EXHIBIT 4

EXPOSITORY STATEMENT

SCOPE

This User Manual describes the Bay Area Rapid Transit (BART) Advanced Automatic Train Control (AATC) Receiver-Transmitter (RT) portion of the BART AATC Radio Set (RS), its installation, and conditions of usage.

APPLICABLE DOCUMENTS

The following Government regulations form a part of this User Manual to the extent specified herein. In the event of a conflict between the regulations referenced herein and the contents of this manual, the regulations shall be considered a superseding requirement.

Title 29, Code of Federal Regulations, Chapter XVII, Part 1910, Subparts G, I, & L	Occupational Safety and Health Standards
Title 47, Code of Federal Regulations, Part 15, Subpart C	Federal Communication Commission Rules

RECEIVER-TRANSMITTER DESCRIPTION

RT Definition

The RT is a multi-functional digital data transmitter-receiver used in BART AATC system for digital data communication and range measurement. The RT with suitable antenna and mounting/installation kits is a BART AATC RS and can be used in a variety of vehicle and wayside configurations. The RT is identical in all RS configurations. Only the differences in the mounting and installation kit (Antenna, Power Source, and mounting) define a specific RS configuration and its use.

RT Operation

The RT provides for data exchange between RSs, between the RT and a Train Controller, and between the RT and a Station Computer. The RT has serial interface capability to a Global Positioning System (GPS) Receiver and the Radio Test Set (RTS), a specialized test equipment.

The RT operation is controlled by firmware (imbedded software). The RT hardware, in combination with this firmware, is designed for operation in a communications network of similar RTs to perform train control or other similar applications. A network can contain as few as two RTs or as many as several hundred RTs. The firmware is specifically designed to support networks of RTs spread out along railways or tunnels, where multiple radio frequency (RF) links may need to be cascaded to provide communications from a source to a remote destination. Highly reliable communications is provided through a variety of techniques including spread spectrum and redundant RF channels.

Using the RF communications signals, the RTs cooperatively measure the range between pairs of RTs. The range measurements are reported to a Control Station, which is connected to one of the RTs in a network, and the Control Station can use these ranges to establish and track the locations of RT equipped vehicles.

The RT operates in the 2.40 to 2.48 GHz frequency band. Its transmit center frequency can be controlled to be anywhere from 2,424.75 to 2,455.75 MHz in 1 MHz steps. The RTs share the RF band using a combination of time division, frequency division, and code division multiple access techniques. The communications network structure is managed by a control station computer, which assigns time and frequency resources to each of the RTs.

Functional Elements

The RT consists of five major modules of functional elements as shown in Figure 1 and described in the following subparagraphs:

MESSAGE PROCESSOR CIRCUIT CARD ASSEMBLY DESCRIPTION

The Message Processor Circuit Card Assembly (MPCCA) is part of the 2-card Signal and Message Processor (SMP) module. The MPCCA performs the following functions:

- Message generation and decyphering
- Encoding of messages for transmission
- Decoding of received messages
- Message validation
- Serial communication with devices connected to the Front Panel connectors

The CCA contains a Motorola 68360 microprocessor, a large Electrically Programmable Logic Device (EPLD), Random Access Memory (RAM), Read-Only Memory (ROM), an oscillator, and various interfacing circuits.

The oscillator frequency is 4.9125 MHz and the maximun signal frequency on the MPCCA is 5 Mhz. Functions of the MPCCA are performed under firmware control, the firmware being contained in the ROM.

The photo shows the componect side of the CCA. No components are mounted on the back side of the CCA.

SIGNAL PROCESSOR CIRCUIT CARD ASSEMBLY DESCRIPTION

The Signal Processor Circuit Card Assembly (SPCCA) is part of the 2-card Signal and Message Processor (SMP) module. The SPCCA performs the following functions:

- Preamble correlation and detection
- Reed-Solomon Encoding and Decoding
- PN code generation
- Signal time tracking
- Signal phase tracking
- Timing generation for the complete R/T

The CCA contains three Application Specific Integrated Circuit (ASIC) devices. U1 is a 512-Stage x 4 bits per stage Digital Correlator (DC) which performs the preamble correlation and detection function. U2 is a Reed-Solomon Encoder/Decoder (RSED) that performs the error encoding and decoding functions. U4 is a Signal Processing (SP) device that performs the timing generation, PN generation, and phase and time tracking functions.

The maximum signal interconnection clock rate on the CAA is 5 Mhz. However, higher clock rates are utilized by the ASIC devices. The RSED ASIC contains an on-chip 40 MHz oscillator circuit which requires connection of an external crystal (Y1). The 40 MHz clock is used only within the RSED ASIC. Additionally a 10 MHZ clock is generated and used completely within the DC ASIC.

