MICROPROCESSOR BASED ANTENNA CONTROLLER DEMONSTRATES FLEXIBLE REMOTE CONTROL OF TELEMETRY ANTENNA SYSTEMS

K.E. Debrunner
Independent Consultant to:
Electro Magnetic Processes, Inc.
9616 Owensmouth Avenue
Chatsworth, California 91311

ABSTRACT

The remote control capabilities of a smart antenna control unit are briefly described. Examples of how these capabilities can be used to improve range coverage and operation are given, and various network configurations are illustrated. Examples of the command language for this antenna controller are also given to illustrate the flexibility of control available and the ease of use of the interface language.

INTRODUCTION

Many real-time telemetry applications require collection of telemetry data across wide geographical areas. This is especially true of telemetry missions associated with joint test operations and war gaming. In addition, weapons testing requires range operations in remote locations often requiring many hours just to deploy range support personnel and to make the range operational and ready for test. Site selection is often dictated by ease of access rather than collection/tracking coverage criteria.

In order to increase equipment availability, many range directors have initiated automated test and calibration schemes for range critical equipment in an effort to keep the equipment operational using the smallest number of highly skilled personnel possible. Centralization of these efforts is also typically a goal because this allows better management of the range by simplifying maintenance procedures and reporting, and also allows centralized, total range system performance testing/monitoring.

Centralization of range data processing is common, both for real-time and post-mission analysis. Data collection is by necessity usually distributed and the collection sites, if in any way complex, are usually manned, bringing on the problems mentioned above. The ACU-6 Antenna Controller has been designed to help the range and mission planners to

address these problems by allowing flexible remote control schemes to be implemented for a wide variety of antenna systems.

THE ANTENNA CONTROL UNIT UNDER REMOTE CONTROL

This paper expands on the EMP Model ACU-6 Antenna Control Unit remote control features. The full capability of the ACU-6 is described in a companion paper.

The ACU-6 antenna controller is an extremely competent antenna control unit capable of interfacing to almost any single or dual axis antenna system. In addition to controlling the antenna system, the ACU-6 can also be equipped to control several different telemetry receivers. All ACU-6 functions can be remotely controlled.

The ACU-6 can be programmed to provide one of three different control capabilities:

1. Slave - This type system controls an antenna system from its own front panel (Local mode), or acepts remote control commands from any of the physical link protocols listed below. All functions in the ACU can be accessed/commanded remotely.

2. Master - This type system cannot control an antenna, but instead acts as a network master for up to eight slave systems. The front panel looks and behaves almost identically as a slave front panel for the currently selected slave. Switching between slaves can be done at any time, and significant events on all slaves are reported regardless of the slave selected.

3. Hybrid - This type system can control one local antenna system and one remote slave.

The ACU-6 can be remotely controlled using any of the following protocols:

1. IEEE-488 (GPIB) - This interface is a standard Talker/Listener device very useful in systems integrating equipments in automated collection and test capabilities.

2. RS-232 - This is the standard long distance interface for ACU-6’s controlled from the users computer. The ACU-6 software and software for this interface option supports full modem control for asynchronous and synchronous modems.

3. 202T Modem - With this option, the ACU-6 is equipped with an integral (internal) 300/1200 Baud FSK modem. Most applications using ACU-6 Masters use this option, allowing direct hook-up to private lines or radio data links.

Figure 1 illustrates the basic remote control scheme for centralized operations where the antenna systems are relatively close.

Figure 2 illustrates a useful variation on the Slave system that implements a command stream “switch” and protocol conversion. In this system, developed for the Navy, an ACU-6 Slave behaves very much like a Hybrid. Commands for either slave system are accepted over the GPIB, and when addressed to the remote slave, are buffered out the serial link using the internal modems and a private voice-grade line. The GPIB slave cannot, however, control the remote slave via its own front panel the way a hybrid can (see below).

Figure 3 illustrates a hybrid controlling both a local antenna and a remote slave system. A dual axis version of this arrangement was developed for the Yuma Proving Grounds. The hybrid and its associated antenna and receiver are located at the Range Control Center. The remote control data link to the slave ACU and the remote telemetry data link are both multiplexed onto one microwave data link, allowing the remote station to track targets and collect flight data completely unattended.

Figure 4 illustrates a dual slave network implemented using both private line and radio link to two ACU-6 slaves. The user computer can control either slave using one RS-232 port to a standard modem.

