Encompass® 4
FCC Licensing Guide

This guide is intended to provide the user with an easy-to-use reference when completing the FCC Universal Licensing System online filing application, and to help determine responses for the various screens applicable to a TransCore RFID system that are typically required for an FCC license application.

This document addresses new or modified U.S. installations and covers TransCore equipment operating in the LN Radio Service 902-904 and 909.75 to 921.75 MHz.

Figure 1 FCC ULS Home Page

TRANSCORE
Trusted Transportation Solutions

For further information, contact:

TransCore
8600 Jefferson Street NE
Albuquerque, New Mexico 87113 USA

TransCore Technical Support

Phone: (505) 856-8007
RFIDtechsupport@transcore.com

TransCore Sales Support

Phone: (800) 923-4824

Web: Transcore.com

Disclaimer

This document is provided only as an aid to completing the application process and may contain errors and/or omissions. While the intent is to provide the user with the information needed to complete a typical application for the installation of a TransCore radio frequency identification (RFID) system, TransCore is not responsible for any misinformation provided by the applicant. The applicant is encouraged to contact the FCC with any questions or concerns they have while completing the application.

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General Information

Overview

Within the United States, TransCore Encompass 4 systems are authorized for modulated operation with center frequencies in the range of 911.75 to 919.75 MHz and for continuous wave (CW) operation in the 902.25 to 903.75 and 910 to 921.5 MHz frequency ranges. These are the bands allocated by the Federal Communications Commission (FCC) for this type of equipment. Modulated protocols available on this reader can include eGo, Super eGo (SeGo), EPC, and/or Interagency Group (IAG) with American Trucking Associations (ATA). ATA protocol includes readers for vehicles and read-only rail installations that use the S-918 standard of the Association of American Railroads.

Up to two of these protocols are available on a given Encompass 4 reader dependent upon which version was specified. Because TransCore readers radiate more than 3 milliwatts (mW) of RF power, in this case from 0.2 up to 2W, the FCC must license them under Section 90.351. This is accomplished by accessing the FCC ULS (Universal Licensing System) webpage at https://www.fcc.gov/wireless/universal-licensing-system, registering with the FCC, and filing online using form 601, **FCC Application for Wireless Telecommunications Bureau Radio Service Authorization**, along with the accompanying schedules. "Figure 1 FCC ULS Home Page" on page 1 shows the FCC ULS website homepage and Figure 2 shows the initial application screen. Only fixed readers are licensed. Transponders on vehicles do not need a PT 90 license so uncheck Mobile on the application screen.

Figure 2 FCC Application Screen

It is the user's responsibility to define the operating frequencies required consistent with the technical requirements of the E4 reader (no two adjacent lane readers within 2.5 MHz of each other) and to file the proper application with the FCC. Due to a significant FCC processing time of approximately three months, this process should be started early in the design phase. Potential interference between multiple readers in close proximity, that is, those within 1000 feet with an unimpeded LOS (line-of-sight) between them, should be identified early in the process so a suitable frequency plan can be developed before applying for the license. The TransCore dealer can provide assistance and support as necessary in completing the application.

Table 1 shows a list of FCC forms that are part of an LN Radio Service application. The correct forms will be automatically generated on the FCC website as you work through the online application process.

NOTE: *In some instances it may be required to register an antenna structure using the Antenna Structure Registration (ASR) online system (Form 854). This is typically only for those installations requiring an antenna structure more than 200 feet in height or for those near airport runways. The highest antenna mounting of an LN Radio service reader is 30 feet above the ground, without special waiver of the rule. If you are uncertain, review the ASR website, which is accessible via the ULS website, or contact the FCC.*

Governmental Entity: If you are considered a governmental entity as defined by the FCC, you can use provisions of 90.353i to simplify licensing on a blanket area basis, using "temporary fixed" locations, and a waiver request of Rule 90.137b. Governmental Entities also are exempt from FCC application and regulatory fees. Contact TransCore should you require examples of such applications.

