

ACU1 M&C SERIAL PROTOCOL



**BRADSHAW
COMMUNICATION
SYSTEMS**

MODEL ACU1 ANTENNA CONTROL UNIT MONITOR & CONTROL SERIAL PROTOCOL

**Bradshaw Communication Systems
94 Worldwide Drive
Dawsonville, Georgia 30534
Telephone: 770-844-9704
Fax: 770-886-0205
<http://www.bcstech.com>**

MONITOR & CONTROL PORT

A. Introduction

The Monitor & Control (M&C) Port section describes the protocol and hardware interface required for use of the ACU1 M&C Port (J8 at the ACU1 rear panel). A terminal or remote Host processor connected to the M&C Port may exercise a set of operational mode commands and obtain complete operational status information from the ACU1 at any time. Any mode command issued by the Host (and accepted by the ACU1) will be observed on the ACU1 front panel display "MODE" portion in brackets (i.e. "(STBY)"). Also, all ASCII command letters must be upper case.

Optional Features

The M&C Port is designed to support the full range ACU1 options. As a result, it is possible that not all commands, fault, and status functions will apply to a particular version ACU1. In this case, the following extensions to the remainder of the protocol specification will apply.

1. The ACU1 will properly acknowledge all command sequences included in this document. Attempts to use commands that are not implemented will be acknowledged but not executed.
2. When the Polarization Option is not implemented, the ACU1 will indicate a Polarization Angle of 0.0 at all times. When using the position designate command with an ACU1 without polarization control, the inclusion of the Polarization Angle is optional; if included, it will be ignored.
3. Azimuth and elevation angles are always indicated by the ACU1 with two decimal places. For the position designate command the least significant digit is optional.

B. Communication Protocol

The M&C Port communication protocol is configured in a master-slave arrangement, that is, the ACU1 will transmit only in response to a command by the Host. A list of the available commands and the corresponding ACU1 responses is, shown in the following table. Any communications from the M&C Port, which does not conform to this table, will be acknowledged by the ACU with an ASCII BEL on a character by character basis. Framing errors, buffer over-run errors, and parity errors will be acknowledged by the ACU with an ASCII BEL.

The communication protocol is based on the command line. In the case of operational mode commands, a command line consists of the command character or character sequence followed by the EXECUTE command. In the case of reporting commands, the command line consists of the command character only. Command lines are executed by the ACU1 after completion of the response sequence.

Prior to completion of a command line, the Host may edit the command line. The Host may transmit an ASCII "/" prior to the completion of a command line to cause the current command line to be ignored. Transmission of an ASCII "/" is acknowledged by the ACU1 with the ASCII character sequence "/ CR LF". The Host may delete the last character in the command line by transmitting a ASCII BS. Characters, which have been acknowledged by the ACU1 with an ASCII BEL, are not considered part of the command line. Transmission of an ASCII BS is acknowledged by the ACU1 with the ASCII character sequence "BS SP BS" unless there are no characters in the current command line; in this case the ACU1 will respond with an ASCII BEL. The ACU1 response to a report command may be aborted at any time by transmission of an ASCII "!"; this transmission will be acknowledged by the ASCII character sequence "! BEL CR LF".

The communication protocol is based on a full duplex communication channel. The ACU1 will allow the Host to transmit a new command line prior completion of the current acknowledgement sequence. All commands, except for ASCII "!" are executed serially, that is, a command is not executed until the previous acknowledgement sequence has been completed.

