NOTE: MIL-STD-751 has been redesignated as a Interface Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

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3 SEPTEMBER 1987
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24 OCTOBER 1961
(SEE 6.3)

DEPARTMENT OF DEFENSE
INTERFACE STANDARD

RADAR OUTPUTS, NAVAL SHIP AND SHORE

AMSC N/A FSC 5840

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DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362-5101

Radar Outputs, Naval Ship and Shore

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FOREWORD

It is the intent of this standard to establish revised requirements for multiplexed and analog outputs of Naval radar systems reflective of technological changes and advancements in current state of the art.

CONTENTS

CONTENTS - Continued

FIGURES

1. SCOPE

1.1 Purpose. This standard establishes and updates the basic requirements for the multiplexed and analog outputs of radar systems used in Naval surface ships, submarines and shore installations.

1.2 Application. The requirements of this technical standard are intended to be used in applying technological advances to new equipment designs for radar systems for various Naval ships and shore installations.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Standard. Unless otherwise specified, the following standard of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation forms a part of this standard to the extent specified herein.

STANDARD

MILITARY
MIL-STD-242/8 - Electronic Equipment Parts, Selected Standards, Connectors (Part 8).

(Copies of standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Radar mile. A radar mile is equal to 2,000 yards.

3.2 Radar trigger pulse. A radar trigger pulse is that pulse which is synchronized with the transmitted pulse of the radar set and used to initiate the active time for the display of radar pulse returns.

3.3 Video signal. A video signal is the signal output of a radar receiver, or other sensor of wide band amplitude modulated signals, that is locked with the time base of the sensor and intensity-modulates the cathode-ray tube of a radar indicator in the same time base.

3.4 Bearing signal. A bearing signal is the means used to convey azimuth position of the radar antenna to the radar indicator.

3.5 Peak pulse amplitude. A peak pulse amplitude (shown as E_{PA} on figure 1), is the maximum absolute value of a pulse, including spikes.

3.6 Pulse decay. Pulse decay (shown as T_D on figure 1), is the interval between those points at which the instantaneous amplitude last reaches 90 percent and 10 percent of peak pulse amplitude.

3.7 Pulse duration. Pulse duration (shown as T_{DUR} on figure 1), is the time interval between the first and last instants at which the instantaneous amplitude reaches 50 percent of peak pulse amplitude.

3.8 Pulse jitter. Pulse jitter is the variation of the normal pulse spacing in a sequence of pulses.

3.9 Pulse repetition rate. Pulse repetition rate consists of the number of pulses or pulse trains generated per unit of time.

3.10 Pulse rise. Pulse rise (shown as T_R on figure 1), is the interval between the instants at which the instantaneous amplitude first reaches 10 percent and 90 percent of peak pulse amplitude.

3.11 Pulse spike. A pulse spike is an unwanted pulse of relatively short duration superimposed on the main pulse.

3.12 Unidirectional pulse. Unidirectional pulse is one in which pertinent departures from the reference level occur in one direction only.

3.13 Pulse edge undershoot. Pulse edge undershoot, (shown as E_U on figure 1), is the maximum instantaneous excursion of the pulse in the negative direction after the waveform crosses the base line following the main positive excursion of the waveform.

3.14 Pulse separation. Pulse separation is the interval between the 50 percent point of the trailing edge of one pulse and the 50 percent leading edge of the succeeding pulse (pulse separation) as shown on figure 2.

3.15 Pulse spacing. Pulse spacing is the interval between the 50 percent point on the leading edge of the first pulse and the 50 percent point on the leading edge of the second pulse (pulse spacing) as shown on figure 2.

3.16 Pulse top. Pulse top is that portion of a pulse between the first and last instants at which the instantaneous amplitude reaches 90 percent of peak pulse amplitude.

3.17 Duty cycle. Duty cycle shall be calculated as follows:

$$100 \text{ percent } X \frac{1}{T A_{max}} \int_0^T A(t)\, dt$$

Where:

A_{max} is the maximum current (or voltage),

A(t) is the current (or voltage) at t,
and
T is the period of measurement (time constants of the metering circuits), long enough to make the integral independent of T.

3.18 RADDS. RADDS is the acronym for a Radar Display and Distribution System. Conventional Naval radar indicators, radar switchboards, data converters and amplifiers assembled and interconnected to work together in a radar surveillance system and not associated with a weapons system, are the basic elements of the RADDS.

