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

Australia Telescope Electronics Group

Parkes Multi Beam Back End

Manual

Contents

Appendix C

MC1 Circuit Diagram
MZ26 Circuit Diagrams
Sampler Pre Amplifier Circuit Diagram
Sampler Mounting PCB Circuit Diagram
Sampler Back Plane

Appendix D

Documentation List

Parkes Multi Beam Back End MS Word docuement R.O
ateg2::\\usr2\users\multibeam\system\mbbacke.doc
M Leach

Pulsar Filter Bank Conversion System MSWord document R.O
ateg2::\\usr2\users\multibeam\pulsar\doc\updoc.doc
M Leach

S6 Multi Beam Sampler Manual MSWord document R.O
ateg2::\\usr2\users\multibeam\s6\doc\msamdoc.doc
M Leach

Multi Beam Correlator Racks MSWord document R.O
ateg2::\\usr2\users\multibeam\system\doc\corr_rck.doc
M Leach

Drawings

Read Only schematics and mechanical drawings can be found in the subdirectories of

ateg2::\\usr2\users\multibeam\

Schematics are Protel Schematic Capture
PCB layouts are protel PCB
Mechanical drawings are generally Microstation Drawings, except for cable equaliser which are drawn in Protel PCB

Overview

This manual describes the RF chain of the Parkes Multi Beam Receiving system from the Receiver post amplifier, Down Conversion Module to the Cable Equalisation Modules. The sampler pre-amplifier and band select filter are also discussed.

The IF output from the Cable Equalisation modules are split into two signals.

One signal is input to the Pulsar Filter Bank Conversion System. This system is described in the document " Parkes Filter Bank Conversion System".

The second split IF signal drives the sampler pre-amplifier and is converted to a two bit digital signal by the S6 module, see "S6 Multi Beam Sampler Manual".

Receiver Package

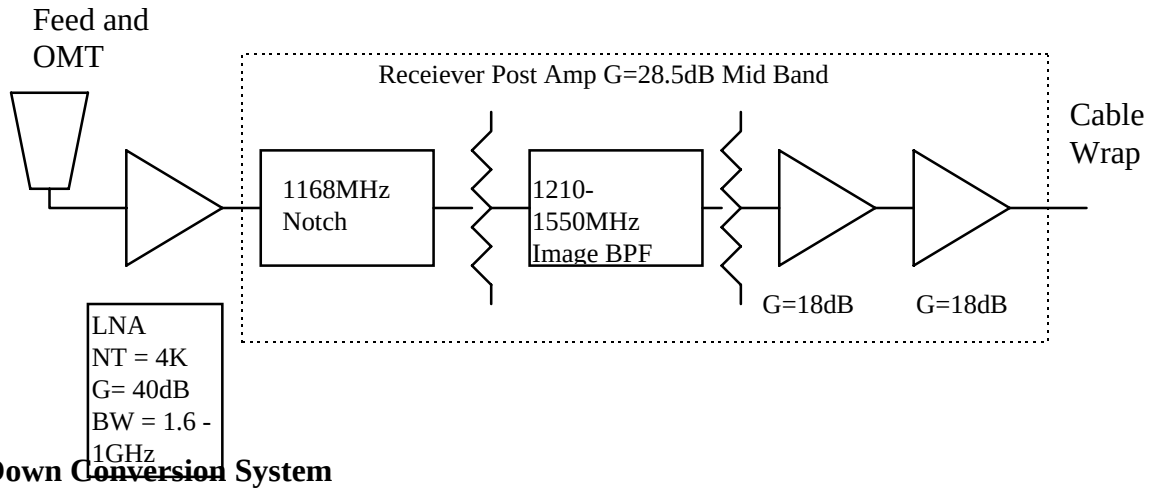
Twenty six Low Noise Amplifiers[1] are mounted on the 20K station of the multi-beam receiver. LNA outputs are taken through the dewar and connected to twenty six post amplifiers. The post amplifiers include an image filter (1210 - 1550 MHz) and a notch filter centred on 1168MHz.

Average receiver terminal temperature of 23.5K was measured at receiver installation.

The notch filter is intended to filter out the Parkes Airport beacon.

The post amplifier has a nominal overall gain of 26.5dB. Outputs from the post amplifiers are connected to a 20m run of Andrews FSJ1-50A low loss cables. The 26 cables pass through a an articulated cable wrap allowing receiver rotation, focus and position translations. Low loss cables are terminated on a rear mounted bulkhead near the down-conversion bin.

