SYSTEM DESIGN DESCRIPTION

Poseidon Scientific Instruments

MWA Receiver Node Re-Packaging

VERSION: 1.0 REVISION DATE: 23/10/09

Approver Name	Title	Signature	Date
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Contents

Section 1. Introduction

1.1 Purpose

This document describes the system design of the repackaged receiver node. The original brief to PSI asked for a design capable of operating in the expected field environment and which allowed for ease of field maintenance, manufacture and construction both within the production facility and on site. This document consists of a collation of information from the existing physical design provided by the MWA project team and the repackaged system design produced in consultation with the MWA receiver designers. The document is structured in a tree-type format realised from PSI's SALEM system ("SALEM" is PSI's Stock, Assembly, Logistics and Engineering Manager System.) with detail items being supplied as PDF and XLS documents for ease of review.

1.2 Scope

This document covers the detailed system design to the following levels of complexity:

a) PSI's SALEM system structure will be the basis of the manufacturing drawings and associated details.

b) Detailed PCB design files including Altium schematic and PCB files provided in PDF format for review. These will allow the PCBs to be manufactured.

c) Incorporation of the receiver clock module into the enclosure design to ensure compatibility of the final design. The clock module is design and manufactured external to PSI.

d) Incorporation of the "digital crate" into the final design. The Digital Crate is to be manufactured and tested external to PSI.

e) Detailed mechanical drawings provided in PDF format for review and some assembly drawings, where appropriate to indicate the system build process. This will include the re-designed ASC mechanical structure.

f) Initial cabling designs/drawings for sub-unit interconnection are provided in PDF format, with the detailed cable design awaiting completion of the assembly of initial pre-production units. Where appropriate some detailed cable drawings and their assembly are provided.

Section 2. System Structure

2.1 System Design Approach

The system design is based on a hierarchical tree structure compatible with PSI's SALEM for product manufacture. The same hierarchical structure has been adopted for the project deliverables for ease of navigation.

The hierarchical structure is number-based such that sub-units numbered [3] will be "part of" sub-units numbered [2] which in turn will be "part of" top level unit numbered [1].

2.2 Overall System Architecture

1	**MST-0432 (v0.052) {MWA Receiver Node Enclosure} Counter†: _MWAA009A**
2	**MST-0448 (v0.005) {MWA Internal Rack} Counter: MWAA010A**
3	**MST-0423 (v0.001) {MWA Digital Rack} Counter: MWAA003A**
4	**MST-0425 (v0.000) {MWA Clock Unit} Counter: MWAA005A**
3	**MST-0422 (v0.004) {MWA Analogue Signal Conditioning Module} Counter: MWAA002A**
	‡[Id:568]MWA ASC Test2
4	**MST-0421 (v0.270) {MWA Analogue Signal Conditioning PCB (ASC)} Counter: PCB MWAP005A**
	[Id:567]MWA ASC Test1
3	**MST-0422 (v0.004) {MWA Analogue Signal Conditioning Module} Counter: MWAA002A**
	‡[Id:568]MWA ASC Test2
4	**MST-0421 (v0.270) {MWA Analogue Signal Conditioning PCB (ASC)} Counter: PCB MWAP005A**
	[Id:567]MWA ASC Test1
3	**MST-0429 (v0.003) {MWA Power Supply Module} Counter: MWAA007A**
4	**MST-0419 (v0.000) {MWA Power Distribution PCB} Counter: PCB MWAP004A**
3	**MST-0426 (v0.005) {Single Board Computer Module} Counter: MWAA006A**
4	**MST-0417 (v0.002) {MWA ATIM Interface & Control Logic PCB} Counter: PCB MWAP002A**
4	**MST-0431 (v0.004) {MWA Dual Octal Temperature Sensor ADC PCB Assembly} Counter: MWAA008A**
5	**MST-0430 (v0.032) {MWA Octal Temperature Sensor ADC PCB 90%} Counter: PCB MWAP008A**
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5	**MST-0430 (v0.032) {MWA Octal Temperature Sensor ADC PCB 90%} Counter: PCB MWAP008A**
2	**MST-0416 (v0.000) {MWA Antenna Tile Interface PCB (ATI)} Counter: PCB MWAP001A**
2	**MST-0416 (v0.000) {MWA Antenna Tile Interface PCB (ATI)} Counter: PCB MWAP001A**
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2	**MST-0416 (v0.000) {MWA Antenna Tile Interface PCB (ATI)} Counter: PCB MWAP001A**
2	**MST-0416 (v0.000) {MWA Antenna Tile Interface PCB (ATI)} Counter: PCB MWAP001A**
2	**MST-0418 (v0.000) {MWA ATIM Transition & 48V Monitor PCB} Counter: PCB MWAP003A**
2	**MST-0418 (v0.000) {MWA ATIM Transition & 48V Monitor PCB} Counter: PCB MWAP003A**
2	**MST-0424 (v0.000) {MWA Air Conditioner Unit} Counter: MWAA004A**
2	**MST-0420 (v0.002) {MWA Air Conditioner Control Box} Counter: MWAA001A**
2	**MST-0447 (v0.002) {MWA Legacy or Optional Masters} Counter: MWAA011A**
3	**MST-0428 (v0.000) {MWA MCC and Fans Power Supply PCB} Counter: PCB MWAP007A**
3	**MST-0427 (v0.000) {MWA Rear Fan Interface PCB} Counter: PCB MWAP006A**

† Named "Counters" are used in SALEM to uniquely assign serial numbers to assemblies.

