

Features

- Carrier Frequency f_{osc} 100 kHz - 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 5-V Regulated Voltage
- Optimized for Car Immobilizer Applications
- Tuning Capability
- Microcontroller-compatible Interface
- Low Power Consumption in Standby Mode
- Power-supply Output for Microcontroller

Applications

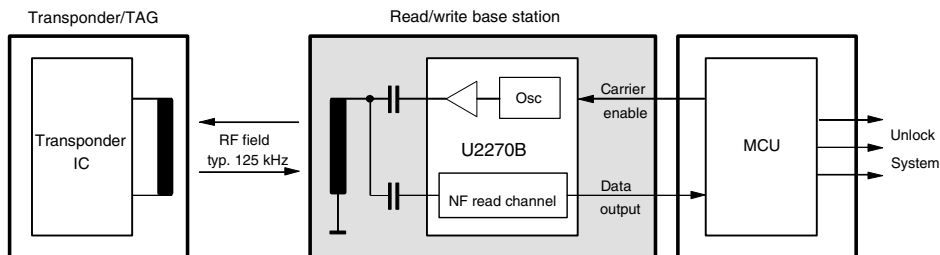
- Car Immobilizers
- Animal Identification
- Access Control
- Process Control

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.

System Block Diagram



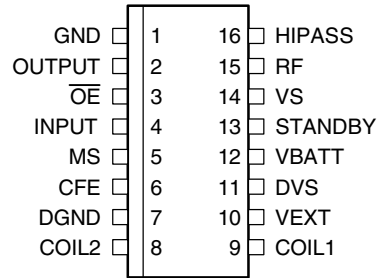
Read/Write Base Station

U2270B



Pin Configuration

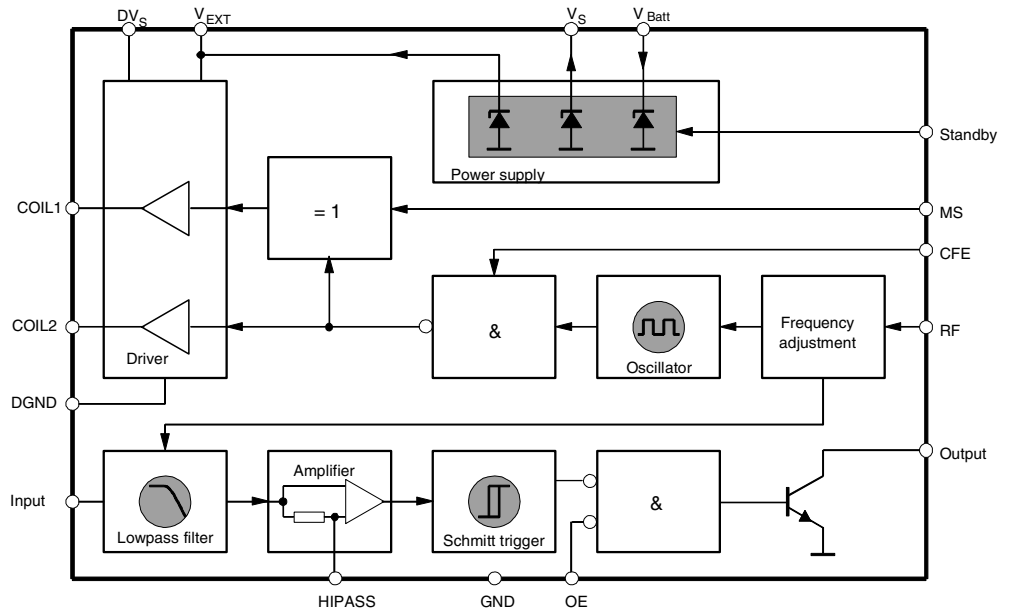
Figure 1. Pinning



Pin Description

Pin	Symbol	Function
1	GND	Ground
2	OUTPUT	Data output
3	$\overline{\text{OE}}$	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 (5 V)
15	RF	Frequency adjustment
16	HIPASS	DC decoupling

