VEHICLE ACCESS CONTROL SYSTEM - *ACCESS SYSTEM*

THEORY OF OPERATION

EXECUTIVE SUMMARY

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

Table 1 - Access 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, 76 μH, Circuit Q ≅ 20
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 access system is to read transponder codes and unlock / unlatch the vehicle door when the appropriate codes are read. The access system is comprised of four major components: 1) Texas Instruments transponder 2) The access reader, 3) the access control module and 4) an electro-mechanical latching mechanism. The transponder is the passkey to the system, worn on the driver's wrist, the access reader contains a wire loop antenna, and the access control module contains the TIRIS receiver and microcontroller circuitry.

To enter a secured door, the driver places his wristband transponder approximately 10 cm from the exterior mounted access reader. The access control module / loop antenna charge the

transponder and the transponder transmits a 64 bit key code back to the access control module though the same antenna. If the transponder code matches one of the ten key codes stored in access control module memory, the access control module energizes an electro-mechanical latch which unlocks and unlatches the vehicle door for five seconds. The access system also incorporates an automotive serial bus used to share key codes access modules controlling other vehicle doors, if so installed. Following is a technical description of the access system topology.

TECHNICAL DESCRIPTION

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

TIRIS Communications

Transponder Charging

The primary function of the access 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 access reader. A transmission circuit Q of approximately 20 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 access system has two operating modes which affect TIRIS read rate. In *active mode*, the access system transmits charge bursts every 400 ms. If no transponder is found after 60 minutes, the system enters *sleep mode*, reducing the burst rate to one transmission every five seconds. Active mode transmission is resumed once a transponder signal is received.

Microcontroller Operations

The access system utilizes the Motorola MC68HC705CA to coordinate the TIRIS receiver, control code management, and latch / unlatch the vehicle upon valid code reception. A *valid code* is one which has been previously programmed into the access 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 latch solenoid coil.

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.

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