Fig 1: Block Diagram Single Channel of Receiver



Down Conversion System

[1] Low Noise Amplifiers were constructed by NRAL at Jodrell Bank.

A single down conversion stage is used to convert the R.F band (1210-1550MHz) to an IF frequency range of 50 to 345MHz. The local oscillator is set to a frequency of 1555MHz.

The Multi Beam Down Conversion Bin is a standard AT style bin. The bin is mounted in a 39U rack in the aerial cabin near the telescope cable bulkhead. The Down Conversion system consists of 6 modules. The ML1 ‘LO Distribution Module’ is third from the right.

There are five MC1 ‘Down Convertor’ modules. Each MC1 module contains six down Convertors. The system allows four spare down Convertors. The module designated MC1_0 is on the extreme right facing the front of the bin.

The bin is powered from +/-20 Volts from the switch mode power supply rack.

Figure 2: Front View Multi Beam Down Conversion Bin

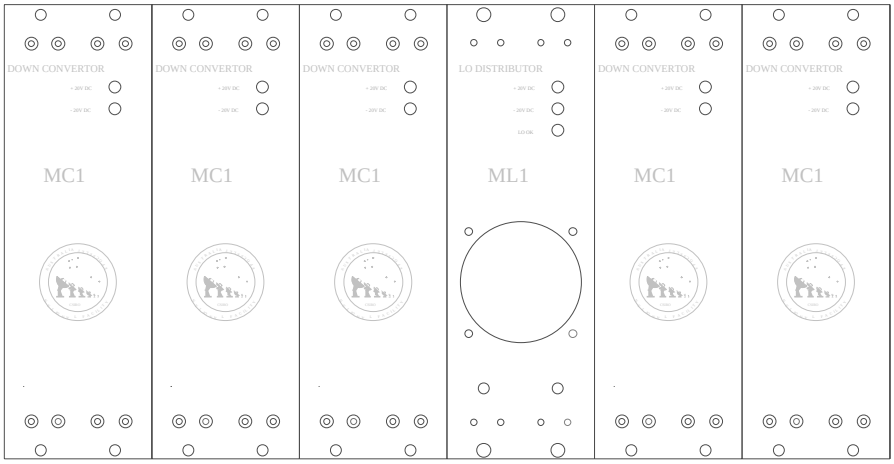
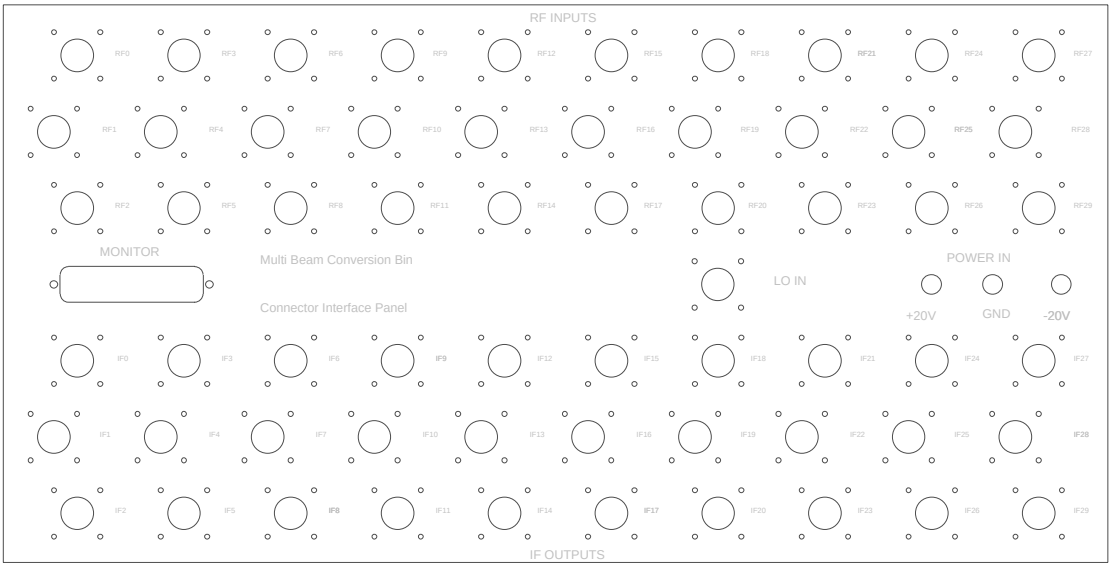


