A. Radar Control Protocol

The interface to the RCP is typically via network UDP multicast packets. Alternatively we can use a serial line, or a UNIX FIFO. When using the network, all transmissions both directions are sent to the same address and port number. This allows the seamless merging of data from multiple clients. It also means that there is no longer a separate wire for transmit and receive as with a serial cable. The data format consists of exactly the serial format with a 16-byte prefix. The prefix consists of the packet size in ASCII (8-bytes), followed by a ASCII code for the type of packet. The first letter of the type is either "T" or "R" for transmit or receive. This is relative to the main controlling host. If coding this up, you will need to filter on the direction.

For coding examples, please look in the utils/antx.C program, as well as in the libs/antenna/ant_netrcv.c and libs/user/UdpSupport.c files. The only coding differences for multicast packets over broadcast packets are that you should specify the interface to use, and issue the IP_ADD_MEMBERSHIP call. Also, you should read a standard network textbook on multicast addressing. There are certain reserved addresses. We recommend using *site–local* addresses.

When using a two-way asynchronous RS-232 data line, the baud rate is typically 9600 (19200+ for shipboard systems). Through this link, IRIS controls the servo and antenna and receives feedback status. Information is transferred in packets consisting of two or more bytes. Each packet begins with a SYNC byte and ends with an END byte of FF(Hex). All SYNC bytes have the MSB set, and the particular value indicates the type of packet to follow. Types currently available are 80(hex) for antenna, C0(hex) for BITE, AF(hex) for Q-BITE, and B0(hex) for time. The packet layouts are shown below. Each type of packet has a specific direction of travel (to or from IRIS), but packets can arrive in any order within the serial stream.

Several types of antenna communication formats are supported. Older systems use the RCV01 and XMT01 formats but the newer systems can use the RCV02 and the XMT02 formats. The RCV03 format is intended for systems on moving platforms, such as ships or airplanes. One of the challenges of these systems is to correct the radar's measured radial velocity for the motion of the platform. To make this correction, the three-dimensional velocity and orientation of the platform must be recorded. Typically, the information comes from an inertial navigation system. For shipboard system, an update rate of approximately 20 reports per second can satisfy the velocity correction requirements at 19200 baud.

The following angles, with the exception of the latitude and the longitude, are transmitted as 14-bit binary angles. The latitude and longitude are both 21-bit binary angles.

- azimuth and elevation
- train order

- pitch, roll, and heading

In the XMT01 format, the angular speed is a signed number in units of 0.55^{o}/sec. In all other formats, the angular rates are in signed 14-bit binary angles per second. Therefore, the largest possible value is 180^{o}/sec (30 rpm) and the step is 0.022^{o}/sec. All velocities are in signed cm/sec with the altitude in signed meters. If some of the information is not available at the full resolution of the data format, the low bits are filled with zeros.

The azimuth and the elevation angles are corrected angles relative to the north and are the angles that the antenna is pointed relative to the deck of the platform. These calculations are derivable from the other angles but are also reported to assist in the data analysis, especially if one of the sensors or the stabilization fails.

The pitch is the angle between the fore-and-aft axis of the platform and the horizontal is measured in the vertical plane. The pitch is positive when the bow is down and the roll is the rotation angle about the fore-and-aft axis in its pitched position. The pitch is measured in the plane perpendicular to the fore-and-aft axis, which is generally not the vertical plane, and the roll is positive when the deck is down on the port side.

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i **Note: The pitch can be directly measured by a level on the fore-and-aft axis but the roll cannot be directly measured by a one-axis tilt meter.**

The heading is referred to as the direction the platform is pointed but is not the same as direction of motion. The platform could be pointed one way and drifting backwards.

The time stamp is a 14-bit counter incremented by the RCP once per millisecond. The RCP should latch all the data for a packet at the same time. This counter allows the host computer to accurately judge the time between samples without the serial line latencies and fluctuations due to the time sharing operating system.

