



ACS1

Antenna Control System



ACS1 Antenna Control System Overview

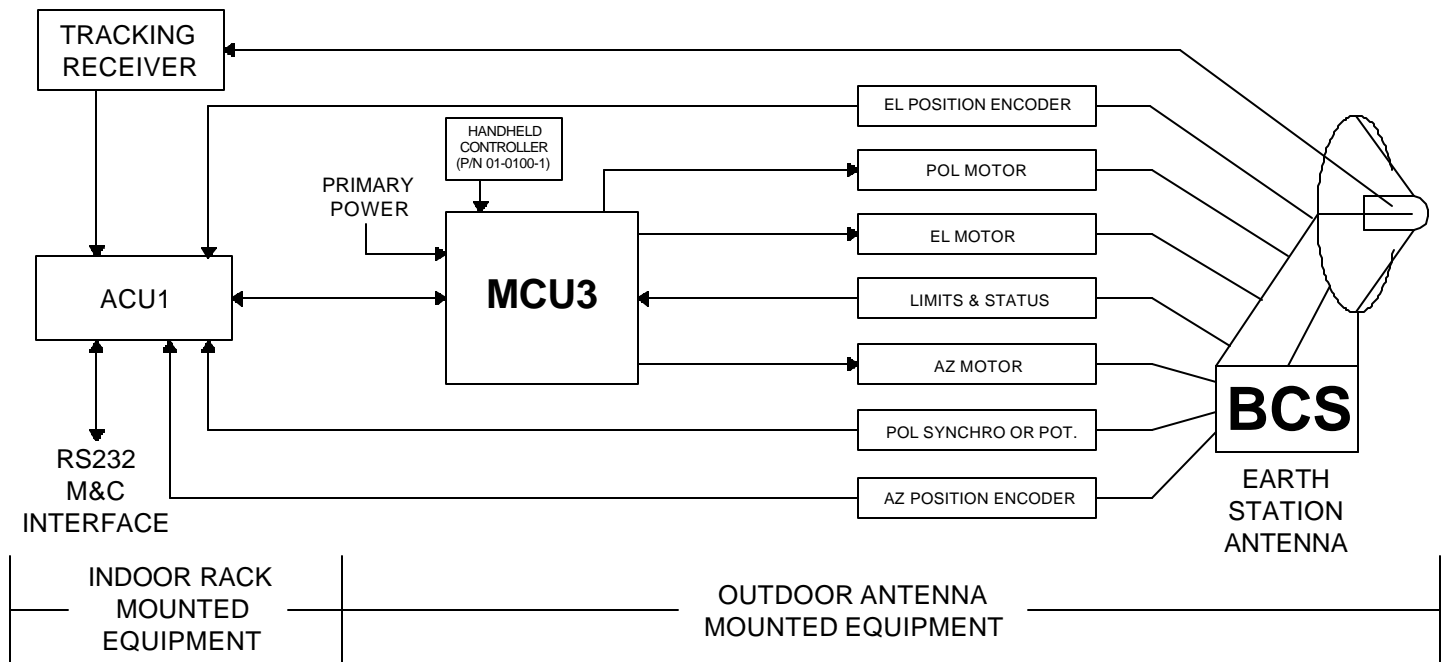
The ACS1 Antenna Control System, developed by Bradshaw Communication Systems, provides automatic satellite tracking control of earth station antennas. The antennas are most commonly steerable parabolic reflectors with two axes of motorized control and an optional motorized feed polarization axis. Control of the antennas usually includes manual pointing ability as well as automatic tracking capabilities for satellites in geosynchronous earth orbit (including inclined orbits with proper options). The ACS1 complements antennas that utilize gearmotor / jackscrew drive trains with very low static backlash. A typical system configuration is shown in Figure 1 and details the specific system components and their typical interconnection.

