



INSTALLATION & OPERATION

A53325 -02 AND -03 AUTOMATIC TRAIN CONTROL (ATC) ETHERNET SPREAD SPECTRUM RADIO

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VERSION A.2

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The equipment covered in this manual has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

DOCUMENT HISTORY

Version	Release Date	Details of Change
A	October 2004	Initial release
A1	February 2006	<ul style="list-style-type: none">• Section 1, page 1-6 and Appendix B:<ul style="list-style-type: none">◆ Added caution that reversed polarity of the input power to the radio will damage the radio.• Updated document title page for clarity. (i.e. A53325 -02 & -03 SSR).• Updated Proprietary Information.• General reformat of entire document to comply with Safetran Technical Publications standards.
A.2	April 2014	Rebrand for Siemens

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NOTES, CAUTIONS, AND WARNINGS

Throughout this manual, notes, cautions, and warnings are frequently used to direct the reader's attention to specific information. Use of the three terms is defined as follows:

WARNING

INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY. WARNINGS ALWAYS TAKE PRECEDENCE OVER NOTES, CAUTIONS, AND ALL OTHER INFORMATION.

CAUTION

REFERS TO PROPER PROCEDURES OR PRACTICES WHICH IF NOT STRICTLY OBSERVED, COULD RESULT IN A POTENTIALLY HAZARDOUS SITUATION AND/OR POSSIBLE DAMAGE TO EQUIPMENT. CAUTIONS TAKE PRECEDENCE OVER NOTES AND ALL OTHER INFORMATION, EXCEPT WARNINGS.

NOTE

Generally used to highlight certain information relating to the topic under discussion.

If there are any questions, contact Siemens Industry Inc., Rail Automation Application Engineering.

ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS

Static electricity can damage electronic circuitry, particularly low voltage components such as the integrated circuits commonly used throughout the electronics industry. Therefore, procedures have been adopted industry-wide which make it possible to avoid the sometimes invisible damage caused by electrostatic discharge (ESD) during the handling, shipping, and storage of electronic modules and components. Siemens Industry, Inc., Rail Automation has instituted these practices at its manufacturing facility and encourages its customers to adopt them as well to lessen the likelihood of equipment damage in the field due to ESD. Some of the basic protective practices include the following:

- Ground yourself before touching card cages, assemblies, modules, or components.
- Remove power from card cages and assemblies before removing or installing modules.
- Remove circuit boards (modules) from card cages by the ejector lever only. If an ejector lever is not provided, grasp the edge of the circuit board but avoid touching circuit traces or components.
- Handle circuit boards by the edges only.
- Never physically touch circuit board or connector contact fingers or allow these fingers to come in contact with an insulator (e.g., plastic, rubber, etc.).
- When not in use, place circuit boards in approved static-shielding bags, contact fingers first. Remove circuit boards from static-shielding bags by grasping the ejector lever or the edge of the board only. Each bag should include a caution label on the outside indicating static-sensitive contents.
- Cover workbench surfaces used for repair of electronic equipment with static dissipative workbench matting.
- Use integrated circuit extractor/insertor tools designed to remove and install electrostatic-sensitive integrated circuit devices such as PROM's (OK Industries, Inc., Model EX-2 Extractor and Model MOS-40 Insertor (or equivalent) are highly recommended).
- Utilize only anti-static cushioning material in equipment shipping and storage containers.

For information concerning ESD material applications, please contact the Technical Support Staff at 1-800-793-7233. ESD Awareness Classes and additional ESD product information are also available through the Technical Support Staff.

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SECTION 1

PRODUCT DESCRIPTION

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SECTION 1 – Product Description

1.0 Introduction

This document is the Operator's Manual for the Automatic Train Control (ATC) Radio used in the Bombardier's FLEXIBLOK™ Automatic Train Control System. This radio is part of the ATC Radio System that provides communications between trains and wayside stations.

The ATC Radio is a Spread Spectrum radio operating in the "Industrial Scientific and Medical" (ISM) band from 2.400 GHz to 2.4835 GHz. It includes an Ethernet port through which it is connected to a host computer. The radios are used to deploy a point-to-multipoint communication network between a host computer on a wayside station and one or more host computers in the trains.

This manual contains a description of the ATC Radio and protocols necessary for normal operation. This includes the physical description of all the external ports, a theory of operation section describing the ATC Radio subsystem, complete definition of the protocol and message formats across the different ports, and the full command dictionary. A separate document, the Maintenance Manual, describes the internal radio architecture, how to perform firmware upgrades, radio checkout, calibration, and troubleshooting.

WARNING

THE ETHERNET RADIO IS A NON-VITAL SYSTEM AND SHOULD NOT BE USED IN ANY APPLICATION WHERE IT WOULD BE REQUIRED TO PERFORM A VITAL FUNCTION, OR WHERE IT INTERFERES WITH OTHER VITAL EQUIPMENT OPERATION.

1.1 Product Description

1.1.1 Radio Components

Figure 1-1 shows a picture of the ATC Radio unit. Table 1-1 identifies various components and accessories that may be shipped with the radio, or procured separately.



Figure 1-1. ATC Radio

Table 1-1. ATC Radio Components / Accessories

COMPONENTS / ACCESSORIES	PART NUMBER
ATC Radio unit.	Z927-00215-0000
Bracket assembly for securing the radio unit to an outdoor mast.	Included in above
CD with this manual, Econsole program and other reference material.	Included in above
Power Inserter Module including 110-240 VAC power supply.	Z932-00184-0000
CAT 5 cable for connection between the radio and the Power Inserter module.	Z706-00236-0000
Auxiliary port cable for RS-232 connection.	Z706-00235-0000

1.1.2 Radio Connectors

The radio enclosure includes two N-female connectors at the top for connection to RF antennas, and two special purpose connectors, at the bottom, for DC power, Ethernet data and control.

The function of each connector is described in Table 1-2 below.

Table 1-2. ATC Radio Connectors

CONNECTOR	TYPE	FUNCTION
A	N-FEMALE	2.4 GHz RF connector to antenna A
B	N-FEMALE	2.4 GHz RF connector to antenna B
C	Lumberg	Auxiliary port (3 pin) used as an RS-232 console port.
D	Lumberg	10/100 Base-T data interface and DC power input (8 pin). Must be connected to the "Power Inserter Unit" with a CAT 5 cable.

An eight conductor CAT 5 cable must be connected between the ATC Radio unit and the Power Inserter Unit. The wiring for this cable is shown in Figure 1-1.

Table 1-3 shows the pin assignment of the three pin, auxiliary port connector. The unit is shipped with a cover in this connector. The connector can be used during installation as a console port. Siemens Rail Automation has available a cable to convert from this non-standard 3-pin connector to a DE-9 connector (for RS-232 console). See Appendix E for cable diagrams.

Table 1-3. Auxiliary Port Connector Pin Assignments

PIN	SIGNAL NAME	ABBR.	DIRECTION
1	Receive Data	RD	Radio Output
2	Transmit Data	TD	Radio Input
3	Ground	GND	

1.1.3 Power Inserter Unit

The Power Inserter Unit includes a power supply for connection to an AC outlet, two RJ45 connectors and a bi-color LED. The two RJ-45 connectors are labeled “To LAN” and “To radio”. The following tables describe those connectors.

Table 1-4. Power Inserter Unit

CONNECTOR / LED	TYPE	FUNCTION
To LAN	RJ-45	10/100 Base-T to be connected to the Local Area Network. Use a straight through cable to connect to a hub and a cross over cable to connect directly to a computer. See table 1.5 for pin assignments.
To Radio	RJ-45	Carries the DC power and Ethernet signals to the radio. See table 1.6 for pin assignments.
LED	Amber/ Green	Amber: Indicates that the power inserter unit has DC power from the wall supply but no power is being drawn by the radio. Green: Indicates that the radio unit is drawing power.

CAUTION

THE POWER INSERTER CONNECTOR LABELED “TO RADIO” INCLUDES DC VOLTAGE IN TWO OF THE PINS. IT MUST NOT BE CONNECTED TO A LAN AS THIS VOLTAGE MAY DAMAGE SOME LAN CARDS.

CAUTION

REVERSED POLARITY OF THE INPUT POWER TO THE RADIO WILL DAMAGE THE RADIO.

