

DATA SHEET

HTRC110

Hitag Reader Chip

Product Specification
Revision 3.0
Public Information

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PHILIPS

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Definitions

| Data sheet status | |
|--|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics section of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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1. Features

Combines all analogue RFID reader hardware in a single chip:

- Optimized for HITAG transponder family
- Robust antenna coil power driver stage with modulator
- High performance adaptive sampling time AM/PM demodulator (patent pending)
- Read and write function
- On-chip clock oscillator
- Antenna rupture and short circuit detection
- Low power consumption
- Very low power stand-by mode
- Low external component count
- Small package (SO14)

2. Introduction

The Hitag Reader Chip HTRC110 is intended for use with transponders, which are based on the HITAG silicon (HT1ICS30 02x or HT2ICS20 02x). (E.g. the HITAG 2 stick HT2DC20 S20 may be operated with the use of the Reader Chip). In addition the IC supports other 125kHz transponder types using amplitude modulation for the write operation and AM/PM for the read operation. The receiver parameters (gain factors, filter cutoff frequencies) can be optimized to system and transponder requirements. The HTRC110 is designed for easy integration into RF-identification readers. State-of-the-art technology allows almost complete integration of the necessary building blocks. A powerful antenna driver/modulator together with a low-noise adaptive sampling time demodulator, programmable filters/amplifier and digitizer build the complete transceiver unit, required to design high-performance readers. A three-pin microcontroller interface is employed for programming the HTRC110 as well as for the bidirectional communication with the transponders. The three-wire interface can be changed into a two-wire interface by connecting the data input and the data output.

Tolerance dependent zero amplitude modulation caused severe problems in envelope detector systems, resulting in the need of very low tolerance reader antennas. These problems are solved by the new Adaptive Sampling Time technique (AST).

3. Ordering Information

| TYPE NAME | DESCRIPTION | ORDERING NUMBER |
|------------------|-----------------------|-----------------|
| HTRC110 01T/02EE | Hitag Reader IC, Tube | 9352 600 91112 |
| HTRC110 01T/03EE | Hitag Reader IC, Reel | 9352 600 92118 |