Figure 3: Rear View Multi Beam Conversion Bin Connector Interface Panel



Local Oscillator Distribution and ML1 Module

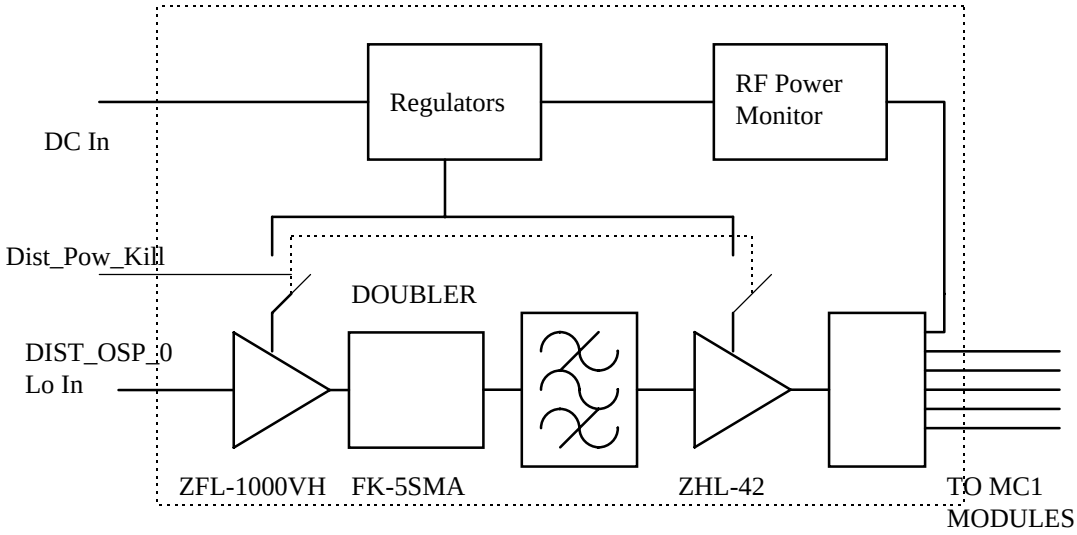
The local oscillator is derived from a synthesiser in the control room. The synthesiser is ‘locked’ to the station clock and outputs a frequency of 777.5MHz at a level of +16dBm. The synthesiser is controlled by the observing program.

Synthesiser output is connected to cable ‘40’, a “half inch” low loss cable running to the aerial cabin. The aerial cabin end of cable 40 connects via the telescope cable leg bulkhead, terminating at the LO IN connector of the Multi Beam Conversion Bin Connector Interface Panel.

The Local Oscillator signal is connected to the Local Oscillator Distribution module ML1 via a semi rigid cable between the LO IN connector on the interface panel and an OSP connector (Dist_OSP_0)[2] on the backplane.

The ML1 module amplifies and doubles the incoming Local Oscillator Frequency. Spurious multiplication products are filtered by a bandpass filter, CF = 1480MHz and BW = 250MHz. The Local Oscillator signal is then amplified and the output split for distribution to the five MC1 Down Conversion Modules. Each MC1 module contains six down Convertors, the total Local Oscillator power level at the outputs of the ML1 module are required to be between +16 and +18dBm.

Figure 4: Block Diagram of ML1 Module



The RF level is monitored at one of the unused splitter outputs. A LED Indicator ‘LO OK’ is lit if the Local Oscillator power level is above a preset threshold. The two unused outputs of the eight way splitter are terminated. The output of the detector is also available at the Monitor Connector, pin 36. Other monitor signals, such as power supply and temperature monitor are detailed in Table 1. A facility to Remotely disable the Local Oscillator power amplifiers by a TTL signal is also available.

Table 1: Interface Panel Monitor Connector Pin Outs for ML1 Modules

[2] See Appendix C Cablist.xls

Signal	Monitor Pin Number	Description
GND	50	DC Power
Mon_+15R1	22	+15 Regulator/ 10 Analogue Monitor
Mon_+15R2	38	+15 Regulator/10 Analogue Monitor
Mon_-15R1	5	-15 Regulator/10 Analogue Monitor
Mon_+20	21	+20V In/10 Analogue Monitor
Mon_-20	37	-20V In/10 Analogue Monitor
Mon_Tmp	4	Temp Mon (1V =100K) Analogue Monitor
Pow_Mon	36	Monitor Power Detector Analogue Voltage
Pow_Kill	1	TTL Level disable Power Amps