ACU1 M&C Port Host Command / ACU1 Response Table

Host Command	ACU1 Response	Description
A	ECHO	Move To SAT A Stored Position (POS A)
B	ECHO	Move To SAT B Stored Position (POS B)
C	ECHO	Move To SAT C Stored Position (POS C)
D	ECHO	Standby Mode (STBY)
E	E CR LF	EXECUTE Command (must follow initial Host command)
F	ECHO	Report Fault and Interlock Status
G	ECHO	Program Track Mode (PTRK)
H	See Binary Status	Report Complete Status in Binary
I	ECHO	Memory Track Mode (MTRK)
J	ECHO	Display Memory Track Table
K	ECHO	Disarm Box Limits
L	ECHO	Arm Box Limits
M	ECHO	Recall ACU1 Real-time Clock (Program Track Only)
N	ECHO	Set ACU1 Real-time Clock (Program Track Only)
P	ECHO	Position Designate Mode (POSD)
R	ECHO	Report Operational Status
S	ECHO	Recall or Change the Current Tracking Signal
T	ECHO	Steptrack Mode (TRK / STTK)
U	ECHO	Update Program Track Table
V	ECHO	Recall Program Track Table
W	ECHO	Recall or Set ACU1 Real-time Clock (Memory Track Only)
X	ECHO	40 SAT Designate Mode (SPXX)
Y	ECHO	Recall or Update the Memory Track Table
Z	ECHO	Recall or Change Memory Track Backup Parameter
/	/ CR LF	Cancel Current Command Line
BS	BS CR BS or BEL	Backspace on current command line
!	! BEL CR LF	Cancel Report

Control Modes

This section provides detailed discussion and examples of the ACU1 control modes available to the Host as listed in the above table. On all control modes, transmission of the control characters to the ACU1 will be echoed to the terminal. Transmission of the character "E" will cause the selected mode to be executed. If it is desired to change a transmitted control mode before execution (transmission of " E "), a " / " or BS must first be transmitted. Incorrect reception of an " E " following a control mode transmission will cause the ACU to transmit a BEL.

Position Designate Mode

Position Designate requires the character "P" followed by the desired azimuth, elevation, and polarization angles per the following format example. The range of angles in azimuth is from 0.00 degrees to 359.99 degrees. The range of angles in polarization is 0.0 degrees to 359.9 degrees. The range of angles in elevation is from 0.00 degrees to 99.99 degrees. A space before "E" is mandatory. Leading and trailing zeros are optional, however, the digit preceding the decimal point and the decimal point are mandatory. If it is desired to change the transmitted position designate command before execution (transmission of "E"), a " / " or BS must first be transmitted. Incorrect transmission of an "E" following position designate transmission will cause the ACU1 to transmit a BEL. After execution of the position designate command, the "MODE" portion of the display will contain the characters "(POSD)".

Host Command Example for Position Designate Mode

Host Command	Azimuth Angle	Elevation Angle	Polarization Angle	Execute Command
P	<u>SP</u> XXX.XX	<u>SP</u> XX.XX	<u>SP</u> XXX.X	<u>SP</u> E
1 ASCII Character	7 ASCII Characters	6 ASCII Characters	6 ASCII Characters	2 ASCII Characters

Standby Mode

Standby Mode is activated by the transmission of a "D" followed by an "E", and will remove the drive enable, causing the earth station antenna to stop all motion. After execution of the Standby command, the "MODE" portion of the display will contain the characters "(STBY)". Transmission of any other mode command will again enable the earth station antenna.

40 Satellite Designate Mode (OPTIONAL)

The 40 Satellite Designate Mode command requires the transmission of the character "X" followed by a satellite number per the following format example. The range of satellite numbers is from 1 to 40. A space before the "E" is required. If it is desired to change the satellite designate command before execution (transmission of "E"), a "/" or BS must first be transmitted. Leading zeros may be omitted.

Host Command Example For 40 Satellite Position Designate Mode

Host Command Sat. No.	Execute Command
X SP XX	SP E
3 ASCII Characters	2 ASCII Characters

Program Track Mode (OPTIONAL)

