**SPECIFICATIONS FOR TELEMETRY & TRACKING PROCESSOR (6-ch)**

**CORTEX DTR-Q or any other equivalent**

**INTRODUCTION**

Proposed system is going to be used in satellite TT&C ground station on 24/7 round the clock basis. The TM/TR Processor shall be capable of providing Telemetry data acquisition, Doppler measurement, Az. & El. error generation for auto tracking (true monopulse) for spacecraft in GEO & LEO orbits and launch vehicle missions. The equipment should functionally adhere to all technical requirement listed below.

**FUNCTIONAL DESCRIPTION**

TM/TR Processor shall perform the following major functions as detailed below.

1. The TR/TM Processor shall operate at 70 MHz and shall accept six inputs from the feed after down conversion, namely, two sum channels, two Azimuth error and two Elevation error channels.
2. The tracking receiver shall carry out pre-detection combining of the sum and the Azimuth and Elevation error signals, after effecting necessary phase alignment for the two polarizations.
3. The TR/TM processor shall combine respective signals from both polarizations when the sum signal level difference between the two polarizations is less than 10 dB. When the difference between the sum channels exceeds 10 dB the best channel will be selected for processing of both tracking and telemetry functions. Suitable hysteresis will be employed to avoid frequent toggling near cross over point.
4. The TR/TM Processor shall be configurable for combined or single selectable RCP or LCP polarization modes, independently, for tracking and telemetry reception function.
5. The TR/TM Processor shall also pre-detection diversity combine the sum channels and carry out Phase, Frequency, BPSK and QPSK demodulation of the carrier.
6. In case of direct PCM/PM or PCM/FM or PCM/BPSK or PCM/QPSK modulated signals, the unit shall bit and frame synchronize the demodulated PCM signal, carry out CCSDS decoding, if required, and make it available as formatted and time tagged data TCP/IP (100 base T or more) and UDP/IP (selectable).
7. The unit should be able to output data with minimum possible (typically < 100 msec.) break, even if the bit rate changes (with also frame size change) in between, by having suitable configuration.
8. In case of PCM/PSK/PM modulated signals the unit shall also carry out PSK sub-carrier demodulation, bit and frame synchronization, for two sub-carriers simultaneously and make both data streams available as formatted and time tagged on a TCP/IP bus.
9. The system should have CCSDS standard Derandomizer, Viterbi and Reed-Solomon Decoders and CCSDS Packet telemetry (VCDU & CADU) processing for both streams and all kinds of modulations.
10. The system shall be capable of providing serialized PCM Telemetry simulation signal for carrying out simulations using external modulator.
11. The system shall accept 5/10 MHz external frequency reference to which all the signal sources of different functions will be phase locked.
12. The system shall accept IRIG-B Mod. Code (or NTP/PTP option) for deriving time information.
13. The system shall also have a simulation and testing function, like BER measurement for internal and long loop checks.
14. The system shall have local and remote monitor and control through TCP/IP (1000/100 Base T).
15. The system shall provide time tagged digital logging of data containing AGC and lock status of both sum channels, combined AGC, Error voltages of azimuth and elevation and Eb/No.
16. The system shall have built-in 70 MHz modulator for simulation function.

**TYPICAL FUNCTIONAL BLOCK DIAGRAM OF TM/TR PROCESSOR**

**DETAILED SPECIFICATIONS:**

1. **Tracking Processor**
   1. Centre Frequency : 70 MHz ±4 MHz selectable
   2. Input bandwidth : Minimum 30 MHz
   3. No. of channels : 6 (2 Sum, 2 Az-error, 2 El-Error)
   4. Operating Mode : Coherent and Non-coherent, selectable
   5. Combiner modes : RCP, LCP individual or Combined, selectable
   6. Combiner Type : Optimal ratio Pre-Detection Combiner for Sum and Error channels
7. Combiner Improvement : i) Within 0.5 dB of theoretical, when
   Difference between channels is less than 10 dB.
   ii) Best channel selected when difference between
   channels exceed 10 dB, with hysteresis to avoid
   frequent toggling at cross-over point.

