

Government of India  
Bhabha Atomic Research Centre  
**Accelerator Control Division**

Ref: ACnD/ACSS/17/520

Date: 27.07.2017

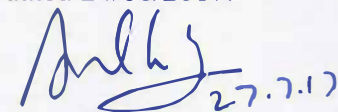
-----TO WHOM SO EVER IT MAY CONCERN-----

Sub: Minor Fabrication job for "Design, schematization, layout, fabrication, component procurement, assembly, testing and supply of modified cards for VME64x based RF protection and Interlock system" conforming to technical specification no ACnD/ACSS/RK/TS05 dated 24/07/2017

Dear Sir/Madam,

1. Quotations are invited for, "Design, schematization, layout, fabrication, component procurement, assembly, testing and supply of modified cards for VME64x based RF protection and Interlock system" conforming to technical specification no. ACnD/ACSS/RK/TS05 dated 24/07/2017.
  2. Bidder shall quote for purchase of raw materials, fabrication, assembly, integration, testing and supply of all items and its accessories.
  3. Taxes and Excise Duties shall be quoted separately. Form AF / H whichever is applicable shall be provided, if required.
  4. The quotation must reach The Head, Accelerator Control Division by 17/08/2017 (12:00 PM) and must be sent in a sealed envelope super scribed with the reference number & the due date given above only through India Ordinary Post/Speed Post.
  5. The address on the envelop should read: The Head,  
Accelerator Control Division,  
1-328S, First floor, Modlab-D  
block, BARC, Trombay,  
Mumbai - 400 085.  
(Kind Attn: Shri R T Keshwani, SO/F, ACnD)
  6. The bidder shall complete the job within 24 weeks from the date of firm work order issued to the bidder. The finished components shall be delivered by the bidder at Accelerator Control Division, BARC, Trombay, Mumbai - 400 085.
  7. Head, Accelerator Control Division reserves the rights to accept / reject any or all quotations without assigning any reason.
  8. Delivery charges if any must be clearly mentioned in the offer. Quotation must also indicate the validity of offer. Quotation must also indicate the VAT no and PAN no of the party.
  9. Drawings / Sketches must be returned along with the offer.
  10. The quotation has to be signed by authorized person with company seal.
  11. Payment will be made by cheque only after satisfactory completion of work on production of bill, delivery challan and advance stamped receipt. It may be noted that IT @ 2% shall be deducted from your bills.
  12. In case of technical clarifications, the suppliers may kindly contact Shri R. T. Keshwani, SO/F, ACnD (Ext No: 022-25593806)
- Encl.: Technical Specification Sheet no: - ACnD/ACSS/RK/TS05 dated 24/08/2017.

R. Keshwani

  
27.7.17  
**Head EMAS, ACnD**

## Technical Specification for minor fabrication enquiry

| <b>Specification no.</b> | <b>Revision no.</b> | <b>Date of Issue</b> | <b>No of pages</b> |
|--------------------------|---------------------|----------------------|--------------------|
| ACnD/ACSS/RK/TS05        | 0                   | 24/07/2017           | 15                 |

Design, schematization, layout, fabrication, component procurement, assembly, testing and supply of modified cards for VME64x based RF protection and Interlock system

### **1.0 Scope of work:**

It is required to design, schematize, layout, fabricate, procure components, assemble, test and supply various cards of VME64x based RF protection and Interlock system (RFPIS) as per our Technical Specifications in this document.

The RFPIS system consists of following cards:

#### **RFPIS has various cards:**

- a) **Front carrier VME64X board which houses Fast Analog input daughter card.**
- b) **Front carrier VME64X board which houses Fast Digital output daughter card**
- c) **A rear carrier board.**
- d) **Inter-card Communication Bus (ICCB) card.**
- e) **Field signals Interface card (FSIC).**
- f) **Operator Interlock and protection card (OPIC).**

#### **For testing these cards, the test set up consists of:**

- a) **LED based Test card for VME64X cards (DTC)**
- b) **Mezzanine connector test card (MCTC)**
- c) **Set of test connectors**

Cards of each type is to be fabricated, assembled and tested. **Some of these cards are to be designed starting from design specifications given in this specification.** Functional details in short for each card has been explained in annexure II.

The supplier shall procure all components (including spare components) as per bill of material (BOM in Annexure III) enclosed. For some of these cards, earlier prototype cards have been fabricated and tested. They need modifications in layout and component footprints. After these modifications, a modified schematic, layout and Gerber files need to be generated by supplier. PCBs should be fabricated as per approved Gerber files and assembled with the required components and finally tested for basic functionality before supply. The Front and rear fascia panels to be fabricated and punched as per the details enclosed in annexure II. The indenting authority shall provide all the necessary details required for the job.

### **2.0 Description of the work:**

- a) The previously existing final schematic design will be supplied in OrCad Capture format and PCB layout files in cadence allegro format along with the confirmed order. The supplier will have to modify schematics and layout get them approved by indenting authority. The supplier has to do fabrication of the PCBs, procurement and mounting of the components as per the final schematic bill of material and carry out testing of the boards.
- b) All the daughter cards have 6 layers and VME carrier board has 14 layers depending on the layout methodology used for routing nets, ground and power supply planes. Rear I/O carrier board has a 8 layer PCB.
- c) The supplier shall review the previously existing schematic and layout and seek clarifications if required. The part numbers given in the functional block diagrams (wherever provided) and BOM in annexure III are indicative only. Any functionally compatible parts can be used with the consent of the indenter.
- d) The supplier can suggest any changes to improve the performance of the boards and implement the same with the consent of the indenting officer. The completed layout shall be submitted to the indenting officer for approval. After the approval, the supplier shall generate the Gerber file in RS-274X format. The supplier has to fabricate the boards from a reputed manufacturer and name of the manufacturer is to be mentioned in the quote.
- e) The PCB fabrication process should be carried out as per the following requirements
  - Meeting FCC EC Standard requirements
  - PCB size: 6U (230mm x 160mm) and material FR4 for VME carrier boards with 14 layers. Mezzanine cards (80mm x 120mm) and material FR4 with 6 layers. Rear carrier board (230mm x 80mm) and FR4 material with 8 layers.
  - Laser photo plotting technique to be used
  - PCB fabrication with Solder Mask Over Bare Copper (SMOBC) / Hot Air Solder Leveling (HASL) technology and all vias shall be masked.
  - SMD resistor and capacitor of appropriate size