Program Track Mode requires a "G" followed by an "E". The Program Track Table may be loaded, updated or examined one point at a time in any mode except the Program Track mode. A "U" followed by the desired point, day, time, azimuth, elevation and polarization data per the following format example allows loading of the program track table. A "V" followed by the desired point per the following format example recalls the point, day, time, azimuth, elevation and polarization data for the selected point. The range of table points is 1 to 170. The range of days is 0 to 7 with 0 being a null entry indicating no action will be taken for this point. The time is a mandatory 5-byte entry with a range of 00:00 to 23:59. The range of angles in azimuth is 0.00 degrees to 359.99 degrees. The range of angles in elevation is 0.00 degrees to 99.99 degrees, the range of angles in polarization is 0.0 degrees to 359.9 degrees. A space before "E" is mandatory. A minimum of seven data points are required with at least one point for each day of the week (1-7) in the Program Track Table. In time data entry, 5-bytes are required with the third byte being a colon. In angular data entry, leading and trailing zeros are optional, however, the digit preceding the decimal point and the decimal point are mandatory. If it is desired to change the transmitted program track data before entry (transmission of "E"), a "/" or BS must first be transmitted. Incorrect transmission of an "E" following a "G", "U" or "V" will cause the ACU1 to transmit a BEL. After execution of the Program Track command "G" (and acceptance of the ACU1), the "MODE" portion of the display will contain the characters "(PTRK)".

Host Command Example for Program Track Mode

Host Command	Execute Command
G	SP E
1 ASCII Character	2 ASCII Characters

Host Command Example for Loading Program Track Table Data

Host Command	Table Point	Day	Time	Azimuth Angle	Elevation Angle	Polarization Angle	Execute Command
U	SP XXX	SP X	SP XX:XX	SP XXX.XX	SP XX.XX	SP XXX.X	SP E
1 ASCII Character	4 ASCII Characters	2 ASCII	6 ASCII Characters	7 ASCII Characters	6 ASCII Characters	6 ASCII Characters	2 ASCII Characters

Host Command Example for Recall of Program Track Table Data

Host Command	Table Point	Execute Command
V	SP XXX	SP E
1 ASCII Character	4 ASCII Characters	2 ASCII Characters

ACU1 Example Response to the "V" Host Command

Table Point	Day	Time	AZ Angle	EL Angle	POL Angle	Suffix
XXX	SP X	SP XX:XX	SP XXX.XX	SP XX.XX	SP XXX.X	CR LF
3 ASCII Characters	2 ASCII Characters	6 ASCII Characters	7 ASCII Characters	6 ASCII Characters	6 ASCII Characters	2 ASCII Characters

The Program Track Clock may be set by the transmission of an ASCII "N". The clock may be recalled by transmission of an ASCII "M". An example of each clock related function is detailed below.

Host Command Example for Setting the Program Track Clock

Host Command	Day	Time	Execute Command
N	SP X	SP XX:XX:XX	SP E
1 ASCII Character	2 ASCII Characters	9 ASCII Characters	2 ASCII Characters

Host Command Example for Recalling the Program Track Clock

Host Command	Execute Command
M	<u>SP E</u>
1 ASCII Character	2 ASCII Characters

ACU1 Example Response to the "N" Host Command

Day	Time	Suffix
X	<u>SP XX:XX:XX</u>	<u>SP CR LF</u>
1 ASCII Character	9 ASCII Characters	2 ASCII Characters

Memory Track Mode (OPTIONAL)

Hours, minutes and seconds are all 2-digit numbers. Azimuth angles range from 0.0 to 359.99. Elevation angles range from 0.0 to 99.99. The digit before the decimal point and the decimal point are required.

To recall the Memory Track time of day the format is as follows:

Host Command Example for Recalling the Memory Track Time of Day

Host Command	Execute Command
W	<u>SP E</u>
1 ASCII Character	2 ASCII Characters

ACU1 Example Response to the "W" Host Command

Prefix	Hours	Minutes	Seconds	Suffix
<u>CR LF SP</u>	XX:	XX:	XX	<u>CR LF</u>
3 ASCII Characters	3 ASCII Characters	3 ASCII Characters	2 ASCII Characters	2 ASCII Characters

To set the Memory Track time of day the format is as follows:

Host Command Example for Setting the Memory Track Time of Day

Host Command	Hours	Minutes	Seconds	Suffix
W	XX:	XX:	XX	<u>SP E</u>
1 ASCII Character	3 ASCII Characters	3 ASCII Characters	2 ASCII Characters	2 ASCII Characters

ACU1 Response to the Set Memory Track Time of Day is: "CR LF"

To recall a Memory Track Table data point the format is as follows:

