INSTRUMENTATION RADAR SYSTEM REQUIREMENTS AND SPECIFICATIONS

I. Introduction

NASA Langley Research Center is upgrading its large Compact Range electromagnetic test facility, known as the Experimental Test Range (ETR). The facility is intended to be used both as a Radar Cross Section (RCS) and Antenna measurement facility. Measurements will be made in a 13' x 13' far field condition test zone covering a frequency range of 300MHz – 18 GHz.

II. Physical Layout

This facility originally built in 1990 has been expanded to its present size in 2004. The current anechoic indoor test chamber dimensions are 40' height x 40' width x 100' length with a corner fed blended rolled edge reflector (26' x26') centrally located at one end of the 40' x 40' front wall. The 26' square reflector is designed to produce a 13' square by 20' deep / test zone. A model handling area and control room is located behind the back wall. The reflector has a 29.5 foot focal length, and as mentioned, is corner fed with an axis of symmetry from the lower left corner to the upper right when facing the reflector, as opposed to the standard vertical axis of symmetry commonly found in compact ranges. The feed for this reflector is therefore in the lower left of the room, the focal point being 7' from both the left sidewall and floor.

An important dimensional consideration for the radar is that there is a volume of space located immediately behind the feed location of approximately a 7' cube for radar system components that need to have close feed proximity. The control room is located 90' away with a narrow access corridor for cable runs. The control room dimensions are approximately 10' x 10'. Standard 110V 60Hz power is available in both locations. Additional power can be installed to support the power requirements for the system.

III. CLIN 1:

NASA Langley Research Center has a requirement for an Instrumentation Radar System. It is recognized that many of the instrumentation radar systems available today have long lists of specifications and capabilities. **The system minimum performance specifications shall be met collectively and verified through overall system performance demonstration.** The overall system performance, with metrics as detailed later in this document, shall form the basis for acceptance testing.

The measurement system shall provide the following **collective minimum specifications** as summarized in the parameter table below. The measurement system will interface with existing or planned upgrades to the feed system and positioning system.

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A. CLIN 1 SPECIFICATIONS

#	Parameter	Specification	Comments
1	Frequency coverage	0.3 – 2.0 GHz (continuous) 2.0 – 18. GHz (continuous)	ability for both monostatic and bi-static
2	Frequency resolution	1 KHz (maximum)	
3	System frequency switching speed	≤ 300 ns	
4	RF power	4 watts or greater	
5	Receiver linear dynamic range	≥ 65 dB	single pulse w/250 MHz video BW
6	Video BW	≥ 250 MHz	for frequencies above 500 MHz
		≥ 150 MHZ	At 300 – 500 MHz operating frequencies
7	A/D conversion (I & Q)	16-bit	1-bit sign, 90 dB of dynamic range
8	Receive channels	Two	
9	Receive gates / channel	Two	
10	Range gate delay	0 ns to max PRP with ≤ 1 ns resolution	
11	Pulse width	6 ns (min.) to ≥ 1.5 μs with ≤ 1 ns resolution	
12	Pulse isolation	≥ 70 dB	
13	Pulse Rate Period	400 ns - 2 μs	PRF: 500 KHz - 2.5 MHz
14	Bias subtraction correction	a) None b) Bi or Poly-phase	Single-pulse Multi-pulse
15	Waveform	Pulse-to-pulse user control	As described below
16	Data rate (samples/sec)	Data to disc at maximum PRF, single frequency	400 ns / single-pulse, single-channel waveform
17	Acquisition triggering of waveforms	a) User control b) TTL input c) Positioner d) Timed	a) software user interface b) edge trigger c) positioner interface trigger d) software driven
18	TTL triggering	latency ≤ 500 ns jitter ≤ 1 ns	
19	Digital Feed Selector	TTL; 3-bit	
20	Positioning System Interfaces		As described below

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The following additional information is provided to further clarify the system operating requirements summarized in the parameter table above.

1.0 Frequency Coverage

Specification: 0.3-2.0 GHz and 2.0-18 GHz

The instrumentation radar system shall be capable of operating over the entire frequency range specified. The frequency coverage can be obtained through the use of banded transceivers to meet additional requirements specified in the document. The system shall provide the ability for both mono-static and bi-static operation.

Each transceiver in the system shall have two transmit ports. The system shall be able to select, via the waveform table, the desired port from which to transmit power. Each transceiver in the system shall have two receive ports. The system shall be able to select, via the waveform table, the desired receive port.

2.0 Frequency Resolution

The instrumentation radar system shall have a synthesized source with a frequency resolution less than or equal to1 KHz.

3.0 System Frequency Switching Speed

The system frequency switching speed shall be less than or equal 300 ns. Frequency switching speed shall be verified by measurement at the receiver, via an external RF loop measurement. The system switching speed shall be referenced to the magnitude and phase steady state response. The magnitude shall be less than or equal to 2.0 dB. The phase stability shall be less than or equal to 0.1 radians.

4.0 RF Power

The total RF power output, per transceiver band, shall be 4 watts or greater as measured at the transceiver transmit output port.

5.0 Receiver linear dynamic range

The system shall have a minimum linear dynamic range of 65 dB, single pulse mode as measured with a video bandwidth of 250 MHz or greater. Linearity shall be defined as +/- 0.2 dB.

6.0 Video BW

The system shall have a maximum video bandwidth that is 250 MHz or greater for transceiver bands operating at 500 MHz or higher. The system shall have a maximum video bandwidth that is 150 MHz or greater for the minimum operating frequency of 300 MHz

7.0 Analog-to-Digital conversion (I & Q)

The system shall convert the received analog signals to digital I&Q pairs using 16-bit analog-to-digital converters.