Table 2: Multi Beam Down Conversion Bin Back Plane RF Connector Layout

MC1_O		MC1_1		ML1		MC1_2		MC1_3		MC1_4	
OSP 21	OSP 7	OSP 21	OSP 7	OSP 21	OSP 7	OSP 21	OSP 7	OSP 21	OSP 7	OSP 21	OSP 7
OSP 20	OSP 6	OSP 20	OSP 6	OSP 20	OSP 6	OSP 20	OSP 6	OSP 20	OSP 6	OSP 20	OSP 6
OSP 19	OSP 5	OSP 19	OSP 5	OSP 19	OSP 5	OSP 19	OSP 5	OSP 19	OSP 5	OSP 19	OSP 5
OSP 18	OSP 4	OSP 18	OSP 4	OSP 18	OSP 4	OSP 18	OSP 4	OSP 18	OSP 4	OSP 18	OSP 4
OSP 17	OSP 3	OSP 17	OSP 3	OSP 17	OSP 3	OSP 17	OSP 3	OSP 17	OSP 3	OSP 17	OSP 3
OSP 16	OSP 2	OSP 16	OSP 2	OSP 16	OSP 2	OSP 16	OSP 2	OSP 16	OSP 2	OSP 16	OSP 2
OSP 15	OSP 1	OSP 15	OSP 1	OSP 15	OSP 1	OSP 15	OSP 1	OSP 15	OSP 1	OSP 15	OSP 1
OSP 14	OSP 0	OSP 14	OSP 0	OSP 14	OSP 0	OSP 14	OSP 0	OSP 14	OSP 0	OSP 14	OSP 0
OSP 13	D	OSP 13	D	OSP 13	D	OSP 13	D	OSP 13	D	OSP 13	D
OSP 12	D	OSP 12	D	OSP 12	D	OSP 12	D	OSP 12	D	OSP 12	D
OSP 11	D	OSP 11	D	OSP 11	D	OSP 11	D	OSP 11	D	OSP 11	D
OSP 10	D	OSP 10	D	OSP 10	D	OSP 10	D	OSP 10	D	OSP 10	D
OSP 9	D	OSP 9	D	OSP 9	D	OSP 9	D	OSP 9	D	OSP 9	D
OSP 8	D	OSP 8	D	OSP 8	D	OSP 8	D	OSP 8	D	OSP 8	D

Table 3: DC and Monitor Connector Pin Out for ML1 Module

Signal	Pin Number	Description
+20 In	17,16,15,14	DC Power

-20 In	50,49,48,47	DC Power	
GND	33,32,31,30,29,28,27,26	DC Power	
Mon_+15R1	1	+15 Regulator/ 10	Analogue Monitor
Mon_+15R2	18	+15 Regulator/10	Analogue Monitor
Mon_-15R1	34	-15 Regulator/10	Analogue Monitor
Mon_+20	2	+20V In/10	Analogue Monitor
Mon_-20	19	-20V In/10	Analogue Monitor
Mon_Tmp	35	Temp Mon (1V =100K)	Analogue Monitor
Pow_Mon	3	Monitor Power Detector	Analogue Voltage
Pow_Kill	36	TTL Level disable Power Amps	

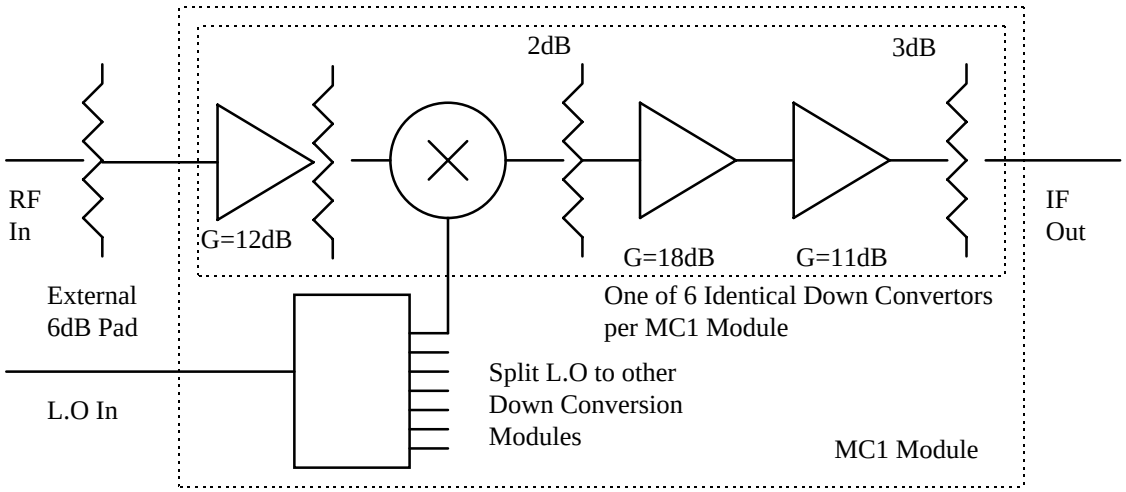
Table 4: Local Oscillator Connections

Signal	LO0	LO1	LO2	LO3	LO4
L.O Out	ML1_21	MCL1_20	MC1_7	ML1_6	ML1_5
LO In	MC1_0_7	MC1_1_7	MC1_2_7	MC1_3_7	MC1_4_7

Down Conversion Module MC1

Six down conversion modules are mounted in each MC1 module.

