VERICHIP

VeriChip H2 Reader (VH2R) -Theory of Operation

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VH2R Theory of Operation

Refer to schematic diagram 911-000090-000.

VH2R is a handheld, battery-operated device for reading the implantable passive RFID chips manufactured according to ISO 11784 and ISO 11785 (134.2kHz, FDX).

The device performs generating the activation magnetic field, receiving and decoding the ASK field modulation signal produced by the chip, validating the received telegram, extracting the identification code, converting the identification code into BCD format, displaying the identification code on the built-in LCD and sending the identification code to a host computer system by means of either wireless Bluetooth connection or USB (full speed) connection.

Activation field generation is performed by the Transmit Antenna coil connected to the single-ended power amplifier Q3 through a resonant network comprised of C16, C17, R20, and R44. Capacitors C18 and C44 may be installed during manufacturing tuning. The power amplifier MOSFET Q3 is driven by the PWM signal produced by the microcontroller U1.

Receiving the field modulation signal from the chip is performed by the two receive antenna coils connected in counter-phase to suppress external noise. The receive antenna is tuned to resonance during manufacturing by the set of fixed tuning capacitors C45, C46, C47 that can be connected to the tank by means of solder jumpers S1, S2, S3. The signal picked up by the coils is passed through the diode demodulator D2. The high frequency (134.2 kHz) carrier is filtered out by the demodulator load/filter network C29, R34, R25, C32. The low frequency component is passed to the active low pass filter designed around U3A, U3B, and U3D. The switch U10 is used to mute the receiver when the activation field is just turned on and ramps up. This reduces filter overload by the strong transient that is produced when the activation field is turned on and shortens the recovery time of the whole receiver.

Filtered baseband signal is applied to one input (pin 10) of the analog comparator inside the system microcontroller U1. The second input of the comparator receives the same baseband signal, but heavily filtered by the low pass filter R18, C20. This filter tracks the signal baseline, but almost completely suppresses the useful data modulation. As the result, the comparator output (not accessible outside the microcontroller) produces the digitized data modulation signal.

The data produced by the comparator is continuously sampled by the microcontroller’s firmware. When an identification telegram that complies with the requirements of ISO 11785 Standard is received, its validity is checked by comparing the received 16-bit CRC checksum with the one calculated by the microcontroller. If the message is found valid, the microcontroller extracts the identification code and re-formats it from binary to BCD format. The message is then sent to the local LCD.

The LCD is connected to the microcontroller in 4-bit write-only mode. The LCD has a temperature-compensated contrast adjustment circuit R2, R3, R5. The LCD also has internal backlight driven by the constant current sink Q2. The current sink provides constant backlight brightness throughout the whole battery voltage range (from 6.4V for a set of fresh alkaline cells down to 4.0V at the end of their useful life).

The backlight circuit is also used for battery voltage monitoring. The voltage drop at the resistor R11 is measured by the microcontroller's ADC. The circuit parameters are selected in such a way that when the battery approaches the end of its life, the current sink starts dropping out of compliance, and the voltage across R11 starts decreasing rapidly. The firmware compares the voltage with a certain threshold programmed into the non-volatile memory during manufacturing process and is then able to detect when the battery voltage drops below the pre-defined value. The low battery threshold of 4.0V allows use of both primary alkaline cells and rechargeable NiCd and NiMH cells.

The reader has a buzzer BZ1 used for audible indication of various processes such as power-up and chip detection. The buzzer is of self-oscillating type and is controlled by a DC signal (pulse) from the microcontroller via the transistor Q4.

Communication interface of the reader consist of two devices, the USB-to-UART chip U9 and the Bluetooth module U6. Since the microcontroller has single UART channel, only one of the two possible interfaces can be used at a time. The selection is performed by the data switch U8 depending on the desired mode of operation which is stored in the non-volatile memory of the microcontroller and recalled during start-up. The data switch is controlled by pin 2 (PD4) of the microcontroller, its high state corresponds to USB interface, and low – to Bluetooth. The communication modules are serviced by a separate reset chip U7. Resistors R49 and R50 are used to select the required polarity of the reset signal to the Bluetooth module depending on the latter's version.

Power management system consists of the LDO regulator U2, input protection devices D8 and F1 and power hold network built around Q1. When the F1 button is first pressed, the Q1 turns on via R42 and lower part of dual diode D1. This turns on the LDO regulator U2 that produces 3.3V for the microcontroller. The latter starts up and asserts its pin 13 (PB1) high. This signal is applied through the diode D5 to the control input of the LDO and thus the power is now maintained even when user releases the button F1. The user can press and release the F1 button any time after that and the switch status will be read by the microcontroller through the upper part of the dual diode D1.

Keypad interface consists of three inputs protected with ESD/EMI suppression chips Z1-Z3. Keypad inputs are active low (the switches connect to ground when pressed) and use internal pull-up resistors of the microcontroller.