HT6720
13.56MHz RFID Transponder

Features

- Wide range operating voltage
- Batteryless RF transponder
- Data transmission in read-only operation
- Max. of 64-bits customer programmable data
- 16-bits CRC error detection code
- OTP data memory
- Very low operating current (4μA @ V_{DD}=3V)
- 13.56MHz carrier frequency
- Output data baud rate: 4.5kbps (Typ.)
- PWM/ASK modulation
- Built-in voltage limiter

Applications

- Interactive leisure products
- Security system
- Access control
- Anti-counterfeit devices
- Material management
- Animal management
- Personnel working time record
- Car park monitoring system

General Description

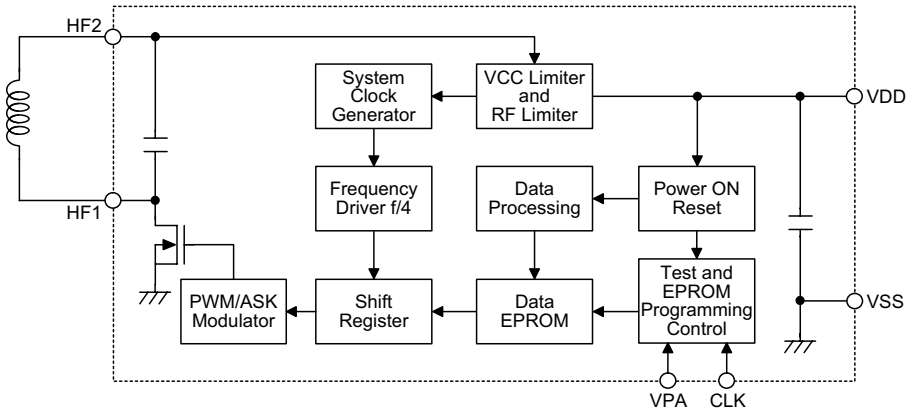
The HT6720 is an RF transponder IC with 13.56MHz RF carrier, which provides a low cost batteryless transponder solution when combined with an external inductor. The inductor and internal capacitor form an LC tank which induce voltage from the radiated 13.56MHz carrier signal generated from the reader antenna. HT6720 has a built-in low power RC oscillator which is activated if the induced carrier field strength is high enough to supply the operating current and the response signal (pre-programmed in the OTP memory) is serially transmitted out. The response data is transmitted using PWM/ASK modulation. Modulation of 13.56MHz is accomplished by damping the LC tank with a fixed baud rate.

The transmission information is stored in a 96 bits one time programmable memory OTP, with a 16-bit CRC code (up to 64 bits reserved for customer). The effective detection range for a small sized antenna is 2cm~10cm which is dependent on antenna format & reader design. The larger the antenna loop used the longer the detection range. It is advisable to use larger antenna to attain a 15 cm detection range.

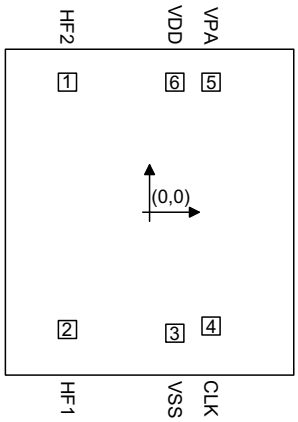
Implementing Holtek's advanced OTP and low power technology, HT6720 offers a very cost effective solution for RF contactless detection system.

A code area of 64-bits (max.) wide is provided so customers can program the device using the specified programmer supplied by Holtek. The pre-programmed ICs are also available upon customer's request.

Block Diagram



Pad Assignment



Chip size: 925×1040 (μm)^2

* The IC substrate should be connected to VSS in the PCB layout artwork.

Pad Coordinates

Unit: μm

Pad No.	X	Y	Pad No.	X	Y
1	–256.65	357.34	4	228.70	–361.37
2	–256.65	–361.99	5	219.80	338.59
3	96.10	–378.15	6	88.89	332.15

Pad Description

Pad No.	Pad Name	I/O	Internal Connection	Description
1	HF2	I/O	CMOS	Connect to an antenna coil for normal operation. Open for data programming.
2	HF1	I/O	CMOS	Connect to an antenna coil for normal operation. Data I/O for programming.
3	VSS	—	—	Negative power supply.
4	CLK	I	CMOS	Open for normal operation. Clock input for programming.
5	VPA	I	—	Open for normal operation. High voltage supplies input for programming.
6	VDD	—	—	Open for normal operation. +5V supply input for programming.

