

## **TWO PART TENDER**

### **SECTION – A**

#### **INVITATION TO TENDER, TENDERING CONDITIONS, QUALIFICATION AND EVALUATION CRITERIA**

## **Invitation to tender**

Electronics Corporation of India Limited (A Government of India Enterprise) invites sealed tenders for the Design, Development, Testing and supply of “**CRDS ATE**” as per the specifications given in “section C” of the tender document. The conditions of contract, which will govern the contract pursuant to the tender, are as contained in “section B” of the tender document. If you are in a position to quote for supply in accordance with the technical specification indicated in “section B”, Please submit your offer in a manner and method specified hereinafter.

### **1.1 Qualifying Requirements**

The vendor shall submit all supporting documents/information necessary for establishing the qualification of the vendor with respect to the qualifying requirements specified, along with “part-I” ( Technical bid) and “part-II” ( Price bid) of the tender. Failure to comply with this requirement shall lead to the rejection of the tender.

### **1.2 Manner and method of submission of offers**

- 1.2.1 All pages of the offer should be typed on the letter head of the bidder and duly signed and stamped by company’s authorized signatory. Hand written quotation will be summarily rejected. Quotation erased or over written will summarily rejected unless all corrections are duly authenticated with signature of bidder on the seal of the company.
- 1.2.2 All tenders in response to this invitation shall submit in TWO PARTS and in different envelopes. All technical specifications and technical details along with commercial terms and conditions shall be included only in “part-I” of the tender, which shall herein after referred as “Part-I” (Technical bid). It shall comprise of two sections namely Technical section and Commercial Section and both sections shall be submitted in a single envelope only. “Part-II” (Price bid) comprising of price and quantity schedule shall be submitted in separate envelope. The above two envelopes shall be put in a single envelope and submitted.
- 1.2.3 The tender shall be submitted with envelope super scribing the TENDER NUMBER and the due date. Quotations through Telex, Fax or email will not be considered. ECIL does not take the responsibility of for the loss of tender /offer in transit.
- 1.2.4 Technical section of “Part-I” (Technical bid) should contain /include only technical specifications, Technical details, literature, references of earlier supplies of similar equipments, time required for submission of approval of ATP and QAP, the delivery schedule, PERT Chart etc. Price details should be furnished only in “part –II” (price bid) of the tender. The vender should also mention any specific assumptions made by him or approach to be adopted by him with respect to various aspects of design, development and manufacturing in the technical section.

- 1.2.5 Commercial bid section of “part-I”( Technical bid) should contain/ include all details relating to price basis, formula for price variation /escalation if allowed along with ceiling thereof, applicability of statutory levies like excise duty, central sales tax/state sales tax, Octroi duty if applicable / freight charges /delivery terms ( free delivery. FOR destination /Mode and terms of payment and all related commercial terms and conditions and also compliance or deviation to the conditions of contract per “section B”
- 1.2.6 The tender will co-relate the price and quantity schedule of terms in “part-II”( price bid) of the tender with description of plant /machinery/equipment/component indicated in “part –I” ( technical bid) . Only Indian parties shall submit the quotation.

### **1.3 Opening of part –II ( Price Bid)**

The “part-II” bid of only such vendors whose “part-I” bids are found acceptable will be opened.

## **2 Criteria for technical Evaluation**

Offers of the vendors who meet the following criteria shall only be considered for technical evaluation. Criteria for technical evaluation is given in table 1

- a) The vendor shall be an ISO 9001 certified Company
- b) The vendor shall be an approved supplier to organizations of Ministry of Defense or Department of Atomic Energy.
- c) The vendor shall have a minimum turnover of Rs. 5.0 crores per Annum for the last 3 years.
- d) The vendor shall have in-house facilities for design, development, fabrication, testing and qualification facilities for execution of CRDS ATE job. The vendor shall have in-house design drafting tools including AutoCAD 2004 or higher and OrCAD16.0 or higher. The vendor shall have experienced man power in sufficient numbers for executing CRDS ATE nature of job.
- e) The vendor should have executed jobs similar to CRDS ATE in past. Vendor shall furnish details of such jobs executed by them in previous three years.
- f) The Vendor shall have similar experience in developing ATE using National Instrument’s Labview.
- g) The vendor must comply with technical specifications of the equipment, provided in the tender document.

**Note1:** The vendor shall give adequate and clear documentation to illustrate the technical specifications of the equipment / solutions offered. List of instruments/electronic cards or any other COTS items to be used in the ATE shall be given along with their make, type No. and brief catalog to assess the suitability from functional and accuracy requirement .

**Note2:** The vendor shall provide documentary proof to prove his adherence to the qualifying criteria. Claims without supporting documentation shall not be considered.

**Table1**

S. No.	Criteria	Compliance
a	Certified Vendor	YES/NO
b	Approved Supplier	YES/NO
c	Financial Status	YES/NO
d	In-house facilities for design, development, fabrication, testing and qualification facilities	YES/NO
e	Experience in ATE development	YES/NO
f	Experience with NI Labview	YES/NO
g	Compliance of technical specification	YES/NO

## **TWO PART TENDER**

### **SECTION – B**

#### **GENERAL TERMS AND CONDITIONS**

## **1 Earnest Money Deposit (EMD)**

Earnest money deposit of Rs. 3.6 Lakhs shall be submitted in the form of Demand Draft /Bank Guarantee at the time of submitting tenders in separate envelope. Quotes received without EMD shall be summarily rejected.

## **2 Validity**

We require validity of quotation for three months from the date of opening “Part-II” (price bid).

## **3 Security Deposit**

Security deposit of value 10% of the contract value by way of bank guarantee/Demand Draft form any nationalized bank shall be submitted immediately after the award of contract. This bank guarantee shall be valid till the end of the contract.

## **4 Confidentiality**

All source information given in this tender document and to the successful bidder for the execution of the job are confidential and proprietary to ECIL and no part of these designs should be reproduced or published in any form or means, electronic or mechanical, including photocopy, on any information storage or retrieval system, nor should these designs be disclosed to third party without the explicit authorization of ECIL.

ECIL has the right to use/modify the designs and equipment delivered under this contract for its products at will, without any separate payment to vendor and without any kind of authorization from vendor.

## **5 Non-disclosure agreement**

The successful bidder would have to submit a non-disclosure agreement in prescribed format to receive the final purchase order.

The vendor shall not prepare any catalog/brochure regarding the development/ manufacturing carried out under this contract until ECIL permits for the same in writing.

## **6 Delivery period and schedule**

The total equipment shall be delivered within 10 months of receipt of the purchase order by the vendor. The vendor shall furnish a brief PERT chart regarding the schedule of activities along with quotation.

The first set of ATE and all design documentation shall be delivered within 8 months from the receipt of purchase order by vendor.

The second set of ATE and documentation shall be delivered within 2 months from the acceptance of first set of ATE.

## **7 Liquidated damages**

In the event of any delay in supply beyond agreed delivery schedule, ECIL shall recover liquidated damages @ 0.5% per week of the value of the undelivered goods subject to a maximum of 5% of the value of the purchase order. For applicability of LD, the inspection call together with test certificate will be treated as delivery date provided materials are accepted during inspection.

## **8 Performance Bank Guarantee**

Vendor need to submit a performance bank guarantee to cover warranty period (24 months from date of installation) for a value of 10% of individual ATE order value and valid till warranty period of ATE.

## **9 Payment Terms**

- a) 90 % of the Order value + taxes within 90 days of completion of SAT (at ECIL) and acceptance along with all documentation & training.
- b) 10 % of the order value shall be paid after completion of warranty period and within 30 days of receipt of supplementary invoice. Alternatively this payment can be made against submission of bank guarantee for an equal amount and valid till the expiry of warranty period.

## **10 Taxes and Levies**

Customs duty exemption certificates, excise duty exemption certificates shall **NOT** be provided by ECIL. All taxes and levies shall be payable by vendor and claimed from ECIL. All payments shall be made in Indian Rupees only.

## **11 Force Majeure:**

If the execution of the contract / supply order is delayed beyond a period stipulated in the contract/supply order as an outbreak of hostilities, declaration of an embargo or blockage or fire, flood, acts of nature or any other contingency beyond the suppliers control due to act of God, then ECIL may allow such additional time by extending the delivery period as ECIL considers to be justified by the circumstances of the case and its decision in this regard shall be final and binding. If and when additional time is granted by the purchaser, the contract/supply order shall be read and understood as if it had contained from its inception the delivery date as extended. Power failure/outage will not be considered as a Force Majeure condition.

The successful bidder will advise, in event of having resort to this clause, by a registered letter, duly certified by the local chamber of commerce, or any statutory authorities, the beginning and end of the cause of the delay, within 15 days of the occurrence and cessation of such Force Majeure conditions. In the event of delay last out of Force Majeure, ECIL will reserve the right to cancel the contract, and provisions governing termination of contract as stated in bid documents will apply.

For delay arising out of Force Majeure, the bidder will not claim the extension in completion date for a period exceeding the period of delay attributable to the causes of Force Majeure and neither ECIL nor the bidder shall be liable to pay extra cost provided it is mutually established that Force Majeure conditions did actually exist.

## **12 Risk Purchase:**

In the event of failure of the vendor to comply with the purchase order terms, ECIL has a right to cancel the order and proceed with an alternative source. In the event of proceeding with such an alternative source, the default vendor shall be liable to bear the extra cost, which may be incurred by ECIL. Such extra cost could be on account of either a higher unit price or any higher rate of foreign exchange conversion rate by such delayed alternative procurement. Recovery of such extra cost would be affected from the available credit in the account of default vendor by invocation of any guarantees issued in favor of ECIL available.

## **13 Arbitration**

- a) Any dispute arising out of Contract/Purchase Order or interpretation of any clause or terms and conditions hereof shall be settled through conciliation by both the purchaser viz. ECIL and the Supplier / Seller, under the specific provisions of arbitration Conciliation Act 1996.
- b) In case the conciliation fails, the parties are at liberty to pursue other lawful options.
- c) Only courts in Ranga Reddy District, State of Andhra Pradesh, INDIA have exclusive jurisdiction over this contract/order notwithstanding the claim for concurrent jurisdiction of other courts.

## **14 Short Closure:**

ECIL has the right to short close the tender even after evaluating the quotations without assigning any reason.

## **15 Inspection and Testing**

The vendor shall be responsible for and shall perform the tests and inspections as per approved ATP. The ATP shall be prepared by vendor and approved by ECIL. These tests are necessary to assess the required performance of the ATE as per detailed test procedures. The tests shall be witnessed by ECIL.



The vendor shall generate a detailed “Test Report” for the tests as per ATP and submit to ECIL. The ATE shall be accepted only if it passes all tests as per ATP.

The QAP to be followed during the execution of the job also shall be prepared by vendor and approved by ECIL. The performance of the ATE shall confirm to this specification.

Failure to meet the quality, inspection or test requirements specified herein or the approved QAP shall be reported to ECIL and shall be considered as sufficient cause for rejection of particular item.

### ***ATE Inspection***

- a) The ATE covered by this contract shall be subjected to stage inspection and testing apart from final acceptance testing. The vendor shall provide all services to establish and maintain quality of workmanship to ensure the mechanical and electrical performance of components, compliance with drawings, identification and acceptability of all materials, any sub-parts and COTS items.
- b) The vendor shall perform his internal inspection and testing before offering the ATE for ECIL inspection. Only after ensuring that his inspection and test results are satisfactory, Vendor shall offer the ATE for ECIL inspection.
- c) The minimum inspection requirements for the ATE shall conform to the design and development requirements. It shall include, if applicable, inspection procedures prescribed by set standards or codes and regulations recognized by the governmental authority having jurisdiction over the installed goods.
- d) ECIL will give notice in writing to the Vendor of any objection to any drawings, COTS items or workmanship of ATE, which is not in accordance with the contract. The vendor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to ECIL giving reasons therein that no modifications are necessary to comply with the ‘contract’. However, ECIL has the final authority to accept or reject the vendor’s views. The equipment or material after rectification by the vendor shall be offered to the ECIL for his final inspection and acceptance without any additional cost to ECIL.

- e) In all cases where the 'Contract' provides for tests whether at a third party's premises or at the works of the vendor, except where otherwise specified, the vendor shall provide general facilities, apparatus and instruments as may be reasonably demanded by ECIL to carry out effectively, such tests of the equipment in accordance with the 'Contract'.
- f) The inspection by ECIL and issue of inspection certificate thereon shall in no way limit the liabilities and responsibilities of the vendor in respect of agreed quality assurance plan forming a part of the 'Contract'.
- g) In the case of stage inspection, the vendor shall proceed from one stage to another only after ECIL gives permission to proceed further after inspecting the drawings/equipment's. The same procedure shall be adopted for any rectifications and/or repairs suggested by ECIL. At all customer hold points, the Vendor shall compulsorily offer drawings/equipment's for inspection of ECIL and waiver, if and by ECIL, shall be obtained in writing for record purposes.
- h) Should ECIL waive the right to inspect anytime of the equipment/ATE, such waiver shall not relieve the vendor in any way from his obligation under the contract. In the event of ECIL on inspection revealing poor quality of goods, ECIL shall be at liberty to specify additional inspection procedures, if required, to ascertain the vendor's compliance with the equipment specifications.
- i) Supplier shall dispatch equipment on the express written instruction from ECIL after satisfactory testing only. Material sent without proper authority will be summarily rejected.

## **16 Acceptance**

Acceptance of the equipment shall be subject to its meeting the specifications and fulfillment of various requirements covered in this document. The vendor shall prepare an acceptance test procedure and submit for approval by ECIL. The acceptance testing shall be carried out, as per the approved procedure, by the vendor at purchaser's premises. The cost of these tests shall be borne by the vendor. The items can be supplied only after the completion of the acceptance test and obtaining a shipping release from the purchaser.

## **17 Certification**

Three copies of inspection reports and test reports covering all aspects of inspection and testing shall be signed by both vendor and ECIL before delivery of the equipment.

## **18 Quality Assurance and Surveillance:**

### **18.1 Quality Assurance**

The contract requires conformance to international and national standards/codes for assured quality and reliability. In line with these requirements, the vendor shall have

documented quality assurance program to assure quality at all stages, i.e, Design, engineering, procurement, manufacture, handling, shipment, installation and commissioning.

## **18.2 Quality Surveillance**

The vendor shall provide test details and results as required by ECIL. If any test fails to comply with requirements, ECIL may reject the equipment.

Stage inspections have to be carried out by vendor`s internal QA department. Where the inspection has to be carried out by ECIL, It has to be necessary carried out jointly by vendor`s internal QA departments and ECIL.

Based on the QAPs included in the tender documents, the vendor shall prepare a detailed QAP covering all activities and submit the same for approval of ECIL.

Calibrated instruments shall be used during inspection examination and testing. Quality control, inspection, testing at vendors works during manufacture and supply is total under the scope of the vendors QAP. ECIL will be verifying and auditing the QA reports duly reviewed and submitted by the vendor as per the QAP and shall also witness the tests at some important critical and hold points as per the QAP.

## **18.3 Packing and Transportation:**

The equipment shall be packed for safe transportation at purchasers end. The item shall be delivered at ECIL, Hyderabad- 500062, and India.

Cost of packing and freight & Insurance (if any) shall be explicitly mentioned by the vendor in quotation and shall be borne by the vendor only.

## **18.4 Technical support /Warranty:**

Supplier shall provide free on-site technical support and warranty for a period of 24 months on-site (Hyderabad/ Vishakhapatnam) from the date of installation of ATEs. Technical support involves but not limited to any minor design optimizations (both hardware and software) that may arise in the course of application development and usage of modules. Additionally, the vendor shall also provide clarifications regarding technical queries that may arise during the usage of ATE.

The supplier shall be responsible for any defect that may arise under proper use because of faulty design and shall remedy such defect. Such a design rectification shall be made by the supplier within reasonable period of 2 to 4 weeks, without any extra cost to ECIL.

## **19 Training**

The supplier shall impart 1week training in the design technology, methodology adapted in designing, operation and maintenance of the ATE in detail at ECIL premises free of cost.

## **20 Ownership**

The requirement being development in nature the total and absolute ownership of the Intellectual Property Rights (IPR) of the project (“CRDS ATE”) shall be with ECIL. ECIL shall have the perpetual license for the Hardware and the software developed for the ATE and no license fee or royalty shall be chargeable at any time. ECIL also has the right to modify & reuse the H/W or S/W modules at its will.

## **Two Pat Tender**

### **SECTION – C**

#### **TECHNICAL SPECIFICATIONS**

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## 1 Scope of Work

This enquiry covers design, development, testing and supply of Automatic Test Equipment (ATE) for modules of Control Rod Drive System (CRDS).

The ATE is envisaged as computer controlled equipment to test CRDS modules for their functionality with minimal human interaction and also to generate test reports automatically with option of printing. The ATE shall be completely independent and standalone with its own set of power supplies; control and monitoring hardware; sensors; software to configure tests; collects & analyses test results and archive test data. ATE design shall be modular in nature for easy serviceability.

Major work packages are:

- i. Design, fabrication of ATE hardware
- ii. Development of ATE Software
- iii. Documentation

### 1.1 Scope of Supply

Item to be supplied are listed in Table 1.

**Table 1: Item supplied**

Sr. No.	Item	Quantity
	Automatic Test Equipment for CRDS modules	Two Numbers
	Source Code Software of Automatic Test Equipment	One Number
	Documents of Automatic Test Equipment	One Set

## 2 Manner and Method for Submission of Offer

The offer must include point by point acceptance/comments to this tender specification.

The offer must include price breakup showing separate prices for the following items:

- i. Bare mechanical rack
- ii. Integration and wiring charges per rack
- iii. Wired ATE hardware racks without internal modules
- iv. Prices of each type of module (unit price and price for total quantity)
- v. ATE software and documents

### **3 Work Execution Plan**

The offer must include work execution plan along with time schedule for all associated activities for scope of work of the tender.

### **4 Subcontract**

The supplier shall not sub-contract any or all of the work without written consent from the purchaser. The supplier shall be responsible for the inspection of the components that are sub-contracted by him.

### **5 Procedure and Stage by Stage Execution Plan**

The supplier shall execute the job in the following manner:

- i. The supplier shall produce detailed drawings (circuit diagrams, schematic diagrams, mechanical drawings, BOM with component specs, test procedures etc) of individual modules and complete racks and submit them to purchaser for approval. Material procurement and manufacture shall start after approval of documents by purchaser. However to expedite the work, changes to this procedure could be effected through mutual agreement, on a case-to-case basis.
- ii. The supplier shall produce the draft artwork of all the printed circuit boards (PCB) from the approved schematics/drawings and submit them to purchaser for approval before PCB fabrication.
- iii. The supplier shall fabricate one number prototype of each type of module and test them thoroughly for confirmation of meeting the requirements. The supplier shall incorporate the required modifications (if any) in the prototypes and correct the drawings accordingly. The supplier shall offer these modules along with corrected drawings to purchaser for testing, qualification and approval.
- iv. The supplier shall produce the final drawings, PCB films etc. incorporating all the modifications and submit them to the purchaser for approval. Production of modules of required quantity of the system shall be based on the final approved drawing.

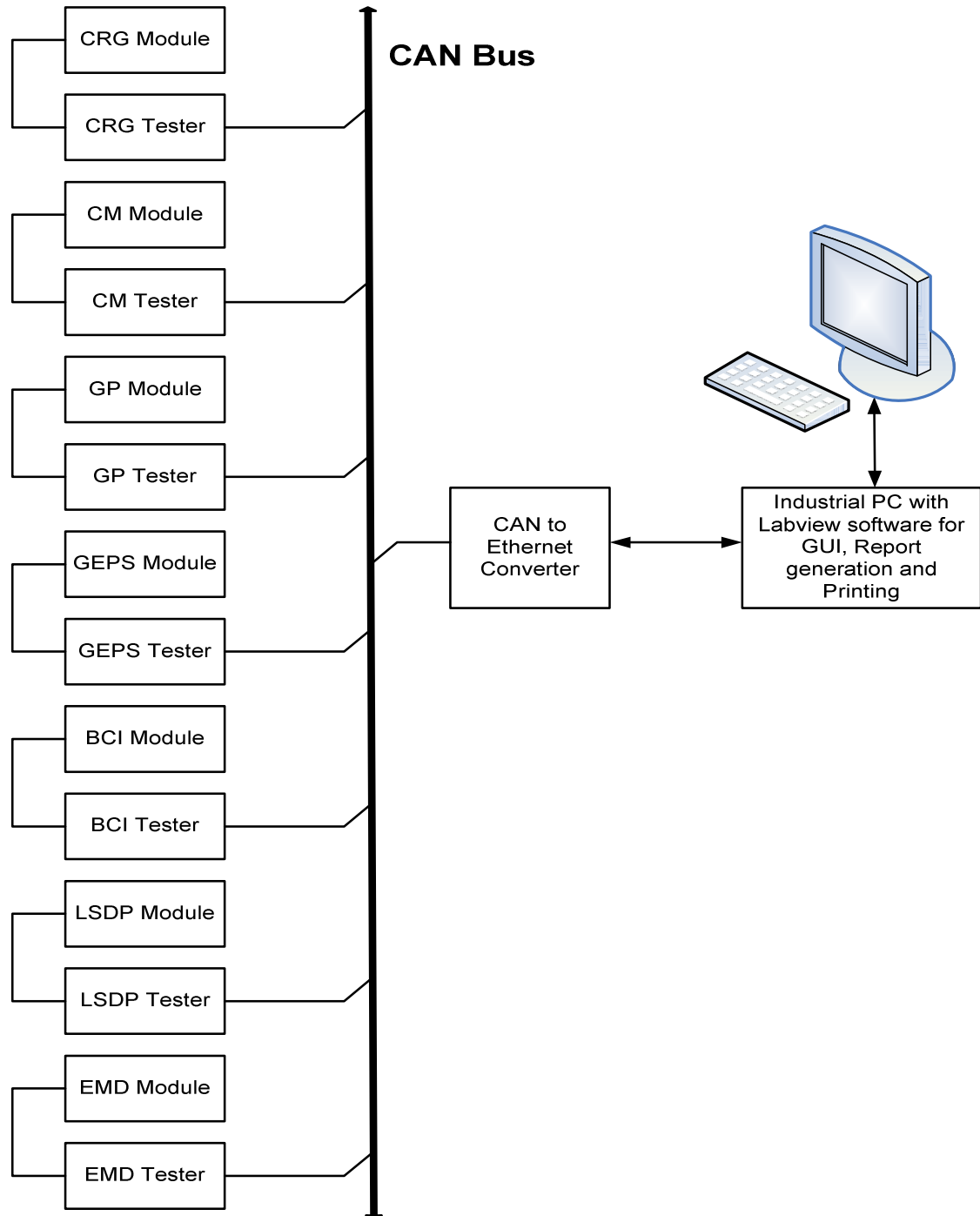
### **6 Functional Requirements**

The CRDS ATE shall be used for testing of following modules of the CRDS.

- i. CRG-001
- ii. GP-001
- iii. GEPS
- iv. CM
- v. BCI

- vi. LSDP
- vii. EMD

Figure 1 is block schematic diagram of the ATE.



**Figure 1: Block Schematic Diagram of CRDS ATE**

Each of the 7 modules shall have its dedicated tester module or a set of modules. The tester shall have all the required resources such as power supplies, simulate loads, simulate sensors, simulate digital/analog inputs and receive digital/analog outputs for the module under test. The tester shall have algorithms built-in for qualification of all types of test cases for the module under test.