4. Block Diagram

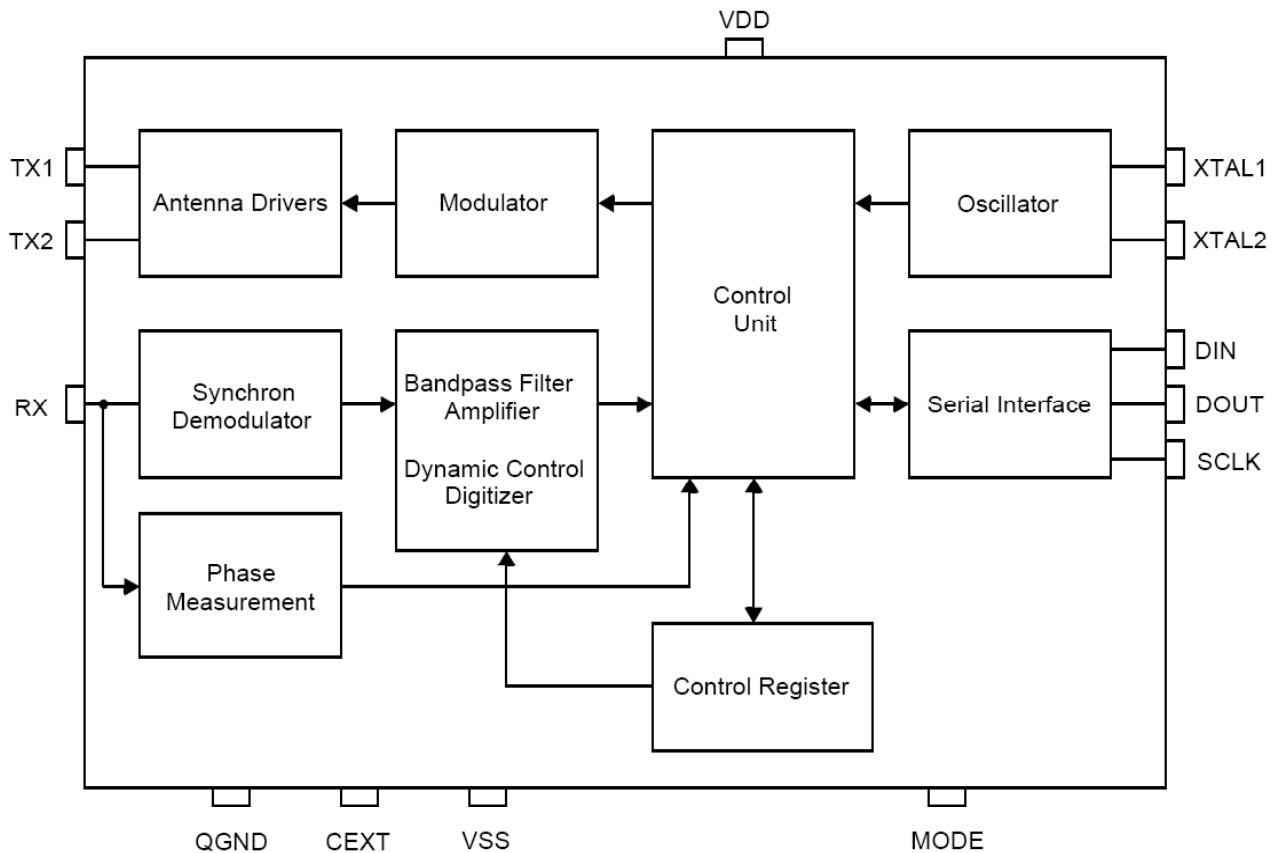


Figure 1: Block diagram Hitag Reader Chip HTRC110

5. Key Data

| | |
|-----------------------------|---|
| Supply VDD | 5 V \pm 10% |
| Clock/Osc. frequency | 4,8,12,16 MHz programmable (antenna carrier frequency 125 kHz) |
| Antenna driver current | 200 mAp continuous |
| Serial interface | CMOS compatible |
| Package | SO14 |
| Operation temperature range | -40°C to +85°C |

6. Pinning Information

6.1. Pinning Diagram

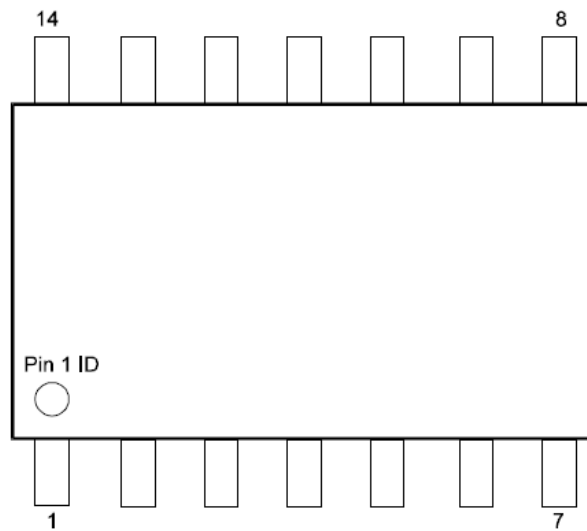


Figure 2: Pinning Diagram

6.2. Pin Description

| Number | Symbol | Description |
|--------|--------|---|
| 1 | VSS | GND, negative supply input |
| 2 | TX2 | Coil driver output |
| 3 | VDD | Stabilized 5 V supply input |
| 4 | TX1 | Coil driver output |
| 5 | MODE | To enable filtering of SCLK and DIN (for active antenna applications) |
| 6 | XTAL1 | Oscillator interface, input |
| 7 | XTAL2 | Oscillator interface, output |
| 8 | SCLK | Microcontroller interface: serial clock input |
| 9 | DIN | Microcontroller interface: serial data in |
| 10 | DOUT | Microcontroller interface: serial data out |
| 11 | n.c. | Not connected |
| 12 | CEXT | High pass filter coupling |
| 13 | QGND | Analog ground bias |
| 14 | RX | Demodulator input |

7. Minimum Application Circuitry

The following figure shows a minimal application circuitry for the HTRC110. The reader coil L_a together with the capacitor C_a forms a series resonant LC circuit ($f = 125 \text{ kHz}$). The high voltages in the LC circuit are divided to safe operating levels by R_v and the chip internal resistor $R_{\text{dem_in}}$ behind the RX-pin. The two capacitors connected to XTAL1 and XTAL2 shall be the recommended values and types from the crystal's data sheet. Alternatively to a crystal a ceramic resonator can be used or an external clock source can be connected to XTAL1.