Absolute Maximum Ratings

Supply Voltage (VDD) 6V

Supply Voltage (VPA) 13.5V

Input Voltage .....V_{SS}–0.3V to V_{DD}+0.3V

Storage Temperature .....–50°C to 125°C

Operating Temperature .....0°C to 70°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Electrical Characteristics

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	V_{DD} pad voltage	2.4	—	6.5	V
I_{dd}	Operating Current	3V	—	—	4	—	μA
		5V	Voltage limiter not started	—	10	—	μA
R_m	Modulation Resistance	5V	—	—	320	—	Ω
V_{LCL}	LC Input Limiter Voltage	—	—	—	6.5	—	V
B_R	Output Data Baud Rate	3V	V_{DD} vs V_{SS}	—	4	—	Kbps
		5V	V_{DD} vs V_{SS}	—	5.5	—	Kbps

Functional Description

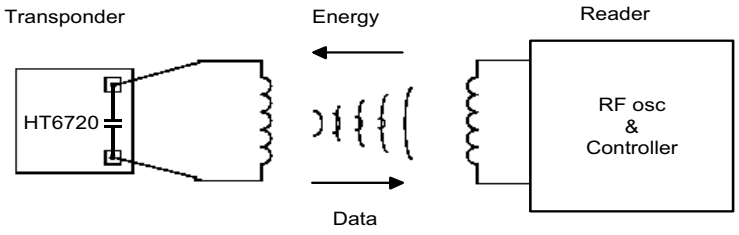
Operation Concept

The reader transmits a 13.56MHz carrier signal from its antenna, the LC tank on the transponder side converts the carrier energy to voltage form and supply to the transponder chip with an internal pump circuit. If the induced energy is high enough, the pumped voltage reaches the break-in voltage of the internal RC-oscillator, the transponder is actuated to transmit its internal data serially by means of damping the LC tank.

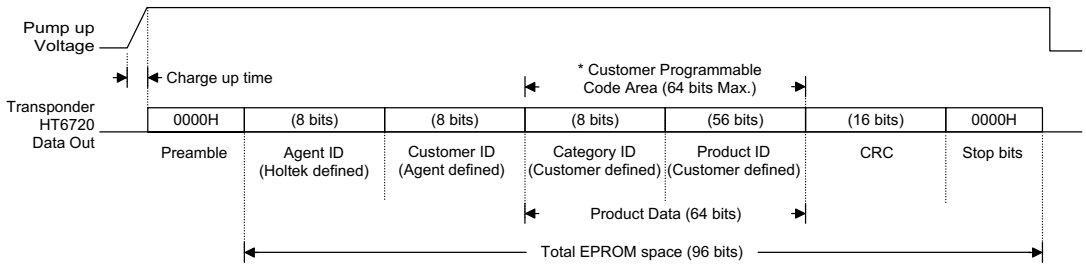
The reader receiving the transponder's data by means of detecting the energy variation on its own antenna, and recognize the information with a microcontroller.

The HT6720 has a built-in internal Voltage Limiter to prevent excess power supply and RF levels induced by the LC tank from damaging the device or causing the device to function abnormally.

A total of 96 bits of OTP memory space is provided, from which 64 bits wide are customer programmable, which can be programmed using the specified programmer supplied by Holtek. The pre-programmed ICs are also available upon customer's request.



Timing & Code Package



Code Package

A total of 96 bits information can be stored in the HT6720, from which 64 bits are customer programmable.

Preamble: Preamble of data, 0000H.

Agent ID: This 8-bit wide code is not customer programmable and is supplied together with the data writer after registering to Holtek. The writer generates the code automatically.

Customer ID: This area is for the Agent, for example used to store current number of customer.

Category ID: Can be used to store the application field information code.

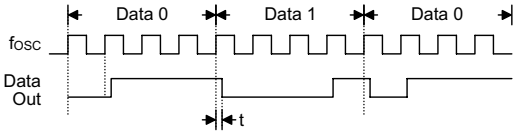
Product ID: Storing the contents of the user ID number or data.

Data CRC: A 16 bits of CRC code is generated automatically by the writer.

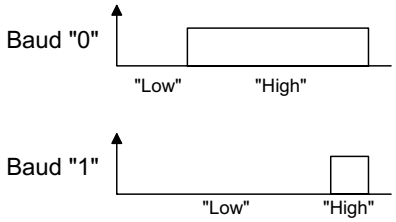
Stop bits: Denotes the end of message, 0000H.

