

Computer Control of Satellite Antennas

This paper discusses the use of the serial interface available on Research Concepts, Inc. (RCI) satellite antenna controllers. The serial communications interface employed on RCI antenna controllers is electrically and mechanically compatible with the SA Bus protocol originally developed by Scientific Atlanta. All antenna controllers that support serial communications are shipped with a diskette (in the back of the manual) which includes software (IBM PC compatible, 3.5" floppy disk) that allows a user or installer to verify the operation of the controller's serial interface. See the table at the end of this section for a description of RCI products that support serial communications and the control software that is included with each controller. Other software packages are available from other vendors. A list of software vendors that have interfaced their products to RCI controllers is given at the end of this document.

The SA Bus protocol is based on RS-422 signal levels with a serial format of 7 data bits, even parity, and 1 stop bit (7E1) at user specified baud rates up to 9600 baud. A network of SA Bus devices consists of a single master (typically a PC) and up to 63 slave devices. The SA Bus communications protocol uses an ASCII message format with non-ASCII characters used for control and checksum information. Documentation of the SA Bus and the unique command sets for each controller are included in the operations manual.

RS-422 is a differential four wire interface which employs 0 and 5 volt signal levels. One pair of conductors is used for transmit and the other for receive. The receive lines of all slave devices are permanently tied to the master's transmit lines. Slave devices have the capability to selectively tri-state, or float their transmit lines. This allows the transmit lines of the slave devices to be tied together – a slave device only enables its transmit lines when it is responding to a command that addressed the device. Electrically, all slave devices are connected in parallel. The physical interconnection of slave devices can be realized via a 'daisy chain' configuration. The RC1000A antenna controller is equipped with a pair of D9 female connectors wired in parallel. The RC2000A/C, RC2500, and RC3000 antenna controllers are equipped with a single D9 female connector. See the appendix on cabling for more information.

Most personal computers (PC's) have at least one RS-232 serial interface port. Note that the RS-232 serial interface is not directly compatible with RS-422. A protocol converter (designated 'RC1KADP RS-232 to RS-422 Protocol Converter') is available from RCI. The converter is attached to the serial port of the PC and converts the RS-232 signal levels of the PC to those required for RS-422. Note that only one protocol converter is needed on each RS-232 port. A table and diagram describing the interface of the protocol converter to an IBM compatible PC and RCI antenna controllers is included at the end of this document. A checkout procedure for the protocol converter is described in the appendix of this document.

The following table briefly describes RCI controllers that support serial communications and lists the control software that is included with each controller.

Product	Description	Software Included with Controller
RC1000A	Single axis controller for use with antennas powered by 36 VDC actuators with integral pulse sensors for position feedback. Polarotor type servo polarization control is supported. All RC1000 antenna controllers produced after Oct.6, 1997 (s/n 5400) include support for the serial port. For units produced before that date support for the serial port was optional. Those units are field upgradable to a configuration that supports serial communications. The upgrade kit is designated RC1KS1.	RC1K.EXE and RC1KDEMO.EXE
RC2000A	Dual axis controller for use with antennas powered by 36 VDC actuators with integral pulse sensors for position feedback. Support for the serial port is included on all antenna controllers. Polarotor type servo polarization control is supported. When equipped with an optional daughterboard (designated RC2KPOL) the RC2000 can control a rotating feeds powered by a low voltage DC motor with potentiometer type position feedback.	RC2KC.EXE and RC2KDEMO.EXE
RC2000C	Same as the RC2000A with support for tracking inclined orbit satellites.	RC2KC.EXE and RC2KDEMO.EXE
RC2500	A dual axis antenna controller for antennas powered by an AIU (antenna interface unit) that employ resolvers for position sense (there is optional support for potentiometer based polarization position sense). All units support serial communications.	RC2500.EXE
RC3000	Auto locating controller for use on satellite uplink vehicles or with deployable terminals. Support for serial communications is an option.	RC3000.EXE

The RC1K.EXE, RC2KC.EXE, RC2500.EXE, and RC3000.EXE programs are written in Borland Turbo C for the DOS operating system. These programs feature a terminal like user interface that allows a user to specify commands to send to the controller. All bytes transmitted to and received from the controller are displayed in both hex and ASCII formats. These programs are suitable for verifying the operation of the controller's serial interface and for use by software developers. They are not suitable for use as a stand-alone control system. Source code is included with these programs. These programs will usually run in a DOS window under Windows 95/98. These programs require the use of either the COM1 or COM2 serial ports in the standard DOS configuration (address 3F8 and interrupt 4 for COM1, address 2F8 and interrupt 3 for COM 2).

