FLAT PACK TRANSPONDER FPT 2000

TECHNICAL DESCRIPTION

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1. INTRODUCTION

1.1 Related documents

Transponder drawing 800960

1.2 Definitions, Acronyms, Abbreviations

Tx:	Transmitter
Rx:	Receiver
OOK:	On-Off-Keying
RF:	Radio Frequency
MOD:	Modulator
BPF:	Bandpass Filter
IAG:	type of protocol (Inter Agency Group)
OSC:	Oscillator

1.3 System Operation

Figure 1 is a block diagram of a typical automatic vehicle monitoring system. The three main components are the Flat Pack Transponder, Reader , Reader Antenna and RF modules. The Flat Pack Transponder is mounted on a vehicle's windshield at a location visible to the Reader antenna. The directivity of the Reader antenna provides a defined capture zone. Up to 8 antennas can be serviced by a single Reader via the RF modules.

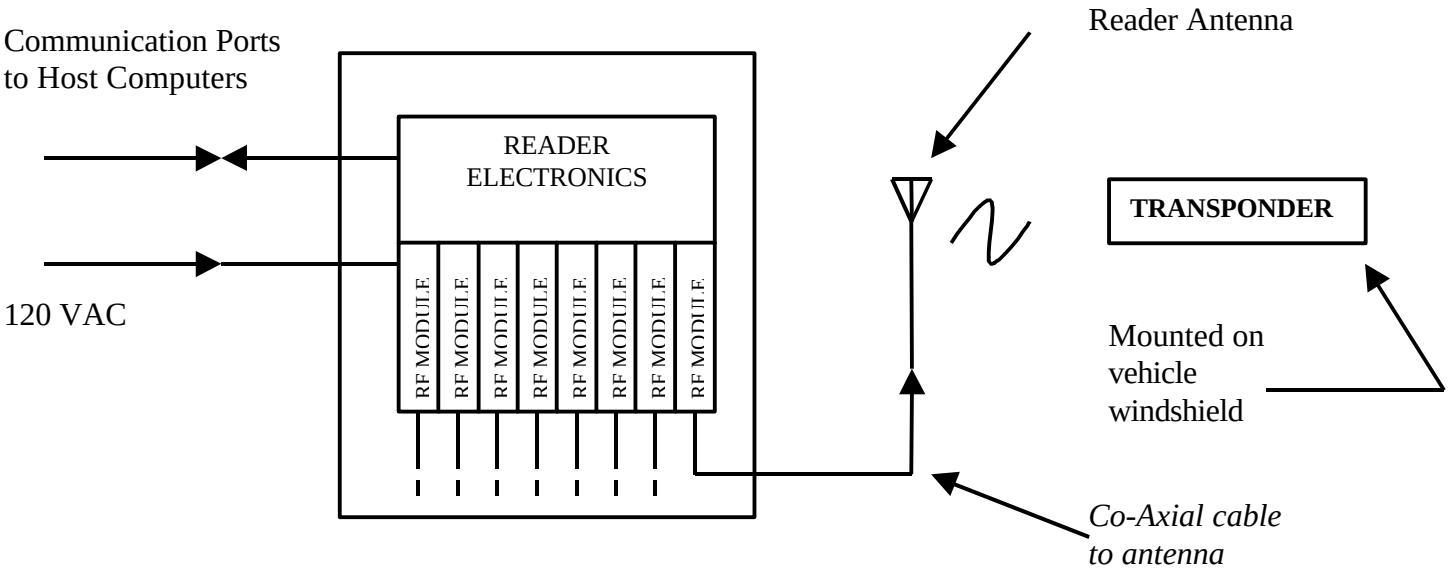


FIGURE 1

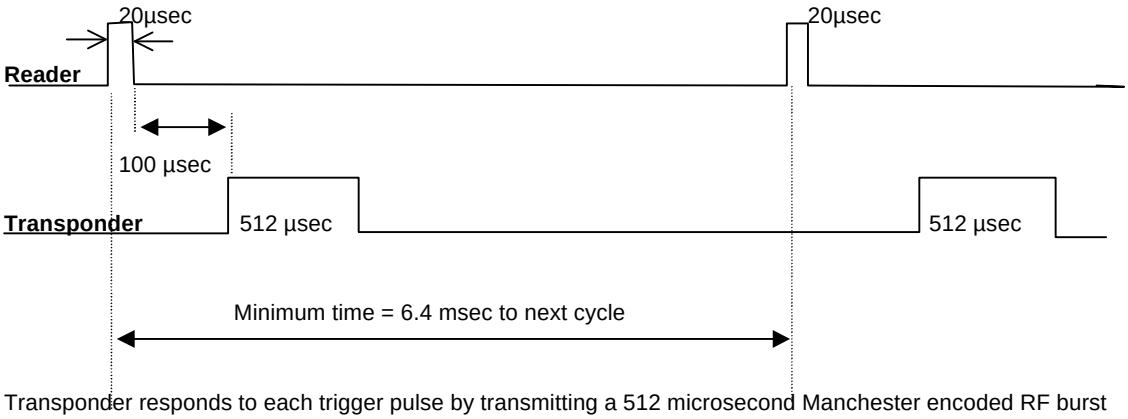
The Reader/RF modules are FCC Part 90 compliant and are typically mounted beside the roadway in a cabinet. The RF modules are connected to the antennas by means of co-axial cables. Transponder installation instructions are provided in Attachment A.

In operation, the Reader via a selected RF module sends out a 915 MHz data stream in the format described below to each antenna in turn thereby establishing an intermittent RF field in each lane of the roadway. When a vehicle equipped with a transponder enters the field the pulses activate the transponder and cause it to respond with a data