Table 1-5. “To LAN” Ethernet Connector Pin Assignments

PIN	SIGNAL NAME	ABBR.	DIRECTION
1	Ethernet Tx	Tx (+)	Radio to Ethernet
2	Ethernet Tx	Tx (-)	Radio to Ethernet
3	Ethernet Rx	Rx (+)	Ethernet to Radio
4	(not connected)		
5	(not connected)		
6	Ethernet Rx	Rx (-)	Ethernet to radio
7	(not connected)		
8	(not connected)		

Table 1-6. “To Radio” Ethernet Connector Pin Assignments

PIN	SIGNAL NAME	ABBR.	DIRECTION
1	Ethernet Tx	Tx (+)	Radio to Ethernet
2	Ethernet Tx	Tx (-)	Radio to Ethernet
3	Ethernet Rx	Rx (+)	Ethernet to Radio
4	+18 VDC	DCV (+)	Power Inserter to Radio
5	+18 VDC	DCV (+)	Power Inserter to Radio
6	Ethernet Rx	Rx (-)	Ethernet to Radio
7	18 VDC ground	GND (-)	Power Inserter to Radio
8	18 VDC ground	GND (-)	Power Inserter to Radio

1.1.4 Outdoor Interconnect Cable

The interconnect cable between the Power Inserter Unit and the ATC Radio Unit carries the following signals

1. DC voltage to supply power to the radio.
2. 10/100 Base-T Ethernet data.

Both these signals are carried in a single CAT 5 cable. The system is designed to allow cable lengths up to 100 meters (300 feet). Siemens Rail Automation carries several pre-made cables of different lengths. See Appendix E for connector diagrams, part numbers, and assembly instructions.

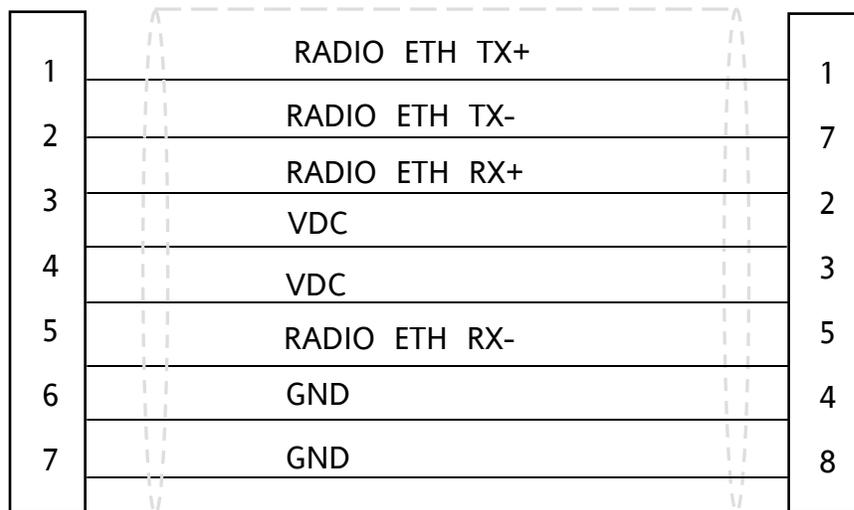


Figure 1-2. CAT 5 Outdoor Interconnect Cable Diagram

1.2 Ordering Information

To order, call Siemens Rail Automation Customer Service at 1-800-793-SAFE (1-800-793-7233).

SECTION 2

THEORY OF OPERATION

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SECTION 2 - Theory of Operation

2.0 System Overview

The ATC radio system is used for train-to-wayside communications. One or more vehicles in a train are equipped with **mobile** radios that communicate with a **base** radio in a fixed wayside station. Several wayside stations exist along the track, each one covering a different **region**. At any given time, within one region, there may be multiple trains/vehicles, each one communicating with the same base radio.

Each radio is connected via Ethernet to a **host** computer. This connection is used to interchange data packets that are transmitted or received over RF, and also for commands to configure and monitor the radio. The **base host** polls the **mobile hosts** within its region sequentially. Poll packets include the destination **train ID** and **vehicle ID** parameters and may also include a **downlink** packet to be delivered to all mobile hosts in the specified train. On power up the mobile host configures its radio with the appropriate train and vehicle IDs. Mobile radios filter the RF packets received from the base radio, passing to their hosts only the packets with a matching train ID. The base host may also transmit a broadcast downlink packet that is accepted by all mobile radios.

Mobile hosts provide **uplink** packets to its mobile radios on a regular basis. Immediately after receiving a poll packet that matches the train ID AND vehicle ID, a mobile radio transmits to the base radio the last uplink packet received from its host. In the typical application, the base host only polls one vehicle in each train.

As a train crosses between adjacent regions there is a **hand-off** process that switches the communications from one wayside station to the next. The different base hosts at the wayside stations are connected through a **Wayside Data Network**, which is separate from the radio system. The base hosts use this network to coordinate the hand-off between adjacent regions.

The uplink and downlink RF transmissions are performed at different RF frequencies. In addition, adjacent regions operate on non-overlapping pairs of frequencies. As a train moves across the region boundary, the mobile host issues a command to the radio to switch to the pair of frequencies of the new region. At about the same time, the base host controlling the region from where the train is departing **hands off** the train to the new base host. This base host starts polling the train ID using the different pair of frequencies. Once the mobile radio responds to the new base radio the hand off is complete.

The RF transmission medium may either be open air or through a Radiax leaky cable connected to each base radio at the wayside stations. In this last case the cable includes amplifiers to compensate for the cable attenuation. These amplifiers are bi-directional and require that the

downlink channel (from base to mobile) use the upper part of the band and the uplink channel (mobile to base) use the lower part of the band.

The two non-overlapping frequency plans need to stay within the amplifier band pass filters. The radio occupies a spectrum bandwidth of 5.5 MHz, which allows ample room for two (or more) channels within each band-pass filter.

2.1 Radio / Host Interface

Each radio is connected, via a private Ethernet, to a host computer. In order to easily use the embedded protocol stack within the hosts, all communication between the radios and hosts is encapsulated in UDP/IP. However, it is not possible to communicate by IP across the wireless link.

The radios and respective controlling hosts communicate on two (logical) bi-directional data paths: a **data channel** and a **command channel**. These are recognized as separate by virtue of being on different UDP port numbers. At startup, the radio opens two UDP ports: one for receiving commands, and one for receiving data.

In the command channel the host generates command packets to the radio and the radio generates a reply for every command.

Data is sent in the form of a standardized information packet, which is addressed to or from a specific vehicle. Data packets received by the radio from its host are treated differently by the base radio and the mobile radio. This is described in the following sections.

2.2 Base Radio's Data Operation

When an UDP-encapsulated data packet is received on the Ethernet port, the base radio reformats and transmits it over RF using pre-configured RF transmit settings (channel, antenna, power, speed). At the end of the RF transmission the radio reverts to receive mode using pre-configured RF receive settings (channel, antenna). If a RF reception does not start within 2 milliseconds following the end of RF transmission, the radio generates a timeout packet to the base host. Otherwise the radio completes receiving the RF message, encapsulates it in UDP/IP and sends it to the base host (using a pre-configured IP address and UDP port). If the RF message is received in error, the base radio sends a UDP/IP encapsulated error packet to the host.

2.3 Mobile Radio's Data Operation

The mobile host sends, on a regular basis, UDP encapsulated data messages to the radio. The radio stores the last received message in its RF uplink data buffer.

The mobile radio is always listening for RF messages using pre-configured RF settings (channel, antenna). Any received messages are checked for an address match to either the pre-configured train address or the broadcast train address. If there is no match, or the message contains CRC or other errors, the message is discarded.

If the message passes these checks, the radio encapsulates it in UDP/IP and sends it to the mobile host (using pre-configured IP address and UDP port). If the message also matches the configured vehicle address, the radio changes to transmit mode using pre-configured RF transmit settings (channel, antenna, power speed) and transmits the uplink data buffer to the base radio. If a loopback bit in the downlink message is set, the radio transmits back the message just received over RF instead of the uplink buffer.

At any given time, the mobile radio's uplink data buffer contains the data most recently received from the host. If a data buffer is received at the same time that a poll triggers the RF transmission of this buffer, it is the radio's responsibility to ensure that the data transmitted is a consistent set: either the old buffer or the new buffer, but not a mixture.