8. Input Impedance : 50 ohms
9. Input VSWR : Better than 1.4:1
10. Isolation between channels : > 50 dB
11. IF and Image rejection : > 80 dB
12. Noise Figure : 10 dB Typical or better
13. Input Level : Sum : -95 dBm to –20 dBm
   Error: -115 dBm to –40 dBm
14. Input Signal Modulation : PM or FM or BPSK, QPSK or OQPSK
15. Search Range : Up to +/- 500 KHz, selectable in steps
16. Coherent PLL Bandwidth : 30, 100, 300, 1000 & 3000 Hz selectable.
   IF bandwidth shall be optimized for error detection function and for data
   demodulation independently.
17. PLL Acquisition Threshold : 10 dB C/ N in selected loop BW or better
   2 dB max degradation with ASB ON
   Using FFT Technique.
   Should be capable of locking correctly to carrier under the following signal dynamics
   and varying modulation formats.
   i) Max. doppler : +/- 200 KHz.
   ii) Max. doppler rate : 5 KHz/sec.
   iii) Max. Fade Rate : 20 dB/sec.
   iv) Typical Modulation Formats:
      1. HK modulation up to 0.7 rad., alone on 25.6 / 32 KHz sub-carrier PSK modulated by PCM bit rate of 1024 / 4000 bps.
      2. As (1) above and another 128 KHz. sub-carrier modulation up to 1.0 rad. PSK modulated by PCM bit rate of 4 kbps / 16kbps.
      3. As (1 & 2) above and up to 0.9 rad of 100 KHz pure tone modulation.
      4. Proper carrier lock to be ensured in case of direct PCM/PM also.
      5. Proper carrier lock should be ensured during uplink and sweep and onboard
         change over to coherent mode.
19. Acquisition Time with ASB On : Less than 2 sec. @ 1KHz PLL BW
20. AGC Time Constant : 1,10,100,1000 msec selectable
21. Cross Correlation IF BW : 50, 150, 500, 1500 & 5000 KHz.
   (Optional requirement: 10 MHz)
22. Cross correlation acquisition : S/N of > 3 dB in selected IF BW Threshold
23. AFC Aid : On/ Off selectable, BW ± 300 KHz
24. Gain Tracking : < 1 dB
25. Phase Tracking : < 5 deg.
   signals separately.
   0 to 359 degrees with accuracy of 1° with memory
   for storing the phase Compensation values
   separately for Az. & El. Channels. Facility for phase
   Adjustment with incremental step of say 1° Phase
   value & error voltage to be displayed on the same
   page. Memory for storing minimum of 20 different
   phasing configurations.
27. Error output Bandwidth : 1 Hz to max. 10 Hz +/- 10% @ 3dB point
28. Error Integration time : 1 msec. to 1 sec selectable
29. Analog Error Output Level : 2 to 10 volts adjustable for \( \Sigma/\Delta = 10 \) dB. Unit shall provide differential analog error O/p for connecting to ACU. To be grounded for no signal condition
30. Error output DC offset adjustment : +/- 3 volts
31. Error output impedance : < 1 K ohms, Differential output
The digital error output at 100 Hz rate shall be available separately on TCP/IP port as an input to the Antenna control unit.
32. Analog AGC output level : 1 volt /10 dB
33. External Reference input : 5 / 10 MHz, 50 ohms 0 +/- 5 dBm
34. Monitoring Parameters (Local & Remote)
   1. Error voltages (Az. & El.)
   2. Signal Level, Lock Status
   3. Selected phase values
   4. Frequency deviation
   5. Selected channel
   6. Other selected parameters
35. Summary page display : Consisting of error voltages, phase setting value, signal strength, selected polarization, frequency deviation, lock status.

Digital AGC & Error Voltages Logging

Digital Logging (optional) : Logging of time tagged receiver AGC, Eb/No & lock indication for sum channels, at 10/100 samples per second (8 bit) with minimum 100 MB memory capability. Logged file will be recalled subsequently in FTP mode.

