

Features

- Carrier Frequency f_{osc} 100 kHz to 150 kHz
- Typical Data Rate up to 5 Kbaud at 125 kHz
- Suitable for Manchester and Bi-phase Modulation
- Power Supply from the Car Battery or from 5V Regulated Voltage
- Optimized for Car Immobilizer Applications
- Tuning Capability
- Microcontroller-compatible Interface
- Low Power Consumption in Standby Mode
- Power-supply Output for Microcontroller

Applications

- Car Immobilizers
- Animal Identification
- Access Control
- Process Control

1. Description

The U2270B is an IC for IDIC[®] read/write base stations in contactless identification and immobilizer systems.

The IC incorporates the energy-transfer circuit to supply the transponder. It consists of an on-chip power supply, an oscillator, and a coil driver optimized for automotive-specific distances. It also includes all signal-processing circuits which are necessary to transform the small input signal into a microcontroller-compatible signal.



Read/Write Base Station

U2270B

Figure 1-1. System Block Diagram

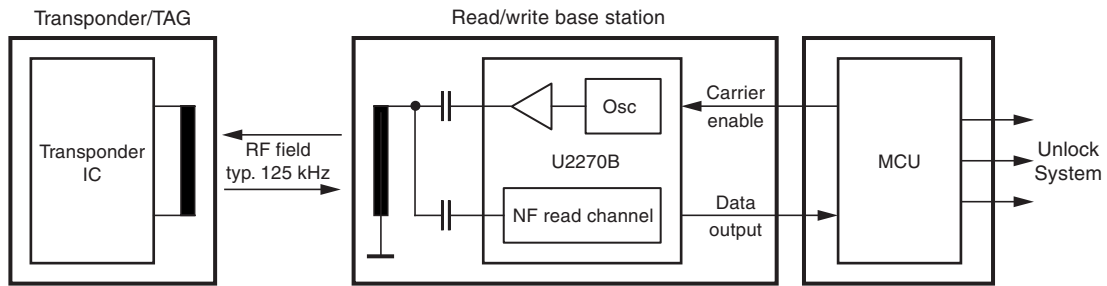
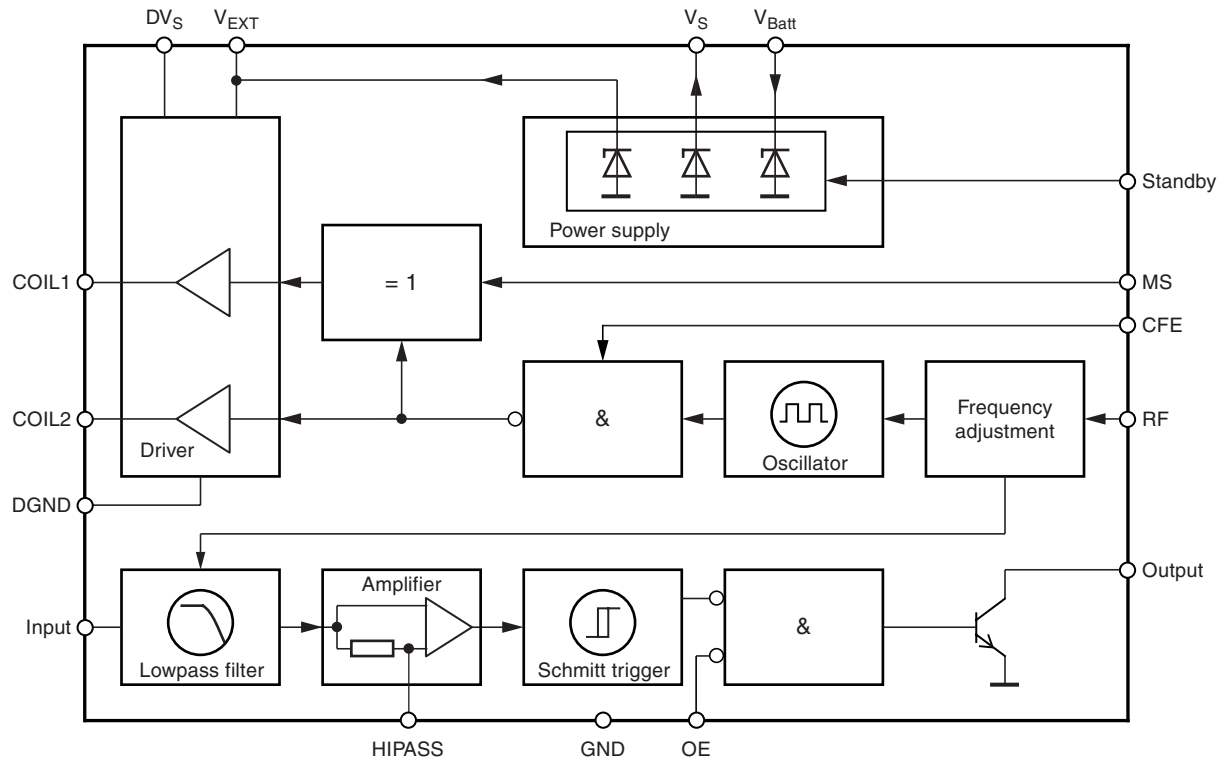