The ACS1 Antenna Control System components have been designed to replace and upgrade obsolete ElectroSpace Systems 93C-23 series control systems and components. By upgrading the hardware technology, and adding a new modern look and feel, while still maintaining the same user interface scheme and pin for pin connectivity, simple plug and play upgrades in existing systems can be realized. Many advantages (in both installation costs and system down time) make the ACS1 system and components the clear choice when replacements or upgrades are required. The familiar and easy to operate user interface shortens the time it takes for current operators to be proficient at operation of the new system, while new users enjoy the benefits of the easy to learn and established operator interface. For new system installations, the long established reliability and performance track record of the ElectroSpace Systems hardware and positioning / tracking algorithms (that are fundamental in the ACS1) provides the new system operator with the high level of confidence needed in a new system from start-up to long term operation.

The control system is configured around the ACU1 Antenna Control Unit (shown above). The ACU1 is the main user interface providing control and status of the antenna condition at any given time. All control software is resident in the ACU1 and is executed on a robust processing system with real-time execution. The ACU1 performs the computations necessary to determine which direction and velocity is required to point the antenna where it is commanded. It issues axis control signals and measures antenna position and received signal strength to ensure the intended antenna destination is reached and maintained in the presence of wind or other disturbances. All ACU1 operating controls and indicators are located on the front panel and all interface cable connectors are located on the rear panel. During normal operation, the antenna angular position, signal strength, operating mode, and summary fault / status are continuously shown on an easy to read front panel display. ACU1 operator commands are accepted on the front panel by an intuitively laid out tactile keypad arrangement. The system is also fully controllable via an RS232C interface allowing remote monitor and control.

The ACS1 with it's variety of ACU1 and MCU series motor control unit options, synchro based absolute angular position encoders, and tracking receiver, will compliment most limited motion antenna mounted axis limit switches and motor combinations thus providing a precise and complete antenna control solution. Continuous and accurate pointing of the antenna at the satellite is attributed to the robust Steptrack and Memory Track algorithms utilized in the ACU1. With their accurate signal peaking capability and ability to compensate for satellite beacon signal degradation and loss, the ACS1 protects earth station traffic from interruptions caused by antenna mispointing.

BRADSHAW COMMUNICATION SYSTEMS



TYPICAL SYSTEM CONFIGURATION
FIGURE 1

ACS1 Antenna Control System Features

- Precision Position Loop with Response Profiling
- AZ & EL Single or Dual Speed Control Capability
- Feed Polarization Control Capability
- Tracking & Trajectory Modes
 - Steptrack (with position feedback independent peaking)
 - Memory Track (compliments Steptrack mode to provide inclined orbit trajectory tracking)
 - Program Track (programmable stored table pointing)
- Manual & Automatic Positioning Modes
 - Manual Jog (allows antenna axes movement manually)
 - 40 Satellite Mode (preprogramming up to 40 satellites)
 - SAT A & SAT B Fast One Button Control Mode
- Safety & Convenience Features
 - Software Adjustable Position Encoder Offsets
 - Software "Box" Limits
 - ACU1 Self Diagnostics & "Watch Dog" Circuit
 - Non-Volatile Parameter & Track Table Storage
 - RS232C Serial M&C Port (93C-23 Series Compliant)
 - Form C Summary Alarm Contacts
 - Automatic Alternate Tracking Source Input
 - Continuous Fault/Status Monitoring & Reporting
 - Emergency Stop Switch at ACU1 & MCU
 - Manual Override Microprocessor Bypass Control
 - Position Encoder Fault Monitoring
- Dual Analog Tracking Signal Inputs
- Handheld Maintenance & Control Unit
- Absolute Angular Position Feedback
- ACU1 Front Panel Display Capabilities
 - AZ, EL, & POL Angular Position
 - Receive Signal Strength
 - Antenna Travel Limits, Fault & Status Alarms
 - Operational Mode
 - Parameter Recall & Store
- Multiple Motor Control Unit (MCU) Options
 - AZ, EL Single Speed 3 Ø AC
 - AZ, EL Dual Speed 3 Ø AC
 - AZ, EL Dual Variable Speed 1 or 3 Ø AC
 - Mechanical Axis Brake Control
- Multiple Tracking Receiver Options
 - L Band
 - C Band
 - Ku Band
- Operation, Installation & Support Materials
 - Operators Manuals Supplied
 - Installation & Maintenance Manuals Supplied
 - M&C Serial Port Protocol Document Supplied

BRADSHAW COMMUNICATION SYSTEMS

ACS1 Antenna Control System Components



ACU1 Antenna Control Unit

The ACU1 is a rack mounted control unit that serves as the main point of antenna control. It contains the CPU, system firmware, control logic I/O, and position encoding circuitry.