transmission on a carrier frequency of 915 MHz. It should be noted that the transponder is only activated when a 20 microsecond “wake-up” pulse is received. It will not radiate energy at any other time. Transponder radiation will be obscured by the stronger Reader RF field. The Transponder Tx data is received by the antenna which passes it to the RF module for detection and then to the Reader for decoding. If the Reader determines that re-programming of the transponder is necessary, the Reader sends an additional pulse stream to the transponder for that purpose.

When the above process is completed on a given lane , it is repeated in the next lane and so on until as many lanes as necessary up to the full 8 lanes have been scanned. The timing for this process which shows RF activity for one lane is depicted in Figure 2. During a typical passage of a vehicle through a lane the transponder is typically read and programmed twice to confirm accuracy of the data and its CRC.

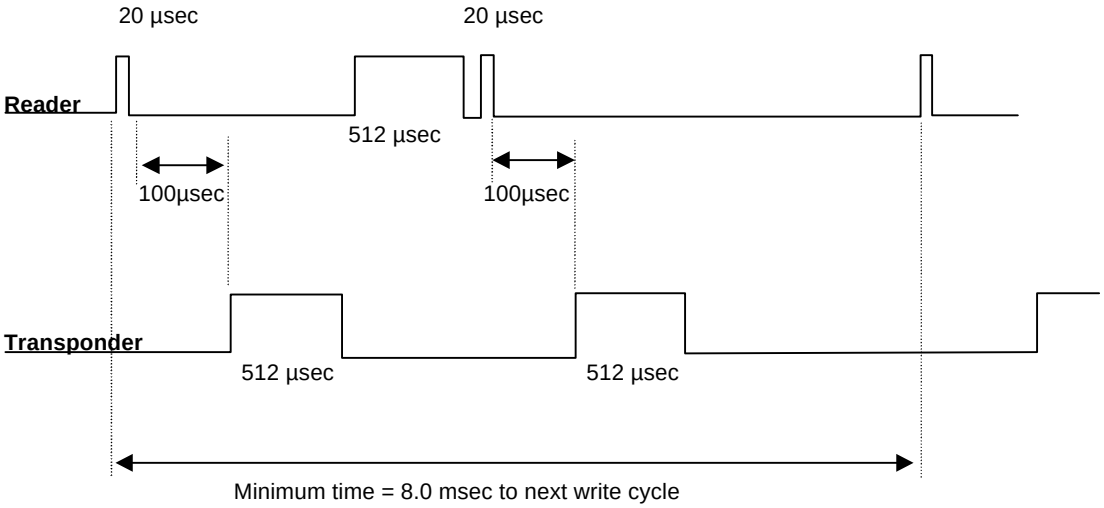
Figure 2 - System Timing Diagram

READ CYCLE



Transponder responds to each trigger pulse by transmitting a 512 microsecond Manchester encoded RF burst (500 kbit/second data rate)

WRITE CYCLE



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1.4 Transponder Overview

The Transponder consists of two major components: the case and a circuit board. The Transponder transmits and receives Manchester encoded data streams in the 915 MHZ frequency band. On-Off Keying modulation is used.

