Automotive
Safety and Convenience
Data Book
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TEMIC
Semiconductors

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Introduction

In the present age of modern communication and increasing mobility, there is an increasing demand for remote control systems. Reasons for using wireless systems are numerous and involve not only comfort, but versatility and flexibility as well as safety and cost savings. This is valid for various applications, such as keyless entry systems for cars and buildings, alarm and security systems, domestic installations and wireless data transfer systems. Wireless data transmission, in the sense of IR- as well as RF-based systems, is well-suited to supply the customer's needs for safety and convenience.

TEMIC has been working for more than 20 years in the area of remote control. With this experience, we can offer our customers dedicated ICs for infrared remote control as well as for radio frequency systems.

Keyless Entry

Remote keyless entry (RF or IR) replaces the traditional key and is either incorporated in the key chain or mechanically integrated in the key. Small size is a must for remote keyless entry. This can be achieved by complete chip sets for compact system solutions and complete transmitter micromodules in chip-on-board technique.

The TEMIC 4-bit microcontroller family is suitable for encoding/ decoding the transmission code as well as for controlling the central door lock.

Immobilizer

A new security system for cars is the electronic immobilizer with an integrated microtransponder in the key.

This system responds only to an individual identification by the owner of the car. Only if this identification, located in the key, matches with the identifier in the car, the engine functions are enabled.

The complete reader functions are integrated in TEMIC's reader IC; arranged round the ignition lock. It can be used with TEMIC's transponder and 4-bit microcontroller family to create a complete, compact and effective anti-theft system with a minimum of components.

MARC4 Family

The TEMIC MARC4 microcontroller family is based on a low-power 4-bit CPU core, the modular architecture is HARVARD-like. This µC family is well-suited for keyless entry- and immobilizer applications as an encoder/ decoder (in RF- and IR-systems).

1. Keyless Entry

The U431xB IC family is designed to realize a low-current UHF remote control system. This system is flexible with regard to amplitude or frequency modulation, different transmission coding and a wide range of data rates. The transmitter as well as the receiver are likewise equipped with a **s**urface **a**coustic **w**ave (SAW) resonator for purpose of frequency stabilization.

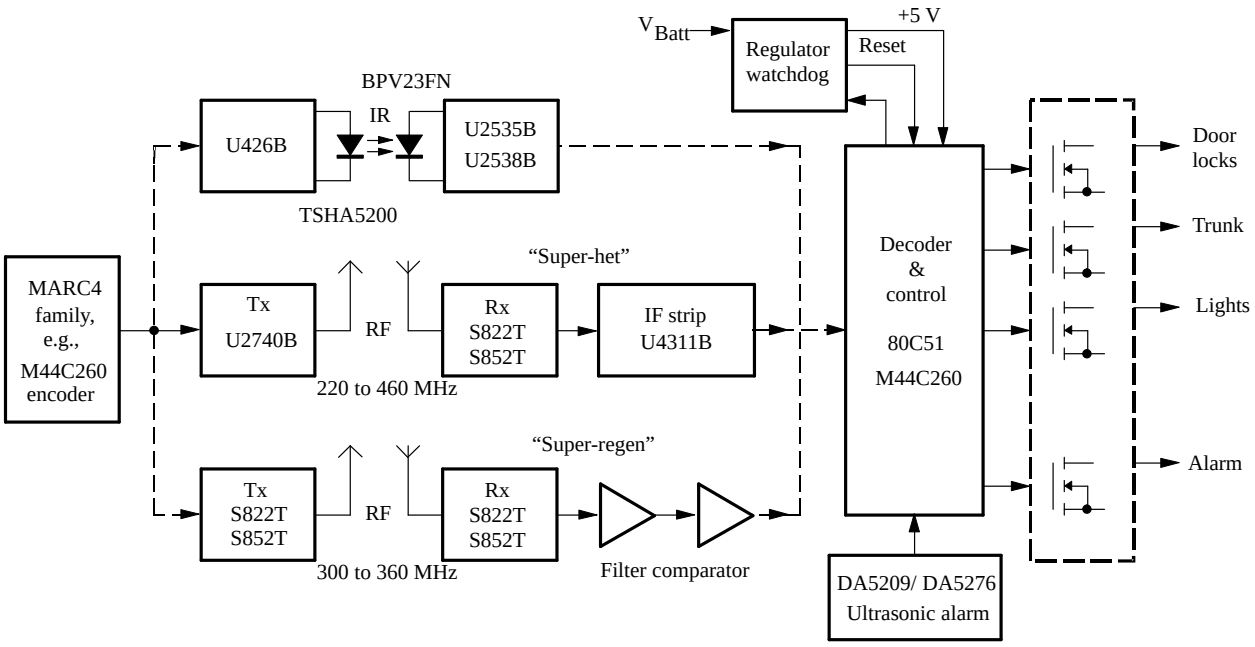
For both, the transmitter and the transceiver's front end, the UHF transistors S822T/ S852T are used, as they are well-suited for low-current operation. The superheterodyne receiver is based on one of the receiver ICs U4311B/ U4313B of TEMIC.