Table 1 FCC Forms that are part of an LN Radio Service Application

Form Number	Form Title
Form 601	Wireless Telecommunications Bureau Radio Service Authorization
Schedule D	Wireless Telecommunications Bureau and/or Public Safety and Homeland Security Bureau Schedule for Station Locations and Antenna Structures
Schedule H	Technical Data Schedule for the Private Land Mobile and Land Mobile Broadcast Auxiliary Radio Services (Parts 90 and 74)
Form 854	Application for Antenna Registration (rarely needed)

Requirements

You are required to provide site-specific information in the online application data entry and in a required attachment describing the system under rules set forth in 90.351 and in the following sections. Before you begin, have this information available:

- Site location including latitude and longitude in NAD-83 (Google Earth) coordinates in DD MM SS.s N and DDD MM SS.s W to the nearest tenth of a second
- Site elevation AMSL (above mean sea level) in meters, along with state and county of location. Determine county for the site location.
- Type of antenna installed along with the technical details of gain and beamwidth
- Antenna structure height AGL (above ground level) in meters
- Antenna height AGL in meters
- Type of reader system installed including protocols being interrogated

FCC Registration

You must register through the FCC's **COmmission REgistration System (CORES)** in order to conduct business with the FCC. After successfully completing registration, you will need to login through CORES to get an **FCC Registration Number (FRN)**. This number will be used to uniquely identify you in all transactions with the FCC.

Accessing the Website

The ULS homepage is at https://www.fcc.gov/wireless/systems-utilities/universal-licensing-system.

1. From the Universal Licensing System home page, under the **Filing** heading, click on **New User Registration.**

Note: *Navigate to the updated version of CORES by clicking the link located at the top of the screen.*

2. Click on **Register** and complete the online form to create a new account. Click the **Create Account** button to submit your information.

Note: *to save time when you are filling out the form, review the password requirements listed on the and click on the link provided to review the list of allowed special characters. Plan your password accordingly.*

3. After successful completion of the registration form, you will see a confirmation screen and receive a confirmation notice in the email address that you provided in the registration. The email confirmation contains a link that you must click on in order to authenticate your email address.

Note: *If the verification link does not work immediately, wait for 15-20 minutes and then retry. If problems continue, try a different web browser or submit a help-desk through the FCC website. Be advised that the FCC may take up to 1-3 days to respond to your help-desk request.*

4. After completing the verification process, return to the CORES home page and input your new Username and Password in the login section. Click the **Log In** button. You will be taken to a Home screen to obtain an FCC Registration Number (FRN).

5. The FCC prefers for all users of a licensee organization to use the same FRN. Determine whether other FCC licenses have been obtained within your company.

    A. If you have an existing FRN, select one of the options on this page to make changes to or associate your name with the existing number.

    B. If you need a new FRN, click on the option to **Register New FRN** and enter the information on the form. An employer identification number or tax identification number is required if this is a business registration. When completed, a new FRN number will be assigned to you. This number and the chosen password are required to proceed with the license registration.

6. Click on the Universal Licensing System link. Select **ULS License Manager** to proceed to the licensing page.

Application Information

This section is a step-by-step guide through the new license application. You are required to fill in certain fields with user-specific information and other fields with equipment-specific information. The focus of this procedure is to explain the appropriate information required for the latter. This process will collect all the necessary information for completion of an LN Radio Service License application (a process that generates **Form 601** as well as **Schedules D** and **H**.)

Note: *As you work through the online application, use the navigation buttons at the bottom of each screen to continue to the next screen or go back. Do not refresh the screens or use the browser arrows to navigate.*

1. From the Universal Licensing System home page, under the **Filing** heading, click on **File Online.**

2. Enter the **FRN number and password** and press **Submit**.

3. Select the link titled **Apply for a New License** to continue to the **Select Service** page.

4. Click on the **Select the radio service for the new license** drop-down menu.

5. Select **LN - 902-928 MHz Location Narrowband (Non-multilateration)** and press **continue**.

6. You will be taken to the **Application Information** screen.

NOTE: *The **Quit Application** link on the top right hand side of the screen will save your progress on the application for up to 30 days. If your form is incomplete, do not forget to complete the application within this timeframe. To return to the saved application after quitting, log in with your FRN and password. When you click **SUBMIT**, the **My Applications** page comes up. Highlight your application in the list and click on **Continue** in the **Work on this Application** box. At any time you can print a preview of the application by clicking on the **Reference Copy** link on the upper right side of the screen.*

General Information

Application Type: Select *Not Applicable*

Authorization Expiration Date (Optional): This can be left blank

Regulatory Status: Select *Private, internal communications*

Type of Radio Service: Select *Radiolocation* and *Fixed*. Select *Mobile* if using any vehicle-mounted readers.

Attachments: Select *Yes*.

Attachments are always required for LN applications of TransCore equipment. Click on **Attachments** in the upper right menu bar and follow the onscreen instructions to attach Exhibit A. Refer to "Exhibit A" on page 16 for a detailed example of Exhibit A with a cover letter.