- Complete Gold flash on full PCB
  - The PCBs should pass all the qualification and Quality control tests including the Bare Board with flying Probe Technique
- f) Procurement and mounting of the components shall be done as per the bill of material generated from the final schematic.
- g) The components shall be assembled and soldered on the PCB as per the conditions explained below. The assembly of the PCB shall be with the following setup:
- Fully automated SMT setup with pick and place for all standard SMD components during production stage
  - Reflow with forced air convection system
  - Minimum three zones of heating profile with independent reflow zones
  - High-resolution microscope visual inspection system.
  - ESD safe environment.
  - ESD safe soldering station for through-hole components and for wiring.
  - The workmanship should be as per the IPC-A-610D electronic assembly standard
  - The correct assembling of all the electronic components especially the FPGA (BGA component) shall be ensured.
- h) The supplier will fabricate PCBs and populate it as per the design and submit it for testing. During the testing of the board, if any design or manufacturing errors are found, the corrections will be intimated to the supplier. The supplier shall incorporate the changes in the design and layout.
- i) The front and rear fascia panels for the boards should be fabricated and engraved. They should have good quality standard ejectors suitable for a VME64X chassis. Details of the fascia requirements of carrier boards and mezzanine cards have been explained in annexure II.
- j) The supplier shall procure necessary commercial grade components as per the final bill of material generated from OrCad Schematic and assemble them on the board. Supplier will also procure and supply 5% of all semiconductor components as spares, in case 5% is a fractional number, the quantity must be rounded to the next higher integer.
- k) The supplier will have to demonstrate the functional working of the various sections of the board by providing suitable test inputs and test codes. The supplier shall provide VHDL codes to demonstrate proper working of DDR3 memory, Ethernet Interface, SPI Interface to ADC as well as DAC. The VHDL codes should be well documented and structured for future modifications. The supplier will have to demonstrate functional testing of the entire board as per the test procedure provided by the Indenter.
- l) **The supplier will have to supply all the boards as specified in indent in full working condition**
- m) Fabrication costs, component cost and testing charges of modules are to be mentioned separately in the quote.
- n) **Additional charges for correction in layout and Gerber generation should be explicitly mentioned in the quotation for correcting errors in the layout and Gerber files due to errors in the user's schematic files. If the charges are not mentioned, it will be assumed to be "free of charge" and included in the quotation.**
- o) If any board is rejected due to manufacturing defects, the supplier will have to supply an additional board as replacement free of cost. **The supplier will have to supply all the boards as specified in indent in full working condition**
- p) All the items fabricated shall have onsite warranty for a period of one year from the date of final acceptance against all manufacturing defects.
- q) If required the purchaser along with experts will visit the supplier and evaluate the capability of the engineers employed by the supplier. Supplier must give details of jobs undertaken of similar complexity in the past three years for any organization.
- r) The supplier must give the details of the infrastructure suitable for this job such as VHDL programming tools, Schematic Capture, PCB layout tools and test equipment such as function generator, Oscilloscopes and logic analyser. In case the firm does not have these tools and equipments but intend to bring them on rent during the execution of the job then it should be clearly mentioned in the technical quotation.
- s) Different types of electronic boards described in annexure II form one complete RFPI. Thus it is mandatory that these boards be sourced from the same supplier. Hence total cost should be the basis of comparison and not the cost of individual boards.
- t) The manufacturer shall provide the following documents at the time of supply of the boards:
1. Corrected OrCad Schematic Files
  2. Final BOM (Bill of Material).
  3. Final PCB layout files in cadence allegro format.
  4. Final Gerbers in RS274-X format
  5. Pick & Place File
  6. N.C. Drill files
  7. Drill Drawing (Fabrication Drawing)
  8. Layer Stack Report

9. Assembly Diagram (PDF format)
10. Archive of complete design folders including intermediate design files and design documents, datasheets.
11. Well documented codes used for testing of board
12. Detailed operation and testing procedure

### 3.0 Deliverables:

The following items shall be supplied to ACnD, BARC after satisfactory testing and inspection by indenting authority. The packaging, transportation and safe delivery shall be in scope of supplier.

| Type no. | Name                                 | Qty (no.) |
|----------|--------------------------------------|-----------|
| 1        | VME64X carrier board                 | 2         |
| 2        | Fast analog Input card               | 1         |
| 3        | Fast Digital Output Card             | 2         |
| 4        | Rear carrier Board                   | 1         |
| 5        | ICCB card                            | 2         |
| 6        | Field signal Interface card          | 2         |
| 7        | OPI card                             | 2         |
| 8        | LED based Test card for VME64X cards | 2         |
| 9        | Mezzanine connector test card        | 2         |
| 10       | Set Of Connectors                    | 1         |

Following table gives idea about nature & scope of work required for each card:

| Type no. | Name                                 | Gerber file available | Circuit Design work | Layout design/ modification | Assembly | Testing |
|----------|--------------------------------------|-----------------------|---------------------|-----------------------------|----------|---------|
| 1        | VME64X carrier board                 | Yes                   | No                  | Yes                         | Yes      | No      |
| 2        | Fast analog Input card               | Yes                   | No                  | No                          |          |         |
| 3        | Fast Digital Output Card             | Yes                   | No                  | Yes                         |          |         |
| 4        | Rear carrier Board                   | Yes                   | No                  | No                          |          |         |
| 5        | ICCB card                            | No                    | Yes                 | Yes                         |          |         |
| 6        | Field signal Interface card          | No                    | NA                  | Yes                         |          |         |
| 7        | OPI card                             | Yes                   | No                  | Yes                         |          |         |
| 8        | LED based Test card for VME64X cards | No                    | No                  | Yes                         |          |         |
| 9        | Mezzanine connector test card        | No                    | No                  | Yes                         |          |         |

### 4.0 Documentation Requirements:

4.1 Before commencing manufacturing, supplier shall furnish the following for purchaser's approval:

4.1.1 The fabrication drawing shall be submitted for approval either in soft/ hard copy form.

4.2 The supplier shall submit a quality assurance (QA) plan to the buyer for acceptance. The plan shall ensure that each item offered for acceptance conforms to the requirements herein.

### 5.0 Requirements of supplier qualification:

5.1 Human resources: The supplier must give the details of human resources including Engineers, Draftsman, assembly mechanic, quality control inspector, etc.

5.2 Infrastructure: The supplier must give the details of infrastructure suitable for this job such as electronic testing equipment, etc. Assembly room and other tools & tackles, Inspection facilities etc.

5.3 Past experience: The supplier must give their past three-year turnover and job executed by them with reference, volume of work and completion schedule, present commitments and anticipated commitments inside and outside India.

5.4 Sub contract: Supplier should list the jobs, which they want to sub-contract. They should also produce the list of sub-contractors and their infrastructures and facilities.

5.5 Supplier shall have necessary electronic hardware test set up at their facility to carry out the above fabrication and testing.

### 6.0 Requirement of price and delivery schedule:

6.1 The supplier shall give a lump-sum price with delivery schedule

## **7.0 Confidentiality clause:**

7.1 No party shall disclose any information to any third party concerning the matters under this Contract generally. In particular, any information identified as "Proprietary" in nature by disclosing party shall be kept strictly confidential by the receiving party and shall not be disclosed to any third party without the prior written consent of the original disclosing party. This clause shall apply to sub-contractors, consultants, advisors or the employees engaged by a party with equal force.