‡ **[Id:Num]Name** refers to a uniquely identified test procedure existing in SALEM

Section 3. System Design Data

The following is a more detailed description of each tree item as given in the system architecture above. Information is provided in summary format in the sections below, additional information is delivered in electronic format as indicated in Section 8 of this document. A status indicator is also provided to indicate readiness for the pre-production prototype. The indicator numbers are defined as below:

Status Indicator	*Description*
1	*Ready for Pre-Production*
2	*Ready for Salem Input*
3	*Ready MWA Approval*
4	*Work in Progress*
5	*Preliminary*

3.1 MST-0432 (v0.052) {MWA Receiver Node Enclosure}

Status 2/3

Counter: _MWAA009A

The receiver node enclosure is the top system-level assembly and includes all the sub-system items that are part of the receiver node. Apart from the sub-assemblies listed in the system tree (Section 2.2), the receiver node enclosure is also made up of a considerable number of mechanical parts a summary of which is given here. A more detailed list is provided in electronic form.

Assembly drawings of the individual parts are given to show how the completed assembly will look.

Document Name	**Description**
Enclosure_Cables.xls	Internal Cables for both modules and interconnections
Enclosure_AC_Wiring.pdf	Proposed AC wiring option
Enclosure_Sys_Diagram.pdf	System Block Diagram
Enclosure_Control_Interconxs.pdf	Control Interconnection System Diagram
Enclosure_DC_Power_Interconxs.pdf	DC Power Interconnection System Diagram
Enclosure_RF_Interconxs.pdf	RF Interconnection System Diagram
Tough Power Board.pdf	Proposed AC power Distribution Board
Enclosure_Input_Pwr_BOM.xls	Input Power Parts List
PrePrototype_photo(1-16).JPG	Selection of photos showing status of the pre-prototype.
MWAM025 Tie down bracket.PDF	Detailed drawings of the enclosure metalwork
MWAM023 AC enclosure interconnect bar.PDF	
MWAM022 AC enclosure tie down bar.PDF	
MWAM014 Connector panel.PDF	
MWAM002 AC Enclosure Sheet metal.PDF	
MWAM001 Sheet metal.PDF	
MWAM013 Flow splitter.PDF	
MWAM021 Main enclosure tie down bar.PDF	

MWAM001 Main enclosure.PDF	Selection of assembly exploded views to show how Main Enclosure is constructed
MWAM001 Main enclosure #1.pdf	
MWAM001 Main enclosure #2.pdf	
MWAM001 Main enclosure #3.pdf	
MWAM001 Main enclosure #4.pdf	

3.2 MST-0448 (v0.005) {MWA Internal Rack}

Status 2/3

Counter: _MWAA010A

The Internal Rack is the sub-system assembly including all the internal electronics of the receiver. Apart from the sub-assemblies listed in the system tree (Section 2.2), the internal rack includes mechanical parts to allow the other equipment to be fitted.

Document Name	Description
MWAM038 Electronics Case.PDF	Selection of assembly exploded views to show how the Internal Electronics Rack is constructed
MWAM038 Electronics Rack #1.pdf	
MWAM038 Electronics Rack #2.pdf	
MWAM038 Electronics Rack #3.pdf	
MWAM038 Electronics Rack #4.pdf	

3.3 MST-0423 (v0.000) {MWA Digital Rack}

Status 2/3

Counter: MWAA003A

The digital rack assembly is a sub-system level assembly and includes the items that were part of the original RRI digital crate. The digital rack includes the following assembly parts:

Digital Rack Mechanical & RRI Backplane PCB

Analogue and Digital Filter Module (Mechanical, RRI PCB and Cables) – 2-off

Aggregation Formatting and Transmission Module (Mechanical, RRI PCB and Cables)

The Mechanical parts are design and supplied by PSI and the PCBs are designed and supplied by RRI

Mechanical drawings and layouts are provided in PDF format.

Assembly drawings of the individual parts are given to show how the completed assembly will look.

Document Name	Description
MWAM037 Digital rack.pdf	Selection of assembly exploded views to show how the Digital Rack is constructed
MWAM037 Digital rack unit #1.pdf	
MWAM037 Digital rack unit #2.pdf	
MWAM037 Digital rack unit #3.pdf	
MWAM037 Digital rack unit #4.pdf	

3.4 MST-0425 (v0.000) {MWA Clock Unit}

Status 3

Counter: MWAA005A

The Clock Unit consists of the externally designed and manufactured FinishLine PCB which is fitted to the PSI mechanical enclosure.

Document Name	Description
MWAM037 Clock receiver unit #1.pdf	Selection of assembly exploded views to show how the Clock Unit is constructed
MWAM037 Clock receiver unit #2.pdf	
MWAM037 Clock receiver unit #3.pdf	
MWAM037 Clock receiver unit #4.pdf	

3.5 MST-0422 (v0.003) {MWA Analogue Signal Conditioning Module}

Status 2/3

Counter: MWAA002A

The analogue signal conditioning module contains Analogue Signal Conditioning PCB (ASC) which is RF screened using a metal enclosure. Further RF testing will be carried out on this module.