Figure 5: Block Diagram of a Single Down Conversion Module



The incoming RF low loss cables, Andrews cable FSJ1-50A, are terminated on a jumper panel mounted on the rear of the 39U rack. Short jumper cables connect from the jumper panel to a set of 6dB attenuators mounted on the Multi Beam Conversion Bin Connector Interface Panel. Attenuators are included to improve mis-match between the down conversion modules and the receiver post amplifier output.

The I.F output from each down-convertor is connected to the telescope cable bulkhead by 2 metre lengths of RG223 cable. Nominal output power from the down conversion stage in the 60-360MHz band is -12dBm.

Each down conversion module is powered by a +15V regulated supply. There are two separate +15V regulated supplies. A -15V regulated supply is required for the temperature monitor. The temperature monitor has a transfer characteristic of 1V=100K.

MC1 module monitor points are detailed in Table 5.

Table 5: Monitor Connector Pin Outs for MC1 Modules

Signal	Mon+15R1	Mon+15R2	Mon-15	Mon+20	Mon-20	Mon_Tmp	GND
MC1_0	Mon_17	Mon_33	Mon_49	Mon_16	Mon_48	Mon_15	Mon_50
MC1_1	Mon_31	Mon_47	Mon_14	Mon_30	Mon_46	Mon_13	Mon_32
MC1_2	Mon_45	Mon_12	Mon_28	Mon_44	Mon_11	Mon_27	Mon_29
MC1_3	Mon_43	Mon_10	Mon_42	Mon_7	Mon_39	Mon_6	Mon_26
MC1_4	Mon_22	Mon_38	Mon_5	Mon_21	Mon_37	Mon_4	Mon_23

Table 6: DC and Monitor Connector Pin Out for MC1 Module

Signal	Pin Number	Description	
+20 In	17,16,15,14	DC Power	
-20 In	50,49,48,47	DC Power	
GND	33,32,31,30,29,28,27,26	DC Power	
Mon_+15R1	1	+15 Regulator/ 10	Analogue Monitor
Mon_+15R2	18	+15 Regulator/10	Analogue Monitor
Mon_-15R1	34	-15 Regulator/10	Analogue Monitor
Mon_+20	2	+20V In/10	Analogue Monitor
Mon_-20	19	-20V In/10	Analogue Monitor
Mon_Tmp	35	Temp Mon (1V =100K)	Analogue Monitor

Table 7: RF and IF Connections MC1 Modules to Interface Panel

IF Number	RF In	Back Plane	IF Out	Back Plane

1	RF0	MC1_0_OSP_0	IF0	MC1_0_OSP_1
2	RF2	MC1_0_OSP_2	IF2	MC1_0_OSP_3
3	RF3	MC1_0_OSP_21	IF3	MC1_0_OSP_20
4	RF4	MC1_0_OSO_13	IF4	MC1_0_OSO_12
5	RF5	MC1_0_OSP_11	IF5	MC1_0_OSP_10
6	RF6	MC1_0_OSP_9	IF6	MC1_0_OSP_8
7	RF7	MC1_1_OSP_0	IF7	MC1_1_OSP_1
8	RF8	MC1_1_OSP_2	IF8	MC1_1_OSP_3
9	RF9	MC1_1_OSP_21	IF9	MC1_1_OSP_20
10	RF10	MC1_1_OSO_13	IF10	MC1_1_OSO_12
11	RF11	MC1_1_OSP_11	IF11	MC1_1_OSP_10
12	RF12	MC1_1_OSP_9	IF12	MC1_1_OSP_8
13	RF13	MC1_2_OSP_0	IF13	MC1_2_OSP_1
14	RF14	MC1_2_OSP_2	IF14	MC1_2_OSP_3
15	RF15	MC1_2_OSP_21	IF15	MC1_2_OSP_20
16	RF16	MC1_2_OSO_13	IF16	MC1_2_OSO_12
17	RF17	MC1_2_OSP_11	IF17	MC1_2_OSP_10
18	RF18	MC1_2_OSP_9	IF18	MC1_2_OSP_8
19	RF19	MC1_3_OSP_0	IF19	MC1_3_OSP_1
20	RF20	MC1_3_OSP_2	IF20	MC1_3_OSP_3
21	RF21	MC1_3_OSP_21	IF21	MC1_3_OSP_20
22	RF22	MC1_3_OSO_13	IF22	MC1_3_OSO_12
23	RF23	MC1_3_OSP_11	IF23	MC1_3_OSP_10
24	RF24	MC1_3_OSP_9	IF24	MC1_3_OSP_8
25	RF25	MC1_4_OSP_0	IF25	MC1_4_OSP_1
26	RF26	MC1_4_OSP_2	IF26	MC1_4_OSP_3
27	RF27	MC1_4_OSP_21	IF27	MC1_4_OSP_20
28	RF28	MC1_4_OSO_13	IF28	MC1_4_OSO_12
29	RF29	MC1_4_OSP_11	IF29	MC1_4_OSP_10
30	RF30	MC1_4_OSP_9	IF30	MC1_4_OSP_8