The RC1KDEMO.EXE and RC2KDEMO.EXE programs are written by Broadcast Automation Systems. They were derived from the DOS version of the AutoPilot software (described in the next section). They support operation of a single RC1000A or RC2000A/C antenna controller. These programs are suitable for use as a standalone control package. These programs will usually run in a DOS window under Windows 95/98. These programs require the use of either the COM1 or COM2 serial ports in the standard DOS configuration (address 3F8 and interrupt 4 for COM1, address 2F8 and interrupt 3 for COM 2). Note that these programs are provided AS IS and are not supported by either RCI or Broadcast Automation Systems.

Note: These programs and the contents of the diskettes included with the antenna controllers can be downloaded from our web site at researchconcepts.com.

AUTOPILOT

RCI distributes the AutoPilot Downlink Manager (DLM) program written by Broadcast Automation Systems. AutoPilot DLM can control the RC1000A, RC2000A, RC2000C and RC2500 antenna controllers as well as the Standard Agile Omni model MT810, MT830, MT830BR and Standard Global Vu MT930 commercial satellite receivers. AutoPilot runs under Windows 95/98/NT/2000. A separate version of the software can control the RCI controllers listed above and DX657 receivers. See the appendices for more information on Standard and DX receivers.

AutoPilot DLM is available in four versions; AP 2/16, AP 4/16, AP 6/16, AP 8/16. For operation with DX receivers append 'DX' to the software version designation. AutoPilot DLM 2/16 can control one or two satellite antennas. AutoPilot DLM 4/16 can control up to four satellite antennas, and so on. All versions will support up to 16 satellite receivers. A demo version can be found on the RCI web site. AutoPilot gives the user the ability to manually jog the antenna and to adjust the receiver parameters as well as schedule antenna and receiver events. In its normal configuration, AutoPilot requires 2 serial ports - one for the antenna controllers and one for the satellite receivers. Note that the Standard Agile Omni 830BR and MT930 receivers can be configured to have an RS-422 compatible serial port. When configured for an RS-422 interface these Standard receivers and RCI antenna controllers can be controlled from single RS-232 serial port equipped with the RC1KADP protocol converter. See the table in the Standard Appendix for more information on 'shared port' configuration.

Other versions of the DLM software are available from Broadcast Automation Systems to control routers, video tape recorders, other types of receivers, and transmit equipment. A list of available drivers for the AutoPilot DLM software can be found on the RCI web site (Products & Services – AutoPilot page). Contact Broadcast Automation Systems (ph: 416-264-8415) for pricing and delivery information on versions of AutoPilot DLM that can control devices other than RCI antenna controllers and the Standard or DX receivers listed above.

Remote Control

Remote control in this discussion refers to the ability to control the satellite antennas and receivers located at a headend facility via a PC at a remote location. A version of the Windows AutoPilot Downlink Manager is available which can control a telephone modem. This version of Downlink Manager is designed to work with RCI antenna controllers and Standard Agile Omni receivers operating in RS-422 mode. The modem at the headend is configured to 'auto answer' and is equipped with an RS-232 to RS-422 protocol converter. The antenna controllers and receivers are configured to share a single RS-422 port.

The standard versions of AutoPilot DLM (as well as the programs included on the diskette with the controllers) do not have the capability to control a modem. To implement remote control on these controllers there are three possible schemes that can be used.

One scheme is to use dedicated channels to connect a PC running AutoPilot with the antenna controllers and receivers at the headend. With this method the RS-232 output from the PC (at a remote location) must be transferred to the headend facility so that the PC thinks that it is located at the headend facility. This can be accomplished using special modems and dedicated phone lines, fiber optic cables, or an STL (studio transmitter link). The thing to keep in mind is that **standard** versions of the AutoPilot software do not have the ability to send control information to configure modems or to provide any initialization information for any devices which may be necessary to implement the communication channel between the remote location and the headend.

