1. Introduction and Specifications

The SIGMET, Incorporated, model RCP8™ provides a convenient interface between a modern weather radar system and advanced application software. All of the radar I/O and low-level antenna control are handled by the RCP8 which communicates with a host computer via an Ethernet interface or a standard RS232 serial line. The application software on the host computer monitors the serial line for status information and issues high-level commands for control. The flexibility of the RCP8 allows the unit to be connected to weather radar systems from different manufacturers. It is fully compatible with SIGMET's previous generation RCP02.

The RCP8 provides position and velocity servos for both the AZ and the EL axes of the antenna, the status monitoring of the transmitter/receiver/antenna servo systems and the control functions such as Radiate On/Off and Servo On/Off. Even synchro signals can be input into the RCP8 directly. The Ethernet or RS232C interface can be connected to virtually any workstation or PC and is fully compatible with SIGMET's RVP8 signal processor and IRIS software system.

The features of the RCP8 are summarized in **Table 1.3**. Of special note are the fail-safe features of the RCP8 which are designed to protect the radar and antenna system in the event of a failure. The flexibility of the I/O design is based on SIGMET's over 25 years of interfacing experience to different weather radar systems.

An optional feature is antenna stabilization for moving platforms, such as ships or airplanes. For shipboard use, the RCP8 accepts position, attitude and speed information from an inertial navigation unit (e.g., the Honeywell MAPS Hybrid system.) The antenna will then scan in Earth coordinates regardless of the platform pitch, roll, or heading.

The speed of modern processors and the flexibility of the Linux operating system allow the RCP8 and the SIGMET IRIS/Radar software to be installed on the same PC with no hardware changes. This is called an "RCP8/RCW" (Radar Control Workstation). This saves the purchase and maintenance cost of an additional PC.

In this chapter:

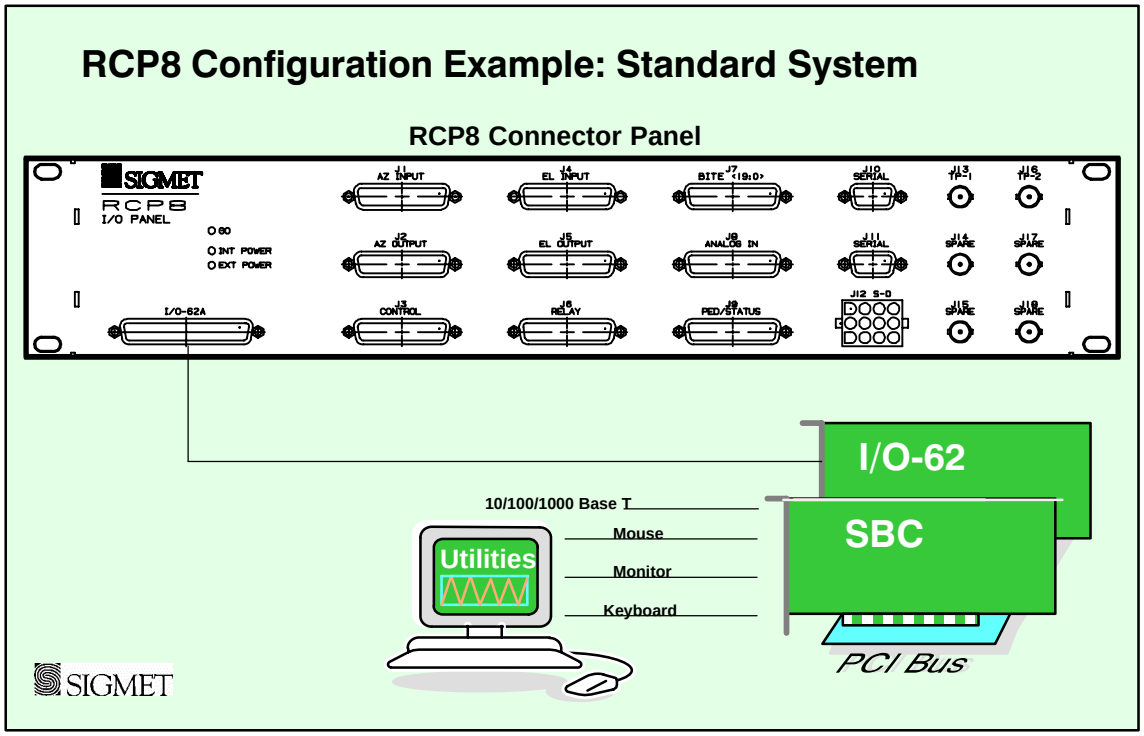
General Architecture	**Section 1.1**
Network Architecture	**Section 1.2**
RCP8 Specifications	**Section 1.3**

1.1 General Architecture

The SIGMET, Inc. RCP8™ is based on a standard PCI architecture under the open Linux operating system. A typical unit is supplied in SIGMET's standard 4U 19" EIA rackmount chassis. Unlike a standard PC, the chassis is ruggedly constructed with redundant power supplies, captive quick release fasteners, PCI card guides and security hold–down bar. A standard system contains the following components listed below and shown in **Figure 1–1**:

- Motherboard or single-board Intel Pentium system with single or dual processors.
- SIGMET I/O-62 general purpose I/O board.
- SIGMET RCP8 Connector Panel (connects to I/O-62).