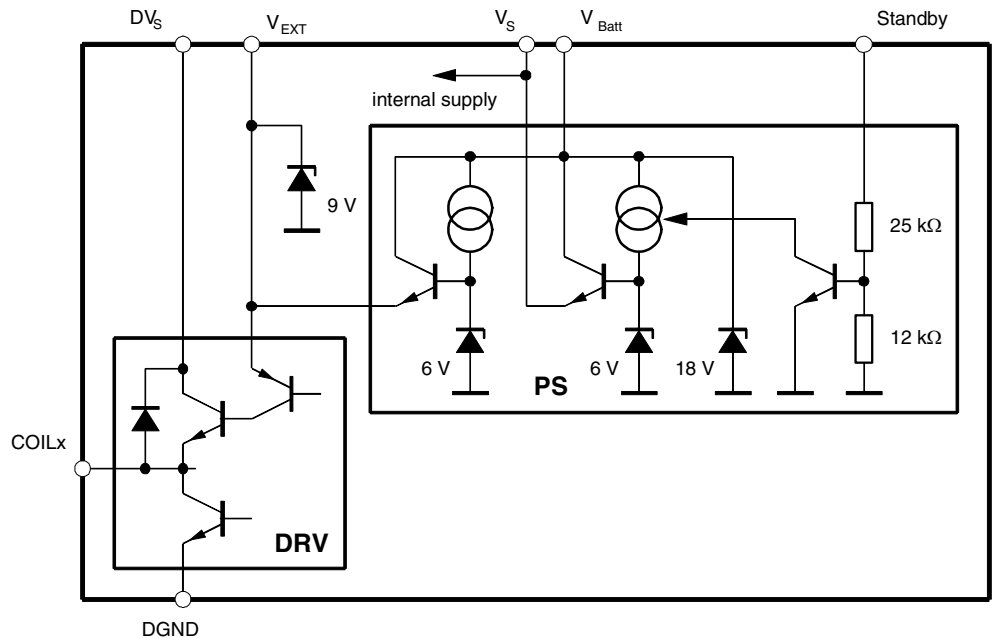
Block Diagram



Functional Description

Power Supply (PS)

Figure 2. 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 12-V battery voltage of a vehicle. The 12-V supply capability is achieved via the on-chip power supply (see Figure 2). The power supply provides two different output voltages, V_S and V_{EXT} .

V_S is the internal power supply voltage except for the driver circuit. Pin V_S is used to connect a block capacitor. V_S can be switched off by 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, like a microcontroller. In conjunction with an external NPN transistor it also establishes the supply voltage of the antenna coil driver, DVS.

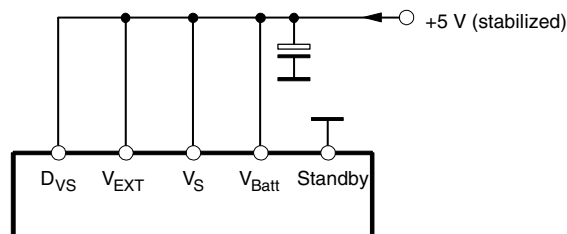
Operation Modes to Power the U2270B

One-rail Operation

The following section explains the 3 different operation modes to power the U2270B.

All internal circuits are operated from one 5-V power rail (see Figure 3). 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.

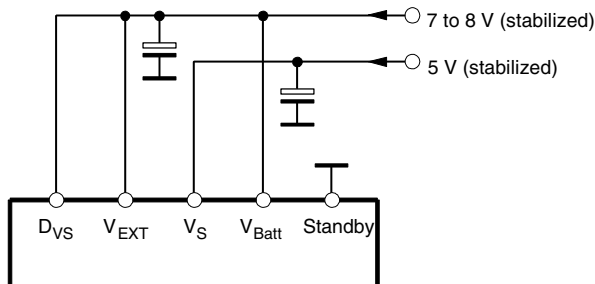
Figure 3. One Rail Operation Supply



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 4). V_S is connected to a 5-V supply, whereas the driver voltages can be as high as 8 V. This operation mode is intended to be used in situations where an extended communication distance is required.

Figure 4. Two Rail Operation Supply



Battery-voltage Operation

Using this operation mode, V_S and V_{EXT} are generated by the internal power supply (see Figure 5). 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 2). The maximum current into the pins is determined by the maximum power dissipation and the maximum junction temperature of the IC.