A second scheme is to have a PC at the headend facility which runs AutoPilot as well as a remote access communication program such as the Symantec Corporation's PC Anywhere. Using the remote access software, a PC at a remote location can dial up the PC located at the headend via a regular telephone line. Once a connection has been made, anything that is typed on the remote PC is registered on the headend PC just as if the user at the remote site were sitting at the headend PC. In a similar fashion, anything that is displayed on the PC monitor at the headend is also displayed on the monitor of the remote PC. On the headend PC, if the remote access software and the AutoPilot software are invoked at system startup, the remote PC will power up and automatically invoke the remote access software and run AutoPilot. Many AutoPilot users have successfully used a remote access program to implement remote control. A moderate amount of computer expertise is required to properly configure the remote access software.

A third method has been used to obtain remote control of an RC2000 antenna controller using the RC2KDEMO.EXE program included with the RC2000 antenna controller. At the headend site a modem which is configured to auto answer incoming calls is installed. At the remote site a PC running communications software (such as ProComm Plus) dials up the modem at the headend. Once a link is established the user shells out of the communications software to obtain a DOS prompt. At the DOS prompt the user invokes the RC2KDEMO.EXE program which is used to control the RC2000 at the headend. The baud rate specified via the CONFIG menu of the RC2KDEMO program must match the baud rate used by the communications program to establish contact with the headend. Also, the number of data bits, parity settings, and stop bits specified for the communications program must match those required for communication with the antenna controller (7 data bits, even parity, and one stop bit).

Appendix - Standard Receivers

The AutoPilot program can interface to 4 different models of Standard receivers - the Agile Omni MT810, the Agile Omni MT830, the Agile Omni MT830BR, and the Global Vu MT930B. The Agile Omni MT830 can be upgraded to the MT830BR configuration by installing the CAM830 module. The model currently in production is the MT930B.

To configure the Standard MT810 and MT830 receivers for serial communication with an IBM compatible PC, an optional circuit board must be installed in the receiver. For the MT810 Agile Omni Professional receiver this option is referred to as the CRC810 Computer Remote Control Board. For the MT830 Agile Omni Broadcast receiver this option is the CRC850 Computer Remote Control Board. The electrical interface used by the PC to communicate with the Standard MT810 and MT830 receivers is referred to by Standard as a TTL interface. The TTL interface is unique - it is not compatible with RS-232, RS-422 or any other common protocol. The connector for the TTL interface is a phono (or RCA) jack. Standard did produce a protocol converter, designated CRC800CI Computer Interface Cabling, that converts the RS-232 serial interface available from a PC into what their receivers want to see. The CRC800CI interfaces to the PC port via a DB25 connector. Note that the CRC800, CRC810, CRC850, and CRC800CI options are no longer available from Standard.

For the MT810 receiver, the address (0 to 31) and baud rate (300, 1200, 2400, and 4800) are selected via DIP switches on the CRC810 board. For the MT830 (without the CAM830 module installed) the address is the last 5 digits of the serial number and the controller can communicate at baud rates up to 4800 baud – the MT830 automatically selects the baud rate based on the baud rate of the received data stream. The serial communications parameters of the MT810 and MT830 are 7 data bits, even parity, and one stop bit (7E1).

The Standard MT830BR satellite receiver can be configured to support either the TTL interface described above, a quasi RS-232 interface, or an RS-422 interface. The word quasi is used with the RS-232 interface because unlike other RS-232 interfaces, the transmit line of the receiver is allowed to float (or tri-state) when the receiver is not transmitting. This allows Standard MT830BR receivers using the RS-232 interface to be controlled directly from a PC port and connected together in a daisy chain configuration. The connector used on the MT830BR is an eight-position mini din jack. A 'Y'-shaped pigtail cable is supplied with the MT830BR receiver than connects to the 8-pin DIN jack on the receiver, a DB9 connector that connects to the PC Comm port or Protocol Converter, and a DB9 connector to daisy chain multiple receivers. The Standard MT830BR's RS-422 interface is compatible with the interface used on the Research Concepts antenna controllers - the only difference is the pinout of the D9 connector. See the paragraph below on shared port operation.

To configure the MT830BR to use the TTL interface, the TTL menu item of the time/date menu must be set to ON. To use either the RS-232 or RS-422 interface, the TTL menu item must be set to OFF. The selection of either RS-232 or RS-422 interfaces is accomplished via internal jumper - please refer to the Standard receiver documentation. The following table provides information on the MT830BR when configured for TTL and RS-232/RS-422 operation.