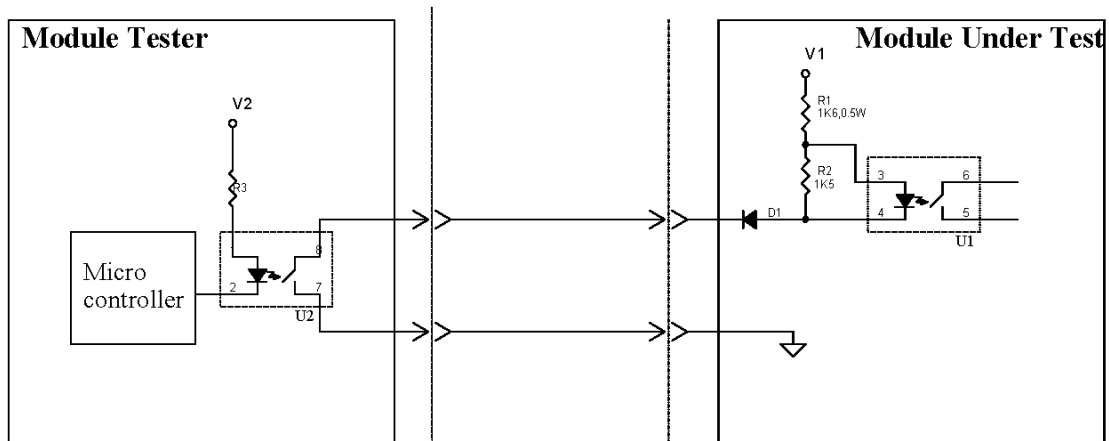
The testing should be as simple as plugging-in the module, selecting the test sequence from a list of pre-configured test and giving a test command and declare PASS/FAIL result along with detailed test log.

Brief description for all the 7 types of modules under test are contained in their respective tester requirement.

### Input/Output Interface for Modules under Test

#### 1. Digital Input Interface

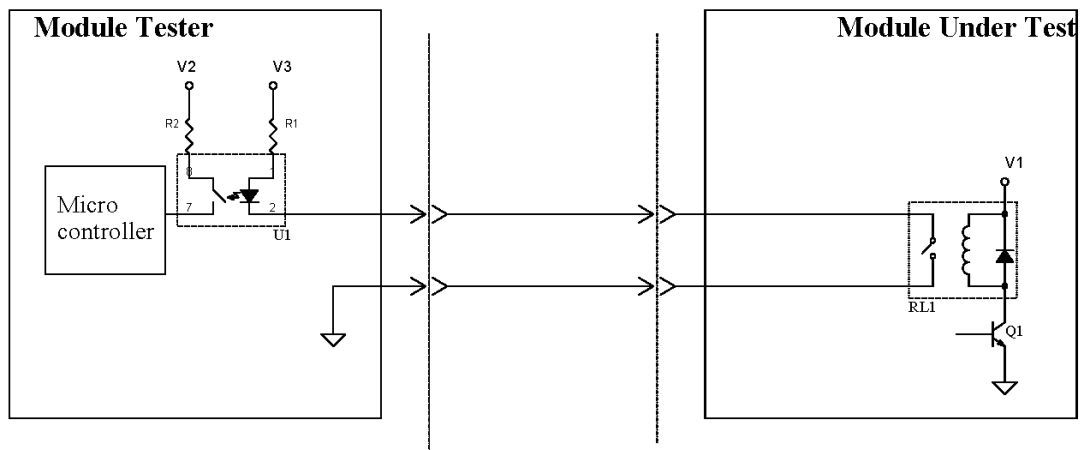
The interface of digital input of module under test to the corresponding tester module is as shown in Figure 2.



**Figure 2: Digital Input Interface**

#### 2. Digital Output Interface

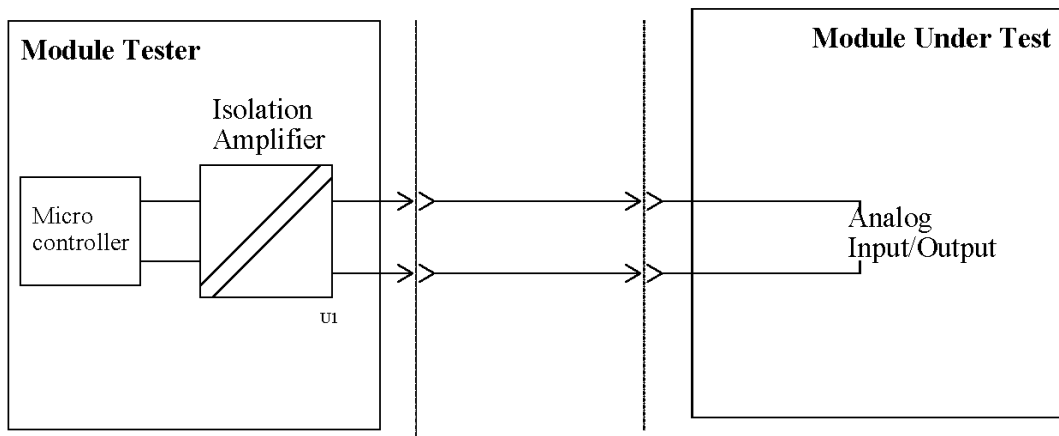
Digital output interface from module under test to the corresponding tester module is shown in Figure 3.



**Figure 3: Digital Output Interface**

### 3. Analog Input/Output Interface

Analog input/output from module under test to the corresponding tester module is shown in Figure 4.



**Figure 4: Analog Input/Output Interface**

## 6.1 CRG-001 Module

### 6.1.1 Module Description

#### 6.1.1.1 Functional Description

This module is powered by 24VDC. The digital input signals of various modes - automatic, remote, emergency power reduction, warning protection and emergency protection - are voted as per 2003 scheme. The voted signals are fed to the logic circuit to generate up and down signals for the “Current Reference generator circuit”, to generate current reference signals as per Figure 5.

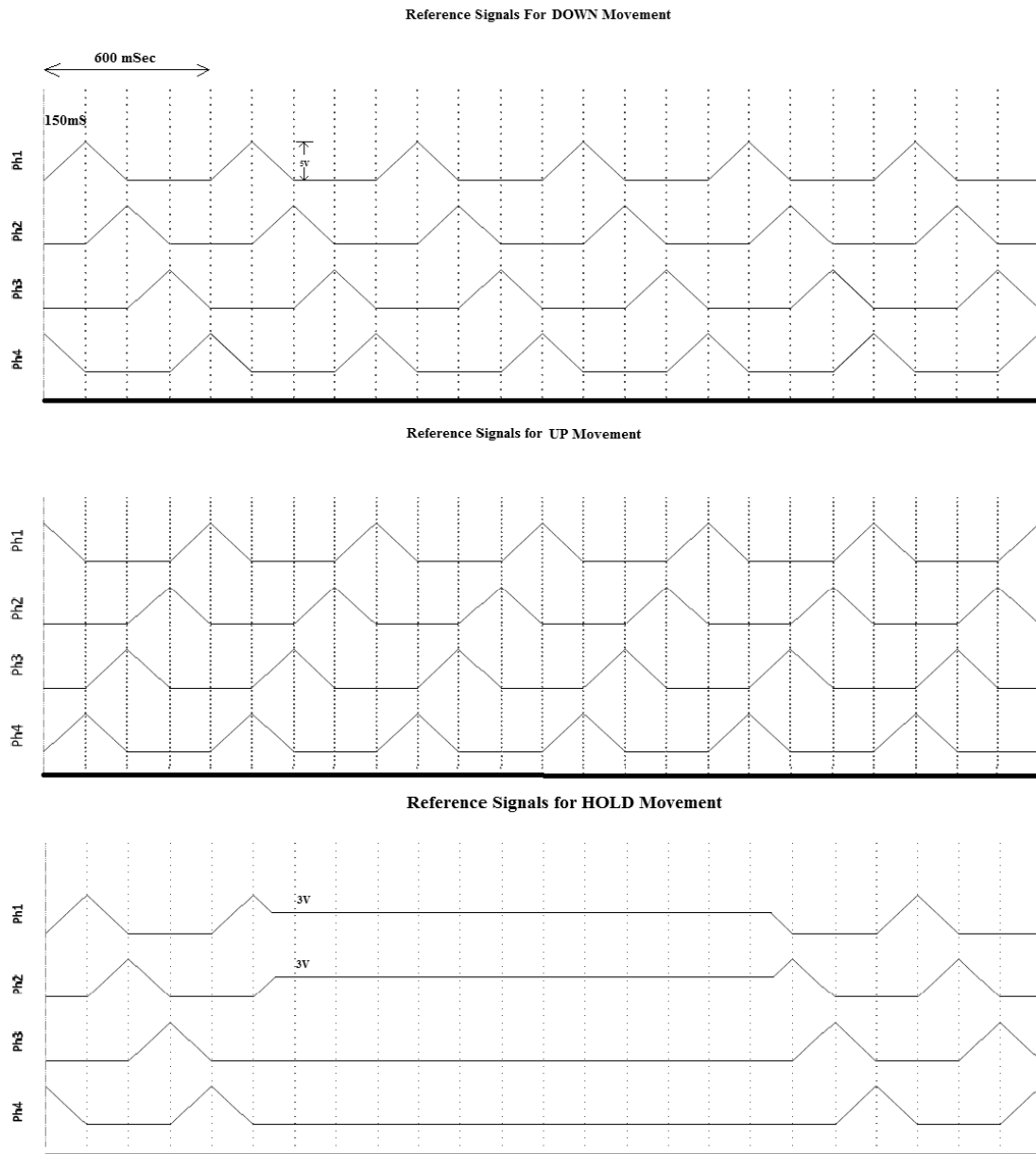
The module shall generate drive down Current Reference signal as long as any

one/more than one of the signals - EPR, WST, WSN, WSP and WSt – is/are true and BLS is not true. The module shall generate drive down Current Reference signal as long as RC and RCD commands are true and BLS is false.

The module shall generate Current Reference signal to drive up in steps of 4mm or less, if RC and RCU are true and TLS is false. Down signal has higher priority than up signal for its execution. Remote up/down signals have higher priority of execution than their automatic counter parts. ILS Hard signal acts as TLS for certain kind of regime operations as per Operating Mode Switch, schedule monitoring and Lock CG Release Signals. The module shall generate drive down Current Reference signal for moving down by 100mm/200 mm from its current position if EP100/EP200 signals become true. It also generates 100(EP)/200(EP) signal by counting numbers of DN cycles released. Module configuration inputs – ESM PV, AOVS, SPEED and PSR IN – are used to configure the module for incorporating/changing desired functionality.

Monitoring circuit is powered by 27V DC supply. Monitoring circuit monitors proper functioning of the module and fault is annunciated locally through LED and relay contact for remote operation.





**Figure 5: Current signal Waveforms**

#### 6.1.1.2 Inputs

##### **DC Power Input**

- i. 27V (Range = 24.3V to 29.7V) for monitoring of module status.
- ii. 24V (Range = 22V to 24.75V) for internal power supply.
- iii. 15V (Range = 13.75V to 15.25V) 4 Nos. Vetting supplies for command input to module

##### **Control Input**

##### **Optically Isolated Digital Input**

- i. 1 No. Quadruplicated EP100 Signal
- ii. 1 No. Quadruplicated EP200 Signal
- iii. 1 No. Triplicated EPR (Emergency power reduction) Signal
- iv. 1 No. Triplicated WST Signal
- v. 1 No. Triplicated WSN Signal
- vi. 1 No. Triplicated WSt Signal ( $WS\tau$ )
- vii. 1 No. Triplicated WSP Signal
- viii. 1 No. Triplicated ACD (Automatic Control Down)Signal
- ix. 1 No. Triplicated ACU (Automatic Control Up)Signal
- x. 1 No. RC CG (Remote Control) Signal
- xi. 1 No. RCU CG Signal
- xii. 1 No. RCD CG Signal
- xiii. 1 No. Duplicate ESM PV Signal
- xiv. 1 No. Lock CG Release Signal
- xv. 1 No. EPs/p Signal
- xvi. 1 No. EP BLS Signal
- xvii. 1 No. Operating Mode Switch Signal
- xviii. 1 No. SPEED Signal

**Un-Isolated Digital Input**

- i. 1 No. 100EP2/3 Signal
- ii. 1 No. 200EP2/3 Signal
- iii. 1 No. BLS2/3(HKB2/3)Signal
- iv. 1 No. TLS (BKB) Signal
- v. 1 No. AO BLS Signal (AO NKV/AO HKB)
- vi. 1 No. AO OFF Signal
- vii. 1 No. Quadruplicated AOVS Signal
- viii. 1 No. ERR MVK Signal
- ix. 1 No. PSR IN Signal
- x. 1 No. ILS Hard Signal
- xi. 1 No. Lock CG Command Signal

**6.1.1.3 Output**

**Control Output**

**Analog Output**

- i. 1 No Phase1 Current Reference Signal
- ii. 1 No Phase2 Current Reference Signal
- iii. 1 No Phase3 Current Reference Signal
- iv. 1 No Phase4 Current Reference Signal

**Digital Output**

- i. 1 No. Lock CG
- ii. 1 No. 100(EP) Signal
- iii. 1 No. 200(EP) Signal
- iv. 1 No. IEP s/p Signal
- v. 1 No. IEP100 Signal
- vi. 1 No. IEP200 Signal
- vii. 1 No. IEP BLS Signal
- viii. 1 No. I Lock CG Release Signal
- ix. 1 No. I Operating Mode Switch
- x. 1 No. ERR RIP Signal

**6.1.1.4 Module Status**

- i. 1 No. Red LED for display of module fault.
- ii. 1 No. Dry contact for Module status.

**6.1.1.5 Module Connector Details:**

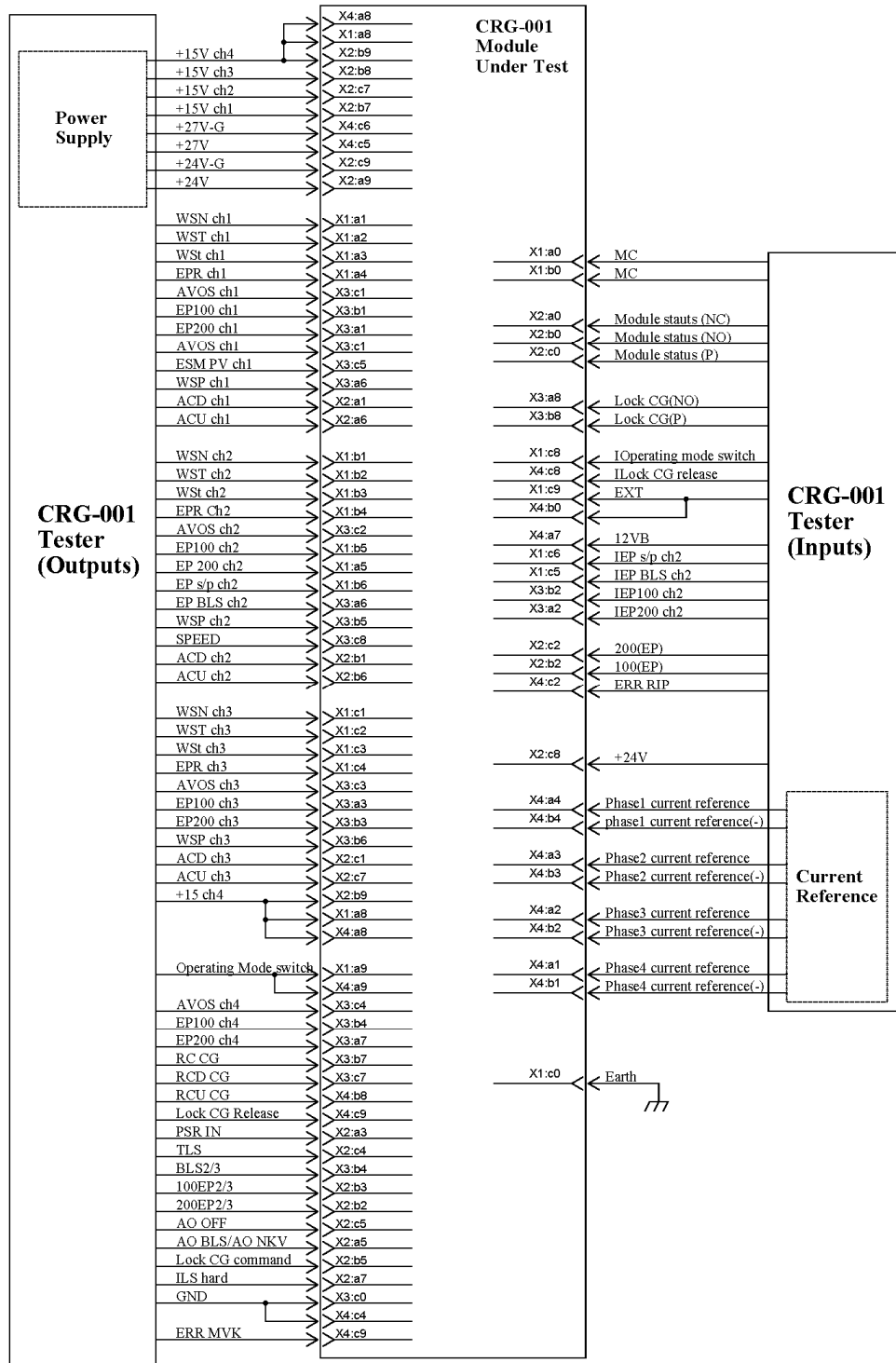
Pin no	X2			Pin No	X1		
	c	b	a		c	b	a
0	Module Status (P)	Module Status (NO)	Module Status (NC)	0	Earth	MC	MC
9	24VCh1-G	+15V Ch4	+24V Ch1	9	EXT	NC	Operating Mode Switch
8	Earth-1	+15V Ch3	+24V	8	I Operating Mode Switch	NC	+15V Ch4
7	+15V Ch2	+15V Ch1	ILS Hard	7	NC	NC	NC
6	ACU Ch3	ACU Ch2	ACU Ch1	6	IEPs/p Ch2	EPs/p Ch2	EP BLS Ch2
5	AO OFF	Lock CG Command	AO BLS/AO NKV	5	IEP BLS Ch2	EP100 Ch2	EP200 Ch2
4	TLS	BLS2/3	NC	4	EPR Ch3	EPR Ch2	EPR Ch1
3	200EP2/3	100EP2/3	PSR IN	3	WSt. Ch3	WSt. Ch2	WSt. Ch1

2	200(EP)	100(EP)	NC	2	WST Ch3	WST Ch2	WST Ch1
1	ACD Ch3	ACD Ch2	ACD Ch1	1	WSN Ch3	WSN Ch2	WSN Ch1

Pin no	X4			Pin No	X3		
	c	b	a		c	b	a
0	NC	EXT	NC	0	GND	NC	NC
9	ERR MVK	NC	Operating Mode Switch	9	NC	NC	NC
8	ILock CG Release	Lock CG Release	+15V Ch4	8	SPEED	Lock CG(P)	Lock CG(NO)
7	NC	NC	12VB	7	RCU CG	RCD CG	RC CG
6	27V-G	NC	NC	6	ESM PV Ch2	WSP Ch3	WSP Ch1
5	+27V	NC	NC	5	ESM PV Ch1	WSP Ch2	NC
4	GND	Phase1 Current Reference - G	Phase1 Current Reference	4	AOVS Ch4	EP200 Ch4	EP100 Ch4
3	NC	Phase2 Current Reference - G	Phase2 Current Reference	3	AOVS Ch3	EP200 Ch3	EP100 Ch3
2	ERR RIP	Phase3 Current Reference - G	Phase3 Current Reference	2	AOVS Ch2	IEP100 Ch2	IEP200 Ch2
1	NC	Phase4 Current Reference - G	Phase4 Current Reference	1	AOVS Ch1	EP100 Ch1	EP200 Ch1

### 6.1.2 Tester Requirements

Figure 6 is Block schematic diagram of the CRG Tester.



**Figure 6: Block Schematic Diagram of CRG Tester**

The tester shall perform tests covered under test cases 1 to 4 automatically and generate test report.

#### **6.1.2.1 Test Case 1 - No Load Power Dissipation**

- i. Connect Module to Test Jig and power ON 24VDC and measure the current drawn by the module. From voltage and current reading, calculate the No load power dissipation of the module.
- ii. Vary 24V Power supply Externally from 22V to 24.75V and verify, Fault LED Relay shall not operate

#### **6.1.2.2 Test Case 2 - Simulation of Down Movement**

- i. Assert two or more WST Inputs (WST Ch1, WST Ch2, WST Ch3) signals Low (15V-G), verify the Down movement waveforms.
- ii. Assert PSR IN input signal Low (12V-G), verify holding current waveform.
- iii. De-assert PSR IN input signal, Verify the Down movement waveforms.
- iv. Assert BLS2/3 input signal Low (12V-G), verify holding current waveform.
- v. De-assert BLS2/3 input signal, Verify the Down movement waveforms
- vi. De-assert applied WST Inputs, verify holding current.
- vii. Repeat step (i) to (vi) with WSN, WSt and WSP inputs
- viii. Assert ESM PV Ch1 input signal Low, verify the Down movement waveforms
- ix. Repeat step (iv) and (v)
- x. De-assert applied ESM PV Ch1 input signal, verify holding current.
- xi. Repeat step (viii) and (ix) with ESM PV Ch2 input.
- xii. De-assert applied ESM PV Ch2 input signal, verify holding current waveform.
- xiii. Assert two or more EPR Inputs (EPR Ch1, EPR Ch2, EPR Ch3) signals Low (15V-G), verify the Down movement waveforms
- xiv. Repeat step (iv) and (v)
- xv. De-assert applied EPR Inputs, verify holding current.
- xvi. Assert RC and RCD input signals Low (15VCh4-G), verify the Down movement waveforms.
- xvii. Repeat step (iv) and (v)
- xviii. De-assert applied RC and RCD input signals, verify holding current.
- xix. Apply 6.6Hz frequency 50% duty signal at two or more ACD Inputs (ACD Ch1, ACD Ch2, and ACD Ch3), Verify the Down movement waveforms.
- xx. Repeat step (iv) and (v)
- xxi. Assert RC input signal, verify holding current waveform.
- xxii. De-assert applied RCD input signal, verify the Down movement waveforms.
- xxiii. De-assert applied ACD inputs, verify holding current waveform.

- xxiv. Assert two or more EP200 Inputs (EP200 Ch1, EP200 Ch2, EP200Ch3, EP200 Ch4) signals Low (12V-G), verify the Down movement waveforms.
- xxv. Repeat step (iv) and (v)
- xxvi. Assert 200EP2/3 signal low (12V-G), verify holding current waveform.
- xxvii. De-assert 200EP2/3 signal, verify the Down movement waveforms.
- xxviii. De-assert applied EP200 Inputs, verify holding current.
- xxix. Assert 200EP2/3 input signal Low (12V-G)
- xxx. Assert two or more EP100 Inputs (EP100 Ch1, EP100 Ch2, EP100Ch3, EP100 Ch4) signals Low (12V-G), verify the Down movement waveforms.
- xxxi. Repeat step (iv) and (v)
- xxxii. Assert 100EP2/3 signal low (12V-G), verify holding current.
- xxxiii. De-assert 100EP2/3 signal, verify the Down movement waveforms.
- xxxiv. De-assert applied EP100 Inputs and 200EP2/3 Input, verify holding current waveform.
- xxxv. Assert AOBSL input signals Low (12V-G), verify the Down movement waveforms.
- xxxvi. Repeat step (iv) and (v)
- xxxvii. Assert SPEED signal Low (15V Ch2-G), verify the Down movement waveforms frequency to be double.
- xxxviii. De-assert SPEED signal, verify the Down movement waveforms.
- xxxix. Assert two or more AOVS Inputs (AOVS Ch1, AOVS Ch2, AOVS Ch3, AOVS Ch4) signals Low (12V-G), verify the Down movement waveforms frequency to be double.
- xl. De-assert applied AOVS signals, verify the Down movement waveforms.
- xli. De-assert applied AOBSL Input, verify holding current.