4.2 . "Restricted information" categories under section 18 of the Atomic Energy Act, 1962 and "Official secrets" under section 5 of the Official Secrets Act, 1923: Any contravention of the above mentioned provisions by any contractor / sub-contractor, consultant, advisor or the employees of the contractor will invite penal consequences under the aforesaid legislation.

4.3 Prohibition against the use of BARC's name without permission for publicity purpose. The contractor or sub-contractors, consultants, advisors or the employees engaged by a party shall not use BARC's name for publicity purpose through any public media like: press, radio, TV or Internet without any prior approval of BARC (wide circular ref.: 2/Misc- 9/Lgl/2001/92 date 30/04/2001

**Annexure II**  
**Description of RFPIS cards and work involved**

The VME64X based RFPI consists of 6U form factor system having multiple boards. The RFPI system consists of following cards:

**RFPI has various cards:**

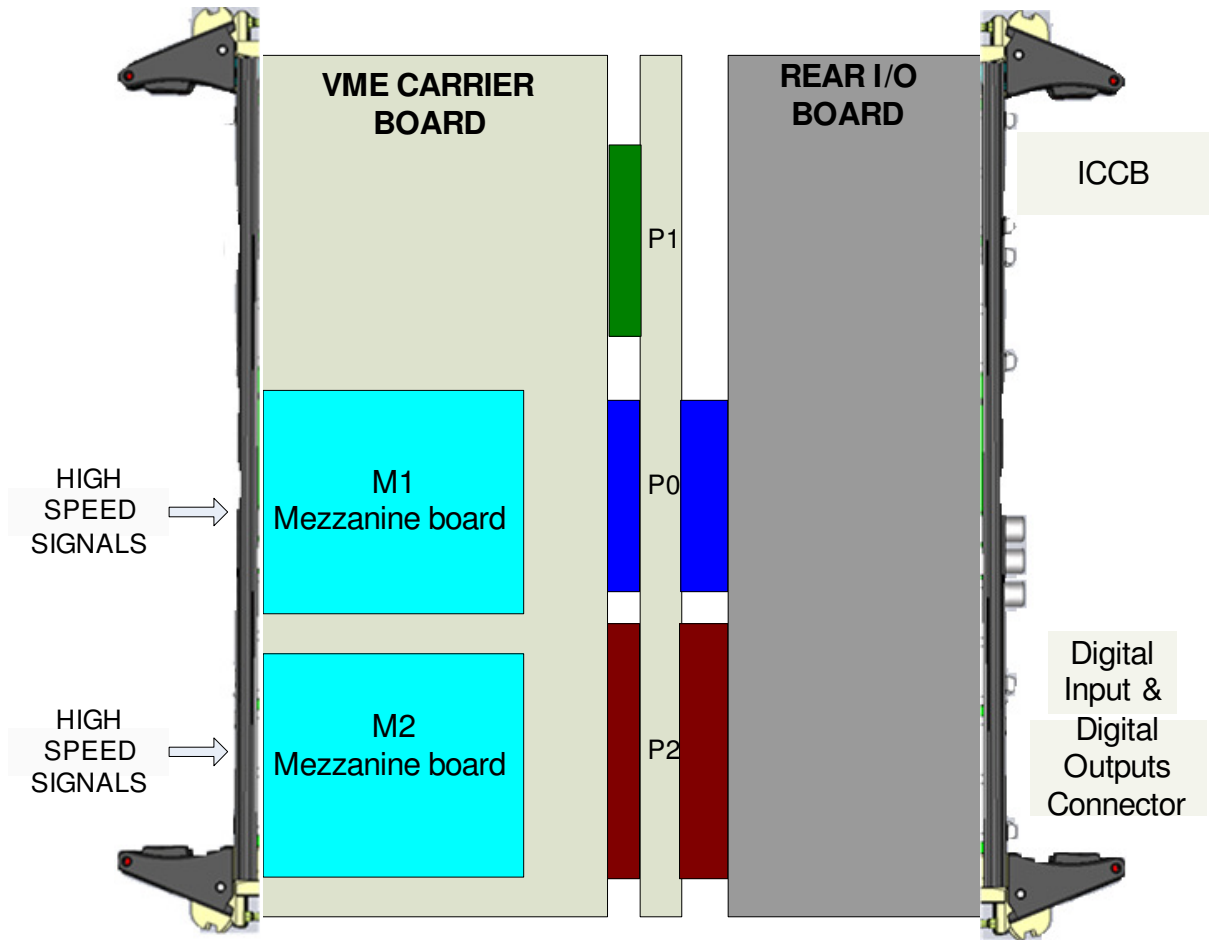
- a) Front carrier VME64X board which houses Fast Analog input daughter card.**
- b) Front carrier VME64X board which houses Fast Digital output daughter card**
- c) A rear I/O carrier board.**
- d) Inter-card Communication Bus (ICCB) card**
- e) Field signals Interface card.**
- f) Operator Interlock and protection card (OPIC).**

**For testing these cards, the test set up consists of:**

- a) LED based Test card for VME64X cards**
- b) Set of test connectors**

**Two types of carrier boards i.e. VME carrier board and rear I/O carrier board and two types mezzanine cards can be used to form RFPIS. One assembly of VME64X carrier card with its daughter cards and rear I/O carrier card is called as module. Detail component break-up of the cards is given in annexure III.**

All the modules in the RFPIS are 6U, VME64X form factor modules having a rear I/O card. The modules have analog sections which are unique to each card and digital sections that are common to all the modules. The digital section like interlock logic, FPGA, DDR3 Memory and the VME interface are on the base board (VME carrier board), which is common to all the IPMS modules. It also has provisions for various power supplies and filters that are required by the carrier board as well as mezzanine boards. **The unique functionality of each module is migrated on to the mezzanine board which are populated on VME base board.** The VME base board has two such mezzanine cards (M1 and M2). The module also has a rear I/O card for interfacing the field and control signals. Architecture of the module is as shown below in figure 1.



**Fig. 1 Architecture of VME module with mezzanine card and rear I/O card.**

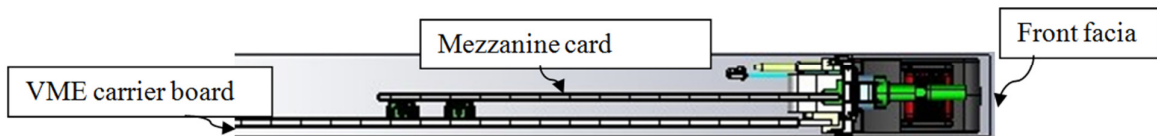
Each mezzanine card on VME64 carrier board has different functionality. Each carrier board has an FPGA for implementing the trip logic and 256MB DDR3 memory interfaced to FPGA. One sets of following cards are required to be developed, fabricated and delivered as part of the RFPIS.

