

**TADIRAN *Telematics* Proprietary**

**Tulip - US -A**

**Specification**

Ver. A

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## Tulip-US - Specification

### General.

This document describes the technical specifications of the TADIRAN TELEMATICS Vehicle Location Unit (VLU).

The commercial brand name of this product is: TULIP -US.

The TULIP –US (VLU) is the mobile portion of Location and Messaging system.

**In this document we use the name VLU for the Tulip-US unit.**

### System Description

The system uses RF signals to provide a mean of locating vehicles equipped with the LOCATION system. The system based on Forward Channel (Paging) transmitted from Pagers to the mobile units and based on Reverse Channel used for Location signal and messaging (from the mobile units to Base-Station). The VLU support multi-channels mode in the paging channel and multi-channels of location channels. The VLU is the in-vehicle transmitter / receiver element of the system. The VLU implements a Paging channel receiver , POCSAG format, FSK modulated at a carrier frequency of 927.778 MHz. The VLU is ready to receive the proper address from the paging channel and to reply in the reverse channel with location signal (Pseudo-Noise sequence, ~1.5M chip Rate) and status response. The reverse channel is phase shaping BPSK modulated signal at 905-908 MHz in the proper time slot.

### **VLU External Interface**

The VLU interface consists of:

- Serial wired interface.
- Main battery input and Backup battery input.
- Alarm interface with up to 10 I/Os.
- Antenna

## **Electrical Characteristics.**

### **Frequency Accuracy and Stability**

#### **Frequency accuracy and stability**

The transmitted RF, location code rate and ECM/RCM bit rate frequencies meets the following requirements for accuracy:

##### **Long term frequency accuracy**

The error of the VLU frequency (Data rate, PN (Pseudo Noise) code and RF) in tracking mode is not exceed 2.3 ppm within the full operational voltage and temperature ranges for a minimum of 5 years.

##### **Automatic Frequency Correction**

The error of the VLU frequency (Data rate, PN code and RF) is not exceeding 1.5 PPM, within 10 hour from detection of an acceptable paging signal. For the purpose of this section, an acceptable paging signal is defined as a signal with a received Eb/No of at least 18 dB and a frequency accuracy (RF, deviation and baud rate) error less than 1 PPM, 95 % of the time.

##### **Power up frequency accuracy**

The error of the VLU frequency (Data rate, PN code and RF) is not exceed 2.3 PPM within 5 seconds after applying primary power within the full operational voltage and temperature ranges, at any time within a two year period from the time the conditions of 3.1.1.2 have been met.

### **Reverse Channel RF Transmitter**

The VLU RF Transmitter used for Location signal, Emergency Channel Messages and Reverse Channel Messages transmission.

#### **Transmit center frequency**

Default Carrier center frequency = 907.997333MHz

#### **Carrier phase noise**

-80 dBc/Hz maximum from 1 KHz to 2.0 MHz.

### **Carrier suppression @ BPSK Modulation**

The modulated carrier is suppressed more than 23 dB.

### **Spurious output**

- 21 dbm

### **Harmonic output**

- 21 dbm

### **Output Power**

#### **Nominal Output Power**

The VLU transmission power output level is greater than 5 watts and less than 9 watts at temperature of  $25 \pm 5^\circ \text{C}$  and an input voltage  $12.6 \pm 0.1$  VDC when transmitting into 50 ohm load with maximum VSWR of 1.5:1. The power is not adjustable.

#### **Output Power degradation**

The power output shall not be degraded by more than 1 dB from the nominal power output for a VSWR of up to 2.0:1. The power output shall not be degraded by more than 5 dB at the extreme environmental conditions when transmitting into a maximum VSWR of 2.0:1.

#### **Power Amplifier Protection**

The VLU is protected from damage when transmitting into any VSWR. No instability or spurious oscillations presents in the transmitted spectrum. The transmitter is not damaged by operating into open or short circuited antenna terminal.

### **Transmitter turn on/off time**

Transmitter output power reach 90 % of its final value within 0.3 mSec after the ON command. Transmitter output power decreases a minimum of 60 dB within 0.3 mSec after OFF command.

## **"Location" Signal Transmission**

Transmission of "Location signal" shall be as response to VLU addressing through the Forward channel. The Location signal composed of a Pseudo Noise sequence (symbol = chip).

### **Location signal modulation**

CPSK - Continuous Phase Shift Keying.  
with constant envelope.