Baud rate

The timing waveform describes the relationship between clock and data out, where the maximum transition delay ″t″ is 1μs, and the internal RC oscillator automatically generates the clock.



A PWM/ASK signal is defined as the following figure:
Baud ″0″: The ratio of low and high is ″1:3″
Baud ″1″: The ratio of low and high is ″3:1″



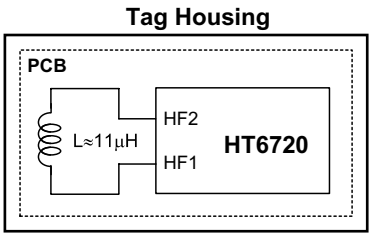
The baud rate is around 4.5kbps typically, for transponder induced V_{DD}=3V.

The internal oscillator frequency f_{OSC} is baud-rate×4.

Application Circuits

Tag

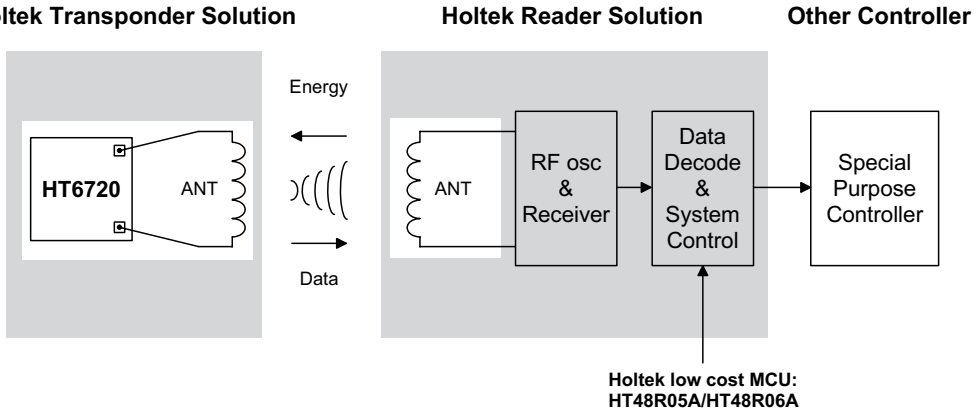
A tag consists of a PCB (or Mylar film) with printed coil, HT6720 and a housing. The housing can be of various shapes.



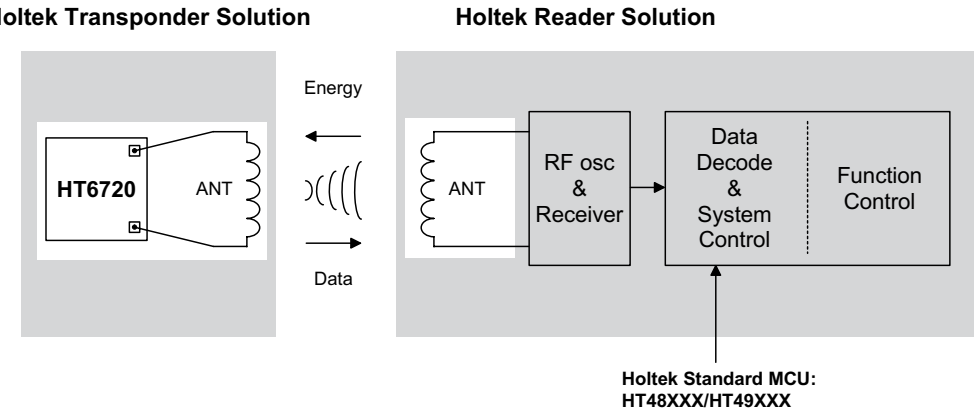
Note: The value of the antenna inductance is 11μH, however the optimum value will be changed slightly due to the variation of the internal resonance capacitor (10pF typically) during process.

For more application information about the reader, refer to Holtek's 13.56MHz RF ID reader data.