A provisional test plan has been created for this PCB called “MWA ASC Test2” (PSI Reference Id-568)

Mechanical drawings and layouts are provided in PDF format.

On approval this item can be released for PSI manufacture.

Document Name	Description
MWAM029 ASC rack front.PDF	Detailed Front Panel Drawings
MWAM028 ASC housing.pdf	Detailed Housing Drawings
ASC Rack unit #1.pdf	Selection of assembly exploded views to show how the ASC Assembly is constructed
ASC Rack unit #2.pdf	
ASC Rack unit #3.pdf	
ASC Rack unit #4.pdf	

3.6 MST-0421 (v0.270) {MWA Analogue Signal Conditioning PCB (ASC)}

Status 2/3

Counter: PCB MWAP005A

The analogue signal conditioning PCB receives the RF signals from the beamformers and provides some amplification and filtering before connecting to the analogue to digital converters in the digital crate.

A provisional test plan has been created for this PCB called “MWA ASC Test1” (PSI Reference Id-567)

Circuit schematics and PCB layouts are provided in PDF format and parts list is provided in XLS format.

On approval this item can be released for PSI manufacture.

Document Name	Description
ASC_BillofMaterials.xls	ASC PCB Parts List
100_ASC_PCB_Schematic_and_PCB_Layers.pdf	PCB Schematics and Layout Files

3.7 MST-0429 (v0.002) {MWA Power Supply Module}

Status 2/3

Counter: MWAA007A

The Power Supply Module (PSM) is a sub-system level assembly and includes all the items that are part of the PSM. Apart from the items listed below, the PSM includes cabling and mechanical assembly parts. Assembly diagrams and layouts are provided in PDF format and a parts list is provided in XLS format.

Power Supply Module includes the Power Distribution PCB covered by item 3.8 below.

Document Name	Description
PSU_Module_Assy&Wiring.pdf	Module assembly and wiring diagrams
PSU_Module_BillofMaterials.xls	Module Parts List
SFE_ACE.pdf	Power Supply Data Sheet
MWAM032 PSU front panel.PDF	Detailed Front Panel Drawings
PSU Rack unit #1.pdf	Selection of assembly exploded views to show how the Power Supply Module Assembly is constructed
PSU Rack unit #2.pdf	
PSU Rack unit #3.pdf	
PSU Rack unit #4.pdf	

3.8 MST-0419 (v0.000) {MWA Power Distribution PCB}

Status 2/3

Counter: PCB MWAP004A

The power distribution PCB distributes the power from the ACE650F (Powerbox) power supply to front panel connectors for ease of assembly and maintenance.

Circuit schematics and PCB layouts are provided in PDF format and a parts list is provided in XLS format.

On approval this item can be released for PSI manufacture. There is no testing required until the assembly is completed in the next production phase.

Document Name	Description
820_PwrDis_PCB_BillofMaterials.xls	Power Distribution PCB Parts List
820_PwrDis_PCB_Schematic_and_PCB_Layers.pdf	PCB Schematics and Layout Files

3.9 MST-0426 (v0.005) {Single Board Computer Module}

Status 3

Counter: MWAA006A

The Single Board Computer module (SBC) is a sub-system level assembly and includes all the items that are part of the SBC. Apart from the items listed below, the SBC includes cabling and mechanical assembly parts. Assembly diagrams and layouts are provided in PDF format and a parts list is provided in XLS format.

Single Board Computer includes the Power Distribution the following assembly parts:

ATIM Interface and Control Logic PCB covered by item 3.10 below
Dual Octal Temp Sensor ADC PCB Assy covered by item 3.11 below
Always-ON Power Supply
SBC & IO Cards
Optical to Ethernet Transceiver

Document Name	Description
SBC_Module_Assy&Wiring.pdf	Module assembly and wiring diagrams
PSU_ATIM-C_to_ATIM-P5.pdf	Specific Control Cable Wiring
SBC_Module_BillofMaterials.xls	Module Parts List
Helios-Datasheet.pdf	Single Board Computer Data Sheet
gpiommdatasheet.pdf	General IO Data Sheet
IMC-101_Series.pdf	Media Converter Data Sheet
IBEX PCXX.pdf	Always-ON PSU Data Sheet
MWAM039 SBC Enclosure.pdf	Detailed SBC Module Drawings
MWAM039 SBC Rack unit #1.pdf	Selection of assembly exploded views to show how the SBC Module Assembly is constructed
MWAM039 SBC Rack unit #2.pdf	
MWAM039 SBC Rack unit #3.pdf	
MWAM039 SBC Rack unit #4.pdf	

3.10 MST-0417 (v0.002) {MWA ATIM Interface & Control Logic PCB}

Status 3

Counter: PCB MWAP002A

The ATIM Interface & Control Logic PCB is a glue-logic control board that interfaces to all the major sub-systems in the receiver node. From the SBC & IO Cards the ATIM I&C communicates with the beamformers, via the transition PCB's, the temperature sensors, via the temperature sensor PCB's, the ASC's and the Digital crate.