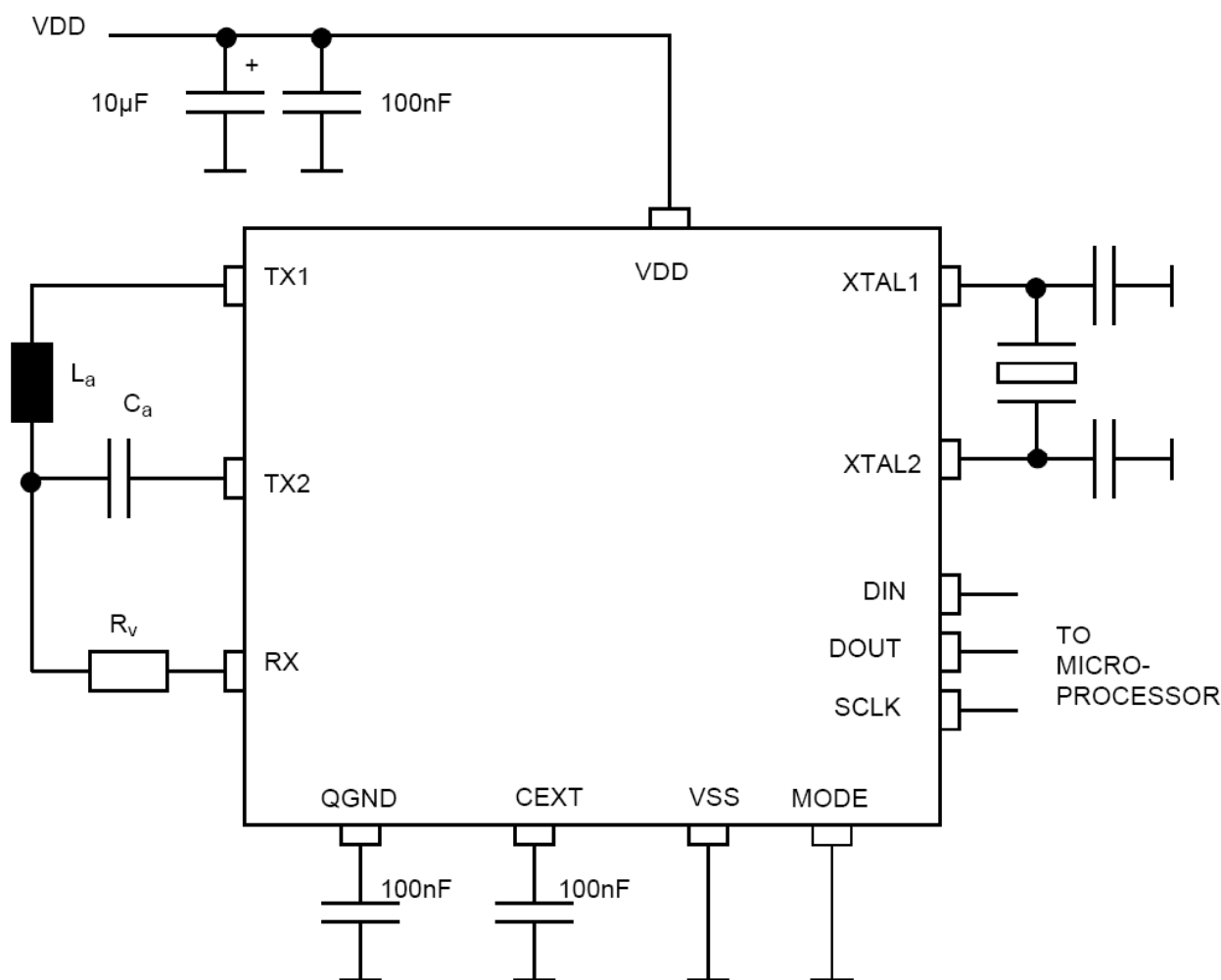


Figure 3: Minimum application circuitry

8. Functional Description

8.1. Power Supply

The HTRC110 works with an external $5V \pm 10\%$ power supply at VDD. The maximum DC-current is $10\text{mA} + \hat{I}_{\text{ant}} * 2/\pi = 137\text{mA}$. For optimum performance, the power supply connection should be bypassed to ground with a 100nF capacitor close to the IC.

8.2. Antenna Driver, Data Input

The drivers deliver a square shaped voltage to the series resonant antenna circuit. Due to the full bridge configuration of the drivers this voltage U_{drvpp} is approximately 10V (peak-peak) corresponding to $\hat{U}_{drv}=5V$. The current flowing through the antenna is sine shaped. It's amplitude is approximately:

$$\hat{I}_{ant} = \frac{4}{\pi} \frac{\hat{U}_{drv}}{R_{ant}} \Leftrightarrow I_{ant_{rms}} = \frac{\hat{I}_{ant}}{\sqrt{2}}$$

8.3. Diagnosis

In order to detect an antenna short or open condition the antenna tap voltage is monitored. An antenna fail condition is reported in the status bit ANTFAIL (see Table 14), if the antenna tap voltage does not go more negative than the diagnosis level DLEV (see Table 16). This condition is checked for every coil driver cycle.

8.4. Oscillator / Programmable Divider / Clock

The crystal oscillator at XTAL1/2 works with either crystal or ceramic resonators. It delivers the input clock frequency of 4,8,12 or 16 MHz. The oscillator frequency is divided by a programmable divider to obtain the carrier frequency of 125 kHz (see Table 10). Alternatively, an external clock signal (CMOS compatible) may be fed into the IC via XTAL1. For example, this signal can be derived from the microcontroller clock.