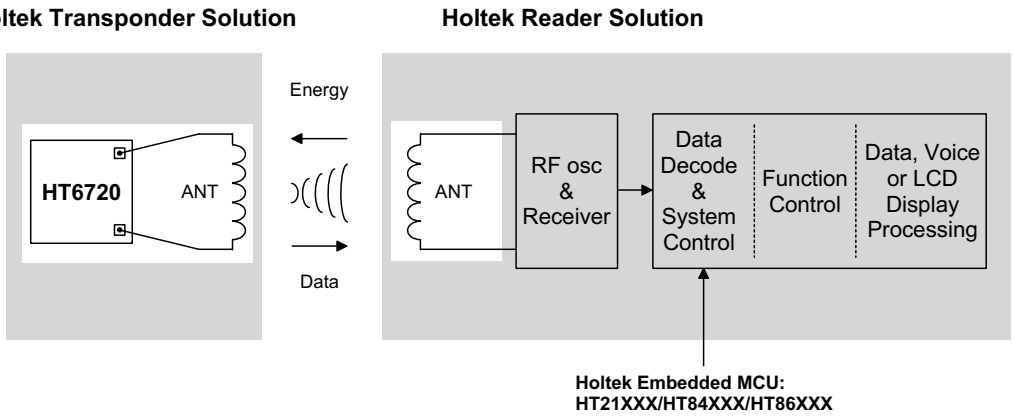
2-chip solution



1-chip solution (I)



1-chip solution (II)



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13.56MHz RF ID Reader

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Introduction

The 13.56MHz RF ID reader for HT6720 consists of transmitting and receiving sections. The reader′s main functions are driving the antenna with 13.56MHz carrier frequency, receiving the back scattered signal from the tag (HT6720), and performing data processing according to PWM/ASK demodulation and data CRC check.

The HT6720 reader includes one 6.5 cm diameter printed antenna (see Fig. reader PCB) and one 8-bit microcontroller, with an effective operation ranging up to 10 cm (depending on antenna size & tag).

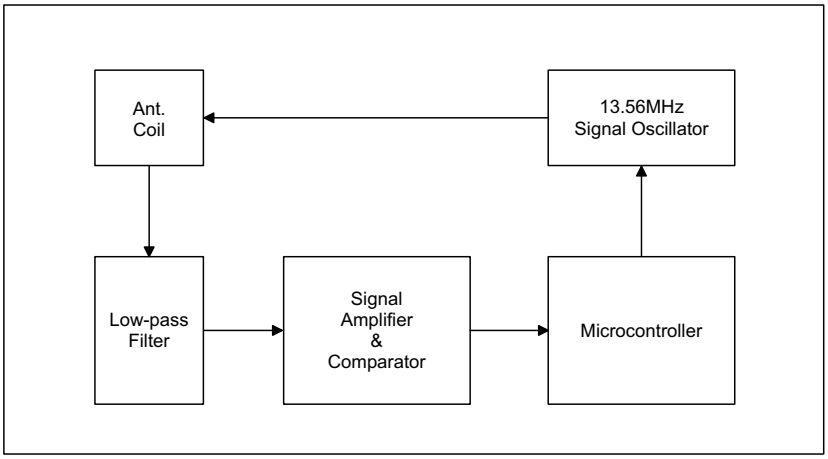
Features

- Operating voltage: 3.3V~5.5V
- 13.56MHz carrier frequency
- PWM and ASK demodulation
- Efficient tag detection
- CRC-CCITT error check
- Easy to build control system
- Low cost RF transponder system solution

Applications

- Interactive leisure products
- Access control
- Security system
- Anti-counterfeit devices
- Personnel working time record
- Material management
- Animal management
- Car park monitoring system

Block Diagram



Pin assignment/Connector description JP1 on PCB

Number	Name	I/O	Description
1	4.5VDC	Input	Battery 1.5V×3 positive power input
2	GND	Input	System ground
3	LED1	Output	ID1 detected output for Demo
4	LED2	Output	ID2 detected output for Demo
5	LED3	Output	ID3 detected output for Demo
6	BEEP1	Output	Buzzer output (+)
7	BEEP2	Output	Buzzer output (–)
8	JP1(VDD)	Output	VDD (4.5V)
9	JP2 (LED1)	Output	PA0, parallel with LED1, active low.

Number	Name	I/O	Description
10	JP3 (LED2)	Output	PA1, parallel with LED2, active low.
11	JP4 (LED3)	Output	PA2, parallel with LED3, active low.
12	JP5	Output	PA3, microcontroller I/O HT48R06A
13	JP6	Output	PA4, microcontroller I/O HT48R06A
14	JP7	Output	PA5, microcontroller I/O HT48R06A
15	JP8	Output	PA6, microcontroller I/O HT48R06A
16	JP9 (GND)	Output	Ground

The reader demo board reserves a 9-pin connector JP1; it can be easily accommodated by software for extended applications. By using the OTP type microcontroller HT48R06A, various control functions are possible by programming HT48R06A with Holtek's development tool and writer. LEDs and buzzer are just for demonstration only. For further applications (ex. adding voice functions, mechanical control, etc;) use the on-board hollows or connect a daughter PCB through the connector JP1.

