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

Australia Telescope Electronics Group

Pulsar Filter Bank Conversion System

Manual

DRAFT

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Overview

During the Multi Beam Hydrogen survey, a Pulsar survey will be undertaken using Pulsar Filter Banks from the University of Manchester.

The Multi Beam receiver system at Parkes has 13 dual polarisation beams, covering a frequency range of ~1550MHz to 1200MHz. Each of receiver RF band is down converted to an IF band of 50MHz to 350MHz with local oscillator set to 1555MHz.

Each IF is equalised for frequency dependent cable losses and split into two outputs, by a Cable Equalisation module in the Multi Beam Interface Rack. The Multi Beam Interface Rack is mounted in the Parkes Telescope Control Room.

The first output connects to the main auto-correlator. The auto-correlator covers the IF frequency range of 128MHz to 192Mhz. The Hydrogen line occurs at 135MHz in the IF band.

The second cable equaliser output connects to a Dual IF Up-Down Convertor. The Dual IF Up-Down Convertor splits each IF band into three bands and frequency translates each band to a 64Mhz to 160MHz band. The 78 frequency translated outputs are then connected to the Pulsar Filter Banks.

Module Description

Layout

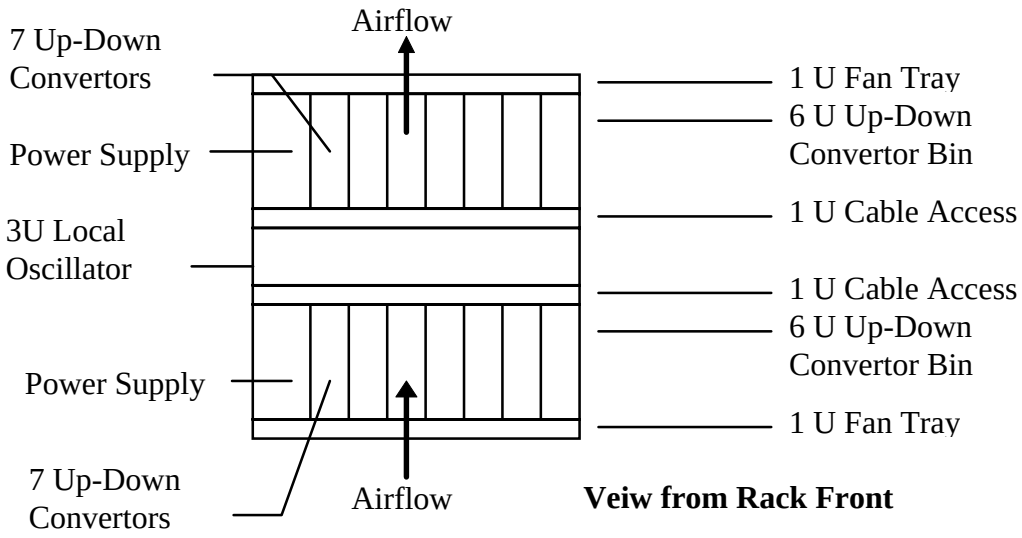
The Dual IF Up-Down Conversion module is built into a modified 13HP wide 6U Eurocard cassette frame. The module is capable of handling two IF inputs. To cover 26 IF inputs, 13 Dual IF Up-Down Convertors are built into two bins in the Multi-Beam Interface Rack.

The 6U Up-Down Conversion Bins are cooled by 1U fan tray modules. The upper bin has a fan tray mounted above the bin, to pull air upwards. A 1U gap is left between the bin and the Local Oscillator Module for cable access. Another 1U gap is left below for cable access. The lower Up-Down Conversion Bin is mounted below the 1U gap. A 1U fan unit is mounted below the last bin. This fan unit blows air upwards.

Access to the module inputs are made at the rear of the bin, the Dual IF Up-Down Convertor modules slide in from the rear of the rack. Module power supply, outputs and Local Oscillator connectors are made from the front of the bin. The front of the bin is covered by a 6U high door.