Figure 1–1: RCP8 Architecture



Depending on the application, other standard commercial PCI cards may be provided by SIGMET or added by the customer for additional I/O capability such as the following:

- 10/100–BaseT Ethernet card for additional network I/O (e.g., a backup network).
- RS-232/RS-422 serial cards for serial angles, remote TTY control, etc.
- Sound card to synthesize audio waveforms for alarm applications.
- GPS card for time synch.
- IEEE 488 GPIB card for control of test equipment.

The front panel of the RCP8 houses a bright, 2-line display that shows diagnostic and error messages as well as the position information. An example is shown below.

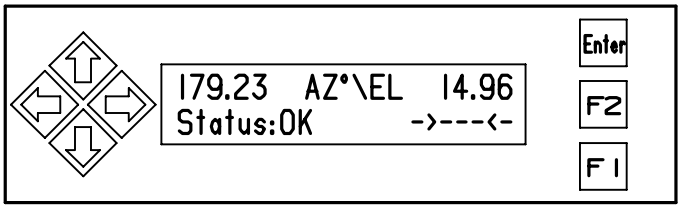


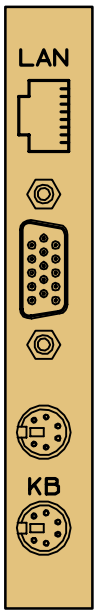
Figure 1–2: Front Panel Display

The front of the unit also contains a CDRW and 1.44 MB diskette for backup, software installation and maintenance.

The RCP8 is configured using a local keyboard, mouse and monitor or can be configured remotely over the network. The configuration menus are TTY text-based menus which allow the configuration of the antenna servos, host computer interface and the programmable control logics. The TTY menus also provide status and monitoring for diagnostic purposes and during the antenna stabilization process. Pin assignments to the Connector Panel are made in the softplane.conf file. This eliminates the need for jumpers and custom wiring.

The major hardware components are described in the sections below. **Section 1.3** contains detailed specifications of the RCP8.

1.1.1 Mother Board or Single-Board Computer (SBC)

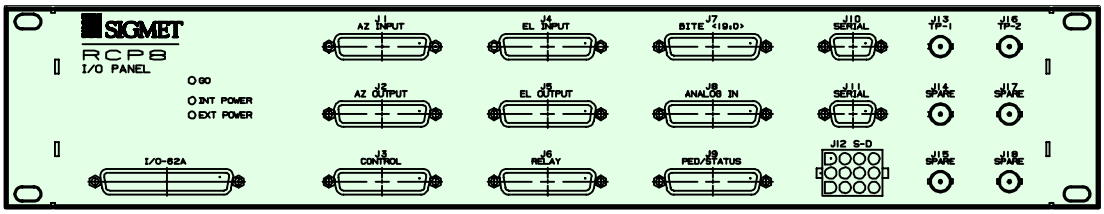


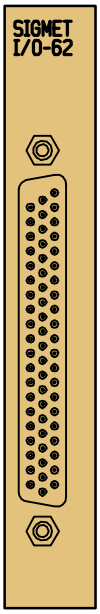
The dual-CPU Pentium mother board or single-board computer (SBC) acts as the host to the Linux operating system and provides all of the compute resources for performing the antenna servo control as well as the status and monitoring . Standard keyboard, mouse and monitor connections are on the SBC or motherboard backpanel, along with typically two 10/100/1000 BaseT Ethernet ports. The system does not require that a keyboard, mouse or monitor be connected which is typically the case at an unattended site. An SBC example is shown on the left.

Motherboards and SBC's are available from many vendors, at various speeds Typically the SBC is equipped with 128 MB RAM. The RVP8 chassis has a front bay for a >20 GB hard disk. CDRW is also provided for backup and software maintenance. Note that the latest versions of the RVP8 software and documentation can always be downloaded from SIGMET's web site for FREE.

The SBC also plays host for SIGMET's RCP8 Utilities which provide test, configuration, control and monitoring software as well as built–in on-line documentation.

1.1.2 I/O-62 PCI Card and I/O Connector Panel





The SIGMET I/O-62 is a short format PCI card that provides extensive I/O capabilities for the RCP8. Note that the identical card is used in the SIGMET RVP8 Digital Receiver and Signal Processor. A typical installation would have one I/O-62 and an RCP8 Connector Panel shown above. The I/O-62 has a single 62-position, high-density "D" connector. This is attached to the rackmount RVP8 Connector Panel via a standard 1.6 m (6 foot) 1:1 cable. Typically the Connector Panel is installed in the same rack as the RCP8.

The I/O-62 is configurable in software, i.e., there is no need to open the chassis to configure jumpers or switches. This means that when a spare board is added, there is no need to perform hardware configuration or custom wiring. The physical I/O lines are summarized in the system specifications, **Section 1.3**.