Electrical Characteristics

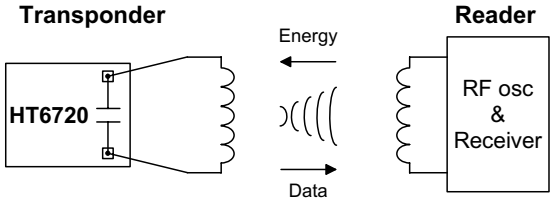
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{ON}	System on Current	Continuously On	—	50	—	mA
I_{STB}	Standby Current	During Off cycle	—	20	—	μA
I_{AVG}	Average Current	No tag is detected	—	7	—	mA
		A tag is detected	—	37	—	mA
V_{DD}	Operating Voltage	—	3.3	4.5	5.5	V
D	Max. Detection Tag Distance	Tag ANT size 7.5cm×4.5cm	7	—	—	cm
		Tag ANT size 3.5cm×3.5cm	4	—	—	cm

Note: The system alternates between On and sleep mode, I_{ON} denotes the current consumption when the system is On; I_{STB} denotes the current consumption when in sleep mode; I_{AVG} is the average of On and sleep current.

Functional Description

Operation Concept

The reader transmits a 13.56MHz carrier signal from its antenna, the LC tank on the transponder side converts the carrier energy to voltage form and supply it to the transponder chip through an internal pump circuit. If the induced energy is high enough, the pumped voltage reaches the break-in voltage of the internal RC-oscillator, the transponder is actuated to transmit its internal pre-programmed data (ID) serially by means of damping the LC tank.



The reader receives the transponder′s data (ID) by detecting the energy variations on its own antenna, and recognize the information with a microcontroller.

Hardware function description

The Reader includes a low cost antenna printed on the PCB (refer to the application circuit). The antenna coil is a necessary device in the RF ID Reader system and the value of the antenna coefficient may affect the sensing distance in reading the tag. Recommended antenna coil inductance value is 1.34μH and diameter is 6.5cm for this demo system (the size and shape have been tuned). However the diameter can be increased to improve the magnetic field for longer detection distance application, or can be reduced to save on the PCB area at the expense of shorter detection distance.

The power of the antenna is supplied from a crystal stabilized 13.56MHz oscillator that is controlled by an 8-bit microcontroller. When the Reader is in sleeping mode, it will switch off both the microcontroller′s RC oscillator (4MHz, Typ.) and the 13.56MHz crystal oscillator. For demo purposes, the system switches between ″On″ and ″sleeping″ for power saving. However for systems wherein power consumption is not an issue such as anti-counterfeit application, the system's power can be always On.

The antenna delivers RF power to the tag (transponder IC; HT6720) and in return, the power variation of the antenna that is induced by the modulation of the transponder IC will be detected.

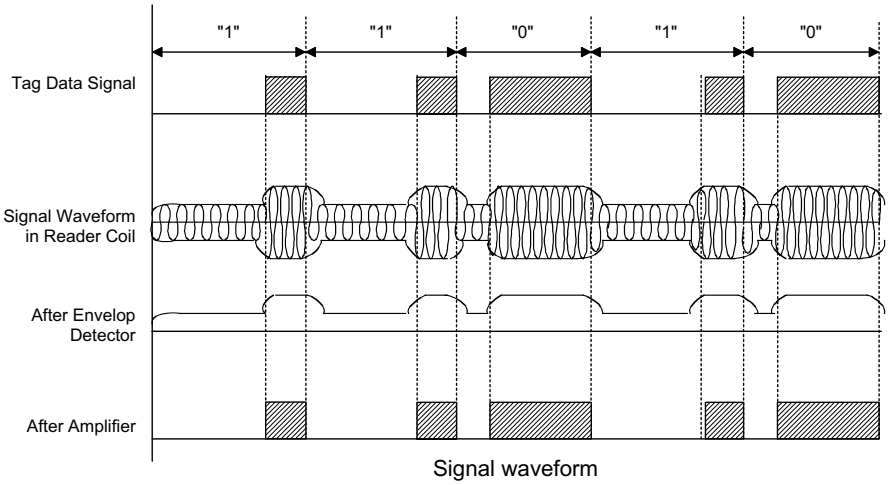
The detection circuit consists of a voltage amplifier, which amplifies the modulated signal received from the antenna circuit, and a waveform shaper to recover the signal transmitted from the transponder IC. The microcontroller in turn decodes the signal and carries out the requested control function. In the demo system, three LEDs are provided to recognize 3 different sample tags. VDD, VSS and PA0~PA6 are provided through a connector (JP1) for extended applications, PA0~PA2 are the default for the LED indicators, PA3~PA6 have no function. Re-programming the HT48R06A is necessary to extend PA0~PA6 functions.