The photo shows the componect side of the CCA. No components are mounted on the back side of the CCA.

INTERCONNECT ASSEMBLY DESCRIPTION

The Interconnect Assembly contains only interconnection etch and provides all the digital signal interconnection and DC power distribution between the modules of the AATC Receiver/Transmitter Assembly. No RF signals are conducted by the Interconnect Assembly. Critical signals are routed between two signal ground traces (one on each side of the signal trace) and are sandwiched between the power and ground distribution layers of the assembly. The modules interconnected are the Converter Amplifier Assembly (CAA), the Radio Frequency Assembly (RFA), the DC/DC Power Supply, and the Signal Message Processor (SMP). Maximum frequency of signals contained on the interconntction etch is 5 MHz.

Both top and bottom side photos are presented.

DC/DC POWER SUPPLY DESCRIPTION

The DC/DC Power Supply converts the radio prime input DC power to the various power forms required by the internal radio circuits. The prime power input voltage range is 21.0 VDC to 40.0 VDC. The prime power is converted to +15 VDC, +5.2 VDC and ±12 VDC. Attached is the Design/Performance Requirements to which the supply was designed.

The prime module within the supply is a VICOR VI-J00 family DC/DC converter. The specific module number is VI-J22-IY (copy of data sheet attached). This module puts out the required +15 VDC. The +15 VDC is then regulated down to the ±12 VDC and +5.2 VDC by three separate series regulators. Output filtering is provided to meet the ripple requirements.

Since the supply is built by a VICOR subsidary, Mission Power Solutions, we do not have the schematic of the supply or the VICOR module.

The photo shows the component side of the circuit board. No components are mounted on the back side of the circuit board. The silver heat sink is attached to the VICOR VI-J22-IY module. This module is encapsulated and no pictures are available.

Radio Frequency Assembly (RFA) Description:

In transmit mode, the RFA performs direct-sequence spreading using 21 chips per message symbol. A 250 MHz local oscillator (LO) and Surface-Acoustic Wave (SAW) filter are used to perform the continuous-phase-shift-modulation (CPSM) which converts the digital signal to a spread signal at the RFA's 248.75 MHz intermediate frequency (IF). After the CPSM modulation, the spread signal is up-converted to 1 of 32 (1 MHz increments) center frequencies (range of 419.75 MHz to 450.75 MHz) using the appropriate LO frequency (range of 171 MHz to 202 MHz). This signal is output to the Converter Amplifier Assembly (CAA) via the TXRF port.

In receive mode, the reverse process is performed. The incoming receive signal (419.75 to 450.75 MHz) from the CAA is down-converted to the RFA's IF frequency of 248.75 MHz using the appropriate LO frequency (range of 171 to 202 MHz). The IF signal is then down-converted to baseband using the 250 MHz LO. At this point the data is recovered using the 2-bit adaptive A/D converter. The I and Q data is output to the Signal and Message Processor (SMP) module - the I-channel being the data and the Q-channel used for decision-making for phase-adjustments of the 250 MHz LO.

The photo shows the component side of the circuit board and the cover. No electrical components are mounted on the back side of the circuit board; only the interface connector is mounted to the back side.

Converter/Amplifier Assembly (CAA) Description:

The ANTENNA port is used for both transmit and receive. Logic signals are provided from the Signal and Message Processor (SMP) module for receive/transmit control. The CAA contains a 2.005 GHz synthesizer which is phase-locked to a 5 MHz reference. The 2.005 GHz signal is used as the local oscillator (LO) in both up-conversion and down-conversion.

In transmit mode, the incoming signal (419.75 to 450.75 MHz) at the TXRF port, from the Radio Frequency Assembly (RFA), is up-converted using the 2.005 GHz LO from the synthesizer to the transmit frequency (2.42475 GHz to 2.45575 GHz). The signal is amplified, incorporating Automatic Gain Control (AGC) to maintain the desired output level of 28.5 dBm $\pm$ 1.0 dB at the ANTENNA port. A bandpass filter near the ANTENNA port is used to suppress out-of-band spurious and harmonics.

In receive mode, the incoming signal (ANTENNA port, 2.42475 GHz to 2.45575 GHz) is down-converted using the 2.005 GHz LO to the receive frequency (419.75 MHz to 450.75 MHz). The bandpass filter near the ANTENNA port provides suppression of out-of-band signals, which could otherwise reduce receiver sensitivity. The receive path of the CAA provides low-noise amplification, additional filtering, and has an overall gain of 13.0 $\pm$ 3.0 dB. This signal is then output to the RFA via the RXRF port.

The photo shows the top (component) side of the various circuit boards that comprise the CAA.. The back side of the circuit boards contain only interconnect etch; no components are mounted on the back sides. The large silver module is a Low Noise Amplifier procurred from Salisbury Engineering, Inc.