Figure 1-2. Block Diagram



2. Pin Configuration

Figure 2-1. Pinning

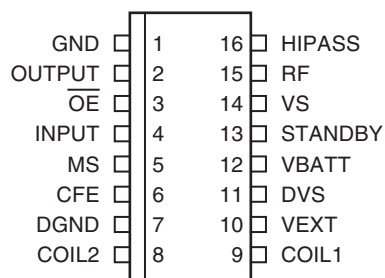


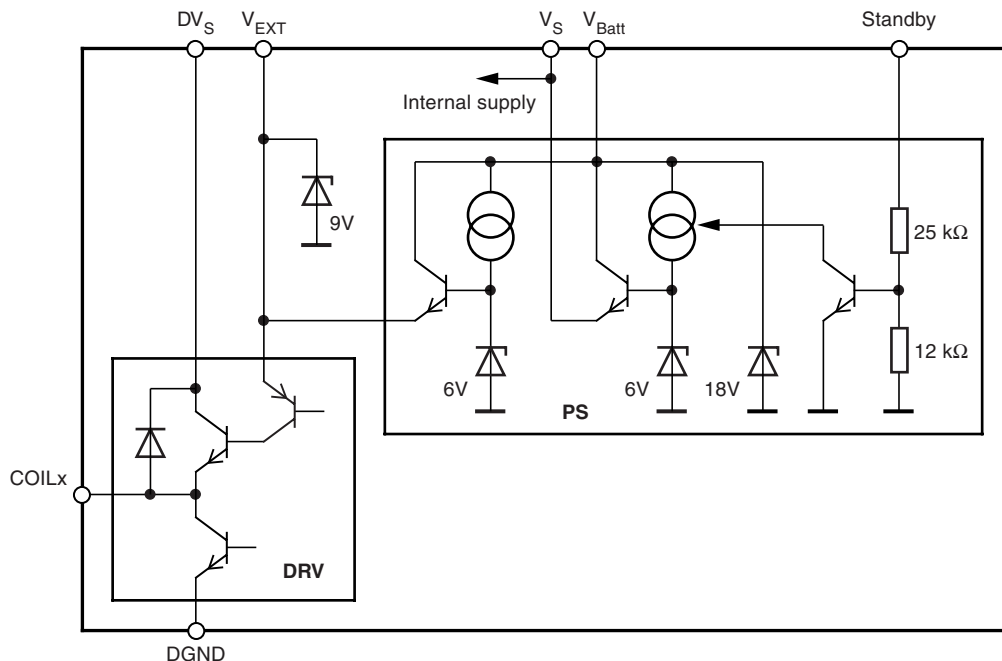
Table 2-1. Pin Description

| Pin | Symbol | Function |
|-----|---------|---|
| 1 | GND | Ground |
| 2 | OUTPUT | Data output |
| 3 | OE | Data output enable |
| 4 | INPUT | Data input |
| 5 | MS | Mode select coil 1: common mode/differential mode |
| 6 | CFE | Carrier frequency enable |
| 7 | DGND | Driver ground |
| 8 | COIL2 | Coil driver 2 |
| 9 | COIL1 | Coil driver 1 |
| 10 | VEXT | External power supply |
| 11 | DVS | Driver supply voltage |
| 12 | VBatt | Battery voltage |
| 13 | STANDBY | Standby input |
| 14 | VS | Internal power supply (5V) |
| 15 | RF | Frequency adjustment |
| 16 | HIPASS | DC decoupling |

3. Functional Description

3.1 Power Supply (PS)

Figure 3-1. Equivalent Circuit of Power Supply and Antenna Driver



The U2270B can be operated with one external supply voltage or with two externally-stabilized supply voltages for an extended driver output voltage or from the 12V battery voltage of a vehicle. The 12V supply capability is achieved via the on-chip power supply (see [Figure 3-1](#)). The power supply provides two different output voltages, V_S and V_{EXT} .

V_S is the internal power supply voltage for everything except for the driver circuit. Pin V_S is used to connect a block capacitor. V_S can be switched off by the STANDBY pin. In standby mode, the chip's power consumption is very low. V_{EXT} is the supply voltage of the antenna's pre-driver. This voltage can also be used to operate external circuits, such as a microcontroller. In conjunction with an external NPN transistor, it also establishes the supply voltage of the antenna coil driver, DV_S .

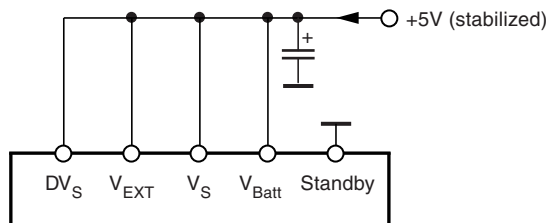
3.2 Operation Modes to Power the U2270B

The following section explains the three different operation modes to power the U2270B.

