NXP PCF7961 - PEPS key chip introduction

1. Basic Introduction

1.1 PCF7961 Introduction

The PCF7961 is a single-chip application solution that combines IMMO (Immobilizer) and keyless entry functionality, using an external coil for contactless communication with a base station, as well as obtaining device power from a magnetic field.

The device is operated by an E-ROM based RISC controller, which is powered by NXP's low-power 8-bit MICRO RISC core MRKII. The MRKII core requires a specific MRKII 2-Link programmer, as well as a specific compilation and debugging environment IAR Embedded Workbench for MRKII.

The transceiver features secure contactless authentication, using keys and random numbers to encrypt communications between the device and the base station. The PCF7961 has a factory-programmed unique serial number that can also be used for key IDE identification.

When using the RKE (Remote Keyless Entry) function, the device is powered by an external battery, the application computing unit can generate rolling codes, the computing unit can be encrypted in HT2 (48-bit key) or HT3 mode (96-bit key), and provides general I/O including external circuits for RKE buttons, LEDs, IR or other optional buttons. The on-chip UHF transmitter supports operation at 315MHz or 434MHz, and does not require other external components except for the reference crystal and loop antenna matching circuit.

1.2 PCF7961 Features

- Single-chip IMMO (vehicle immobilizer) and keyless entry solution with on-chip UHF transmitter
- 512 bytes of EEPROM expandable data storage
- 32-bit unique device identification IDE
- HT2 48-bit encryption, HT3 96-bit encryption
- 8-bit RISC architecture MRK II
- Low power operation mode 300μA, IDLE mode 20μA, PD mode 100nA,
- Programmable low battery detection

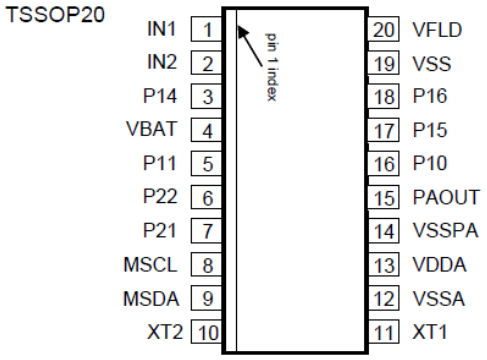
1.3 PCF7961 encryption method

PCF7961 supports multiple encryption methods and provides secure communication between devices and base stations. The encryption calculation unit is integrated into the hardware. Different PCF7961 models use different encryption methods. The following table shows the encryption method table for specific PCF7961 models.

PCF7961 料号	支持加密方式
PCF7961A	HITAG-2
PCF7961E	HITAG-2 Extended
PCF7961M	HITAG-AES
PCF7961X	HITAG-3

1.4 PCF7961 Pin Introduction

1.4.1 PCF7961 Pin Definition



PCF7961 chip pin diagram

FUNCTION	DESCRIPTION	PIN TSSOP20
IN1	Input, Transponder Interface (Coil)	1
IN2	Input, Transponder Interface (Coil)	2
P14	General purpose I/O with switch able internal pull-up and Wake Up sense	3
VBAT	Battery Supply Voltage (Battery pos. Terminal)	4
P11	General purpose I/O with internal pull-up and Wake Up sense	5
P22	General purpose I/O, Wake Up sense and Timer 1 compare output (PWM)	6
P21	General purpose I/O, with switch able internal pull-up, Wake Up sense and Timer/Counter 1 Capture input / Interrupt input	7
MSCL	ROM Monitor Serial Clock Output	8
MSDA	ROM Monitor Serial Data with internal pull-up	9
XT2	XTAL Oscillator	10
XT1	XTAL Oscillator	11
VSSA	Transmitter analogue ground	12
VDDA	Transmitter analogue supply voltage	13
VSSPA	Transmitter power amplifier ground	14
PAOUT	Transmitter power amplifier output	15
P10	General purpose I/O with internal pull-up and Wake Up sense	16
P15	General purpose I/O, external clock input and Wake Up sense	17
P16	General purpose I/O, Voltage comparator input and Wake Up sense	18
VSS	Common Ground (Battery neg. Terminal)	19
VFLD	Rectified LF Field Supply Voltage	20

PCF7961 Pin Definition

1.4.2 PCF7961 programming interface definition

The MRKII 2-Link programmer has a 10-pin IDC interface. The spacing between the 5-pin single-wire female connector and the adapter is 2.54mm. The following table shows the definition of the PCF7961 5-pin programming and debugging interface.

PIN	SIGNAL	TYPE	Description
1	GND	-	Common ground
2	MSDA	NC	Monitor Interface Serial Data
3	VBAT	NC	Battery Supply Voltage (positive)
4	MSCL	NC	Monitor Interface Serial Clock
5	WakeUp	NC	Target WakeUp (P10)