Rule section 47 CFR 90.351 contains the requirements for the technical showings required to be attached to the application, as drafted in Exhibit A of this document:

Each application to license an LMS system should include the following supplemental information:

1. A detailed description of the manner in which the system will operate, including a map or diagram

2. The necessary or occupied bandwidth of emission, whichever is greater

3. The data transmission characteristics as follows:

   A. The vehicle location update rates

   B. Specific transmitter modulation techniques used

   C. For codes and timing scheme: A table of bit sequences and their alphanumeric or indicator equivalents, and a statement of bit rise time, bit transmission rates, bit duration, and interval between bits

   D. A statement of amplitude-versus-time of the interrogation and reply formats, and an example of a typical message transmission and any synchronizing pulses utilized

4. A plan to show the implementation schedule during the initial license term

Fees and Exemptions: Select *No* for both options unless your organization is a governmental entity (or otherwise allowed by the FCC) and the request is exempt from fees. Be prepared to submit the state-legislature enabling legislation if the organization has never been licensed by the FCC.

Waivers: Select the *No* option, unless you are a governmental entity applying for a blanket license, in which case select *Yes*.

Grandfathered Frequencies: Select the *No* option if this filing is not covered by grandfathered privileges, previously approved by waiver, or functionally integrated with an existing station.

Note: *It is very rare to answer yes to this question.*

Applicant Information

Applicant Name and Type

Enter all the required information in the following categories:

Legal Entity Type: Select from drop down menu

Applicant Address: Complete address information

FRN of Real Party in Interest (Optional): If RPI is different from applicant, enter FRN of RPI to retrieve name. Otherwise, leave blank.

Name of Real Party in Interest (Optional): Same as above

Contact Name: Provide contact information. If possible, designate a second technical person who can also track the application or license and answer FCC technical questions.

Contact Address: Provide contact information, include contact information for the second technical person as well.

Demographics (Optional): These fields may be left blank if desired

Ownership and Qualifications

These questions are in regard to alien status and basic qualifications.

Alien Ownership: Read through and answer *Yes/No* questions as appropriate

Basic Qualification: Read through and answer *Yes/No* questions as appropriate

Control Point

Information included in the Control Point page is typically the home office location of the applicant. Use a real physical address and phone number that is normally staffed so that if the FCC is trying to resolve interference, it can request and promptly have your organization turn off the reader. Press the **Add** button and enter the appropriate information in the boxes provided.

Note: *It is possible to have multiple control points. When some options are clicked, the screen will expand to show other portions that should be completed.*

Administrative

Eligibility

Rule Section: The typical RFID rule section is *90.351*.

Describe Activity: Input a brief summary of expected activity, such as *Installation of RFID system to track vehicles entering and leaving the yard*.

Extended Implementation (Optional): Answer is typically *No*.

Associated Call Signs (Optional): Leave blank. There are no call signs associated with this equipment.

Location

Location List

The Location screen contains the most critical information required by Schedule D. Enter the appropriate information in the provided boxes and dropdown menus.

Select **Add Location** to enter a new location for a reader system.

Location: This field has a dropdown menu. When you select an option, other menu items will populate the screen requesting additional information.

For example, if you select **F Fixed** from the dropdown menu, other menu items will appear on screen requesting additional information to include:

FCC Antenna Structure Registration Type: Select the appropriate option. Other menu options will appear on selection of one of these fields.

Site latitude: (to 0.1 second using NAD-83 Google Earth coordinates)

Site longitude: (to 0.1 second using NAD-83 Google Earth coordinates)

Street Address including City, State, and **County:** Complete this information

Site Elevation AMSL (meters): Elevation of the ground

Overall Ht AGL w/o appurtenances (meters): Height of support structure or tower

Overall Ht AGL with appurtenances (meters): Height of support and antenna

Support Structure Type: Choose the appropriate option from the dropdown menu

NOTE: *Up to 6 locations can be on one application, and each location may contain as many readers as necessary for that location (typically within 75 feet of each other). If there are more than six locations, then multiple applications will need to be submitted with additional fees for each application.*

Airport Identifier: In most cases, the Airport Identifier can be left blank unless the proposed site is adjacent to an airport.

Site Status: Determine if the frequencies used for this system are to have Primary (P) or Secondary (S) protection in conjunction with other fixed site facilities. This can be left blank if the Commission's rules do not recognize Primary or Secondary protection. Otherwise, select **P** if primary protection is wanted for the site or **S** for no protection. In most cases, the typical selection would be **P**.