3.2.1 One-rail Operation

All internal circuits are operated from one 5V power rail (see [Figure 3-2](#)). In this case, V_S , V_{EXT} and D_{VS} serve as inputs. V_{Batt} is not used but should also be connected to that supply rail.

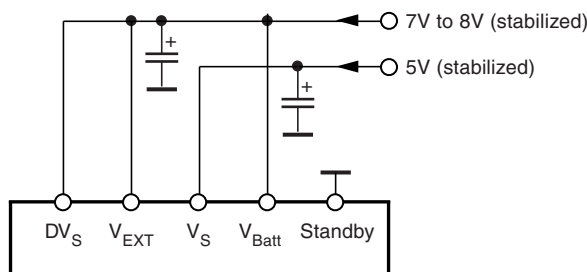
Figure 3-2. One-rail Operation Supply



3.2.2 Two-rail Operation

In this application, the driver voltage, D_{VS} , and the pre-driver supply, V_{EXT} , are operated at a higher voltage than the rest of the circuitry to obtain a higher driver-output swing and thus a higher magnetic field (see [Figure 3-3](#)). V_S is connected to a 5V supply, whereas the driver voltages can be as high as 8V. This operation mode is intended to be used in situations where an extended communication distance is required.

Figure 3-3. Two-rail Operation Supply



3.2.3 Battery-voltage Operation

Using this operation mode, V_S and V_{EXT} are generated by the internal power supply (see [Figure 3-4 on page 6](#)). For this mode, an external voltage regulator is not needed. The IC can be switched off via the STANDBY pin. V_{EXT} supplies the base of an external NPN transistor and external circuits, like a microcontroller (even in standby mode).

Pin V_{EXT} and V_{Batt} are overvoltage protected via internal Zener diodes (see [Figure 3-1 on page 4](#)). The maximum current into the pins is determined by the maximum power dissipation and the maximum junction temperature of the IC.

Figure 3-4. Battery Operation

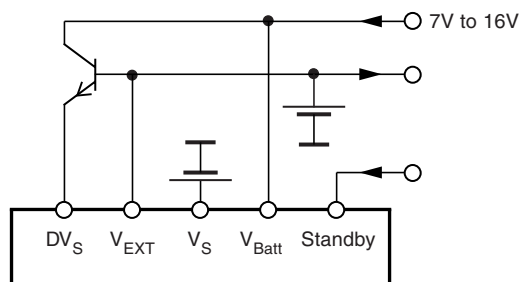


Table 3-1. Characteristics of the Various Operation Modes

| Operation Mode | External Components Required | Supply-voltage Range | Driver Output Voltage Swing | Standby Mode Available |
|---------------------------|--|--------------------------|-----------------------------|------------------------|
| One-rail operation | 1 voltage regulator 1 capacitor | 5V \pm 10% | \approx 4V | No |
| Two-rail operation | 2 voltage regulators 2 capacitors | 5V \pm 10% 7V to 8V | 6V to 7V | No |
| Battery-voltage operation | 1 transistor 2 capacitors Optional, for load dump protection: 1 resistor 1 capacitor | 6V to 16V | \approx 4V | Yes |

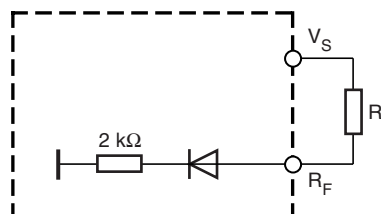
3.3 Oscillator (Osc)

The frequency of the on-chip oscillator is controlled by a current fed into the R_F input. An integrated compensation circuit ensures a wide temperature range and a supply-voltage-independent frequency which is selected by a fixed resistor between R_F (pin 15) and V_S (pin 14). For 125 kHz, a resistor value of 110 k Ω is defined. For other frequencies, use the following formula:

$$R_f[\text{k}\Omega] = \frac{14375}{f_0[\text{kHz}]} - 5$$

This input can be used to adjust the frequency close to the resonance of the antenna. For more details see Section [“Applications” on page 10](#).

Figure 3-5. Equivalent Circuit of Pin R_F



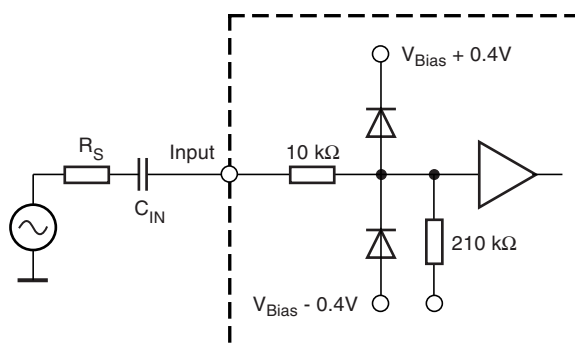
3.4 Low-pass Filter (LPF)

The fully integrated low-pass filter (4th-order Butterworth) removes the remaining carrier signal and high-frequency disturbances after demodulation. The upper cut-off frequency of the LPF depends on the selected oscillator frequency. The typical value is $f_{\text{Osc}} / 18$, and data rates up to $f_{\text{Osc}} / 25$ are possible if bi-phase or Manchester encoding is used.