MT830BR Configuration Information

Configuration Item	TTL Interface	RS-232/RS-422 Interface
TTL Menu Item	Set to ON	Set to OFF
Serial Communications	7 Data Bits, Even Parity, One Stop Bit	8 Data Bits, No Parity, 1 Stop Bit (8N1)

Parameters	(7E1)	
Addressing	Last 5 digits of Receiver serial number	Set via the Front Panel ADDR Menu Item – 0000 to 9999
Baud Rate	Up to 4800 Baud – Automatically Syncs to the Incoming Data Stream	Set via the Front Panel BAUD Menu Item – 300, 1200, 2400, 4800, 9600, and 19200 Baud

The Standard Global Vu MT930B satellite receiver can be configured via the front panel to operate in an EIA232 or 'RS-485' interface mode. EIA232 appears to be a subset of the RS-232 interface employed on the MT830BR – the DTR and DSR signals are not included in the EIA232 specification. The 'RS-485' interface is compatible with the RS-422 interface employed by the MT830BR. The connector used on the MT930 is a D9 male. The serial communications parameters are 8 data bits, no parity, and 1 stop bit (8N1). The user can set the address and baud rate via the front panel. The range of addresses is 0000 to 9999 and the supported baud rates are 300, 2400, 9600, 19200, and 38400 baud.

The RS-485 port on early versions of the MT930B was miswired. The following is an excerpt from an addendum for early MT930B documentation provided by Standard.

RS485 Physical Interface

When RS485 is selected:

Pin Connector	Description
1	NC
2	NC
3	NC
4	IN (+); Noninverting Receiver Input
5	GND; Common Ground
6	OUT (+); Noninverting Driver Output
7	OUT (-); Inverting Driver Output
8	IN (-); Inverting Receiver Output
9	NC

Note: Some units with serial numbers less than 98U010400 have been wired with pins 4 and 8 reversed. Units with serial number 98U010400 or less have been inspected and/or corrected, and are marked with a small paper dot label (about 4 mm in diameter).

For more information about the communication capabilities of the Standard receivers please contact Standard Communications at (310) 532-5300.

Standard MT830BR and MT930B Shared Port Operation/Connection to an RC1KADP Protocol Converter

It is possible for Standard MT830BR and/or MT930B receivers configured for RS-422 operation to be controlled via a common RC1KADP protocol converter by the AutoPilot DLM software. The RCI controllers and Standard receivers can be connected in a 'daisy chain' configuration. Electrically both types of devices are connected in parallel. The pinout on the D9 connectors used to interface to the two types of devices is different. The following table describes the differences.

RC1KADP J3 Connector	RCI Antenna Controller D9 Connector Terminal	Standard MT830BR and MT930B RS-422 D9 Connector Terminal
SHLD		
RXD	4	6
/RXD	6	7
TXD	3	4
/TXD	9	8

Appendix - DX 657 Receiver

The DX 657 receiver has the ability to be controlled via a serial interface. The data format is 7 data bits with even parity and 1 stop bit (7E1) at a data rate of 1200 baud. Multiple receivers can be controlled from a single RS-232 port. One DX 657 receiver must have the RS-232 control option installed. Other DX 657 receivers can then be interfaced via RJ11 (telephone) connectors to the receiver with the RS-232 option installed.

Appendix - RC1KADP Checkout Procedure

To verify the operation of the RC1KADP and PC serial port, a loopback test on the RS-422 side of the protocol converter can be performed. To configure the RC1KADP for the loopback test, disconnect the serial communications interface cable from the controller, and on connector J3 (the one with 5 terminals) of the RC1KADP, connect RXD to TXD and /RXD to /TXD. During a loopback test, any character transmitted by the PC is also received by the PC. Use the RC2KC.EXE, RC1K.EXE, RC2500.EXE, or RC3000.EXE programs described earlier to send characters out of the PC serial port and display the received characters. If the received characters match the transmitted characters the serial port and protocol converter are working.

If the loopback test works but attempts to communicate with the antenna controller are unsuccessful try to repeat the test by placing jumpers on the D9 connector that plugs into the controller. If the loopback test works when the jumpers are placed on the 5 terminal connector of the RC1KADP but not when jumpered at the connector that plugs into the controller either the connector is miswired or there is an open circuit in the cable connecting the RC1KADP to the controller.