2.4 Addressing

The protocol involves addressing on several levels:

1. Ethernet (MAC) addresses (in the Ethernet MAC header). These have no significance other than being unique by virtue of being derived from manufacturer ID and serial numbers.
2. IP addresses in the IP header of the UDP datagrams. The radios' factory IP address defaults to the non-routable address 192.168.1.2. However a command is provided allowing the host to change the radio IP address. The new address can be stored in non-volatile memory. If the radio IP address is not known, there are two other command interfaces (Econsole and serial RS-232) that may be used to find or modify the IP address.
3. Train/vehicle addresses (4 bytes each). These are used by the FLEXIBLOK system to identify mobile hosts. On power up the hosts configure these addresses into the radios. In normal operation, all mobile hosts on a train are addressed by the same train address. Additionally, a train broadcast address (0x0000FFFF) will be recognized, providing for data to be sent to all trains in a region. The train address of all zeroes is reserved as the destination address used in uplink RF transmissions.

2.5 Packet Formats

2.5.1 UDP Data Packets

The packets traveling on the Ethernet between the host and the radio are UDP/IP/Ethernet with the following layout.

Table 2-1. UDP Packet Structure

BYTES	HOST TO RADIO	RADIO TO HOST	DESCRIPTION
0-5	Dest MAC address	Dest MAC address	Ethernet Encapsulation
6-11	Src MAC address	Src MAC address	
12-13	0x0800	0x0800	
14-33	IP header	IP header	UDP/IP encapsulation RFC-768 (UDP) RFC-760 (IP).
34-35	Src port (any)	Src port: radio UDP data port	
36-37	Dest port: radio UDP data port	Dest port: UDP peer data port	
38-39	Length of UDP payload (14-500)	Length of UDP payload (14-500)	
40-41	Checksum	Checksum	
42-43	Flags	Flags	Payload
44-47	Pad (all zeroes)	RF Statistics	
48-51	Train Address	Train Address	
52-55	Vehicle Address	Vehicle Address	
56-	Data	Data	

The UDP source and destination port fields can be configured using the `udp-configuration` command.

Note that the train/vehicle address is always the address of the mobile host involved in the transaction. For downlink traffic (from base host to mobile host) this is the **destination** address while for uplink traffic (from mobile host to base host) this is the **source** address.

The Flags field include the following four bits, numbered with bit 0 as the most significant bit. All undefined bits will be set to zero.

Table 2-2. Flags Field

BIT	NAME	DESCRIPTION
0	Loopback	Set by the base host. Causes the mobile radio with a matching train and vehicle address to transmit the downlink packet back instead of the uplink packet provided by its host. This loopback reply packet from the mobile radio will also have this bit set. In addition the mobile radio does not forward these loopback packets to its host.
1	Timeout	Set by the base radio. The base radio expects a reply for every RF transmission. After a preset delay (~2milliseconds) following the end of the RF transmission, if an RF reception has not started, the base radio generates a packet with this bit set to inform the base host that a reply will not be forthcoming. This packet contains the Train/Vehicle address of the outgoing packet, but no data.
2	RF error	Set by the base radio. If the base radio receives a reply, but the reply contained a CRC or other error, it generates a packet to the base host with this bit set.
3	Test Mode	The base radio may be set in a test mode, executing an automatic poll loop (see poll-loop command). While in this test mode, the radio does not forward over RF the UDP data packets received from a host computer. While in test mode the radio replies to these UDP data packets with a UDP data packet with this bit set.

The RF Statistics field consists of four bytes filled by the radios as follows:

Table 2-3. RF Statistic Field

BYTE	DESCRIPTION	RANGE
44	Local Tx power (dBm)	0 to 23
45	Remote Rx RSSI	-35 to -80
46	Remote Tx power (dBm)	0 to 23
47	Local Rx RSSI	-35 to -80

If for any reason the radio can not fill any of these parameters, it will write the value –1 (0xFF) into that field. For example, the mobile radio will never fill the field Remote Rx RSSI.

2.5.2 UDP Command Packets

Command packets have the same UDP/IP encapsulation as the data packets but use different UDP ports. The table below shows the complete command packets:

Table 2-4. Command Packet Format

BYTES	HOST TO RADIO (command)	RADIO TO HOST (response)	DESCRIPTION
0-5	Dest MAC address	Dest MAC address	Ethernet Encapsulation
6-11	Src MAC address	Src MAC address	
12-13	0x0800	0x0800	
14-33	IP header	IP header	UDP/IP encapsulation RFC-768 (UDP) RFC-760 (IP).
34-35	Src port (any)	Src port: radio UDP cmd port	
36-37	Dest port: radio UDP cmd port	Dest port: UDP peer cmd port	
38-39	Length of UDP payload (6-500)	Length of UDP payload (6-500)	
40-41	Checksum	Checksum	Payload
42-45	Command Sequence number	Command Sequence number	
46-47	Pad (all zeroes)	Reply code	
48-	Command text	Reply text	

The command and reply text is in ASCII. Refer to the command dictionary in appendix A for the valid commands.

The host always initiates the command, and the radios reply to every command. The command sequence number field, in the reply, “echoes” the contents of the sequence number field in the command. There is an exception to this rule on power up, at which time the radio issues an “unsolicited reply” message. This is described in section 2.6.

The values of the “reply code” field are shown in the following table.

Table 2-5. Reply Code Field

REPLY CODE	DESCRIPTION
0	Command executed successfully
1	Unsolicited reply Startup
2	Response text overflow (truncated above 494 characters)
3	Unknown command
4	Ambiguous abbreviation
5	Illegal or ambiguous argument name
6	Argument value out of range
7	Required argument missing
8	Command failed
9	Command rejected. Waiting for a “Start” command

2.5.3 ARP Packets

The radio supports the Address Resolution Protocol (ARP) by generating and responding to the appropriate ARP packets per RFC-826.

2.5.4 Econsole Packets

Econsole is a proprietary stream-oriented text transfer protocol. It is used with a Windows or Linux based utility program to allow configuration and maintenance of radios without requiring IP addresses for the radios to be known. One important use of Econsole is downloading firmware upgrades into to radios’ flash file storage.

For reference, the format of Econsole packets is shown below:

Table 2-6. Econsole Packet Format

BYTES	CONTENT	COMMENTS
0-5	Dest ether address	48-bit MAC address
6-11	Src ether address	48-bit MAC address
12-13	Packet length	Excluding these first three fields
14-16	SNAP prefix	0xAA, 0xAA, 0x03
17-19	OUI	0x00, 0xD0, 0x39 (UC Wireless)
20-21	Protocol	0x00, 0x01 (Econsole)
22-23	PDU type	
24-25	Connection ID	
26-27	0,0	Padding for alignment
28-31	TxSeq	
32-35	RxSeq	
36-39	Nbytes	
40-	Payload	<Nbytes> bytes of text data

2.5.5 RF Packets

The UDP/IP encapsulated packets transferred over the Ethernet are reformatted for transmission over RF. The RF packets are generated and consumed by the radios. The packet format is shown below for reference and to facilitate computation of packet airtime. Other than the preamble and physical layer header, all bytes are transmitted at one of the four speeds supported by the radio.

Table 2-7. RF Packet Format

BYTES	CONTENTS
N/A	RF preamble (512 microseconds)
	Phy header (256 microseconds)
0-1	Sync pattern
2-3	Packet length
4-7	RF link destination address (train address for downlink packets. Zero for uplink packets).
8	Packet Type
9	Transmit Power
10	RSSI of last received RF packet
11	Pad (all zeroes)
12-N	Payload data, beginning with 2 bytes of Flags of the UDP payload.
N-(N+3)	32-bit CRC

2.5.5.1 RF Link Destination Address

Mobile radios set their own RF port address to the train address programmed by the mobile host after power up. The base radio sets its RF port address to zero (which is illegal as a train address).

For downlink packets the base radio copies the destination train address from the payload into the RF link address field of the RF packet. For uplink packets the mobile radios write a zero into the RF link address field.

2.6 Power Up Sequence

After power up, or if the radio reboots, the radio enters a “safe” mode where it is guaranteed not to initiate any RF transmissions. While in this state the radio issues “unsolicited reply startup” messages over the UDP interface, to alert the host computer that it just rebooted. The radio generates this message repeatedly, every 200 milliseconds, until the host sends it the “start” command. Until that time the radio discards any UDP data packets. While in the safe mode, the radio also does not execute any UDP commands other than the “start” command. If a UDP command is received while in safe mode the radio replies with the reply code 9 – Waiting for “start” command.

With this scheme the host computer does not have to rely on the configuration saved in the radio. After an unexpected reboot, the radio does not initiate RF transmissions (possibly in a wrong channel) until the host has been notified. The host will then stop sending UDP data messages, and issue the start command followed by other configuration commands.

SECTION 3

INSTALLATION & SETUP

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SECTION 3 – Installation & Setup

3.0 General

It is recommended that an initial check be performed on the bench before a field installation.