Figure 5. Battery Operation

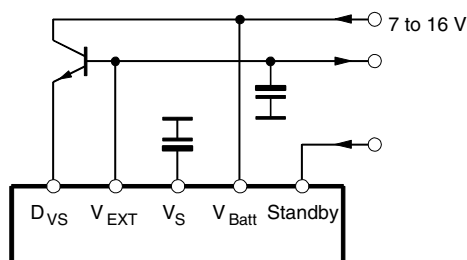


Table 1. Characteristics of the Various Operation Modes

Operation Mode	External Components Required	Supply-voltage Range	Driver Output Voltage Swing	Standby Mode Available
One-rail operation	1 Voltage regulator 1 Capacitor	5 V ±10%	≈ 4 V	No
Two-rail operation	2 Voltage regulators 2 Capacitors	5 V ±10% 7 V to 8 V	6 V to 7 V	No
Battery-voltage operation	1 Transistor 2 Capacitors Optional for load dump protection: 1 Resistor 1 Capacitor	6 V to 16 V	≈ 4 V	Yes

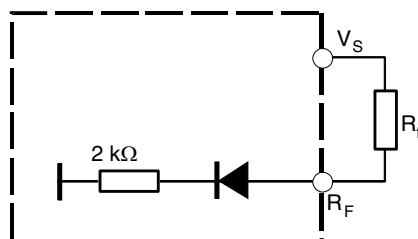
Oscillator (Osc)

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 kΩ is defined. For other frequencies, use the following formula:

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

This input can be used to adjust the frequency close to the resonance of the antenna. For more details refer to the section “Applicatons” and to the application note ANT019.

Figure 6. Equivalent Circuit of Pin R_F



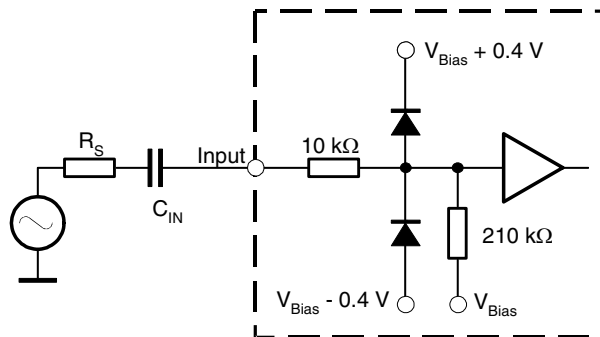
Filter (LPF)

The fully-integrated lowpass 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 $f_{OSC}/18$. That means that data rates up to $f_{OSC}/25$ are possible if Bi-phase or Manchester encoding is used.

A highpass characteristic results from the capacitive coupling at the input pin 4 as shown in Figure 7. The input voltage swing is limited to $2 V_{pp}$. For frequency response calculation, the impedances of the signal source and LPF input (typical 220 k Ω) have to be considered. The recommended values of the input capacitor for selected data rates are given in the section “Applications”.

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 7. Equivalent Circuit of Pin Input



Amplifier (AMP)

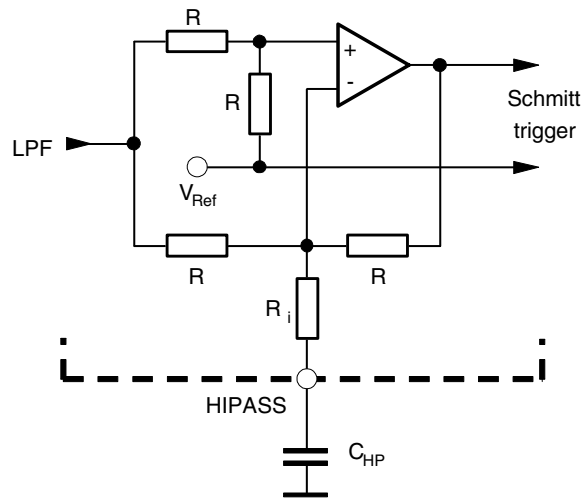
The differential amplifier has a fixed gain, typically 30. The HIPASS pin is used for dc decoupling. The lower cut-off frequency of the decoupling circuit can be calculated as follows:

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

The value of the internal resistor R_i can be assumed to be 2.5 k Ω .

Recommended values of C_{HP} for selected data rates can be found in the section “Applications”.