Circuit schematics and PCB layouts are provided in PDF format and a parts list is provided in XLS format.

On approval this item can be released for PSI manufacture.

Document Name	Description
550_ATIM_I&C_BillofMaterials.xls	PCB Parts List
550_ATIM_I&C_PCB_Schematic_and_PCB_Layers.pdf	PCB Schematics and Layout Files

3.11 MST-0431 (v0.004) {MWA Dual Octal Temp Sensor ADC PCB Assy}

Status 1

Counter: MWAA008A

The dual octal temperature sensor assembly takes two generic PCB's and fits with extra parts to make a top and bottom items which are then combined to make the dual temperature sensor unit.

Unit testing will be carried out on the dual sensors before insertion into the SBC.

3.12 MST-0430 (v0.032) {MWA Octal Temperature Sensor ADC PCB 90%}

Status 1

Counter: PCB MWAP008A

The octal temperature sensor PCB 90% is the generic PCB which when fitted with extra parts determines if the part is a top or bottom item of the dual temperature sensor unit.

Circuit schematics and PCB layouts are provided in PDF format and parts lists are provided in XLS format.

This PCB is ready for PSI for manufacture and has been fully integrated to Salem. There is no testing required until the assembly is completed in the next production phase.

Document Name	Description
TempMon_BillofMaterials.xls	PCB Parts List
TempMon_PCB_Schematic_and_PCB_Layers.pdf	PCB Schematics and Layout Files

3.13 MST-0416 (v0.000) {MWA Antenna Tile Interface PCB (ATIF)}

Status 3

Counter: PCB MWAP001A

The antenna tile interface PCB distributes the power & Control signals to the Beamformers which are external to the receiver node enclosure and, as such, are fitted with a robust external connector.

Circuit schematics and PCB layouts are provided in PDF format and parts list is provided in XLS format.

On approval this item can be released for PSI manufacture.

Document Name	Description
521_ATIF_BillofMaterials.xls	PCB Parts List
521_ATIF_Schematic_and_PCB_Layers.pdf	PCB Schematics and Layout Files

3.14 MST-0418 (v0.000) {MWA ATIM Transition & 48V Monitor PCB}

Status 2

Counter: PCB MWAP003A

The ATIM Transition & 48V Monitor PCB is a transition board that interfaces the control logic to ATIF PCB in the receiver node.

Circuit schematics and PCB layouts are provided in PDF format and a parts list is provided in XLS format.

On approval this item can be released for PSI manufacture.

Document Name	Description
540_ATIM_transition_BillofMaterials.xls	PCB Parts List
540_ATIM_transition_Schematic_and_PCB_Layers.PDF	PCB Schematics and Layout Files

3.15 MST-0424 (v0.000) {MWA Air Conditioner Unit}

Status 2

Counter: MWAA004A

The Air Conditioner Unit (ACU) is a sub-system level assembly and includes all the items that are part of the ACU. The ACU includes mechanical assembly parts and some cabling. Assembly diagrams and layouts are provided in PDF format.

Document Name	Description
AirCon_TempMon_Wiring.pdf	Module assembly and wiring diagrams
MWAM004 Air Conditioner Cover Sheet Metal.PDF	Detailed Metalwork Drawings
KPC800 spec sheet.pdf	Air Conditioner Data Sheet
AC Unit #1.pdf	Selection of assembly exploded views to show how the air conditioner unit is constructed
AC Unit #2.pdf	
AC Unit #3.pdf	
AC Unit #4.pdf	

3.16 MST-0420 (v0.002) {MWA Air Conditioner Control Box}

Status 2/3

Counter: MWAA001A

The air conditioner control box is a purpose build item which interfaces to the ATIM Interface and Control PCB (within the SBC Module). It controls the power to the air conditioner and also provides an interface for the ACU temperature sensors.

Build Photos are provided in JPG format and a parts lists are provided in XLS format.

On approval this item can be released for PSI manufacture. A control test jig has already been assembled and a prototype unit has been created for internal analysis.

Document Name	Description
AC_Control_CloseUp1.JPG	Selection of photos showing how the AC Control Unit was Assembled.
AC_Control _Assembly.JPG	
AC_Control_ProtectionRemoved.JPG	
AC_Control_CloseUp2.JPG	
AC_Control_Lid.JPG	
AC_Control_Lid_Removed.JPG	
AC_Control_TopView.JPG	
AC_Control_BottomView.JPG	
AC_Control_Resistors.JPG	
AC_Control_Box_BOM.xls	

3.17 MST-0447 (v0.002) {MWA Legacy or Optional Masters}

Status 5

Counter: MWAA011A

This area contains both legacy units leftover from the original enclosure design and optional units which may or may not be used in the final design. No information is provided in this phase of the release.

3.18 MST-0428 (v0.000) {MWA MCC and Fans Power Supply PCB}

Status 5

Counter: PCB MWAP007A

Optional item no information is provided in this phase of the release.

3.19 MST-0427 (v0.000) {MWA Rear Fan Interface PCB}

Status 5

Counter: PCB MWAP006A

Optional item no information is provided in this phase of the release.