Host Command Example for Recalling a Memory Table Data Point

Host Command	Hours	Minutes	Execute Command
Y <u>SP</u>	XX:	XX	<u>SP E</u>
1 ASCII Character	3 ASCII Characters	2 ASCII Characters	2 ASCII Characters

ACU1 Example Response to the "Y" Host Command

Prefix	Hours	Minutes	Azimuth Angle	Elevation Angle	Suffix
<u>CR LF</u>	XX:	XX	<u>SP XXX.XX</u>	<u>SP XX.XX</u>	<u>SP CR LF</u>
2 ASCII Characters	3 ASCII Characters	2 ASCII Characters	7 ASCII Characters	6 ASCII Characters	3 ASCII Characters

To set a Memory Track Table data point the format is as follows:

Host Command Example for Setting a Memory Track Table Data Point

Host Command	Hours	Minutes	Azimuth Angle	Elevation Angle	Execute Command
Y <u>SP</u>	XX:	XX	<u>SP XXX.XX</u>	<u>SP XX.XX</u>	<u>SP E</u>
2 ASCII Characters	3 ASCII Characters	2 ASCII Characters	7 ASCII Characters	6 ASCII Characters	2 ASCII Characters

ACU1 Response to a Set Memory Track Table Data Point is: "CR LF"

To recall the entire Memory Track Table in a single listing the format is as follows:

Host Command Example for Memory Track Table Recall List

Host Command	Execute Command
J	<u>SP E</u>
1 ASCII Character	2 ASCII Characters

ACU1 Response to the "J" Command is "CR LF" then the table listing as follows:

00:00	SP XXX.XX	SP XX.XX	CR LF
00:10	SP XXX.XX	SP XX.XX	CR LF
00:20	SP XXX.XX	SP XX.XX	CR LF
↑	↑	↑	↑
↓	↓	↓	↓
23:50	SP XXX.XX	SP XX.XX	CR LF

To set the Memory Track Backup parameter to active, the format is as follows:

Host Command Example to Set Memory Track Parameter to Active

Host Command	Backup Parameter Value	Execute Command
Z	SP 1	SP E
1 ASCII Character	2 ASCII Characters	2 ASCII Characters

ACU1 Response to the "Z" Set Backup parameter to active is: "CR LF"

To set the Memory Track Backup parameter to NOT active, the format is as follows:

Host Command Example to Set Memory Track Parameter to NOT Active

Host Command	Backup Parameter Value	Execute Command
Z	SP 0	SP E
1 ASCII Character	2 ASCII Characters	2 ASCII Characters

ACU1 Response to the "Z" Set Backup parameter to NOT active is: "CR LF"

To recall the Memory Track Backup parameter current stored value, the format is as follows:

Host Command Example for Memory Track Backup Parameter Recall

Host Command	Execute Command
Z	SP E
1 ASCII Character	2 ASCII Characters

ACU1 Response Example for the "Z" Host Command if Memory Track Backup is Active

Prefix	Backup Parameter Stored Value	Suffix
CR LF	1	CR LF
2 ASCII Characters	1 ASCII Character	2 ASCII Characters

ACU1 Example Response to "Z" Host Command if Memory Track Backup is NOT Active

Prefix	Backup Parameter Stored Value	Suffix
CR LF	0	CR LF
2 ASCII Characters	1 ASCII Character	2 ASCII Characters

Tracking Signal Recall / Change

The Tracking Signal may be recalled or changed by the M&C Port. Changing the Tracking Signal requires the transmission of the character "S" followed by the desired signal number per the following format example. The allowable value range for the Tracking Signal is 0 to 7.

Host Command Example for Changing the Tracking Signal

Host Command	Tracking Signal Value	Execute Command
S	SP X	SP E
1 ASCII Character	2 ASCII Characters	2 ASCII Characters

ACU1 response to the "S" Host Tracking Signal Change Command: "CR LF"

Host Command Example for Recalling the Current Tracking Signal Stored Value

Host Command	Execute Command
S	SP E
1 ASCII Character	2 ASCII Characters

ACU1 Response to the "S" Host Tracking Signal Recall Command

Prefix	Tracking Signal Stored Value	Suffix
CR LF	X	CR LF
2 ASCII Characters	1 ASCII Character	2 ASCII Characters

Box Limit Mode (OPTIONAL)

The box limits command requires an "L" followed by the box size in degrees per the following format example. The parameter must be between 0.00 and 5.00 degrees, inclusive. Otherwise, the protocol is identical to the position designate command. Upon execution of the box limits command (transmission of "E"), the current azimuth and elevation positions are memorized and the box limit function is armed. This data may be determined by the status reporting function (transmissions of "R"). Transmission of a "K" followed by an "E" will disarm the box limit function.