The position of the platform is reported by the latitude, the longitude, and the altitude. Since the altitude may not be implemented for systems on ships, the setting will be zero.

Table A–1: Status Packet RCV01 Format (RCP to Host)

Char	Function
1	SYNC Byte (80 Hex)
2	Azimuth Low 7 bits
3	Azimuth High 7 bits
4	Elevation Low 7 bits
5	Elevation High 7 bits
6	Status #1 D6 = Low air flow D5 = Low Waveguide pressure D4 = Servo power D3 = Antenna Local mode D2 = Interlock D1 = Standby D0 = Radiate On
7	Status #2 D6 = RCP02 is shutdown D5 = LSB pulse width D4 = T/R power On D3 = T/R Local mode D2 = Encoders calibrated D1 = MSB pulse width D0 = Magnetron current normal
8	End Of Message (FF Hex)

Table A–2: Control Packet XMT01 Format (Host to RCP)

Char	Function
1	SYNC Byte (80 Hex)
2	Azimuth Low 7 bits
3	Azimuth High 7 bits
4	Elevation Low 7 bits
5	Elevation High 7 bits
6	Control Word #1 D6 = MSB of Pulse Width D5 = Leave Pulse width unchanged D4 = Spare D3 = Signal Generator On D2 = Signal Generator CW D1 = EL (1 = Scan, 0 = Position) D0 = AZ (1 = Scan, 0 = Position)
7	Control Word #2 D6 = Reset RCP02 on edge D5 = Noise Source On D4 = LSB of Pulse width D3 = Radiate On complemented D2 = Radiate On D1 = Servo Power On D0 = T/R Power On
8	Control Word #3 (all spare)
9	Signal generator level (unsigned 0–127dB attenuation)
10	AZ/EL Antenna speed (signed 7 bit, 0.55 degree resolution)
11	END OF MESSAGE (FF Hex)

Table A–3: Status Packet RCV02 / RCV04 Format (RCP to Host)

Char	Function
1	SYNC Byte (80 Hex)
2	Azimuth Low 7 bits
3	Azimuth High 7 bits
4	Elevation Low 7 bits
5	Elevation High 7 bits
6	Azimuth Rate Low 7 bits
7	Azimuth Rate High 7 bits
8	Elevation Rate Low 7 bits
9	Elevation Rate High 7 bits
10	Status #1 D6 = Low air flow D5 = Low Waveguide pressure D4 = Servo Power D3 = Antenna Local mode D2 = Interlock Open D1 = Standby D0 = Radiate On
11	Status #2 D6 = RCP02 is shutdown D5 = LSB pulse width D4 = T/R Power On D3 = T/R Local mode D2 = Azimuth encoder calibrated D1 = MSB pulse width D0 = Mag. current normal
12	Status #3 D6 = IRIS Mode 2 D5 = IRIS Mode 1 D4 = IRIS Mode 0 D3 = Elevation encoder calibrated D2 = Signal Generator fault D1 = Signal Generator On D0 = Signal Generator CW
13	Signal generator level (0=max power)
14	Time Stamp Low 7 bits
15	Time Stamp High 7 bits
16	END OF MESSAGE (FF Hex)

Table A–4: Control Packet XMT02 / XMT04 Format (Host to RCP)