#### **6.1.2.3 Test Case 3 - Simulation of UP Movement**

- i. Assert RC and RCU inputs Signals Low (15VCh4-G), verify the UP movement waveforms for 2 seconds and after completion of UP movement, 5 seconds Pause time shall start. (In this time no UP movement command accepted) and also verify holding current waveform.
- ii. De-assert applied signals, verify holding current waveform.
- iii. Apply 6.6Hz frequency 50% duty signal at two or more ACU Inputs (ACU Ch1, ACU Ch2, ACU Ch3), Verify the UP movement waveforms.
- iv. Assert TLS input signal Low (12V-G), verify holding current waveform.
- v. De-assert applied TLS input signal, verify the UP movement waveforms.
- vi. Assert RC input signal Low, verify holding current.
- vii. Assert RCU input signal, verify the UP movement waveforms.

- viii. Assert AO OFF input signal Low, verify holding current.
- ix. De-assert applied AO OFF input signal, verify the UP movement waveforms
- x. Assert Lock CG Command input signal, verify holding current waveform and Lock CG Relay shall get energized.
- xi. De-assert applied Lock CG Command input signal, verify the UP movement waveforms and Lock CG Relay shall get De-energized.
- xii. Assert ILS Hard input signal, verify holding current waveform and Lock CG Relay shall get energized
- xiii. Assert Operating Mode switch input signal Low, verify the UP movement waveforms and Lock CG Relay shall get De-energized.
- xiv. Apply 6.6Hz frequency 50% duty signal at two or more ACD Inputs (ACD Ch1, ACD Ch2, ACD Ch3), Verify the Down movement waveforms.
- xv. Assert RC input signal Low, verify holding current waveform.
- xvi. Assert RCU inputs Signals Low (15VCh4-G), verify the UP movement waveforms for 2 seconds and after completion of UP movement, 5 seconds Pause time shall start. (In this time no UP movement command accept) and also verify holding current waveform.
- xvii. Assert two or more EP200 Inputs (EP200 Ch1, EP200 Ch2, EP200Ch3, EP200 Ch4) signals Low (12V-G), verify the Down movement waveforms
- xviii. Assert 200EP2/3 signal low (12V-G), verify holding current.
- xix. De-assert RCU input signal, verify holding current waveform
- xx. Assert RCU inputs Signals Low (15VCh4-G), verify holding current waveform.
- xxi. Assert RCD input signals Low (15VCh4-G), verify the Down movement waveforms.
- xxii. Assert BLS2/3 input signal Low (12V-G), verify holding current waveform.
- xxiii. De-assert BLS2/3 input signal. Verify the Down movement waveforms
- xxiv. De-assert RCD, 200EP2/3, EP200 and ACD signals and assert RC and RCU signals, verify the UP movement waveforms.
- xxv. De-assert applied ACU input signals, verify holding current.

#### **6.1.2.4 Test Case 4 - Simulation of 24V Supply Fault**

- i. Switch-off 24V supply and verify that Fault LED must Glow & Module status relay shall operate



## **6.2 GP-001 Module**

### **6.2.1 Module Description**

#### **6.2.1.1 Functional Description**

The module is powered by 24V DC. 27V is used for Module Status relay outputs and LED indications for Fault LED. GP-001 module has CAN Communication channel. It receives certain digital inputs through CAN bus and few of them are converted into relay contact and the contact is used within the module. Module status are also send through the CAN bus for further use.

GP-001 module is used for monitoring the health of TLS, ILS, and BLS limit switches by apply voltage to the test coils through a capacitor for limited time.

GP-001 module is also used for generating Grip signal which shutdowns the GEPS module. 96V is used for providing power to motor. GP-001 module receives analog reference current for all the four phases of the motor. Using these current reference, it generates PWM signals to feed current to the motor proportional to the reference current. The duty cycle of PWM signal is changed to regulate current in the motor windings based on current feedback.

2004 logic is implemented on EPBLS signals to generate AO NKV signal for CRG module and EPBLS signal for microcontroller.

2004 logic is implemented on EP s/p signals. The vetted output is used to turn-off motor currents and again provides holding current on BLS2/3 signal becoming true. It is achieved by implementing logic which shutdown the Power MOSFET Driver till BLS2/3 signal is not received.

Also there is an input signal generated from CRG module and named as ERR RIP. It is generated when there is any fault in CRG module. On receipt of ERR RIP signal, Power MOSFET Driver is shutdown.

In addition to the above conditions, shutdown of the Power MOSFET Driver is also activated by any fault in 96V supply and internal DC-DC Converter failure.

Below are the healthy conditions of GP-001 module. If any of the below condition is true, the monitoring section de-energises Module Status relay and energises the Fault LED.

- i. DC-DC Converters are un-healthy.
- ii. 96V supply is un-healthy.
- iii. EP s/p signal is true.
- iv. AO OFF signal true.
- v. ERR RIP signal true.
- vi. The facia switch is in off position.

#### **6.2.1.2 Inputs**

##### **DC Power Inputs**

- i. 24V (Range = 22V to 24.75V)

- ii. 27V (Range = 24.3V to 29.7V) For monitoring of module status
- iii. 96V (Range = 90V to 98V)

### **Control Inputs**

#### **Optically Isolated Digital Inputs**

- i. 1 No. Quadruplicated EPBLS Signal
- ii. 1 No. Quadruplicated EP s/p Signal
- iii. 1 No. EP100 Ch1 Signal
- iv. 1 No. EP200 Ch1 Signal
- v. 1 No. TLS 1 Signal
- vi. 1 No. LOCK CG Release Signal
- vii. 1 No. Operating Mode Switch Signal
- viii. 1 No. BLS Signal (TLS, ILS, BLS Coil Mechanism)
- ix. 1 No. ILS Signal (TLS, ILS, BLS Coil Mechanism)
- x. 1 No. TLS Signal (TLS, ILS, BLS Coil Mechanism)
- xi. 1 No. Triplicate ACU Signal
- xii. 1 No. Triplicate ACD Signal
- xiii. 2 Spare Input Signal

#### **Un-Isolated Digital Inputs**

- i. 1 No. AO OFF Signal
- ii. 1 No. BLS2/3 Signal
- iii. 1 No. ERR RIP Signal
- iv. 1 No. MRST Signal

### **Analog Inputs**

- i. 1 No. Phase 1 Current Reference Signal
- ii. 1 No. Phase 2 Current Reference Signal
- iii. 1 No. Phase 3 Current Reference Signal
- iv. 1 No. Phase 4 Current Reference Signal

### **Serial communication**

- i. 1 No. CAN Link.
- ii. 1 No. RS-232 Link

### **Toggle Switch**

- i. 1 No. toggle switch for ON/OFF of power supply of MOSFET Driver Section.

### **Connector for Loading Software**

- i. 1 No. D-Sub 9 Pin Male Connector is used for programming of controller.

### **6.2.1.3 Outputs**

#### **Motor Power Outputs**

- i. 4 No PWM voltages of 96 Volts peak modulated with 1 KHz Frequency for driving 4 phases of the motor. The current in the motor phases shall be as per Figure 5 under 3 modes of operation – UP, Down and Hold – with current peak of 5 Amp in Up and Down mode and 3 Amp in hold mode.

#### **Grip Contact**

- i. +24V-2 (Range = 22V to 24.75V)) Vetting supply for Grip signal
- ii. 1 No. Grip Signal

#### **Limit switch Test Coil Output**

- i. POWER (TLS, ILS, BLS Test Coil mechanism)
- ii. 1 No. CORE OUT Signal (TLS, ILS, BLS Coil Mechanism)

#### **Control Outputs**

##### **Digital Outputs**

- i. 1 No. isolated EPBLS Ch1 Signal
- ii. 1 No. isolated EPs/p Ch1 Signal
- iii. 1 No. isolated EP100 Ch1 Signal
- iv. 1 No. isolated EP200 Ch1 Signal
- v. 1 No. Lock CG Command Signal
- vi. 1 No. ERR MVK Signal
- vii. 1 No. AO NKV Signal
- viii. 1 No. BLS Contact Signal
- ix. 1 No. TLS Contact Signal
- x. 1 No. No. ILS Hard signal
- xi. 8 Spare Output Signals

### **6.2.1.4 Module Status**

- ii. 1 No. Red colour LED for display of module fault.
- iii. 1 No. Green colour LED for indicating availability of power supply of MOSFET Driver Section.
- iv. Module status – In the form of solid state relay contacts (P and NO).

**6.2.1.5 Module Connector Details**

Pin no	X4		
	c	b	a
0	+96V	CORE OUT	ILS
9		TLS	EP100 Ch1
8		Module Status(P)	EP s/p Ch1
7	GP Phase4(-)	Module Status(NO)	GP Phase2(-)
6	4 Phase (-ve) SM	4 Phase (+ve) SM	2 Phase (-ve) SM
5			
4	GP Phase4(-)'		GP Phase2(-)'
3	GP Phase4(-)'	GP Phase2(-)'	
2	GP Phase4(-)	2 Phase (+ve) SM	GP Phase2(-)
1			

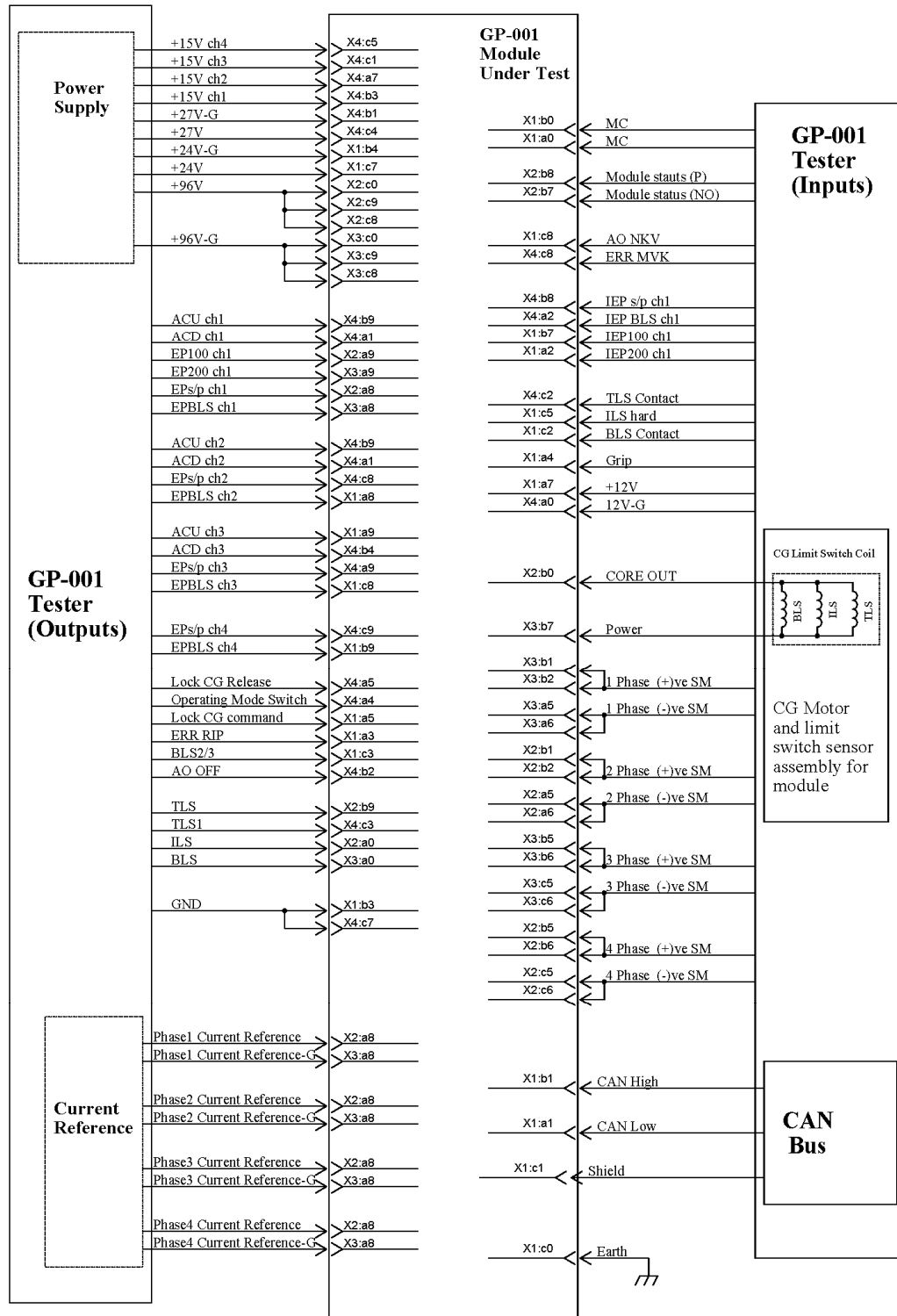
Pin No	X3		
	c	b	a
0	Earth	MC	Earth
9	Phase 1 Current Reference	EPBLS Ch4	Phase 1 Current Reference
8	EPBLS Ch3	--	EPBLS Ch3
7	+24V	IEPBLS Ch1	+24V
6	Phase 3 Current Reference - G	Phase 1 Current Reference - G	Phase 3 Current Reference - G
5	ILS Hard	--	ILS Hard
4	Spare D4-A	--	24V-G
3	BLS 2/3	GND	BLS 2/3
2	BLS contact	AO NKV	BLS contact
1	Shield	CAN H	Shield

Pin no	X4			Pin No	X3		
	c	b	a		c	b	a
0	--	Config CCG	12V COM	0	96V-G	ACU Ch2	BLS
9	EP s/p Ch4	ACU Ch1	EP s/p Ch3	9		ACD Ch2	EP200 Ch1
8	EP s/p Ch2	IEP s/p Ch1	Earth 1	8		--	EPBLS Ch1
7	GND	Phase 2 Current Reference	+15V Ch1	7	GP Phase3(-)	POWER	GP Phase1(-)
6	Phase 4 Current	Phase 2 Current	Phase 4 Current	6	3 Phase (-	3 Phase	1 Phase (-

	Reference - G	Reference - G	Reference			ve) SM	(+ve) SM	ve) SM
5	+15V Ch4	Earth 2	Lock CG Release		5			
4	+27V	ACD Ch3	Operating Mode Switch		4	GP Phase3(-)'		GP Phase1(-)'
3	TLS 1	+15V Ch1	ERR MVK		3	GP Phase3(-)'	GP Phase1(-)'	
2	TLS contact	AO OFF	IEP100 Ch1		2	GP	1 Phase	GP
1	+15V Ch3	27V-G	ACD Ch1		1	Phase3(-)	(+ve) SM	Phase1(-)

### 6.2.2 Tester Requirements

Figure 7 is Block schematic diagram of GP-001 Tester.



**Figure 7: Block Schematic Diagram of GP-001 Tester**

The tester shall perform tests covered under test cases 1 to 5 automatically and generate test report.

#### **6.2.2.1 Test Case 1 - No Load Power Dissipation**

- iii. Connect Module to Test Jig and power ON 24VDC and measure the current drawn by the module. From voltage and current reading, calculate the No load power dissipation of the module.
- iv. Vary 24V Power supply Externally from 22V to 24.75V and verify, Fault LED Relay shall not operate

#### **6.2.2.2 Test Case 2 - Simulation of Control Inputs**

- i. Switch ON the 96V Supply of GP-001 module and provide all four Triangular Phase Current Reference with Peak Current reference of 5A, all phases shifted with respect to each other by 90° and with time period of any phase is 600msec.
- ii. Activate any one EPBLS (EPBLS Ch1, EPBLS Ch2, EPBLS Ch3 and EPBLS Ch4) and verify AO NKV LED does not Glow. Now activate more than one of EPBLS signals and verify Glow of AO NKV LED.
- iii. Activate any one EPs/p (EPs/p Ch1, EPs/p Ch2, EPs/p Ch3 and EPs/p Ch4) and verify Module will work Normal (current in the motor). Now Activate more than one of EPs/p signal and verify that Module will disable and no current in Load. Now Activate BLS2/3 signal and verify Module will work Normal and current in load as per Triangular Phase Current Reference.
- iv. Activate AO OFF signal and verify that Module will disable and no current in Load. Now activate BLS2/3 signal and verify Module will work normal and current in load as per Triangular Phase Current Reference.
- v. Activate ERR RIP signal and verify that Module will disable and no current in Load.
- vi. Activate TLS signal and verify that TLS Contact Close.
- vii. Activate ILS signal and verify that ILS Hard Contact Close.
- viii. Activate BLS signal and verify that BLS Contact Close.

#### **6.2.2.3 Test Case 3 - Fault Simulation & Indication**

- i. Put 24V at OFF position. FAULT LED should be ON and Power SM LED should be OFF. ERR MVK Contact at Test Jig should be close and Module Status relay should operate. Also, there is no current in Inductive Load. Now put +24V at ON position, check module for normal working.
- ii. Put ON/OFF Switch (Front Facia) at OFF position. FAULT LED should be ON and Power SM LED should be OFF. ERR MVK Contact should be closed and Module Status relay should be closed. Also, there is no current in the Load. Now put ON/OFF Switch (Front Facia) at ON position, check module for normal working and current in the load.
- iii. Increase 96V supply, when it reaches between 112V and 117V, High Voltage Cut-OFF Phase should be activated and FAULT LED and Power SM LED

should be ON, ERR MVK Contact should be closed and Module Status relay should be closed. Also, there is no current in the Load. Now decrease +96V supply, Recovery voltage shall be 8 to 12V less than the Cut-OFF voltage.

- iv. Decrease +96V supply, when it reaches between 75V and 80V, Low Voltage Cut-OFF Phase should be activated and FAULT LED and Power SM LED should be ON, ERR MVK contact should be closed and Module Status relay contact should be closed. Also, there is no current in the Load. Now Increase +96V supply, Recovery voltage shall be 8 to 12V less than the Cut-OFF voltage.

#### **6.2.2.4 Test Case 4- Simulation of Signal Isolation**

- i. Activate EPBLS Ch1 signal and verify that IEPBLS Ch1 contact shall be close.
- ii. Activate EP200 Ch1 signal and verify that IEP200 Ch1 contact shall be close.
- iii. Activate EP100 Ch1 signal and verify that IEP100 Ch1 contact shall be close.
- iv. Activate EPs/p Ch1 signal and verify that IEPs/p Ch1 contact shall be close.

#### **6.2.2.5 Test Case 5- Simulation of Signals on CAN Communication**

- i. The module receives certain commands via CAN bus. The commands are converted into digital outputs and consumed within the module. Certain module diagnostics results are also sent to other modules via the CAN bus. Total size of receive and transmit data is of the order of 2 words.

#### **6.2.2.6 Test Case 6- simulation of Limit Switch Testing**

- i. Command is issued via CAN bus to initiate the testing of limit switches – BLS, ILS and TLS. On receipt of command, the module shall feed test voltage to coils of the limit switches and reads changed status of the limit switches. After analyzing, it sends test status via CAN bus.

#### **6.2.2.7 CG Motor and Limit Switch Sensor Assembly**

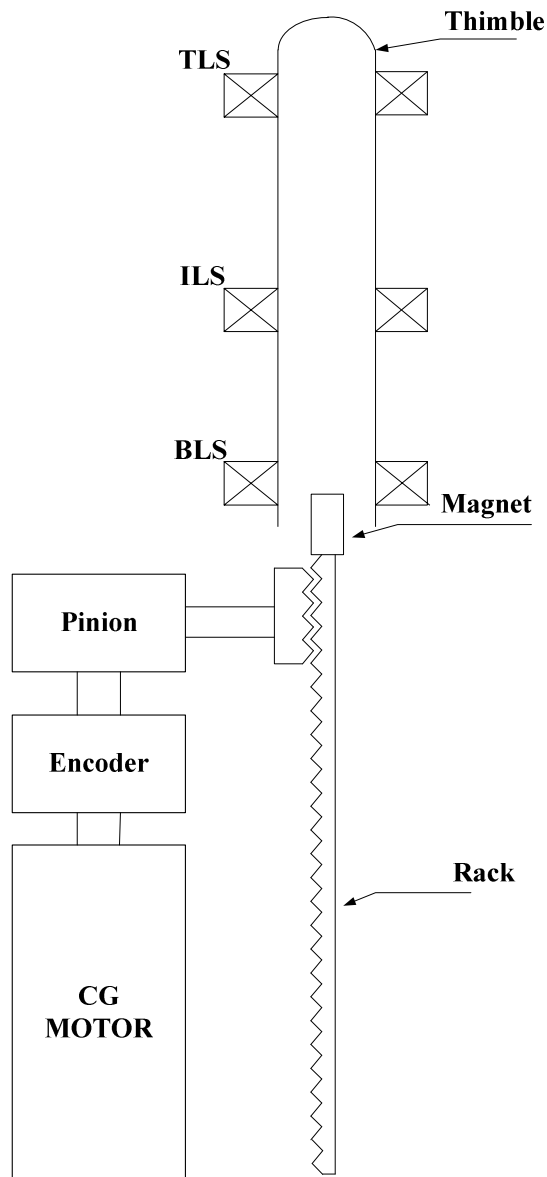
Figure 8 is the block schematic of CG motor load and limit switch sensor assembly. This shall be part of GP module tester. Motor and limit switches used here are the actual ones for which the module under test is designed.

Motor shall be powered GP module to move the limit switch magnet UP or DN. The magnet is moved to check the functionality of limit switch test coil interface of the GP module in presence and absence of magnet in vicinity of the limit switch.

The motor shall also be used for load GEPS module. The motor currents shall be read by GP, GEPS tester for analysis of output current from the GP, GEPS modules.

The Purchaser shall supply motor, encoder, BLS, ILS and TLS switches as free issue material to the supplier and the supplier shall fabricate remaining parts of the assembly.





**Figure 8: CG Motor and Limit switch Sensor Assembly**

### **6.3 GEPS Module**

#### **6.3.1 Module Description**

##### **6.3.1.1 Functional Description**

The module is powered by 15V (4 Channels), 24V, 27V, 48V and 96V DC power. It receives 1 No. quadruplicated trip contact from “EPI Modules”, 1 No. duplicated trip contact from “EMD Modules”, 4 Nos. current feed-back 4-phases of the CCG motor – from “GP Module”.

The five input contacts are optically isolated. The quadruplicated signals are voted as 2-out-of-4 schemes. The voted signal is ORed with the trip signal from the “Electromagnet Drive”. The Ored signal and 4 current signals are the input of the logic circuit, which generates Upr and Reg and Grip signals.

The module monitors the 4 current feedbacks for their proper value – either triangular wave shape current of 5A peak with 90-degree phase shift and 1-2-3-4-1 or 1-4-3-2-1 sequence or DC current in any two consecutive phases (total current in 2 phases 5A). It will memories the current before fault and shall start generating Upr and Reg signals to maintain the memories current values to those two phases via this module and also generate a optically isolated digital signal for the “GP Module” to switch off all the power transistors in this module.