Host Command Example to Set and Arm Box Limits

Host Command	Desired Box Limit Angular Value	Execute Command
L	SP X.XX	SP E
1 ASCII Character	2 ASCII Characters	2 ASCII Characters

ACU1 Response to the "L" Box Limits Set and Arm command: "CR LF"

Host Command Example to Disarm Box Limits

Host Command	Execute Command
K	SP E
1 ASCII Character	2 ASCII Characters

ACU1 Response to the "K" Box Limits Disarm command: "CR LF"

Remote Reporting Functions

This section provides detailed discussion and examples of the ACU1 remote reporting functions available to the Host as listed in the ACU1 M&C Port Host Command / ACU1 Response Table. The Host may request all reporting functions, by transmission of one of three ASCII characters to the ACU1. The monitoring functions with their corresponding ASCII characters are summarized as follows. The ASCII character used to invoke the monitoring function is not echoed.

Monitoring Function	ASCII Character
AZ Angle, EL Angle, POL Angle, Mode, Tracking Signal Strength	R
Fault and Status Information – ASCII Format	F
Mode and Fault/Status – BIT Format	H

Report Function

In response to an "R", the ACU1 provides the following data as shown in the following formatted example.

Example of Data & Format Transmitted by the ACU1 in Response to the "R" Command

Azimuth Angle	Elevation Angle	Polarization Angle	Control Mode	Tracking Signal Strength	Suffix
SP XXX.XX	SP XX.XX	SP XXX.X	SP XXXXXX	SP X X.X	CR LF
7 ASCII Characters	6 ASCII Characters	6 ASCII Characters	7 ASCII Characters	5 ASCII Characters	2 ASCII Characters

Fault / Status Reporting

In response to an "F", the ACU1 will transmit a series of messages describing the current ACU status as shown in the following formatted example. Each status message is a 9 ASCII character string separated by carriage return, line feed, and space. At the end of the last message, an ETX is transmitted. If no faults are present, only CR, LF, ETX is transmitted.

Example of Data & Format Transmitted by the ACU1 in Response to the "F" Command

First Message	Second Message	Last Message
SP XXXXXXXXX	CR LF SP XXXXXXXXX	CR LF SP XXXXXXXXX CR LF ETX
9 ASCII Characters	9 ASCII Characters	9 ASCII Characters

Binary Status Function

System status of the ACU1 may be obtained in binary format by transmission of the ASCII character "H" to the ACU1. The binary status function includes the current mode status and the fault/status report. The binary status transmission consists of 5 consecutive bytes. The first byte (byte 0) contains mode information. Bytes 1 through 3 contain fault/status information. Byte 4 contains a check sum such that the addition without carry of all five bytes of the transmission

equals FF in hexadecimal. On ACU1 units equipped with the Program Track option Byte 4 contains, the binary value 1-171 for the Program Track Table error point value, also the check sum is contained in Byte 5.

The first byte (byte 0) is encoded into a hexadecimal value per the following list and contains the mode information. A one indicates that the condition is true.