**1.0 Description, design aspects, fabrication aspects of different cards of RFPIS**

**1.1VME64X card:**

This board has VME interface, glue logic, 256MB DDR3 Memory, Altera FPGAs for implementing trip logic and VME interface. This board also has a rocket IO connector which utilises the PCIe (1x, 4x, 8x) hard IP core available in Aria2 FPGA. The bus interface glue logic is required for 5V to 3.3V logic conversion. The front panel fascia has LEDs for displaying status of some events and monitoring terminals. The carrier board also has provisions for various power supplies and filters that are required by the carrier board as well as mezzanine boards. The BOM of VME card may be found in Annexure III. *This card has all resistors of SMT type package 0402.*

**1.1.0 Mechanical Dimensions:** All the modules are 6U, VME64X form factor modules and have a host carrier card and two daughter cards (mezzanine cards) on the front as well as rear board. Architecture of the module is as shown below in figure 2.



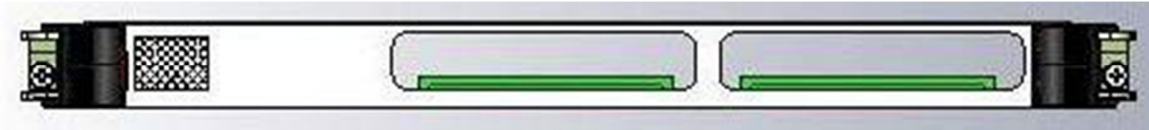
**Fig. 2 Architecture of VME module with one mezzanine card**

The mezzanine cards are connected to the host board through Samtec connectors. Samtec make connector QTH-90-01-L-D-A will be used as mezzanine card Header. The VME carrier card PCB is on the lower side. The mezzanine card is the

upper PCB. The green connector between Mezzanine card and VME card is the Samtec connector( HSMC connector in fig.2.)which separates the boards by 5mm .

**1.1.1 VMEHost Board Layout:** The Samtec connectors on the mezzanine card is to be located on the edge of the PCB to minimize the keep-out area required on both, the host boards and the mezzanine card. The components are mounted on top side of the mezzanine card and the QTH header is mounted on the bottom surface of the card. The connectors are placed sufficiently away from the board's edge to allow for two mounting holes. This ensures a rigid connection between the host board and mezzanine card.

**1.1.2 Facia mechanical arrangement:** The front view of facia is shown in figure 3 below. The cutaway sections houses mezzanine card bezel. The 5X7 LED connector is visible on left hand side. The space between bezel and LED will house card specific connectors and potentiometers and test points for setting up the trip limit.



**Fig. 3 Front view of Facia**

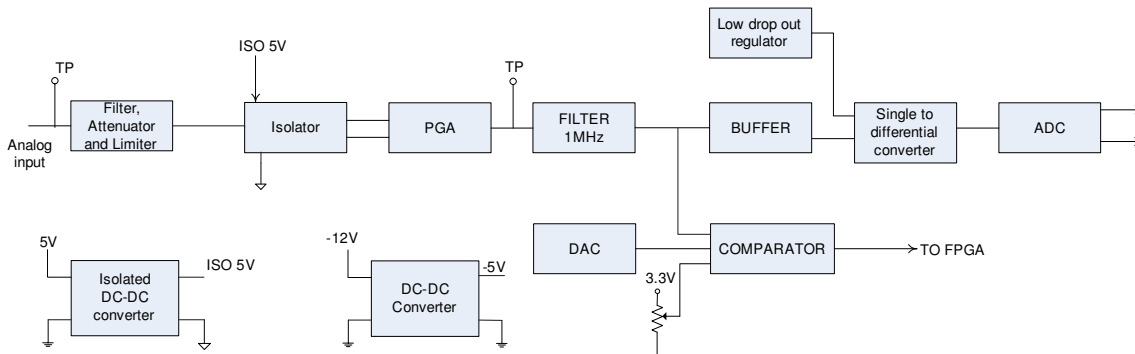
**1.2 Fast Analog input card:**

This card monitors the analog voltages and current of process variables at various points in the target system. The analog input signal is given to isolator, PGA, filter and 8 channel ADC. The filter output is compared against a local set point as well as DAC controlled set point.

Analog input board is a mezzanine board of size approx. (120\*75) mm<sup>2</sup>. The board will have one HSMC connector of 160 pins and will be mating with HSMC connectors on the VME 64X based carrier board. Each analog input board has to process 8 input analog signals coming from an RF amplifier.

The analog inputs to the board are of range (0-2.5)V DC. These signals are to be isolated from the module ground and are to be compared with set limits set by DAC. The limits can be set either by a local touch screen or remotely using GUI. Both upper and lower limits are to be set for each parameter. If the measured parameters are above the maximum set limit or below the min. set limit, it is declared as a fault by a comparator output. The fault signal is interfaced to a FPGA through HSMC connectors. Input connector on the front panel is to be suitably selected so as to accommodate 8 input signals with GND. Block diagram is as seen in figure 4

Provision to change the gain of the input signals and filters to remove conductive noise is to be provided for each input (Bandwidth of 1MHz). The signals are digitized continuously using a suitable ADC and the measured signals are continuously displayed locally and remotely. The sampling frequency may be 1 or 2 MHz. Provision to give an external trigger to the ADC also is to be provided. The ADC output should be LVDS and are interfaced to FPGA through HSMC connector. Refer to figure below for block diagram of typical channel.



**Fig. 4 One analog channel of mezzanine card**

The key specifications of card are as follows:

- No of analog inputs: 08
- Analog input voltage range: 0 to 2.5 V
- Input Impedance for analog inputs: 10 Kohm
- Bandwidth of analog input signals: 1 MHz



### 1.3 Fast Digital Output Board:

Digital output board is a mezzanine board of size approx. (120\*75) mm<sup>2</sup>. Minimum 20 digital outputs are to be provided from this digital output module which will be used to control different components of RF amplifier. The digital output signals are interfaced to FPGA through HSMC connectors on the board. The digital outputs from FPGA is to be translated to TTL signal and isolated signals should be provided on the front panel on suitable connectors. Refer to figure for block diagram of typical channel.

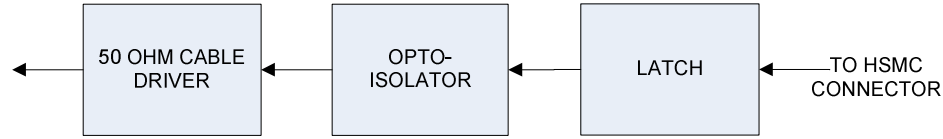


Fig.5 Digital Output Channel

The key specifications of card are as follows:

Isolation: 5 KV

No of digital Outputs: 20

Digital Output voltage: TTL compatible

Driver: 30 ohm cable driver.