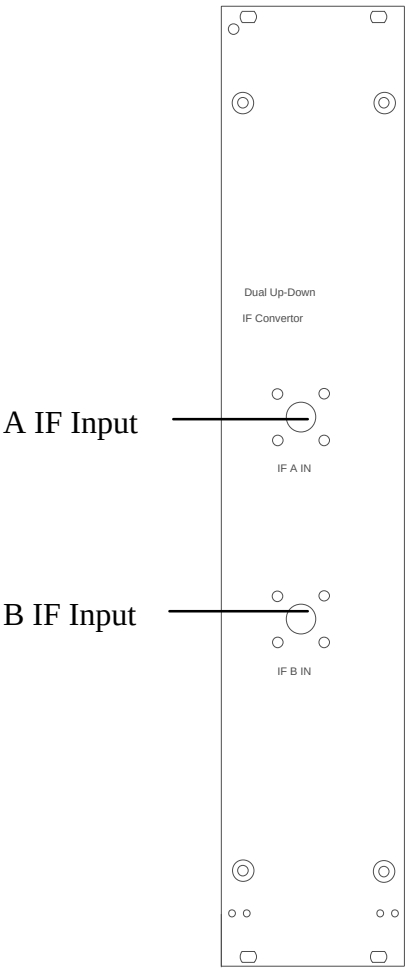
All input, output and Local Oscillator connections are made with BNC connectors.

Multi Beam Interface Rack Pulsar Conversion System Module Positions

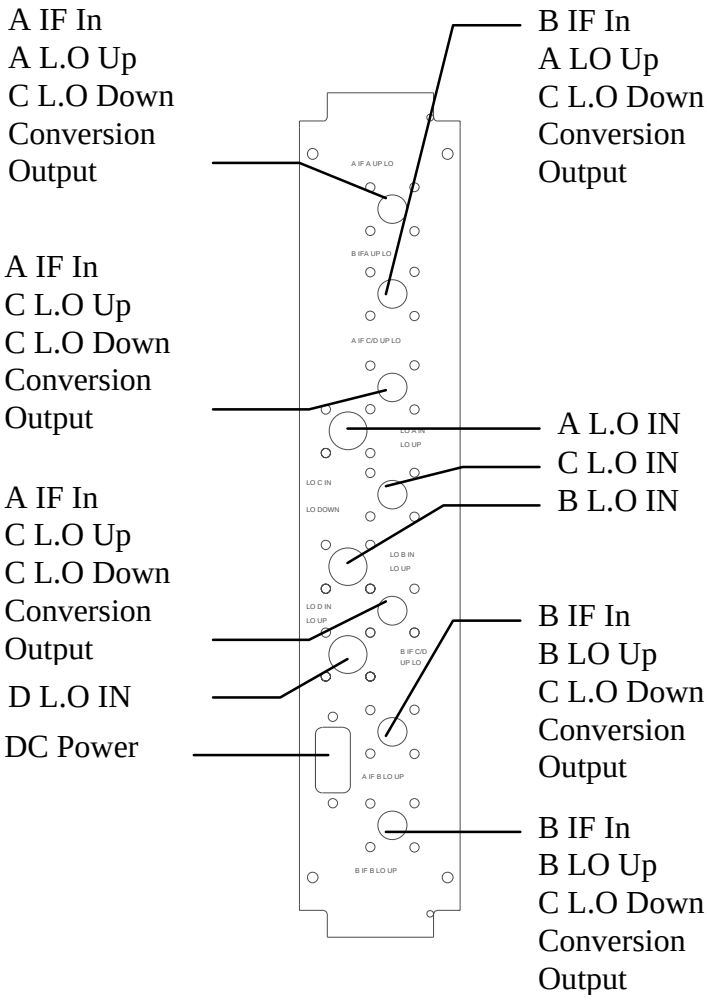


Dual IF Up Down Convertor Front and Rear Panel Input-Output Connections

Front Panel



Rear Panel



Power Supply

Each 9 pin D male connector is used for DC power. Pins 1,3,5,7,9 are +15V, pins 2,4,6,8 are ground.