8.5. Adaptive Sampling Time Demodulator

The demodulator senses the absorption modulation applied by a transponder when inserted into the field. The signal is picked up at the antenna tap point between L_a and C_a . It is divided by R_v and the internal resistor R_{dem_in} to a level below 8V (peak) with respect to QGND at the RX-pin (see Figure 3). Internally the signal is filtered with a second order low pass filter.

The antenna current and therefore the tap voltage is modulated by the transponder in amplitude and/or phase. This signal is fed into a synchronous demodulator recovering the baseband signal. The amplification and the bandpass filter edge frequencies of the demodulator can be adapted to different transponders via settings in the configuration pages.

The phase between the driver excitation signal and the antenna tap voltage depends on the antenna tuning. With optimum tuning, the phase of the antenna tap voltage is 90 degrees off the antenna driver signal. Detuning of the antenna resonant circuit results in a change of this phase relationship.

The HTRC110's built-in phase measurement unit allows the measurement of this phase relationship with a resolution of $360^\circ/64=5.625^\circ$. This can be used to compute a sampling time that compensates the mistuning of the reader antenna. The phase measurement procedure can be carried out:

- either once before the first communication starts, if the position of the transponder does not change with the respect to the reader antenna

- or during the communication (after sending the write pulses and before receiving the answer of the transponder), if the tag is moving.

Before the system is switched into WRITE_TAG-mode, the demodulator has to be frozen. This is internally done by clamping the input of the amplifier/filter unit to QGND. Doing so avoids large transients in the amplifier and the digitizer, which could affect settling times. In addition to the clamping, there exist other means in the HTRC110, which allow further reduction of the settling times. All the parts of the circuitry, which are associated with these functions, are controlled by the FREEZE0, FREEZE1 and THRESET bits, which are located in configuration page 2.

For more details concerning WRITE Timing, Demodulator Setting, Power Up Sequence, etc. please refer to the HTRC110 application note.

8.6. Idle and Power-down Mode

The HTRC110 can be switched into idle mode via setting the PD-bit and resetting the PD_MODE-bit. In this idle mode, only the oscillator and a few other system components are active.

It is also possible to switch the IC completely off. This is achieved by the power-down mode (PD=1, PD_MODE=1). Within this mode also the clock oscillator is switched off. This reduces the supply current of the HTRC110 to less than 20µA.

8.7. Serial Interface

The communication between the HTRC110 and the microcontroller is done via a three wire digital interface. The interface is operated by the following signals:

| | |
|------|-------------|
| SCLK | Clock |
| DIN | Data Input |
| DOUT | Data Output |

SCLK and DIN are realized as Schmitt-Trigger inputs. DOUT is an open drain output with internal pullup resistor.

Every communication between HTRC110 and microcontroller begins with an initialization of the serial interface. The interface initialization condition is a low-to-high transition of the signal DIN while SCLK is high.

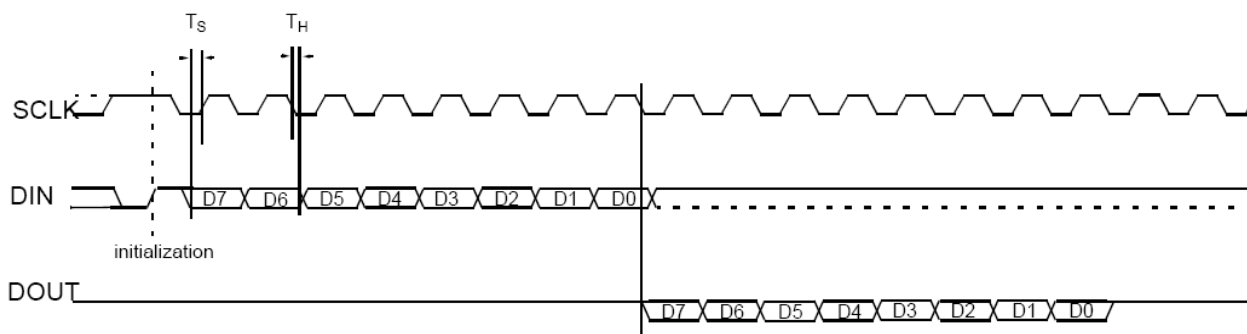


Figure 4: Serial Signaling

All commands are transmitted to the HTRC110 serial interface starting with Most Significant Bit (MSB). DIN and DOUT are valid when SCLK is high.