### **PN Code generator**

#### **PN Code Rate & Length.**

PN "chip" Rate = 1.49140625 MHz  
PN code Period Length = 1023 chips.

## **Location Signal Spectrum**

### **Discrete Spectral Line Suppression**

The spectrum of the transmitted signal does not contain any discrete spectral lines that exceed the level of the continuous spectrum within  $\pm 6$  MHz of the center frequency or are greater than - 47 dB of the peak output beyond  $\pm 6$  MHz when measured using 100 KHz bandwidth.

### **"Location Signal" Spectral Density Envelope**

The transmitted spectral output does not exceed the envelope defined in figure 3.3.3-1 with the peak center frequency ( $f_0$ ) output used as the reference level measured in resolution bandwidth of 100 KHz and video bandwidth of 10KHz.

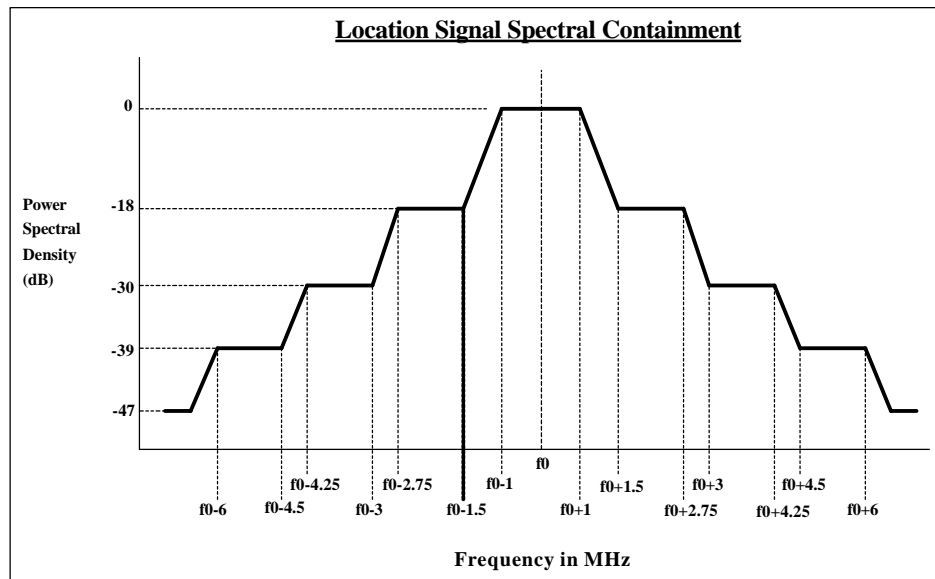


Figure 3.3.3-1: Location Signal Spectrum

In addition, according FCC part 90.210(K) , output power does not exceed the envelope defined in figure 3.3.3-2 when measured in resolution bandwidth of 100 KHz and video bandwidth 100 KHz.

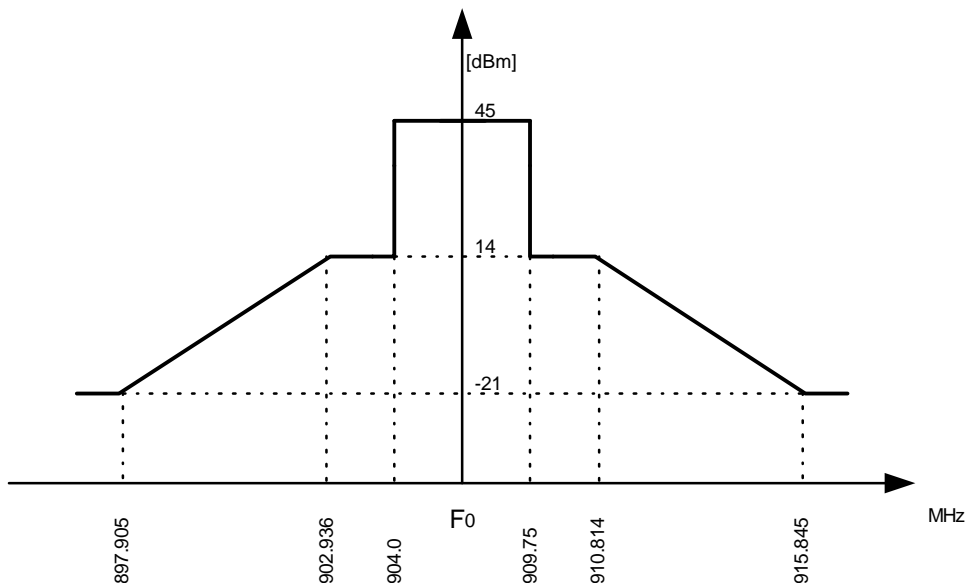


Figure 3.3.3-2: FCC Spectrum Envelop

## Location Signal Transmission Length

## Transmission timing

Transmission is synchronized with the received POCSAG signal (see Figure 3.3.4-1).