If more I/O is required, then a second I/O-62 can be installed. This makes for easy expandability of the system.

ESD Protection Features

Since the I/O lines are connected to the radar system, there is a potential for lightning or other ESD type damage. This is addressed aggressively by the I/O-62 in two ways:

- Every wire is protected by a **Tranzorb** diode which transitions from an open to a full clamp between ±27 to ±35 VDC. Additionally, the Connector Panel uses **Tranzorb** diodes on every I/O line for double protection.
- High-voltage tolerant front-end receivers/drivers are used. All components connected to the external pins can tolerate up to ±40V. For example, the TTL and wide range inputs use protectors that normally look like 100 Ohm resistors, but open at high voltage.

These features make the RCP8 very robust to transient surges.

Run Time FPGA Configuration

The SIGMET I/O-62 card is built around a 100K–Gate FPGA which, in addition to driving the I/O signals on the 62-position connector, also coordinates the PCI traffic. These chips are SRAM–based, meaning that they are configured at run time. This allows the FPGA code to be automatically upgraded during each RVP8 code release without needing to physically reprogram any parts.

The board's basic I/O services use up only 40% of the complete FPGA. The leftover space makes it possible to add smart processing right on the I/O-62 board to handle custom needs. Some examples include generating custom serial formats, data debouncing, and signal transition detection. In general, I/O functions that would either be tedious or inappropriate for the host computer SBC can likely be moved onto the I/O-62 card itself.

The following two pages summarize the electrical characteristics of the I/O for both the the I/O-62 and the connector panel.

1.2 System Network Architecture Options

The RCP8 provides considerable flexibility for network operation. This allows remote control and monitoring of the system from virtually anywhere on the network, subject to the user's particular security restrictions.

There are three basic types of workstations/computers to consider:

- **RCP8** itself- this can be equipped with a local keyboard, mouse and monitor.
- **Host Computer Radar Control Workstation (RCW)-** this is running the user's application software (e.g., the SIGMET, Inc. IRIS/Radar™ software and utilities).
- **Remote Workstation**- a networked workstation used for remote control and monitoring. This may be running only X–Windows or additionally the user's application software or the IRIS application software.

The RCP8 provides two types of physical interfaces:

- **RS232C serial line interface**- typically running at 9600 baud.
- **Ethernet socket interface**- at 10/100/1000 BaseT. The SIGMET AntExport software provides a socket interface to other workstations on the network.
- **Native connection-** here the RCP8 is used to run application software locally. The local connection is via a FIFO interface.

Combining the different types of workstations and the physical interfaces, SIGMET supports three different ways of connecting the RCP8 to a network:

- **Case 1: Standard Serial Line**- the connection. between the RCP8 and the Host RCW.
- **Case 2: Combined RCP8/RCW**- To eliminate the need for a separate host computer, the RCP8 and RCW can be run on the same computer. Note that SIGMET can only guarantee the performance of this configuration if the RCW is running the SIGMET IRIS software. However, user's are free to run their own application software directly on the RCP8.
- **Case 3: TCPIP Socket**- Ethernet connection between the RCP8 and the Host RCW. (Support is pending for this feature)

These three cases are discussed in the following sections.