Figure 5 illustrates a network implemented without any user computer. Five ACU-6 slaves are controlled over private lines and radio link using one ACU-6 master. Three slaves are attached to the private line using balancing networks in a multi-drop scheme while the other two slaves are linked via to serial radio relays. In this scheme, the three slaves on the private line are distributed fairly close to the control center, which houses the master ACU-6. The slave linked via the first radio link is on a mountain peak and provides coverage of a valley that would be masked by any antenna system in the main range complex. The second radio link extends this coverage to the next mountain range, again allowing coverage to extend beyond the line of sight. This network arrangement allows total coverage of an extended flight test over remote and/or inaccessible terrain, without the need to deploy operators to remote sites. These systems can be colocated with existing microwave relay sites for convenience and expediency. The only requirement to visit the remote sites if for periodic or corrective maintenance.

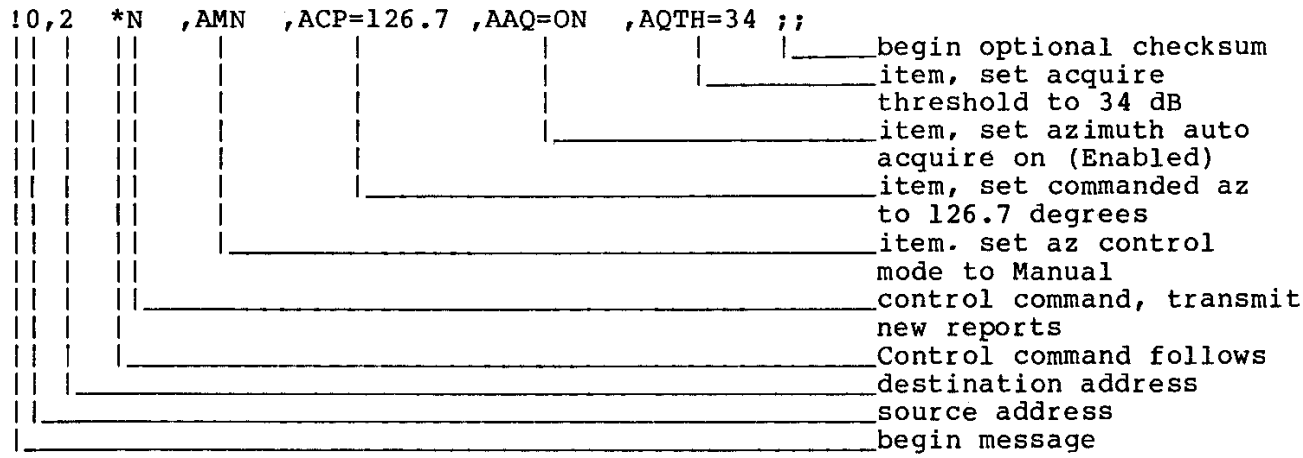
THE ACU-6 COMMAND LANGUAGE

The Command Language designed for the ACU-6 possesses some very significant attributes. It is defined using only printable ASCII characters - no “special” or control characters are used. This means that virtually any computer can be connected to the