8.8. Glitch Filter for Increased Noise/Interference Immunity

Connecting Pin 5 (MODE) to VDD enables digital filtering of the SCLK and the DIN input signals. This mode offers improved immunity against glitches on these interface signals. It is intended to be used in the so called “Active Antenna Applications” where the microcontroller and the reader communicate via long signal lines (e.g. 1 meter).

In other applications Pin 5 (MODE) has to be connected to GND.

Please refer to the HTRC110 application note for a detailed description of this feature.

9. Commands

Table 1 depicts the HTRC110 command set summary.

Table 1: HTRC110 Commands

| Command Name \ Bit No. | 7 MSB | 6 | 5 | 4 | 3 | 2 | 1 | 0 LSB | Remark |
|------------------------|----------|---|----|----|----|----|----|----------|---|
| GET_SAMPLING_TIME | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 bit resp. (0 0 D5-D0) |
| GET_CONFIG_PAGE | 0 | 0 | 0 | 0 | 0 | 1 | P1 | P0 | 8 bit resp. (X3-X0 D3-D0) |
| READ_PHASE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 8 bit resp. (0 0 D5 - D0) |
| READ_TAG | 1 | 1 | 1 | - | - | - | - | - | READ_TAG-mode |
| WRITE_TAG_N | 0 | 0 | 0 | 1 | N3 | N2 | N1 | N0 | WRITE_TAG-mode with pulse width programming |
| WRITE_TAG | 1 | 1 | 0 | - | - | - | - | - | WRITE_TAG-mode |
| SET_CONFIG_PAGE | 0 | 1 | P1 | P0 | D3 | D2 | D1 | D0 | 4*4 config bits available |
| SET_SAMPLING_TIME | 1 | 0 | D5 | D4 | D3 | D2 | D1 | D0 | |

9.1. READ_TAG

This command is used to read the demodulated bit stream from a transponder: After the assertion of the three command bits the HTRC110 instantaneously switches to READ_TAG-mode and transmits the demodulated, filtered and digitized data from the transponder. Data comes out and should be decoded by the microcontroller. READ_TAG-mode is terminated by a low to high transition at SCLK.

Table 2: READ_TAG Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|---------|---|---|---|---|---|---|---|---|---------------------------------|
| Command | 1 | 1 | 1 | - | - | - | - | - | received data available at DOUT |

9.2. WRITE_TAG_N

This command is used to write data to a transponder.

If N3-N0 are set to zero, the signal from DIN is transparently switched to the drivers. A high level at DIN corresponds to antenna drivers switched off, a low level corresponds to antenna drivers switched on.

If any binary number between 1 and 1111 is loaded into N3-N0 the drivers are switched off at the next positive transition of DIN. This state is held for a time interval equal to $N * T_0$ ($T_0=8\mu s$). This method relaxes the timing resolution requirements to the microcontroller and to the software implementation while providing exact, selectable write pulse timing. WRITE_TAG-mode is terminated immediately by a low to high transition at SCLK.

Table 3: WRITE_TAG_N Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|---------|---|---|---|---|----|----|----|----|-------------|
| Command | 0 | 0 | 0 | 1 | N3 | N2 | N1 | N0 | no response |

9.3. WRITE_TAG

This is the 3 bit short form of the previously described command WRITE_TAG_N. It allows to switch into WRITE_TAG-mode with a minimum communication time.

The behaviour of the WRITE_TAG command is identical to WRITE_TAG_N with two exceptions:

- WRITE_TAG-mode is entered after assertion of the 3rd command bit.
- No N parameter is specified with this command; instead the N value, which was programmed with the most recent WRITE_TAG_N command, is used. If no WRITE_TAG_N was issued so far, a default N=0 (transparent mode) will be assumed.

Table 4: WRITE_TAG Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|---------|---|---|---|---|---|---|---|---|-------------|
| Command | 1 | 1 | 0 | - | - | - | - | - | no response |

9.4. READ_PHASE

This command is used to read the antenna's phase, which is measured at every carrier cycle. The phase is coded binary in D5-D0.

Table 5: READ_PHASE Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|----------|---|---|----|----|----|----|----|----|--------|
| Command | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| Response | 0 | 0 | D5 | D4 | D3 | D2 | D1 | D0 | |

9.5. SET_SAMPLING_TIME

This command specifies the demodulator sampling time t_s . The sampling time is coded binary in D5-D0.

Table 6: SET_SAMPLING_TIME Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|---------|---|---|----|----|----|----|----|----|-------------|
| Command | 1 | 0 | D5 | D4 | D3 | D2 | D1 | D0 | no response |

9.6. GET_SAMPLING_TIME

This command is used to read back the sampling time t_s set with SET_SAMPLING_TIME. The sampling time is coded binary in D5-D0.