For this bench check out you need two radios. One unit will be configured to operate as the “base” and the other as the “mobile”. The approach described uses two terminals connected to the auxiliary ports of the radios. The checkout could also be performed using the “Ethernet Console Program” to emulate the terminal across an Ethernet connection. Refer to appendix D for detailed information on the Econsole program.

3.1 Bench Check Out

1. Connect each radio Console Port to a terminal, or a PC running a terminal emulation program. Configure the terminal settings as follows:

Baud rate: 9600
Word length: 8 bits
Parity: none
Stop bits: 1

2. Connect each Power Inserter Unit to the respective radio using a CAT 5 cable as defined in section 2.
3. Connect each radio Antenna A port (N type connector) to an appropriate 2.4 GHz band antenna using an RF coaxial cable. Alternatively you could use an RF attenuator and coax cables to connect the two radio’s antenna ports back to back. Use at least 40 dB attenuation when connecting the antenna ports of two radios this way.
4. Connect the two Power Inserter Units to a power outlet of the appropriate voltage.
5. The radios output a banner identifying the software and hardware versions and serial number, followed by the command prompt:

```
atc-nnnnn #>
```

where nnnnn are the last five digits of the radio serial number.

6. Configure one radio as a “mobile” by issuing the following commands:
 - > `load factory`
 - > `node type=mobile reply=on train=1 vehicle=1`
 - > `save-configuration`

7. Configure the second radio as a “base” and initiate a poll loop by typing the commands:
 - > `load factory`
 - > `save-configuration`
 - > `poll-loop train=1 vehicle=1`

8. The base radio will now be polling the mobile and reporting various statistics. Verify that the TxPackets cumulative count is increasing and that the Dropped packet count is zero. Press the [Space] bar to stop the test.

9. The terminal connected to each radio can be used to further modify the radio’s operating parameters. Section 4 describes the command language used to perform those functions.

3.2 Field Installation

When operating the radios in the field the operator must ensure that any appropriate limits imposed by different jurisdictions are not violated. These are described in the following sections:

3.2.1 Output Power Limits (FCC)

The Federal Communications Commission (FCC) regulations limit the maximum Effective Isotropic Radiated Power (EIRP) for spread spectrum systems operating in the 2.4 GHz band. Close to the band edges, the output power must be limited to avoid spilling over into the FCC protected band from 2.4835 GHz to 2.500 GHz. The table below takes these considerations into account and shows the maximum allowed output power for the various antennas

Table 3-1. Maximum Output Power (dBm)

CHANNEL	FREQUENCY (MHz)	ANTENNA GAIN		
		9 dBi	18 dBi	24 dBi
3	2406.0			23
4	2408.0			23
5	2410.0			23
6	2412.0			23
7	2414.0			23
8 to 30				23
31	2462.0			23
32	2464.0			23
33	2466.0			23
34	2468.0			22
35	2470.0			21
36	2472.0			20
37	2474.0			10

3.2.2 Output Power Limits (CE)

The European Telecommunications Standards Institute (ETSI) regulations impose a limit of 20 dBm as the maximum Effective Isotropic Radiated Power (EIRP) for direct sequence spread spectrum systems operating in the 2.4 GHz band. The installer must reduce the output power of the radio so that this limit is not exceeded. The antenna gain, cable and connector losses must be taken into account when computing the maximum output power.

3.2.3 Maximum Permissible Exposure (MPE) Limitations

The installer must mount all transmit antennas so as to comply with the limits for human exposure to radio frequency (RF) fields per paragraph 1.1307 of the FCC Regulations . The FCC requirements incorporate limits for Maximum Permissible Exposure (MPE) in terms of electric field strength, magnetic field strength, and power density.

Antenna installations must be engineered so that MPE is limited to 1 mW/cm², the more stringent limit for "uncontrolled environments". The table below specifies the minimum distance that must be maintained between the antenna and any areas where persons may have access, including rooftop walkways, sidewalks, as well as through windows and other RF-transparent areas behind which persons may be located.

Table 3-2. Minimum Distance calculation to avoid Antenna Radiation Hazard (exposure of 1 mW/cm²)

Antenna Gain (dBi):	9	18	24
Max. Output Power	23	23	23
MPE safe distance (cm)	11*	28*	63*

NOTE

For fixed location transmitters, the minimum separation distance is 2 meters even if calculations indicate a lower MPE distance.

SECTION 4

COMMANDS

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SECTION 4 - Commands

4.0 CONFIGURATION TECHNIQUES

There are three ways to configure the radio. One uses the auxiliary port at the bottom of the unit and consists of an asynchronous RS-232 link used for issuing configuration commands and monitoring the local radio status and performance. This port is always set to operate with the following parameters:

Baud rate: 9600
Word length: 8 bits
Parity: none
Stop bits: 1

The radio may also be configured through the Ethernet port using an “Ethernet Console Program” (Econsole) installed at a PC. This PC must be connected to the LAN where one or more radios are connected via Ethernet. From this PC it is then possible to configure all the radios directly connected to the LAN. Refer to appendix D for instructions on the installation of Econsole.

The third configuration method is using a UDP/IP stack. The packet formats and protocol for this method are described in section 2 of this manual.

After power up the radio performs several diagnostic and calibration tests. At the end of these tests it outputs the command prompt through the serial port. The default prompt is:

```
atc-nnnnn #>
```

where `nnnnn` are the last five digits of the radio serial number. If a node “name” has been assigned to the node, the prompt will be that name.

The “help” command provides a list of all the commands available. To get more detailed help for a specific command, type “help command-name”.

The radio keeps a history of several of the previously issued commands. Those commands can be viewed by pressing the up-arrow and down-arrow keys on the keyboard. Any of those previously issued commands can then be edited and re-entered by pressing the <Carriage Return> key.

4.1 COMMAND SEQUENCE

The command interpreter in the ATC Radio is designed to accommodate both a novice as well as an expert operator. All commands and parameters have descriptive names so that they are easily remembered and their meaning is clear. In order to be descriptive however, those commands are sometimes long. As the operator becomes familiar with the command language, typing the complete words could become cumbersome. The radio command interpreter recognises any abbreviations to commands and parameter names, as long as they are unambiguous. If an ambiguous command is entered, the radio will output all possible choices.

Commands have the following generic form:

command parameter=value parameter=value

Following is a brief list of syntax rules:

Words (for commands, parameters, or values) can be abbreviated to a point where they are unambiguous)

Some commands or parameters consist of compound words separated by a hyphen. With compound words, the hyphen is optional. Additionally each word in a compound word can be abbreviated separately. For example, the following are all valid abbreviations for the command “save-configuration”: “save”, “savec” s-c” “sc”.

The parameter and value lists are context sensitive, i.e., in order to solve ambiguities the command interpreter only considers parameters valid for current command, or values valid for the current parameter.

The arguments “parameter=value” must be entered with no blank spaces on either side of the ‘=’ sign. Those arguments (parameter/value pairs) can be listed in any order.

Even though parameters can be listed in any order, there is a “natural” order known by the command interpreter. This allows the user to specify parameter values without having to type the parameter names. For example the command:

>spectrum-analysis input=a-antenna display=table

can be entered as (using abbreviation rules as well):

>spa a t

Using the preceding rule, for commands that have a single argument, the “parameter name” part of the argument is always optional, i.e., you can enter:

>command value

For example the command:

```
>load-configuration source=main
```

can be shortened to any of the following:

```
>load-configuration main  
>load main  
>load
```

Not all parameters associated with a command need to be specified. Depending on the command, when a parameter is omitted it either assumes a default value or keeps the last value assigned to that parameter.

The following sections describe the various commands grouped according to their functionality.

4.2 CONFIGURATION MANAGEMENT COMMANDS

A “radio configuration” consists of a set of programmable parameters that define the radio operation with regard to a variety of operating modes. The radio holds four configurations at all times, identified as “current”, “main”, “alternate”, and “factory”.

The “main” and “alternate” configurations are both stored in non-volatile memory. They can be loaded into the “current” configuration with the “load” command. On power up the radio loads the “main” configuration from non-volatile memory into the current configuration.

The “current” configuration is the set of parameters currently being used and can be modified by the operator through several commands. This configuration is volatile. If the current configuration has been modified it should be saved using the “save” command. Otherwise the modifications will be lost if power is removed.

The “factory” configuration can not be modified by the operator and is used to return the radio to the factory default condition. It is useful as a starting point to create a customised configuration.