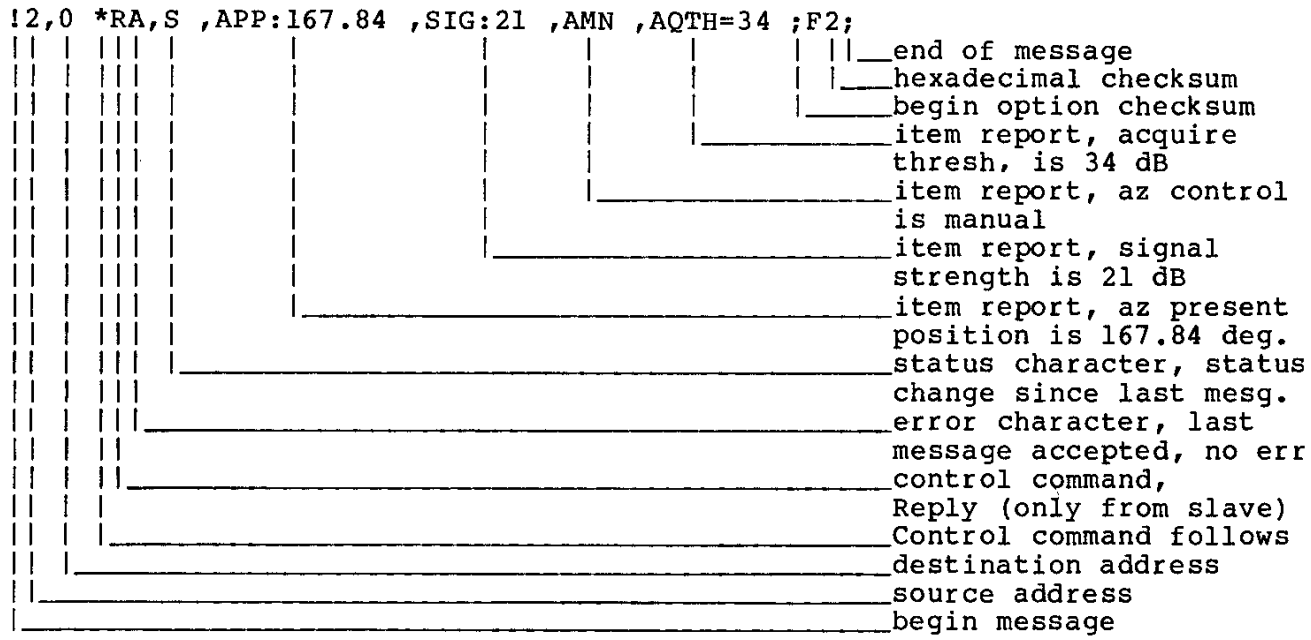
ACU-6 over any protocol supported with no risk of collision with other communication protocols or operating system idiosyncrasies. The only exception to this is the use of “XON and XOFF” in systems specifically requiring this form of buffer synchronization. Even this is not likely since the ACU-6 protocol is half-duplex in nature. Full-duplex links are easily supported for compatibility, but the language definition and networking schemes are really implemented as half-duplex.

An example ACU-6 message is shown below to illustrate the message format. The various fields within the message are marked and explained. Note that the “spaces” in the messages are legal - all undefined characters are treated as “white space” allowing for imbedded spaces, carriage returns, and other control characters and even comments. This can be useful in messages more readable. Binary state variables are commanded and reported with readable messages: “ON” and “OFF”, “MN” (manual) and “AT” (auto), “HI” (high) and “LO” (low), and so on. ANSI standards are followed for the representation of real and integer numbers, and the ACU-6 will accept a real when expecting an integer, and vice versa, when possible, responding with a “questionable argument” status instead of rejecting the argument and responding with an “argument error” status.

The following is an example of a message from a master (user computer or Master ACU-6) to a slave:



The slave response to the above message might look something like this:



The examples above are relatively simple. The language definition allows for broadcast, repeat messages, error handling and notification, short status requests for rapid polling, and much more. The complete ACU-6 command language definition is many pages, and is therefore not presented here. It is hoped that the examples above convey the flavor of the protocol, and illustrate the flexibility, power, and ease of use this definition represents.

CONCLUSIONS

The ACU-6 remote control capabilities offer a new set of solutions to the range planner. Integrated testing and control of range equipments, both for system verification and troubleshooting, and for integrated mission control is becoming more attractive as more equipment manufacturers offer remote control in various forms. The ACU-6 is useful in these configurations, and also in configurations where no existing integration has been implemented. These capabilities offer options for unattended collection sites and range coverage extensions heretofore unavailable.

