Wayside Signaling Systems

MicroLok® II Wayside Control System - General Information and Configuration Guide

ASTS USA's MicroLok II multi-purpose wayside controller has become the rail industry’s dominant package for performing vital and non-vital management of signaling systems. As of January, 2009 over 2400 units were operating on five U.S. and Canadian Class I railroads, eight U.S. mass transit systems, rail lines in three European countries, six different rail lines in Australia, two major mass transit lines in China and 14 rail lines spanning India to Malaysia. Since the first MicroLok II equipment was first installed in 1996, the system has provided fault-free service for tens of millions of operating hours (cumulative).

Installations now range from simple end-of-siding to double-track universal crossovers, and include advanced applications such as Driverless Automatic Train Control (ATC) and Communications-Based Train Control (CBTC). In addition, the system has been given expanded duties (from its original deployment as an interlocking controller) for applications such as dark territory and highway crossing control. MicroLok II can also be configured as a full, stand-alone non-vital controller, providing “code line” serial communications with a central office and numerous local I/O channels for equipment such as Local Control Panels and ground detectors.

General Information

Introduction

The MicroLok II system is a versatile, microprocessor-based logic controller designed specifically for railroad and rail mass transit applications. Its basic function is to monitor various inputs (via discrete channels and remote communications links) and process these inputs according to instructions contained in a standard ASTS USA-designed Executive software program, and a user-customized Application software program. Based on these computations, the system will deliver discrete-channel and/or coded outputs to operate local equipment and subsystems under its control, and/or deliver remote communication messages to other electronic controllers or computer systems within a network. In vital applications such as railroad interlocking and highway crossing control, MicroLok II is designed to downgrade system operation to a safe state in the event its processing software detects a failure. This is done using a combination of “Diversity & Self-Checking” and “Inherent Fail-Safety” techniques.

To further enhance system reliability and availability, vital MicroLok II systems can be configured in redundant (on-line and standby) pairs. Several configurations are available (e.g. “Hot Standby”, “Seamless Redundant”) to ensure the least disruptive hand-off from the failed system to the back-up system. Failover can be handling using an external relays or via an LAN-style communications link.

In addition to vital applications, MicroLok II units can be configured as entirely non-vital systems. In a typical railroad application, the CPU manages code line communications with a CTC office using one of several commonly used protocols such as Genisys®, ARES, ATCS and MCS-1. The same unit can house several non-vital I/O boards to handle LCP and other operations.

Inputs and Output Management

MicroLok II is electrically and electronically compatible with a wide range of electro-mechanical, discrete-logic solid-state devices and other processor and computer-based systems. Parallel-channel inputs can be taken from electrical contacts of devices such as...
General Information (cont’d)

Inputs and Output Management (cont’d)

relays and switch machine circuit controllers. Parallel-channel outputs can be delivered to energizing devices such as relay coils and power conditioning modules for switch machine motors, signal lamps, etc. Options are provided for different output power levels (e.g. 12V or 24V) and uni-polar or bi-polar channel configurations as required by the application. Several different types of coded outputs are available for generating dc track circuit block signals and cab signal speed code rates on several different cab carrier frequencies.

In vital control applications, output power is switched through the contacts of a Vital Cut-Off Relay (VCOR). The coil of this relay is controlled by a internal power supply output from the MicroLok II electronics. In turn, this output is controlled by the vital CPU logic. In event the CPU detects an external or internal failure, the CPU terminates the power supply output, thus removing power from the VCOR coil. Vital equipment such as switch machines and signals revert to a safe state. Note: MicroLok II signal driving circuits can be configured so that the signal head displays a red aspect following a system shutdown, even though vital output power routed through the VCOR has been disconnected.