3.20 MWA RF Enclosure RFI Shielding

Status 4

At time of quotation, no quantitative information as to allowable levels of RFI emissions had been supplied to PSI. Similarly no base-line data on emission levels from the existing receiver electronics has been supplied to PSI. Consequently PSI contracted to use best practice in the design of the receiver enclosure.

On 23/02/09 PSI was provided with the Draft ASKAP RFI Standards for Equipment to be deployed on the MRO and we expect the enclosure design to comply with the requirements for equipment located between 1 km and 10 km from other facilities on the basis that the outer enclosure will provide >20dB of attenuation. However it will be a matter for testing to determine if the inner shielding is sufficient to reduce the unknown emission level of the electronics down to the level required by the draft standard.

This section describes the RFI shielding measures designed into the enclosure. Cost minimisation was a factor in choosing these measures.

1. A minimum of two layers of shielding to be used between the electronics rack and the outside world. The outer enclosure having >20dB attenuation for 70MHz and above.

2. The main outer enclosure is 1mm zinc-seal steel sheet with fully welded seams and powder coated.

3. The RFI sealing flanges in this enclosure will be masked to leave zinc surface exposed for conductive contact. (If MWA rejects the zinc surface as unsuitable then Chomerics "Chomask" tape is suggested to provide a nickel surface however this will add the order of $100 to the cost of each enclosure.)

4. The access lid is to be sealed using a rectangular cross-section RFI gasket, for example Chomerics "Soft-Shield" 4850-strip. This is held under compression between the zinc-seal surfaces by pressure applied by screw-down lid clamps.

5. The access panels other than the main lid or the other junctions in the enclosure will be metal-to-metal contact with screws (stainless steel into zinc plated nuts) at ~50mm spacing.

6. The joints where moisture ingress might be an issue will be sealed on outer edges using Sikeflex polyurethane sealant after assembly.

7. Subject to demonstrated need, self-adhesive copper tape (conductive adhesive) will be applied over the inside edges of flanges.

8. All RF cable entries will ground the shields at the entry point into the enclosure.

9. The AC mains cable will use flexible metal conduit grounded at the enclosure entry – RFI shielding at the far end of this cable is MWA's responsibility.

10. The AC mains supply will pass through an RFI Industries filter (Schaffner FN 2080-6/06) immediately inside the main enclosure. Connections and wiring around the mains entry point will be enclosed in a perforated metal screen.

11. The main's cabling between the enclosure entry point just described and the rack unit and the air-conditioner switching box will be unscreened 3-core mains cable.

12. The rack units requiring mains power will use RFI filtered IEC entry connectors.

13. The air conditioner switching box will be die-cast aluminum but there will be no additional RFI filtering at its mains entry or on the cables connected to the AC unit unless this proves necessary after testing.

14. The optical cable entry is still to be determined based on whether the FTU is internal or external to the receiver enclosure. This is a MWA systems engineering decision.

15. Inside the main enclosure the MWA electronics "rack" will itself be shielded using the following approach:
    a. The aluminum rack enclosure is 2mm thick, perforated with 20mm diameter holes at 30mm pitch for air flow. All rack units have aluminum front panel's min 2mm thick. The rack unit is connected to the outer enclosure and the AC mains earth with dedicated earthing strap.
    b. Subject to need demonstrated by testing, copper mesh screen may be added over the air-flow perforations in the rack housing.
    c. The abutting edges of the front panels of the individual rack units may be sealed using self-adhesive copper tape. The same applies to junctions between the front panels and the aluminum rack itself.
    d. All RF cable entries into the rack unit will have shields grounded to the front panels. (Shields of cables exiting to the outside are therefore grounded both at the rack unit and the external enclosure.)
    e. All cabling will be screened with those screens connected to metal connector backshells contacting grounded.
    f. The Single Board Computer rack unit will have an additional (3rd level) of RFI shielding being housed in a fully enclosed aluminum box (screwed overlapping flanges, screw spacing typ. 50mm or less).

16. Only one layer of RFI shielding will be applied to the ACU. This will be the steel cover.

17. The air flow through the air-conditioner condenser side will be via perforated ports in the steel cover.

18. The switching of ACU motors will be via zero-crossing synchronised solid state relays. A soft-start of 0.1sec will be applied to the compressor motor to minimise surge currents.

19. Because of limited access for the screw fasteners, one edge of the cover for the ACU will use beryllium-copper "D" finger-stock gasket against the zinc-seal surface.

3.21 MWA Enclosure Thermal Design

Status 1

The MWA enclosure has been designed based on the following assumptions:

1. Operating environment:
    a. Max ambient (air) 45°C
    b. Min ambient (air) -5°C
    c. Solar flux (worst-case direct overhead) 1000 W/m^2

2. Internal load approx 400 W

3. Internal operating temperature set-points of 20°C & 30°C

4. Standby internal load of < 20W

5. Max internal standby temperature < 85°C

6. “Swappable” cooling pack to allow for future finessed cooling designs to be adapted to the electronics enclosure.

7. Design to be compatible with a sun-shade should it prove necessary.

A worst-case external skin temperature of 90°C is calculated for those parts of the enclosure exposed to direct normal solar incidence.