Telescope Cables

Twenty six I.Fs from the down conversion modules are run down the telescope in low loss FSJ1-50A cable. The cable run of 117m terminates in a bulkhead inside the spiral stair case at the control room. The cables are extended to the Multi Beam Interface rack with 15 metre lengths of LMR-200 cable. The twenty six IF cables terminate at the MZ26 Cable Equaliser module.

MZ26 Cable Equaliser Module

The MZ26 Module is intended to cancel the frequency dependent loss of the telescope cables, a slope of nearly 10dB over the 300MHz band. The Cable Equaliser consists of 3U 19 inch rack mount case. Thirteen dual channel modules plug into a back plane from the rear of the module.

The front panel mounts indicators and control switches. The front panel opens vertically to allow access to the module power supplies.

The MZ26 cable equaliser module equalises the frequency response to be flat to 0.5 dB from 60MHz to 360MHz.

Figure 6: Front View of MZ26 Cable Equaliser

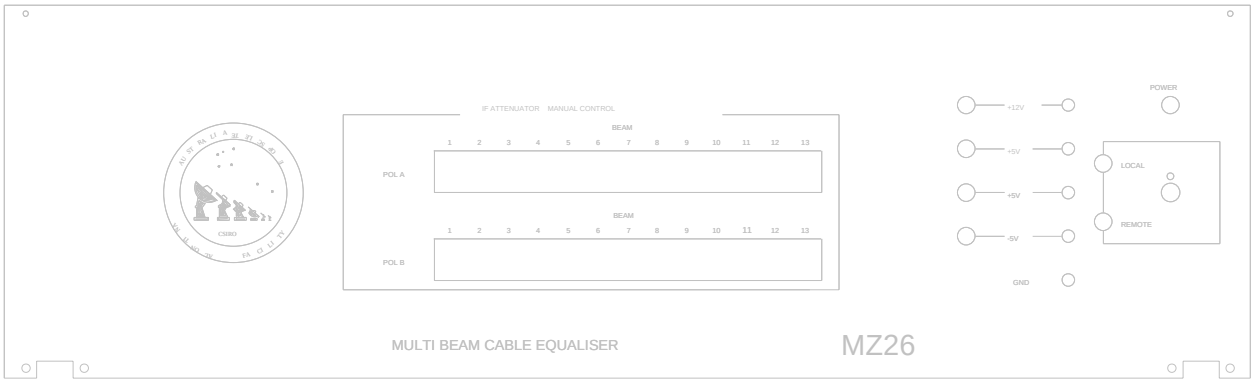
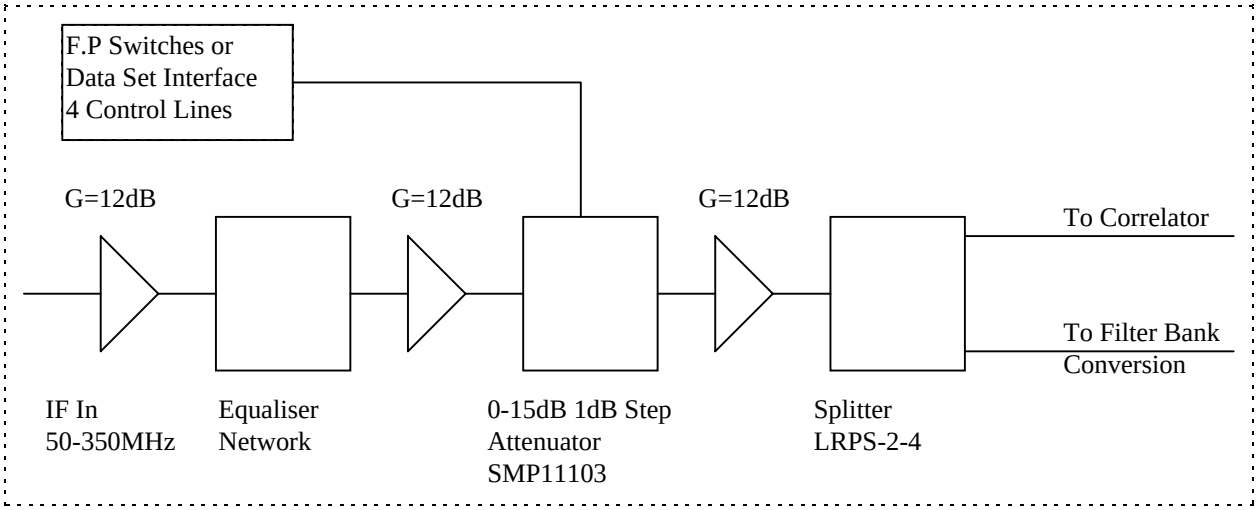