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8.0/ 9.0 Receiver input channels / range gates

The instrumentation radar system shall have a minimum of two receiver input channels with two range gates. The system shall be capable of simultaneously sampling each range gate independently.

10.0 Receiver gate delay

The receiver gate delay, for each range gate, shall be user selectable and configurable with a time resolution less than or equal to1 ns over the full range of the specified PRP.

11.0 Pulse width

The system shall be capable of variable pulse widths ranging from 6 ns minimum to a maximum width of 1.5 μs, with a resolution less than or equal to 1 ns. The amplitude of the measured pulse width shall be flat to within +/- 0.2 dB.

12.0 Pulse isolation

The system shall provide receive pulse isolation that is greater than or equal to 70 dB, within 12 ns of the transmit pulse, leading and trailing edges, for a video bandwidth setting of 250 MHz. The system shall provide receive pulse isolation that is greater than or equal to 70 dB, within 20 ns of the transmit pulse, leading and trailing edges, for a video bandwidth setting of 150 MHz.

13.0 Pulse rate interval

The system shall operate with a pulse rate period ranging from 400 ns to 2 μs, in single pulse mode. The power output specification shall be maintained, at the minimum power specified, across the transceiver bandwidth, for each transceiver band, at the minimum pulse rate period, (max Pulse Repetition Frequency).

14.0 Bias subtraction correction

The system shall provide bias subtraction correction for operation in the following modes:

a) Single pulse operation; none required
b) Bi-phase;
c) Poly-phase

15.0 Waveform

The system shall be capable of generating various waveforms. As a minimum, the system shall be capable of pulse-to-pulse user control for waveform generation to include the following parameters:

a) frequency (at single pulse operation)
b) pulse width
c) range gate(s)
d) range delay(s)
e) transmit port
f) receive port(s)
    1) either or both of the two transmit ports (mono-static)
    2) either or both of the two receive ports (bi-static)
g) feed selection
h) pulse rate period
i) integration

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16.0 Data rate (samples/sec)
The system shall be capable of a minimum data transfer rate (data to disc) that supports continuous, single-pulse operation at the specified maximum PRF.

17.0 Acquisition triggering of waveforms
The system shall be capable of the following:
a) User control; software user interface defined
b) TTL input; edge triggered
c) Positioner; positioned interface triggered; selectable
d) Timed; software driven

18.0 TTL triggering
The TTL trigger shall have a latency of less than or equal to 500 ns and jitter less than or equal 1 ns.

19.0 Digital Feed Selector
The system shall have a digital TTL output port, with 3-bit depth, under wave table control.

20.0 Positioning System Interface
The system shall be capable of interfacing and controlling three (3) independent model position control systems. The systems planned to be in use in the facility are described below.

a) The system shall provide interface and control of two (2) independent industry standard position control systems.

b) The system shall be capable of controlling an existing linear axis stepper motor field prober with a Parker 6104 motor controller. The system shall provide an interface to the Parker 6104 motor controller.

B. Operating Modes
The government intends to operate this system utilizing various operating modes that are available within state-of-the-art instrumentation radar systems on the market today. This includes single pulse operation as described in the requirements above. Although the single pulse operation is only one of many modes in which the system will be used, it is the mode that stresses system operation and is most likely to uncover timing discrepancies.

C. System diagnostics
The system shall be capable of assessing system health and performing self diagnostics on both a real-time and scheduled basis.

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D. Acceptance Testing

The contractor shall provide to the Government a set of acceptance test procedures, both factory acceptance test (FAT) and site acceptance test procedures (SAT), for review and approval prior to performance of the acceptance tests. These two sets of procedures shall be separate deliverables under the contract with delivery based on date determination of FAT and SAT. The contractor shall include an end-to-end system performance test within the acceptance test procedures as a pass/ fail metric.

E. Warranty

The manufacturer shall provide a minimum 3 year warranty.

F. Deliverables & Schedule

1. Preliminary Design Review (PDR) – 8 weeks after contract award to be held at the contractor's location. The PDR package shall be delivered to the Government at the PDR.

2. Critical Design Review (CDR) – 12 weeks after contract award to be held at contractor's location. The CDR package shall be delivered to the Government at the CDR.

3. Final Design Review (FDR) – 16 weeks after contract award to be held at the contractor's location. The FDR package shall be delivered to the Government at the FDR.

4. The contractor shall institute an action item tracking spreadsheet. The contractor shall update the spreadsheet and deliver it to the government on a monthly basis indicating current status on all items.

5. Factory Acceptance Test (FAT) – Date to be determined by the Contracting Officer after award based on delivery schedule

6. Delivery of Equipment – The equipment delivery shall be within 9 months of contract award to include the following:
   a) Instrumentation Radar System
   b) User's Manuals and Supporting Documentation
   c) System's Drawings and Schematic Diagrams of Delivered Product

7. Site Acceptance Test (SAT) – Date to be determined by the Contracting Officer after award based on delivery schedule

IV. CLIN 2: On Site Training

The contractor shall provide training at LaRC for up to 5 NASA Langley personnel on the delivered instrumentation radar system.

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V. CLINs 3-5: Maintenance

The contractor shall provide options for annual support service and maintenance for a total of three (3) years on an annual basis following delivery and acceptance of the instrumentation radar system.

The options for support service and maintenance shall address as a minimum the following:

- Telephone support during normal business hours.
- Onsite support
- Access to available spares.
- Parts and materials