DC power is provided by a switch mode supply. The switch mode supply is mounted in a 14HP section of the bin. The switch mode supply is nominally set to +17V. This voltage can be adjusted at the front of the power supply module.

Each module is powered by a separate 15 Volt regulator and draws 0.75A. DC voltage test points are available on the Dual IF Up-Down Convertor Module front panel. LED indicators on the front panel are lit when each regulator is on.

Electrical Description

Local Oscillator Distribution

The up conversion local oscillators, A L.O and B L.O are connected from the rear panel to 2 way splitters. The A L.O drives M5 and M12. The B L.O drives M6 and M11.

The final two channels can be driven from either the C L.O or the D L.O input. In the default configuration the C L.O input drives a 2 way splitter, S3. The outputs of S3 drive two four way splitters S7 and S8. Capacitor C49 connects the L.O from S8 to mixer M10. Capacitor C20 connects an output of S7 to mixer M4.

If the D L.O input is used C20 and C49 are disconnected. The unused outputs should be terminated with 50 ohm terminating resistors, R9 and R11. The D L.O input connects to a 2 way splitter, S4. The outputs of S4 drive mixers M4 and M10 via C50 and C21. The RF transmission line tracks that are unterminated should be cut near C21 and C50.

Table 1: Components changes required for D Local Oscillator Use

	R9	R11	C20	C49	C21	C50
C L.O			0.001uF	0.001uF		
D L.O	50 Ohms	50 Ohms			0.001uF	0.001uF

The recommended power levels for each Local Oscillator input are presented in the table 2

Table 2: Local Oscillator Input Power Levels

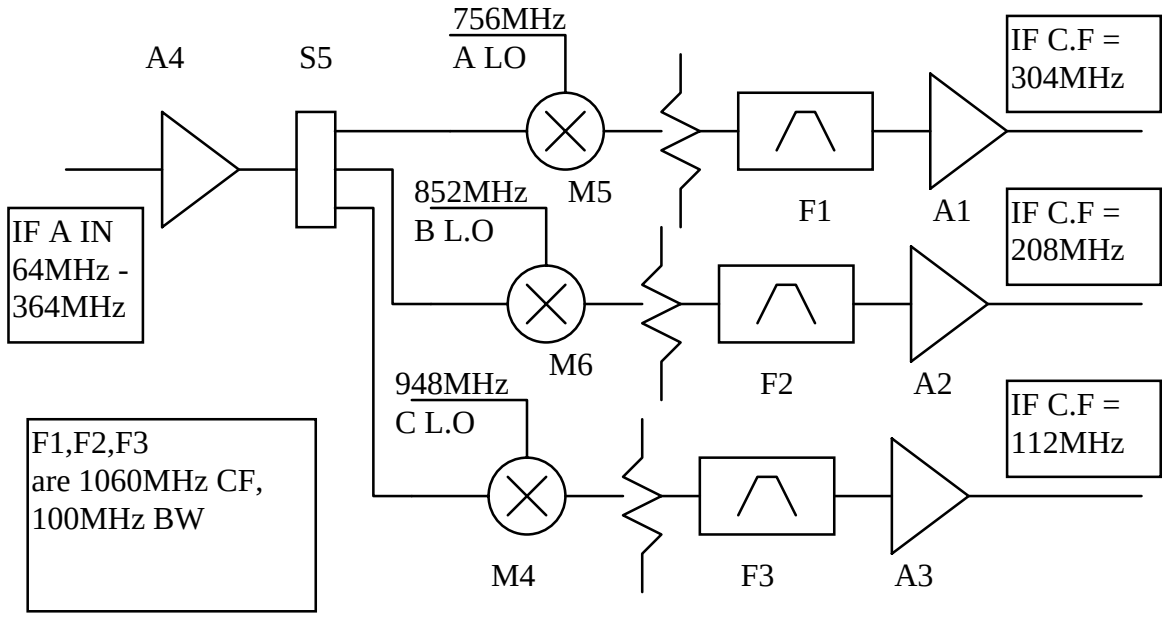
	A L.O In	B L.O In	C L.O In	D L.O In
L.O Freq.	756MHz	852MHz	948MHz	User selected
Power Level	+10dBm	+10dBm	+16dBm	+10dBm