Char	Function
1	SYNC Byte (80 Hex)
2	Azimuth Low 7 bits
3	Azimuth High 7 bits
4	Elevation Low 7 bits
5	Elevation High 7 bits
6	Control Word #1 D6 = MSB of Pulse Width D5 = Leave Pulse Width unchanged D4 = Spare D3 = Signal Generator On D2 = Signal Generator CW D1 = EL (1 = Scan 0 = Position) D0 = AZ (1 = Scan 0 = Position)
7	Control Word #2 D6 = Reset RCP02 on rising edge D5 = Noise Source On D4 = LSB of Pulse width D3 = Radiate On complemented D2 = Radiate On D1 = Servo Power On D0 = T/R Power On
8	Control Word #3 D6 = IRIS Mode 2 D5 = IRIS Mode 1 D4 = IRIS Mode 0 D3 = Radar Workstation A okay D2 = Radar Workstation B okay D1 = Data Processor A okay D0 = Data Processor B okay
9	Signal Generator level (0–127 dB attenuation)
10	AZ Antenna Speed Low 7 bits
11	AZ Antenna Speed High 7 bits
12	EL Antenna Speed Low 7 bits
13	EL Antenna Speed High 7 bits
14	END OF MESSAGE (FF Hex)

Note: If EL in position mode, maximum positive velocity is sent in the velocity field, if EL in scan mode, maximum or minimum elevation position is sent in the position field. If AZ in position mode, maximum positive velocity is sent in the velocity field, if AZ in scan mode, 0 is sent in the position field.

Table A–5: Status Packet RCV03 Format (RCP to Host)

Char	Function
1	SYNC Byte (80 Hex)
2	Identification byte
3	Azimuth Low 7 bits (Earth relative)
4	Azimuth High 7 bits
5	Elevation Low 7 bits (Earth relative)
6	Elevation High 7 bits
7	Train Order Low 7 bits (azimuth of pedestal relative to the ship)
8	Train Order High 7 bits
9	Elevation Order Low 7 bits (elevation of pedestal relative to the ship)
10	Elevation Order High 7 bits
11	Pitch Low 7 bits
12	Pitch High 7 bits
13	Roll Low 7 bits
14	Roll High 7 bits
15	Heading Low 7 bits
16	Heading High 7 bits
17	Azimuth Rate Low 7 bits
18	Azimuth Rate High 7 bits
19	Elevation Rate Low 7 bits
20	Elevation Rate High 7 bits
21	Pitch Rate Low 7 bits (LSB = Zero)
22	Pitch Rate High 7 bits
23	Roll Rate Low 7 bits (LSB = Invalid Roll)
24	Roll Rate High 7 bits
25	Heading Rate Low 7 bits (LSB = Invalid Heading)
26	Heading Rate High 7 bits
27	Status #1 D6 = Low air flow D5 = Low Waveguide pressure D4 = Servo power D3 = Antenna Local mode D2 = Interlock open D1 = Standby D0 = Radiate ON

28 Status #2

D6 = RCP02 is shutdown
D5 = LSB pulse width
D4 = T/R Power on
D3 = T/R Local mode
D2 = Azimuth encoder calibrated
D1 = MSB pulse width
D0 = Mag. current normal

29 Status #3

D6 = Reserved
D5 = Reserved
D4 = Reserved
D3 = Elevation encoder calibrated
D2 = Signal Generator fault
D1 = Signal Generator On
D0 = Signal Generator CW

30 Signal generator value (0=full signal)

31 Time Stamp Low 7 bits
32 Time Stamp High 7 bits

33 Latitude Low 7 bits
34 Latitude Middle 7 bits
35 Latitude High 7 bits

36 Longitude Low 7 bits
37 Longitude Middle 7 bits
38 Longitude High 7 bits

39 Altitude Low 7 bits
40 Altitude High 7 bits

41 Velocity East Low 7 bits (LSB = Invalid Lat/Lon)
42 Velocity East High 7 bits

43 Velocity North Low 7 bits (LSB = Zero)
44 Velocity North High 7 bits

45 Velocity Up Low 7 bits (LSB = Invalid Altitude)
46 Velocity Up High 7 bits

47 END OF MESSAGE (FF Hex)

Table A–6: Status Packet RCV05 Format (RCP to Host)

