue	MZ24 Master	1	1	1	CN3-1	A/DS0
+20R2	S.E Analogue	MZ24 Slave	2	2	2	CN3-20	A/DS8
+9R1	S.E Analogue	MZ24 Master	3	3	3	CN3-2	A/DS1

+9R2	S.E Analogue	MZ24 Slave	4	4	4	CN3-21	A/DS9
+5R1	S.E Analogue	MZ24 Master	5	5	5	CN3-3	A/DS2
+5R2	S.E Analogue	MZ24 Slave	6	6	6	CN3-22	A/DS10
Signal	**Type**	**Source**	**Divider In**	**Divider Out**	**Tag Strip**	**Monitor Card**	**Monitor Sig**
-5R1	S.E Analogue	MZ24 Master	7	7	7	CN3-4	A/DS3
-5R2	S.E Analogue	MZ24 Slave	8	8	8	CN3-23	A/DS11
-9R1	S.E Analogue	MZ24 Master	9	9	9	CN3-5	A/DS4
-9R2	S.E Analogue	MZ24 Slave	10	10	10	CN3-24	A/DS12
TempR1	S.E Analogue	MZ24 Master	11	11	11	CN3-6	A/DS5
TempR2	S.E Analogue	MZ24 Slave	12	12	12	CN3-25	A/DS13
PLL DET	S.E Analogue	MZ23	13	13	13	CN3-7	A/DS6
spare	S.E Analogue		14	14	14	CN3-26	A/DS14
spare	S.E Analogue		15	15	15	CN3-8	A/DS7
spare	S.E Analogue		16	16	16	CN3-27	A/DS15
GND			17	17	17	CN3-9	
GND			18	18	18	CN3-28	
GND			19	19	19	CN3-10	
GND			20	20	20	CN3-29	
P.A ON	D/I	MZ23			21	CN2-1	D/I 0
PLL LOCK	D/I	MZ23			22	CN2-2	D/I 1
SPARE	D/I				23	CN2-3	D/I 2
SPARE	D/I				24	CN2-4	D/I 3
SPARE	D/I				25	CN2-5	D/I 4
GND					26	CN2-17	
GND					27	CN2-18	
PA ON	D/O	MZ23			28	CN1-1	D/O 0
SPARE	D/O				29	CN1-2	D/O 1
SPARE	D/O				30	CN1-3	D/O 2
SPARE	D/O				31	CN1-4	D/O 3
GND					32	CN1-17	
GND					33	CN1-18	

The analogue voltage resistive dividers are located on an interface pcb in the block control computer bin. Spare monitor and control points are also be accessed at this point.