II Telemetry Processor

A. RECEIVER

The receiver shall perform the following functions.

1. Receives two orthogonal (Channel RCP and LCP) polarizations of IF signals at 70 MHz with independent acquisition management.
2. Tracking of both IF channels using two, second order PLLs.
3. Anti-sideband facility using FFT selectable.
4. Optimal Ratio Pre-detection diversity combination of channels A and B.
5. PM, FM, BPSK and QPSK demodulation of telemetry and ranging signals.
6. Automatic recovery of data frame lock even in case of modulation On/Off, in presence of carrier, for all kind of modulation.
7. Doppler measurement from the best channel or combined received signal.

Specifications:

1. Input Frequency : 70 MHz ±4 MHz
2. Input bandwidth : +/-15 MHz (3 dB)
3. No. of IF Receivers : 2 (for SUM Signals)
4. Isolation between inputs : > 60 dB
5. Acquisition Range : Up-to +/- 500 KHz Selectable
7. VSWR : < 1.4
8. Dynamic Range : -20 dBm to -95 dBm
9. Noise Figure : 10 dB (Typical)
10. Noise Density : -95 dBm/Hz Max.
11. Loop BW : 30, 100, 300, 1000, 3000 Hz Selectable
12. AGC Time Constant : 1,10,100,1000 msec. Selectable Should hold lock for a variation of 30 dB within dynamic range.
13. AGC Type : Non-coherent before carrier Acquisition, there after Coherent.
14. AGC Output : Analog/ Digital
15. Lock in threshold (PM) : 10 dB C/N in selected PLL BW.
   Capable of locking correctly to carrier under the following signal dynamics and varying modulation formats, by analyzing spectral symmetry.
   i) Max. doppler : +/- 200 KHz.
   ii) Max. doppler rate : 5 KHz/s
   iii) Max. Fade Rate : 20 dB/s
   iv) Typical Modulation Formats:
      1. HK modulation up to 0.7 rad., alone on 25.6 / 32 KHz sub-carrier PSK modulated by PCM bit rate of 1024 / 4000 bps.
      2. As (1) above and another 128 KHz. sub-carrier modulation up to 1.0 rad. PSK modulated by PCM bit rate of 4 kbps / 16kbps.
      3. As (1 & 2) above and up to 0.9 rad of 100 KHz pure tone modulation.
      4. Proper carrier lock to be ensured in case of direct PCM/PM also.
      5. Proper carrier lock should be ensured during uplink and sweep and onboard change over to coherent mode.
17. Threshold degradation with ASB On : <1 dB
18. Acquisition time (with ASB on) : < 1 sec
19. Combiner Type : Optimal ratio / pre-detection combiner
   Combiner modes : CH-A, CH-B, Combined
20. Combiner Improvement : i) within 0.5 dB of theoretical, when difference between channels is < 10 dB.
   ii) Best channel selected when S/N difference between channels exceed 10 dB, with hysteresis to avoid frequent toggling at cross-over point.
21. Demodulation Modes : PM, FM, BPSK, QPSK and OQPSK.
22. Demodulation Frequency Response : i) Sub-carrier freq. upto 1024 KHz.
   ii) Direct PCM/PM(Bi$\Phi$L) and BPSK and QPSK (I+Q) having basic data rate of 10Mbps. 20 Msymbols/s with Viterbi & RS coding.
23. PM demodulation index : 2 rad. Max.
24. FM Max. Deviation : 20 MHz.
25. FM Threshold : < 6 dB
26. AFC range for FM demodulation : Up-to +/- 250 KHz
27. Acquisition threshold for BPSK : $E_b/N_0$ of +3 dB or better
28. Doppler Measurement : On best channel selected or combined signal (with hysteresis to avoid toggling)
i) Resolution : 0.01 Hz.
ii) Accuracy : 0.1 Hz or better RSS @ -65dBc phase noise
iii) Data Format : As per agreed ICD.
iv) Time tagging Resolution : 0.1 milli sec

29. Group Delay Stability :
   < 10 nsec over signal dynamic range
   < 5 nsec over 8 hours
   < 15 nsec over carrier frequency
   < 5 nsec over temperature

30. Outputs :
   1. Video output (50 ohms, 1V/rad)
   2. Optional: Analog AGC o/p (RCP, LCP & combined) for recording (1V/10 dB)
   3. Digital AGC data, 100/10 samples/s 8 bits. AGC for channels A, B & combined and Eb/N0 time tagged and logging locally.