Table 7: GET_SAMPLING_TIME Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|----------|---|---|----|----|----|----|----|----|--------|
| Command | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| Response | 0 | 0 | D5 | D4 | D3 | D2 | D1 | D0 | |

9.7. SET_CONFIG_PAGE

This command is used to set the amplifier and filter parameters (cutoff frequencies, gain factors) and the different operation modes. P1 and P0 select one of four configuration pages.

Table 8: SET_CONFIG_PAGE Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|---------|---|---|----|----|----|----|----|----|-------------|
| Command | 0 | 1 | P1 | P0 | D3 | D2 | D1 | D0 | no response |

Table 9: Config Pages

| Command/Page No. | Bit No. | P1 | P0 | D3 | D2 | D1 | D0 |
|-------------------|---------|----|----|----------|---------------|------------|---------|
| SET_CONFIG_PAGE 0 | | 0 | 0 | GAIN1 | GAIN0 | FILTERH | FILTERL |
| SET_CONFIG_PAGE 1 | | 0 | 1 | PD_MODE | PD | HYSTERESIS | TXDIS |
| SET_CONFIG_PAGE 2 | | 1 | 0 | THRESETH | ACQAMP | FREEZE1 | FREEZE0 |
| SET_CONFIG_PAGE 3 | | 1 | 1 | DISLP1 | DISSMART-COMP | FSEL1 | FSEL0 |

Table 10: Bit Initial Conditions

| Bit name | Description | Initial condition | |
|--------------|--|-------------------|--|
| FILTERL | main low pass cutoff frequency | 0 | 0: fL = 3 kHz 1: fL = 6 kHz |
| FILTERH | main high pass cutoff frequency | 0 | 0: fH = 40 Hz 1: fH = 160 Hz |
| GAIN0 | amplifier_0 gain factor | 0 | 0: gain ₀ = 16; 1: gain ₀ = 32 |
| GAIN1 | amplifier_1 gain factor | 1 | 0: gain ₁ = 6.22; 1: gain ₁ = 31.5 |
| TXDIS | disable coil driver | 0 | 0: coil driver active 1: coil driver inactive |
| HYSTERESIS | data comparator hysteresis | 0 | 0: hysteresis OFF 1: hysteresis ON |
| PD | power down mode enable | 0 | 0: device active 1: device power down |
| PD_MODE | select power down mode | 0 | 0: idle mode 1: power down |
| FREEZE0 | facility to achieve fast settling times | 0 | see table 11 |
| FREEZE1 | facility to achieve fast settling times | 0 | see table 11 |
| ACQAMP | store signal amplitude as reference for later amplitude comparison | 0 | see status bit AMPCOMP |
| THRESET | reset threshold generation of digitizer | 0 | |
| FSEL0 | clock frequency select LSB | 0 | 00: 4MHz, 01: 12MHz |
| FSEL1 | clock frequency select MSB | 0 | 10: 8MHz, 11: 16MHz |
| DISSMARTCOMP | disable smart comparator | 0 | 0: smart comparator = ON 1: smart comparator = OFF |
| DISLP1 | disable low pass 1 | 0 | 0: low pass = ON 1: low pass = OFF |

Table 11: Freeze Bit Description

| FREEZE1 | FREEZE0 | Meaning |
|---------|---------|--|
| 0 | 0 | normal operation |
| 0 | 1 | main low pass is frozen; main high pass is precharged to QGND |
| 1 | 0 | main low pass is frozen; time constant of main high pass is reduced by a factor of 16 for FILTERH=0 and by a factor of 8 for FILTERH=1 |
| 1 | 1 | time constant for main high pass is reduced by a factor of 16 for FILTERH=0 and by a factor of 8 for FILTERH=1; second high pass is precharged |

9.8. GET_CONFIG_PAGE

This command has three functions:

1. Reading back the configuration parameters set by SET_CONFIG_PAGE command
2. Reading back the transmit pulse width programmed with WRITE_TAG_N
3. Reading the system status information

P1 and P0 select one of four configuration pages. The response (X3 X2 X1 X0 D3 D2 D1 D0) contains the contents of the selected configuration page in its lower nibble. For P=0 or P=1 the higher nibble reflects the current setting of N (the transmit pulse width). For P=2 or P=3 the system status information is returned in the higher nibble.