A monitoring circuit powered by 27V shall monitor fuses in the power supply and other functions in the module and operate fault LED on facia, and generate relay contact.

#### **6.3.1.2 Inputs**

##### **DC Power Inputs**

- i. 24V (Range = 22V to 24.75V)
- ii. 27V (Range = 24.3V to 29.7V) For monitoring of module status
- iii. 48V (Range = 45V to 49V)

##### **Control Inputs**

##### **Isolated Digital Inputs**

- i. 1 No Clutch ON/OFF signal.
- ii. 1 No quadruplicated Trip signal

##### **Analog Inputs**

- i. 4 Nos. motor phase currents in hold or run mode with wave shape as defined in Figure 5.

##### **Toggle Switch**

- i. 1 No toggle switch for deactivation of current through GEPS.

#### **6.3.1.3 Outputs**

##### **DC Power Output**

- i. 4 No PWM voltages of 48 Volts peak modulated with 1 KHz Frequency for driving 4 phases of switched reluctance motor under hold mode. The current in the motor phases shall be as per Figure 5

#### **6.3.1.4 Module Status**

- i. 1 No. Red colour LED (FAULT) for display of module fault.
- ii. 1 No. Green colour LED (PICK UP) for indicating motor currents supplied by this module.

- iii. 1 No. Red colour LED (FAULT 24V) for indicating absence of 24V DC power.
- iv. Module status – In the form of solid state relay contacts (P1, NO1 and NC1).
- v. Grip – In the form of solid state relay contacts (P1, NO1, NC1, P2, NO2 and NC2)

### 6.3.1.5 Module Connector Details

Pin no	X1		
	c	b	a
0	Earth	MC	
9	24V-G	EP Ch4	24V-G
8	Earth-1	EP Ch3	Earth-1
7	Spare1	EP Ch2	Spare1
6	Spare1_Supply	EP Ch1	Spare1_Supply
5	NC	GP Phase2(-)	NC
4	+15V Ch4	GP Phase2(-)'	+15V Ch4
3	Clutch ON/OFF	Phase2(-)	Clutch ON/OFF
2	+15V CH4		+15V CH4
1	+24V	Phase2(+)	+24V

Pin no	X2		
	c	b	a
0	Earth-2	+24V	
9	NC	Grip(NO2)	Grip(NC2)
8	48V-G	Grip(P1)	Module Status(NO1)
7		Grip(NO1)	Module Status(P1)
6	Grip(P2)	Grip(NC1)	Module Status(NC1)
5	NC	GP Phase4(-)	GP Phase3(-)
4	24V-G	GP Phase4(-)'	GP Phase3(-)'
3	+27V	Phase4(-)	Phase3(-)
2	+48V		
1		Phase4(+)	Phase3(+)

### 6.3.2 Tester Requirements

Figure 9 is Block schematic diagram of GEPS tester.

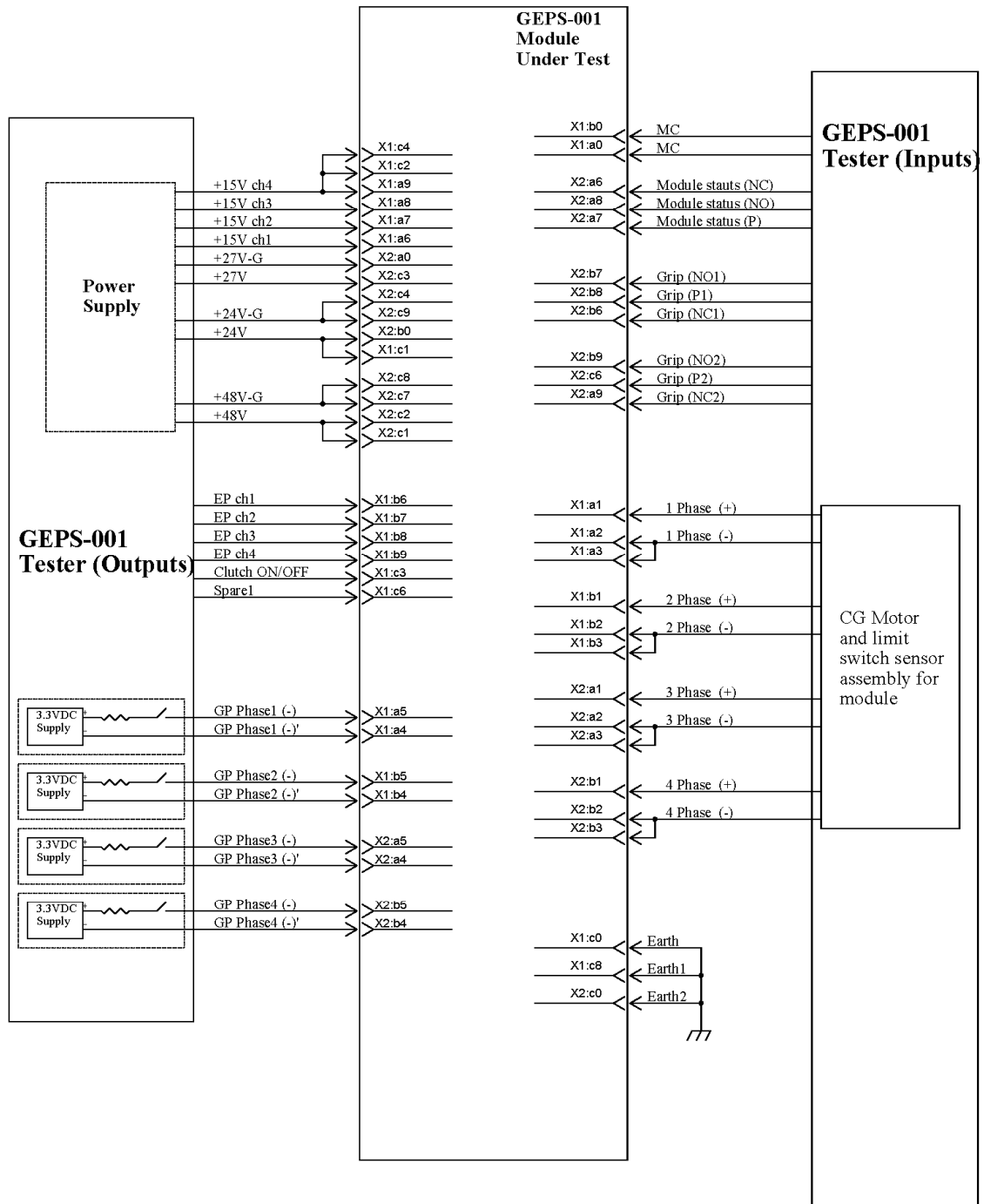


Figure 9: Block Schematic Diagram of GEPS Tester

The tester shall perform tests covered under test cases 1 to 3 automatically and generate test report (Pass/Fail).

#### **6.3.2.1 Test Case 1- No Load Power Dissipation**

- i. Apply 24VDC to the GEPS module and measure the current drawn by the module.
- ii. Now vary 24V Power supply from 22V to 24.75V and verify, Fault LED & Module Status Relay shall not operate.

#### **6.3.2.2 Test Case 2- Simulation of Control Inputs**

- i. Put front facia switch at 1 position and verify absence of holding current in the motor. Now put the switch at 0 position and verify presence of holding current in the motor.
- ii. Quadruplicated EP signals are voted as per 2004, on activation of the signal holding current in the motor becomes zero. Verify functioning of EP and its redundancy.
- iii. Activate Clutch ON/OFF signal and verify absence of holding current in the motor.
- iv. Activate GP Phase1 and GP Phase2 signals and verify for absence of current in all 4 phases of the motor. Now, deactivate GP Phase1 and GP Phase2 and verify current in phase1 and phase2 of the motor.
- v. Repeat the test (iv) for phases 23, 34 and 41.

#### **6.3.2.3 Test Case 3- Fault Simulation & Indication**

- i. Put 24V at OFF position. FAULT LED and FAULT 24V LED shall glow and Module Status relay should operate. Now put 24V at ON position, check module for normal working.

### **6.4 CM Module**

#### **6.4.1 Module Description**

##### **6.4.1.1 Functional Description**

This module is powered by 24V and 27V DC power. Current drawn by the 2 coils of electromagnet of EPS is monitored for detection of the healthiness of power circuits of the two coils.

The module receives four Nos. 110VDC power (interlocked drive power for the solenoid). Current drawn from each one of the four Nos. of 110V power is measured. The measured current is compared for current more than 200mA (>160mA) for generating a signal “Two Coils Healthy” and also to generate a signal “One Coil Healthy” if current is more than 100mA (70mA to 160mA).

Monitoring circuit powered by 27V, monitors healthiness of the module – availability of 24V DC, simultaneous indication of both “One Coil Healthy” and “Two Coils Healthy” signals for any one of the four solenoids i.e. both signal TRUE, under current and over current through any solenoid in presence of 110VDC.

The module fault status is indicated by a relay contact for remote monitoring and thru LED display on the facia of the module.

#### 6.4.1.2 Inputs

##### DC Power Inputs

- i. 24V (Range = 22V to 24.75V) ( For internal power supply)
- ii. 27V (Range = 24.3V to 29.7V) (For monitoring of module status)
- iii. 4 Nos. of 110V DC (Range = 103V to 112V) power for electromagnet coil of 4 EPS mechanisms

##### Control Inputs

Not applicable

#### 6.4.1.3 Outputs

##### DC Power Outputs

4 Nos. of 110V DC (Range = 103V to 112V) power for electromagnet coil of 4 EPS mechanisms.

##### Relay Outputs

- i. 4 Nos. NO contacts of one Coil healthy contacts (closing when only one Coil is powered).
- ii. 4 Nos. NO contacts two Coils healthy contacts (closing when both the Coils are powered).

#### 6.4.1.4 Module Status

1 No. Red LED for display of module fault.

1 No. Dry contact for Module status.

#### 6.4.1.5 Module Connector Details

Pin no	X1		
	c	b	a
0	Earth	MC	
9	Module Status(NO)	Two Coils healthy EPS4(NO)	One Coil healthy EPS4(NO)
8	Module Status(P)	Two Coils healthy EPS4(P)	One Coil healthy EPS4(P)
7	Two Coils healthy EPS3(NO)	One Coil healthy EPS3(NO)	Two Coils healthy EPS2(NO)
6	Two Coils healthy EPS3(P)	One Coil healthy EPS3(P)	Two Coils healthy EPS2(P)
5	One Coil healthy EPS2(NO)	Two Coils healthy EPS1(NO)	One Coil healthy EPS1(NO)

4	One Coil healthy EPS2(P)	Two Coils healthy EPS1(P)	One Coil healthy EPS1(P)
3	Earth-1	27V-G	+27V
2	110V(A34)-G	NC	24V-G
1		NC	+24V

Pin no	X2		
	c	b	a
0	110V (EP4)-G	110V(A33)-G	110V (EP3)-G
9			
8	110V(A32)-G	+110V(A34)	
7		+110V (EP4)	
6	110V (EP2)-G	+110V(A33)	
5		+110V (EP3)	
4	110V(A31)-G	+110V(A32)	
3		+110V (EP2)	
2	110V (EP1)-G	+110V(A31)	
1		+110V (EP1)	

#### 6.4.2 Tester Requirements

Figure 10 is Block schematic diagram of CM tester.

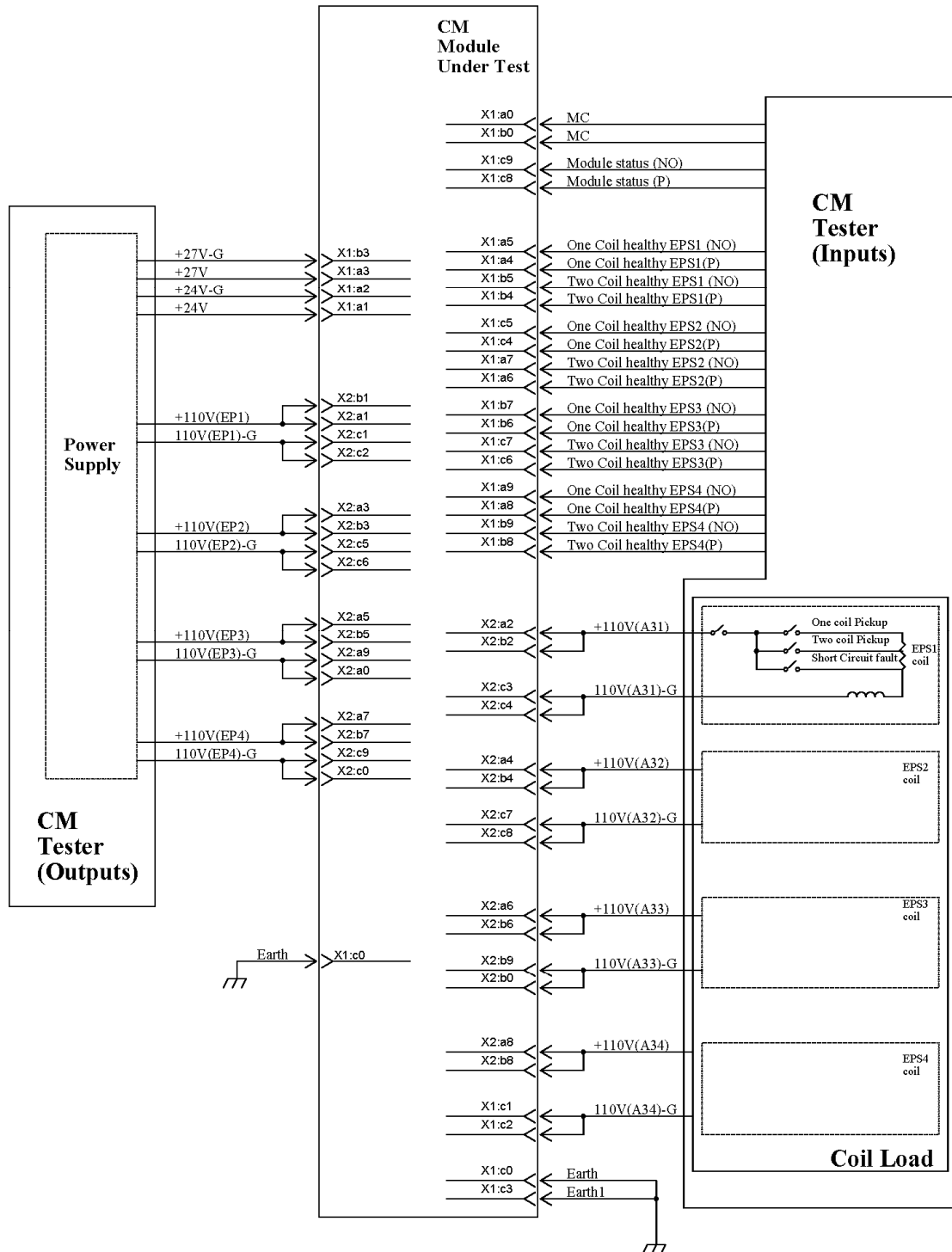


Figure 10: Block Schematic Diagram of CM Tester



The tester shall perform tests covered under test cases 1 to 7 automatically and generate test report.

#### **6.4.2.1 Test Case 1 - No Load Power Dissipation**

- i. Connect Module to Test Jig and power ON 24VDC and measure the current drawn by the module. From voltage and current reading, calculate the No load power dissipation of the module.
- ii. Vary 24V Power supply Externally from 22V to 24.75V and verify, Fault LED Relay shall not operate

#### **6.4.2.2 Test Case 2 – Simulation of All EPS at No load & No 110V DC Input**

Put 24V and 27V, check One Coil and two coils healthy EPS1, EPS2, EPS3, EPS4 relays shall De-energize. Module Status Relay shall energize and Fault LED shall not Glow.

Now vary 24V Power supply from 22V to 24.75V and verify, One Coil and two coils healthy EPS1, EPS2, EPS3, EPS4 relays shall De-energize. Module Status Relay shall energize and Fault LED shall not Glow.

Now vary 27V Power supply from 24.3V to 29.7V and verify, One Coil and two coils healthy EPS1, EPS2, EPS3, EPS4 relays shall De-energize. Module Status Relay shall energize and Fault LED shall not Glow

#### **6.4.2.3 Test Case 3 – Simulation of EPS1 Coil**

Apply voltage 110VDC between +110V (EP1) and 110V (EP1)-G inputs without any load, check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS1 relay and Two coils healthy EPS1 relay shall remain De-energize.

Now vary 110VDC Power supply from 103V to 112V and verify Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS1 relay and Two coils healthy EPS1 relay shall remain De-energize.

Connect EPS1 Coil Load between +110V(EP1) and 110V(A31)-G outputs, Select EPS1 Coil Load switch at One Coil Pickup (70mA-80mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS1 relay shall Energize and Two coils healthy EPS1 relay shall remain De-energized.

Select EPS1 Coil Load switch at Two Coils Pickup (190mA-200mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS1 relay shall De-energize and Two coils healthy EPS1 relay shall Energize.

Select EPS1 Coil Load switch at Short Circuit fault(340mA- 360mA), check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS1 relay shall De-energize and Two coils healthy EPS1 relay shall remain Energized.

#### **6.4.2.4 Test Case 4 – Simulation of EPS2 Coil**

Apply voltage 110VDC between +110V (EP2) and 110V (EP2)-G inputs without any load, check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS2 relay and Two coils healthy EPS2 relay shall remain De-energize.

Connect EPS2 Coil Load between +110V(EP2) and 110V(A32)-G outputs, Select EPS2 Coil Load switch at One Coil Pickup (70mA-80mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS2 relay shall Energize and Two coils healthy EPS2 relay shall remain De-energize.

Select EPS2 Coil Load switch at Two Coils Pickup (190mA-200mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS2 relay shall De-energize and Two coils healthy EPS2 relay shall Energize.

Select EPS2 Coil Load switch at Short Circuit fault(340mA- 360mA), check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS2 relay shall De-energize and Two coils healthy EPS2 relay shall remain Energize.

#### **6.4.2.5 Test Case 5 – Simulation of EPS3 Coil**

Apply voltage 110VDC between +110V (EP3) and 110V (EP3)-G inputs without any load, check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS3 relay and Two coils healthy EPS3 relay shall remain De-energize.

Connect EPS3 Coil Load between +110V(EP3)] and 110V(A33)-G outputs, Select EPS3 Coil Load switch at One Coil Pickup (70mA-80mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS3 relay shall Energize and Two coils healthy EPS3 relay shall remain De-energize.

Select EPS3 Coil Load switch at Two Coils Pickup (190mA-200mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS3 relay shall De-energize and Two coils healthy EPS3 relay shall Energize.

Select EPS3 Coil Load switch at Short Circuit fault(340mA- 360mA), check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS3 relay shall De-energize and Two coils healthy EPS3 relay shall remain Energize.

#### **6.4.2.6 Test Case 6 – Simulation of EPS4 Coil**

Apply voltage 110VDC between +110V (EP4) and 110V (EP4)-G inputs without any load, check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS4 relay and Two coils healthy EPS4 relay shall remain De-energize.

Connect EPS4 Coil Load between +110V(EP4) and 110V(A34)-G outputs, Select EPS4 Coil Load switch at One Coil Pickup (70mA-80mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS4 relay shall Energize and Two coils healthy EPS4 relay shall remain De-energize.

Select EPS4 Coil Load switch at Two Coils Pickup (190mA-200mA), check Module fault LED shall not Glow, Module Status Relay shall Energize, One Coil healthy EPS4 relay shall De-energize and Two coils healthy EPS4 relay shall Energize.

Select EPS4 Coil Load switch at Short Circuit fault(340mA- 360mA), check Module fault LED shall Glow, Module Status Relay shall De-energize, One Coil healthy EPS4 relay shall De-energize and Two coils healthy EPS4 relay shall remain Energize.

#### **6.4.2.7 Test Case 7 – 24V Supply Fault Simulation**

Put 24V supply OFF and verify that Fault LED shall Glow and Module status relay shall operate. Now resume 24V and observe that the fault shall disappear.

### **6.5 BCI Module**

#### **6.5.1 Module Description**

##### **6.5.1.1 Functional Description**

This module receives 24V and 27V DC power for its operation. It receives following signals in the form of dry contacts- WST, WS $\tau$ , WSN, EPR and WSP. It generates WS2/3 and EPR 2/3 signals in the form of contacts. This also contains relays for multiplication of contacts for 200(EP) 2/3, TLS (BKB), BLS2/3(HKB2/3) and 700mm.

It generates 15V from 24V for one of the four channels of 15V-15V1K, 15V2K, 15V3K and 15V4K.

The triplicated signals of WST, WS $\tau$ , WSN, EPR and WSP are isolated optically and voted as per 2 out of 3 schemes. This implements required logics and operate WS2/3 and EPR2/3 relays.

This module shall contain 2 Nos. capacitor banks (Brake Capacitor Bank) of 20.4 $\mu$ F/400V each.

Monitoring circuit powered by 27V, monitors the proper functioning of the module fuse status, status of 15V etc.

##### **6.5.1.2 Inputs**

27V (Range = 24.3V to 29.7V) For monitoring of module status.

24V (Range = 22V to 24.75V) For internal power supply.

15V (Range = 13.75V to 15.25V) Vetting supply for command input to module.

#### **Control Inputs**

### **Isolated Digital Inputs**

- 1 No. Triplicated WST signal(Warning Signal by Temperature)
- 1 No. Triplicated WS $\tau$  signal(Warning Signal by Period)
- 1 No. Triplicated WSN signal(Warning Signal by Power)
- 1 No. Triplicated WSP signal(Warning Signal by Pressure)
- 1 No. Triplicated EPR signal(Emergency power reduction)
- 1 No. BLS CG signal
- 1 No. TLS (BKB) signal (BKB traced as direct input from the mechanism via GP)

### **Un-Isolated Digital Inputs**

- i. 1 No. 200mm(EP)2/3 signal
- ii. 1 No. BLS 2/3(HKB2/3) signal(Bottom terminal switch)
- iii. 1 No. 700mm signal

## **6.5.1.3 Outputs**

### **Power Outputs**

- Voltage : 15V DC (Range = 13.75V to 15.25V)
- Maximum Power Rating : 25W
- Nominal Power : 5W
- Module Part Number : VI-JW2-IZ (Vicor)

### **Relay Outputs**

- WS 2/3 – in the form of solid-state contacts (P1, NO1, NC1, P2, NO2 and NC2). Rating of the contacts is 200V, 0.12A.
- EPR 2/3 – in the form of solid-state contacts (P1, NO1, NC1, P2, NO2 and NC2). Rating of the contacts is 200V, 0.12A.
- TLS – in the form of solid-state contacts (P1, NO1, P2 and NO2). Rating of the contacts is 200V, 0.12A.
- BLS CG – in the form of solid-state contacts (P1, NO1, P2 and NO2). Rating of the contacts is 200V, 0.12A.
- 200mm ORed with BLS – in the form of changeover relay contacts (P, NO). Rating of the contacts shall be 28V, 1A.
- 200mm – in the form of changeover relay contacts (P and NO). Rating of the contact shall be 28V, 1A.
- 700mm- in the form of changeover relay contact (P1, NO1, P2, and NO2). Rating of the contacts shall be 28V, 1A.

## **6.5.1.4 Module Status**

- i. 1 no. Green colour LED (15V) for indication of availability of 15V.