Char	Function
1–15	These bytes exactly match the RCV02 / RCV04 format
16	Dual-System Status D6 = RCP02 is configured as a Dual-System D5 = Dual-System Mode MSB D4 = Dual-System Mode LSB D3 = This packet was sent from Unit "A" D2 = Information is known about the "Other" unit D1 = Unit "A" is the preferred system D0 = Unit "B" is disabled Note: The 2-bit Dual-System Mode codes are: 00 : Unknown mode 01 : System "A" 10: System "B" 11 : Auto Switch
17	Dual-System Status D6 = Unit "B" is okay D5 = Unit "B" Activity Code MSB D4 = Unit "B" Activity Code LSB D3 = Unit "A" is disabled D2 = Unit "A" is okay D1 = Unit "A" Activity Code MSB D0 = Unit "A" Activity Code LSB Note: The 2-bit Dual-System Activity codes are: 00 : Inactive 01 : Warmup 10: Active Now 11 : Reserved
18	Dual-System Status D6 = RCP02 is configured for voluntary flipping D5 = Unit "B" is offering to give up control D4 = Unit "A" is offering to give up control D3 = Unit "B" would be used if it were available D2 = Unit "A" would be used if it were available
19	D0:2 = Current Polarization XMT control 0=Horizontal; 1=Vertical; 2=Alternating; 3=Simultaneous D3 = Polarization switch is OK to run
20	Spare
21	Spare
22	Spare
23	Spare
24	END OF MESSAGE (FF Hex)

Table A–7: Control Packet XMT05 Format (Host to RCP)

Char	Function
1–13	These bytes exactly match the XMT02 / XMT04 format
14	Control Word #4 D6 = Dual-System: Mode MSB D5 = Dual-System: Mode LSB D4 = Dual-System: Offer to relinquish control D3 = Dual-System: Unit would be used if available D2 = Spare D1 = Spare D0 = Spare Note: The 2-bit Dual-System Mode codes are: 00 : No mode 01 : System "A" 10: System "B" 11 : Auto Switch
15	D0:2 = Requested Polarization XMT control 0=Horizontal; 1=Vertical; 2=Alternating; 3=Simultaneous; 7=Unchanged
16	Spare
17	Spare
18	END OF MESSAGE (FF Hex)

Table A–8: Time Packet (RCP to Host)

Char	Function
1	SYNC Byte (B0 Hex)
2	Year Low 7 bits
3	Year High 7 bits
4	Month
5	Day
6	Hour
7	Minute
8	Second
9	1/100 of Second
10	Status
11	END OF MESSAGE (FF Hex)

Table A–9: Generic BITE Status Packet (Both ways)

Char	Function
1	SYNC Byte (C0 Hex)
2	BITE Unit ID byte (selectable in the range 00–7F Hex)
3	Status byte #1
4	Status byte #2
.	
.	
.	
N–1	Status byte #N–3
N	END OF MESSAGE (FF Hex)

The BITE status packet consists of from 3 to 20 bytes. The first two and the last bytes are used for identification purposes. The middle bytes must have the MSB set to zero and can contain arbitrary status in the lower 7 bits. Typically this is used to report back individual bits containing the results of tests such as cabinet interlocks, airflow sensors, and power supply checks. This report should be sent by the BITE every time the status changes. It should also send a report in response to the interrogate command. IRIS sends the interrogate command every 60 seconds.

Table A–10: BITE Command Packet (Both ways)

Char	Function
1	SYNC Byte (C0 Hex)
2	Command (0x4D = Interrogate, 0x44=Sample Data, 0x43=Reset)
3	End Of Message (FF Hex)

Table A–11: Auxiliary Control BITE Packets (Both ways)

Char	Function							
1	SYNC Byte (C0 Hex)							
2	BITE Unit ID byte (User Choice)							
3	Control/Status Bits	6	5	4	3	2	1	0
4	Control/Status Bits	13	12	11	10	9	8	7
5	Control/Status Bits	20	19	18	17	16	15	14
6	Control/Status Bits	27	26	25	24	23	22	21
7	Control/Status Bits	34	33	32	31	30	29	28
8	Control/Status Bits	41	40	39	38	37	36	35
9	Control/Status Bits	48	47	46	45	44	43	42
10	Control/Status Bits	55	54	53	52	51	50	49
11	Control/Status Bits	62	61	60	59	58	57	56
12	Control/Status Bit							63
13	END OF MESSAGE (FF Hex)							

This example BITE packet is supported by the SIGMET RCP02 and RCP8 Radar Control Processors, and is an example of a mapping of arbitrary control and status bits into a BITE packet.