1.2.1 Case 1: Standard Serial Line Interface

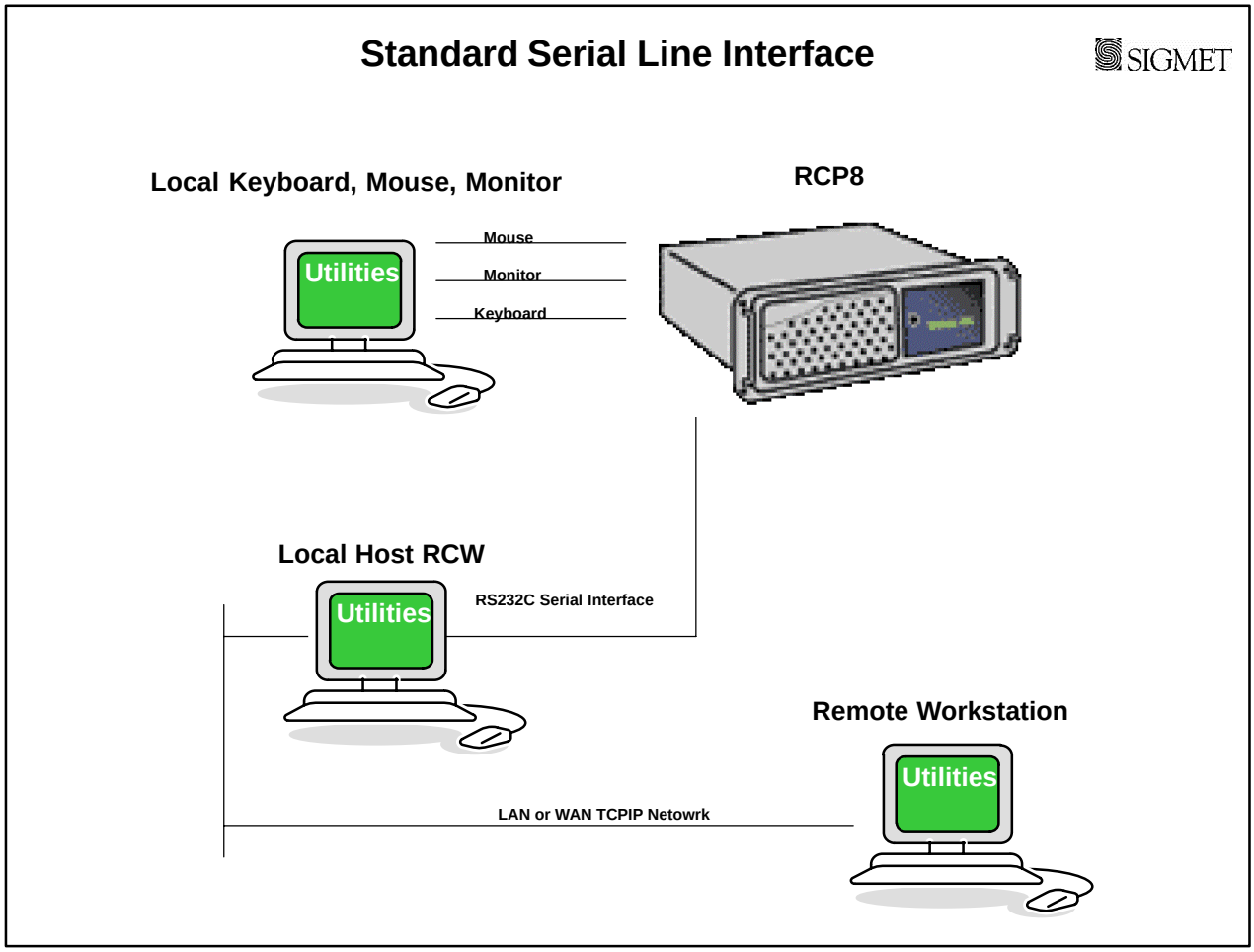


Figure 1–3: Network Architecture- Case 1: Standard Serial Interface

This architecture is used for most applications. Note that this is the identical architecture used for the previous generation RCP02. The access by the remote computer assumes that there is sufficient band–with to export an X–Window from the RCW. This typically requires at least 128 KBit/sec. Note that satellite links may have this band width, but their latency will lead to slow X–Window export. In this case, it is better to use the Case 3: Hybrid Serial/Socket approach.