Table 12: GET_CONFIG_PAGE Command

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Remark |
|----------|----|----|----|----|----|----|----|----|--------|
| Command | 0 | 0 | 0 | 0 | 0 | 1 | P1 | P0 | |
| Response | X3 | X2 | X1 | X0 | D3 | D2 | D1 | D0 | |

Table 13: Config Pages

| Bit No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------------|---------|---------|---------|---------|----|----|----|----|
| GET_CONFIG_PAGE 0 | N3 | N2 | N1 | N0 | D3 | D2 | D1 | D0 |
| GET_CONFIG_PAGE 1 | N3 | N2 | N1 | N0 | D3 | D2 | D1 | D0 |
| GET_CONFIG_PAGE 2 | 0 (RFU) | 0 (RFU) | AMPCOMP | ANTFAIL | D3 | D2 | D1 | D0 |
| GET_CONFIG_PAGE 3 | 0 (RFU) | 0 (RFU) | AMPCOMP | ANTFAIL | D3 | D2 | D1 | D0 |

Table 14: Status Bit Description

| Bit name | Meaning | |
|----------|-----------------------------|--|
| ANTFAIL | antenna failure | 0: antenna ok 1: antenna failure |
| AMPCOMP | amplitude comparison result | When ACQAMP is set, the actual amplitude of the data signal is stored as reference. After resetting ACQAMP status bit AMP-COMP is set when the actual data signal amplitude is higher than the stored reference. |

10. Absolute Maximum Ratings

Table 15 lists the limiting values. Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

Table 15: Limiting Values

| Parameter | Symbol | Min. | Max. | Unit |
|------------------------------|--------------------|------|---------|------|
| Voltage at any pin except RX | | -0.3 | +6.5 | V |
| Voltage at any pin except RX | | -0.3 | VDD+0.3 | V |
| Voltage at RX pin | | -10 | +12 | V |
| Maximum junction temperature | T _j | | 140 | °C |
| Storage temperature range | T _{store} | -65 | +125 | °C |

11. DC Characteristics

Table 16 lists the DC characteristics. All voltages are measured to V_{ss} , $T_{amb} = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$.

Table 16: DC Characteristics

| Parameter | Conditions | Symbol | Min. | Typ. | Max. | Unit |
|-------------------------------|---|----------------|----------|----------|-----------|------------------|
| Supply | | | | | | |
| Supply voltage | | VDD | 4.5 | 5.0 | 5.5 | V |
| Operating supply current | VDD=5.5V, $I_{TX1}=I_{TX2}=0$ | I_{On} | | 4 | 10 | mA |
| Idle current ⁽¹⁾ | VDD=5.5V | I_{Id} | | 0.2 | 0.4 | mA |
| Power down current | VDD=5.5V | I_{pd} | | 7 | 20 | μA |
| Drivers (TX1, TX2) | | | | | | |
| Output peak-current | permanent | I_{ant} | | | 200 | mA_p |
| Output peak-current | 1:4 On/off-ratio $t_{on} < 400\text{ms}$ | $I_{antPulse}$ | | | 400 | mA_p |
| Output resistance | both drivers together | | | 2.5 | 7 | Ω |
| Demodulator Input | | | | | | |
| Voltage range | U_{RX} with respect to QGND | | -8 | | 8 | V |
| QGND Potential | | | 0.35 VDD | 0.42 VDD | 0.5 VDD | V |
| Impedance | | R_{dem_in} | 17 | 25 | 33 | $\text{k}\Omega$ |
| Diagnosis Level (DLEV) | | | | | | |
| | U_{RX} with respect to QGND, VDD=5V | DLEV | -1.5 | -1.15 | -0.8 | V |
| Digital Inputs | | | | | | |
| Data input high voltage | | V_{IH} | 0.7 VDD | | VDD+0.3 V | V |
| Data input low voltage | | V_{IL} | - 0.3 V | | 0.3 VDD | V |
| Digital Outputs | | | | | | |
| Output low | $I_{OL\ max} = +1\text{mA}$ | V_{OL} | | | 0.4 | V |
| Output drive capability | $V_{OL} \leq 0.4\text{V}$ | | 1 | | | mA |