Environmental Effect and Quiet Zones

Refer to Section 1.1307 of 47 CFR to determine if transmitting from this location could have a significant environmental impact and answer the related question accordingly. In most cases, this would typically be *No*. If the answer is *Yes,* an environmental assessment will be required per 47 CFR, Sections 1.1308 and 1.1311.

If the site is located in a quiet zone listed in Item 27b of the instructions, then list the date the Quiet Zone entity was notified. This can usually be left blank.

Antenna

NOTE: *If you are a governmental entity and are using the blanket licensing process, leave the Antenna information blank.*

Select the location from the **Select Location** box and click on **Add Antenna** from the **Antennas** box. Enter the data required when the screen populates.

Note: *Although some locations may have multiple antennas, the FCC requires information for only one antenna per location.*

AAT: (above average terrain): height is not required in the CW bands (902.25 to 903.75 and 910 to 921.5 MHz) when the reader is configured for ATA-only.

Enter AAT in meters AMSL (above mean sea level) for readers operating in the modulated band (911.75 to 919.75 MHz) for any of the other protocols (eGo, SeGo, or IAG).

Antenna height: Enter in meters AGL (above ground level).

Azimuth: Typically not applicable since it may not be known in advance. Refers to the angle in the horizontal plane of the antenna main lobe with respect to true north. The azimuth angle can range from 0° to 360° and defaults to north (0°) if nothing is entered.

Polarization: For nearly all installations, properly mounted antennas imply horizontal (H) Polarization for the system.

Gain: Beamwidth and Gain are antenna parameters that can be found in Table 2 for TransCore antennas, under columns entitled *Peak Gain (dBi)* and *Horizontal Beamwidth (deg)*. If you use other manufacturers' antennas, use their stated values for beamwidth and gain. If the Polarization and Gain fields are left blank, then default values of vertical (V) polarization and 6 dBi gain are used. However, NONE of these parameters should be left blank.

Note: *If the antenna to be employed is not listed in Table 2, contact TransCore Technical Support for the required information.*

Table 2 Electrical Parameters for Typical TransCore RFID Antennas

Antenna	Encompass 4 Maximum Power (watts)	Peak Gain (dBi)	EIRP* (watts)	ERP† (watts)	Horizontal Beamwidth (deg)	Vertical Beamwidth (deg)	Polarization (Linear)
ISM Panel (4-patch)	2.0	12	31.7	19.3	40	40	Horizontal
Encompass 4 Internal/AA3153 Beacon Toll	2.0	10.5	22.4	13.6	50	60	Horizontal
AA3152 Universal Toll (UTA)	2.0	13	39.9	24.3	32	35	Horizontal
AA3110 Parapanel	2.0	11.5	28.3	17.2	75	28	Horizontal
AA3100 Yagi	2.0	12.15	32.8	20.0	41	49	Vertical or Horizontal
AA3140 PCB Log-Periodic (wedge)	2.0	8.15	13.1	7.9	60	90	Vertical or Horizontal
Dual Patch	2.0	10	20.0	12.2	60	45	Horizontal

*Line losses not accounted for.
†In units of watts, ERP = EIRP/1.64. In units of dBm, ERP = EIRP - 2.15 dB.

Because the Encompass 4/SmartPass 4 readers typically seen in the field come with an internal antenna, the figures shown in the first row will apply in most cases. Encompass 4 readers with internal antennas can be identified by part number 10-400Y-0xx and model number 05530-yy.

For readers equipped with the optional port for an external antenna (P/N: 10-401Y-0xx and M/N: 05531-yy), any of these antennas could be employed depending on application requirements. Parameters shown in Table 2 for peak gain and beamwidth are nominal figures based on specifications, not actual measurements. The actual figures seen in the real world can vary due to factors such as frequency, temperature, manufacturing tolerances, etc.

NOTE: *The maximum ERP limit for Part 90 operation is 30 W which is about 44.8 dBm. This corresponds to an EIRP of 49.2 W or 46.9 dBm.*

When complete, press **Save** and then proceed to the **Frequency** page.

Frequency

Select Location: Highlight the location in the **Select Location** box and select the antenna in the **Select Antenna** box, then click on **Add New Frequency.**

Lower or Center Frequency: Input the center frequency of each reader at each location. Encompass 4 Readers use only one frequency, but if this is a reader that uses multiple frequencies, enter each frequency and emission designation.