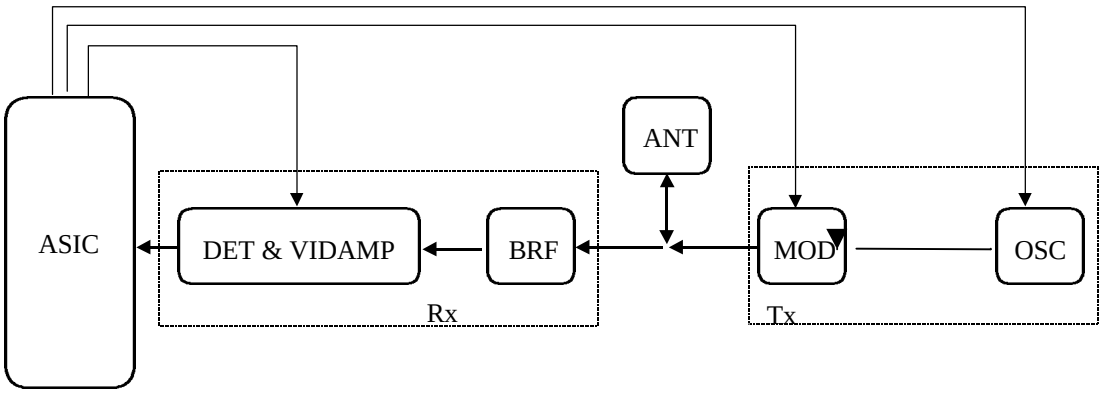
There are five major electronic subsystems on the circuit board:

1. The “hook” Antenna which receives and transmits RF energy
2. The RF Transmitter has two sub-sections. An RF Oscillator that is turned on by the ASIC during the entire time the Transponder transmits. The modulator which converts the baseband Manchester encoded data delivered from the ASIC to the 915 MHz band using OOK (On-Off Keying) data stream.
3. The Receiver which demodulates the 915MHz band RF pulses received from the reader via the antenna.
4. The ASIC which provides: Rx, Tx data and control interfaces, Manchester encoding/decoding, CRC generation/detection. The control interfaces keep the transponder circuitry in low current (“idle mode”) until a trigger pulse of between 10 and 30 microseconds is detected. The ASIC transmits a Manchester encoded 256 frame at 500 kilobits per second when a valid trigger pulse is detected. The ASIC only stores the incoming bit stream if the CRC is correct.
5. The Battery which provides 3.60 volt power to operate the transponder.

2. Specifications

Modulation	On-Off Keying of a Manchester encoded data stream	
Nominal Tx Frequency:	915 MHz	
Peak Tx RF power	-10 to -2 dBm	
Modulation Depth	>25 dB	
Tx Side bands and Harmonics	-25 dBm	
Data Rate:	500 $\pm$ 15 kilobits per second	
Power	3.6VDC	Lithium Battery

3. Block Diagram of the Transponder

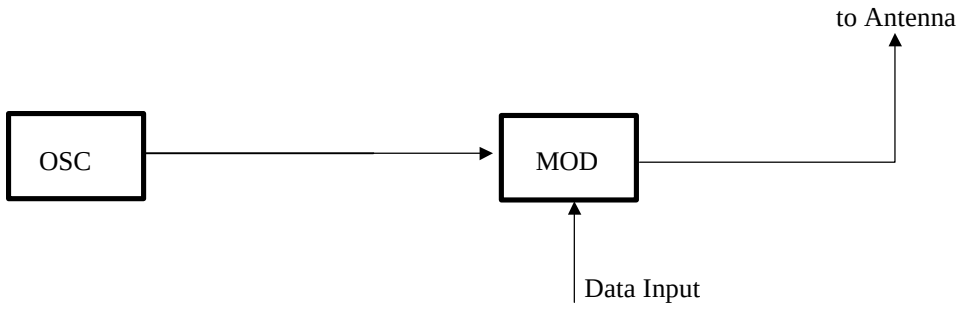


4. Transmitter

The transponder transmits the data stream to the reader after receiving the 20µsec trigger pulse from the reader (IAG protocol),. This generates an OOK modulated signal centered at 915 MHz. The RF output power from the transponder is between -7 to -2 dBm.