Monitor & Control:
1. Input Frequency
2. PM/FM/BPSK/QPSK selection
3. ASB On/Off, Loop BW
4. Receiver mode

B. PSK DEMODULATOR AND BIT SYNC.

The PSK Demodulator and Bit Sync. Shall perform the following functions:

1. Sub-carrier frequency selection and locking.
2. Bit rate selection.
3. **Simultaneous BPSK demodulation of two sub-carriers.**
4. Bit synchronization (3 bit soft decision or better)
5. Simultaneous processing of 2 bit streams (PCM/PSK) for low rate telemetry.
6. Capable of handling a bit rate change over (one bit rate at a time) in the direct PCM modulated stream, using suitable configuration, for high rate telemetry (PCM/PM, PCM/FM) and the data made available on different ports.
7. $E_b/N_0$ Evaluation and data output with AGC.
8. During the bit rate changeover, the data loss shall not be more than 3 telemetry frames with appropriate settings.
9. The telemetry frame shall contain the data quality bit information corresponding to the frame sync pattern errors.

**Specifications:**

1. Type of demodulation : PCM/BPSK
2. PCM Code : Bi-phase (L,M,S) or NRZ (L,M,S)
3. Sub-carrier Frequency Range : 5 KHz to 1024 KHz. in 1 Hz step
4. PCM bit rate (For sub-carrier modulation): 100 bps to 250 Kbps in 1bit step.
5. PCM bit rate for direct modulation : Upto 10 Mbps basic data rate (With Bi-Phase Code). Up to 20 M symbols/s with Viterbi & RS coding for direct PCM/PM, PCM/FM, BPSK and QPSK modulation)
6. No. of sub-carrier to be processed : 2, simultaneously
   - Capability to handle a bit rate change over, in high rate direct PCM modulated stream and provide continuous data with minimum (<100 msec.) break.
7. Sub-carrier loop BW : 0.1, 0.3, 1, 3% of bit rate
8. PCM loop BW : 0.1, 0.3, 1, 3% of bit rate
9. Sync. Threshold : $E_b/N_0 < 2$ dB.
10. Bit sync fly-wheeling : Should be able to hold lock for data containing 128 bits of continuous zeros or ones, with 1000 bits gap.
11. PSK demod./ Bit sync. Performance : $<1$ dB of theoretical up to 2 Mbps, $<2$ dB up-to 10 Mbps

**Monitor & Control**
1. Sub-carrier frequencies, Bit rates, PCM codes
2. Lock status, Loop BW, $E_b/N_0$

**C FRAME SYNCHRONIZER**

The frame sync. Shall perform the following functions
1. Frame locking using dedicated sync. word by classical locking phases of Search, Check and Lock.
2. For all kinds of modulation, the frame sync should be able to lock automatically, without the need for manual receiver re-acquisition, when the modulation is made OFF and ON in between, with the carrier being present continuously.
3. Time tagging at the end of sync. word detection.
4. Processing of 2 TM streams, Automatic BPSK/ QPSK ambiguity resolution.
5. Derandomizer (CCSDS Standard).
6. CCSDS standard RS and Viterbi decoding, CCSDS Packet Telemetry Processing.