The access to change the radio configuration can be password protected. This password is set by the user with the “change-password” command. Once a password is set, issue the “lock” command to prevent any unauthorised changes to the configuration. Once locked, the configuration can only be modified by issuing the “unlock” command with the correct password.

When the configuration is unlocked, the radio prompt ends with the characters ‘#>’ to remind the user that the configuration is unlocked. In locked mode the prompt does not include the ‘#’ character. Once a password is set, the radio will automatically lock the configuration after 10 minutes without any commands being issued.

The configuration management commands are listed below:

NOTE

'0x' introduces a hexadecimal expression.

change-password

enable-configuration="ASCII string"

This command allows the user to set or change a password used to “lock” and “unlock” access to the commands that change the radio configuration. The radio is shipped with no password, which allows access to all commands. Once a password is set and the configuration is locked, the password is needed to unlock the access to those commands. After changing the password you should also issue the “save-configuration” command to save the new password in non-volatile memory.

Example:

```
> change-password enable-configuration=bh7g8
```

CAUTION

The ATC Radio is shipped with no password. If the “change-password” command is issued make sure you do not forget the password. Once locked, without a password, the radio must be returned to the factory to be unlocked.

display-configuration

source= current or main or alternate or factory

Displays all the parameter values for the specified configuration. If the source is not specified it defaults to “current”.

Examples:

```
> display-configuration source=current
> discon
```

load-configuration

source=main or alternate or factory

Loads the specified configuration into the current set of parameters controlling the radio operation. If no source is specified it defaults to the “main” configuration.

Examples:

```
> load-configuration source=factory
> load
```

lock

This command locks the access to all the commands that can alter the radio configuration. Once locked use the “unlock” command to regain access to those commands. Note that a password must be set prior to the “lock” command being issued (the radios are shipped with no password), otherwise the lock command has no effect. If a password is set, the radio automatically “locks” the configuration at the end of 10 minutes with no command activity.

save-configuration

destination=main or alternate

Saves the current set of radio operating parameters into one of the two non-volatile configurations. If the destination is not specified it defaults to main.

Examples:

```
> save-configuration destination=alternate
> save
```

unlock

enable-configuration="ASCII string"

This command, with the correct password, unlocks the access to the commands that allow the radio configuration to be altered.

Example:

```
> unlock enable-configuration=bh7g8
```

4.3 MAJOR CONFIGURATION PARAMETERS

These commands change several operating parameters of the radio that are part of the radio “configuration”. When entering commands with multiple parameters, if a parameter is not included, that parameter keeps its current value.

ethernet

speed=auto or *10hdx* or *10fdx* or *100hdx*

Sets the Ethernet port speed to auto-negotiate, 10Mbps half-duplex (10hdx), 10 Mbps full-duplex (10fdx), 100 Mbps half-duplex (100hdx) or turns the Ethernet port off.

In installations requiring very long outdoors CAT5 cable, operation at 100 Mbps may become unreliable. For this reason the auto-negotiate setting allows only 10 Mbps half or full-duplex. For operation at 100 Mbps you need to specify that speed explicitly.

ip-configuration

address=<ip address>

netmask=<string>

gateway=<ip address>

This command configures the radio IP address, netmask and gateway. The command is not available across the UDP interface.

node

type=base or *mobile*

The radio at a wayside station must be configured as the “base”. All radios on the trains must be configured as “mobile”. Communications are established in a point to multipoint mode between the base and the mobiles.

reply-mode=off or *on-match* or *always*

Specifies how a mobile radio responds to a poll from the base radio as follows:

off: radio never transmits over RF.

on-match: radio generates a reply if both the train and vehicle addresses in the poll packet match the respective addresses of the mobile radio.

always: radio replies to every poll packet received independent of the train and vehicle addresses. In the reply packet the radio fills the train and vehicle address fields with the

values in the poll packet rather than the values of the radio. This mode is used as a simulation tool, where a single mobile radio simulates the presence of a large number of mobiles.

poll-timeout=0 or 1

The base radio starts a timer at the end of every RF transmission. After 2 milliseconds, if a reply has not yet started being received, it declares a timeout. When the poll-timeout is set to one (1) the base radio sends a UDP packet to the base host indicating that a timeout has occurred. When set to zero the base radio does not generate this timeout packet.

train-address=0..0x0FFFFFFE

Where '0x' introduces a hexadecimal expression.

28 bit field specifying the train address. Note that the following values have special meaning:

0x00000000 - reserved for the "base" radio. The radios use the train address in the RF packets as the packet link destination address. All mobile radios address their uplink packets to radio zero. Therefore address zero should not be used as a valid train address.

0x0000FFFF – Broadcast address.

vehicle-address=0..0xFFFFFFFF

Where '0x' introduces a hexadecimal expression.

32 bit field specifying the vehicle address.

rf-parameters

receive-channel=3..37

receive-antenna=a, b

transmit-channel=3..37

transmit-antenna=a, b

transmit-speed-kbps= 250, 500, 1375, 2750

transmit-power-dbm=0..23

This command configures all the parameters used during RF transmission and reception. The same parameters can also be configured with the "rf-receive-setup" and "rf-transmit-setup" commands.

Note that for the radio to establish a link with another radio, the receive channel must match the transmit channel of the peer. The radio accepts transmit speeds in formats: 250, 500, 1375, and 2750.

rf-receive-setup

channel=3..37

antenna=a, b

This command configures the channel, and antenna used in the RF reception.

Note that for the radio to establish a link to its peer, the channel selected by this command must match the channel selected as the transmit channel of the remote radio.

rf-transmit-setup

channel=3..37

antenna=a, b

speed-kbps= 250, 500, 1375, 2750

power-dbm=0..23

This command configures the channel, antenna, speed, and transmit power used in the RF transmissions.

Note that for the radio to establish a link to its peer, the channel selected by this command must match the channel selected as the receive channel of the remote radio. The radio accepts transmit speeds in formats: 250, 500, 1375, and 2750.

udp-configuration

peer-address=<ip address>

data-port=1..0xFFFF

command-port=1..0xFFFF

peer-data-port=1..0xFFFF

peer-command-port=1..0xFFFF

max-response-bytes=500..1466

socket-mode=1 OR 2

Where '0x' introduces a hexadecimal expression.

This command configures the parameters specific to the UDP interface to the host computer across the local Ethernet. The command is not available across the UDP interface itself, i.e. these parameters must be configured and saved using the Serial or Econsole command interfaces.

The **peer-address** is the IP address of the host computer connected to the radio. All UDP data and command packets are sent to this address. The factory default is the unroutable address 192.168.1.1

The **data-port** and **command-port** parameters are the UDP port numbers used by the radio to receive data and commands.

If the **socket-mode** parameter is set to 2, then the radio sends the UDP data and command packets to the ports specified by the **peer-data-port** and **peer-command-port** parameters.

If the **socket-mode** parameter is set to 1, then the radio sends the UDP data and command packets to the ports specified in the “Source” port field of the last UDP data and command packets received.

The **max-response-bytes** parameter allows extending the length of the UDP packets generated by the radio beyond the default 500.

4.4 INSTALLATION AND LINK MONITORING COMMANDS

These commands are useful as installation aids, system troubleshooting, and monitoring link statistics after the link is established.

display-packets

This command displays one line with the cumulative number of packets transmitted and received over the RF and UDP data ports since the unit was powered up.

See also the “monitor-packets” command.

monitor-packets

This command continuously displays the number of packets transmitted and received over the RF and UDP data ports. Every time the command is invoked the counts start from zero. To exit the command depress the [Space] bar.

This command is not available across the UDP interface. From the UDP interface use the “display-packet” command instead.

poll-loop

train-address=0..0x0FFFFFFE

vehicle-address=0..0x0FFFFFFE

interval-ms=10 or 20 or 30 or 40 or 50 or 100

size-bytes=14..500

Where '0x' introduces a hexadecimal expression.

The poll-loop command causes the base radio to automatically generate and transmit poll packets addressed to the specified train and vehicle address. The RF poll packets have the loopback bit set, which causes the addressed mobile radio to echo back the poll packet.

The **interval-ms** parameter specifies the time interval between consecutive poll packets. After transmitting the poll packet, the base radio waits 2 milliseconds for a reply. If the interval parameter is shorter than the air time for the poll and reply packets, the base radio initiates the next poll cycle as soon as the reply packet is completely received.

While in this mode, the base radio displays the following statistics:

TxPackets: Cumulative number of poll packets transmitted.

Dropped: Cumulative number of missed or replies with errors.

Percent: Percent of dropped packets over all transmit packets.