Software function description

The RF ID software demodulates the PWM/ASK code, recognize tag ID, check input data format (CRC-CCITT), and enable the corresponding LED and Buzzer if a valid ID has been received.
The software controls system On/Off duty to reduce power consumption, and it is able to turn on the reserved output port by re-programming the HT48R06A.
There are three LEDs to indicate three kinds of different tags detected. And a Piezzo buzzer "beep" when a valid tag signal has been detected.

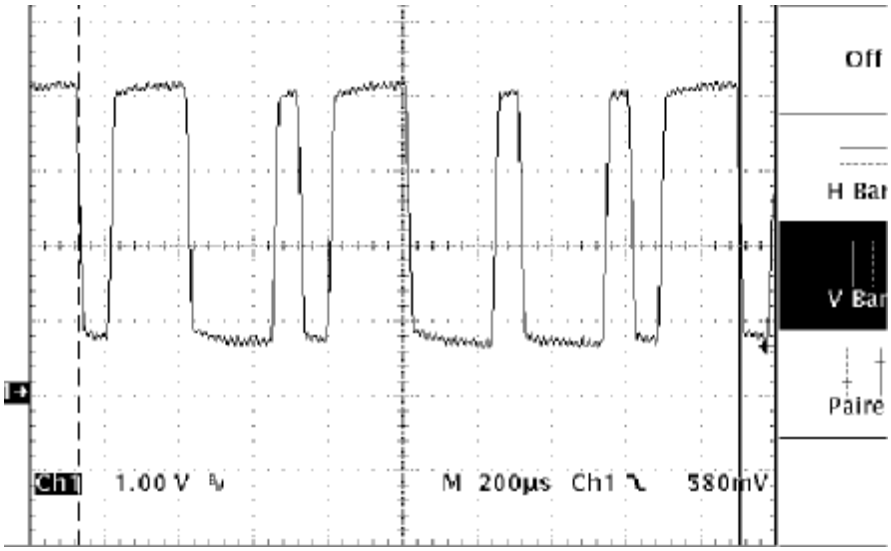
Waveforms

The following figure describes the waveform between Tag and Reader.



Signal waveform

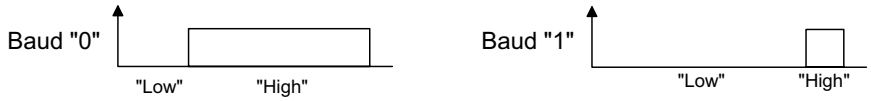
Scope data after amplifier:



The data between two cursors are ″0 1 0 1 1 0″, and software will decode these data.

Baud rate

A PWM/ASK signal is defined in the following:
Baud ″0″: The ratio of low and high is ″1:3″
Baud ″1″: The ratio of low and high is ″3:1″

