VEHICLE ACCESS CONTROL SYSTEM - *IGNITION SYSTEM*

THEORY OF OPERATION

EXECUTIVE SUMMARY

The Vehicle Access Control System (VACS) is an RFID based keyless entry, ignition, and security system designed for package delivery vehicles. This document outlines the operation and theory of the *ignition* portion of VACS called the ignition system. Following is a summary of the Ignition system topology.

Table 1 - Ignition System Technical Summary

Technology Basis:	Texas Instruments TIRIS RFID System
Transponder:	TIRIS RI-TRP-R9QL Disk Type FSK Transmission: 134.2 kHz mark, 122.2 kHz Space 8.7 kbit/s, 101 dBμA/m at 5 cm (max)
Receiver Components:	RI45538 RFID Receiver IC: 17.1776 Mhz Crystal Oscillator Charging Transmitter: 134.2 kHz, 0.50 Duty Cycle 130 dBμA/m at 5 cm
Antenna System:	Loop Antenna, 65 μH, Circuit Q ≅ 21
Electronic Control:	Motorola 68HC705C8A ,4.000 Mhz Crystal Oscillator Harris CDP68HC68S1 Wire-Line Serial Bus
Power Source:	12 Volt Automotive Battery

FUNCTIONAL DESCRIPTION

The purpose of the ignition system is to read transponder codes and activate the vehicle accessories and/or start the engine when the appropriate codes are read. The ignition system is comprised of four major components: 1) Texas Instruments transponder 2) The ignition reader, 3) the ignition control module and 4) an assorted vehicle relays (DC). The transponder is the passkey to the system, worn on the driver's wrist, the ignition reader contains a wire loop antenna, and the ignition control module contains the TIRIS receiver and microcontroller circuitry.

To activate the vehicle accessories, the driver places his wristband transponder approximately 10 cm from the dash-mounted ignition reader and depresses the ACC/START push-button. The

ignition control module / loop antenna charge the transponder and the transponder transmits a 64 bit key code back to the ignition control module though the same antenna. If the transponder code matches one of the ten key codes stored in ignition control module memory, the ignition control module energizes the accessories relay. Holding-in the ACC/START relay an additional 0.5 second energizes the engine start relay, and cranks the engine. The ignition system also incorporates an automotive serial bus used to share key codes with access modules controlling vehicle doors, if so installed. Following is a technical description of the ignition system topology.

TECHNICAL DESCRIPTION

All electronic circuitry resides on one double-sided through hole circuit board, with the exception of the loop antenna and DC control relays. Details of TIRIS communications are outlined below.

TIRIS Communications

Transponder Charging

The primary function of the ignition system is to read transponder codes. This is accomplished through the use of the Texas Instruments RI45538 TIRIS receiver IC. The device performs TIRIS transponder charging, data demodulation and synchronization functions as directed by the Motorola MC68HC705C8A microcontroller. A TIRIS read operation involves charging the transponder, then detecting and demodulating the FSK transmission. When directed to charge a transponder, the RI45538 generates two 134.2 kHz logic signals used to gate a push-pull MOSFET power stage. The power stage drives a series resonant circuit consisting of a tuning capacitor and the loop antenna, located in the ignition reader. A transmission circuit Q of approximately 21 generates an antenna voltage and magnetic field of roughly 50 Volts and 130 dBμA / m at 6 cm respectively. Charging duration is roughly 50 ms. During the charge cycle, voltage induced across the transponder's loop antenna is rectified and used to charge a power capacitor. Capacitor energy powers the transponder transmitter which is activated after the charge burst has terminated.

Data Reception

After the transponder has detected the end of the charge burst, it transmits 128 bits of keycode and header information using FSK modulation. Typical space / mark frequencies are 132.4 kHz / 123.2 kHz respectively at a maximum transmission rate of 8.7 kbit/s. Each bit duration is 16 RF cycles yielding a space duration of 119 μs and a mark duration of 130 μs. The maximum

transmission time for 128 bits is 20 ms. Maximum transponder output field strength at 5 cm is 101 dBµA/m.

The FSK information is detected by the VACS TIRIS receiver using the same hardware used to generate the charge burst. In receive mode, the antenna circuit is tuned for a slightly lower Q to accommodate the wider FSK bandwidth signal generated by the transponder. The microcontroller disables the RI45538 transmitter to terminate the charge burst, and after a waiting time, the RI45538 decodes the FSK data. Clock information is derived from the FSK signal and the RI45538 generates data bits which are processed by the microcontroller.

The ignition system transmits a charge burst every 125 ms while the ACC/START push-button is depressed. Bursts are not transmitted if the push-button is not depressed.

Microcontroller Operations

The ignition system utilizes the Motorola MC68HC705CA to coordinate the TIRIS receiver, control code management, and activate the accessories / engine relays upon valid code reception. A *valid code* is one which has been previously programmed into the ignition system's National Semiconductor NM93C46 EEPROM. Ten keycodes (maximum) and one master code may be stored in memory. The processor interrogates each transponder and compares its code with contents of the EEPROM. When a match is found, the processor activates a digital output which energizes the appropriate accessories / start relay.

When a master transponder code is read, the processor places the system in program mode, allowing manipulation of the EEPROM memory. Three programming operations are allowed: a single keycode may be added, all keycodes may be deleted or a new master code may be reprogrammed. All modules present on the Harris serial bus are placed in program mode, and the contents of all EEPROMs is duplicated during the programming operation.

The ignition system also monitors four digital inputs for vehicle security; two door read switches, and two motion sensor units. These devices are not part of the VACS ignition system and are supplied by others. The microcontroller enables the vehicle horn (alarm) digital output based on the ignition system security mode and state of the security digital inputs.

Please refer to the following references for more detailed TIRIS information.

REFERENCES

[1] *CF45538N/NS TIRIS RF Module IC Reference Manual*
Texas Instruments, Inc.
Revision 1.3, May 19, 1994

[2] *RF Module Sequence Control for Read Only Transponder, 64-Bit Read/Write Transponder, Multipage Transponder*
Texas Instruments, Inc.
Revision 2.2, July 8, 1993

[3] *23 mm Glass Encapsulated Transponder Reference Manual*
Texas Instruments, Inc.
July 30, 1994