Outbound Power: Current setting of the base radio transmit power.

Outbound RSSI: Receive signal strength of the last packet at the mobile radio

Inbound Power: Current setting of the mobile radio transmit power

Inbound RSSI: Receive signal strength of the last packet received at the base.

While in the poll-loop test mode, the base radio discards all UDP data packets received from the host (the radio replies to those packets indicating that it is currently in test mode).

The "REPLY MODE" on the mobile unit must be either "ON" or "ALWAYS."

This command is not available across the UDP interface. To exit the poll-loop mode depress the [Space] bar.

spectrum-analysis*input=a-antenna* or *b-antenna**display=graph* or *table**dwell-time-ms=0..1000*

This command performs a scan of **all** the channels in the band, dwelling on each channel for the specified amount of time (defaults to 20 milliseconds). While on each channel it measures the RSSI for that channel and stores its peak value. It then displays the data collected in a graphical or table formats (defaults to “graph”).

During the test the RF input into the radio can be selected between one of the two antennas.

Note that even though the RF channels are spaced 2 MHz apart, the receiver RF bandwidth is approximately 5 MHz. Therefore the RSSI value reported for each channel represents the total energy in an 5 MHz band centered around that channel. For this reason, a narrow band transmitter will show up in the spectrum analysis report as a lobe with 5 MHz bandwidth. Conversely, you do not need to find a quiet 5 MHz wide region in the spectrum analysis report to select a quiet channel, i.e., any single channel sample that shows a low “noise” level, is a good candidate to select as a receive channel.

Examples:

```
>spectrum-analysis input=b-antenna
```

```
>spa dwell=500
```

time-analysis*channel=0..50**input=a-antenna* or *b-antenna**display=graph* or *table**dwell-time-ms=1, 2, 5, 10, 20, 50, 100, 200, 500*

This command measures the RSSI for a **single** channel over a period of time. Each “sample” consists of the maximum RSSI measured during the dwell time specified (defaults to 20 milliseconds). After collecting 60 samples the RSSI values are displayed graphically or numerically (defaults to “graph”).

In this test the RF input into the radio can be selected between one of the two antennas.

Examples:

```
>time-analysis input=b-antenna
```

```
>tia in=a dis=t dwell=500
```

4.5 EVENT LOGGING COMMANDS

The radio keeps track of various significant events in an “event log”. This event log holds up to 500 events. The first 100 entries in the log are filled sequentially after power up and are not overwritten. The remaining 400 entries consist of the last 400 events recorded. All events are time-tagged with system time.

Events are classified in different categories from level 0 (catastrophic error) to 7 (information).

clear-log

region= all-events or *reboot-reasons*

This command clears the contents of the system event log from the specified “region”. After a code upgrade it is recommended to clear the reboot reasons since the pointer in non-volatile memory pointing to the reason message may no longer be valid.

display-log

region=end or *beginning* or *all-events* or *reboot-reasons*

length=1..500

id=0..200

min-level=0..7

max-level=0..7

This command outputs to the terminal the specified “region” of the event log. The “length” parameter specifies the number of events to output (defaults to 10). The remaining parameters provide filters to leave out specific events. If the “id” parameter is specified, only the event identified by that id will be displayed. The “min-level” and “max-level” settings allow the user to display only the events with the specified category range.

The “reboot-reasons” region of the event log consist of the last four events that that caused the radio to reboot. These events are stored in non-volatile memory. The time tag in these events is the time the radio was up since it was rebooted, not the time of day.

Examples:

```
>display-log region=all
```

```
>display-log region=all length=300 min-level=2 max-level=6
```

4.6 FILE UTILITIES

The ATC Radio maintains a file system that allows multiple programs to be stored in either non-volatile flash PROM or volatile RAM. New programs can be downloaded into the radio memory through the console port or through the Ethernet port using the “Econsole” program.

One of the programs in flash PROM is designated as the default program to run after reboot. On power up that program is copied from PROM into RAM and the code runs out of RAM.

Both sections of memory (non-volatile flash PROM and volatile RAM) are segregated into two “directories”. The non-volatile flash PROM is called “flash” signifying the flash PROM and the volatile RAM is called “tmp” signifying the temporary status of the program. Use the “directory” command to view the programs loaded and whether they are in non-volatile or volatile memory.

Any program can be invoked with the command “run” without making it the default file. Use the “set-default-program” command to change the program that runs after power up.

console-speed-bps

```
baud-rate-bps=9600 or 19200 or 38400 or 57600 or 115200
```

Sets the Auxiliary port of the radio to the specified baud rate. This setting is not saved in the radio configuration, the auxiliary port always powers up set for 9600 baud.

This command is useful to speed up the download process over the auxiliary port. Before issuing the download command, use this command to change the radio console speed to the highest baud rate supported by the PC. Then change the terminal settings to match the radio speed. Issue the download command described below and initiate the transfer at the terminal.

Example:

```
>console-speed-bps baud-rate-bps=115200
```

copy-file

source=filename

destination=filename

Copies the source file into the destination. If the memory location is not defined (flash or tmp), the command assumes the flash directory.

Examples:

```
>copy tmp/atc01_02 atc01_02
```

delete-file

filename=filename

Deletes the specified file from RAM or Flash PROM. If the memory location is not defined (flash or tmp), the command assumes the flash directory.

Examples:

```
>delete atc01_03
```

directory

format=short or ***full***

Lists all the files currently stored in flash PROM and RAM, their size, the sectors occupied and the MD5 checksum (full version). It also indicates which of the files is the default program. Files stored in flash PROM have the **flash/** prefix. Files stored in RAM have the **tmp/** prefix.

Examples:

```
>dir full
```

download-file

source=path/filename

destination=filename

method=inline or ***binary***

Downloads a program file from a PC to the radio.

To download a file through the Ethernet port you need to be running the Econsole program on a PC attached to a radio through the Ethernet port. In this case the program file must be in binary zipped format (with extension **.bz**). The *path/* in the source parameter is the PC directory where the file resides. The program file is transferred to the ATC Radio and is stored in the radio memory under the name specified by the destination parameter. If the destination parameter is omitted, the file will be stored in Flash PROM with the same name as the source. You need to specify the “**.bz**” extension in the command. The download “method” to use must be “binary” which is the default.

Example:

```
>download C:\load\atc01_12.bz
```

download the file atc01_12.bz from the PC directory C:\load into the radio file flash/atc01_12

If the download is performed from a terminal connected to the auxiliary port, the file is in ASCII format and has the extension **.dwn**. The download method must be “inline”. The source parameter is not needed since, after issuing the command, you must initiate the transfer of the file from the terminal.

Example:

```
>download dest=atc01_12 method=inline
```

After issuing the command initiate the file transfer using the terminal facilities.

run

filename=filename

Executes the specified file. The file is first copied into RAM and then the program is executed out of RAM. If the radio is rebooted or power cycled, the radio reverts back to the program defined as the default boot program. If the memory location is not defined (flash or tmp), the command assumes the flash directory.

Example:

```
>run atc01_04
```

set-default-program***filename=filename***

Sets the specified file as the default program to be loaded upon reboot or power cycle. Since the default program must reside in flash memory, the “flash/” prefix is assumed and is not required for the command.

Example:

```
>set-default-program atc01_04
```

4.7 MISCELLANEOUS COMMANDS***date***

The ATC Radio sets the internal radio date and time automatically by decoding Network Time Protocol (NTP) packets in the Ethernet LAN. The “zone” parameter specified with the “date” or “time” command will then be used to display the date/time in local time. The “zone” value is saved as part of the radio configuration.

If NTP packets are not available, the user can initialize the radio date and time with either the “date” or “time” commands. The parameters for both commands are identical, but the parameter order is different. The date command can be entered as:

```
> date 16-may-2000 10:32:06
```

date=day-month-year

Sets the date used by the radio. The day / month / year parameter may be separated by any valid separator (‘-’ ‘/’ etc.)

time=hh:mm:ss

Sets the radio time in hours, minutes and seconds. Use colons to separate the three fields.

zone=zone-code* OR *offset

Sets the time zone to be used by the radio to translate the NTP time to local time. It can be specified by an offset from GMT (-0800 or +0200 for example), or as a “zone-code”. The valid “zone-codes” and the respective offsets are shown in following Table 4-1.