Figure 7: Block Diagram Single Channel of Cable Equaliser Module



Individual attenuators, (0 to 15dB in 1dB steps), are used to set the power level of each IF channel. The attenuators can be controlled from front panel switch when the Local/Remote mode switch is in Local Mode. When in Remote Mode the attenuators are set by the observing software via the Multi Beam Interface Rack AT Dataset. NOTE: The Multi Beam Interface Rack Data set is powered by the MZ25 Local Oscillator Distribution Module.

The incoming IF signal is split into two identical signals. One signal is used to drive the correlator, the other signal is input to the pulsar filter bank conversion system.

With the equaliser attenuator set to 7dB a loss of 13dB is expected from the telescope cables and each cable equaliser module output across the 60-360MHz band. Total power at the outputs over the 50-350MHz band is nominally -25dBm.

Front panel switch buffering and a simple AT data set interface functions are contained on the MZ26 Back plane.

Data Set Interface

The MZ26 modules are programmed by either 8 or 16 bit addressed writes from the Multi Beam Interface Rack AT data set. The same AT dataset can be used to read wether the MZ26 module is in Remote or Local Mode. No provision for read back of attenuator settings has been made.

Dataset address bus space is set by JP2 and JP3 on the MZ26 backplane. JP1 selects wether the Hi or Low byte from a 16 bit Data set transfer is used for programming data.

Table 8: MZ26 Cable Equaliser Module Links Defining Data Set Address Space

JP 1	JP 2	JP-3	Address Space	Hi/Lo Byte from Data Buss
0	0	0	00-15	Low
1	0	0	00-15	Hi
0	0	1	16-31	Low
1	0	1	16-31	Hi
0	1	0	32-47	Low
1	1	0	32-47	Hi
0	1	1	48-63	Low
1	1	1	48-63	Hi

The AT dataset interface is used to program two attenuator settings, ie one cable equaliser module, per eight bit write. Data bits 0-3 are used to program the A polarisation of a beam, bits 4-7 are used to program the B polarisation. Cable equaliser 1 , ie. Beam 1, is addressed by Base + 0.