Reliability of vital, parallel-channel I/O channels is achieved in several ways. First, each channel is continuously checked by the CPU logic at the MicroLok II end for its operating integrity. This is done in a repeating background fashion that is transparent to normal communications with external equipment. If any individual channel fails one of these tests, the channel is logged as failed and the CPU declares a failure condition. I/O channel reliability is further enhanced with the use of “Isolation Modules” in the lines between the MicroLok II system. These modules help shield the MicroLok II electronics from voltage transients by providing the electronic equivalent of “double-break” circuit protection.

MicroLok II systems can also be outfitted with non-vital I/O channels for a variety of support functions. Examples include receiving manual switch inputs from an interlocking Local Control Panel (LCP), operating LCP indicator lamps, as well as monitoring equipment house ground detector and commercial power status.

Remote Communications

MicroLok II CPU circuitry is equipped with several ports for high-rate message exchange with external systems such as other MicroLok II units (vital or non-vital), digital Audio Frequency (AF) track circuits and other ASTS USA processor-based equipment, data transmission system field interface units and media converters (e.g. fiber-optic modems), and local or distant computer systems, including those in a Central Office. Several EIA “RS”-series data ports on the CPU PCB are available for this purpose. Multiple MicroLok II serial links can be networked in a traditional Master-Slave structure, or to take advantage of TCP/IP connectivity. TCP/IP provides a means for multiple MicroLok II units to communicate more efficiently, such as in transit applications or multi-unit standard interlocking applications.

A separate MicroLok II “Hub” and “Network Interface Adapter” offer an efficient way of interfacing MicroLok II to existing networks and supporting the implementation of wayside IP connectivity for transmission of vital and non-vital data through a broadband backbone network. In addition to exchange of routine railway control information, IP connectivity permits remote observation and modification of MicroLok II software, including downloading of event and error logs for diagnostic purposes.
MicroLok® II Wayside Control System –
General Information and Configuration Guide

**Application and Executive Software**

All MicroLok II vital and non-vital systems share a common Application software platform that contains an extensive set of tools for composing, testing, and loading software, as well as performing diagnostics and maintenance. As a result, users of various MicroLok II-based systems need only become familiar with a single software platform for all field applications. For the system’s application software, the “MicroLok II Development System” offers a variety of means to design the vital or non-vital logic, including the familiar Boolean format which provides an easy method of simulating relay logic circuits. Within the Development System, the “MicroLok II Tools” program gives maintenance personnel and application engineers a broad spectrum of software-related capabilities such as uploading of executive and application software, configuration of system during commissioning, and viewing system status and historical data from system, user and error logs. The familiar Windows® format is employed to make procedures as user-friendly as possible.

All MicroLok II systems are programmed at ASTS USA with standard Executive software that performs vital and non-vital input processing, decision-making and generates outputs based on instructions contained in the Application software. From time to time, ASTS USA will issue version updates to the Executive software, typically to accommodate a new feature or function. Users are informed through a carefully conducted revision notification process. Both Executive and Application software are uploaded to the vital CPU electronics via an on-unit, PC-compatible serial port. Replacement of EPROM chips is not required.

**Diagnostics and Repair**

MicroLok II systems are designed for ease of troubleshooting and maintenance on several levels. Cardfile PCB front panels contain both alphanumeric and discrete LED displays that can indicate a system failure or fault with an individual I/O or power-delivery line. On the CPU board front panel, selected logs and configuration settings are observed by operating several toggle switches and observing the resulting data on the alphanumeric displays.