**Specifications:**
1. Bit rate : 100 bps - 10 Mbps without coding, 20 Mbps with RS & Viterbi coding
2. Sync. Pattern Length : 16 to 32 bits programmable
3. Sync. Window : 1 or 3 bits
4. Frame length : 16 to 4096 words per frame.
5. Error parameters tolerance (Selectable):
   a) Search to Check : 0 to 7
   b) Check to Lock : 1 to 8
   c) Lock to Search : 1 to 8
6. Time tagging : Corresponds to last bit of FS code (desirable)
7. Data Output Format : TCP/IP (1000/100 base T) and UDP/IP
8. Data Decoding : 1. Derandomizer (CCSDS), 2. Reed-Solomon Decoder (CCSDS)
9. Data Quality Indicator : The header should contain Information on data Quality like Rx., PSK demod, Bit & Frame Sync lock status, FS error presence, no of uncorrected errors for coded signal etc.

**Monitor & Control:**
1. Lock Status (S,C,L)
2. Setup parameters, Quality byte indicating F.S. Errors etc.
D TIME AND FREQUENCY REFERENCE

This unit shall perform the following functions.

1. Distribution of reference frequency to other internal units.
2. Demodulation of input time code.
3. Time distribution to other internal functions.
4. Shall have Leap second & leap year management.
5. Provides time tagging information to other modules
6. Accepts 1 pps signal for ranging time tag.

**Specifications:**

1. Input frequency : 5 / 10 MHz.
2. Input Level : 0 dBm +/- 5 dB
3. Impedance : 50 ohms.
4. VSWR : < 1.3:1
5. Reference frequency output : Suitable for internal distribution.
6. Input time code : IRIG-B (optional NTP/PTP)
7. Time code Input level : 0.5 volt to 6 volt p-p
8. Time tag capacity : 365 days, 23 hours, 59 minutes, 59 seconds & 999 milliseconds.
9. Resolution / Accuracy : 0.1 msec.

E TM SIMULATOR

The TM Simulator shall perform the following functions.

1. Programmable sub-carrier frequency and bit rate generation.
2. PCM generation using PRN sequence or stored TM file from disk.
3. Code conversion.
4. Analog PSK/PCM or PCM signal output with amplitude control.
5. BER Measurement.
6. Internal Noise generator at 70 MHz (C/No coverage 30 to 80 dBHz).
7. Encoding for RS and Convolution coding

**Specifications:**

1. Analog signal output level : 0.1 V to 3V peak in 0.1V steps.
2. Impedance : 50 ohms
3. Sub-carrier frequencies (Sine) : 5 KHz to 1024 KHz in 1Hz step.
4. Bit rate : 100 bps to 256 Kbps (For low rate TM)
   Up-to 10 Mbps for direct PCM Mod. (For high rate TM)
5. PCM code : NRZ (L,M,S) and bi-phase (L,M,S)
6. PCM sequence type : PRN / stored frame or stored file from HDD or LAN
7. Modulation type : PCM/PSK on sub-carrier, PCM/PM
   PCM/FM, PCM/BPSK, PCM/QPSK
8. BER Measurement
   • Automatic delay adjustment between transmitted and received signal.
   • Bit to bit comparison between transmitted and received signal.
9. S/N dynamic range : $+2\text{dB} \leq E_b/N_0 \leq 12\text{dB}$
10. BER measuring range : $10^3$ to $10^8$ and totalizer
Monitor & Control
1. Sub-carrier frequency
2. Bit rate, PCM code, PCM sequence
3. Modulation type, BER etc.

Optional Requirement: 2nd simulator (having same above specs.) for simultaneous two sub carrier simulation.

F IF MODULATOR

The IF Modulator shall perform the following functions.

1. Handles externally fed or internally generated simulation video for modulation.
2. Phase locking to external 5MHz reference.
3. Should accept external PCM and PCM/PSK (sub-carrier) signals during simulation for all specified modulations.