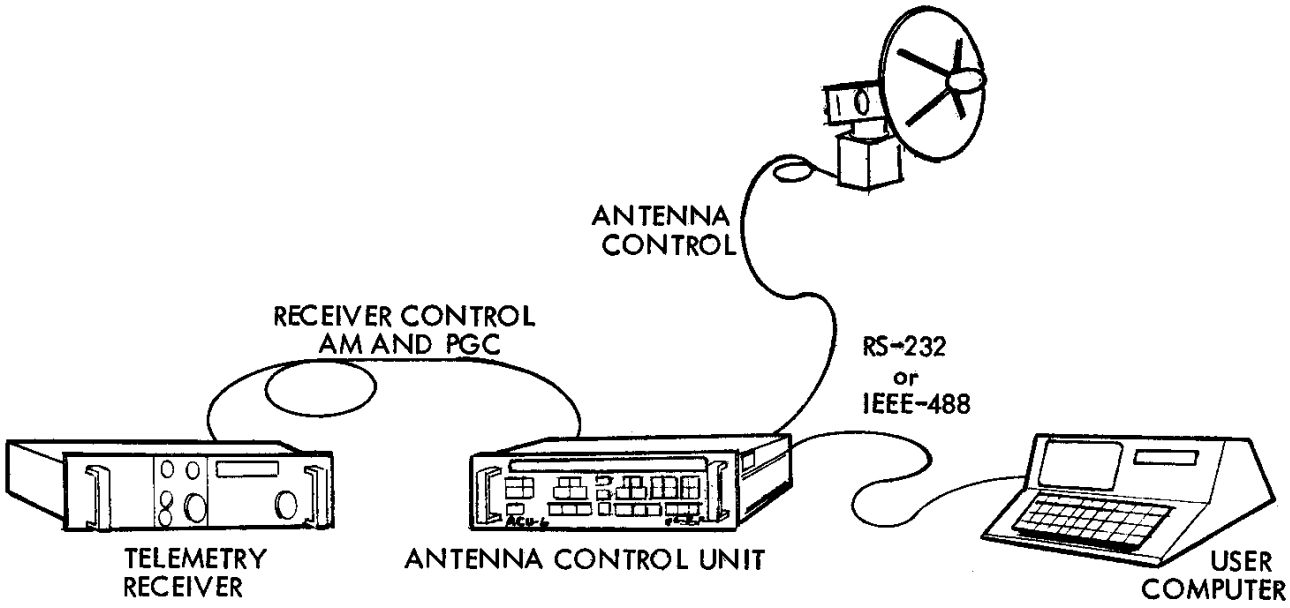


FIGURE 1 - REMOTELY CONTROLLED ACU-6

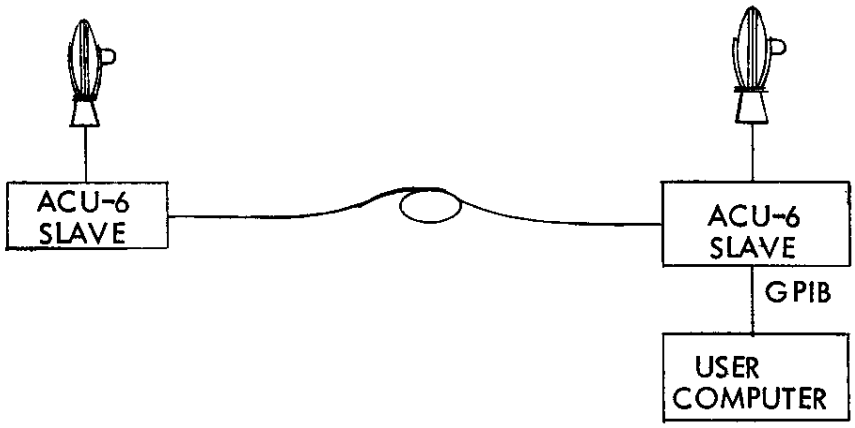


FIGURE 2 - SLAVE SYSTEM WITH PROTOCOL SWITCH

FIGURE 3 - HYBRID CONFIGURATION