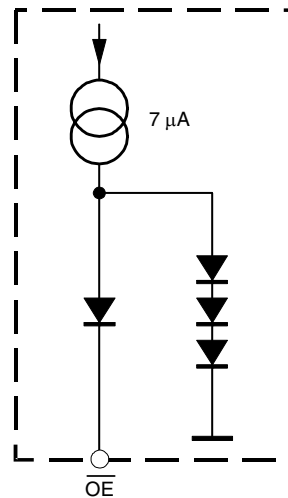
Figure 8. Equivalent Circuit of Pin HIPASS



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 9. Equivalent Circuit of Pin OE



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 a 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 (refer to the function table). The equivalent circuit of the driver is shown in Figure 2.

Figure 10. Equivalent Circuit of Pin MS

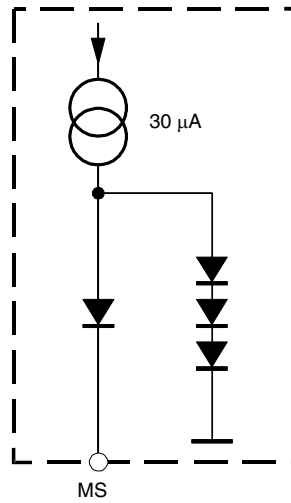
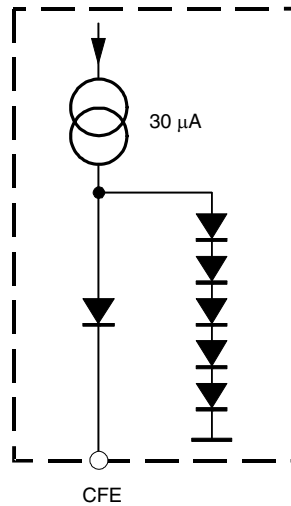


Figure 11. Equivalent Circuit of Pin CFE



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

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 $V = 7\text{ V}$ to 16 V 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 5-V supply rail is available, it can be used to power the U2270B. In this case, please check that the voltage is noise-free. An external power transistor is not necessary.

The application depends also 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 2. 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 the 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 3. Recommended Cap Values

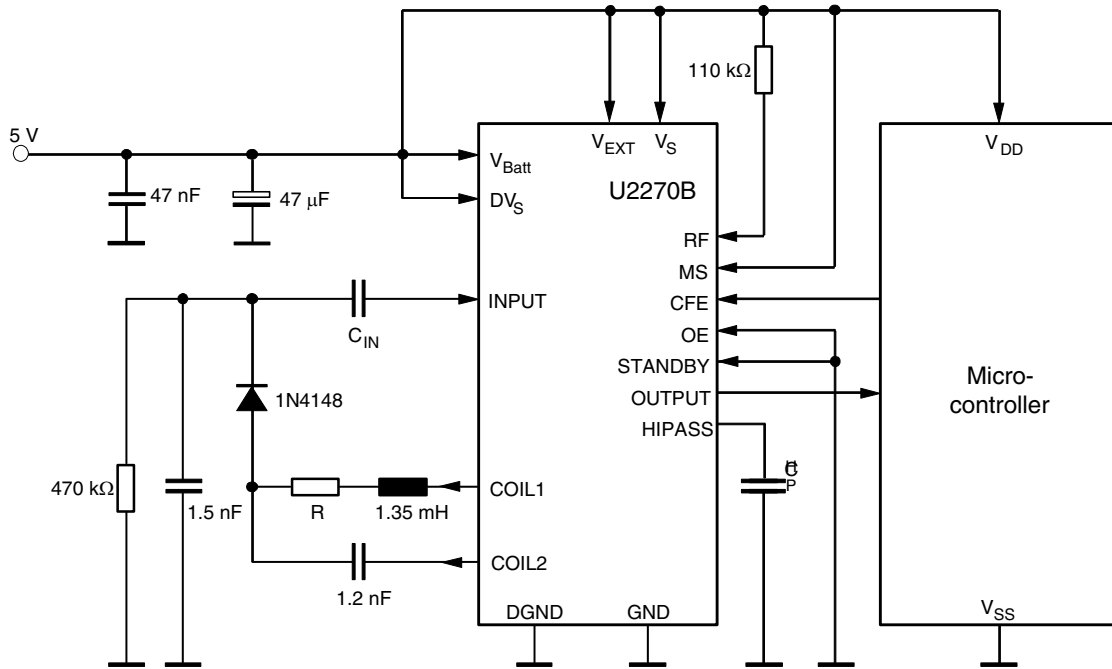
Data Rate $f = 125\text{ kHz}$	Input Capacitor (C_{IN})	Decoupling Capacitor (C_{HP})
$f/32 = 3.9\text{ kbit/s}$	680 pF	100 nF
$f/64 = 1.95\text{ kbit/s}$	1.2 nF	220 nF

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 from 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 of is $d \approx 10\text{ cm}$.