- ii. 1 no. Green colour LED (24V) for indication of availability of 24V.
- iii. 1 no. Green colour LED (27V) for indication of availability of 27V.
- iv. 1 no. Red colour LED (27V FAULT) for indication of fuse failure of 27V.
- v. 1 no. Red colour LED (24V FAULT) for indication of fuse failure of 24V.
- vi. 1 No. Red colour LED (FAULT) for indication of module fault
- vii. 1 no. Fuse 27V F1 of 2A in series of 27V power supply.
- viii. 1 no. Fuse 24V F2 of 2A in series of 24V power supply.
- ix. Module fault – in the form of solid-state relay contacts (P, NO and NC).  
Rating of the contacts shall be 200V, 0.12A.

#### 6.5.1.5 Module Connector Details

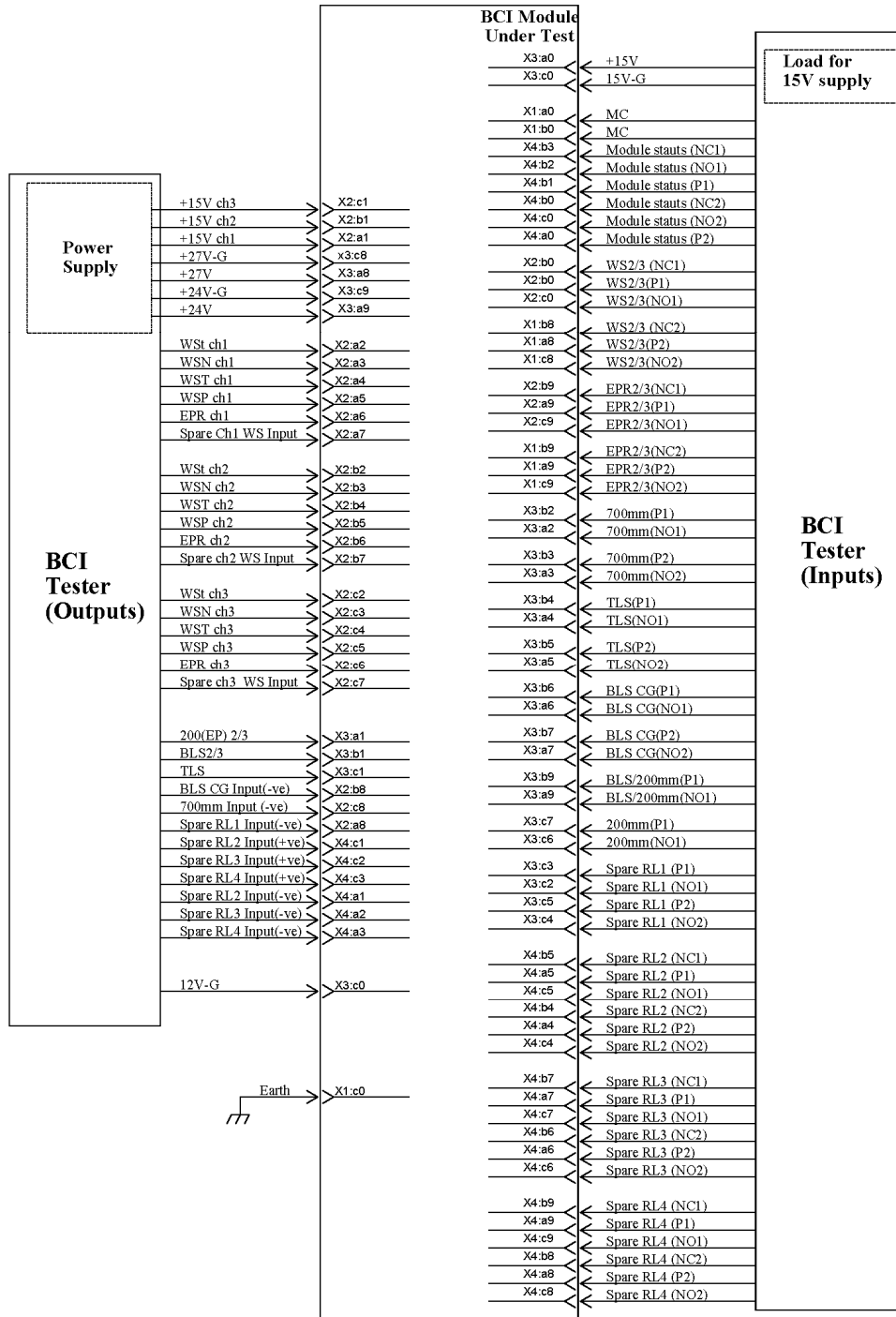
Pin no	X2			Pin No	X1		
	c	b	a		c	b	a
0	WS2/3 (NO1)	WS2/3 (NC1)	WS2/3 (P1)	0	Earth	MC	MC
9	EPR2/3 (NO1)	EPR2/3 (NC1)	EPR2/3 (P1)	9	EPR2/3 (NO2)	EPR2/3 (NC2)	EPR2/3 (P2)
8	700mm Input (-Ve)	BLS CG Input (-Ve)	Spare RL1 Input(-Ve)	8	WS2/3 (NO2)	WS2/3 (NC2)	WS2/3 (P2)
7	Spare Ch3 WS Input	Spare Ch2 WS Input	Spare Ch1 WS Input	7	Earth-1	NC	NC
6	EPR Ch3	EPR Ch2	EPR Ch1	6	BC1-Common	BC1-C3	BC1-C1
5	WSP Ch3	WSP Ch2	WSP Ch1	5	BC1-C2	BC2-Common	BC1-C4
4	WST Ch3	WST Ch2	WST Ch1	4	Spare D4-A	BC2-C1	Spare D4-K
3	WSN Ch3	WSN Ch2	WSN Ch1	3	Spare D3-A	BC2-C2	Spare D3-K
2	WS $\tau$ Ch3	WS $\tau$ Ch2	WS $\tau$ Ch1	2	Spare D2-A	BC2-C3	Spare D2-K
1	+15V Ch3	+15V Ch2	+15V Ch1	1	Spare D1-A	BC2-C4	Spare D1-K

Pin no	X4			Pin No	X3		
	c	b	a		c	b	a
0	Module Status (NO2)	Module Status (NC2)	Module Status (P2)	0	15V-G	24V-1-G	+15V
9	Spare RL4 (NO1)	Spare RL4 (NC1)	Spare RL4 (P1)	9	24V-G	BLS/200m m (P)	+24V
8	Spare RL4 (NO2)	Spare RL4 (NC2)	Spare RL4 (P2)	8	27V-G	BLS/200m m (NO)	+27V
7	Spare RL3 (NO1)	Spare RL3 (NC1)	Spare RL3 (P1)	7	200mm (P)	BLS CG (P2)	BLS CG (NO2)

6	Spare RL3 (NO2)	Spare RL3 (NC2)	Spare RL3 (P2)	6	200mm (NO)	BLS CG (P1)	BLS CG (NO1)
5	Spare RL2 (NO1)	Spare RL2 (NC1)	Spare RL2 (P1)	5	Spare RL1 (P2)	TLS (P2)	TLS (NO2)
4	Spare RL2 (NO2)	Spare RL2 (NC2)	Spare RL2 (P2)	4	Spare RL1 (NO2)	TLS (P1)	TLS (NO1)
3	Spare RL4 Input (+Ve)	Module Status (NO1)	Spare RL4 Input (-Ve)	3	Spare RL1 (P1)	700mm (P2)	700mm (NO2)
2	Spare RL3 Input (+Ve)	Module Status (NC1)	Spare RL3 Input (-Ve)	2	Spare RL1 (NO1)	700mm (P1)	700mm (NO1)
1	Spare RL2 Input (+Ve)	Module Status (P1)	Spare RL2 Input (-Ve)	1	TLS	BLS2/3	200(EP)2/3

### 6.5.2 Tester Requirements

Figure 11 shows Block schematic diagram of BCI tester.



**Figure 11: Block Schematic Diagram of BCI Tester**

The tester shall perform tests covered under test cases 1 to 7 automatically and generate test report (Pass/Fail).

#### **6.5.2.1 Test Case 1 - No Load Power Dissipation**

- i. Connect Module to Test Jig and power ON 24VDC and measure the current drawn by the module. From voltage and current reading, calculate the No load power dissipation of the module.
- ii. Vary 24V Power supply Externally from 22V to 24.75V and verify, Fault LED Relay shall not operate

#### **6.5.2.2 Test Case 2 – Simulation of “EPR” and “Spare Ch WS Input” Control Inputs**

Assert any two control Inputs out of three (EPR Ch1, EPR Ch2 and EPR Ch3) Signals Low (15V-G) and verify that EPR2/3 Solid State relay gets energized.

Now vary 27V Power supply from 24.3V to 29.7V, 24V supply from 22V to 24.75V and 15V supply from 13.75V to 15.25V, ensure that EPR2/3 Solid State relay remain gets energized.

De-assert any two control Inputs out of three (EPR Ch1, EPR Ch2 and EPR Ch3) Signals and verify that EPR2/3 Solid State relay gets De-energized.

Assert any two control Inputs out of three (Spare Ch1 WS Input, Spare Ch2 WS Input and Spare Ch3 WS Input) Signals Low (15V-G) and verify that EPR2/3 Solid State relay gets energized.

De-assert any two control Inputs out of three (Spare Ch1 WS Input, Spare Ch2 WS Input and Spare Ch3 WS Input) Signals and verify that EPR2/3 Solid State relay gets De-energized.

#### **6.5.2.3 Test Case 3 – Simulation of WST, WS $\tau$ , WSN and WSP Control Inputs**

Assert any two control Inputs out of three (WST Ch1, WST Ch2 and WST Ch3) Signals Low (15V-G) and verify that WS2/3 Solid State relay gets energized.

De-assert any two control Inputs out of three (WST Ch1, WST Ch2 and WST Ch3) Signals and verify that WS2/3 Solid State relay gets De-energized.

Assert any two control Inputs out of three (WS $\tau$  Ch1, WS $\tau$  Ch2 and WS $\tau$  Ch3) Signals Low (15V-G) and verify that WS2/3 Solid State relay gets energized.

De-assert any two control Inputs out of three (WS $\tau$  Ch1, WS $\tau$  Ch2 and WS $\tau$  Ch3) Signals and verify that WS2/3 Solid State relay gets De-energized.

Assert any two control Inputs out of three (WSN Ch1, WSN Ch2 and WSN Ch3) Signals Low (15V-G) and verify that WS2/3 Solid State relay gets energized.

De-assert any two control Inputs out of three (WSN Ch1, WSN Ch2 and WSN Ch3) Signals and verify that WS2/3 Solid State relay gets De-energized.



Assert any two control Inputs out of three (WSP Ch1, WSP Ch2 and WSP Ch3) Signals Low (15V-G) and verify that WS2/3 Solid State relay gets energized.

De-assert any two control Inputs out of three (WSP Ch1, WSP Ch2 and WSP Ch3) Signals and verify that WS2/3 Solid State relay gets De-energized.

#### **6.5.2.4 Test Case 4 – 15V Output Supply Verification**

At nominal input of 24V check DC-DC converter output as 13.75V to 15.25V DC.

Repeat above step at 20V & 28V input. The DC-DC converter output shall be 13.75V to 15.25V DC.

Connect 5W load at DC-DC converter output and DC-DC converter output at 20V, 24V and 28V input. The output voltage shall be 13.75V to 15.25V DC.

#### **6.5.2.5 Test Case 5 – Fuse Fault Simulation & Indication**

Remove 27Vfuse, Fuse Fail (27V) LED shall Glow & Module status relay shall operate. Place the Fuse back and observe that the fault shall disappear.

Remove 24V fuse, Fuse Fail (24V) & Fault LED shall Glow & Module status relay shall operate. Place the Fuse back and observe that the fault shall disappear.

#### **6.5.2.6 Test Case 6 – Simulation of 24V/15V Supply Fault**

Switch OFF 24V supply and verify that the Fault LED shall Glow & Module status relay shall operate. Now resume 24V and observe that the fault shall disappear.

#### **6.5.2.7 Test Case 7 – Simulation of relays for multiplication of contacts**

Assert 200(EP) 2/3 Signal Low (12V-G) and Verify BLS/200mm and 200mm signal contact.

Assert BLS2/3 Signal Low (12V-G) and Verify BLS/200mm signal contact.

Assert 700mm Signal Low (12V-G) and Verify 700mm signal contact.

Assert BLS CG Input (-Ve) Signal Low (12V-G) and Verify BLS CG signal contacts.

Assert TLS Signal Low (12V-G) and Verify TLS signal contacts.

Assert Spare RL1 Input Low (12V-G) and Verify Spare RL1 signal.

Assert Spare RL2 Input (+Ve) High (+24V) and Spare RL2 Input (-Ve) Low (24V-G) and Verify Spare RL2 signal.

Assert Spare RL3 Input (+Ve) High (+24V) and Spare RL3 Input (-Ve) Low (24V-G) and Verify Spare RL3 signal.

Assert Spare RL4 Input (+Ve) High (+24V) and Spare RL4 Input (-Ve) Low (24V-G) and Verify Spare RL4 signal.

## **6.6 LSDP Module**

### **6.6.1 Module Description**

#### **6.6.1.1 Functional description**

The input voltages of 12V and 24VDC are converted into 12V-3 and 12V-1 DC respectively using DC-DC converters having galvanic isolation. The outputs of DC-DC converters are connected in parallel using diodes

.

Two Nos. identical circuits generate biasing voltage ( $+12V \pm 10\%$ ,  $400\text{Hz} \pm 1\%$  Rectangular wave shape voltage) for coils of two limit switches – TLS and BLS. Biasing current in the coil is passed through a peak detector circuit, amplifies by Gain amplifier and compared with comparator to detect the presence of permanent magnet in vicinity of the coil. The comparator output drives a relay coil and its contacts show the status of limit switch position. In case of the failure of input 24VDC, 12VDC power to all the relays is cut-off, except one BLS relay.

The monitoring circuit powered by 27VDC, monitors proper functioning of all the blocks-open/ short circuit of the coils, simultaneous actuation of TLS and BLS relay coils, absence of any one of the 12 volts or 24 volts power supply and turns on module fault LED and switches on the fault relay in case of fault.

#### **6.6.1.2 Inputs**

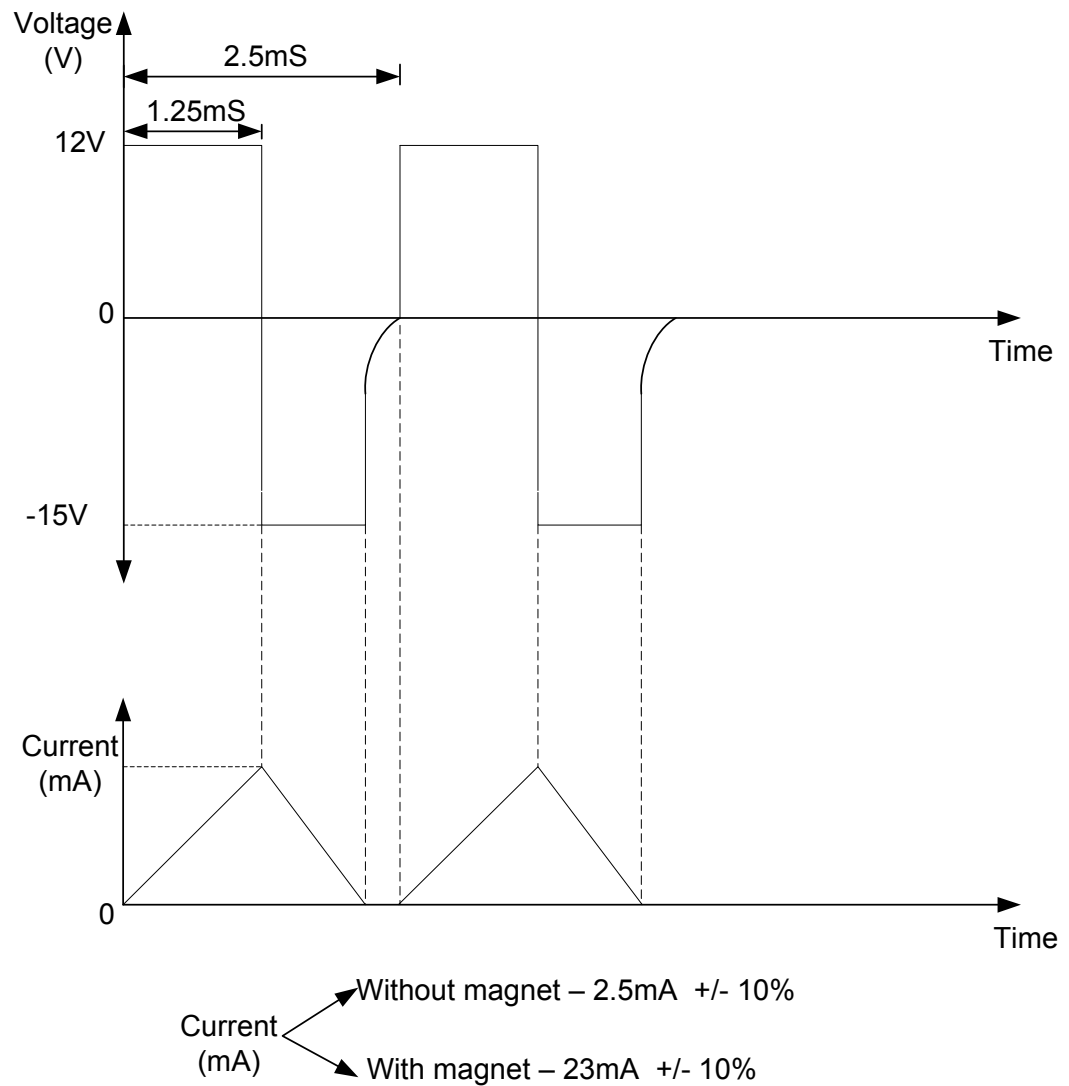
- i. 27V (Range = 24.3V to 29.7V) for monitoring of module status.
- ii. 24V (Range = 22V to 24.75V) for internal power supply.
- iii. 12V (Range = 10.6V to 12.6V) from Battery.

#### **6.6.1.3 Outputs**

##### **Control Outputs**

Voltage and current parameters of Inductive limit switch are given below and for waveform refer Figure 12.

- i. Voltage across the terminals of the coil is  $+12V \pm 10\%$  and  $-15V \pm 10\%$ ,  $50 \pm 5\%$  duty cycle,  $400\text{Hz} \pm 1\%$  wave.
- ii. Coil peak current is 2.5mA without magnet.
- iii. Coil peak current is 23mA with magnet.



**Figure 12: Biasing Voltage and Current through Limit Switch Coil**

#### Relay Outputs

- Module fault – in the form of solid-state relay contacts (P and NO). Rating of the contacts shall be 200V, 0.12A.
- Nos. 'NO' BLS (Bottom Limit switch) contacts (closing when mechanism reaches bottom limit). In the form of DPDT relay contacts (P, NO), Rating of the contacts shall be 28V, 1A.
- 4 Nos. 'NO' and 1No. 'NC' TLS (Top Limit Switch) contacts. In the form of DPDT relay contacts
- (4 Nos. P and NO, 1 No. P and NC), Rating of the contacts shall be 28V, 1A.

**6.6.1.4 Module Status**

- i. 1 no. Green colour LED (24V) for indication of availability of 24V.
- ii. 1 no. Red colour LED (24V FAULT) for indication of fuse failure of 24V.
- iii. 1 No. Red colour LED (FAULT) for indication of module fault
- iv. 1 no. Fuse 24V F1 of 0.5A in series of 24V power supply.

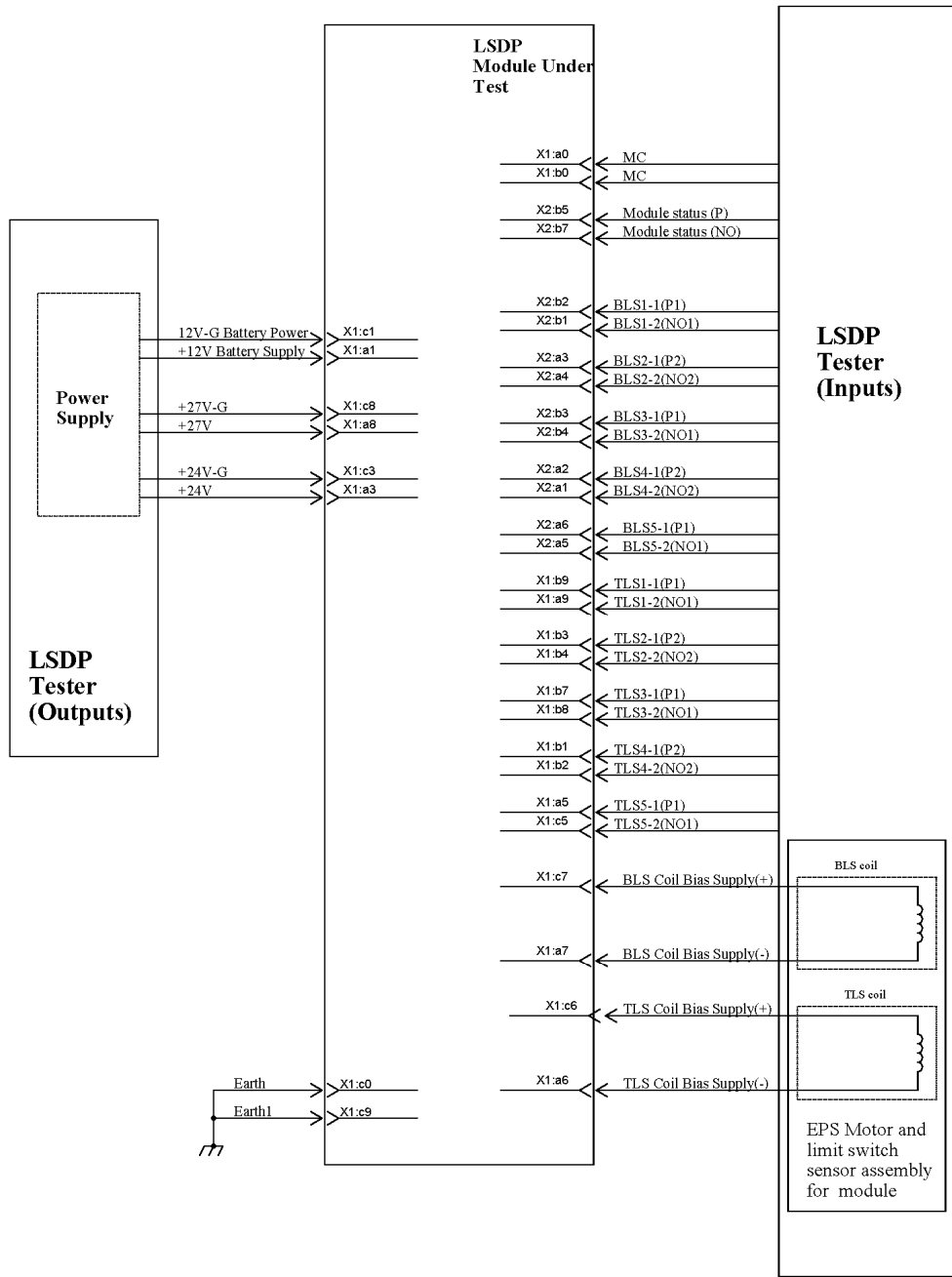
**6.6.1.5 Module Connector Details**

Pin no	X1		
	c	b	a
0	Earth	MC	
9	Earth-1	TLS1-1	TLS1-2
8	27V-G	TLS3-2	+27V
7	BLS Coil Bias Supply(+)	TLS3-1	BLS Coil Bias Supply(-)
6	TLS Coil Bias Supply(+)	NC	TLS Coil Bias Supply(-)
5	TLS5-2	NC	TLS5-1
4	NC	TLS2-2	NC
3	24V-G	TLS2-1	+24V
2	NC	TLS4-2	NC
1	12V-G Battery Power	TLS4-1	+12V Battery Power

Pin no	X2		
	c	b	a
0	NC	NC	NC
9	NC	NC	NC
8	NC	NC	NC
7	NC	Module Status ( NO)	NC
6	NC	NC	BLS5-1
5	NC	Module Status (P)	BLS5-2
4	NC	BLS3-2	BLS2-2
3	NC	BLS3-1	BLS2-1
2	NC	BLS1-1	BLS4-1
1	NC	BLS1-2	BLS4-2

**6.6.2 Tester Requirements**

Figure 13 shows Block schematic diagram of LSDP tester.