1.5 Typical Application Circuit

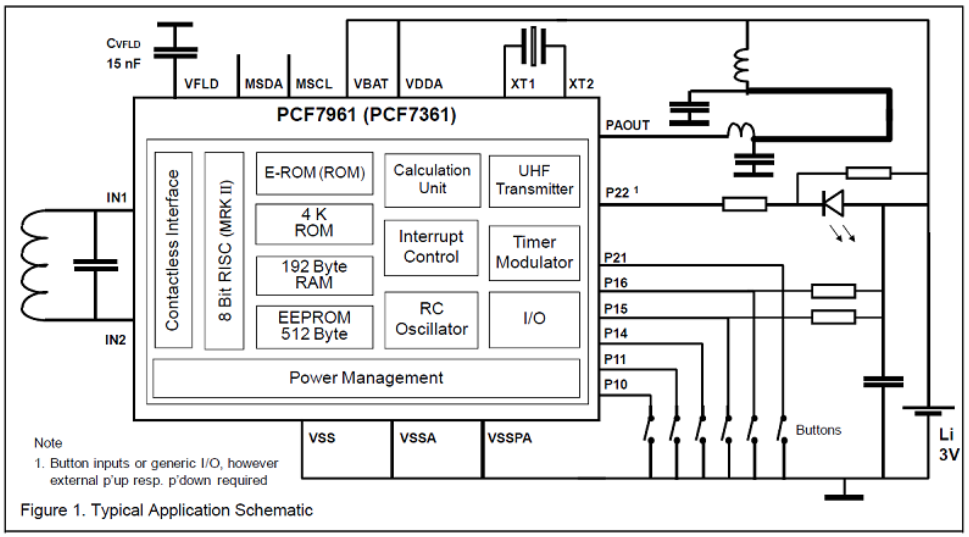


Figure 1. Typical Application Schematic

The figure shows the minimum application circuit of PCF7961. PCF7961 provides 7-channel general-purpose IO to implement up to 7 keyless entry command buttons, 192 Byte RAM, and 512 Byte EEPROM.

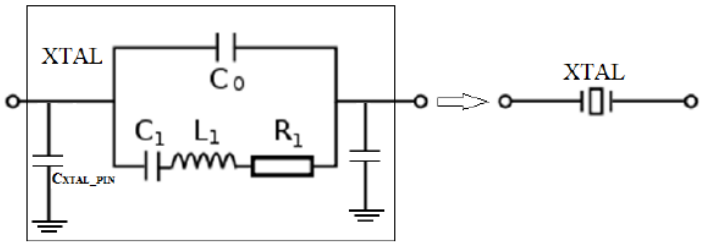
2. UHF signal

2.1 UHF frequency

The PCF7961 UHF transmitter supports operation at 315MHz or 434MHz. The division ratio between the ideal carrier frequency fTx and the actual phase-locked loop reference frequency XREF is 32. The recommended settings for common XTAL frequencies are 9.8433MHz and 13.56MHz.

The UHF transmitter uses a set of control registers XFCON to control the XTAL oscillator frequency deviation, whether it is frequency fine-tuning or FSK modulation, and another set of control registers PACON to control the power amplifier, whether it is amplitude fine-tuning or ASK modulation.

The available frequency deviation of the crystal oscillator mainly depends on the crystal parameter C1 (static load capacitance). The C1 value is related to the crystal size. The smaller the crystal, the smaller the C1 value. Therefore, during the hardware design phase, it is recommended to use the frequency deviation calculation document provided by NXP to verify the available frequency deviation of the application.



(1) R1, L1, C1 and Co are crystal parameters

Fig 1. The crystal pin capacitance C_{XTAL_PIN}

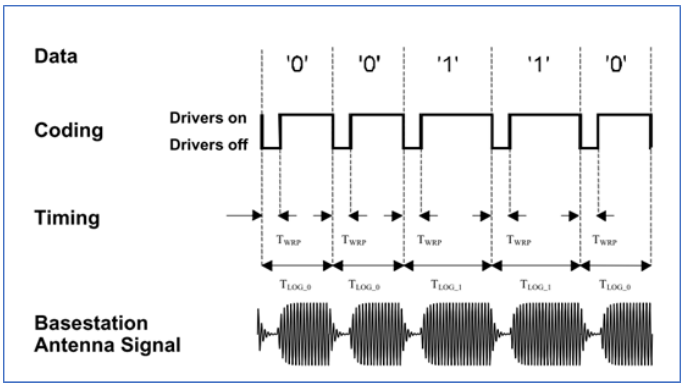
2.2 UHF modulation

2.2.1 ASK modulation

ASK (Amplitude Shift Keying) Amplitude keying, the possible states of the digital modulation signal correspond to the binary information symbol or its corresponding baseband signal state, and the modulated signal is called a binary digital modulation signal. Keying with binary information symbols is also called binary amplitude keying, which is represented by 2ASK, that is, OOK (On-Off Keying) binary on-off keying. This modulation method has inferior noise resistance performance to other modulation methods.

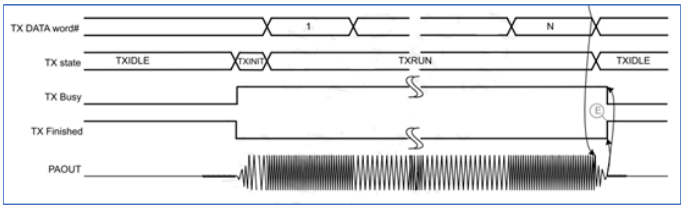
When the debugged baseband signal is 1, the carrier is transmitted;

When the debugged baseband signal is 0, no carrier is transmitted;



2.2.2 FSK modulation

FSK (Fequency Shift Keying) frequency shift keying uses two oscillation sources with different frequencies to represent signals 1 and 0. The 1 and 0 of the digital signal are used to control the alternating output of two independent oscillation sources. This modulation method has good anti-noise and anti-attenuation performance.



2.2.3 FSK modulation UHF signal example

As shown in the figure below, the UHF signal under FSK modulation is detected in the spectrum analyzer. The UHF signal parameters are: the center frequency is 433.922 MHz, and the fdev frequency deviation is ± 55 KHz.