Upper Frequency: This field is optional and may be left blank.

Frequency Carrier: This field is optional and may be left blank.

Be sure to enter the center frequency to be used, not the band edge: eGo/SeGo and IAG interrogation downlink modulated frequency band is licensed on center frequencies of 911.75 to 919.75 MHz.

ATA CW may use frequency bands of 902.25 to 903.75 MHz and 910 to 921.5 MHz within the United States.

Wider emissions must be completely within the sub-band when applied to the center frequency. For example, some older RFID systems used an emission bandwidth of 6 MHz total, which means they must be at least 3 MHz from the band edges. The sub-band edges are 902 to 904 MHz for the CW carrier ATA or un-modulated backscatter uplink, and 909.75 to 921.75 MHz band edge for modulated downlinks of other protocols.

Applicants should also note that use of the sub-band 919.75 to 921.75 MHz is on a shared basis with another radio service. The FCC will want an acknowledgment of such an understanding and will often return an application asking for such confirmation. To head off such a time delay, it is recommended that a short note stating that the applicant is aware that this sub-band is shared with another radio service and if (in the rare case) interference arises that mitigation efforts will be undertaken that may include moving the frequency.

Station Class: Enter **LR**

Number of Units (reader): Typically **1.** If multiple readers at the same location use the same frequency, indicate the total number of readers to ensure all readers are licensed.

Number of Paging Receivers: Leave blank, don't enter 0, since it is not applicable.

Output Power: Refer to Table 2

ERP: Refer to Table 2

Note: *The ERP figures shown in* Table 2 *do not take into account any line losses that would be seen when external antennas are used.*

Click **Save Frequency**. The screen will return to the **Frequency List** page and the frequency information that was recently added will appear in the **Select Frequency** box (Figure 3).

Highlight the newly added frequency and click **EDIT**. **Emission Information** boxes are added to the screen. **Add Emission Information:** All Encompass 4 readers are covered under the FCC emission designator 685KL1D.
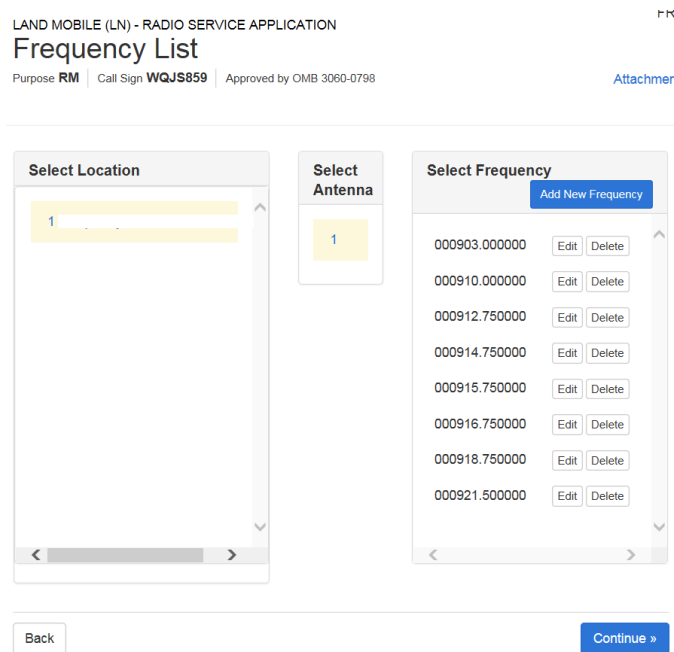

Figure 3 Example of FCC Frequency List Screen

General Certification Statements

You should read and understand the information on the **General Certification Statements** screen before completing. Enter the full name and title of the authorized party to sign. The name entered will also be used as the signature name.

Check Errors

A checklist will appear with red X's to flag areas on the form with incorrect or incomplete information. Use the **Back** button at the bottom of the screen to go back and correct errors and missing information until the flagged areas are cleared.

Completing the Process

The application should be ready for submittal. However, prior to submission the application should be saved and reviewed. Click on the **Reference Copy** link in the upper right hand corner of the screen to view a copy of your application.

If you are not ready to submit, you may save the application at any time during the process. Click on **QUIT** in the upper right corner. This will save your application for up to 30 days. If you do not return to the application within 30 days, all information will have to be re-entered.

Note: *If you return to the ULS after saving the application, be sure to change at least one character in your address or similar before submitting, otherwise the online program will not allow the submission to be made.*

After you have reviewed the application, press the **Submit** button. After submitting the application, the FCC file number will be displayed. Please record the number for future reference (including leading zeros) and save your submittal screen showing the application with the file number for future reference.