Extruded (blue) polystyrene sheet (thermal conductivity < 0.03 W/m/K) was chosen for its combination of economics and mechanical robustness.

The worst-case heat flux into the enclosure from ambient is calculated as 90 W. Allowing for the worst case solar exposure raises this to 120 W although this may be reduced by increasing the insulation thickness under the lid.

Under the worst-case standby conditions the internal temperature is calculated to reach 60°C. Note that in preliminary design discussions with MWA, PSI stated that the AC was intended to run whenever necessary to maintain the internal operating temperature. The requirement for stand-by operation where the AC unit would not be powered while there was internal heat load under worst-case conditions was added later by MWA. The ACU is not designed, or tested, to turn on with evaporator temperatures above 45°C. It will be necessary to test and develop a protocol for re-starting the ACU from the worst-case standby-by operation.

The ACU chosen has a rated cooling capacity of 800W. Note the unit has a capacity-correction factor of 1.25 at 45°C ambient and a 15°C internal turn-on point, that is, a worst-case cooling capacity of 1000W. This suggests a smaller 650W AC unit might be suitable and the design “allows” for this by changing the opening size in MWAM002. However PSI does not recommend the use of the capacity-correction factor because of the combination of:

- the evaporator temperature being higher than the nominal operating range
- restricted air flow through the condenser unit
- allowance for margin on condenser intake air temperature
- allowance for margin on the heat flux calculations

Because of the “bolt-on” nature of the ACU, this design choice can be revisited when there is some field data to support more detailed calculations.

Some testing has been performed at PSI to verify satisfactory operation of the unit with the higher than nominal evaporator temperature. This was done with a temporary enclosure loaded with 450W and with 50°C air supplied to condenser. When operating at on and off set-points of 30°C & 20°C respectively, the KPC800 operated satisfactorily with ~50% duty cycle.

The KPC800 manufacturer’s data suggests the cycle off time should be at least 10 minutes; the cycle-off time will depend on the final internal thermal mass. Based on the KPC800 refrigerant

charge, an estimate of the internal metalwork and the expected internal heat load off-time is calculated at 8 minutes under worst case conditions. This may be increased by adding some thermal mass; for example a few litres of water in PET bottles but more detailed testing is required to confirm any need for increased thermal mass.

PSI has insulated the preliminary enclosure metalwork and has constructed an AC switching control box. Dave Emrich from MWA has indicated he will provide PSI with a basic controller (implementing PSI's proposed AC state diagram) so that the operation of the AC unit can be tested more rigorously.

3.22 Design for Manufacturing and Serviceability

Status 1

In formulating the design for the Receiver Enclosure, PSI has considered manufacturing productivity and efficiency as well as serviceability rather than a simple minimum cost of components approach. This approach should lead to a minimum overall life-cycle cost since the manufacturing process and commitment to service over many years represents a significant real cost.

Hence, where PSI has faced a choice it has employed principles of standardisation, reuse and Modular design. For example standardisation of interconnect cables allows the reuse of one cable design in several places. PSI has also broken the receiver electronics rack into distinct modules with a view to both efficient manufacture and ease of service/upgrade. This also mitigates risk in the design since replacement or redesign of one module has minimal overall impact. In particular PSI's approach to cooling with an ACU allows for minimal risk in producing a unit capable of functioning in the intended environment; at the same time the cooling module can be removed and replaced by alternatives if this is felt necessary.

PSI has also used a "Design for Assembly/Manufacture/Service" approach which will pay off when large numbers of receivers are to be manufactured. For example the use of a PCB to distribute power from the PSU to connectors will avoid wiring time and errors offsetting the effort required to design the PCB.

PSI's approach has therefore been to aim for reduced overall life-cycle costs and mitigation of risk both in manufacture and maintenance.

Section 4. External Interfaces

4.1 External Interface Overview

The following is a list of the external interfaces provided on the receiver enclosure:

- Power
- Optical
- Beamformer Control & Power
- Beamformer RF

More detailed information on each interface is covered below:

4.2 External Interfaces

4.2.1 Power

The power interface is for standard AC mains provided via a standard Australian AC mains plug. To meet expected EMI/EMC requirements, the plug will protrude from 2 meters of screened conduit. The MWA project team is responsible for devising an assembly method to this plug and will need to provide suitable screening at the attachment point.

At the interface to the plug the following requirements must be met:

Voltage: 216 to 253 VAC

Frequency: 50 to 60 Hz

Power: 1500 W (Maximum)

Inrush Current: Cold Start, 30A @ 230V

4.2.2 Optical

The optical interface is M16 Environmental Cable Gland to allow entry of the Prysmian SM@RTCORE 12 fibre loose tube optical cable with a nominal diameter of 9.1mm. The fibres will be terminated internally in the receiver enclosure using a Fibre Termination Unit (FTU) that is yet to be specified in Salem.