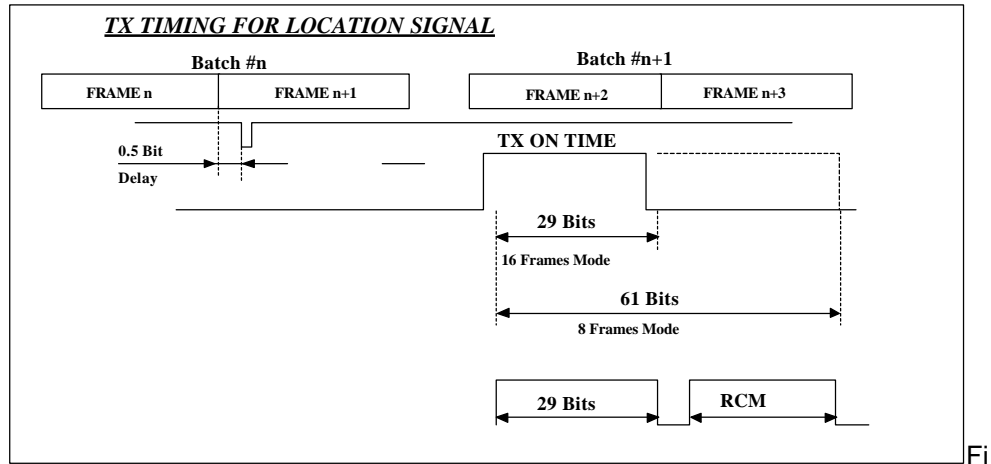


Figure 3.3.4-1: PN Transmit timing.

The transmission timing of any FCM (Forward Channel Message) initiated transmission is delayed by one batch from the current timing.

## Emergency / Reverse Channel Message Transmitter

ECMs and RCMs utilize the same communications RF channel. The VLU transmits RCM'S in response to FCMs. The VLU transmits Emergency Channel Messages (ECM's) corresponding to the operation defined in the next sections.

### ECM/RCM Channel.

#### ECM/RCM signal modulation

The modulation of the ECM or RCM signal is BPSK.

#### ECM/RCM Data Rate

Data Rate = 11.6516 KHz (PN Clock /128)

#### ECM transmission length

The transmission length of the ECM and RCM\_A is 128 bits (net) excluding transmission rise and fall times. Additional 1,0,1,0 sequences are added at the start or end of the transmission.

#### RCM/ECM Transmission timing

Transmission is synchronized with the received POCSAG signal (see Figure 3.4.1.4-1).



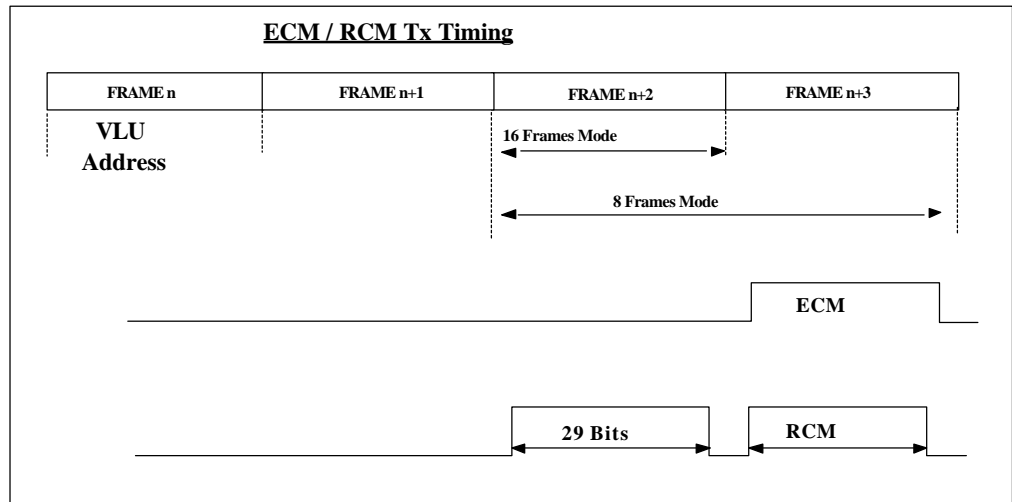


Figure 3.4.1.4-1: ECM / RCM\_A Transmit timing.