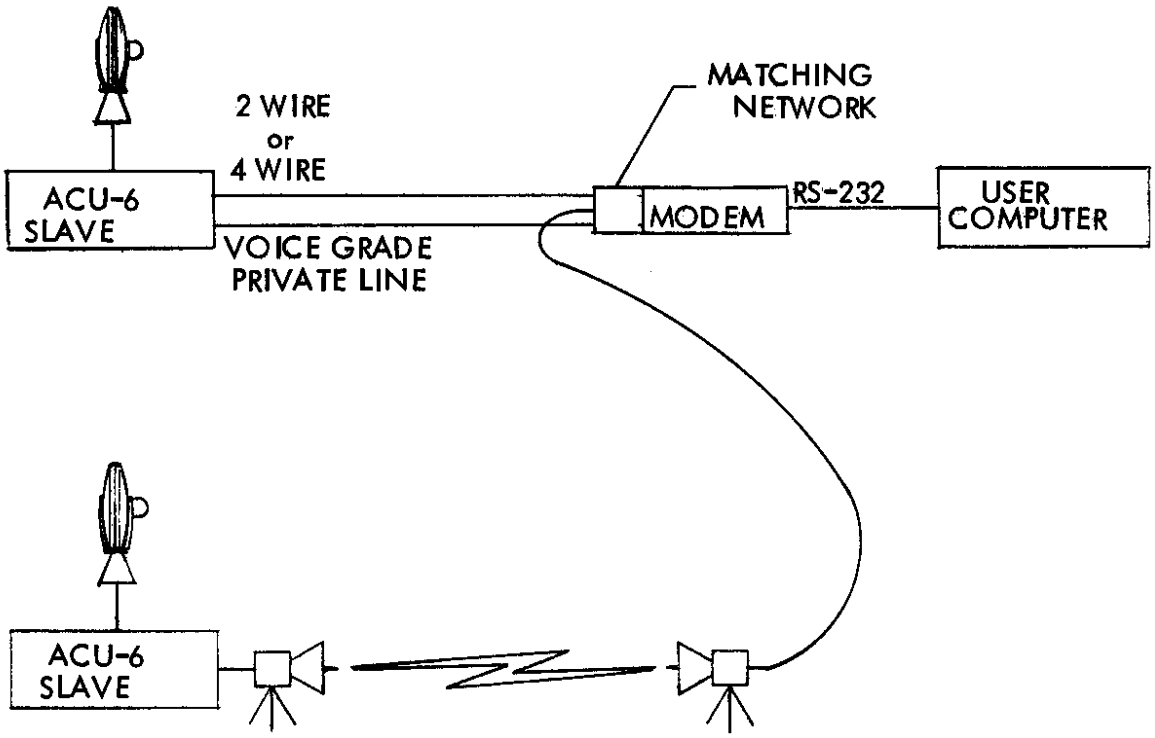


FIGURE 4 ACU-6 NETWORK USING EXISTING USER COMPUTER AS MASTER

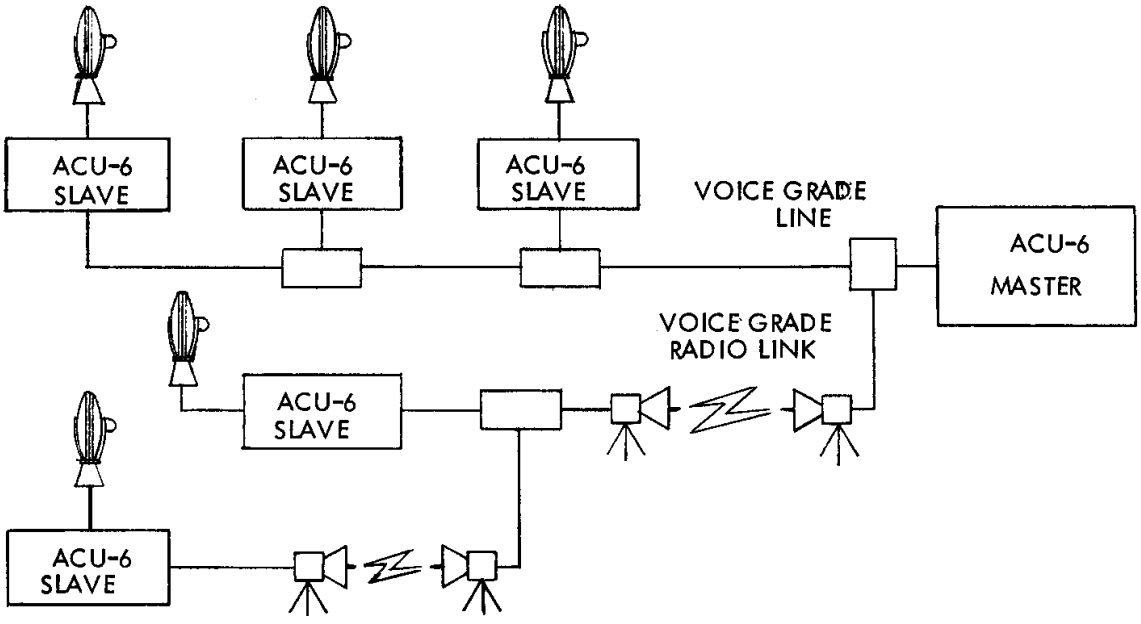


FIGURE 5 - ACU-6 EXAMPLE NETWORK USING ACU-6 MASTER