4.1 General Description

The transmitter consists of an oscillator and modulator. The oscillator generates the CW signal at 915 MHz. The RF signal is modulated by the modulator stage which provides OOK modulation and amplification of the RF signal. The output of the modulator is connected to the antenna.



TRANSMITTER BLOCK DIAGRAM

4.2 Detailed description

4.2.1 Oscillator

The oscillator consists of a SAW resonator and RF amplifier and its associated circuitry. The SAW resonator provides the frequency stability of the oscillator. The output of the oscillator is RF continuous wave signal with center frequency of 915MHz.

Circuit Components: U2, U4, C2, C3, C4,R2.

4.2.2 Modulator and filter

The Modulator receives the RF continuous wave signal from the oscillator. It amplifies and modulates the signal using the On-Off keying modulation. The output nominal frequency is at 915 MHz signal, modulated with 500kHz data stream. The output of the modulator has a filter which removes the harmonics of the wanted signals.

Circuit Components: U3, C6, R5, R4, C5.

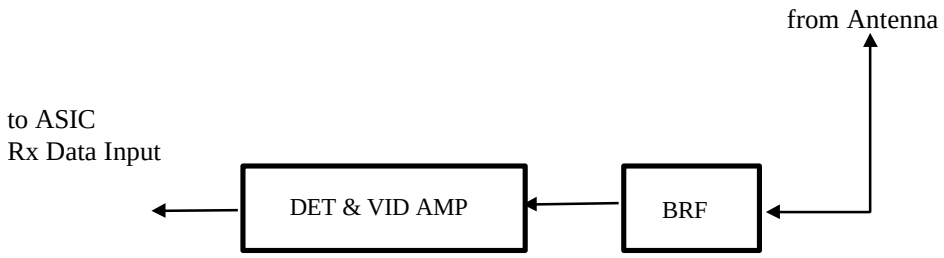
4.2.3 The Antenna

The antenna is etched on the PCB with its matching circuit, which matches the antenna impedance to the 50 ohms. The matching circuit is designed to provide a proper match when the PCB antenna is installed inside the transponder case and transponder is in the free space.

Circuit Components: L2, R6.

5. RECEIVER

5.1 Receiver Block Diagram



When the transponder receives the 20 µsecond trigger pulse the ASIC places the Receiver in a high current / high bandwidth state which allows for the

reception of the 500 kbits/second data stream from the roadside reader . This message is 256 bits long and is sent by the roadside reader approximately 100 μseconds after it receives the data transmitted from the transponder.

The above block diagram shows the receiver structure. The transponder receives the 915 MHz modulated signal (modulation data rate of 500 Kbps) from the antenna. A band pass filter is used to block the unwanted signals. After detection (demodulation), the resulting envelope goes to the video amplifier which provides the final digital pulse shaping.

Circuit Components: FIL1, C7, L1, Q1,R6,R7,R13,R8, R9, R10, R11.

6. ASIC

The ASIC is responsible for all the functions in the data link layer of the IAG protocol. It supplies Manchester encoded data to the modulator at 500 kilobits per second. It decodes the base-band Manchester stream received from the detected RF signal at the output of the Det & VIDAMP block shown above. Controls signals from the ASIC turn on the oscillator and put the receiver in high bandwidth receive mode.

The ASIC contains both digital and analog circuits. The frequency of the clock required for the digital circuits is determined by R1.

Circuit Components: U1, R1

7. Table of component and its functions

Item No	Component	Function
	Oscillator	
1	U2	Amplifier for the oscillator
2	U4	SAW Resonator-provides frequency stable oscillations
3	C2,C3,R2	Phase matching components
4	C4,R3	Output matching circuit for the oscillator
	Modulator	
5	U3	Modulator Amplifier
6	C6	Coupling capacitor
7	C5,R4,length of the transmission line	Filter for the harmonics
8	R5	Matching resistor
	Antenna	
9	L2,R6	Antenna impedance matching circuit
	Receiver	
10	FIL1	Band pass filter
11	R7,R13,C7,L1	Matching circuit
12	Q1	Dual transistors
13	R8,R9,R10,R11	Biasing resistors
14	C10,C11	De-coupling capacitors
	Asic	
15	U1	ASIC
16	R1	External bias resistor for built-in oscillator
17	C9,C12,C13,C14	De-coupling capacitors