Up Down Conversion Description

Each IF input is amplified and then spilt into three RF signal paths. Each RF path is identical except for the frequency of the up conversion local oscillator.

Outputs of the three way splitter are taken to an Up Conversion stage. This stage consists of a mixer, filter and amplifier. The filter is 6 stage bandpass design centred on 1060 MHz. The passband is nominally 100MHz wide. The different L.O frequencies translate the input band into three 100MHz bands.

A IF Input Dual IF Up Down Convertor, Up Conversion Section



Up conversion stages are followed by a down conversion stage. A common down conversion local oscillator connects to mixers M1,2,3,7,8 and 9. The down conversion stage consists of a mixer, an attenuator and a pair of cascaded amplifiers.

The total gain through the Dual IF Up-Down Convertor is nominally 34dB.

The tables 3,4 and 5 detail the frequency translations through the system.

Table 3: IF band to Up Conversion Band Frequency Translation Table.

	Input IF CF	2nd IF C.F	Input IF Low Freq	2nd IF Low Freq	Input IF Hi Freq	2nd IF Hi Freq
A LO	304MHz	1060MHz	254MHz	1010MHz	354MHz	1110MHz
B L.O	208MHz	1060MHz	158MHz	1010MHz	258MHz	1110MHz
C L.O	112MHz	1060MHz	62MHz	1010MHz	162MHz	1110MHz

Table 4: Input IF Frequency to Pulsar Band Translation Table

	Input IF CF	Output C.F	Input IF Low Freq	Output Low Freq	Input IF High Freq	Output High Freq
A LO	304MHz	112MHz	254MHz	62MHz	354MHz	162MHz
B L.O	208MHz	112MHz	158MHz	62MHz	258MHz	162MHz
C L.O	112MHz	112MHz	62MHz	62MHz	162MHz	162MHz

Table 5: Multi Beam RF Frequency to Pulsar Band Translation Table

	Input RF CF	Output C.F	Input RF Low Freq	Output Low Freq	Input RF High Freq	Output High Freq
A LO	1251MHz	112MHz	1301MHz	62MHz	1201MHz	162MHz
B L.O	1347MHz	112MHz	1397MHz	62MHz	1297MHz	162MHz
C L.O	1443MHz	112MHz	1493MHz	62MHz	1393MHz	162MHz

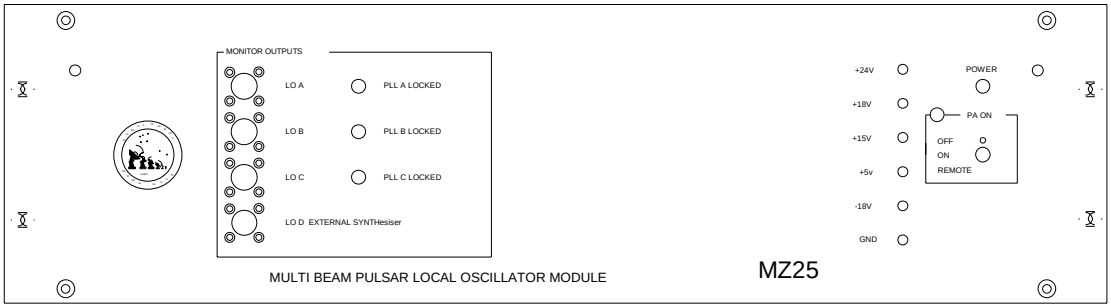
Local Oscillator System

Layout

The MZ25 , Multi Beam Pulsar Local Oscillator Module, is built into a 3U 19” rack mounting chassis. The module is capable of providing three fixed L.Os for 15 Dual IF Up Down Convertors. The fixed L.Os are derived by internal synthesisers from the station clock. Provision is made a for an external L.O signal to connected and distributed to 15 Dual IF Up Down Convertors.