Tracking Receiver

The Tracking Receiver is a rack mounted receiver that provides an analog voltage proportional to signal strength to the ACU1 for use in peaking the antenna during Steptrack.



MCU3 Motor Control Unit

The MCU3 Motor Control Unit is an antenna mounted Variable Frequency Drive (VFD) based unit responsible for dual speed control of the antenna motors in response to commands issued by either the ACU1 or the Handheld Controller. The unit is also responsible for handling antenna limit switch and emergency stop button logic, motor circuit protection, ACU1 / Handheld control logic, as well as providing fault and interlock status to the ACU1. Housed in an automatically heated weatherproof enclosure, the MCU3 is ideally suited for the outdoor environment. The MCU3 provides adjustable and consistent axis motor speed (in both normal and slew speeds) as well as dynamic motor braking allowing for a more precise positioning and better overall tracking performance.



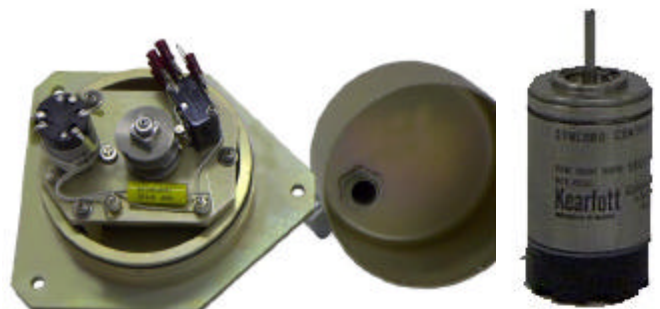
MCU4 Motor Control Unit

The MCU4 Motor Control Unit is an antenna mounted Solid State Relay (SSR) based unit responsible for single or dual speed control of the antenna motors in response to commands issued by either the ACU1 or the Handheld Controller. The unit is also responsible for handling antenna limit switch and emergency stop button logic, motor circuit protection, ACU1 / Handheld control logic, as well as providing fault and interlock status to the ACU1. Housed in a weatherproof enclosure, the MCU4 is ideally suited for the outdoor environment. The MCU4 uses solid state zero crossing technology for controlling axis motors providing for smooth operation and long relay life when compared to conventional reversing contactors. The MCU4 is the ideal solution where low cost is required over variable speed.



Handheld Control Unit

The Handheld Control Unit when plugged into the MCU3 or MCU4 provides handheld control at the antenna. Priority logic in the MCU automatically takes control from the ACU1 when the handheld is plugged in.



4:1 Position Encoder

Synchro

The 4:1 Position Encoder is used on the azimuth & elevation axes to provide highly accurate angular position feedback to the ACU1 for use in positioning of the main reflector. The Synchro is used to provide feedhorn polarization angle.