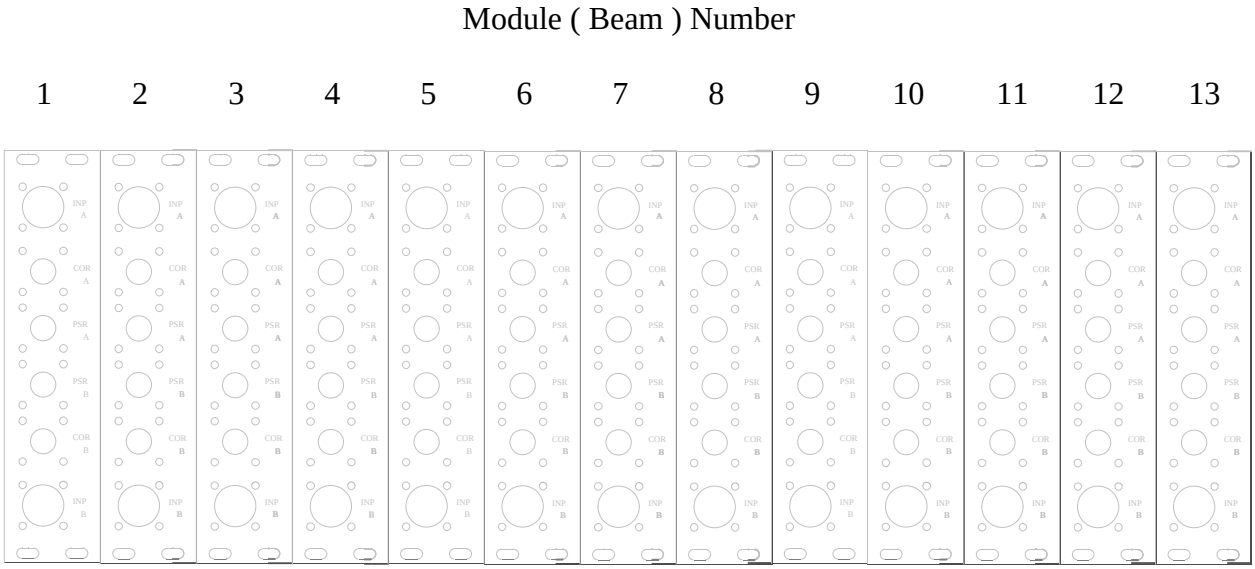
A dataset read any where in the selected address returns the Remote/Local status of the MZ26 module. If bit 0 is set the MZ26 module is Remote Mode, if Bit 1 is set the MZ26 is in Local Mode.

Table 9: MZ26 Dataset Address Space

Beam	Address	Data Bits 0-3	Data Bits 4-7
1	Base + 0	A Pol	B Pol
2	Base + 1	A Pol	B Pol
3	Base + 2	A Pol	B Pol

4	Base + 3	A Pol	B Pol
5	Base + 4	A Pol	B Pol
6	Base + 5	A Pol	B Pol
7	Base + 6	A Pol	B Pol
8	Base + 7	A Pol	B Pol
9	Base + 8	A Pol	B Pol
10	Base + 9	A Pol	B Pol
11	Base + A	A Pol	B Pol
12	Base + B	A Pol	B Pol
13	Base + C	A Pol	B Pol

Figure 8: Rear View of MZ26 Module Showing Individual Module Position



Filter Bank Conversion System

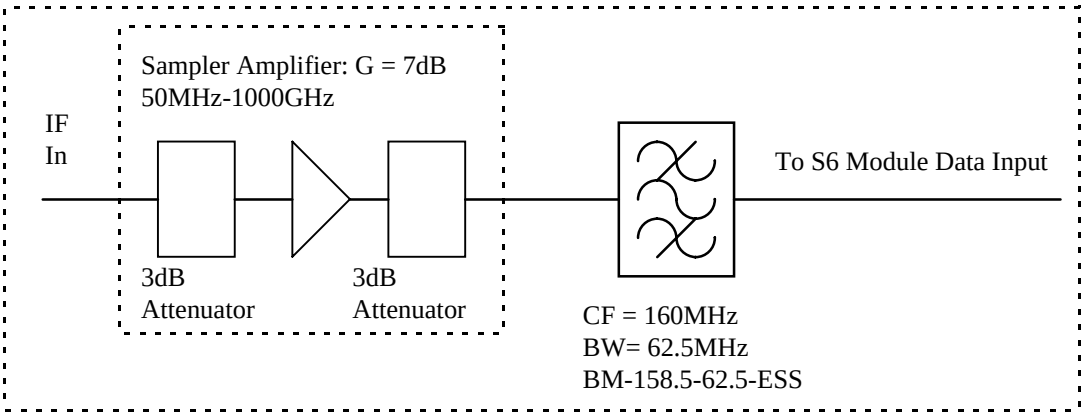
Covered in document “Parkes Pulsar Filter Bank Conversion System”

Sampler Mounting PCB, Pre-Amplifier and Band Select (Anti-Alias) Filter

The correlator output from the cable equaliser are run in RG223 cables through to the multi beam correlator racks, see document “ Multi Beam Correlator Racks”.

The equalised IF is connected to an amplifier block and band select filter before the signal is input to the S6 module. Total power expected at the sampler input is nominally -31dBm in the 64MHz Band.

Figure 9: Sampler Amplifier and Filter Block Diagram



The mounting pcb is used to supply DC power, SYNC and Blank signals from Sampler Back Plane. The mounting pcb is also used to mount the MK1 RF box used to house the sampler amplifier.