The MZ25 front panel provides a power switch and a Power Amplifier mode control switch. The Power Amplifier Mode control switch has three positions. In the OFF mode DC power is removed from the Power Amplifiers. In the ON mode DC power is available to the Power Amplifiers. A Remote mode is also available, the Power Amplifiers can be controlled by an external T.T.L level. With no TTL signal applied the P.A remains on. The P.A ON indicator is lit when D.C power is switched to the Power Amplifiers.

MZ25 Module Front Panel Controls



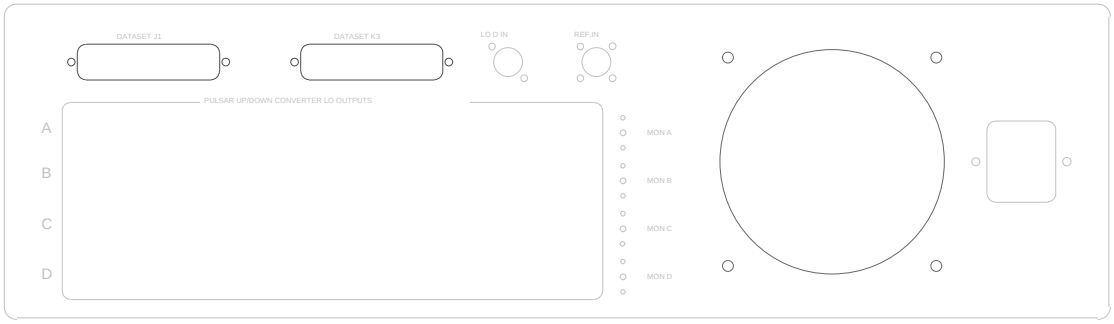
Test points for the D.C supplies are available on the front panel.

Table 5: MZ25 D.C Supply Distribution

Test Point	DC Supply Function
+24V	Power Supply to Power Amplifier
+18V	+DC Supply to Synthesiser VCO and Filter Amplifiers
+15V	Power Supply to Power Amplifiers
+5V	Power Supply to Synthesiser logic
-18V	Power Supply to Synthesiser Filter Amplifiers

Three phase lock indicators for each of the fixed synthesisers are brought out to the front panel. The associated monitor outputs for each fixed synthesiser are 10dB down on the level supplied to the Dual IF Up Down Conversion modules. The monitor outputs are only active when the P.A ON indicator is lit.

MZ 25 Module Rear Panel



The station clock is connected to the RF IN BNC connector on the rear panel. The station clock can be either 5 or 10 MHz depending on the setting of links in the internal synthesisers. The Reference level should be +3dBm to -3dBm.

The external L.O signal, L.O D is made on the rear panel with a BNC connector.

All L.O outputs are made with SMA connectors. There are 15 connectors for each L.O signal. A single output is connected to the front panel via a 10dB pad.

Mains power is made from an IEC connector to the extreme right of the rear panel.

Data Set connectors J1 and K3 connect internal monitoring and control signals to a remote source.