**Figure 13: Block Schematic Diagram of LSDP Tester**

The tester shall perform tests covered under test cases 1 to 6 automatically and generate test report.

#### **6.6.2.1 Test Case 1 – No Load Power Dissipation**

- i. Connect Module to Test Jig and power ON 24VDC and measure the current drawn by the module. From voltage and current reading, calculate the No load power dissipation of the module.
- ii. Vary 24V Power supply Externally from 22V to 24.75V and verify, Fault LED Relay shall not operate

#### **6.6.2.2 Test Case 2 – Simulation of BLS Relay operation**

- i. Simulate BLS coil magnetized condition by connecting low inductance coil and verify that BLS relay gets energized.
- ii. Now vary 27V Power supply from 24.3V to 29.7V, 24V supply from 22V to 24.75V and 12V supply from 10.6V to 12.5V, ensure that BLS relay remain gets energized.
- iii. Simulate BLS coil demagnetized condition by connecting high inductance coil and verify that BLS relay gets de-energized.
- iv. Simulate BLS coil open circuit condition by not connecting any coil and verify that BLS relay gets De-energized, fault LED glows and Module status relay activates.
- v. Simulate BLS coil short circuit condition by shorting the BLS coil and verify that BLS relay gets De-energized, fault LED glows and Module status relay activates.

#### **6.6.2.3 Test Case 3 – Simulation of TLS Relay operation**

- i. Simulate TLS coil magnetized condition by connecting low inductance coil and verify that TLS relay gets energized.
- ii. Simulate TLS coil demagnetized condition by connecting high inductance coil and verify that TLS relay gets de-energized.
- iii. Simulate TLS coil open circuit condition by not connecting any coil and verify that TLS relay gets de-energized, fault LED glows and Module status relay activates.
- iv. Simulate TLS coil short circuit condition by shorting the TLS coil and verify that TLS relay gets de-energized fault LED glows and Module status relay activates.

#### **6.6.2.4 Test Case 4 – Simultaneous Activation of BLS & TLS Relays**

- i. Simulate BLS and TLS coils magnetized condition by connecting low inductance coils and verify that BLS and TLS relays get De-energized, fault LED glows and Module status relay De-activate.

#### **6.6.2.5 Test Case 5 – Fuse Fault Simulation & Indication**

- i. Remove 24V fuse, Fuse Fail (24V) & Fault LED shall Glow & Module status relay shall de-energized, Place the Fuse back and observe that the fault shall disappear.

#### **6.6.2.6 Test Case 6 – Simulation of 24V/12V Supply Fault**

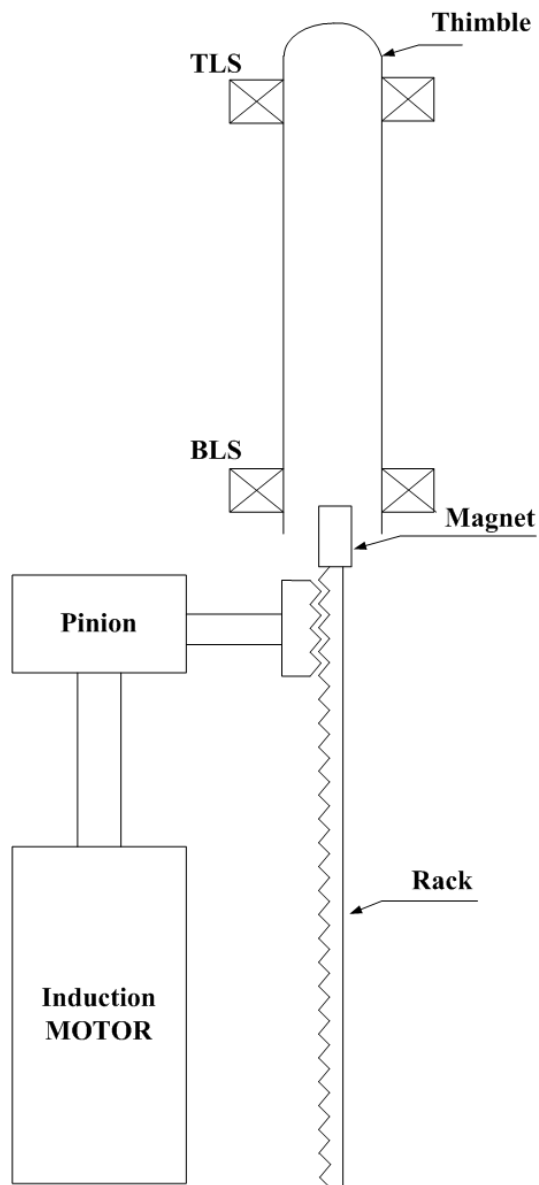
- i. Switch OFF 24V supply and verify that the Fault LED shall Glow & Module status relay shall de-energize. Now resume 24V and observe that the fault shall disappear.
- ii. Switch OFF 12V supply and verify that the Fault LED shall Glow & Module status relay shall de-energize. Now resume 12V and observe that the fault shall disappear.
- iii. Switch OFF 24V supply and simulate BLS coil magnetized condition by connecting low inductance coil and verify that BLS5 relay contact gets energized.

#### **6.6.3 EPS Motor and Limit Switch Sensor Assembly**

Figure 14 is the block schematic of limit switch sensor assembly. This shall be part of LSDP module tester. Limit switches and magnet used here are the actual ones for which the module under test is designed.

Motor is powered to move the limit switch magnet UP or DN. The magnet is moved to check the functionality of limit switch with presence and absence of magnet.

The Purchaser shall supply Thimble, magnet, BLS and TLS switches as free issue material to the supplier and the supplier shall fabricate remaining parts of the assembly.



**Figure 14: EPS Motor and Limit Switch Assembly**

## **6.7 EMD Module**

### **6.7.1 Module Description**

#### **6.7.1.1 Functional Description**

This module is fed by 24V, 15V, 27V and 110V DC power. The quadruplicated EP EM input signals are isolated using 4 Nos. Opto-couplers powered by 4 channels of 15V DC power supplies. These inputs work on “2-out-of-4” logic for energizing/de-energizing 110V DC electro-magnet power supply.

Logic circuit powered by 24V, receives BLS contacts and Drop EP signals for 4 EPSs. It ensures dropping of only one EPS even if commanded for more than one. The +24V is connected thru the “Active EP” switch. The module generates 4 NO and 8 NC contacts for implementation of interlocks. F1, F2, F3 and F4 fuses are in



series with +110V supply of electromagnet of EPS1, EPS2, EPS3 and EPS4 respectively.

“Monitoring Circuit” powered by 27V DC, monitors fuse fail, de-energizing of electromagnets in absence of EP EM or Drop EP signals and display the fault on front facia panel thru LEDs, and generates relay contact. Module fault shall not occur in absence of 110V DC input power.

#### **6.7.1.2 Inputs**

##### **DC Power Inputs**

24V (Range = 22V to 24.75V) ( For internal power supply)

27V (Range = 24.3V to 29.7V) (For monitoring of module status)

15V (Range = 13.75V to 15.25V) Vetting supply for command input to module

110 V (Range = 103V to 112V) (Power for Electromagnets coil of EPS mechanisms)

##### **Control Inputs**

##### **Isolated Digital Inputs**

Quadruplicated “EP EM” signals i.e. EP EM Ch1, EP EM Ch2, EP EM Ch3 and EP EM Ch4.

4 Nos. EP “Drop” signals for 4 EPS mechanisms i.e. Drop EP1, Drop EP2, Drop EP3 and Drop EP4.

4 Nos. BLS signals from 4 EPS mechanisms i.e. BLS EP1, BLS EP2, BLS EP3 and BLS EP4.

##### **Toggle Switch**

1 No. toggle switch contact for activation/ de-activation of EP drop.

#### **6.7.1.3 Outputs**

##### **DC Power Output**

110 V DC (Range = 103V to 112V) power for the Electromagnet Coils of 4 EPS mechanisms

##### **Control Outputs**

4 Nos. NO (Normally Open) contacts of relay connected on 110V DC circuit.

8 Nos. NC (Normally Closed) contacts of relay connected on 110V DC circuit

#### **6.7.1.4 Module Status**

- i. 1 No. Red LED for display of module fault.
- ii. 1 No. Dry contact for Module status
- iii. 1 No. Green LED for display of 110V availability.
- iv. 1 No. Red LED for 24V fuse fault.

- v. 1 No. Red LED for 15V fuse fault.
- vi. 1 No. Red colour LED for F1 fuse fail indication.
- vii. 1 No. Red colour LED for F2 fuse fail indication.
- viii. 1 No. Red colour LED for F3 fuse fail indication.
- ix. 1 No. Red colour LED for F4 fuse fail indication.
- x. 1 No. Dry contact for Module status.

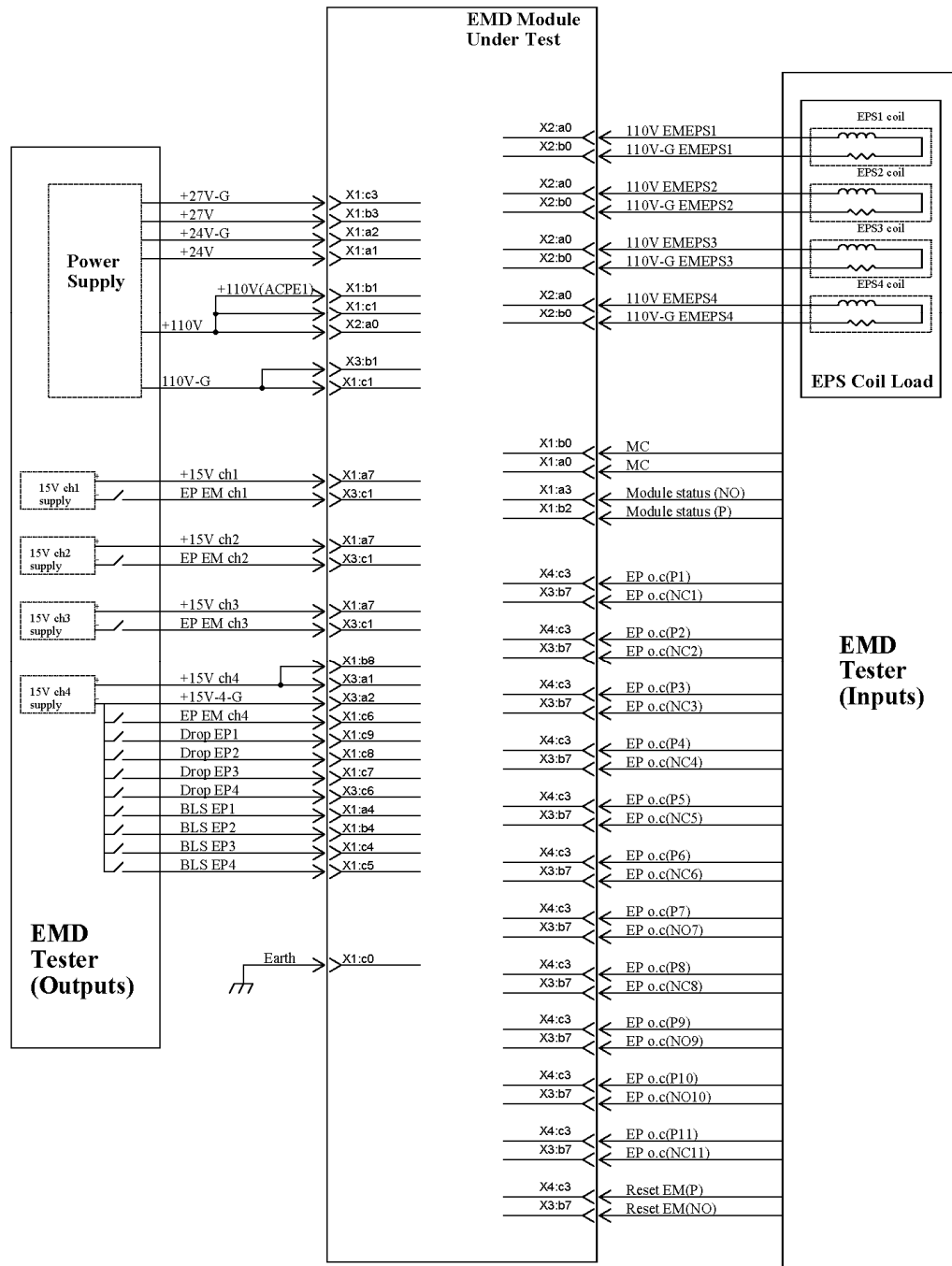
#### 6.7.1.5 Module Connector Details

Pin no	X2			Pin No	X1		
	c	b	a		c	b	a
0	NC	NC	+110V	0	Earth	MC	
9	NC	NC	NC	9	EP EM Ch1	110V EMEPS2	EP EM Ch1
8	NC	NC	NC	8	EP EM Ch2	+15V Ch4	EP EM Ch2
7	NC	NC	NC	7	EP EM Ch3	+15V Ch3	EP EM Ch3
6	NC	NC	NC	6	EP EM Ch4	110V-G EMEPS2	EP EM Ch4
5	NC	NC	NC	5	BLS EP4	NC	BLS EP4
4	NC	NC	NC	4	BLS EP3	BLS EP2	BLS EP3
3	NC	NC	NC	3	27V-G	+27V	27V-G
2	NC	NC	NC	2	NC	Module Status (P)	NC
1	NC	NC	NC	1	+110V (ACPE1)		+24V

Pin no	X4			Pin No	X3		
	c	b	a		c	b	a
0	NC	EP o.c(NO10)	EP o.c(P7)	0	NC	NC	NC
9	EP o.c(P3)	EP o.c(P10)	EP o.c(NO7)	9	Drop EP1	110V EMEPS4	110V EMEPS3
8	NC	EP o.c(P9)	NC	8	Drop EP2	EP o.c(NC6)	EP o.c(P8)
7	EP o.c(NC11)	EP o.c(NO9)	NC	7	Drop EP3	EP o.c(NC1)	EP o.c(NC5)
6	NC	NC	NC	6	Drop EP4	110V-G EMEPS4	110V-G EMEPS3
5	EP o.c(P2)	NC	EP o.c(P4)	5	NC	EP o.c(NC2)	EP o.c(NC4)
4	NC	NC	NC	4	Reset EM(P)	EP o.c(P11)	NC
3	EP o.c(P1)	NC	EP o.c(P5)	3	Reset EM(NO)	EP o.c(NC3)	NC
2	NC	NC	NC	2	Earth-1	NC	15V Ch4-G
1	EP o.c(P6)	NC	EP o.c(NC8)	1	110V-G	+15V Ch4	

### 6.7.2 Tester Requirements

Figure 15 shows Block schematic diagram of EMD tester.



**Figure 15: Block Schematic Diagram of EMD Tester**

The tester shall perform tests covered under test cases 1 to 5 automatically and generate test report.

#### **6.7.2.1 Test Case 1 - No Load Power Dissipation**

- i. Connect Module to Test Jig and power ON 24VDC and measure the current drawn by the module. From voltage and current reading, calculate the No load power dissipation of the module.
- ii. Vary 24V Power supply Externally from 22V to 24.75V and verify, Fault LED Relay shall not operate

#### **6.7.2.2 Test Case 2 – Energizing/De-energizing 110V DC Electro-magnet Power**

- i. Assert EP EM Ch1 Signal Low (15VCh1-G), EP EM Ch2 Signal Low (15VCh2-G), EP EM Ch3Signal Low (15VCh3-G) EP EM Ch4 Signal Low (15VCh4-G) and Verify that 110 V DC power for the Electromagnet Coils of 4 EPS mechanisms shall available (110V EMEPS1, 110V EMEPS2, 110V EMEPS3 and 110V EMEPS4).and check EP o.c Relays shall get energized.
- ii. De-assert any one input of EP EM Ch1, EP EM Ch2, EP EM Ch3 and EP EM Ch4 (Removing 15VCh1-G from EP EM Ch1 or 15VCh2-G from EP EM Ch2 or 15VCh3-G from EP EM Ch3 or 15VCh4-G from EP EM Ch4) and check 110 V DC power for the Electromagnet Coils of 4 EPS mechanisms remains available (110V EMEPS1, 110V EMEPS2, 110V EMEPS3 and 110V EMEPS4) and EP o.c Relays remains energize.
- iii. De-assert any two inputs of EP EM Ch1, EP EM Ch2, EP EM Ch3 and EP EM Ch4 (Removing 15VCh1-G from EP EM Ch1 and 15VCh2-G from EP EM Ch2 or 15VCh2-G from EP EM Ch2 and 15VCh3-G from EP EM Ch3 or 15VCh3-G from EP EM Ch3 and 15VCh4-G from EP EM Ch4 or 15VCh4-G from EP EM Ch4 and 15VCh1-G from EP EM Ch1) and check 110 V DC power for the Electromagnet Coils of 4 EPS mechanisms shall not available (110V EMEPS1, 110V EMEPS2, 110V EMEPS3 and 110V EMEPS4) and EP o.c Relays shall get de-energized.
- iv. Repeat Step (i).

#### **6.7.2.3 Test Case 3 – Drop EP and BLS EP Control Inputs with Active EP Switch ON**

- i. Assert only Drop EP1 Signal Low (15VCh4-G) and Verify that RL4 relay gets energized and check that 110 VDC power for the Electromagnet Coil EPS1 shall not Available.
- ii. De-assert Drop EP1 Input (Remove 15VCh4-G from Drop EP1) and put BLS EP1 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS1 shall Available.
- iii. Assert again Drop EP1 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS1 shall Available and Module fault LED shall Glow and Module fault Relay Shall get de- energized.
- iv. De-assert Drop EP1 Input and BLS EP1 Input and check that 110 VDC power for the Electromagnet Coil EPS1 shall Available and Module fault LED shall not Glow and Module fault Relay Shall get energized.

- v. Assert only Drop EP2 Signal Low (15VCh4-G) and Verify that RL5 relay gets energized and check that 110 VDC power for the Electromagnet Coil EPS2 shall not Available.
- vi. De-assert Drop EP2 Input (Remove 15VCh4-G from Drop EP2) and put BLS EP2 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS2 shall Available.
- vii. Assert again Drop EP2 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS2 shall Available and Module fault LED shall Glow and Module fault Relay Shall get de- energized.
- viii. De-assert Drop EP2 Input and BLS EP2 Input and check that 110 VDC power for the Electromagnet Coil EPS2 shall Available and Module fault LED shall not Glow and Module fault Relay Shall get energized.
- ix. Assert only Drop EP3 Signal Low (15VCh4-G) and Verify that RL6 relay gets energized and check that 110 VDC power for the Electromagnet Coil EPS3 shall not Available.
- x. De-assert Drop EP3 Input (Remove 15VCh4-G from Drop EP3) and put BLS EP3 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS3 shall Available.
- xi. Assert again Drop EP3 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS3 shall Available and Module fault LED shall Glow and Module fault Relay Shall get de- energized.
- xii. De-assert Drop EP3 Input and BLS EP3 Input and check that 110 VDC power for the Electromagnet Coil EPS3 shall Available and Module fault LED shall not Glow and Module fault Relay Shall get energized
- xiii. Assert only Drop EP4 Signal Low (15VCh4-G) and Verify that RL7 relay gets energized and check that 110 VDC power for the Electromagnet Coil EPS4 shall not Available.
- xiv. De-assert Drop EP4 Input (Remove 15VCh4-G from Drop EP4) and put BLS EP4 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS4 shall Available.
- xv. Assert again Drop EP4 Signal Low (15VCh4-G) and check that 110 VDC power for the Electromagnet Coil EPS4 shall Available and Module fault LED shall Glow and Module fault Relay Shall get de- energized.
- xvi. De-assert Drop EP4 Input and BLS EP4 Input and check that 110 VDC power for the Electromagnet Coil EPS4 shall Available and Module fault LED shall not Glow and Module fault Relay Shall get energized.
- xvii. Assert two or more Drop EP Signal Low and check that 110 VDC power for the Electromagnet Coil EPS shall Available and Module fault LED shall Glow and Module fault Relay Shall get de- energized.
- xviii. De-assert applied two or more Drop EP Signal and check that 110 VDC power for the Electromagnet Coil EPS shall remain Available and Module fault LED shall not Glow and Module fault Relay Shall get energized.

- xix. If Active EP switch OFF then Drop EP1, Drop EP2, Drop EP3, Drop EP4, BLS EP1, BLS EP2, BLS EP3 and BLS EP4 shall De-asserted.

#### **6.7.2.4 Test Case 4 – Fuse Fault Simulation & Indication**

- i. Remove F1 Fuse, check 110 VDC power for the Electromagnet Coil EPS1 shall not Available & F1 fuse fail and module Fault LEDs must Glow & Module status relay operate. Place Fuse back and observe that the fault shall disappear.
- ii. Remove F2 Fuse, check 110 VDC power for the Electromagnet Coil EPS2 shall not Available & F2 fuse fail and module Fault LEDs must Glow & Module status relay operate. Place Fuse back and observe that the fault shall disappear.
- iii. Remove F3 Fuse, check 110 VDC power for the Electromagnet Coil EPS3 shall not Available & F3 fuse fail and module Fault LEDs must Glow & Module status relay operate. Place Fuse back and observe that the fault shall disappear.
- iv. Remove F4 Fuse, check 110 VDC power for the Electromagnet Coil EPS4 shall not Available & F4 fuse fail and module Fault LEDs must Glow & Module status relay operate. Place Fuse back and observe that the fault shall disappear.
- v. Remove 24V Fuse, 24V fuse fail and module Fault LEDs must Glow & Module status relay operate. Place Fuse back and observe that the fault shall disappear.
- vi. Remove 15V Fuse, 15V fuse fail and module Fault LEDs must Glow & Module status relay operate. Place Fuse back and observe that the fault shall disappear.

#### **6.7.2.5 Test Case 5 – Simulation of 24V Supply Fault**

- i. Put 24V supply OFF and verify that Fault LED must Glow & Module status relay shall operate. Now resume 24V and observe that the fault shall disappear.

### **6.8 Industrial PC Specifications**

Brief specifications of Industrial PC are as given in Table 2.