These RCPs contains 64 auxiliary status and control variables, labeled S[0:63] and C[0:63]. These bits may be sent to and from the host computer in the form of 13-byte BITE packets holding the full set of 64 bits. The format of these packets is the same in both directions, and the identification byte is selectable so that conflicts with other BITE packets can be avoided.

Table A–12: Q–BITE Status Packet (Both ways)

Char	Function
1	SYNC Byte (AF Hex)
2	BITE Unit ID byte (selectable in the range 00–7F Hex)
3	Status byte #1
4	Status byte #2
.	
.	
.	
N–1	Status byte #N–3
N	END OF MESSAGE (FF Hex)

The Q-BITE (Quantitative byte) status packets consists of from 3 to 128 bytes. The first two and last bytes are used for identification purposes. The middle bytes must have the MSB set to zero and can contain an arbitrary value in the lower 7 bits. Typically this is used to report back voltage/power levels. This report should not be sent by the BITE every time the status changes. This report is sent in response to the Q-bite interrogate command. IRIS sends the interrogate command every 60 seconds.

The Q-BITE data stream consists of a series of integer values. Each value is packed into a series of 7-bit characters, using between 1 and 5 depending on the desired resolution. The low bits come first, and IRIS supports up to 32 bits per value. IRIS can easily be configured to display any such values with appropriate units and scaling.

Table A–13: Simple Q–BITE Example

Char	Function
1	SYNC Byte (AF Hex)
2	BITE Unit ID byte (Selectable in range 00–7F)
3	V1 Trigger frequency (Hz) (low bits)
4	V1 Trigger frequency (Hz) (High bits)
5	V2 Thyratron voltage (0.1 Volts) (low bits)
6	V2 Thyratron voltage (0.1 Volts) (high bits)
7	END OF MESSAGE (FF Hex)

Table A–14: Q-BITE Interrogate Packet (Both ways)

Char	Function
1	SYNC Byte (90 Hex)
2	Command (0x01 or 0x4D=Interrogate, 0x44=Sample Data, 0x43=Reset)
3	End Of Message (FF Hex)

Table A–15: BITE Individual Command Packet (Host to RCP)

Char	Function
1	SYNC Byte (C1 Hex)
2	ID of the BITE unit for which the command will be applied
3	Command: 0x4D=Interrogate, 0x44=Sample Data, 0x43=Reset
4	END OF MESSAGE (FF Hex)

The BITE individual command packet is used to request information about a single BITE unit, separate from all the others.

The RCP should respond to an **Interrogate** packet by sending the current version of the specified BITE status packet. The RCP should respond to a **Sample Data** packet by sending requests out the the remote device to get information, then responding to the host computer with the new BITE status packet when the information arrives. The RCP should responds to the **Reset** packet by sending a reset command to the remote device.

Table A–16: Chat-Mode Packet (Both ways)

Char	Function
1	SYNC Byte (F1 Hex)
2...7	7-Bit ASCII characters (possibly NULL terminated)
8	END OF MESSAGE (FF Hex)

These packets are sent in both directions to convey serial TTY communication. Up to six 7-bit characters can be sent in each packet with two characters of overhead for SYNC and END. This allows up to 75% of the available serial bandwidth to be used for chatting. If a "chat" mode packet contains fewer than six characters, then a NULL (zero byte) is inserted after the last one.