Application 1

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

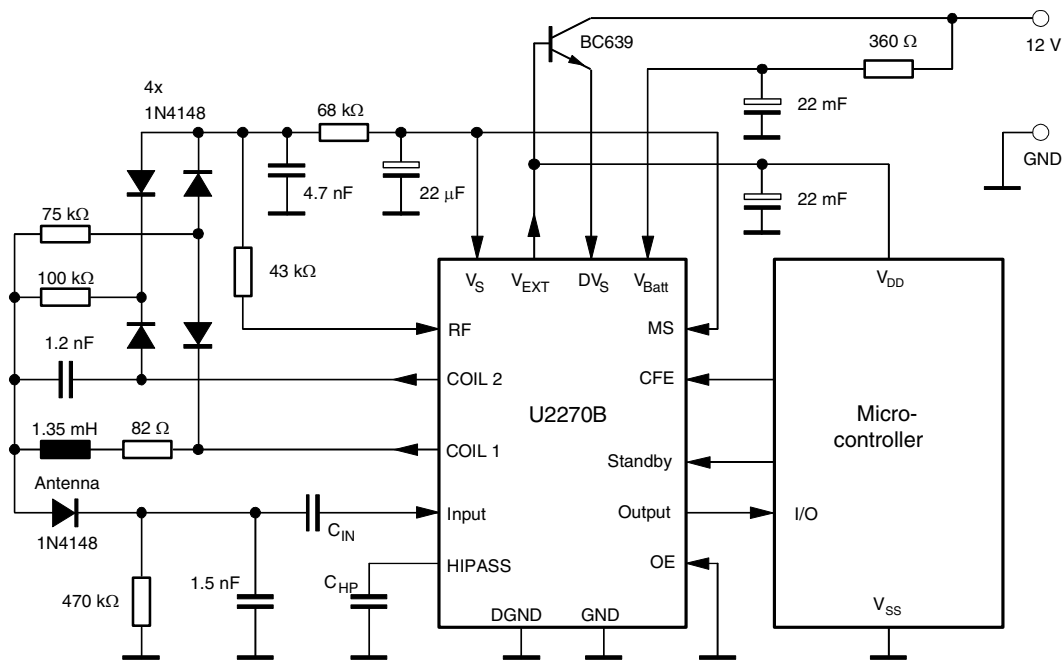
Figure 12. Application Circuit 1



Application 2

Basic application using diode feedback. This application allows higher communication distances than application 1