3.19 RADDS digital data stream (RDS). The RDS is a serial 64 bit composite radar data signal consisting of digitized radar and digitized ship's information.

3.20 Sensor converter (SCV). The definition of a SCV, as applied herein is a data converter that digitizes analog signals from radar sets and from other sources of analog information and multiplexes these digital signals into a serial data stream. The serial data stream of 3.19 and 5.5 is an example of the data conversion performed by an SCV and utilized with radar equipment.

4. GENERAL REQUIREMENTS (Not applicable)

5. DETAILED REQUIREMENTS

5.1 Radar output requirements. Radar systems designed and built for use by the Navy shall be in accordance with the standards herein.

5.1.1 Radar outputs. A radar system shall provide radar output signal that will operate and control a basic baseline radar display system which shall consist of :

(a) A real time cathode-ray tube display operating in a PPI or radar height indicator;
(b) An indicator that shall operate and provide radar information in ambient illumination ranging from the low illumination of a ship's CIC to a ship's bright daylight bridge illumination;
(c) Operation with analog video;
(d) Operation with radar triggers, azimuth data, bearing signals, and ship's information multiplexed into a serial digitized format from a SCV;
(e) Control hardware and firmware flexible for radar display.

5.2 Video requirements. Video requirements shall be as specified in 5.2.1 through 5.2.1.6.

5.2.1 Video signal characteristics. Three analog video signals shall be provided from each radar set. Each of the three signals shall be of different video processing and shall have the following basic characteristics:

5.2.1.1 Polarity. The video shall be a unidirectional signal of positive polarity.

5.2.1.2 Peak amplitude. The amplitude of any video signal shall be 2.0 ± 0.5 volts measured across 75 ohms plus or minus 5 percent. The signal, noise, or both, may vary from zero to peak amplitude.

5.2.1.3 Trailing edge undershoot. The trailing edge undershoot of any video pulse shall be less than 5 percent of peak pulse amplitude.

5.2.1.4 Duty cycle. The duty cycle of signal plus noise, measured during signal time, shall be from 0 to 70 percent.

5.2.1.5 Video output. The video signals from the radar set output shall be connected to standard Navy coaxial cable connectors, selected in accordance with MIL-STD-242/8. Sufficient electrical isolation shall be provided so that when any video output signal is grounded, all other video output signals shall remain within the limits as specified herein.

5.2.1.6 Video measurements. Video measurements shall be taken at the video output of the radar set, terminated with a 75 ohm load.

5.3 Antenna bearing. Radar antenna analog bearing signals shall be transmitted from the radar set to an SCV for multiplexing into the RDS or to other users of analog bearing signals by one of the following methods:

(a) Five wire synchro, 60 hertz, for unstabilized bearing angles shall always be available from Navy radar sets.
(b) Voltage regulator (VR) sin alpha/VR cos alpha sweep voltages for stabilized bearing angles shall be provided by three dimensional radar sets, where VR is 18.75 volts direct current and alpha is the bearing angle in stabilized coordinates.
(c) By, a parallel digital word that sends true bearing of a three dimensional radar transmitted beam.

5.4 Trigger requirements. Trigger requirements shall be as specified in 5.4.1 through 5.4.1.12.

5.4.1 Trigger pulses. The master trigger (Tm1) shall be provided from the radar set to an SCV for multiplexing or any other user of an analog master trigger. Master trigger two (Tm2), horizon trigger (Th), and early trigger (Te) shall also be provided from radar sets in various configurations for special operations to an SCV for multiplexing with Tm1 or to users of analog pulses. The analog trigger pulses shall have the following basic characteristics:

5.4.1.1 Polarity. The trigger shall be a unidirectional pulse of positive polarity.

5.4.1.2 Duration. The duration of the trigger pulse, shown as (T_{DUR}) on figure 1, shall be 1 to 10 microseconds (μs).

5.4.1.3 Pulse amplitude. The peak pulse amplitude, shown as E_{PA} on figure 1, shall be 20 ± 5 volts measured across 75 ohms plus or minus 5 percent.

5.4.1.4 Rise time. The rise time, shown as T_R on figure 1, shall be less than 20 percent of pulse duration, shown as T_{DUR} on figure 1. At no time shall the rate of rise be less than 100 volts per µs.