4.2.3 Beamformer Control & Power

The control and power interface of the eight analogue beamformers enters the Receiver Node Enclosure through a 19-way Female (Souriau UTO71619SH) Metal Circular Connector. The connector has the following pinouts which have been defined by the MWA Project Team:

Number	Pin	Signal
1	A	+48V
2	B	+48V RTN
3	C	WxZo

4	D	WxYo
5	E	TxdZo
6	F	TxdYo
7	G	RxdAo
8	H	RxdBo
9	J	RxClkAo
10	K	RxClkBo
11	L	TxClkYo
12	M	TxClkZo
13	N	WyYo
14	P	WyZo
15	R	NC
16	S	NC
17	T	NC
18	U	NC
19	V	NC

4.2.4 Beamformer RF

The 16 RF signals (80-300 MHz) from the eight analogue beamformers enter the Receiver Node Enclosure through F-Type bulkhead coaxial connectors.

Section 5. References

A list of all documents utilised in developing the System Design Description.

Document No.	Document Title	Date	Author
1	MWA-LFD Project Wiki – Receiver Node Section	NA	Various
2	Data Pack for Temperature Monitor Board	18/02/09	M. Waterson
3	MWA Eight Channel Cavity CAD models	18/02/09	M. Waterson
4	Clock design information to PSI	14/04/09	FinishLine
5	ATIM Modifications List	20/05/09	M. Waterson
6	Altium Library Files for ATIM	29/05/09	M. Waterson
7	Fiber optic BOM, SCH, PCB files	16/07/09	FinishLine
8	New I2C distribution & addresses (revised)	27/08/09	M. Waterson
9	Revised ATIM and matching power monitor schematics	02/09/09	M. Waterson
10	520 ATIF files	3/09/09	M. Waterson
11	ATIF marked up schematics	17/09/09	D. Emrich
12	Mark Waterson Notes – Electronic Format	19/03/09	M. Waterson
13	Mark Waterson Notes2 – Electronic Format	02/04/09	M. Waterson
14	Digital Crate PDF's	19/03/09	Various
15	PSI and MWA Equipment Photographs	19/03/09	Various

Section 6. Glossary

The following is a list of terms and acronyms used within this system design document:

Acronym	Meaning	Explanation
ACU	Air Conditioning Unit	The air conditioner and associated metalwork and cables
ADFB	ADC Filter Bank	2 boards each containing 4 2-channel digitizer and polyphase filter banks.
AGFO	Aggregation Formatting & Transmission	Combines the selected bands from the 16 digitized input streams, reformats, and sends data out in 3 fibres. Also receives and regenerates the system clock(s).
ASC	Analogue Signal Conditioning PCB or Module	Input protection, filter and gain stage of the RF signals from the Beamformers.
ATIM	Antenna Tile Interface Module	Supplies control, phase switching, and power to each of the 8 tiles.
Backplane	Digital Backplane	Host for ADFB and AGFO, multiple series interconnects and power distribution
BFC	Beam Former Cables	The control and power cables between the Beam Formers and Receivers.
MCC or SBC	Monitor Control Computer	Local intelligence to control receiver, using Ethernet over fibre to central node. Includes the SBC (Single Board Computer).
MWA	Murchison Widefield Array	Site location of the Receiver Nodes.
PSU	Receiver Power	Mains power in, all local power out under MCC control.
Receiver	Receiver Enclosure	The enclosure, environmental protection, and thermal management.
SALEM	Stock, Assembly, Logistics and Engineering Manager	SALEM is the Poseidon Scientific Instruments production assembly management system.

Section 7. Revision History

Version	Date	Name	Description
0.0	09/10/09	Derek Carroll	First Draft
0.1	14/10/09	Derek Carroll	Incorporated Ian's Comments
0.2	20/10/09	Derek Carroll	Update to System Structure
1.0	23/10/09	Derek Carroll	Release Version

Section 8. Appendices

Links to electronic supplied information, PDF's, XLS's, photo's drawings, etc.

8.1 Electronic Files

The following is a list of the electronic files provide on the receiver enclosure:

README.txt

- **MWA_Receiver_Repackaging**
  - **General_Information&Introduction**
    - ReceiverNode_Repackaging Phase3.pdf *(This document)*
  - **System_Design_Data**
    - **Receiver_Node_Enclosure-MST-0432**
      - Enclosure_Cables.xls
      - Enclosure_AC_Wiring.pdf
      - Enclosure_Sys_Diagram.pdf
      - Enclosure_Control_Interconxs.pdf
      - Enclosure_DC_Power_Interconxs.pdf
      - Enclosure_RF_Interconxs.pdf
      - Tough Power Board.pdf
      - Enclosure_Input_Pwr_BOM.xls
      - PrePrototype_photo1.JPG
      - PrePrototype_photo2.JPG
      - PrePrototype_photo3.JPG
      - PrePrototype_photo4.JPG
      - PrePrototype_photo5.JPG
      - PrePrototype_photo6.JPG
      - PrePrototype_photo7.JPG
      - PrePrototype_photo8.JPG
      - PrePrototype_photo9.JPG
      - PrePrototype_photo10.JPG
      - PrePrototype_photo11.JPG
      - PrePrototype_photo12.JPG
      - PrePrototype_photo13.JPG
      - PrePrototype_photo14.JPG
      - PrePrototype_photo15.JPG
      - PrePrototype_photo16.JPG
      - MWAM025 Tie down bracket.PDF
      - MWAM023 AC enclosure interconnect bar.PDF
      - MWAM022 AC enclosure tie down bar.PDF
      - MWAM014 Connector panel.PDF
      - MWAM002 AC Enclosure Sheet metal.PDF
      - MWAM001 Sheet metal.PDF
      - MWAM001 Main enclosure.PDF
      - MWAM001 Main enclosure #4.pdf
      - MWAM001 Main enclosure #1.pdf
      - MWAM001 Main enclosure #2.pdf
      - MWAM001 Main enclosure #3.pdf
      - MWAM013 Flow splitter.PDF
      - MWAM021 Main enclosure tie down bar.PDF
    - **Antenna_Tile_Interface_PCB(ATIF)-MST-0416**
      - 521_ATIF_Schematic_and_PCB_Layers.pdf
      - 521_ATIF_BillofMaterials.xls
    - **Internal_Rack-MST-0448**
      - MWAM038 Electronics Case.PDF
      - MWAM038 Electronics Rack #4.pdf
      - MWAM038 Electronics Rack #1.pdf
      - MWAM038 Electronics Rack #2.pdf
      - MWAM038 Electronics Rack #3.pdf
      - **Digital_Rack-MST-0448**
        - MWAM037 Digital rack.pdf