ACS1 Antenna Control System Specifications

- **Tracking Accuracy**
 - 10% of the receive 3 dB beamwidth, RMS, or better for beamwidths $\geq 0.20^\circ$ and up to 3° orbit inclinations in Steptrack mode.
 - Approaches 7% of the receive 3 dB beamwidth, RMS, or better for beamwidths $\geq 0.20^\circ$ and up to 6° orbit inclinations with valid track table in Memory Track mode.
- **Absolute Position Encoding Accuracy**
 - 0.02° RMS Azimuth & Elevation
 - 0.08° RMS Polarization
- **Front Panel Display Resolution**
 - 0.01° Azimuth & Elevation
 - 0.1° Polarization
- **Absolute Position Encoding Repeatability**
 - Typically 1 LSB at 14 Bits
- **M&C Interfaces**
 - RS232C Serial M&C Port (ESI 93C-23 Compatible)
 - Summary Alarm - Form C, 24V @ 1A Max.
- **4:1 Position Encoders (azimuth & elevation axes)**
 - Custom, 0.50 inch shaft, front or rear mounting
- **Synchro (polarization axis)**
 - Size 11 Servo Interface w/ 0.125 inch shaft
- **Limit / Interlock Switch Inputs**
 - Azimuth CW & CCW - Normally Closed
 - Elevation Up & Down - Normally Closed
 - Polarization CW & CCW - Normally Closed
 - System Interlock - Normally Closed
 - Azimuth Axis Interlock - Normally Closed
 - Elevation Axis Interlock - Normally Closed
 - Polarization Axis Interlock - Normally Closed
- **Hardware Fault & Status Reporting**
 - Azimuth CW & CCW Limits
 - Elevation Up & Down Limits
 - Polarization CW & CCW Limits
 - Emergency Stop / System Interlock
 - Azimuth & Elevation Circuit Breaker Tripped
 - Azimuth, Elevation, & Polarization Interlocks
 - Azimuth & Elevation VFD Fault (MCU3 only)
 - AZ, EI, or POL Position Encoder Fault
 - Local Control Status (Handheld Plugged In)
 - ACU1 RAM/ROM Fault
 - ACU1 Parameter Corruption Fault
- **Approvals**
 - All ACS1 components designed to meet or exceed CE and UL 508 requirements.
- **Environmental**
 - Rack Mounted Equipment
+32° F to +122° F, 90% humidity, non-condensing
(-0° C to +50° C, 90% humidity, non-condensing)
 - Outside Equipment
-40° F to 122°F, 100% humidity
(-40° C to +50° C, 100% humidity)
- **ACU1 Antenna Control Unit**
 - Rack Mount ANSI/EIA 2 Rack Height Chassis
 - Dimensions
3.5" high x 19.0" wide x 13.5" deep
(88.9mm high x 482.6mm wide x 342.9mm deep)
 - Weight
13.5 LBS (6.12 Kg)
 - Power Requirements
90-264VAC / 47-63Hz / 0.75 Amps Max
 - Display & Keyboard
Alphanumeric 20 Character Vacuum Florescent
17 Key, Tactile Feedback
 - Tracking Receiver Interface
DC Signal Proportional to Receive Signal Strength
 $\pm 10V$ Analog, 0.1 to 1.0 V/dB Gradient
Primary & Secondary Tracking Signal Inputs
- **MCU3 / MCU4 Motor Control Units**
 - Enclosure
Wall Mounted Weatherproof NEMA 4X Light Gray
Fiberglass Polyester Enclosure. Hinged Cover
with Pad-Lockable Quick Release Latches.
 - Dimensions
18" high x 16" wide x 10" deep
(45.7cm high x 40.6cm wide x 25.4cm deep)
 - Weight
33 LBS (15.0 Kg) MCU3
26.5 LBS (12 Kg) MCU4
 - Power Requirements - See Configuration & Options
- **Model 7000 Tracking Receiver**
 - Rack Mount ANSI/EIA 1 Rack Height Chassis
 - Dimensions
1.75" high x 19.0" wide
(44.5mm high x 482.6mm wide)
 - Power Requirements
110/220VAC / 40-60Hz Auto-Sensing
 - Display & Keyboard
2x20 Character Backlit LCD / 6 Key, Tactile
 - Tracking Receiver Input - See Configuration & Options
 - Tracking Receiver Output
0 - 8 VDC for -75 to -60dBm Input
 - Lock/Alarm - Form C, 24V @ 1A Max
 - Noise Bandwidth 50 kHz
 - AFC 20 kHz
 - Tracking Threshold:
4dB C/N for acquisition, <1 dB for lock

Specifications subject to change without notice.