Table 4-1. Time Zones, Zone Codes and Offsets

ZONE	ZONE CODE	OFFSET
Pacific Standard Time	PST	-0800
Pacific Daylight Time	PDT	-0700
Mountain Standard Time	MST	-0700
Mountain Daylight Time	MDT	-0600
Central Standard Time	CST	-0600
Central Daylight Time	CDT	-0500
Eastern Standard Time	EST	-0500
Eastern Daylight Time	EDT	-0400
Greenwich Mean Time	GMT	0000

help [command-name]

If no command is specified, displays the complete list of commands. If a command is specified it displays the valid parameter and corresponding values for that specific command.

Example:

```
>help monitor-link
```

history

Displays the previous commands entered.

logout

Closes the current Econsole session.

ping

destination=<string>

count=0..500

size-bytes=32..1400

This command causes the radio to “ping” the destination address and display the results. The “ping” packet consists of an ICMP packet with a length specified by the “size-bytes” parameter. The destination is any valid IP address. When the destination host receives the packet it generates a reply of the same size. Upon receiving the reply the radio displays the round trip delay. This process is repeated the number of times specified by the “count” parameter (defaults to 4).

reboot

Resets the radio causing the software to perform a complete start up sequence. This is equivalent to power cycling the radio off and on.

start

After power up or reboot, this command must be issued for the radio to start accepting UDP data or command packets (the radio will accept the start command through the UDP interface).

time

time=hh:mm:ss

date=day-month-year

zone=zone-code or offset

This command is identical to the “date” command explained above except for the order of the parameters. It allows the time and date to be entered as:

```
> time 10:32:06 16-may-2000
```

version

Displays the radio model and software version.

APPENDIX A

COMMAND SUMMARY

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APPENDIX A – Command Summary

This appendix lists all commands organized in the respective functional groups. Parameters that are part of the radio configuration are identified by having an entry under the “Factory Configuration” heading. When entering a command, if a parameter that is part of the radio configuration is omitted, the value for that parameter is not modified.

For commands that are not part of the radio configuration, if a parameter is omitted, the value for that parameter defaults to the value indicated in bold.

Table A-1. Configuration Management Commands

Command	Parameters	Values
change-password	enable-configuration	<string>
display-configuration	source	current main alternate factory
load-configuration	source	main alternate factory
lock		
save-configuration	destination	main alternate
unlock	enable-configuration	<string>

Table A-2. Major Configuration Parameters

COMMAND	PARAMETERS	VALUES	FACTORY CONFIGURATION
ethernet	speed	auto, 10hdx 10fdx 100hdx	auto
ip-configuration	address	Ip-address	192.168.1.2
	netmask	Ip-address	255.255.255.0
	gateway	Ip-address	0.0.0.0
node	type	base mobile	base
	reply-enable	off on-match always	off.
	train-address	0 to 0x0FFFFFFE	0
	vehicle-address	0 to 0xFFFFFFFF	0
rf-parameters	receive-channel	3..37	20
	receive-antenna	a, b	a
	transmit-channel	3..37	20
	transmit-antenna	A, b	a
	transmit-speed-kbps	250, 500, 1375, 2750	250
	transmit-power-dbm	0..23	18
rf-receive-setup	channel	3..37	20
	antenna	a, b	a
rf-transmit-setup	channel	3..37	20
	antenna	a, b	a
	speed-kbps	250, 500, 1375, 2750	250
	power-dbm	0..23	18
udp-configuration	peer-address	Ip-address	192.168.1.1
	data-port	1..0xFFFF	421
	command-port	1..0xFFFF	422
	peer-data-port	1..0xFFFF	5001
	peer-command-port	1..0xFFFF	5002
	max-response-bytes	500..1466	486
	socket-mode	1..2	2

Table A-3. Installation and Link Monitoring Commands

COMMAND	PARAMETERS	VALUES
display-packets		
monitor-packets		
poll-loop	train-address	0..0x0FFFFFFE
	vehicle-address	0..0xFFFFFFFF
	interval-ms	10, 20, 30, 40, 50 , 100
	size-bytes	14.. 500
spectrum-analysis	input	a-antenna b-antenna
	display	graph table
	dwel-time-ms	1...1000 (def: 20)
time-analysis	channel	0..50
	input	a-antenna b-antenna
	display	graph table
	dwel-time-ms	1, 2, 5, 10, 20 , 50, 100, 200, 500

Table A-4. Event Logging Commands

COMMAND	PARAMETERS	VALUES
clear-log	region	all-events reboot-reasons
display-log	region	end beginning all-events reboot-reasons
	length	1..500 (def 10)
	id	0...200
	min-level	0...7 (def: 0)
	max-level	0...7 (def: 7)

Table A-5. File Utilities

COMMAND	PARAMETERS	VALUES
console-speed-bps	baud-rate-bps	9600, 19200, 38400 57600, 115200
copy-file	source	filename
	destination	filename
delete-file	filename	filename
directory	format	short full
download-file	source	path/filename
	destination	path/filename
	method	binary inline
run-file	filename	filename
set-default-program	filename	filename

Table A-6. Miscellaneous Commands

COMMAND	PARAMETERS	VALUES	FACTORY CONFIGURATION
date	date	dd-mmm-yyyy	
	time	hh:mm:ss	
	zone	offset or code	GMT
help	command		
history			
logout			
ping	destination	ip address	
	count	0..500 (def 4)	
	size-bytes	32..1400	
reboot			
start			
time	time	hh:mm:ss	
	date	dd-mmm-yyyy	
	zone	offset or code	GMT
version			

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APPENDIX B

SPECIFICATIONS

RF SPECIFICATIONS	DETAIL
RF Frequency Band	2.406 GHz to 2.474 GHz (center frequencies)
RF Signal Bandwidth (-20 dBc)	4.6 MHz
RF Channels	35 (12 non-overlapping)
Transmitter Output Power	0 to 23 dBm (programmable)
Modulation Type	direct sequence spread spectrum
RF Data Rates (one way)	250, 500, 1375, 2750 Kbps
Receiver Sensitivity (10 ⁻⁶ BER)	-92 dBm (@ 250 Kbps) -90 dBm (@ 500 Kbps) -88 dBm (@ 1375 Kbps) -85 dBm (@ 2750 Kbps)
DATA INTERFACES	
Auxiliary Port	RS-232
Ethernet Port	10/100 BaseT (auto-negotiate)
POWER REQUIREMENTS	
Input Voltage (Outdoor Unit)	+8 12 to +30 32 Volts DC
Input Voltage (AC)	110 VAC or 220 VAC
Power Consumption	less than 5 7 Watts
POWER TRANSIENT SURGE PROTECTION	
Peak Power Dissipation	1500 W (with 10/1000 μsecond waveform)
Peak Pulse Current	35 A (with 10/1000 μsecond as defined by R.E.A.)

CAUTION

REVERSED POLARITY OF THE INPUT POWER TO THE
RADIO WILL DAMAGE THE RADIO.

SPECIFICATIONS

ENVIRONMENT	DETAIL
Temperature	-40 to +70 Degrees C
Max. Humidity	90% non-condensing
MECHANICAL	
Dimensions	4.72" wide x 8.66" high x 2.20" deep (120mm W x 220 H x 56 D)
Weight	2.4 lbs. (1.1 Kg).

APPENDIX C

CHANNEL FREQUENCY ASSIGNMENT

Table C-1. Channel Frequencies

CHANNEL	FREQUENCY (GHz)	CHANNEL	FREQUENCY (GHz)	CHANNEL	FREQUENCY (GHz)
3	2.406	15	2.430	27	2.454
4	2.408	16	2.432	28	2.456
5	2.410	17	2.434	29	2.458
6	2.412	18	2.436	30	2.460
7	2.414	19	2.438	31	2.462
8	2.416	20	2.440	32	2.464
9	2.418	21	2.442	33	2.466
10	2.420	22	2.444	34	2.468
11	2.422	23	2.446	35	2.470
12	2.424	24	2.448	36	2.472
13	2.426	25	2.450	37	2.474
14	2.428	26	2.452		

Table C-2. Non-Overlapping Channels

NUMBER OF NON-OVERLAPPING CHANNELS	SUGGESTED CHANNEL ALLOCATION	FREQUENCY SEPARATION (MHz)
12	3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36	6.0

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APPENDIX D

ETHERNET CONSOLE PROGRAM

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D.0 General

The Econsole v201 for Windows program was developed in order to accommodate the remote configuration of a radio, i.e. the configuration in cases where the physical access to the radio is not feasible, or it is cumbersome. The software consists of two parts: the client and the server. The client runs on the administrator's PC, while the server runs on the radio.

The communication is done via a TCP-like protocol. There is an acknowledgment for every packet that is sent, as well as a retransmission mechanism when a packet gets lost.