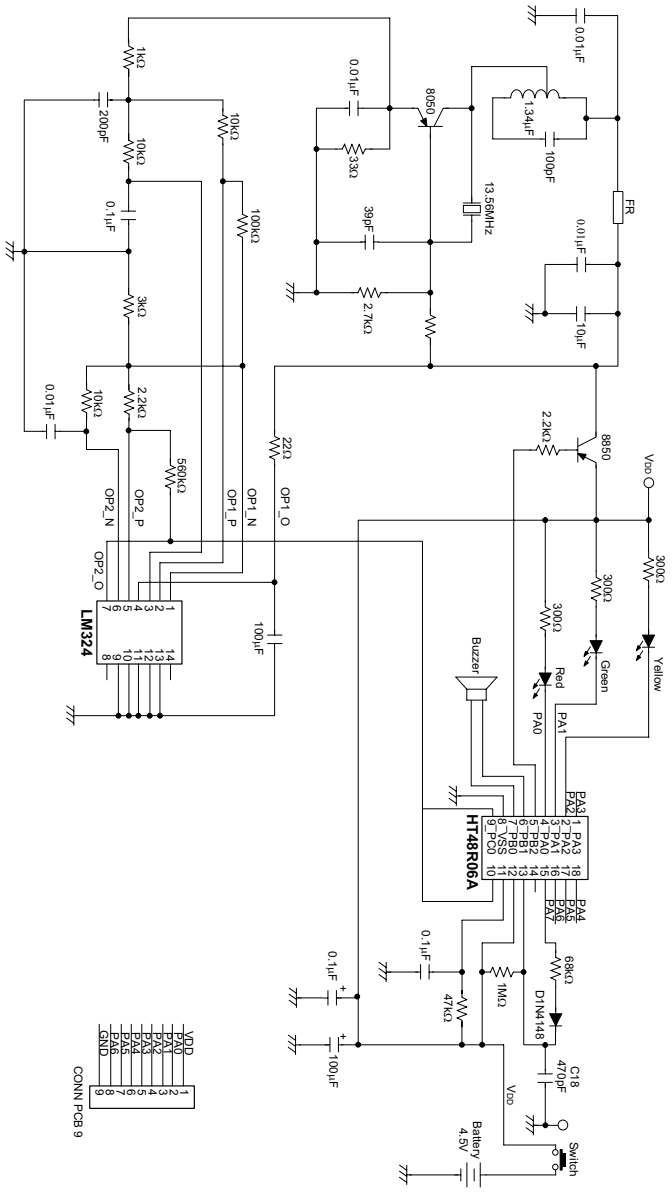


The baud rate is 4.5kbps (Typ.), for transponder induced V_{DD}=3V.

Note: For leisure product applications, the CRC check may be neglected, and the accuracy requirement of baud rate and duty is not critical.

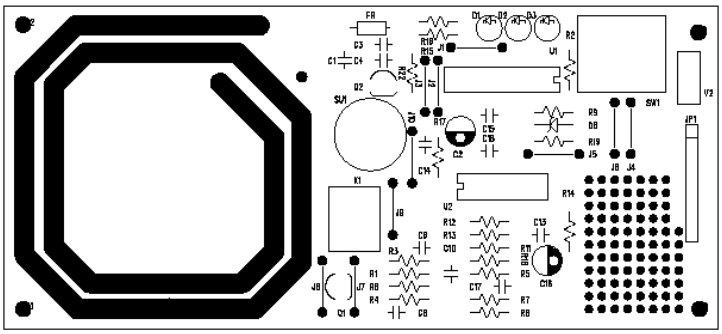
Application Circuit

HT6720 reader

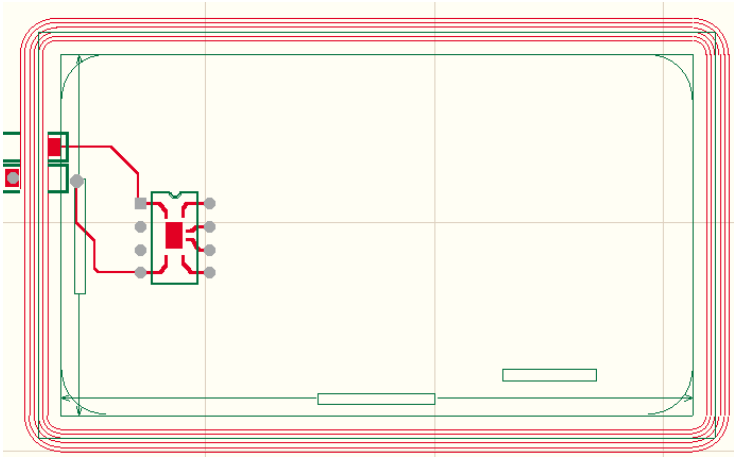


Note: The circuit is subject to change for performance enhancement.