1.2.2 Case 2: Combined RCP8/RCW

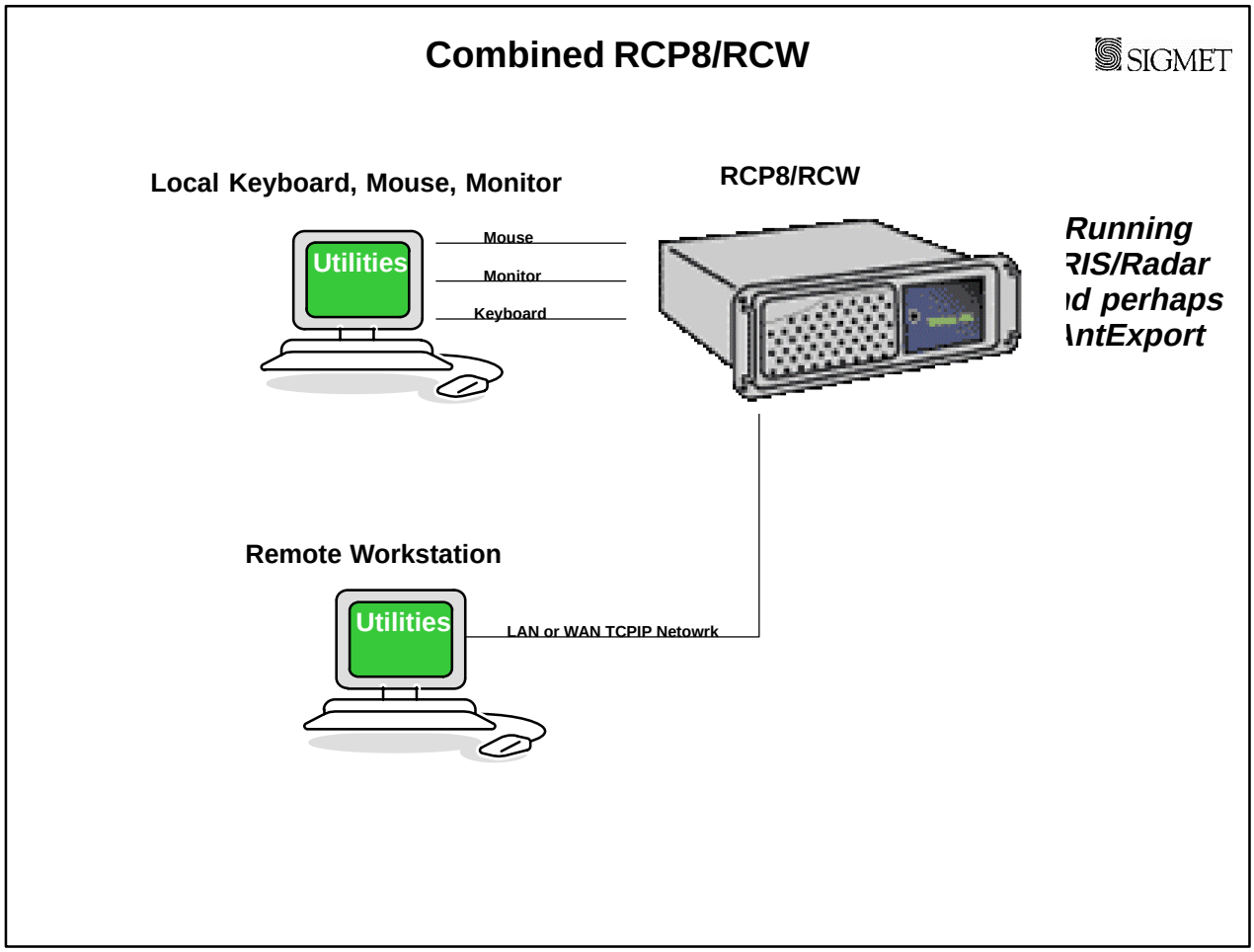


Figure 1–4: Network Architecture- Case 2: Combined RCP8/RCW

Because of the speed of modern computers, the RCP8 and IRIS/Radar software can be run on the same machine. In this case, access from a remote workstation is done by X–Window export. In the case of a slow link to the Remote Workstation, AntExport can be run on the RCP8/RCW to service a low-speed connection to a remote workstation.