Each radio allows multiple sessions, i.e. more than one client can be connected concurrently to the same server (radio). Nevertheless, for performance reasons, it is not recommended to have more concurrent sessions than they are really needed, and definitely not more than the maximum number which currently is four.

D.1 System Requirements

- Win95, Win98, Windows ME, WinNT, Win2000, WinXP
- NetBIOS installed
- WinPCap installed

Note: With regard to Windows NT platform, the code has been tested with versions 4.0, or newer. There is also a Linux beta version

D.2 Installation for Windows

In order to install the WinPCap library, if not already installed, just click on the WinPCap.exe. Support and updates for this library can be found at <http://netgroup-serv.polito.it/winpcap/>. It is strongly suggested to uninstall older versions of the library and reboot the machine before installing the new one. NetBIOS is a software component that comes by default with all Windows systems, so you don't have to install it. To start the Econsole, simply open a MS-DOS window and type *econ*. For available command line arguments, please read the "*input arguments*" section.

D.3 Included Files

- *win_readme.doc* The file that you are reading
- *econ.exe* The EConsole client
- *WinPCap* The Windows installer for the WinPCap library
- *input_script.txt* A sample input script file, that contains a list of radio commands.

D.4 Input Arguments

You can provide the following arguments in the command line, even though none of them is required.

D.4.1 Input file

There are two sources for the input commands: the keyboard, or a text file. The second option is useful when you are running the same set of commands periodically, so you want to avoid retyping them every time you want to execute them. If there is an input file in the command line, then the keyboard will be deactivated and only the function keys will be available. If the specified file cannot be found, the application will be terminated.

example:

C: > econ -i input.txt

Sample input file:

```

help
# this is a comment - note that the character # must appear as the first character
time
date
# the following is a local command specifying a delay in seconds
. delay 10
time
. delay 1.5
version
logout

```

As you probably noticed from the above file, all the lines are interpreted as radio commands, unless:

- a) They start with the character '#' which implies a comment
- b) They start with the character '.' which implies a local command. Currently there is only one local command, namely the *delay <time in secs>*

Important note: All the input scripts should end with the *logout* command. Since all the commands are terminated with the new line character, there must be one command per line and after the final *logout* command you must have an extra empty line.

D.4.2 Output file

When you want to capture the output of a session into a text file, you can pass the filename as an argument. If the file does not exist it will be created, otherwise it will be overwritten.

example:

```
>econ -o output.txt
```

D.4.3 Radio MAC address

If you are interested in a specific radio, you can pass its MAC address and let the client ignore any response from other radios. That's very handy when you are always getting connected to the same radio and you want to avoid the manual selection of a preferred one. Very useful also in case you are using scripts for fully automated procedures.

example:

```
>econ -r 00:78:24:22:BA:4F
```

D.4.4 Radio Serial Number

The same functionality as above (see Radio MAC address) can be achieved by providing the radio serial number, instead of the radio physical address. Note that you should not include the initial UC characters of the serial number (i.e. type *11078* instead of *UC11078*)

example:

```
>econ -r 11787
```

D.4.5 Local Physical Address

Even though econsole identifies the PC local physical address automatically, there are some cases in which the user wants to specify the local address on his/her own. These cases usually arise when there are multiple NIC cards with the same names under WinNT operating system. In such case, the econ might pick up the wrong MAC address, and therefore the user should supply manually the physical address as a command line argument.

example:

```
>econ -m 00:78:24:22:BA:4F
```

D.4.6 Inverse Screen Colors

You can change the default settings (white texture on black background) by providing the `-b` option, which will change the settings to black characters on white background.

example:

```
>econ -b
```

D.4.7 Change the console window size

Currently you can specify two values, either 25 or 50. These values indicate the number of lines of the MS-DOS window.

example:

```
>econ -l 50
```

D.4.8 Help

Function keys, including F1, are activated after you get connected to a radio. If you want to get help from the command line, you can use the `-h` argument.

example:

```
>econ -h
```

Syntax:

```
econ <argument list>
```

```
argument list = argument list | argument | {}
```

```
argument = -o outputfile | -i inputfile | -r MAC address
```

Examples:

Let's say you want to read a list of commands from the text file called `in.txt`, and capture the output to a text file called `out.txt`. You are also interested only in a specific radio with MAC address equal to `00:78:24:22:BA:4F`. In that case, you will start the EConsole with the following arguments (the arguments order is irrelevant):

```
>econ -i in.txt -o out.txt -r 00:78:24:22:BA:4F or
```

If you are reading from the keyboard, and you are simply interested in capturing the output of the session, use the following syntax:

>econ -o out.txt

Since no input file was specified, it is assumed that the keyboard will be used for input, and ALL radios will participate in the discovery process.

D.5 Function Keys

Currently there are 6 different function keys.

- F1** - Online help - gives a short description of the other function keys and the input arguments.
- F2** - Active/deactivate diagnostic messages. Initially diagnostic messages are not shown, therefore if you want to see them you should press F2. Diagnostic messages include warnings, and retransmission info in order to get an idea of the connection's speed/integrity. Error messages are always shown.
- F3** - Terminates the current session and closes the application.
- F4** - Close the session with the current radio and display the results of the initial discovery phase to allow the user to connect to a new radio.
- F5** - Reverse/Restore screen settings. Initially the screen displays white letters on black background, but you can reverse it to black letters on a white background.
- F6** - Increases the console window buffer. This introduces a side bar which enables the user to scroll up and down. Available in Windows NT Only.

D.6 Troubleshooting & Updates

D.5.1 Common Problems

1. Failed to open adapter.

This usually happens when you haven't installed properly the WinPCap library, or you have an older version of it. Please visit <http://netgroup-serv.polito.it/winpcap/> to get the latest version. You should also make sure that your Ethernet adapters are working properly.

2. Cannot find radio(s) even though they are running properly.

Make sure that:

- The Ethernet cables are OK.
- You are getting connected to the right network segment (i.e. try all Ethernet adapters).
- You are using the right MAC address. The system tries to identify the adapter physical address through some NetBIOS calls in the Win9X case, or some NDIS queries in the WinNT/Win2000 case. If NetBIOS is not installed, the econ will probably use the wrong local host MAC address. Also if there are more than one Ethernet adapter installed with the same name, this might cause a problem in the WinNT case.

Resolution: Use the command line argument to specify the correct physical local address. You can see all the local physical addresses by executing the *ipconfig -all* command.

Example:

```
>econ -m 00:78:24:22:BA:4F
```

3. Find a radio but not getting connected.

Check if the maximum number of sessions has been reached. The maximum number of sessions on the server side is limited to four, therefore you should NOT connect to the same radio multiple times if not absolutely necessary. When the number of sessions reaches the limit the radio will ignore any new discovery messages.

Another reason might be a unreliable RF link causing a high packet loss. Since during the discovery phase there isn't any retransmission mechanism, it is quite possible that you managed to "see" the radio, but you weren't able to connect to it, because the connection request packet was lost. In such case, try to connect again.

4. High drop rate - screen freezes momentarily - connection times out.

There are two possible causes.

1. The link between the client (PC) and the server (radio) is very weak. If the packet drop rate is more than 20%, then the connection is problematic.
 2. There are multiple sessions opened on the same server. With many concurrent sessions the server response may be noticeably slower. Always close the session gracefully by executing the *logout* radio command, and not by closing the MS-DOS console. If the *logout* command is not issued the session at the server will remain open for an additional 15 minutes. Use the *list long* command to find out the number of open sessions.
5. If I leave the client inactive for half an hour, and try to type a new command, I get an unable to transfer packet message or I get a "session timeout - application will be closed" message.

An open session times out after 15 minutes of inactivity on the server side, and 30 minutes on the client side.

D.6 Acknowledgements

The WinPCap library was obtained from "Politecnico di Torino" and the code is distributed in binary form as part of the Econsole. The following copyright notice applies to that library.

```

/*
 * Copyright (c) 1999, 2000
 * Politecnico di Torino. All rights reserved.
 *
 * Redistribution and use in source and binary forms, with or without
 * modification, are permitted provided that: (1) source code distributions
 * retain the above copyright notice and this paragraph in its entirety, (2)
 * distributions including binary code include the above copyright notice and
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 * features or use of this software display the following acknowledgement:
 * `` This product includes software developed by the Politecnico
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 * written permission.
 * THIS SOFTWARE IS PROVIDED ``AS IS'' AND WITHOUT ANY EXPRESS OR IMPLIED
 * WARRANTIES, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF
 * MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
 */

```

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