5.4.1.5 Decay time. The decay time, shown as T_D on figure 1, shall be less than three times the rise time or 1 µs, whichever is greater.

5.4.1.6 Pulse top. The instantaneous value of the pulse top shall be not less than 80 percent of the peak pulse amplitude, shown as E_{PA} on figure 1, nor greater than the peak pulse amplitude.

5.4.1.7 Trailing edge undershoot. The trailing edge undershoot, shown as E_U on figure 1, of any trigger pulse shall be less than 5 percent of peak pulse amplitude.

5.4.1.8 Synchronization. The 50 percent of peak pulse amplitude point on the leading edge of the output trigger and the 50 percent of peak pulse amplitude point of the radar transmitted pulse shall be synchronized to within plus or minus 0.5 µs.

5.4.1.9 Jitter. The jitter of the output trigger pulse, with respect to the radar transmitted pulse, shall not exceed 0.02 µs.

5.4.1.10 Trigger output. The trigger pulses from the radar output shall be connected to standard Navy coaxial connectors, selected in accordance with MIL-STD-242/8.

5.4.1.11 Trigger output isolation. Sufficient electrical isolation shall be provided so that when any trigger output is grounded, all other output trigger pulses shall meet the requirements as specified herein.

5.4.1.12 Trigger measurements. Trigger measurements shall be taken at the trigger output of the radar set, terminated with a 75 ohm load.

5.5 RADDS serial data stream.

5.5.1 RADDS serial data stream composition. An SCV shall generate the RADDS serial data stream from analog radar trigger, azimuth, true bearing signals and ship's movement information. The serial data stream shall consist of pulse and digital information in a format described in 5.5.2 and 5.5.3 and multiplexed into the form shown on figure 3.

5.5.2 Data stream format. The RADDS digital data stream shall be in the following format:

(a) A Tm pulse of 4 µs duration shall initiate the RADDS data stream.
(b) Eight to 59 µs after the leading edge of Tm, 64 data bits shall be transmitted in 128 µs.

(c) Each data bit shall start at the beginning of a 2 µs interval.
(d) The data stream shall be sampled 1 µs after the leading edge of each data bit.
(e) A high logic level at this point in time shall indicate a digital 1.
(f) A low logic level shall indicate a digital 0.
(g) Each data bit shall transit to a high level for 500 ± 100 nanoseconds (ns) for 0 or remaining at a high level for 1500 ± 100 ns for 1.
(h) Each data bit shall transit to a low logic level before transmission of the following data bit.

Te and Th pulses shall be transmitted in the time gate of the data stream shown on figure 3.

5.5.3 Data bit assignment. Data assignment for 64 digital bits of the RADDS data stream shall be as follows:

Digital bit number	Bit status and explanation		
1 video for present Tm (see figure 3, Tm1)	0 present	1 not present (set by Th/Rsy)	
2 synchro azimuth for next Tm (see figure 3, Tm2)	0 present	1 not present	
3 through 14 next Tm synchro azimuth data MSB[1] is bit number 3	All 0's angle is minimum	All 1's angle is maximum	Note: Each step between all 0's and all 1's corresponds to a specific antenna angle
15 future use	0		
16 future use	0		
17 bearing	0 relative	1 true	
18 next Tm stabilized azimuth	0 present	1 not present	

See footnotes at end of table.

Digital bit number	Bit status and explanation		
19 through 30 Tm2 stabilized azimuth data MSB is bit number 19	All 0's angle is minimum	All 1's angle is maximum	Note: Each step between all 0's and all 1's corresponds to a specific antenna angle
31 future use	0		
32 ship's head marker (future use)	0 present	1 not present	
33 DRA[2] input	0 present	1 not present	
34 DRA north	0 equals 0	1 equals approximately 2.7 yards	
35 DRA south	0 equals 0	1 equals approximately 2.7	
36 DRA east	0 equals 0	1 equals approximately 2.7	
37 DRA west	0 equals	1 equals approximately 2.7	
38 radar/other	1 radar	0 other (future)	
39 through 42 sensor ID	(see Sensor Identification)		
43 future variable word	0		
44 through 47 future variable word address	0		
48 through 63 future variable word data	0		
64 even parity bit			

[1] Most significant bit.
[2] Dead reckoning analyzer.