1. Output Frequency : 70 +/- 4 MHz.
2. Type of Modulation : PM/FM/BPSK/QPSK Selectable
3. Sweep Range : ±1 KHz to ±500 KHz in steps of 1 KHz, single sweep positive going. Automatic disabling of modulation while sweeping.
4. Sweep Rate (Linear) : 1 KHz/s to 150 KHz/s in steps of 1 KHz/s.
5. Output Level : -60 to 0 dBm. Adjustable.
6. Output stability over a day/ temp. range: +/- 0.5dB
7. Output impedance : 50 ohms
8. VSWR : < 1.3
9. Phase Noise (PM Mode) : 10 dB max. degradation when locked to station 5/10 MHz reference
10. Spurious : Better than -60 dBc
11. Harmonics : Better than -60 dBc
12. No. of External Modulation Inputs : 1 for connecting external TC video
13. Modulation Input Impedance : 50 ohms
14. Modulation Sensitivity : 1 rad./ volt
15. PM Modulation Index : 2 radians (Max) in steps of 0.1 rad.
16. Sense : Positive
17. Linearity : 2%
18. Group Delay Stability : < 5 ns over 8 hours
   < 10 ns over dynamic range
   < 15 ns over temperature
   < 5 ns over Doppler
19. Phase non-linearity : < 6 deg over the band

Monitor & Control
1. Sweep range and rate, sweep start/ stop.
2. Modulation Index, Output level, Carrier on/off
3. Noise generator power setting
4. External reference lock indication
5. Modulation input ON/OFF, Modulation type
Accessories:
1. Spectrum Analysis Display and spectral data on LAN
2. Data Logging on internal Hard disk (100 GB min.) for logging time tagged digital AGC, lock status and M&C data and retrieval of the same.
3. Display of selected words.
4. Self-test sequence for locating faults including TCP/IP Ports.

GENERAL
1. Power : 230 V±10%, 47-53 Hz, 1-Phase
2. Dimension : 19” Rack mountable, Max. 5U height
3. Operating Temperature : 5-45 deg C, Max. Humidity 95%
4. Storage Temperature : 0-55 deg C
5. Remote interface : TCP/IP (1000/100 Base T)
   Requirement as per Annexure-A.
6. MTBF : To be specified by party. Min. 40,000 hours
7. MTTR : ≤ 1.0 Hr with spare parts available
8. Operation & Maintenance Manual : To be provided in English (both Hard & soft copy)
9. Warranty : Minimum 3 years comprehensive warranty from OEM covering on-site support.

Data Exchange Formats:
Once the confirm Purchase Order is received, party shall submit preliminary Interface Control Document (ICD) to ISTRAC for Review. Document shall cover all data exchange format (Telemetry Data, Doppler data, Tracking error info., Monitoring & Control requests etc.) being used by any TT&C ground station. Based on the feedback provided by ISTRAC and with mutual agreement, party shall carry out any changes required in ICD and submit FINAL copy of the ICD to ISTRAC along with Factory Acceptance Test Results for review and clearance by ISTRAC.

Design Review:
The party shall have sufficient experience and expertise in manufacturing similar equipments. The product offered shall be based on a proven design which is already been demonstrated in the field and not on any new development which is yet to be qualified. The party shall provide the list of customers, to whom similar systems have been supplied earlier by them and performance certificates from the concerned for all the functional & performance related parameters of the product including Doppler & Tracking performance.

ISTRAC reserves right to call for the design review (DR) of the system under production. If requested by ISTRAC, design review shall be held within 10 weeks from the placement of the order. This review shall address the high level design of the system, mapping the system requirements to the ordered specifications. The venue of DR shall be ISTRAC, Bangalore / Video Conference mode. Party shall deliver all relevant documents required for design review 2 weeks before the actual review.
The design review shall include:

- System Overview
- General architecture with proposed hardware and software modules.
- Design considerations and design details of major subsystems.
- Performance analysis of major requirements and specifications.
- Preliminary analysis of reliability, availability, Maintainability etc.
- Mechanical, Environmental and thermal design aspects.
- List of hardware and software elements.
- Detailed activity and time schedule.

Additionally, if asked by ISTRAC, party shall be ready to provide one fully functional Telemetry & Tracking Processor unit to ISTRAC for technical assessment during tender evaluation process before the placement of actual order.