BRADSHAW COMMUNICATION SYSTEMS

ACS1 Antenna Control System Configuration & Options

The ACS1 Antenna Control System is comprised of multiple components as detailed in Figure 1. The ACU1 Antenna Control Unit may be combined with several different MCU Motor Control Units and Tracking Receiver options to obtain an optimum performance system at an economical price. All ACS1 components come with detailed Operator and Installation & Maintenance Manuals. The following sections detail the various options for each of the ACS1 components. By combining the required components a requirement specific system can be assembled.

<ul style="list-style-type: none"> • ACU1 Antenna Control Unit <ul style="list-style-type: none"> • P/N 99-01000-1 ACU1 w/ Memory Track (No Polarization Control) • P/N 99-01000-2 ACU1 w/ Memory Track & Polarization Control • P/N 99-01000-3 ACU1 w/ 40 Satellite Programmability, Program Track & Polarization Control <p>All ACU1 standard part numbers come with the following:</p> <ul style="list-style-type: none"> • Steptrack Mode • SAT A & SAT B Fast One Button Control Mode • Manual Jog Mode • All Features Listed Under "Safety & Convenience" • AZ & EL Single & Dual Speed Control Ability • AZ & EL Axis Mechanical Brake Control Ability • Dual Analog Tracking Signal Inputs • NEMA 15P Power Cord - 6FT Long • All Mating Connectors 	<ul style="list-style-type: none"> • Model 7000 Tracking Receiver <ul style="list-style-type: none"> • P/N 99-02000-1 L Band Tracking Receiver Input Frequency: 950-1750 MHz @ -60dBm Nominal Input Impedance: 50 ohms L Band Freq. Select: Over 500MHz on 10KHz steps (local/rem.) Input Connector: Type "BNC" Female 50 ohm • P/N 99-03000-1 C Band Tracking Receiver Input Frequency: 3700-4200 MHz @ -60dBm Nominal Input Impedance: 50 ohms C Band Freq. Select: Over 500MHz on 10KHz steps (local/rem.) Input Connector: Type "N" 50 ohm • P/N 99-04000-1 Ku Band Tracking Receiver Input Frequency: 10.95-12.75 GHz @ -60dBm Nominal Input Impedance: 50 ohm Ku Band Freq. Select: Over 500MHz on 10KHz steps (local/rem.) Input Connector: Type "SMA" Female 50 ohm <p>All Units - Output DC Signal Strength Mating Connector Provided</p>
<ul style="list-style-type: none"> • MCU3 Motor Control Unit <ul style="list-style-type: none"> • P/N 00-01000-1 MCU3 w/208V VFD AZ/EL 3 Ø - 3HP Max. POL 1 Ø - 0.25HP Max. 3 Ø, 208 VAC+/-10%, 50/60Hz+/-5%, 35A Max. OR 1 Ø, 230 VAC+/-10%, 50/60Hz+/-5%, 60A Max. • P/N 00-01000-2 MCU3 w/208V VFD AZ/EL 3 Ø - 5HP Max. POL 1 Ø - 0.25HP Max. 3 Ø, 208 VAC+/-10%, 50/60Hz+/-5%, 53A Max. • P/N 00-01000-3 MCU3 w/380V VFD AZ/EL 3 Ø - 3HP Max. POL 1 Ø - 0.25HP Max. 3 Ø, 380 VAC+/-10%, 50/60Hz+/-5%, 30A Max. • P/N 00-01000-4 MCU3 w/380V VFD AZ/EL 3 Ø - 5HP Max. POL 1 Ø - 0.25HP Max. 3 Ø, 380 VAC+/-10%, 50/60Hz+/-5%, 43A Max. <p>For an exact power analysis for your system requirements please contact Bradshaw Communication Systems directly.</p> <p>All MCU3 standard part numbers come with the following:</p> <ul style="list-style-type: none"> • External Mounted Emergency Stop Button • External Handheld Controller Connector • Removable & Replaceable Cable Entry Gland Plate • Adjustable VFD Drive Parameters • Independently Adjustable Track & Slew Speeds 	<ul style="list-style-type: none"> • MCU4 Motor Control Unit <ul style="list-style-type: none"> • P/N 02-01000-1 MCU4 Single Speed AZ/EL 5HP Max. w/o Brake Control POL 1 Ø - 0.25HP Max. 3 Ø, 208-380 VAC+/-10%, 50/60Hz+/-5%, 55A Max • P/N 02-01000-2 MCU4 Dual Speed AZ/EL 5HP Max. w/o Brake Control POL 1 Ø - 0.25HP Max. 3 Ø, 208-380 VAC+/-10%, 50/60Hz+/-5%, 55A Max • P/N 02-01000-3 MCU4 Single Speed AZ/EL 5HP Max. w/Brake Control POL 1 Ø - 0.25HP Max. 3 Ø, 208-380 VAC+/-10%, 50/60Hz+/-5%, 55A Max • P/N 02-01000-4 MCU4 Dual Speed AZ/EL 5HP Max. w/Brake Control POL 1 Ø - 0.25HP Max. 3 Ø, 208-380 VAC+/-10%, 50/60Hz+/-5%, 55A Max <p>For an exact power analysis for your system requirements please contact Bradshaw Communication Systems directly.</p> <p>To use the MCU4, the antenna AZ & EL axis velocities in degrees per second must be in the range of 0.5/(D)(F) to 1.5/(D)(F), where "D" is reflector diameter in meters and "F" is receive frequency in gigahertz.</p> <p>All MCU4 standard part numbers come with the following:</p> <ul style="list-style-type: none"> • External Mounted Emergency Stop Button • External Handheld Controller Connector • Removable & Replaceable Cable Entry Gland Plate