A high-pass characteristic results from the capacitive coupling at the input pin 4 as shown in [Figure 3-6](#). The input voltage swing is limited to $2 V_{\text{pp}}$. For frequency response calculation, the impedances of the signal source and LPF input (typical $210 \text{ k}\Omega$) have to be considered. The recommended values of the input capacitor for selected data rates are given in [Section 4.](#), “Applications”, on [page 10](#).

Note: After switching on the carrier, the DC voltage of the coupling capacitor changes rapidly. When the antenna voltage is stable, the LPF needs approximately 2 ms to recover full sensitivity.

Figure 3-6. Equivalent Circuit of Pin Input



3.5 Amplifier (AMP)

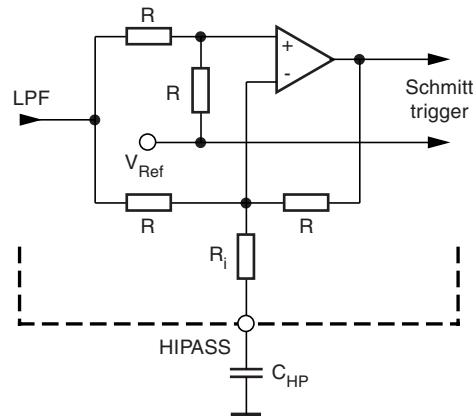
The differential amplifier has a fixed gain, typically 30. The HIPASS pin is used for DC decoupling. The lower cut-off frequency of the decoupling circuit can be calculated as follows:

$$f_{\text{cut}} = \frac{1}{2 \times \pi \times C_{\text{HP}} \times R_i}$$

The value of the internal resistor R_i can be assumed to be $2.5 \text{ k}\Omega$.

Recommended values of C_{HP} for selected data rates can be found in [Section 4.](#), “Applications”, on [page 10](#).

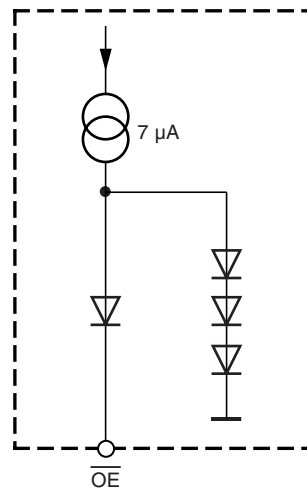
Figure 3-7. Equivalent Circuit of Pin HIPASS



3.6 Schmitt Trigger

The signal is processed by a Schmitt trigger to suppress possible noise and to make the signal microcontroller-compatible. The hysteresis level is 100 mV symmetrically to the DC operation point. The open-collector output is enabled by a low level at OE (pin 3).

Figure 3-8. Equivalent Circuit of Pin OE



3.7 Driver (DRV)

The driver supplies the antenna coil with the appropriate energy. The circuit consists of two independent output stages. These output stages can be operated in two different modes. In common mode, the outputs of the stages are in phase; in this mode, the outputs can be interconnected to achieve a high-current output capability. Using the differential mode, the output voltages are in anti-phase; thus, the antenna coil is driven with a higher voltage. For a specific magnetic field, the antenna coil impedance is higher for the differential mode. As a higher coil impedance results in better system sensitivity, the differential mode should be preferred.

The CFE input is intended to be used for writing data into a read/write or a crypto transponder. This is achieved by interrupting the RF field with short gaps. The various functions are controlled by the inputs MS and CFE (see “[Function Table](#)” on page 10). The equivalent circuit of the driver is shown in [Figure 3-1 on page 4](#).

Figure 3-9. Equivalent Circuit of Pin MS

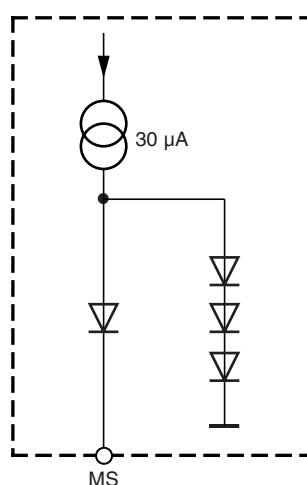
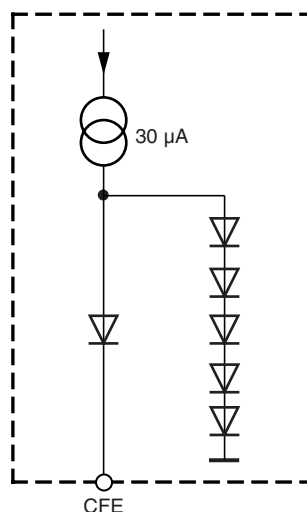






Figure 3-10. Equivalent Circuit of Pin CFE



3.8 Function Table

| CFE | MS | COIL1 | COIL2 |
|------|------|---|---|
| Low | Low | High | High |
| Low | High | Low | High |
| High | Low |  |  |
| High | High |  |  |

| OE | Output |
|------|----------|
| Low | Enabled |
| High | Disabled |

| STANDBY | U2270B |
|---------|--------------|
| Low | Standby mode |
| High | Active |

4. Applications

To achieve the system performance, consider the power-supply environment and the magnetic-coupling situation.