If the loopback test on the RS-422 side of the protocol converter doesn't work, remove the cable connected to the RC1KADP's RS-232 interface (the 3 terminal connector) and jumper the conductors that were connected to the RS-232 transmit (TXD) and receive (RXD) terminals of the PC (pin 2 to pin 3 on the computer's D9 male or D25 male serial port connector). If the loopback test does not work, the PC's serial port may be defective or not configured properly.

Appendix – Cabling

The RS-422 output of the RC1KADP protocol converter should be routed to the controllers in a daisy chain fashion. Four conductor, shielded cable with a bare drain wire should be used to connect the protocol converter and controllers together. If the cable contains 24 AWG conductors it is possible to twist a pair of conductors together from the separate legs of the daisy chain and solder them into the 'solder cup' of a common D9 type connector terminal. A short length of 3/32" heat shrink tubing can be placed over both conductors and the connector terminal solder pot to provide insulation and strain relief.

At the RC1KADP the drain wire should be connected to the SHLD terminal. At the controller the drain wires of cables that terminate on the common connector should be spliced together. The drain wires can either be spliced together inside the connector shell or the drain wires can be tied to an unused terminal on the controller's SA Bus connector – the unused connections on the RC1000A, RC2000A/C, RC2500, and RC3000 antenna controller's SA Bus connector are open circuited.

Examples of 4 conductor, 24 AWG, shielded cables with a bare drain wire are Belden 9504, 9681, 1421A, 88104, 89504, 82504 cables and Alpha 5094C, 5494C, 25494 cabling. For twisted pair cable configurations place the RXD, /RXD signals on one pair and the TXD, /TXD signals on another pair.

Appendix - Software Vendors

The following companies have produced software to control RC1000 and RC2000 antenna controllers:

Broadcast Automation Systems, (416) 264-8415	Email: wjcoutts@rogers.com
Image Communications, (941) 322-2534	Website: www.compusat.com
Louth Automation, (650) 320-2002	Website: www.louth.com
Phillips Automation, (408) 866-9373	Website: www.broadcastphillips.com
Crystal Computer Corporation, (770) 932-0970	Website: www.crystalcc.com
Link Research, +44 1923 244 233 (England)	Website: www.linkres.co.uk
Florical Systems, (352) 372-8326	Website: www.florical.com
M and C Systems, (972) 422-5524	Website: www.mcsys.com
Kerrvayne Systems, (905) 475-6161	
Gentner Communications, (800) 945-7730	Website: www.gentner.com
Danfix Systems, +46-8-760-5907 (Sweden)	Email: dgarde@algonet.se
Sundance Digital, Inc., (972) 444-8442	Website: www.sundancedigital.com
Novus Development, (303) 277-1966	Website: www.novusdevelopment.com
BBC Technology, BNCS, +44 20 8 225 8739	Website: www.bncs.co.uk

RC1KADP PROTOCOL CONVERTER WIRING

IBM PC Serial Port Signals	IBM PC Serial Port	Cable from J2 ADP	RC1KADP J2 Terminal Strip	RC1KADP J3 Terminal Strip	Cable from RC1KADP J3	RC2000 J3	RC2000 J3 Signal Name
	DB9 male	DB9 female	See note	See note	DB9 male	DB9 female	
				SHLD			
Transmit data	3	3	RXD	RXD /RXD	4 6	4 6	Transmit /Transmit
Receive data	2	2	TXD	TXD /TXD	3 9	3 9	Receive /Receive
Common	5	5	Ground				

IBM PC Serial Port Signals	IBM PC Serial Port	Cable from J2 ADP	RC1KADP J2 Terminal Strip	RC1KADP J3 Terminal Strip	Cable from RC1KADP J3	RC2000 J3	RC2000 J3 Signal Name
	DB25 male	DB25 female	See note	See note	DB9 male	DB9 female	
				SHLD			
Transmit data	2	2	RXD	RXD /RXD	4 6	4 6	Transmit /Transmit
Receive data	3	3	TXD	TXD /TXD	3 9	3 9	Receive /Receive
Common	7	7	Ground				

NOTE: The RC1KADP, J2/J3 connectors, are equipped with clamp type terminals. Each terminal can accommodate one or two 20 AWG or smaller wires. Secure wire clamps with a 1/8" (3mm) wide straight blade screwdriver. If the RS-422 cable is shielded, the shield should be connected to the SHLD terminal of connector J3 of the RC1KADP.