1. Power consumption of external quartz or any other external component is not included

12. AC Characteristics

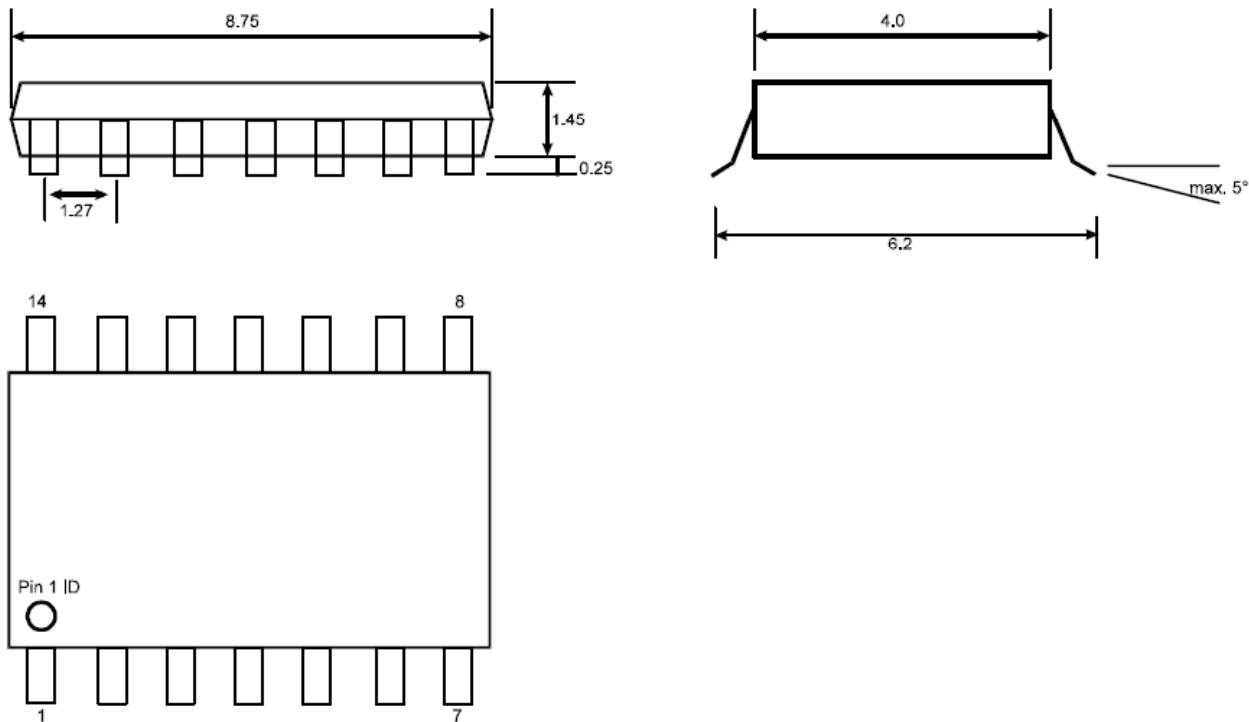
Table 17 lists the AC characteristics. $T_{amb} = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$.

Table 17: AC Characteristics

| Parameter | Conditions | Symbol | Min. | Typ. | Max. | Unit |
|--|----------------------|------------|------|------|-----------|------------------|
| XTAL Oscillator (XTAL1/XTAL2) | | | | | | |
| Frequency range | depending on FSEL | f_{osc} | 4 | | 16 | MHz |
| Start-up time | | | | 4 | 10 | ms |
| Input capacitance | XTAL1 | | | 5 | | pF |
| Input resistance | XTAL1 to XTAL 2 | | 0.9 | 1.3 | 3.0 | M Ω |
| External Clock (XTAL1) | | | | | | |
| Frequency range | depending on FSEL | | 4 | | 16 | MHz |
| Duty cycle | | | 40 | | 60 | % |
| Serial Interface | | | | | | |
| Setup time | MODE pin at V_{ss} | T_S | 50 | | | ns |
| Hold time | MODE pin at V_{ss} | T_{IH} | 50 | | | ns |
| Receiver | | | | | | |
| Sensitivity | at RX input | U_{RX} | 2 | 1 | | mV _{pp} |
| Receiver delay | FILTERL=0 | T_{RCV0} | 290 | 310 | 340 | μs |
| Receiver delay | FILTERL=1 | T_{RCV1} | 160 | 175 | 190 | μs |
| Recovery from Clock Stable to Demodulator Valid | | | | | | |
| Recovery time demodulator ⁽¹⁾ | | T_{RPD} | | | 5 | ms |
| Recovery from WRITE-pulse | | | | | | |
| Recovery of demodulator ⁽¹⁾ | | T_{RWD} | | | 500 | μs |
| Recovery from AST-step | | | | | | |
| Recovery of demodulator | | T_{RAST} | | 0.7 | 1.5 | ms |
| Phase measurement error | | | | | ± 5.7 | deg |

1. These short times require special command sequences. Please refer to the application note “AN97070 Read/Write Devices based on the HITAG Read/Write IC HTRC110”.

13. Package



14. Abbreviations

| | |
|---|--------------------|
| Amplitudes of sine shaped signals: | \hat{U}, \hat{I} |
| Peak-to-peak of arbitrary shaped signals: | U_{pp}, I_{pp} |
| Zero-to peak of arbitrary shaped signals: | U_p, I_p |

15. Revision History

| Revision | Date | CPCN | Page | Description |
|----------|-----------|------|------|--|
| 2.2 | Jan 1999 | | | Initial Version |
| 3.0 | July 2006 | | 3 | Add Disclaimer Section: <ul style="list-style-type: none">- Philips Field of Use- Philips Right to make changes |

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