The selection of the appropriate power-supply operation mode depends on the quality of supply voltage. If an unregulated supply voltage in the range of $V = 7V$ to $16V$ is available, the internal power supply of the U2270B can be used. In this case, standby mode can be used and an external low-current microcontroller can be supplied.

If a $5V$ supply rail is available, it can be used to power the U2270B. In this case, check that the voltage is noise-free. An external power transistor is not necessary.

The application also depends on the magnetic-coupling situation. The coupling factor mainly depends on the transmission distance and the antenna coils. The following table lists the appropriate application for a given coupling factor. The magnetic coupling factor can be determined using Atmel®'s test transponder coil.

Table 4-1. Magnetic Coupling

| Magnetic Coupling Factor | Appropriate Application |
|--------------------------|--|
| $k > 3\%$ | Free-running oscillator |
| $k > 1\%$ | Diode feedback |
| $k > 0.5\%$ | Diode feedback plus frequency altering |
| $k > 0.3\%$ | Diode feedback plus fine frequency tuning |

The maximum transmission distance is also influenced by the accuracy of the antenna's resonance. Therefore, the recommendations given above are proposals only. A good compromise for the resonance accuracy of the antenna is a value in the range of $f_{res} = 125 \text{ kHz} \pm 3\%$. Further details concerning the adequate application and the antenna design is provided in Section "Antenna Design Hints".

The application of the U2270B includes the two capacitors C_{IN} and C_{HP} whose values are linearly dependent on the transponder's data rate. The following table gives the appropriate values for the most common data rates. The values are valid for Manchester and bi-phase code.

Table 4-2. Recommended Capacitor Values

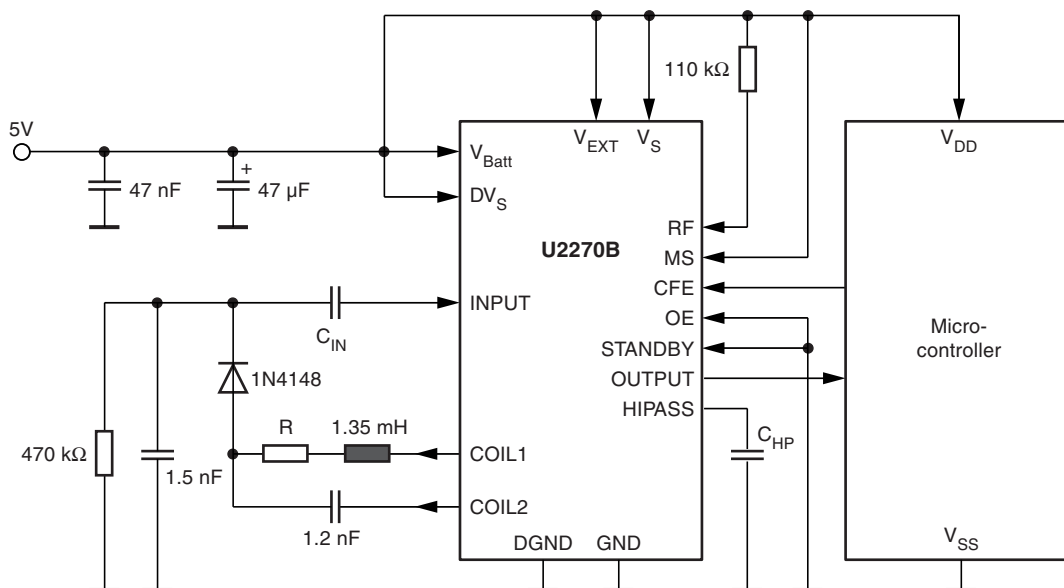
| Data Rate $f = 125 \text{ kHz}$ | Input Capacitor (C_{IN}) | Decoupling Capacitor (C_{HP}) |
|---------------------------------|------------------------------|-----------------------------------|
| $f / 32 = 3.9 \text{ Kbits/s}$ | 680 pF | 100 nF |
| $f / 64 = 1.95 \text{ Kbits/s}$ | 1.2 nF | 220 nF |

The following applications are typical examples. The values of C_{IN} and C_{HP} correspond to the transponder's data rate only. The arrangement to fit the magnetic-coupling situation is also independent of other design issues except for one constellation. This constellation, consisting of diode feedback plus fine frequency tuning together with the two-rail power supply, should be used if the transmission distance is $d \approx 10 \text{ cm}$.

4.1 Application 1

Application using few external components. This application is for intense magnetic coupling only.