Factory Acceptance Tests:

For Telemetry & Tracking Processor, the factory acceptance tests shall be carried out before shipment, as per the standard procedures. The supplier shall provide the types of tests to be carried out & the test procedures for carrying out the Factory Acceptance Tests well in advance, for the approval & mutual agreement. The tests results shall be submitted to ISTRAC for approval, before the actual shipment of the equipment. ISTRAC reserves the right to witness the tests, if required.

General Conditions:

1. The party shall provide slab wise quotation (for e.g. Qty. 1-2, 3-5 etc.) up to quantity 5 nos.
2. This is a **TWO PART tender**. So, bidder shall submit techno-commercial offer and price bid in two separate sealed covers. Techno-commercial bid shall include all commercial terms & conditions, delivery place, delivery schedule etc.
3. The party shall be ISO 9001:2008 certified one with established Quality Assurance Plan which shall consist of periodical inspections and progressive Quality Control throughout the developmental and production cycle of the product offered.
4. The bidder shall provide complete technical details of the offer with detailed explanation of the function of the system, the various options available and any other information that may be required to evaluate the offer.
5. The bidder shall bring out point-by-point technical compliance matrix against all the specifications and functional requirements. The bidder shall explicitly bring out all the points in the remark column wherever the specifications are not met or exceeded. ISTRAC reserves right to reject any incomplete offer.
6. The bidder may obtain required clarifications, if any, before presenting the bid.
7. If ISTRAC requires, Party shall provide hands on training covering full installation and operational aspects of the offered product after delivery. Any cost implications towards that shall be clearly mentioned by the party in his offer.
8. The bidder shall bring out all the optional features of the offer and shall accordingly quote the price for each of the options separately.

9. Use of high reliable screened components to be ensured.

10. The system shall be considered to be accepted by ISRO only after the successful completion of the on-site acceptance tests (performed at Bangalore) duly certified by ISRO.

11. At the time of installation and commissioning of the system if it is found that some additional hardware accessories or software items with licenses are required to complete the configuration to meet the total system requirement of the configuration which were not included in the vendor's original list of deliverables then vendor is required to supply such items to ensure the completeness of the configuration at no extra cost. Vendor should ensure completeness of the list of deliverables in the offer to avoid such discovery during installation.

12. The bidder shall also provide the quotation for the essential spare cards/ modules/ components that may be required for the maintenance of the system at site.

13. The bidder shall also provide the quotation for extended warranty period (after the expiry of standard warranty) up to 5 years.

14. Software updates, if any, should be supplied free of cost, as and when required.

15. The bidder shall guarantee supply of spares and maintenance support for at least 10 years from the date of acceptance of the system.

Annexure-A

Remote Monitoring & Control Requirements as per following table:

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<tbody>
<tr>
<td>1</td>
<td>For M &amp; C transaction should be in the decodable commands.</td>
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<tr>
<td>2</td>
<td>All parameters monitored locally should be present on the remote interface for monitoring &amp; commanding.</td>
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<tr>
<td>3</td>
<td>There should be a single monitoring command to get all parameters.</td>
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<td>4</td>
<td>The monitoring data block should be byte oriented and of fixed length.</td>
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<td>5</td>
<td>There should be a header &amp; trailer at fixed defined byte location.</td>
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<td>6</td>
<td>Group-wise monitoring commands and individual parameters monitoring commands may also be made available.</td>
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<td>7</td>
<td>The command format should be text oriented.</td>
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<td>8</td>
<td>It should be possible to chain monitoring &amp; control commands. Chained commands &amp; response should be delimited by defined character (, ; , etc.). If monitoring commands are chained &amp; sent, it is desirable that the response should also be sent in same order.</td>
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<tr>
<td>9</td>
<td>The response time for any monitoring command should be less than 300 msec. Similarly, when control command is given, the control operation should get executed immediately &amp; must be observed in the next monitoring data.</td>
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<tr>
<td>10</td>
<td>It is preferred to get data from the system on polling basis. This means asynchronously sending data is not preferred.</td>
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