5.6 Radar outputs for raster scan displays (RSD). Video signals from radar sets for distribution to RSD shall be in analog form. Other radar signals to RSD shall be in RADDS digital data stream format.

5.6.1 RSD video. Raster scan displays shall accept three analog video signals from each radar set. Mixing and processing of the three video signals shall be accomplished within the RSD. One of the three videos shall be IFF video, which may be displayed separately or mixed with one of the other two radar videos.

5.6.2 Azimuth information. The primary method for transmitting azimuth information from the radar set shall be 12 bit digital data, and the backup method shall be 5 wire synchro, before being converted to the RADDS data stream and distribution to an RSD.

5.6.2.1 True relative azimuth. True or relative azimuth information shall be generated within the RSD from whatever azimuth information is provided by the radar set. Whenever a radar set supplies azimuth information to the RSD through the RADDS data stream, synchro amps shall not be required at the radar set. True bearing shall not be a requirement of the radar set output.

6. NOTES

6.1 Intended use. This military standard should be used by designers of Navy surface ship, submarine and shore based radar equipment to specify the requirements for radar set signal outputs and the input signal requirements for radar indicators and displays.

6.2 Subject term (key word) listing.

Analog
Data bit assignment
Data stream format
Digital
RADDS
RADDS digital data stream (RDS)
Raster scan displays (RSD)
Sensor converter (SCV)

6.3 Changes from previous issue. Asterisks or vertical lines are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
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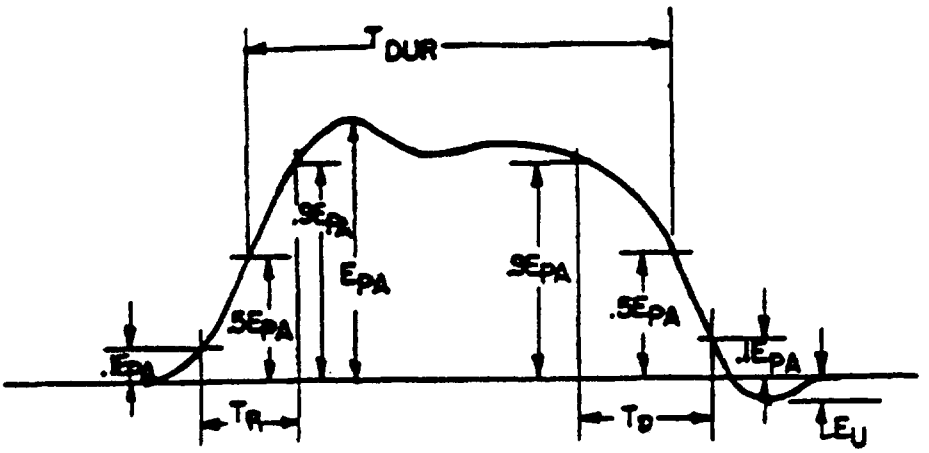
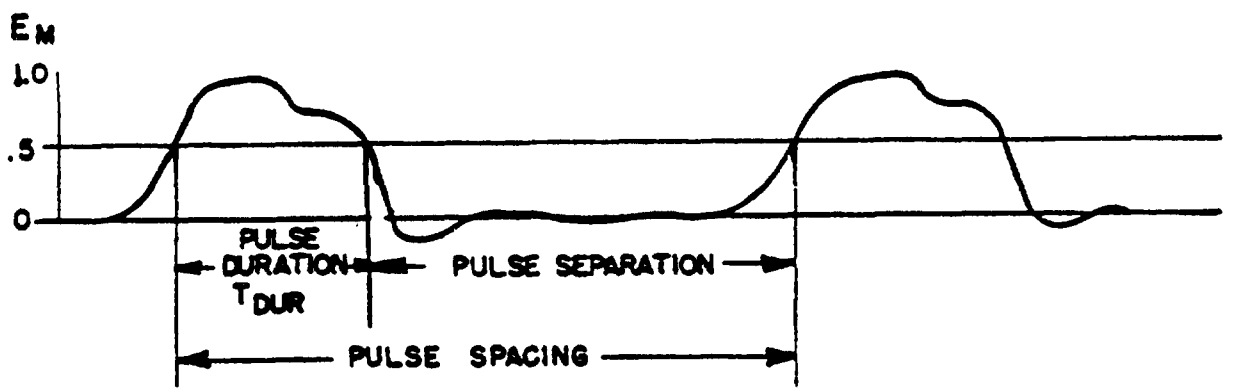