For more in-depth diagnostics, a PC can be connected to the MicroLok II CPU to observe a wide variety of data such as performance of individual I/O channels and serial communications ports, routine (normal) event logs and error logs. Field servicing of MicroLok II units simply consists of replacing faulty plug-in PCBs, reloading Application software (if required) and resetting the system. To verify that individual PCBs are faulty, ASTS USA offers shop test equipment that performs exhaustive, chip-for-chip tests of PCB circuits. Boards in need of repair or replacement are returned to ASTS USA Batesburg, SC Service Center for service.
**Configuration/Application Guide**

**Central Processing Unit (CPU)**
- Common to all MicroLok II-based systems (vital and non-vital);
- Manages other PCBs in system cardfile;
- Performs system decision-making functions and continuous internal/external diagnostics;
- Commands system to safe state in event of failure;
- Carries Application, Executive S/W
- Provides four high speed data ports for remote comms;
- Provides single high speed data port for software uploading and log downloading;
- Front-panel switches and displays permit selective diagnostics, configuration setting;
- PCB ordering information: See *RSE-1D2*

**Vital Outputs: General**
- Typically used to operate switch machines, switch locks, searchlight signal mechanisms, misc. relay-controlled devices;
- Standard Vital Output PCB: 16 channels, 12V or 24V;
- Mixed Vital I/O PCB: 8 output channels, 8 input channels, 12V, 24V or 50V
- Isolated 8-Output PCB: 8 uni-polar or 4 bi-polar vital outputs, 12V or 24V
- PCB front panel LEDs monitor individual output channels
- PCB ordering information: See *RSE-1D2.2*

**Vital Outputs: Conditional Power Assurance**
- Power for all outputs routed through vital relay (VCOR) contacts.
- CPU cuts off outputs’ power upon diagnostics failure (controlled equipment reverts to safe state)
- Application information: See *RSE-1D10*
- PN-150B relay used for normal contact loads (see *RSE-4E1*)
- PN-150HD relay used for heavy contact loads (see *RSE-4E2*)
**Vital Outputs: External Isolation and Bi-Polar Configuration**

- Output Isolation Modules provide equivalent of “double-break” protection for devices/circuits in separate house.
- Also permits installation of bi-polar output circuit.
- 12V up to 50V output versions.
- Useful in MicroLok II “Hot Standby” systems (*RSE-1A6*).
- Output Isolation Modules ordering information: See *RSE-1D6*.

**Vital Outputs: Switch Machine Interface**

- Solid-state SML Modules permit direct drive of electric machines.
- 24V and 110V (input) models.
- Eliminates need for electro-mechanical relays.
- Permits simultaneous control of two switch machines.
- Compatible with 2-, 3- or 5-wire controlled machines.
- Application information: See *RSE-1D12*.
- Ordering information: See *RSE-1D12*, *-3A1*, *-3A2*, *-3A3*.

**Vital Inputs: General**

- Typically used to monitor relay contact inputs (e.g. track occupancy);
- Vital Input PCB: 16 channels, 12V, 24V or 50V;
- Mixed Vital I/O PCB: 8 input channels, 12V, 24V or 50V;
- PCB front panel LEDs monitor individual input channels;
- PCB ordering information: See *RSE-1D2.2*.

**Vital Inputs: External Isolation**

- Electrically isolates external inputs’ battery source.
- Configurable for 2 uni-polar inputs or 1 bi-polar input.
- Built-in surge and short circuit protection.
- Module ordering information: See *RSE-1D7*. 
**Configuration/Application Guide (cont’d)**

**Vital Inputs and Outputs: DC-Coded Track Circuit Applications**

- Isolated I/O PCB: 4 inputs, 2 outputs (all circuit-protective)
- Non-Isolated I/O PCBs: 4+4 (12V), 4+4 (12/22V) options
- Application information: See *RSE-1A3, -1A5*
- PCB ordering information: See *RSE-1D2.5*

**Non-Vital Inputs and Outputs**

- Suitable for variety of non-vital applications (e.g. power off, ground detection, LCP interface)
- Isolated (circuit-protective) or non-isolated options
- Input+output PCB options: 16-in/8-out, 32-in/32-out channels
- Input-only PCB option: 16 or 32 isolated (circuit-protective) channels
- Output-only PCB option: 32 isolated (circuit-protective) channels
- PCB ordering information: See *RSE-1D2.3*