You can also save the complete application by using the top right button labeled **Reference Copy** or **Print Preview**, and in the upper left of the first page the FCC file number and date-time (Eastern Time Zone) of submission will be shown. After these steps are completed, proceed to the payment remittance process, unless your application is exempt.

After these steps are completed, proceed to the payment remittance process.

One or two business days after submission, you can check the progress of the application by selecting the **ULS application** tab and entering the application file number. If the application has not been approved after three months, contact the FCC.

Follow-Up

Once you receive the license you have one more step – the build-out notification.

Be sure to keep your FCC registration information and licensee information current. It is TransCore's understanding that there is no fee for an administrative update to change name of person, address, or phone number. Change of ownership or company name requires FCC consent in advance through FCC transfer of control form 603, which is filed online. There is a consummation follow-up notification associated with this process. If contacted, be sure to respond promptly to all FCC inquiries, and remember to renew your license, which typically operates on 10-year terms.

Build-out Notification

If you obtain a regular permanent license (generally not applicable to a blanket license), you need to also notify the FCC when the station is constructed. Your license copy will have a build-out notification date that is one-year from the grant date start of the license term.

NOTE: *Be sure to follow up with this required notification because those new sites will automatically be TERMINATED approximately one year later.*

Typically, a licensee has 8 to 12 months from the date of issuance of a license to complete construction and then notify the FCC that the frequencies are in use at each location. This rule section 90.155 (of 47 CFR-Code of Federal Regulations) is now enforced by a computerized process.

The FCC wants to ensure its ULS database is current and accurate. To accomplish this, the FCC has chosen to use the above-described termination methodology as a means of attaining this accuracy if:

1. Your permanent FCC license has been granted for an RFID/AVI system in the LN radio service (the code for narrowband non-multilateration location systems, that is, any 902 to 928 MHz AVI system requiring a Part 90 license such as TransCore's equipment), and

2. Your license has a construction deadline

You must file the required construction notification before the construction deadline (typically the first year) expires, and within the timely period of 15 days of completion. Otherwise, the license will be terminated.

The FCC Public Notice for build-out notification can be found at:

https://www.fcc.gov/wireless/support/knowledge-base/universal-licensing-system-uls-resources/constructioncoverage

For further details on guidelines and instructions regarding build-out notification contact TransCore Technical Support.

Appendix A

Example Exhibit A with Cover Letter

Site License Showings Template for Commercial entities

<Date>

Federal Communications Commission via ULS online submission

Transportation Infrastructure Radio Service

1270 Fairfield Road

Gettysburg, PA 17325-7245

RE: Application for non-multilateration ITS LN Radio Service- 90.351

FRN: <Insert FCC Registration Number obtained from CORES FCC ULS or used previously by your organization>

Dear Processor:

The <Company Name> encloses an application for operation of a non-multilateration ITS LN Radio Service for vehicle monitoring and access control. This application is in accordance with the rules in section 90.351, specifically 90.353h that allows non-multilateration for location, identification and statusing vehicles for intelligent transportation services such as access control.

The ITS equipment is manufactured by TransCore's Amtech Technology Center.

Thank you for your attention to this application. If you have any questions feel free to call myself, or the contact representative indicated on the application.

Sincerely,

<Name, title>

<Company Name>

<Address, Division, Suite>

<City State Zip>

<Phone >

<Fax - optional> <E-mail>

<List Contact Person – Optional but highly recommended so that another person receives communication from FCC about the application or license – could be distributor or other technical person with knowledge of system operation.

<Name, title, >

<Address, Division, Suite>

<City State Zip>

<Phone >

<Fax - Optional>

<E-mail>>

Exhibit A

The purpose of this Exhibit is to provide additional information in support of the attached application for authorization of an automatic vehicle monitoring (AVM) station(s) under Section 90.351 of the Rules, specifically in the LN non-multilateration Radio Service. The accompanying application proposes to use an Amtech E4 reader with internal antenna that will be mounted permanently. The FCC ID equipment authorization grant is FIHE4PT90V5.

Eligibility

The applicant is eligible under the Sections of Part 90.351 of the FCC Rules. The applicant will use the proposed automatic vehicle monitoring facility to identify vehicles that have been tagged by or in cooperation with the applicant.