**Table 2: Industrial PC Specifications**

Sr No.	Item	Specification
1	Processor	Intel Core i3-3220
2	Motherboard	64 bit Windows 7 compatible
3	Main memory	8 GB DDR3 1600 MHz

4	I/O ports	1 Serial, 1 Parallel
5	Expansion Slots	2 conventional PCI bus connector
6	HDD Controller	4 SATA ports 3.0 Gb/s
7	Power supply	400 Watts
8	Monitor	LED-20 inch
9	Key board	Multimedia Keyboard
10	Mouse	Optical mouse- on USB port
11	DVD drive	24 X SATA DVD writer
12	Hard Disk	SATA internal 1TB
13	Ethernet card	Copper gigabit PCI card
14	Cabinet	ATX with PWM controlled cabinet cooling fan
15	Operating systems	Windows 7 professional- 64 bit

## 6.9 Printer Specifications

Brief specifications of Printer are as given in Table 3.

**Table 3: Printer Specifications**

Sr No.	Item	Specification
1	Printer Type	Color Laser Jet
2	Print Speed	Up to 21 ppm black (letter), Up to 21 ppm color (letter)
3	Print Resolution	Up to 600 x 600 dpi
4	Standard Connectivity	Hi-Speed USB 2.0 port, 10/100 Ethernet networking
5	Processor	600 MHz
6	Memory	384 MB/128 MB
7	Print Option	Duplex
8	Minimum System Requirement PC	Microsoft® Windows® 7 (32-bit/64-bit), Windows Vista® (32-bit/64-bit):

9	Recommended Monthly pages	Up to 750 to 2,000 pages
10	Display	2-line LCD (text)

## 7 AC Source Specifications

The equipment shall be designed to perform satisfactorily for input power supply as specified in Table 4.

**Table 4: AC Source Specification**

Sr No.	Parameters	Range
1	Voltage	230 V
2	Frequency	50 Hz or 400Hz
3	Phase	1
4	Prolonged variations of voltage	±5 %
5	Repeated short time deviation of voltage	-13 % to +8 %
6	Short time deviation of voltage	-25 % to ±8 %
7	Prolonged deviation of frequency	-4 % to +2 %
8	Repeated short time deviation of frequency	-5 % to +4 %
9	Short time deviation of frequency	-7 % to +4 %

Note: - Short time deviations are for duration of up to 3 sec, repeated short time between 3 to 5 sec and prolonged deviations for more than 5 sec.

## 8 Environmental Specifications

### 8.1 Temperature and Humidity Specifications

The equipments shall meet all the specifications over temperature range of 0°C to 50°C. Continuous working ambient conditions are 35°C to 40°C at relative humidity of 95±3%.



## **9 Mechanical Specifications**

The ATE shall be accommodated in three numbers racks. The tentative arrangement of sub-assemblies is given in Figure 16.

General specification for each of the three types of racks is given below.

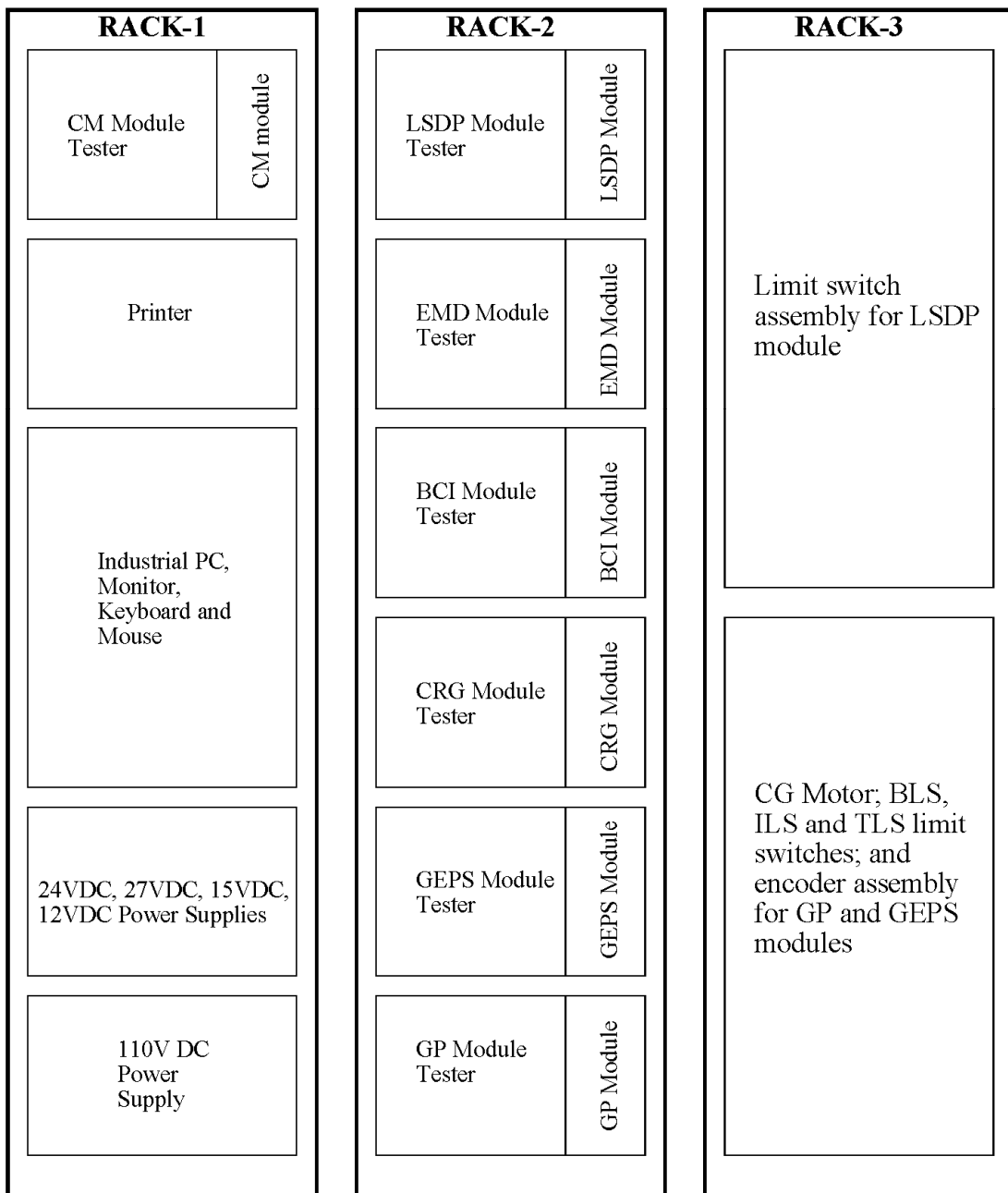
Dimensions: 2000 mm height, 600 mm width and 800 mm depth

No of tiers: 6

Mounting – self standing

Cooling – forced air cooling arrangement with dust filters

The racks shall have rugged structure with good finish. They shall be fitted with all required accessories including eye bolts, rack light arrangement, earth rail, door lock, identification strips etc.



**Figure 16: General Arrangement of CRDS ATE**

### 9.1 Mechanical Details of Modules

Brief mechanical details about all the 7 types of modules under test are given below. This contains modules Front view, Top view, RH side view and Rear view of module. The views contain required information such as LED, switch, fuse, connector in terms of their numbers used and location in the module. Modules over all dimensions are also included.

9.1.1 CRG Module

Figure 17 is general assembly for the CRG module.

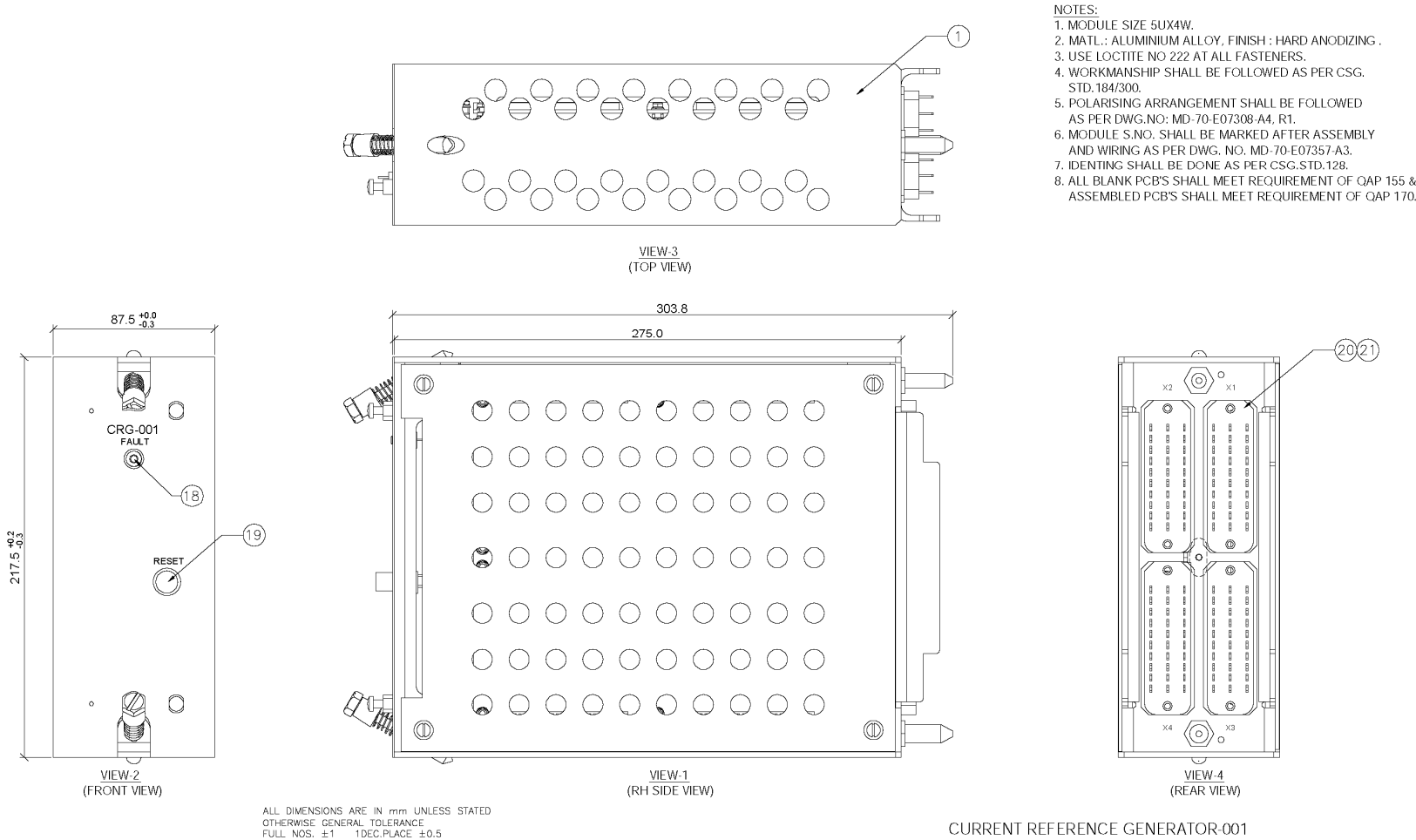
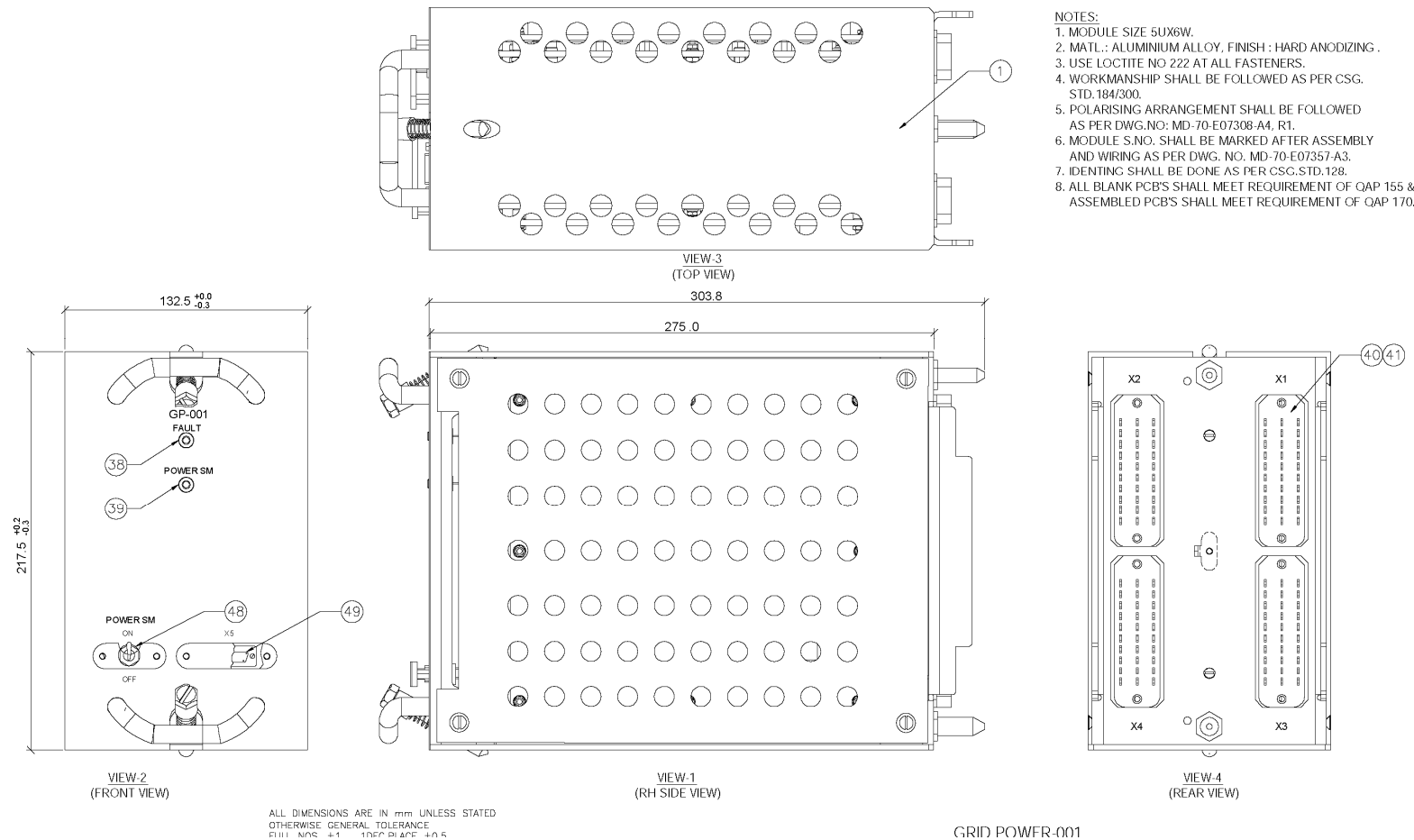


Figure 17: General Assembly of CRG Module

### 9.1.2 GP Module

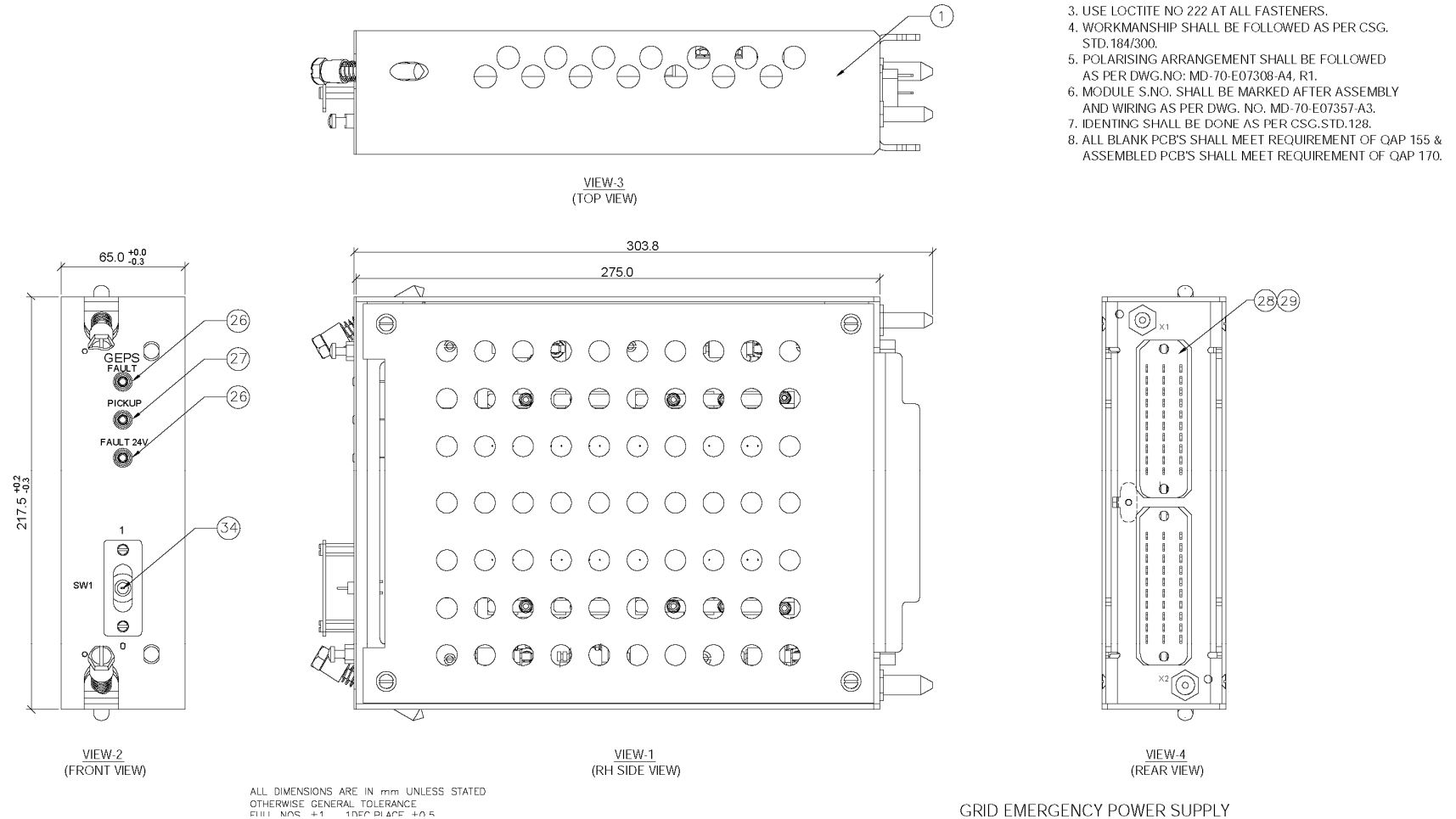
Figure 18 is general assembly for the GP module.



**Figure 18: General Assembly of GP Module**

### 9.1.3 GEPS Module

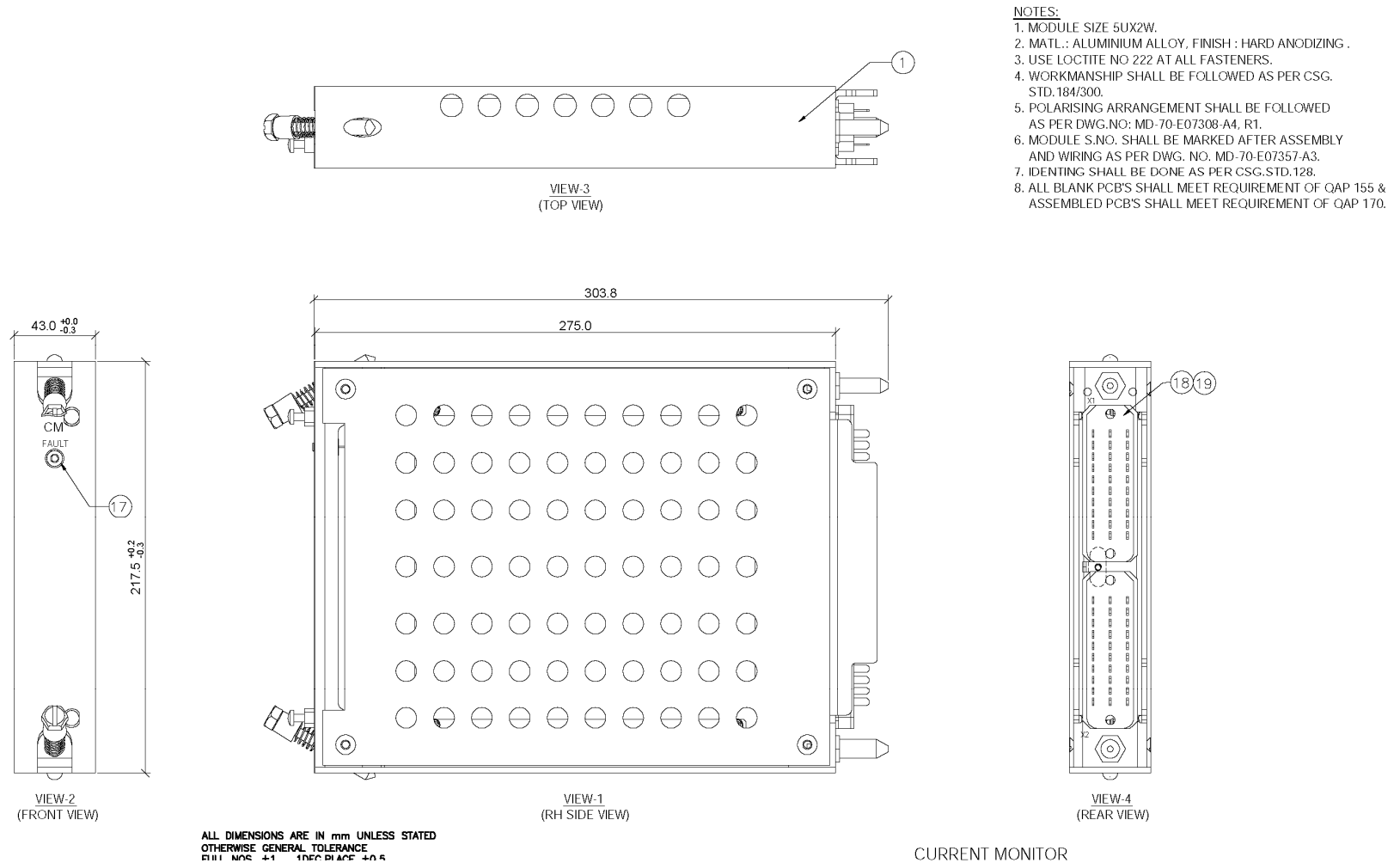
Figure 19 Figure 19 is general assembly for the GEPS module.