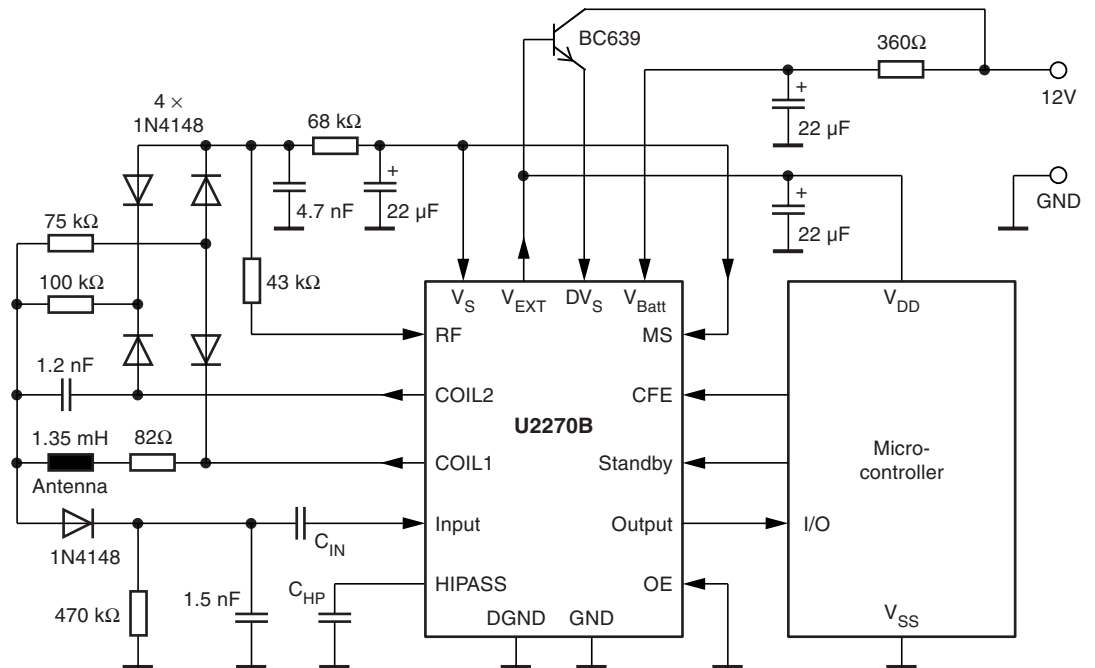
Figure 4-1. Application Circuit 1



4.2 Application 2

Basic application using diode feedback. This application allows higher communication distances than [Application 1](#)

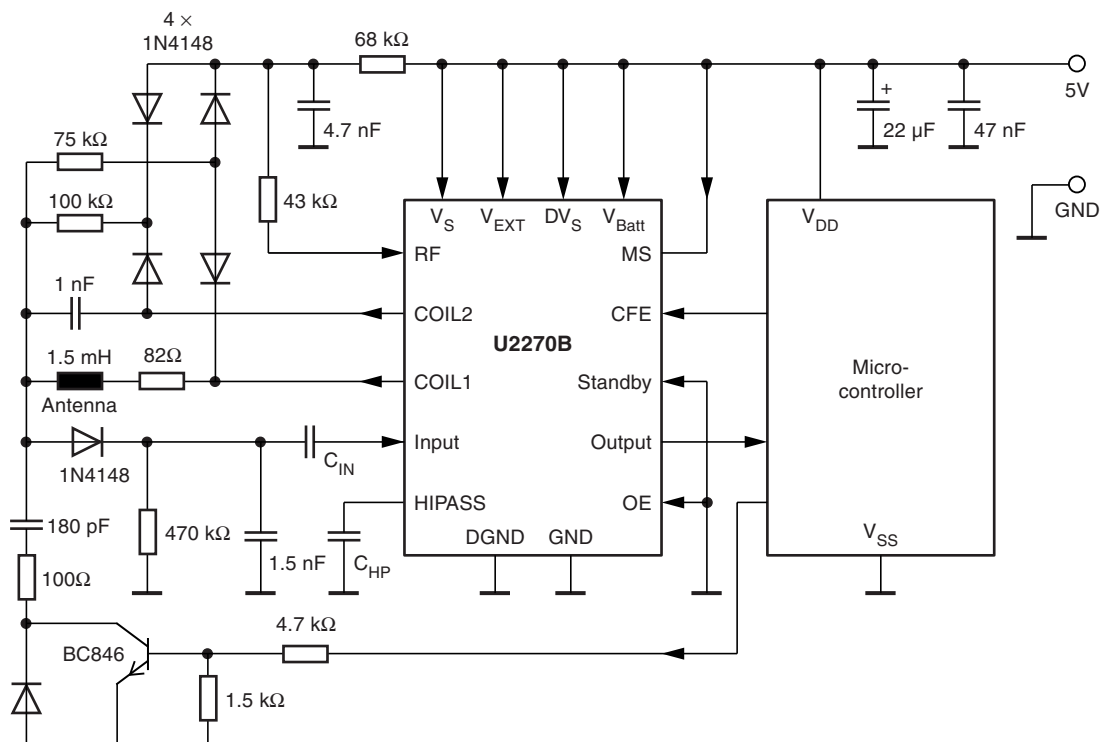
Figure 4-2. Application Circuit 2



4.3 Application 3

This application is comparable to “Application 2” but alters the operating frequency. This allows higher antenna resonance tolerances and/or higher communication distances. This application is preferred if the detecting microcontroller is close to the U2270B, as an additional microcontroller signal controls the adequate operating frequency.