Nature of the project and public interest showing

By this request, the applicant seeks to operate an AVM system. The system is to be installed is designed to identify vehicles as they approach the facilities specified herein. The installation will serve the public interest in that it will provide for more accurate and rapid identification of vehicular traffic thereby increasing both efficiency and safety of the applicant's operations.

Description Of System Operation (47 Cfr 90.351)

This section supplies a detailed description of the manner in which the proposed system will operate. As such, it provides the information required by Section 90.351 of the Rules.

Introduction

The TransCore technology consists of tags (transponders), and readers (interrogators). The system works by having a reader send out a radio frequency beam toward a tag. The tag modifies a portion of the signal and reflects it back to the reader. It is the reflected signal that carries the identification code. These tags are attached to an object such as a vehicle, or railcar. When the object approaches a reader, an identification code is retrieved electronically from the tag. The reader then relays the identification code to a computerized management system.

The tags can be either beam-powered (no battery) or battery-powered, but neither type emits an identification signal unless interrogated by a reader. Beam-powered tags use the signal energy from the reader to power the tag circuitry. There is no RF transmitter on either backscatter version of the tag. Thus, the tag is not a transmitter and does not contain components to generate RF signals. This slight modification of the signal includes the unique identification code of the tag. This method of communication is called modulated backscatter. The battery-powered tags stay energized at all times, and battery life is not affected by the number of times a tag is read.

IAG active transmission tags are also covered by this application. They are compatible with tolling systems in the northeastern part of the United States.

The block diagram of Figure 4 indicates the function of each component. The RF Module transmits an interrogation signal in the direction of a tag. The RF Module receives the reflected signal from the tag and relays this information to the Reader. The Reader decodes the information contained in the tag and relays the information to a host computer for subsequent use to identify, track and schedule the tagged objects. The actual installation will use a single antenna integrated with the reader for easy mounting on a wall or relatively short pole.
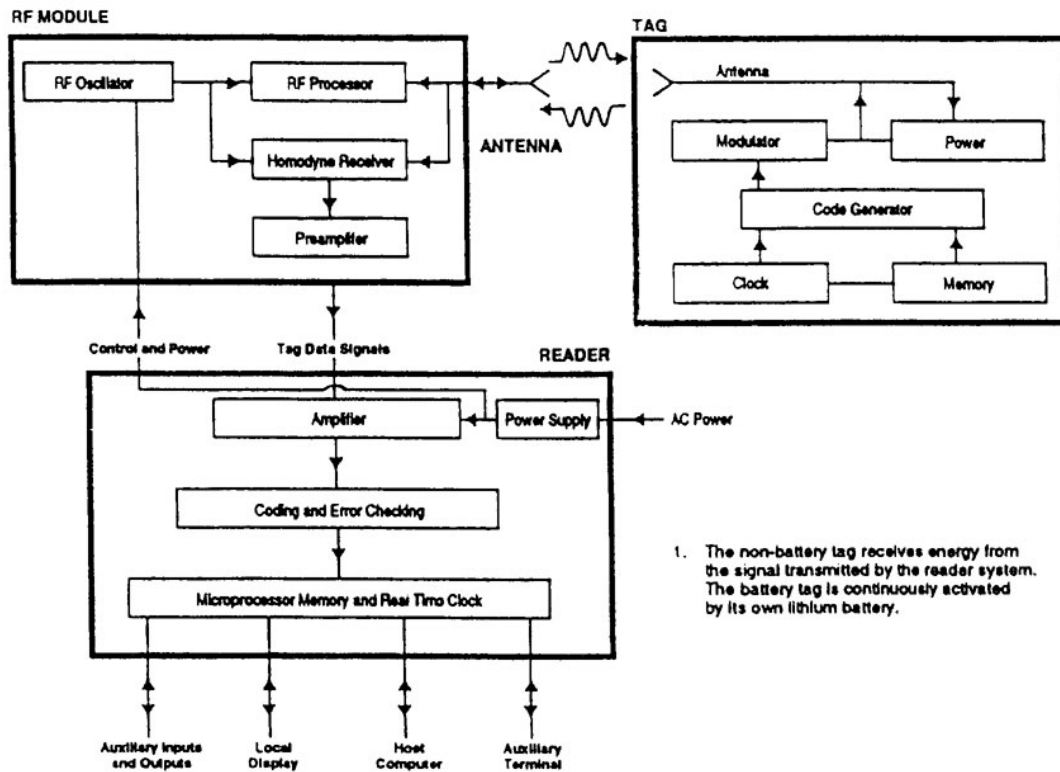
TransCore Proprietary

Figure 4 Block Diagram of the RF Module, Reader, Antenna, and Tag

Description of System Operation

RF Module

The RF module is composed of an RF oscillator, RF processor, homodyne receiver, and preamplifier. The RF module is responsible for transmitting and receiving radio energy. RF energy is generated by the RF oscillator and amplified by the RF processor. This energy is transmitted through the antenna, and the RF energy reflected by the tag is also received by the same antenna. For SeGo, a separate downlink interrogation frequency is often used.