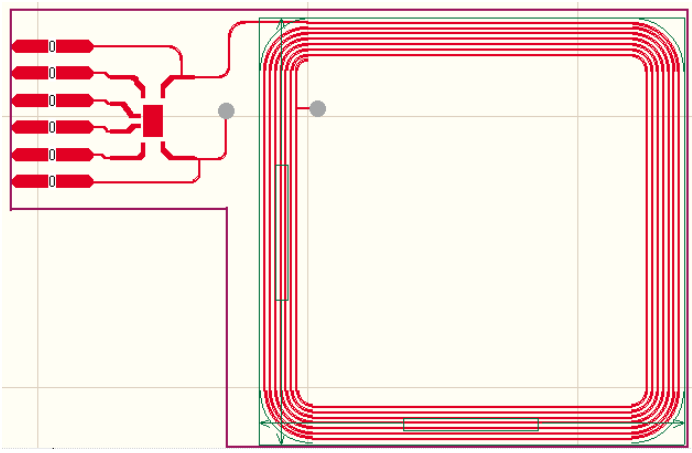
PCB of HT6720 reader (component side, 2 sided without through hole)



Tag1 7.5 cm × 4.5 cm antenna PCB (single sided)



Tag2 3.5 cm × 3.5 cm antenna PCB (single sided)

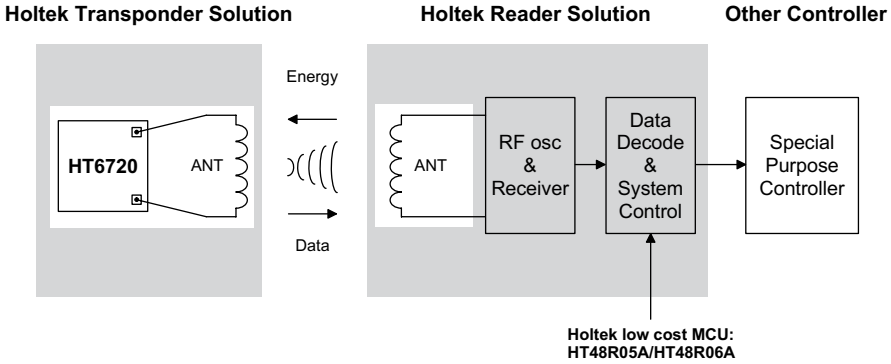


Component list (reader only)

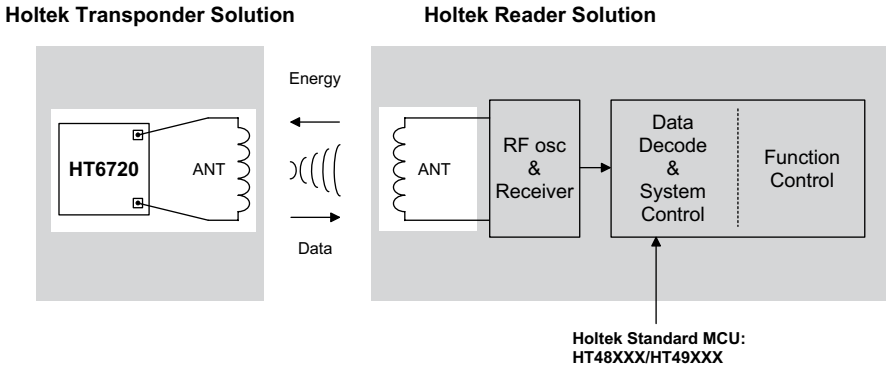
Item	Value	Number
Capacitor (electrolytic)	100μ	2
Capacitor (electrolytic)	10μ	1
Capacitor (Mylar)	0.01μ	4
Capacitor (Ceramic)	200p	1
Capacitor (Ceramic)	470p	1
Capacitor (Ceramic	39p	1
Capacitor (Ceramic	0.1μ	3
Capacitor (Ceramic	100p	1
Resistor +/– 5%	1M	1
Resistor +/– 5%	560k	1
Resistor +/– 5%	100k	1
Resistor +/– 5%	68k	1
Resistor +/– 5%	47k	1
Resistor +/– 5%	10k	3
Resistor +/– 5%	9.1k	1
Resistor +/– 5%	3k	1
Resistor +/– 5%	2.7k	1
Resistor +/– 5%	2.2k	2
Resistor +/– 5%	1k	1
Resistor +/– 5%	300	3
Resistor +/– 5%	33	1
Resistor +/– 5%	22	1
LED		3
Buzzer	Piezzo	1
Ferrite bead		1
Transistor NPN	8050	1
Transistor PNP	8550	1
X'tal oscillator	13.56MHz	1
Op amp	LM324	1
ANT coil printed on PCB	11μH	1
PCB single sided process	140mm×64mm	1

Product Application for HT6720 & Reader

2 chip solutions



1 chip solution (I)



1 chip solution (II)