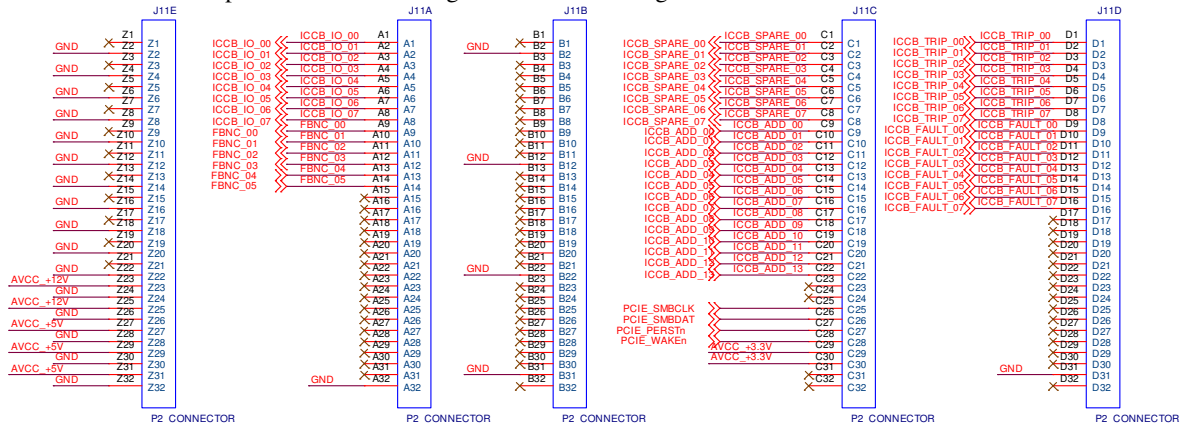
### 1.4 Rear I/O carrier card:

This board is of size approx. (230\*80) mm<sup>2</sup>. Its basic purpose is to facilitate connections between various connectors and translate signals from VME signal level to field signal level.

*Interface for ICCB connector:*

The rear carrier board will be used to interconnect the different boards in the system and also to generate digital I/O signals to be used in the field. Level translator ICs will be used on the rear carrier board so as to interface the signals to FPGA.

Rear carrier board will be interfaced with P2connector of VME chassis. The rear carrier card will route P2A 1-8 pins (ICCB\_IO), P2C 1-22 (ICCB\_spare and ICCB\_add) and P2D 1-16 pins (ICCB\_trip and ICCB\_fault) to ICCB connector on the back panel. P2 connector signals are shown in figure 6below.



Whenever Rear I/O transition boards are implemented, any connector that plugs into the rear of the backplane shall use the same pin numbering scheme, mirror image, as used on the front boards.

Fig. 6 P2 connector signals on Rear Carrier Board of Type II

ICCB is a 50 pin connector with 46 signals and 04 GND pins. ICCB connector details are given below in figure 7below. The signals at ICCB are obtained from P2 connector after suitable level translation. FXMA2104 IC is 4 channel level translator suitable for this system. Multiple translators would be needed to accommodate these 46 signals.

| J12              |    |    |                 |
|------------------|----|----|-----------------|
| TRIP_07          | 1  | 2  | FAULT_07        |
| TRIP_06          | 3  | 4  | FAULT_06        |
| TRIP_05          | 5  | 6  | FAULT_05        |
| TRIP_04          | 7  | 8  | FAULT_04        |
| TRIP_03          | 9  | 10 | FAULT_03        |
| TRIP_02          | 11 | 12 | FAULT_02        |
| TRIP_01          | 13 | 14 | FAULT_01        |
| TRIP_00          | 15 | 16 | FAULT_00        |
| GND              | 17 | 18 | GND             |
| IO_07            | 19 | 20 | SPARE_07        |
| IO_06            | 21 | 22 | SPARE_06        |
| IO_05            | 23 | 24 | SPARE_05        |
| IO_04            | 25 | 26 | SPARE_04        |
| IO_03            | 27 | 28 | SPARE_03        |
| IO_02            | 29 | 30 | SPARE_02        |
| IO_01            | 31 | 32 | SPARE_01        |
| IO_00            | 33 | 34 | SPARE_00        |
| GND              | 35 | 36 | GND             |
| ICCB_ADD_SIG_137 | 37 | 38 | ICCB_ADD_SIG_06 |
| ICCB_ADD_SIG_139 | 39 | 40 | ICCB_ADD_SIG_05 |
| ICCB_ADD_SIG_141 | 41 | 42 | ICCB_ADD_SIG_04 |
| ICCB_ADD_SIG_143 | 43 | 44 | ICCB_ADD_SIG_03 |
| ICCB_ADD_SIG_045 | 45 | 46 | ICCB_ADD_SIG_02 |
| ICCB_ADD_SIG_047 | 47 | 48 | ICCB_ADD_SIG_01 |
| ICCB_ADD_SIG_049 | 49 | 50 | ICCB_ADD_SIG_00 |

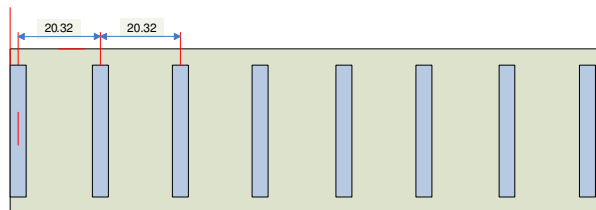
**Fig.7 ICCB signals for Rear Carrier Board**

*Interface for field signals:*

P2A A9-A14 (BNC 0-5) will be connected to six right angles BNC connectors on the back panel after suitable signal level translator (from 2.5V to 5V using FXMA2104 IC. Out of these 6 signals, 3 are outputs and 3 are input signals. Three input signals on BNC connectors will be processed by an AND gate and level translator before interfacing to P2 connector. Three output signals on BNC connectors are obtained from P2 connector signals after suitable level translation. There may be need of providing optical isolation for each BNC I/O and hence a power supply IC for supply isolation may be needed.

**1.5 ICCB card:**

The connector PCB for ICCB bus shorting is required for RFPIS. In Rear carrier board of RFPIS, a 34 pin 2 row connector is used for ICCB bus. The mating connector has to be provided on PCB shown below in figure below. This connector has height of about H=60 mm. The pitch horizontal distance between VME connectors from Wiener datasheet is 20.32 mm. Since we need 08 connectors on ICCB card, length of card is to be restricted accordingly mm and height to H mm where H will be decided by height of 34 pin connector used. The connectors shall be named from C1 to C8 from left to right. Front view of ICCB card is as shown below:



**Fig. 8 ICCB card layout**

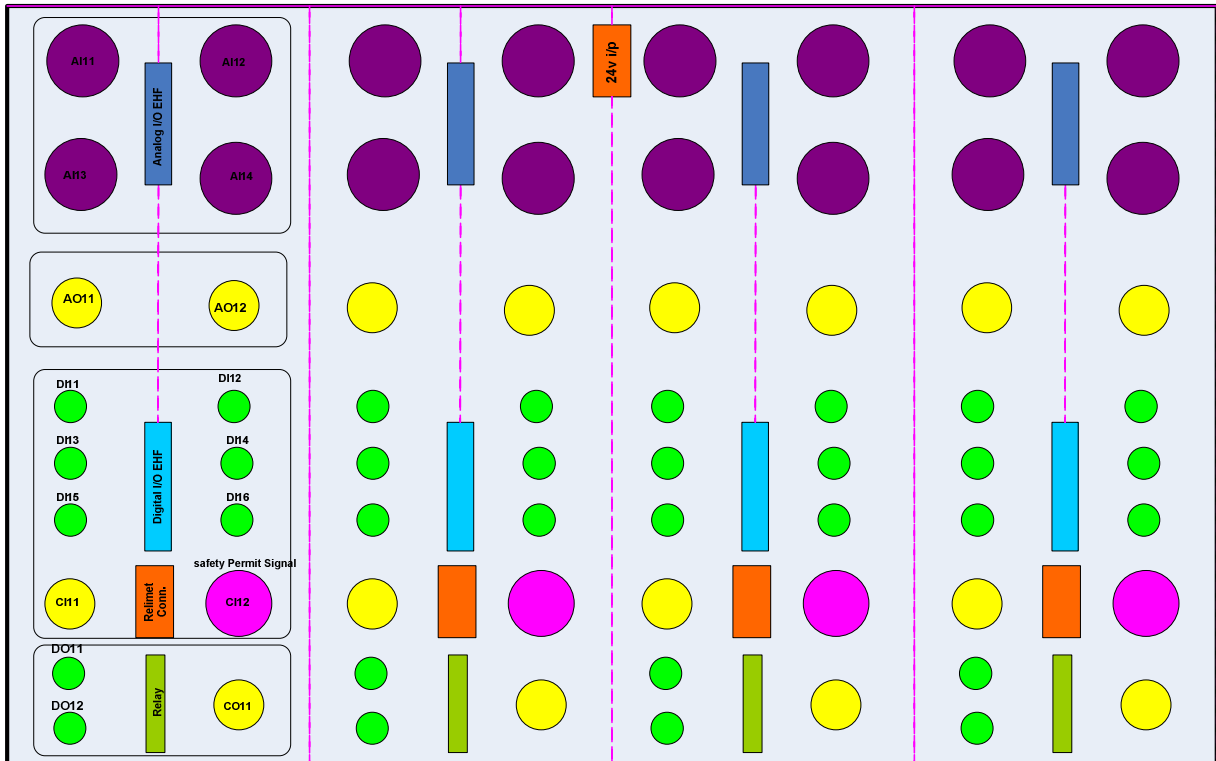
Electrically, these connectors are shorted 1:1. The card has to have ground planes on both external surfaces and all tracks to be routed through internal PCB layers.

**1.6 Field signal interface card:**

It encompasses for each RFPI system:

- 1) Interface for 4 AI with power supply on 2 pins and signals on 2 pin on a 4 pin connector.
- 2) Interface for 2 AO on isolated BNC
- 3) Interface for 8 DI (6 on SMA, 1 on burndy connector and 1 on isolated BNC)
- 4) Interface for 3 DO (1 relay contact output on isolated BNC, 2 SMA outputs)

Interface Card shall have provision for four such RFPIS interface. Size of card is 320mm by 210 mm. The card shall have 12 no. of mounting holes along the border. The layout of connectors is as seen in figure.



Note: Different Colours in above figure represent different connector types.

**Fig. 9 Layout of connectors on patch panel card..**

The BOM particulars for patch panel card are in annexure III

### 1.7 Operator Interlock and protection card (OPIC)

It is a VME64X based module with sixteen digital inputs and sixteen digital outputs. The module can give synchronized output pulses, duty cycle and phase delay of which can be varied. Provision to transmit eight optical outputs and receive eight optical inputs also has msut provided in the module.

Other features of OPIS are:

The module can accept sixteen digital inputs and can generate sixteen digital outputs with 50 ohm cable driver. The module can accept optical input signals from different subsystems and can provide optical outputs as well. VME64X based module and can be controlled remotely. Live insertion and removal of the module supported. Phase delay and duty cycle of each pulse outputs are controllable independently. The delay can be varied from 1ns to 10's of seconds. Different operating conditions can be programmed in the FPGA.

The BOM particulars for patch panel card are in annexure III

### 1.8 LED based Test card for VME64X cards

In order to enable semi-automatic testing of VME64X cards, a test card of form-factor larger than VME64X shall suffice. It shall have features as follows

(1) While testing indications of data & address line status on LED's:

These are o/p lines on VME64X bus. Translators would be used to protect VME backplane. The translator input would be from VME bus and its output is routed to LED's. Total 64 lines would be tested.

(2) While testing indications of data & address line status on seven segment:

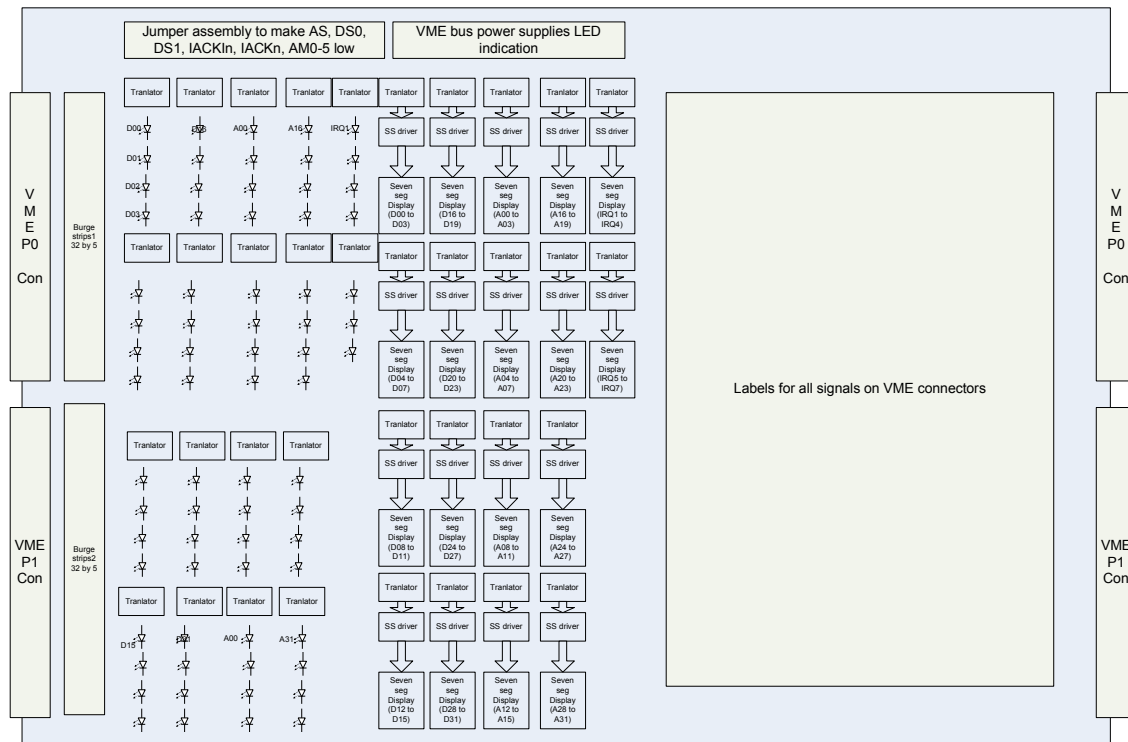
Translator and seven segment driver (e.g MC14495) shall be used to drive seven segment for each set of 04datalines/address lines.