The RF module transmits the uplink frequency of RF energy and receives that same frequency after is reflected as a modulated signal from the tag.

Transmitter output power is typically 2 watts or less. Maximum effective radiated power (ERP) is as indicated in this application. Actual ERP will often be less than the maximum in order to operate with the least power that will provide reliable service.

Some products incorporate RF module components in the reader, which may also house the antenna.

Reader

The RF module receives the modulated signal from the tag and passes the data to the reader. The reader decodes the data and performs error checking, reporting the tag number to the controller.

This low power signal will be continuously directed at the area into which tagged vehicles will travel. Accordingly, we request authority for continuous transmission.

Antenna

The reader system uses a single antenna to transmit and receive RF energy to and from the tag. Note that the antenna is for localized coverage in a specific direction; the antenna does not have omnidirectional coverage patterns. Because the antenna will be mounted less than twenty (20) feet above ground and is normally canted downward, no height above average terrain has been calculated.

Tag

The tag is composed of the modulator, power, code generator and clock, memory, and antenna circuits. All of the tag's circuits are located on a single printed circuit board. The clock circuit sequences all circuit functions such that information stored in the memory circuits is conveyed to the reader system within precise timing. The information stored in the memory circuit is permanent, and is a unique code that is specified by the owner prior to installation of the tag onto its respective object (container, rail car, truck, etc.).

Amtech has the capability of producing two versions of the tag: battery-powered and nonbattery-powered. Regardless of whether the tag has a battery or not, a tag does not transmit RF energy, it only reflects energy transmitted by the reader system.

The tag conveys 64, 128, or 256 bits of digital information (depending upon model) by modulating the reflected energy. The reflected energy is modulated by varying the efficiency of the tag's antenna. IAG tags contain an active transmitter.

The homodyne receiver is used to separate the transmitted CW energy from the information reflected by the tag.

Bandwidth

The reader emission designation is 685KL1D for the transmitted downlink to the tag.

In order to accommodate the bandwidth of the signal transmitted by the reader, backscatter uplink bandwidth is 110 kHz: Emission Designation 110KN0N for the uplink. When reflected from the tag, however, this signal spreads over a wider bandwidth. The occupied bandwidth of the reflected signal is about 2.5 MHz.

Vehicle Location Update Rates

The vehicle location update rate is every time a tagged vehicle passes a reader location. At such times, its tag ID is read and the vehicle's location is updated.

Power and Modulation Techniques

Each reader emits a coded interrogation signal. The system specifications are listed in Table 3:

Table 3 Encompass 4 Coded Interrogation Signals

Description	Value
Nominal RF power (measured at transmitter)	2 Watts or less
Standard transmit and receive frequency range	902.25 to 903.75 MHz and 910 to 921.5 MHz for backscatter uplinks
	911.75 to 919.75 MHz for downlinks
Transmitter emission codes	685KL1D for downlink and 110KN0N for uplink
Antenna Gain	E4 10 dbi =7.85 dbd, Beamwidth 72 degrees 12.2 W ERP
Tag Reflected Signal occupied Bandwidth	2.5 MHz

System Codes

Some tag products are coded in Weigand format. Character usage, other products use a binary field sub-field definition.

Other tags use the SeGo format, organized into 64 bit pages.

IAG data is 256 bits of data transmitted with Manchester Coding following the 20 microsecond interrogation pulse

Statement of Interrogation and Reply Formats

The newer SeGo protocol is also used in some installations, having a higher signaling rate, but no sub-bit encoding, rather using a checksum.

Planned Installation

The applicant anticipates installation of the number of transmitters specified on the application within twelve months of the grant of this application and will provide the FCC the Construction Build-out Notification within that 12 month period.

Prior Licensing History

The Commission has granted a host of identical or similar applications throughout the 902-904 and 909.75 to 921.75 MHz band previously.

Implementation Schedule

Describe when installation will start and when operation will start. Wording should include the phrase "after the FCC license is granted."

Note: *this application may take 2 months or more for processing.*

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