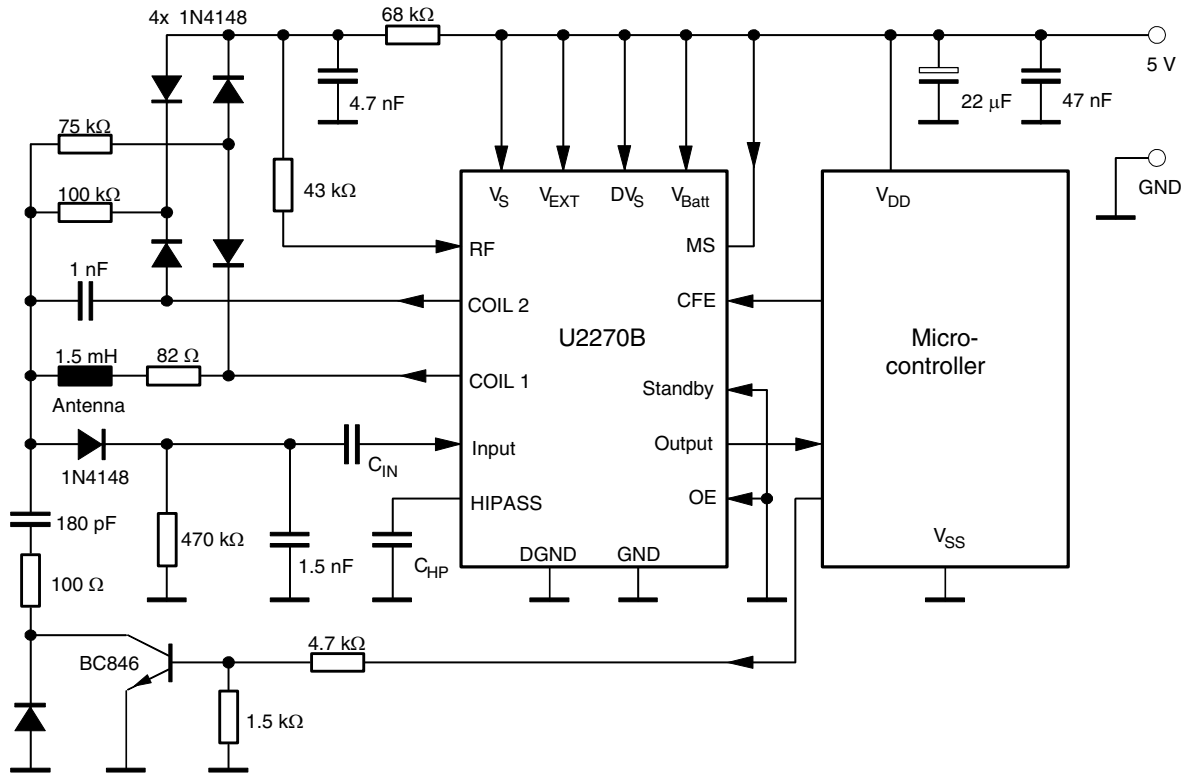
Figure 13. Application Circuit 2



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 14. Application Circuit 3



Note: Application examples have not been examined for series use 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.

Absolute Maximum Ratings

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	$V_S, V_{EXT}, DV_S, Coil 1, Coil 2$	-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

Thermal Resistance

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

Operating Range

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

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

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	$f = 3 \text{ kHz}$ (squarewave) 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	5-V application without load connected to the coil driver	10, 11, 12 and 14	I_S		4.5	9	mA
Standby current	12-V 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	$I_L = \pm 100 \text{ mA}$ $V_S, V_{EXT}, V_{Batt}, DV_S = 5 \text{ V}$ $V_{Batt} = 12 \text{ V}$	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
Lowpass filter - Cut-off frequency	Carrier freq. = 125 kHz		f_{cut}		7		kHz
Amplifier - Gain	$C_{HP} = 100 \text{ nF}$				30		

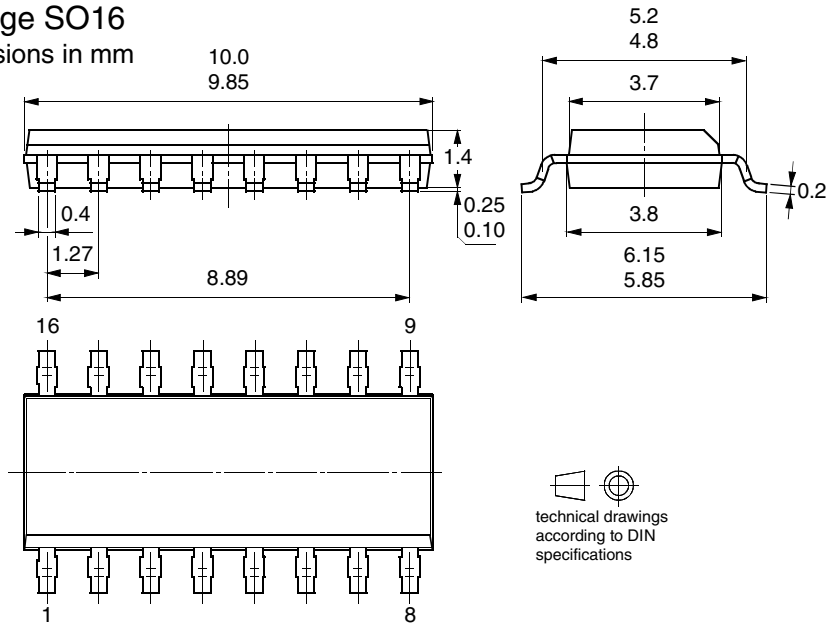
Note: 1. REM1: In application 1 where the oscillator operates in free-running mode, the IC must be soldered free from distortion. Otherwise, the oscillator may be out of bounds.

Ordering Information

Extended Type Number	Package	Remarks
U2270B-FP	SO16	

Package Information

Package SO16
Dimensions in mm





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