1.2.3 Case 3: Socket Interface Using AntExport

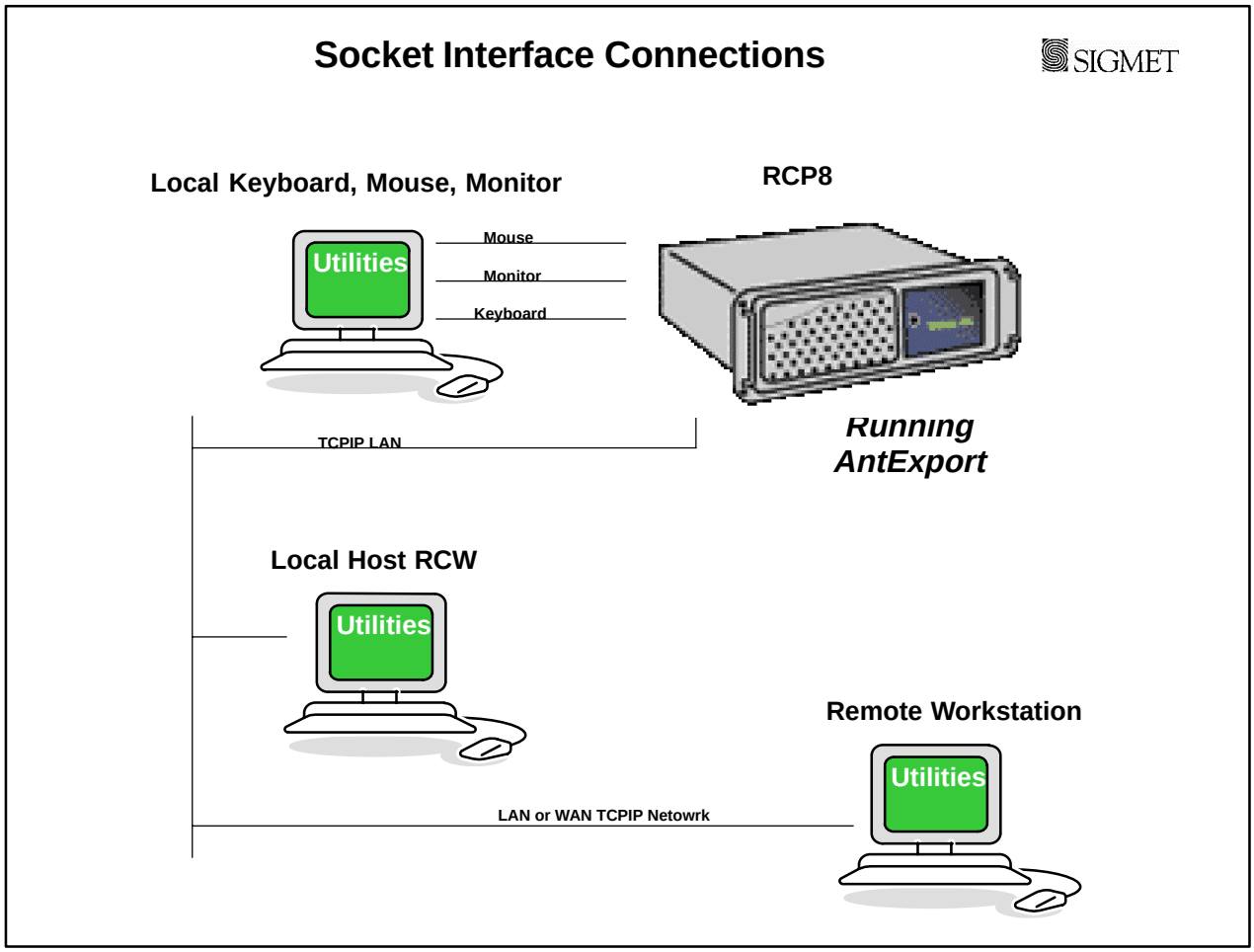


Figure 1–5: Network Architecture- Case 3: Socket with AntExport

In this architecture the RCP8 runs AntExport to provide a socket connection between the RCP8 and the Host computer. Note that any computer on the network can, in theory, function as a direct controller of the RCP8.

1.3 RCP8 Specifications

1.3.1 Antenna Control I/O and Features

- **Approach:** Digital position and velocity servos with interactive software parameter tuning.
- **AZ/EL Position Input:** TTL 16–bit binary angle, 14–bit BCD or 90V 60Hz synchro (nominal).
- **AZ/EL Position Output:** TTL 16–bit binary angle.
- **AZ/EL Tachometer Input (if available):** $\pm$ 70V signed analog input voltage.
- **Servo drive error**: $\pm$ 10V analog output to AZ/EL servo amplifiers
- **Servo Control/Status:** On/Off control via TTL or switch closure output. On/Off status via wide range input.
- **Antenna:** Local mode switch input, switch closure or TTL.
- **Alternate Control Relay Signal:** 12V output to external relays to switch to alternate control such as handwheels when the antenna is in local mode or "shutdown" state.

1.3.2 Fail–safe Antenna Protection Features

- **Elevation Soft Limits:** Automatic software override brings antenna to a gentle stop at the specified limits.
- **Elevation Shutdown Limits**: Antenna is placed in shutdown state if the upper or lower limit is exceeded.
- **Elevation Limit Switch Inputs:** EL Hi/Low TTL or switch closure. Antenna is placed in a shutdown state if a limit switch is encountered.
- **Tachometer Check Watchdog:** The calibrated tachometer is compared to the differenced position for consistency. Shutdown is invoked if the check fails. Protects against loss of tach or position sensors.
- **Antenna Response Watchdog:** Based on an internal model of the antenna inertia and damping moments, the response of the antenna to drive output requests is checked for consistency. Shutdown is invoked if the check fails. This protects the antenna from a jammed or broken gear, or if equipment such as a scaffold is inadvertently hit by the antenna.
- **Antenna Maximum Speed Watchdog:** Shutdown is invoked if the specified maximum speed of the antenna is exceeded.
- **Antenna Max Acceleration Limit:** Based on the internal antenna model, this check limits the drive output to stay within a specified acceleration limit.

1.3.3 Optional Shipboard Stabilization

- **Approach:** Stabilization algorithms scan the antenna in "earth" coordinates using AZ and EL velocity and position servos that are adjusted for the pitch, roll and heading (and rates of change) of the platform.
- **Platform Motion Sensor Input:** Pitch, roll heading and rates and absolute platform position and velocity from inertial navigation system such as the Honeywell MAPS system on SDLC serial line or Seatex, Inc. Seapath 200 system on RS232C serial line. GPS update and "at–sea" alignment are highly recommended for any INU system.
- **Range of Operation:** Typical 0 to 65° elevation (earth relative) for up to 15° of attitude change. **Note**: Antenna pedestal should be capable of ~ –20° of elevation.
- **Typical Performance:** 0.1° of accuracy for elevation angles in the range 0 to 65° for inclinations, up 15° over 10 second periods. Exact performance depends on servo drive performance.
- **Built–in Display Features:** Selectable earth or pedestal relative AZ/EL position and/or velocity.

1.3.4 Radar Status/Control I/O and Features

- **I/O Configuration:** The softplane.conf file is used to configure the I/O pin assignments to the Connector Panel. This virtually eliminates the need for jumpers and custom wiring typical of legacy systems.
- **Standard Status Wide Range Inputs:** Servo Power, Antenna Local Mode, Lower and Upper EL Limit switches, T/R power, T/R Local Mode, Radiate Standby, Radiate on, Magnetron Current, Wave Guide Pressure, Airflow, Interlock, external Reset input signal, Trigger Blanking input signal and pulse width (up to four coded in two bits).
- **Standard Control Outputs:** These are wide range inputs or switch closures to ground. Standard parameters are Servo power, T/R power On/Off, Radiate On/Off (TTL or switch closure), Cabinet Relay, Trigger Blanking, equipment Reset signal, and pulse width (up to four bits).
- **BITE I/O:** Up to 60 TTL lines configurable in groups of 10 to be either input or output lines. These are used for BITE/IO. Note that 100 additional lines can be added by adding a second I/O-62 card.
- **Programmable Control Logics:** User programmable status/control logic actions in a flexible C–like programming interface. For example, if the antenna radome is opened, the system can automatically sound an alarm for a programmable time and immediately de–radiate and stop the antenna.