**Wayside Signal Operation: LED**

- “LED 12” PCB drives up to 12 ASTS USA LED signals;
- Signal unit power supplied by Constant Current Regulator; no slide-wire resistor needed;
- Built-in LED-fail detection capability (i.e. “Lamp Out”)
- MicroLok II can drive non-ASTS USA LED signals with appropriate interfaces;
- Application information: See *RSE-1A12*
- LED 12 PCB ordering information: See *RSE-1D2.4*
- LED signal ordering information: See *RSE-7A1, -7A2*

**Wayside Signal Operation: General DC Incandescent**

- Vital DC Lamp Driver PCB: Up to 16 lamps, 300W (max.);
- Direct drive of color-light, position-light and searchlight signal lamps;
- Capable of driving, 16, 18, 24, 25W lamps;
- PCB front panel LEDs monitor individual channels;
- PCB ordering information: See *RSE-1D2.4*
Wayside Signal Operation: DC Coded Track Circuit Applications
- PCBs for colorlight and searchlight signals
- 18W or 25W lamps
- 1 or 2 signal heads
- 2 spare isolated inputs also available
- Application information: See RSE-1A3, -1A5, -1A6
- PCB ordering information: See RSE-1D2.4

Wayside Signal Operation: AC Incandescent
- AC Lamp Driver Module interfaces MicroLok II vital output channel to AC signal head;
- Module capability: Up to 4 AC lamp circuits;
- Augmented with "Filament Checker" to confirm lamp filament integrity;
- “Redundancy PCB” permits parallel lamp control from separate MicroLok II systems;
- Module ordering information: See RSE-1D5

DC-Coded Track Circuits: MicroTrax®
- Permits exceptionally long track circuits
- Train detection plus through-the-rails communications of track codes
- Inherent broken-rail/faulty insulated joint detection
- MicroTrax Coded Track Circuit PCB options for non-cab, cab-compatible applications
- Application information: See RSE-1A3, -1A5, -1A8
- PCB ordering information: See RSE-1D2.5

DC-Coded Track Circuits: E-Code™
- Fully compatible with all versions of ElectroCode track circuits
- Integrates MicroTrax features with ElectroCode applications
- Allows control of both ElectroCode and MicroTrax T.C.s from one MicroLok II system
- Application information: See RSE-1A2, -1A3, -1A5
- PCB ordering information: See RSE-1D2.5
### DC Coded Track Circuits: Track Interface
- Track interface panels isolate rail transient voltages from MicroLok II electronics.
- Provides high immunity to unwanted signals.
- Also provides compatible operation with existing cab.
- Cab and non-cab models available.
- Applications: See RSE-1A2, -1A3, 1A5, -1A6, -1A8.
- Panel ordering information: See RSE-1D3.

### DC Coded Track Circuits: Shunt Speed Optimization
- Reduces shunt detection time down to 100 milliseconds.
- Valuable in detection zones requiring release of switch lock.
- Wired with MicroTrax Track Interface Panels.
- Module ordering information: See RSE-1D4.

### Digital AF Track Circuits: Communication and Train Detection
- Serial communications to digital AF track cardfiles to deliver profile-based cab commands.
- Key feature of ASTS USA driverless and driver-operated ATC systems.
- Integral with Interlocking MicroLok II cardfiles, or in separate “Track” MicroLok II cardfiles.
- Separate train detection line via relay contact input to Vital Input PCB channel (typical).