Figure 4-3. Application Circuit 3



Note: Application examples have not been examined for series production or reliability, and no worst case scenarios have been developed. Customers who adapt any of these proposals must carry out their own testing and be convinced that no negative consequences arise from the proposals.

5. Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

All voltages are referred to GND (Pins 1 and 7)

| Parameter | Pin | Symbol | Min. | Max. | Unit |
|------------------------------------|--------------------------------|---|--------------|---------------------------|------|
| Operating voltage | 12 | V_{Batt} | V_S | 16 | V |
| Operating voltage | 8, 9, 10, 11, 14 | $V_S, V_{EXT}, DV_S, \text{Coil 1, Coil 2}$ | -0.3 | 8 | V |
| Range of input and output voltages | 3, 4, 5, 6, 15, 16 2 and 13 | V_{IN} V_{OUT} | -0.3 -0.3 | $V_S + 0.3$ V_{Batt} | V |
| Output current | 10 | I_{EXT} | | 10 | mA |
| Output current | 2 | I_{OUT} | | 10 | mA |
| Driver output current | 8 and 9 | I_{Coil} | | 200 | mA |
| Power dissipation SO16 | | P_{tot} | | 380 | mW |
| Junction temperature | | T_j | | 150 | °C |
| Storage temperature | | T_{stg} | -55 | 125 | °C |
| Ambient temperature | | T_{amb} | -40 | 105 | °C |

6. Thermal Resistance

| Parameter | Symbol | Value | Unit |
|-------------------------|------------|-------|------|
| Thermal resistance SO16 | R_{thJA} | 120 | K/W |

7. Operating Range

All voltages are referred to GND (Pins 1 and 7)

| Parameter | Pin | Symbol | Value | Unit |
|-------------------|--------|-----------------|------------|------|
| Operating voltage | 12 | V_{Batt} | 7 to 16 | V |
| Operating voltage | 14 | V_S | 4.5 to 6.3 | V |
| Operating voltage | 10, 11 | V_{EXT}, DV_S | 4.5 to 8 | V |
| Carrier frequency | | | 100 to 150 | kHz |

8. Electrical Characteristics

All voltages are referred to GND (Pins 1 and 7)

| Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit |
|--|---|----------------------------|--|-------------------|-------------------|------------|--|
| Data output - Collector emitter - Saturation voltage | $I_{out} = 5 \text{ mA}$ | 2 | V_{CEsat} | | | 400 | mV |
| Data output enable - Low-level input voltage - High-level input voltage | | 3 | V_{il} V_{ih} | 2.4 | | 0.5 | V V |
| Data input - Clamping level low - Clamping level high - Input resistance - Input sensitivity | $f = 3 \text{ kHz}$ (square wave) Gain capacitor = 100 nF | 4 | V_{il} V_{ih} R_{in} S_{IN} | 10 | 2 3.8 220 | | V V k Ω mV _{pp} |
| Driver polarity mode - Low-level input voltage - High-level input voltage | | 5 | V_{il} V_{ih} | 2.4 | | 0.2 | V V |
| Carrier frequency enable - Low-level input voltage - High-level input voltage | | 6 | V_{il} V_{ih} | 3.0 | | 0.8 | V V |
| Operating current | 5V application without load connected to the coil driver | 10, 11, 12 and 14 | I_S | | 4.5 | 9 | mA |
| Standby current | 12V application | 12 | I_{St} | | 30 | 70 | μA |
| V_S - Supply voltage - Supply voltage drift - Output current | | 14 | V_S dV_S/dT I_S | 4.6 1.8 | 5.4 4.2 3.5 | 6.3 | V mV/K mA |
| Driver output voltage - One-rail operation - Battery-voltage operation | $I_L = \pm 100 \text{ mA}$ $V_S, V_{EXT}, V_{Batt}, DV_S = 5V$ $V_{Batt} = 12V$ | 8, 9 | V_{DRV} V_{DRV} | 2.9 3.1 | 3.6 4.0 | 4.3 4.7 | V_{PP} V_{PP} |
| V_{EXT} - Output voltage - Supply voltage drift - Output current - Standby output current | IC active Standby mode | 10 | V_{EXT} dV_{EXT}/dT I_{EXT} I_{EXT} | 4.6 3.5 0.4 | 5.4 4.2 | 6.3 | V mV/K mA mA |
| Standby input - Low-level input voltage - High-level input voltage | | 13 | V_{il} V_{ih} | 3.1 | | 0.8 | V V |
| Oscillator - Carrier frequency | RF resistor = 110 k Ω ("Application 2"), REM 1 ⁽¹⁾ | | f_0 | 121 | 125 | 129 | kHz |
| Low-pass filter - Cut-off frequency | Carrier frequency = 125 kHz | | f_{cut} | | 7 | | kHz |
| Amplifier gain | $C_{HP} = 100 \text{ nF}$ | | | | 30 | | |

Note: 1. REM 1: In "Application 1" where the oscillator operates in free-running mode, the IC must be soldered free from distortion. Otherwise, the oscillator may be out of bounds.