1.3.5 Application Software for Test/Monitoring

- **"antenna" Utility:** For control and monitoring of the antenna and standard status and control parameters. Includes sun tracking feature for antenna alignment check.

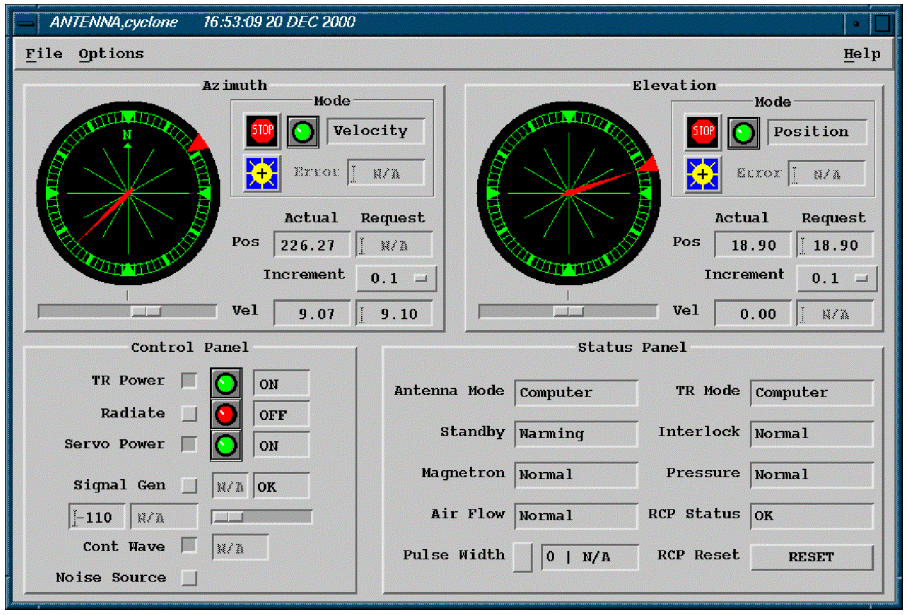
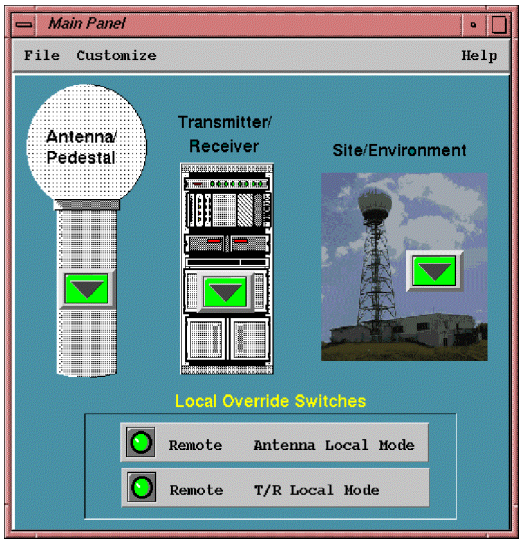
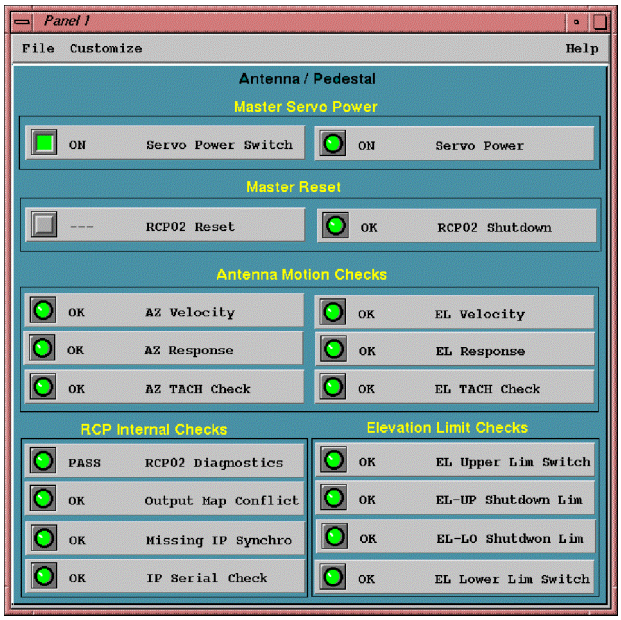


Figure 1–6: Antenna and Bitex utility examples

- **"bitex" BITE Examiner Utility:** For status monitoring and control of BITE (built-in test equipment). Graphical backgrounds and control/status widgets can be customized by the user, including quantitative BITE from analog inputs.