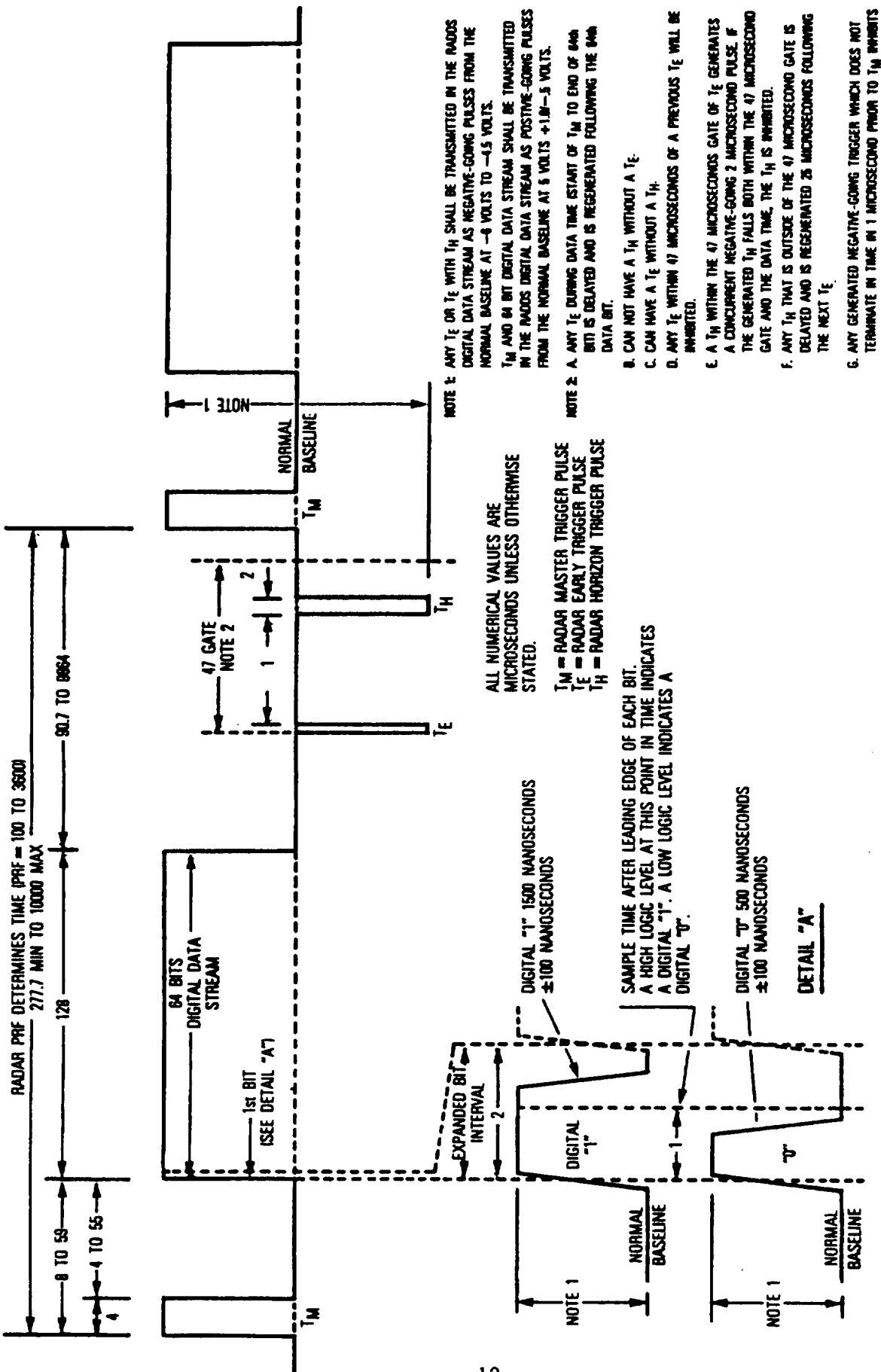
SH 131983

FIGURE 1. Pulse waveform.



SH 131984

FIGURE 2. Two pulse waveforms.



SH 131986

FIGURE 3. RADDS digital data stream.

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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
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5. PROBLEM AREAS

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b. Recommended Wording:

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