MODE	HEX CODE
SAT A	00
SAT B	01
SAT C	02
Steptrack	04
Manual Jog	05
Program Track	06
Memory Track	07
Standby	0C
Position Designate	0F
Satellite 1 (40 SAT)	80
Satellite 2 (40 SAT)	81
Satellite 3 (40 SAT)	82
Satellite 4 (40 SAT)	83
Satellite 5 (40 SAT)	84
Satellite 6 (40 SAT)	85
Satellite 7 (40 SAT)	86
Satellite 8 (40 SAT)	87
Satellite 9 (40 SAT)	88
Satellite 10 (40 SAT)	89
Satellite 11 (40 SAT)	8A
Satellite 12 (40 SAT)	8B
Satellite 13 (40 SAT)	8C
Satellite 14 (40 SAT)	8D
Satellite 15 (40 SAT)	8E
Satellite 16 (40 SAT)	8F
Satellite 17 (40 SAT)	90
Satellite 18 (40 SAT)	91
Satellite 19 (40 SAT)	92
Satellite 20 (40 SAT)	93
Satellite 21 (40 SAT)	94
Satellite 22 (40 SAT)	95
Satellite 23 (40 SAT)	96
Satellite 24 (40 SAT)	97
Satellite 25 (40 SAT)	98
Satellite 26 (40 SAT)	99
Satellite 27 (40 SAT)	9A
Satellite 28 (40 SAT)	9B
Satellite 29 (40 SAT)	9C
Satellite 30 (40 SAT)	9D
Satellite 31 (40 SAT)	9E
Satellite 32 (40 SAT)	9F
Satellite 33 (40 SAT)	A0
Satellite 34 (40 SAT)	A1
Satellite 35 (40 SAT)	A2
Satellite 36 (40 SAT)	A3
Satellite 37 (40 SAT)	A4
Satellite 38 (40 SAT)	A5
Satellite 39 (40 SAT)	A6
Satellite 40 (40 SAT)	A7

The following chart provides decoding for bytes 1 - 3 containing the system fault and status messages. Again, a one indicates that the condition is true.

Status Message Coding Chart

WORD	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
1	Message 7	Message 6	Message 5	Message 4	Message 3	Message 2	Message 1	Message 0
2	Message 15	Message 14	Message 13	Message 12	Message 11	Message 10	Message 9	Message 8
3	Message 23	Message 22	Message 21	Message 20	Message 19	Message 18	Message 17	Message 16

Data Word Format

Each word is 11 bits long and is organized as below.

BIT 1	START BIT
BIT 2	DATA BIT 0
BIT 3	DATA BIT 1
BIT 4	DATA BIT 2
BIT 5	DATA BIT 3
BIT 6	DATA BIT 4
BIT 7	DATA BIT 5
BIT 8	DATA BIT 6
BIT 9	DATA BIT 7
BIT 10	PARITY (ODD)
BIT 11	STOP BIT

This format is identical for transmission both to and from the ACU1. All numbers and characters are in ASCII code except for the Binary Status Report, which is 8-BIT binary.

The summation of bits 2 through 10 will yield odd parity.

Data Link Organization

The data link is organized in a master-slave arrangement; that is, the ACU1 will not transmit unless requested by the Host. The data link is a full duplex channel; that is, either side may transmit or receive simultaneously. Baud rate is 9600.

All circuit functions and signal levels are per RS-232-C. A "1" is -10V while a "0" is +10V. The ACU1 M&C Port is located at the rear panel and is identified as J8. The J8 connector is a 25 Pin D-Sub Socket (female) type. Pin-out of this connector is as follows:

Circuit	J8 Pin Number
Protective Ground	1
Transmitted Data	2
Received Data	3
Clear To Send	5
Data Set Ready	6
Signal Ground	7
Signal Detect	8
Data Terminal Ready	20

All other pins not shown above have no connection in the ACU1. A description of each of the circuits is given below.

PROTECTIVE GROUND	This line is connected directly to chassis ground.
TRANSMITTED DATA	This line contains data sent from the computer to the ACU1.
RECEIVED DATA	This line contains data sent from the ACU1 to the computer.
CLEAR TO SEND	This line is held constantly high by the ACU1 to enable transmission from the computer.
DATA SET READY	This line is held constantly high by the ACU1 to enable transmission from the computer.
SIGNAL GROUND	This line establishes ground reference potential for all circuits except PROTECTIVE GROUND.
SIGNAL DETECT	This line is held constantly high by the ACU1 to enable transmission from the computer.
DATA TERMINAL READY	This line allows control of transmission from the ACU1 by the computer. A high level from the computer will allow ACU1 transmission. A low level will inhibit transmission.