ACS1 Antenna Control System Configuration & Options... Continued

• **MCU Handheld Controller**

- P/N 01-01000-1
MCU Handheld providing:
Automatic Control Priority On Plug-In To MCU
Normal(Track) & Slew Speed Selection
Azimuth Axis CW & CCW Direction Jog
Elevation Axis Up & Down Direction Jog
Polarization Axis CW & CCW Direction Jog
3.5 Foot Interconnecting Cable
- P/N 01-01400-"X" ("X" = Length Required In Feet)
Connectorized Handheld Extension Cable
Max Length 1000 Feet

• **Position Encoders**

- P/N 99-05000-1
4:1 Position Encoder (2 each required, 1 AZ, 1 EL)
Weatherproof NEMA 4X Design
Weatherproof Cable Entry Gland Included
- P/N 99-05000-2
Synchro Transmitter (1 each required for POL)
Servo Mounting Size 11 Device

All position encoders are designed for 1:1 coupling to their respective axis. Any offset from a 1:1 relationship will require additional gear reduction that is not included. Please consult with BCS if antenna axes are not 1:1 ratio.

• **ACS1 Cabling Kits**

- P/N 02-02000-"X" ("X" = Length Required In Feet)
Kit of cables listed below allowing "X" feet of separation from the antenna mounted MCU and the ACU1. Cables between antenna mounted motors and limit switches and the MCU are estimated sufficient for an 11-meter earth station antenna.

The following cables are provided in each kit:

- Azimuth, Elevation, & Pol. Motors to MCU
- Azimuth, Elevation, & Pol. Limit Switches to MCU
- Azimuth, Elevation, & Pol. Position Encoders to ACU1
- ACU1 to MCU Control Cable
- ACU1 to MCU Status Cable

Other kits are available and can be designed to fit your job requirement. Please consult with BCS to determine your specific system cabling requirements. By adding length to the base part number above, larger or smaller antennas may be easily accommodated.

• **Additional Services** (Available On Request)

- Site Surveys
- Turnkey or Partial Installation
- Start-Up Services
- Repair Services
- Maintenance Contracts
- Training Classes
- Custom System and/or Component Design



Conclusion

With over 40 years of combined experience in the Satellite Communications Industry, Bradshaw Communication Systems (BCS) has the solution to get your job done right and on time. By providing extremely high quality products and services at economical prices, BCS has become a respected name in the industry and the right choice when it comes to satellite earth station antenna products and services. BCS has provided custom solutions for numerous customers and stands ready to provide components, systems, and services to best fit your specific requirements. Please contact BCS today regarding your requirements.