(3) Input lines: Jumpers would be needed to test VME i/p lines e.g AS, DS0, DS1, IACKIn, IACKn, AM0-5 of VME64X.

(4) IRQ lines: For IRQ1-7 (Seven signals) two translators&two seven segment display arrangement would be provided.

Layout of card is shown in figure below.

Card size: 400mm by 230 mm.



**Fig. 10 Layout of connectors & components test card**

The BOM particulars for this card are in annexure III

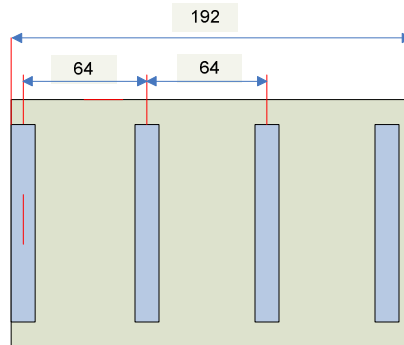
**1.9 Mezzanine connector test card**

This card would be used to test health of mezzanine connector. It shall short various pins on mezzanine connector as per circuit. It shall have LED's for each power supply pin on mezzanine connector. It will have samtec mating connector that mates with existing samtec connector on VME64Xbrd. Card Size: approximately 80mm by 40 mm

The BOM particulars for this card are in annexure III

**1.10 Set of test connectors**

As per list provided in BOM. ICCB connector is also in the list which has details as below. The connector for ICCB bus shorting is required for RFPIS. In Rear carrier board of RFPI, a 34 pin 2 row connector of 2mm pitch is used for ICCB bus. The mating connector has to be provided as part of ICCB connector as shown below. This connector has height of about H mm. The pitch horizontal distance between VME connectors from Wiener datasheet is 20.32 mm. It is required to keep distance of about 64 mm from connector to connector on ICCB. Since we need 04 connectors on ICCB, total length of cable is to be restricted to 192 mm. . Front view of ICCB connector:



**Fig. 11 ICCB card layout**

**Annexure III**  
**Bill of material for RFPI System**

The part numbers given in the BOM are indicative only. Any functionally compatible parts can be used with the consent of the indenter.

**(1) Bill of Material for VME carrier card type 1 and type II**

**Bill of Material for One VME carrier card**

**Total No of boards required      02no:s**

| <b>Sr no</b> | <b>Item name</b>      | <b>Qty (no.)</b> |
|--------------|-----------------------|------------------|
| 1            | PTH04070W             | 2                |
| 2            | LT1964ES5SD           | 1                |
| 3            | LT1963A-2.5           | 1                |
| 4            | EPCS64                | 1                |
| 5            | 74LVCO0ADR            | 1                |
| 6            | PLX9054               | 1                |
| 7            | 50MHz oscillator      | 1                |
| 8            | AT93C56               | 1                |
| 9            | VME connectors        | 3                |
| 10           | EP4CE55F484           | 1                |
| 11           | MT41J128M16           | 1                |
| 12           | Rocket I/O connectors | 1                |
| 13           | QSH 60-01-LD-DPA      | 2                |
| 14           | ASP-122953-01         | 2                |
| 15           | SN74VMEH22501A        | 10               |
| 16           | CY62177EV30           | 1                |
| 17           | 5CGTFD9EF35C7N        | 1                |
| 18           | PC28F00AP30BFA        | 2                |
| 19           | NB6N14SMNG            | 1                |
| 20           | FXMA2104U             | 8                |

**(2) Bill of Material for One FAI mezzanine card**

**Total No of boards required      01no:s**

| <b>Sr no</b> | <b>Item name</b>         | <b>Qty (no.)</b> |
|--------------|--------------------------|------------------|
| 1            | ASP-122952-01            | 1                |
| 2            | DCR021205P-U             | 1                |
| 3            | TA6F13A                  | 8                |
| 4            | SAMTEC_EHF-117-01-L-D-RA | 1                |
| 5            | ADS5294IPFPR             | 1                |
| 6            | 18uH MSS7341T-183        | 1                |
| 7            | XAL4040-103ME            | 4                |
| 8            | GLFR1608T100M-LR         | 8                |
| 9            | AD8253 ARMZ              | 8                |
| 10           | LTC6406CUD               | 8                |
| 11           | 339H-1-103-LF            | 8                |
| 12           | SM43TW502                | 8                |
| 13           | SN74LVC1T45              | 1                |
| 14           | SMB connector            | 1                |
| 15           | ACPL-C87A                | 8                |
| 16           | HCPL-0738                | 1                |
| 17           | CAT24C512WE              | 1                |
| 18           | LT1635CS8                | 8                |

|    |                |   |
|----|----------------|---|
| 19 | LT1963AEST-1.8 | 1 |
| 20 | LT1964ES5-5    | 1 |
| 21 | AD8608ARUZ     | 2 |
| 22 | CMP402GRU      | 4 |
| 23 | AD5628BRUZ-2   | 2 |

**(3) Bill of Material for One FDO mezzanine card**

**Total No of boards required 02no:s**

| Sr no | Item name                | Qty (no.) |
|-------|--------------------------|-----------|
| 1     | ASP-122952-01            | 1         |
| 2     | DCR021205P-U             | 2         |
| 3     | SAMTEC_EHF-125-01-L-D-RA | 1         |
| 4     | JUMPER                   | 1         |
| 5     | MSS7341T-103             | 5         |
| 6     | XAL4040-103ME            | 3         |
| 7     | RED LED_SMD              | 6         |
| 8     | HCPL-0738                | 10        |
| 9     | CAT24C512WE              | 1         |
| 10    | SN64BCT2544              | 5         |
| 11    | 74LCX16373/SO            | 1         |
| 12    | TEST POINT               | 89        |
| 13    | SN74LVC8T245             | 1         |

**(4) Bill of Material for One Rear I/O carrier card**

**Total No of boards required 01no:s**

| Sr no | Item name                                       | Qty (no.) |
|-------|---|-----------|
| 1     | Rear facia (Custom made as per drawing)         | 1         |
| 2     | BNC connectors                                  | 6         |
| 3     | 1uF capacitors                                  | 50        |
| 4     | SAMTEC_EHF-117-01-L-D-RA                        | 1         |
| 5     | HEADER_06X02_254X254_S                          | 1         |
| 6     | XAL4040-103ME                                   | 3         |
| 7     | P0_VME connector                                | 1         |
| 8     | 10k & different values                          | 100       |
| 9     | FXMA2104UMX                                     | 14        |
| 10    | 74LS08  | 1         |
| 11    | SN64BCT2544                                     | 1         |
| 12    | LM1117MP-2.5/NOPB                               | 1         |
| 13    | P2_VME connector                                | 1         |
| 14    | Ejector handles(Part nos 20817-614 & 20817-612) | 2         |