- MWAM037 Digital rack unit #4.pdf
- MWAM037 Digital rack unit #1.pdf
- MWAM037 Digital rack unit #2.pdf
- MWAM037 Digital rack unit #3.pdf
- **Clock_Unit-MST-0425**
  - MWAM037 Clock receiver unit #4.pdf
  - MWAM037 Clock receiver unit #1.pdf
  - MWAM037 Clock receiver unit #2.pdf
  - MWAM037 Clock receiver unit #3.pdf
- **Analogue_Signal_Conditioning_Module-MST-0422**
  - MWAM029 ASC rack front.PDF
  - MWAM028 ASC housing.pdf
  - ASC Rack unit #4.pdf
  - ASC Rack unit #1.pdf
  - ASC Rack unit #2.pdf
  - ASC Rack unit #3.pdf
  - **Analogue_Signal_Conditioning_PCB-MST-0421**
    - ASC_BillofMaterials.xls
    - 100_ASC_PCB_Schematic_and_PCB_Layers.pdf
- **Power_Supply_Module-MST-0429**
  - PSU_Module_Assy&Wiring.pdf
  - PSU_Module_BillofMaterials.xls
  - SFE_ACE.pdf
  - MWAM032 PSU front panel.PDF
  - PSU Rack unit #4.pdf
  - PSU Rack unit #1.pdf
  - PSU Rack unit #2.pdf
  - PSU Rack unit #3.pdf
  - **Power_Distribution_PCB-MST-0419**
    - 820_PwrDis_PCB_BillofMaterials.xls
    - 820_PwrDis_PCB_Schematic_and_PCB_Layers.pdf
- **SBC_Module-MST-0426**
  - SBC_Module_Assy&Wiring.pdf
  - PSU_ATIM-C_to_ATIM-P5.pdf
  - SBC_Module_BillofMaterials.xls
  - Helios-Datasheet.pdf
  - gpiommdatasheet.pdf
  - IMC-101_Series.pdf
  - IBEX PCXX.pdf
  - MWAM039 SBC Enclosure.pdf
  - MWAM039 SBC Rack unit #4.pdf
  - MWAM039 SBC Rack unit #1.pdf
  - MWAM039 SBC Rack unit #2.pdf
  - MWAM039 SBC Rack unit #3.pdf
  - **ATIM_Interface_and_Control_PCB-MST-0417**
    - 550_ATIM_I&C_PCB_Schematic_and_PCB_Layers.pdf
    - 550_ATIM_I&C_BillofMaterials.xls
  - **Dual_Octal_TempMon_Assy-MST-0431**
    - **Octal_TempMon_PCB-MST-0430**
      - TempMon_PCB_Schematic_and_PCB_Layers.pdf
      - TempMon_BillofMaterials.xls
- **ATIM_Transitionand48V_Monitor_PCB-MST-0418**
  - 540_ATIM_transition_Schematic_and_PCB_Layers.PDF
  - 540_ATIM_transition_BillofMaterials.xls
- **Air_Conditioner_Unit-MST-0424**
  - AirCon_TempMon_Wiring.pdf
  - AC Unit #1.pdf
  - AC Unit #2.pdf
  - AC Unit #3.pdf
  - AC Unit #4.pdf

KPC800 spec sheet.pdf
MWAM004 Air Conditioner Cover Sheet Metal.PDF

Air_Conditioner_Control_Box-MST-0420
AC_Control_CloseUp1.JPG
AC_Control _Assembly.JPG
AC_Control_ProtectionRemoved.JPG
AC_Control_CloseUp2.JPG
AC_Control_Lid.JPG
AC_Control_Lid_Removed.JPG
AC_Control_TopView.JPG
AC_Control_BottomView.JPG
AC_Control_Resistors.JPG
AC_Control_Box_BOM.xls

Legacy_or_Options-MST-0447 (Empty)
MCCandFans_PSU_PCB-MST-0428
Rear_Fan_Interface_PCB-MST-0427