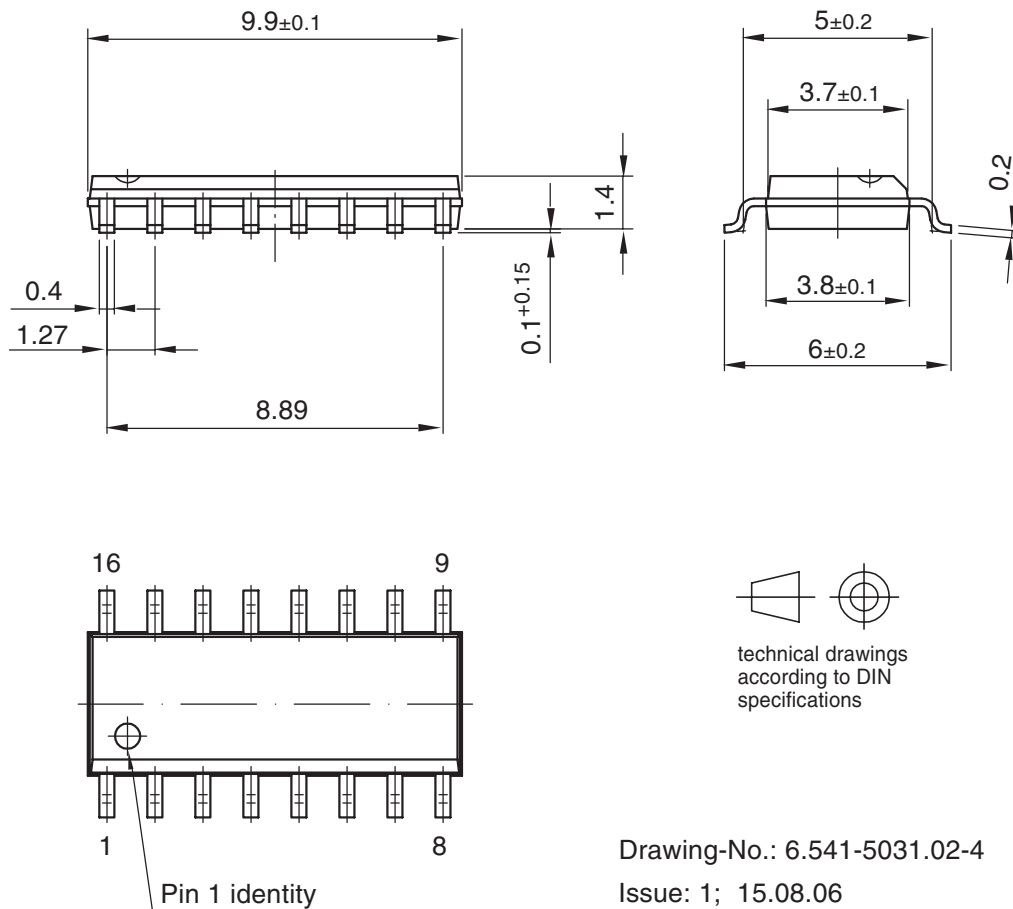
9. Ordering Information

| Extended Type Number | Package | Remarks |
|----------------------|---------|---------------------------|
| U2270B-MFPY | SO16 | Tube, Pb-free |
| U2270B-MFPG3Y | SO16 | Taped and reeled, Pb-free |

10. Package Information

Package: SO 16

Dimensions in mm



11. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

| Revision No. | History |
|------------------|---|
| 4684E-RFID-01/08 | <ul style="list-style-type: none"> Put datasheet in a new template Section 3.4 “Low-pass Filter (LPF)” on page 7: Typo removed Section 8 “Electrical Characteristics” on page 15: Parameter V_S alignment corrected |
| 4684D-RFID-09/06 | <ul style="list-style-type: none"> Put datasheet in a new template Pb-free logo on page 1 deleted Section 10 “Package Information” on page 16 changed Minor grammatical corrections and fixed broken cross references |
| 4684C-RFID-12/05 | <ul style="list-style-type: none"> Last page: Legal sentence changed |
| 4684B-RFID-09/05 | <ul style="list-style-type: none"> Put datasheet in a new template Pb-free Logo on page 1 added New heading rows on Table “Absolute Maximum Ratings” on page 14 added Ordering Information on page 16 changed |



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