**(5) Bill of Material for One ICCB card**

**Total No of boards required 02no:s**

| Sr No | Part no                          | Qty (no.) |
|-------|----------------------------------|-----------|
| 1     | 2 mm 34 pin female FRC connector | 8         |

**(6) Bill of Material for One FSI card:**

**Total No of boards required 02no:s**

| Sr No. | Item name  | Qty (no.) | Remarks |
|--------|--|-----------|---------|
| 1      | Relay RS part no : 217-2719  | 4         |         |
| 2      | 3 pin connector:<br>TE connectivity part no: 282836-3 OR<br>Phoenix contact part no 1843237 with its<br>mating conn part no: 1847048 | 1         |         |
|        | 4 pin connector: Phoenix contact part no   | 4         |         |

|    |  |    |   |
|----|--|----|---|
|    | 1843240 with its mating conn part no: 1847071/   |    |   |
| 3  | Fischer 4 pin LEMO socket part no: DBPU 103 A053-130 along with mating plug part no: S 103 A053-130+ and backshell part no E31 103.1/6.7 + B ; S | 18 |   |
| 4  | Isolated BNC: TE connectivity part no: 16345050 or amphenol part no 315493   | 16 |   |
| 5  | Long SMA: Digikey part no: J10130-ND   | 32 |   |
| 6  | Burndy connector: Souriau part nos. UT0010-4SH with Gasket: UTFD12B and Dust cap: UT010DCG & along with crimp contacts part no RC16M23K          | 04 | Along with it purchase mating part: UT06104PH (one no only ) , its metal cable clamp UT010AC (One no only) along with contact pin part no. RM16M23K |
| 7  | EHF connector straight 34 pin  | 08 |   |
| 8  | LED's resistors and TP's   | 10 |   |
| 9  | EHF 34 pin 1.27 mm FRC cable 1 metre length  | 08 |   |
| 10 | GRF1-P-C-08-1000-C1-S samtec MMCX based connector with six no of BNC termination   | 04 |   |

**(7) Bill of Material for One OPI card:**

**Total No of boards required 02no:s**

| Sr no | Item name                | Qty (no.) |
|-------|--------------------------|-----------|
| 1     | LTC6754ISC6              | 1         |
| 2     | 74LCX16373               | 1         |
| 3     | DS1023S-25+              | 1         |
| 4     | 74ALVC164245DL           | 1         |
| 5     | HCPL-0738                | 1         |
| 6     | NB6N239SMN               | 1         |
| 7     | ADT1.5-1                 | 1         |
| 8     | N74F3037D                | 1         |
| 9     | SI9400                   | 1         |
| 10    | CY62177EV30LL-55BAXI     | 1         |
| 11    | TA07-11CGKWA             | 1         |
| 12    | THD 10-2411WIN           | 1         |
| 13    | SN74VMEH22501A           | 10        |
| 14    | NTS0104PW                | 1         |
| 15    | TPS3828-33DBVT           | 2         |
| 16    | PTH05060WAH              | 2         |
| 17    | NC7WZ14P6X               | 1         |
| 18    | NC7S08/SOT23             | 1         |
| 19    | PTH03050WAH              | 1         |
| 20    | LTC1643AHCGN             | 1         |
| 21    | EPCS16SII6N              | 1         |
| 22    | MAX6952EAX               | 1         |
| 23    | L213-100.0M              | 1         |
| 24    | NC7SZ32M5X               | 1         |
| 25    | LT1764AEQ-3.3#PBF        | 1         |
| 26    | PTVS5V0P1UP              | 2         |
| 27    | PTVS12VP1UP,115          | 2         |
| 28    | SML-LX1206IC-TR          | 2         |
| 29    | SAMTEC_EHF-117-01-L-D-RA | 1         |

|    |                         |   |
|----|-------------------------|---|
| 30 | RF8                     | 2 |
| 31 | SMA-J-P-X-ST-EM1        | 1 |
| 32 | 70246-1001, Altera JTAG | 1 |
| 33 | CON20A                  | 1 |
| 34 | JUMPER                  | 4 |
| 35 | CON3                    | 2 |
| 36 | 10uH, SER1390-103MLB    | 2 |
| 37 | SER1390-153MLB          | 3 |
| 38 | 47uH, SER1390-473MLB    | 2 |
| 39 | IRF7413ZTRPBF           | 2 |
| 40 | TP0610T                 | 2 |
| 41 | SI9410DY                | 1 |
| 42 | DIN 160_ZABCD-R         | 2 |
| 43 | EP4CE55F484             | 2 |
| 44 | EP4CE55F23C7N           | 1 |
| 45 | 2N2222                  | 1 |

**(8) Bill of Material for LED-based test card card:**

**Total No of boards required 02no:s**

| Sr no | Item name   | Qty (no.) |
|-------|---|-----------|
| 1     | Translators (same used in VME64X card)                | 36        |
| 2     | LED's   | 64        |
| 3     | Seven segment drivers MC14495                         | 16        |
| 4     | Seven segment display                                 | 16        |
| 5     | Jumpers   | 11        |
| 6     | Resistors   | 64        |
| 7     | P0 VME connector                                      | 2         |
| 8     | P1 VME Connector                                      | 1         |
| 9     | Ejector handle  | 2         |
| 10    | Burge strip (5 by 32)                                 | 02        |
| 11    | Harting connector (Mouser part no 617-02-07-160-1101) | 02        |

**(9) Bill of material Mezzanine connector test card**

**Total No of boards required 02no:s**

| Sr no | Item name                               | Qty (no.) |
|-------|---|-----------|
| 1     | Samtec connector part no: ASP-122952-01 | 01        |
| 2     | LED's                                   | 20        |

**(10) Bill of Material for test connectors for IPMS**

**Total No of connectors required 01 set as per following table**

| Sr No | Connector                                  | Qty (no.) | Comment                   |
|-------|--|-----------|---------------------------|
| 1     | BNC to SMA                                 | 04        | Length approximately 1.5m |
| 2     | BNC to SMB                                 | 04        |                           |
| 3     | BNC to LEMO                                | 04        |                           |
| 4     | BNC to BNC                                 | 04        |                           |
| 5     | SMA to SMA                                 | 04        |                           |
| 6     | 34 pin EHF to EHF with length maximum 0.5m | 10        |                           |
| 7     | 50 pin EHF to EHF with length maximum 0.5m | 10        |                           |
| 8     | ICCB cable as per figure 11                | 02        |                           |