### Interlocking Track Circuits: OS
- Built-in MicroLok II capability for interlocking train detection.
- Injects and monitors 400 Hz signal (ideal for interlocking rails).
- PCB ordering information: See RSE-1D2.5.
### Configuration/Application Guide (cont’d)

**Cab Signal Code Generation**
- Built-in MicroLok II capability for cab signal carrier and code generation
- Standard 60 and 100 Hz carriers available
- Standard 75, 120 and 180 CMP rates available
- System can be designed with customized carriers and rates
- PCB ordering information: See RSE-1D2.7

**Inter-System Communications: IP Connectivity**
- Based on peer-to-peer protocols, enabling faster on-demand communications (rather than slower polling method)
- Provides MicroLok II interface to existing networks; installation-customized links not required.
- Permits multiple MicroLok II units to communicate more efficiently (e.g. complex transit applications or multi-unit interlockings)
- Suitable for vital and non-vital communications
- Also enables IP-based access to MicroLok II logs
- Application information: See RSE-1A11
- Ordering information for TCP/IP modules: See RSE-1D13

**IP Connectivity: Serial-Ethernet Translation**
- Converter Module translates MicroLok II Peer messages (from CPU serial ports) to/from Ethernet standard
- Permits routing of MicroLok II Peer messages using TCP and UDP network protocols
- Suitable for MicroLok II peer-based central office communications
- Compatible with HMAC-to-peer protocol messages
- Converter ordering information: See RSE-1D9
**Inter-System Communications: Standard Serial Link Ports**

- Four CPU PCB serial ports for MicroLok II external communications
- CPU Ports 1 and 2 (Master): RS-485, asynchronous, up to 19,200 BPS
- CPU Ports 3 and 4 (Slave): RS-423/423, synchronous or asynchronous, up to 19,200 BPS
- Serial Link Relay PCB: Provides RS-485 serial link between “Interlocking” and “Track” MicroLok II systems (ATC applications)
- PCB ordering information: See *RSE-1D2.1*

**Standard Serial Link: Communications-Protective Devices**

- Serial Isolator Unit: Protects RS-232/RS-423 link between MicroLok II CPU and code system from voltage transients.
- ATCS-Compatible Serial Isolator: Provides transient signal protection on Motorola MCP Radio-based non-vital serial links with MicroLok II
- Serial Communications Adapter Panel: Protects serial communications between MicroLok II and other systems in separate wayside houses.
- Application and ordering information: See *RSE-1D8*

**MicroLok II Executive Software**

- Installed in all MicroLok II-based systems (vital and non-vital)
- Performs vital and non-vital logic actions based on Application software instructions
- Performs continuous safety-critical diagnostics (internal and external)
- Safely downgrades system in case of diagnostic failure
- Performs recording and playback of routine logs and user-specified events
- Version updates (from ASTS USA) accommodate new technologies (e.g. IP communications)
- Version updates uploaded via CPU-connected PC
MicroLok® II Wayside Control System –
General Information and Configuration Guide

MicroLok II Application Software: General
- Customizes the MicroLok II system to user’s exact, location-specific requirements
- Functional equivalent of 4095 relays with 50 contacts/relay
- Functional equivalent of 400 adjustable timers
- Incorporates variety of Windows®-based design and checking tools (“Development System”)

MicroLok II Application Software: Development System
- **Text Editor**: Creates MicroLok II application logic source file using any DOS or Windows-based text editor application (Boolean logic-based)
- **Logic Compiler**: Checks application logic source file for errors and generates final application file
- **Ladder Logic Graphic User Interface (GUI) Tool**: Enables application logic to be developed using Ladder Logic approach
- **Reverse Compiler**: Assures application source file was translated correctly by the application-logic compiler
- **Comparison Tool**: Compares running program with original program to verify intended application is in use
- **Logic Checker Application**: Allows viewing and printing of source programs in alternatives to the Boolean logic (e.g. ladder logic, simple relay, AAR/AREMA relay style)
- **Maintenance Tools Program**: Provides variety of tools to view and troubleshoot MicroLok II system operations
MicroLok® II Executive and Application Software: Genisys® II CSIB PCB

- Variant of MicroLok II vital software for non-vital code system applications
- Loaded into same CPU PCB hardware as MicroLok II vital systems

MicroLok®, MicroTrax® and Genisys® are registered trademarks of Ansaldo STS USA, Inc.