1.3.6 SIGMET I/O-62 PCI Card

- Short format PCI card with 62-position "D" connector. Multiple cards may be installed.
- Includes D/A, A/D, discrete inputs and outputs (TTL, wide range, RS422, etc.) See summary table below.
- Expandable I/O allows the addition of a second I/O-62 and Connector Panel.
- I/O pin assignment mapping by **softplane.conf** file allows easy reconfiguration of the pin assignments without need for custom wiring.
- ESD protection using Tranzorb™ silicon avalanche diode surge suppression and high-voltage tolerant components.

	SIGMET I/O-62 Summary of Electrical Interfaces
Qty	**Description**
40	Lines configurable in groups of 8 to be either inputs or outputs. The electrical specifications are software defined within each group as follows: •Single-ended TTL input or output with software–configured pull-up or pull-down resistors for inputs. •Wide range inputs (±27VDC, threshold +2.5VDC), often used for "lamp voltage" status inputs. •RS-422/485 @ 10 MBit/sec (requires two lines each). RS-422 receivers can be configured in software to have 100-Ohm termination between each pair.
8	A/D convertors configurable as 0, 4, or 8 convertors, ±2V, 12 bits @ 10 MHz, These lines are shared with some of the 40 I/O lines listed above.
2	D/A convertors, ±10V 1 MHz update rate, output can drive a 75-Ohm load.
2	SPDT relays on the board. These are often used for switching high power relays. Contacts are diode protected.
2	RS-232C full duplex lines (Tx and Rx)
4	12V 75-Ohm trigger drivers .
2	Power/Ground pairs of 12V power (filtered, fused) for external equipment or remote backpanel use (up to 24 W total). Polyfuse technology acts like a circuit breaker with auto reset in the event of an overload.
8	Ground wires for signal grounds from the remote back panel.

1.3.7 RCP8 Standard Connector Panel

- Mounts on front or rear of standard 19" EIA rack and connects to I/O-62 via 1:1 62-pin 1.8-m cable (provided).
- 3 internal relays and 4 12V relay control signals for switching external devices.
- Programmable pin assignments made in **softplane.conf**.
- Diagnostic power supply and self test LED's for troubleshooting.

RVP8 Connector Panel Summary

J-ID	Label	Type	Description
J1	AZ INPUT	DBF25	Up to 16–bits of parallel TTL binary or BCD angle
J2	AZ OUTPUT	DBF25	Up to 16–bits of parallel TTL binary angle in earth coordinates.
J3	CONTROL	DBF25	16 assignable digital control/status lines and two RS422 differential lines. Default control assignments are Pulse Width (2 bits) Radiate On, Radiate Off, Reset. Default status assignments are Pulse Width (2 bits), Radiate, Servo Power, Transmit Power, Reset.
J4	EL INPUT	DBF25	Up to 16–bits of parallel TTL binary or BCD angle
J5	EL OUTPUT	DBF25	Up to 16–bits of parallel TTL binary angle in "earth" coordinates.
J6	RELAY	DBF25	3 internal relays, contact rating 0.5 A continuous. The switching load is 0.25 A and 100V, with the additional constraint that the total power not exceed 4VA. 4, 12V relay control signals, up to 200mA. (Note that external relays should be equipped with proper diode protection to shunt the back EMF).
J7	BITE 19:0	DBF25	20 additional TTL I/O lines each configurable to be input or output. Used for BITE Status and Control
J8	ANALOG IN	DBF25	10 differential analog inputs, up to ±20V max multiplexed into A/D convertor sampling each at >1000 Hz.
J9	PED/STATUS	DBF25	AZ/EL Tachometer Differential inputs (±2 to 70 VDC) and AZ/EL Drive outputs (±10 VDC). Additional status inputs: Wave Guide Pressure, Airflow, Interlock, Mag Current, Local Mode, Standby, El Upper and Lower Limit Switches.
J10	SERIAL	DBF9	RS232C
J11	SERIAL	DBF9	RS232C
J12	S–D	Modular	3 x 4 matrix connector for AZ and EL synchro and reference inputs (nominally 90V and 60 Hz).
J13	TP1	BNC	Programmable scope test point. 75 Ohms
J14/15	SPARE	BNC	

J16	TP2	BNC	Programmable scope test point. 75 Ohms
J17/18	SPARE	BNC	

1.3.8 Physical and Environmental Characteristics

Packaging

- Motherboard Configuration 4U rackmount with 6 PCI slots
- Single Board Computer Configuration 4U rackmount with 14 PCI slots
- Dimensions of standard 4U chassis
  43.2 wide x 43.2 long x 17.8 cm high
  17 wide x 17 long x 7.00 inch high
- Redundant Power Supplies. Three hot–swap modules with audio failure alarm.

Input Power

- Main Chassis 60/50 Hz 115/230 VAC Manual switches for voltage selection.

Power Consumption

- Standard RCP8 120 Watts

Environmental

- Temperature 0C (32F) to 50C (122F)
- Humidity 0 to 95% non–condensing

Reliability

- MTBF>50,000 hours (based on actual RCP02 field data).