Table 6: MZ25 Rear Panel Connector J1 pinout

J1 Pin Number	Signal Name	Signal Type	Description
50	GND	Power	Supply Ground to AT Data Set
17	+9V	Power	Supply Power To AT Data Set
33	+20V	Power	Supply Power To AT Data Set
49	-20V	Power	Supply Power To AT Data Set
16	GND	Power	Supply Ground To AT Data Set
29	DSADD0	Link	Internal Link for A.T DS Address
45	DSADD1	Link	Internal Link for A.T DS Address
12	DSADD2	Link	Internal Link for A.T DS Address
28	DSADD3	Link	Internal Link for A.T DS Address
44	DSADD4	Link	Internal Link for A.T DS Address
38	GND	GND	
5	Mon +24	Analog Mon	Monitor Power Supply
21	Mon +18	Analog Mon	Monitor Power Supply
37	Mon +15	Analog Mon	Monitor Power Supply
4	Mon +5	Analog Mon	Monitor Power Supply
20	Mon -18	Analog Mon	Monitor Power Supply

Table 7: MZ25 Rear Panel Connector K3 pinout

K3 Pin No.	Signal Name	Signal Type	Description
46	Lock A	TTL Mon	Phase Lock Indicator A
13	Lock B	TTL Mon	Phase Lock Indicator A
29	Lock C	TTL Mon	Phase Lock Indicator A
45	PA ON	TTL Mon	P.A D.C control signal
33	Turn P.A On	TTL Cntrl	Control for P.A in remote Mode

Electrical Description

Synthesiser Module

The synthesiser module is a general purpose phase locked loop synthesier built into a standard AT MK5 module. The module is designed to use a reference frequency of 1,5 or 10MHz. The synthesiser uses a Qualcomm Q3216 phase lock loop IC and a Q3500C-0613T VCO (tuning range 650-1300MHz).

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

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

An internal reference divider is set by links R0-R3. The reference divided output needs to be set to 1MHz. Reference links must be set for the required divisor less one.

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.

The VCO divider is set by links SW1-4 through to SW2-9. The VCO divider ratio is set by the following formula N= (10 * (M +1)) + A.

In order to program LO A, (VCO output = 756Mz), M should be set to 74 and A should be set to 6. The VCO divider output can be checked at TP1.

Link SW2-4 must connected in order to enable the prescaler.

Table 8: 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

The Q3216 internal phase comparator is 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 the low pass filter to reduce the effect of reference spurs. The output of the notch filter drives the VCO.

Signal Distribution

Local Oscillators A and B is filtered to reduce the 2nd harmonic output from the VCO. Pads are used to match gain, and each synthesiser output is amplified by a Mini Circuits ZFL-1000VH amplifier. The amplifier outputs are then connected to a 16 splitter, ZC16PD-960.

Local Oscillator A is filtered to reduce the 2nd harmonic output from the VCO. Pads are used to match gain, and a Mini Circuits ZFL-1000VH amplifies the Local oscillator output. The amplifier output is connected to a 16 splitter.

Local Oscillator C has similar architecture except the amplifier used is Mini Circuits, ZHL-1000-3W.

External Local Oscillator D input is connected to a pad, then a ZHL-1000VH amplifier. This amplifier directly drives the 16 way splitter. The Local Oscillator D path gain is +8dB.

Monitor and Power Supply

Two printed circuit boards are used to switch D.C power to the power amplifiers and provide monitor signals.

Monitor p.c.b A switches the +15V supply to the ZHL-1000VH amplifiers. This pcb also provides the lock indicator for L.O A. Power supply regulators for the +15V, +9V +5V and -15V supplies are also mounted on this p.c.b. Resistive divide by ten are used to provide analogue monitoring signals of the D.C supplies.

Monitor p.c.b switches the +24V supply to the ZFL-1000-3W power amplifier. The p.c.b also supplies the phase lock indicators for L.O B and L.O C. The Power Amplifier ON Led is also driven from this p.c.b.

A linear power supply was constructed using a 160VA toroidal transformer with two separate 18V taps. One tap is used to power the ZFL-1000-3W amplifier, an LM350 is used to regulate the supply to +20V

The second tap powers a regulator block, with +18, +15 and +5 regulators. The +18V and +5V are used on the synthesisers. The +15V is used to power the ZHL-100VH amplifiers. A DC-DC convertor is used to provide -24V from the unregulated 24V. The -24V is regulated to -18V and is used to power the synthesisers.