## "Forward" Channel Receiver.

### Signal Parameters

The received signal is a modified CCIR Paging Code Number 1 (POCSAG) format FSK modulated  $\pm 4.5$  KHz at center frequency of 927.778266 MHz. The data format of the modified POCSAG format consists of 32 bit SYNC followed by 16 frames of VLU address or message of 32 bit each.

1. Frequency: 927.7778266 MHz
2. Modulation: FSK  
 $\pm 4.5$  KHz (+4.5 KHz = "0").
3. Data rate: 2400 bps.
4. Frequency accuracy: 1 ppm.

### Sensitivity

Input signal @ antenna = -115 dBm

### Spurious Rejection

The receiver operates with a maximum degradation of 3 dB in the presence of spurious signals of the following frequencies and levels above measured sensitivity:

Frequencies from center	Spurious level
$\pm 50$ KHz to $\pm 500$ KHz	65 dB
$\pm 500$ KHz to $\pm 2$ MHz	65 dB
$\pm 2$ MHz to $\pm 20$ MHz	65 dB
$> \pm 20$ MHz	100 dB

The spurious signal is modulated with 400 Hz at the frequency deviation of  $\pm 2.7$  KHz (as per EIA-RS-204C).

## **Image rejection**

Image rejection: > 60 dB.

## **Selectivity**

An FSK signal of 927.778266 MHz  $\pm$  50 KHz at a level of -50 dBm modulated with 1000 Hz Sine wave and deviation of  $\pm$  9 KHz, shall cause a degradation of no more than 3 dB in the specified sensitivity as defined herein.

## **Power supply requirements.**

### **Protected Voltage Range**

There is no damage to the VLU with input voltages in the range from 0 to 26 VDC. The VLU is also protected against reverse voltage connection.

### **Full Operating range**

The full operational range of the input voltage shall be from 8.5  $\pm$  0.2 to 16.1  $\pm$  0.5 VDC (according to operation temperature).

### **Optional Back-up Battery**

The VLU operates with an optional, externally mounted back-up battery. If connected, the VLU switches to operation with the back-up battery when vehicle power fails. The VLU shall charge the back-up battery when vehicle power is available.

### **Low Voltage Shutdown**

No circuitry exhibit unstable or unpredictable behavior at any input voltage. In shutdown mode the VLU consumes less than 5 mA.

### **Maximum Current Draw**

The current draw (peak or average) of the VLU under any condition specified herein shall not exceed 3 A.

### **Transient Protection**

The VLU withstands voltage transients as specified by SAE J1211 in table 3 and table 4. When these transients applied to the VLU, no damage occurs to the VLU.

## **Environmental Characteristics**

### **Temperature range**

Operating Temperature : -30° to 60° C.  
Storage Temperature : -40° to 85° C.

### **Humidity**

The VLU operates in an environment with up to 95% humidity, Non-condensing at 50° C with testing criteria set forth by the SAE document SAE J1211 (June 1978), section 4.2.

### **Shock and Vibration**

Shock as per RS-152-B paragraph 15 and RS-204-C paragraph 25, Vibration as per RS-152-B paragraph 14 and RS-204-C paragraph 24.

### **Bench handling (Non-operating)**

The VLU does not sustain damage and shall meet the specified performance requirement after being subject to 4 inch pivot drops on each of the faces on which it may be placed for servicing or installation, the criteria set forth by SAE J1211 paragraph 4.8 shall be used for testing.

### **Electromagnetic Compatibility (EMC)**

The VLU meets the EMC criteria set forth by SAE J1113 paragraph 2.

### **Altitude**

10,000 feet operating, 40,000 feet storage.

### **Performance at Extreme Environmental Conditions**

Sensitivity -	-112 dBm.
Frequency -	± 2.3 ppm.
Power output	- 1.6 Watt (32 dBm).