**Figure 19: General Assembly of GEPS Module**

### 9.1.4 CM Module

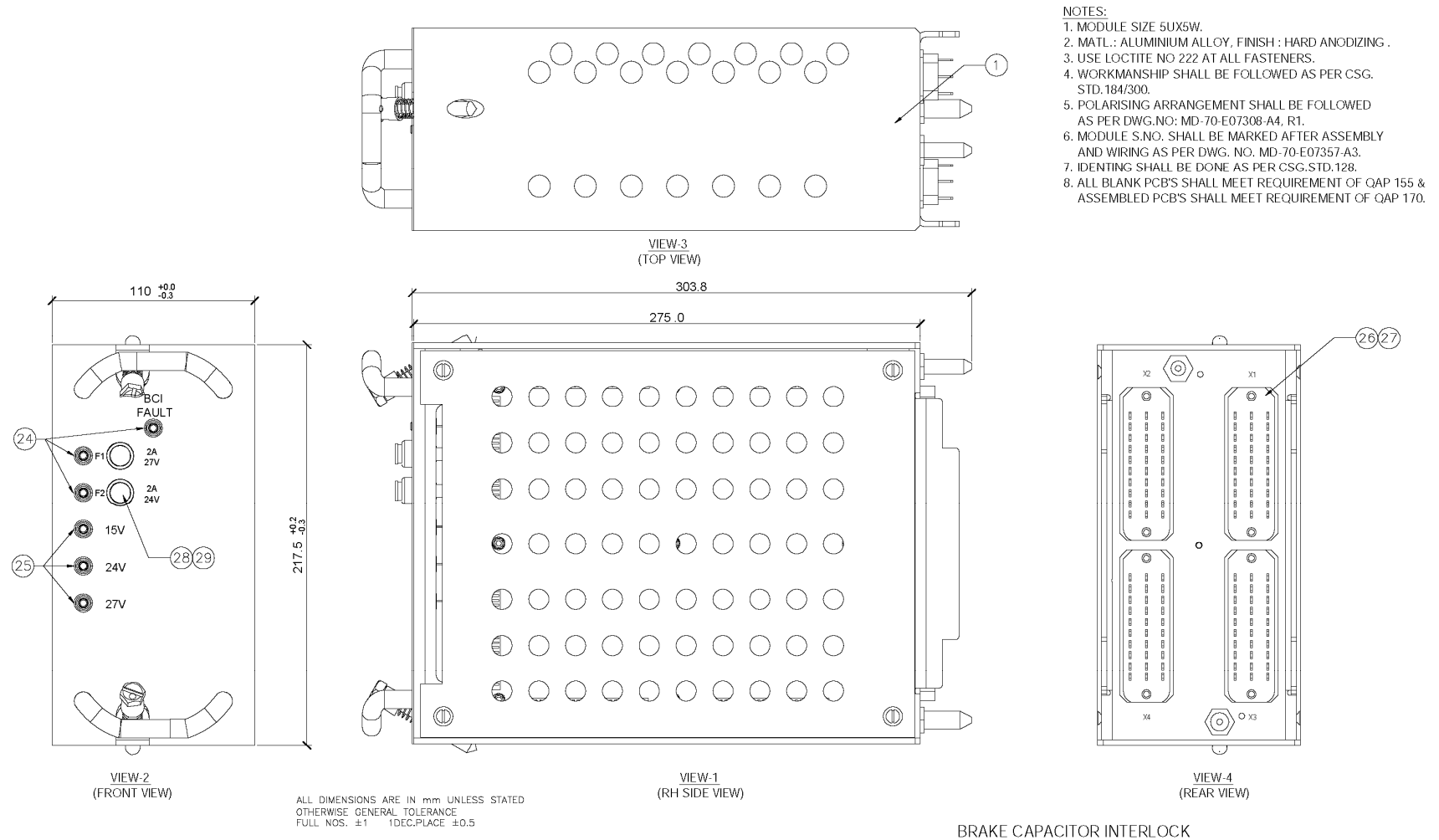
Figure 20 is general assembly for the CM module.



**Figure 20: General Assembly of CM Module**

### 9.1.5 BCI Module

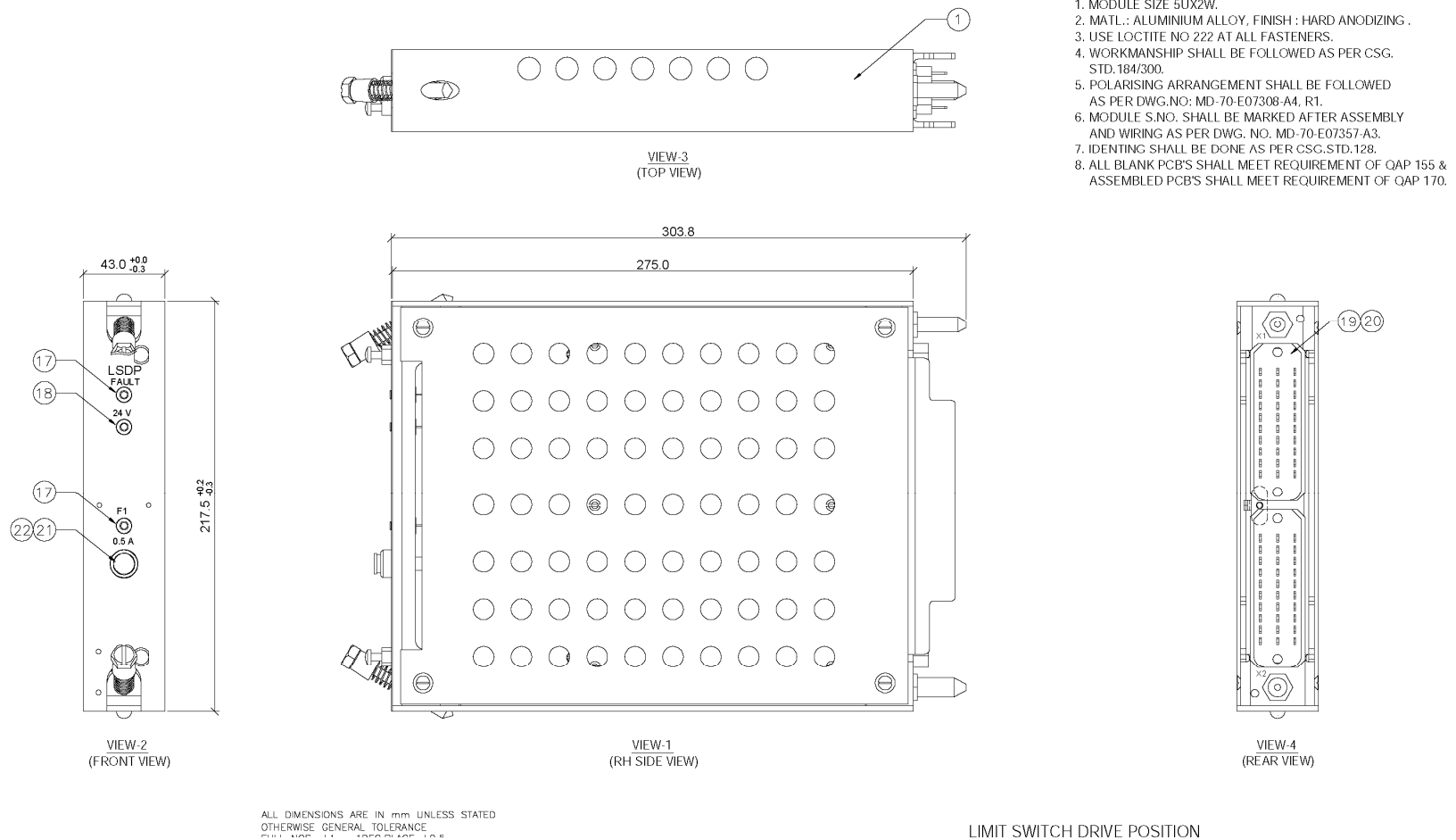
Figure 21 is general assembly for the BCI module.



**Figure 21: General Assembly of BCI Module**

### 9.1.6 LSDP Module

Figure 22 is general assembly for the LSDP module.

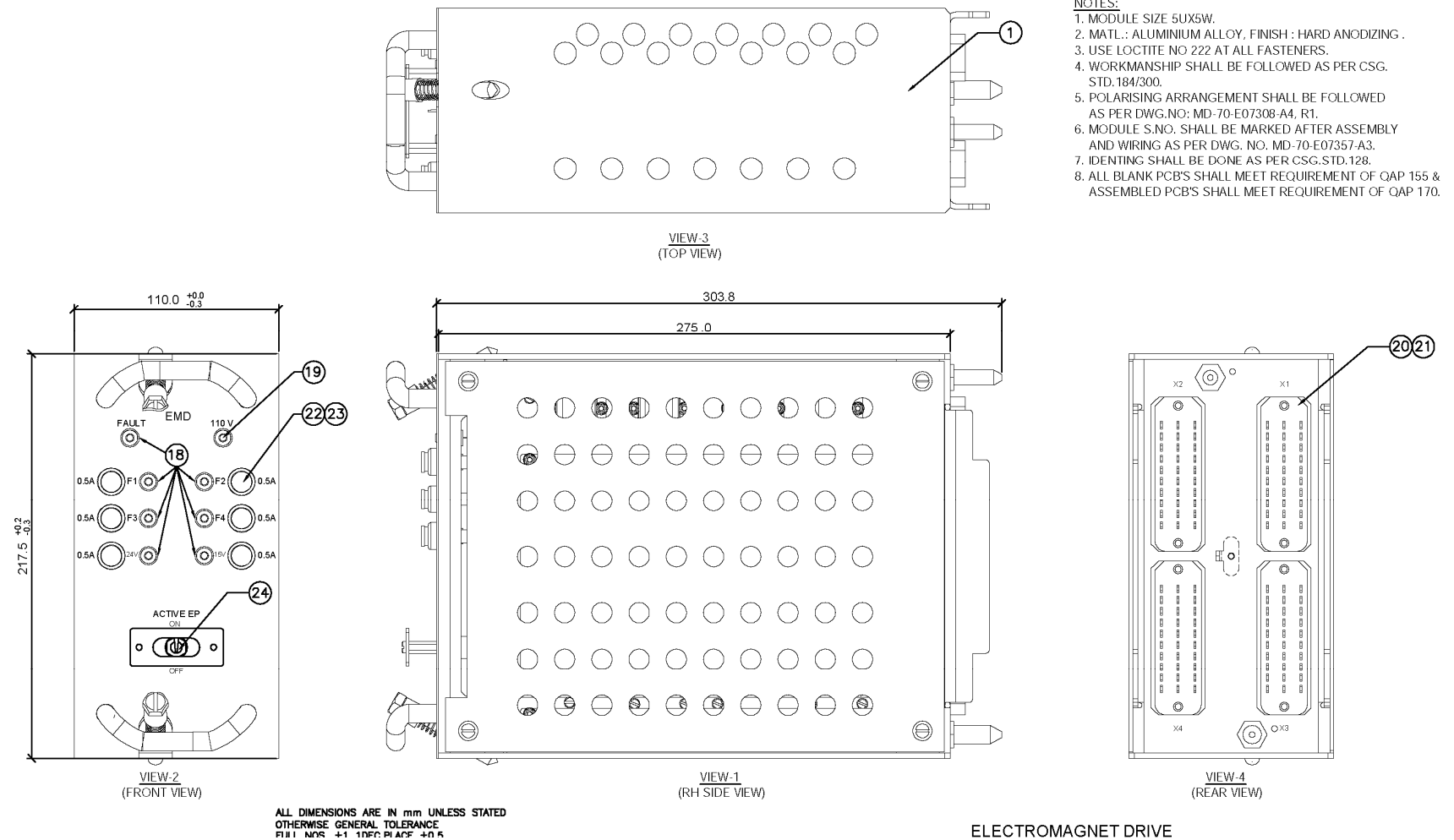


**Figure 22: General Assembly of LSDP Module**



### 9.1.7 EMD Module

Figure 23 is general assembly for the EMD module.



**Figure 23: General Assembly of EMD Module**

## **10 Design Features of CRDS ATE**

- i. Latest version of LAB VIEW full development suit latest version shall be used for HMI.
- ii. Only one of the 7 types of module shall be tested at a time.
- iii. All the logic level outputs from the tester shall have optical isolation. All the analog outputs from modules under test shall be galvanically/optically isolated before feeding them to the tester.
- iv. All the Testers shall use micro-controller of PIC make of required MIPS to simulate inputs, reading relay outputs and analog outputs of test modules. The controller shall also have CAN serial bus interface to read/write and verify data on CAN bus of the GP module.
- v. Free-issue material – CG motor, limit switches, magnets etc. – shall be provided to simulate certain input/outputs of the tester.
- vi. The ATE shall have provision for power supplies – 12V, 15V, 24V, 27V, 96V, 110V DC – and shall be designed using M/s VICOR make DC-DC converters. These supplies shall not be loaded beyond 70% of its nominal rating. These shall be used as common supplies for 7 types of tester modules.
- vii. All the test modules (7 No's) will be in power on condition while one unit will be under test at a time. Hence the ratings of power supply shall cater to requirement of sum of all modules together.
- viii. All the cables should be twisted pair shielded.
- ix. ELCB for Shock protection shall be provided.
- x. Location of Power supply instruments and power supply cables shall be away from the signal wiring.
- xi. All live points shall be covered to prevent electric shock and dust ingress.
- xii. Smoke detector shall be provided to blow a buzzer whenever smoke is detected without insertion of control PC.
- xiii. ATE shall be covered sufficiently to prevent rodent intrusions.
- xiv. All the electrical schematic and PCB design shall be drawn using ORCAD Version 16.5.
- xv. All the mechanical drawings shall be drawn using AUTOCAD Version 14.

## **11 Integration and Wiring**

- i. All wires used shall be Teflon insulated with sufficient voltage/current margins.
- ii. Field I/O wirings shall be by multi strand Teflon insulated wires.

- iii. The power supply wiring shall be by thicker gauge multi strand Teflon insulated wires in minimum 2-4 different colors suitable for field supply and control supplies.
- iv. Proper internal wiring routing should be followed to separate the control signals and power signals within the rack
- v. Proper ferruling system for numbering the source destinations for all connections is to be used.
- vi. All rack to rack interconnections shall be made using circular mounted on top of the rack. The connectors shall be identified by printed legends on them.
- vii. All standard practices & procedures as per CSG-STD for wiring, soldering, crimping, termination, earthing, etc should be followed.

## 12 Free-Issue Material

S.N.	Item	Quantity
1.	CG motor along with encoder assembly	Two
2.	CG limit switch	Six
3.	CG limit switch magnet	Two
4.	EP limit switch	Four
5.	EP limit switch magnet	Two
6.	All the hardware required for building slots for module under test	One set for each type of module

CG motor along with encoder, CG limit switches and CG limit switch magnet shall be used as sub-assemblies for building simulator for GP tester.

EP limit switch and EP limit switch magnet shall be used as sub-assemblies for building simulator for LSDP tester.

## 13 Quality Assurance Plan

The supplier shall generate a detailed QAP (material inward inspection to finished product) in consultation with purchaser, for the job.

Quality assurance and expediting relating to all aspects of the contract shall be carried out by the purchaser or his authorized representative. For this purpose, supplier and his subcontractors (if any) shall:

- i. Allow access at all reasonable times during manufacture, assembly and testing to the premises in which the work will be carried out.

- ii. Furnish the latest drawings, instruments, testing equipment etc. required for inspecting the job. Prints of all the latest required drawings and approved procedures shall be made available for inspection and retention, if so desired.
- iii. Produce an inspection plan to the purchaser's satisfaction and notify when checkpoints on the plan are imminent, so that the purchaser's representative may be present, if it is so desired.
- iv. Supplier shall obtain acceptance of the material in the form of shipping release from the purchaser's representative before the shipment.
- v. Waiver of quality surveillance or acceptance of the items by purchaser or his authorized representative shall not relieve the supplier from responsibility for supplying the items in accordance with specification requirements of this document and the purchase order.

## **14 Inspection, Testing and Acceptance**

The supplier shall be responsible for and shall perform all the tests and inspections mentioned in this specification and any other tests, which may be necessary to assess the required performance of the equipment as per detailed test procedures and QAP prepared by supplier and approved by the purchaser. The performance of the equipment shall conform to this specification. The tests shall be witnessed by purchaser's representatives.

Failure to meet the inspection or test requirements specified herein shall be reported to the purchaser and shall be considered as sufficient cause for rejection of particular item. The supplier shall generate documents for "Test Procedure" and "Test Report" having detail test procedure and test report for the functional tests and type tests. Then only manufacturing drawings shall be finalized and the final production for the required quantity shall be taken up.

### **14.1 Inspection and Testing**

#### **14.1.1 Inspection**

Mechanical dimensions and electrical wiring shall be inspected and checked for conformance with the relevant drawings.

All components used in the equipment shall be checked for mechanical and electrical requirements specifications during incoming inspection stage.

#### **14.1.2 Testing**

Functional tests shall be carried out under prevalent ambient conditions to check that the equipment conforms to the input output specifications.

##### **14.1.2.1 Insulation Resistance Test**

The test shall be performed with a 500 volts megger and the megger value shall be more than 100 MΩ. The purpose of this is to test insulation strength of the wired rack with out its internal electronic modules. All the modules shall be tested separately for insulation test. The test voltage shall depend upon the working voltage of the module.

#### **14.1.2.2 Dielectric Test**

Basic purpose is to check for voltage standoff between circuit and chassis and between parts of the circuits that are separated by galvanic isolation in the design. In general the test voltage for performing the test is as follows:

1. Test voltage shall be 500V AC (50Hz) for nominal operating voltages below 72V DC (50V AC).
2. Test voltage shall be 1000V AC (50Hz) for nominal operating voltages below 72V DC- 125V DC (50V- 90V AC).
3. Test voltage shall be 1500V AC (50Hz) for nominal operating voltages below 125V DC- 315V DC (90- 225V AC).
4. Test voltage shall be 2000V AC (50Hz) for nominal operating voltage (380V AC).

#### **14.1.2.3 Burn-in Test**

The equipments shall be kept ON at prevailing ambient temperature for a continuous duration of 168 Hours for burn-in test. The operating set up for burn-in shall be as follows:

1. All the 3 racks shall be integrated and remain functional during the burn-in period.
2. All the 7 types of modules shall be plugged in their respective location.
3. Automatic testing on the modules shall be performed periodically – one module every hour – and Test reports shall be generated.

#### **14.2 Acceptance**

Acceptance of the equipment shall be subject to its meeting the specifications and fulfillment of various requirements covered in this document. Equipment shall be shipped only after a shipping release is issued by an authorized representative of purchaser.

#### **15 Certification**

Three copies of inspection reports and test reports covering all aspects of inspection and testing shall be signed by a responsible internal inspection agency of the supplier as well as by the purchaser's quality surveillance representative and sent to the purchaser before delivery of the finished material.

#### **16 Packing and Forwarding**

The equipment shall be packed in wooden boxes for safe transportation and long storage at purchaser's end.

The item shall be delivered at ECIL, Hyderabad -500062

#### **17 Abbreviations**

Abbreviation	Description
--------------	-------------

ATE	Automatic Test Equipment
BCI	Brake Capacitor Interlock
BLS	Bottom Limit Switch
CG	Compensating Grid
CRDS	Control Rod Drive System
CRG-001	Current Reference Generator-001
CM	Current Monitor
EMD	Electromagnet Drive
EPS	Emergency Protection System
GP-001	Grid Power-001
GEPS	Grid Emergency Power Supply
ILS	Intermediate Limit Switch
LSDP	Limit Switch Drive Position
TLS	Top Limit Switch

## **TWO PART TENDER**

### **SECTION – D**

#### **FORMATS TO BE USED IN SUBMISSION OF PART 1 (TECHNICAL & COMMERCIAL BID EXCEPT PRICE BID)**

## 1. SCHEDULE OF VENDOR'S PARTICULARS

Vendor shall furnish here the following particulars:

1	Name of the Vendor	
2	Address of the vendor	
3	Telegraphic and email addresses of the vendor	
4	Name and designation of the officer of the vendor to whom all references shall be made for expeditious technical co-ordination	
5	Place of manufacture and assembly	
6	Certifications the vendor has obtained from accreditation agencies (e.g. ISO etc.)	
7	Whether Registered with ECIL as a vendor	YES/NO <sup>\$</sup>
8	Copies of Balance Sheet, P&L account and IT returns for past 3 years submitted	YES/NO

<sup>\$</sup> If, NO Please submit Vendor Registration form (can be down loaded from [www.ecil.co.in](http://www.ecil.co.in)) duly filled in and with supporting documents.

SIGNATURE\_\_\_\_\_

DESIGNATION\_\_\_\_\_

COMPANY \_\_\_\_\_



DATE \_\_\_\_\_

SEAL OF THE COMPANY

## 2 SCHEDULE OF VENDOR'S EXPERIENCE

Vendor shall furnish here the list of similar jobs executed by him:

Sl	Description of Work including Qty.	Order No. and Date	Value of Order	Delivery date as per Order	Actual Date of delivery	Customer name & Contact information.

SIGNATURE \_\_\_\_\_

DESIGNATION \_\_\_\_\_

COMPANY \_\_\_\_\_

DATE \_\_\_\_\_

SEAL OF THE COMPANY

### 3 SCHEDULE OF MANUFACTURING , DELIVERY AND OTHER RELATED ACTIVITIES

Vendor shall indicate here the time for manufacture, delivery and other activities of each module as shown below:

Sl	Task Description*	Week No. from date of PO( start)	Week No. from date of PO ( completion)	Time requirement in weeks
1	Mechanical Design			
2	Instrument procurement			
3	QAP			
4	Software design			
5	ATP preparation			
6	Code development			
7	Assembly & integration			
8	Testing & report			
9	Acceptance test			
	Shipping			
	Total period for execution			

\*The above task descriptions are only indicative; the supplier may elaborate and include finer details.

SIGNATURE\_\_\_\_\_

DESIGNATION\_\_\_\_\_

COMPANY \_\_\_\_\_

DATE \_\_\_\_\_

SEAL OF THE COMPANY

**4 SCHEDULE OF ATE DESIGN TECHNOLOGY , COMPONENTS**

Vendor shall indicate here the envisaged design technology & the components to be used in CRDS ATE.

Sl	Technology/ Components(COTS) *	Platform	Interface	Type /Version No.	Make
1	ATE Software			Labview	
2	Power supply Sources				
3	Storage Mixed Signal Oscilloscope				
4	CAN Analyzer				
5	Microcontroller				PIC
6	Programming Tools				
7	Potential free Contacts as O/P (RLY)				
8	Contact/SPST Switch (SM) I/P				
9	DMM (6 ½ digit)				
10	DMM (0-1000)V (5½ digit)				
11	Ammeter				
12	Current Probes				
13	Coil Load				
14	PC				
15	ORCAD for electrical schematic and PCB design			16.5 version	
16	AUTOCAD for Mechanical drawings			Version14	
17	Any other instrument /Card				

**Note:**

\*The above technology and component descriptions are only indicative; the supplier shall elaborate and include data sheets, write-ups, justification for choosing the proposed technology and components with respect to the technical requirements mentioned in “Section C” for **CRDS ATE**.

SIGNATURE\_\_\_\_\_

DESIGNATION\_\_\_\_\_

COMPANY \_\_\_\_\_

DATE \_\_\_\_\_

SEAL OF THE COMPANY

## **TWO PARTS TENDER**

### **SECTION – E**

#### **FORMATS TO BE USED IN SUBMISSION OF PART 2 (PRICE BID)**

**ELECTRONICS CORPORATION OF INDIA LIMITED**

**(A Government of India Enterprise)**

**CONTROL AND AUTOMATION DIVISION**

Price for Design, Development, Inspection and Testing of CRDS ATE

S/No	Item Description	Quantity	Price	Taxes and Levies	Total Item price
1	Automatic Test Equipment for CRDS modules	2			
2	Source Code Software of Automatic Test Equipment	1			
3	Documents of Automatic Test Equipment	1			
4	Packing & Transportation				

Total order value Rs.....

Note:

1. For each item, the vendor shall indicate all components under taxes and levies separately.
2. All prices shall be in Indian rupees.
3. The cost of individual COTS items( electronic cards/instruments), which forms the part of ATE Hardware, shall be given as an Annexure to price bid so as to enable us to order these items separately in the event of failure after the warranty period.

SEAL OF THE COMPANY

Authorized signature.