These monolithic ICs in bipolar technology include all necessary parts from IF signal processing to data output. The receiver ICs, together with the transistors and the low-power microcontroller M44C260, make it possible to realize an UHF receiver with an average current consumption of approximately 1 mA. This out-standing feature is achieved by a standby- or a polling concept in conjunction with a special circuit arrangement.

A further type of receiver ICs is the U4314B, which is suited exclusively for AM operation. It achieves a supply current below 1 mA without any sleep mode, but also without baseband processing.

The U2740B is a single-chip PLL transmitter for automotive keyless entry. With an on-board voltage-controlled oscillator (VCO), the U2740B provides a compact solution for small form-factor designs with improved performance over SAW-based transmitters.

System Solution for Keyless Entry



Comparison Infrared versus RF-Systems

The infrared key for remote controlling of central locking systems in cars is now a standard feature of luxury- and mid-range cars. It will also be offered in the lower vehicle ranges in the near future. IR remote control systems are inexpensive, well experienced and can be easily realized with conventional production techniques. Recently in some areas, low-power radio links are replacing infrared systems. Especially in the car market, RF-based systems offer the advantage of not being affected by dirt, ice and snow. Nowadays, the car's windows are often additionally shaded to reduce excessive heating of the car interior. Unfortunately, the shading attenuates the IR transmission of the remote control systems just as much as the emission from the sun.

If we compare the advantages and drawbacks of infrared and radio frequency systems, it becomes obvious that radio frequency technology helps to overcome some of the restrictions of infrared technology. However, in the infrared technology are other problems to be solved; so both systems are likely to co-exist.

The Infrared System

Common infrared remote control systems use a gallium-arsenide light-emitting diode as transmitter which emits light of 800 nm to 1000 nm wavelength. It is possible to speak of rectilinear propagation. Reflection mainly takes place at visibly reflecting surfaces. Diffraction at edges is restricted to just a few wavelengths and can therefore be neglected. For this reason, several receiving diodes should be installed to ensure correct operation under various conditions. If appropriate, an omni-directional receiving diode can be used. Operation of the system is restricted to an area in which the user can see the reaction. Interference may be caused by continuous light from the sun and from the headlights of other vehicles, 100 Hz components of mains-operated incandescent lamps and their harmonics in the case of gas-discharge lamps. Recently, interfering light in the 30-kHz band from modern energy-saving lamps with switched-mode power supply also has to be considered. Spectral components of the data signal within these frequency bands should be avoided by coding.
On the transmitter side, for purpose of current saving, pulse position modulation with an extremely low mark-to-space ratio is used. Operation is done by a single IRED (**I**nfra **R**ed **E**mitting **D**iode) with an extreme directional characteristic. This high directional characteristic of the IRED is a frequent object of customer criticism, since aiming at the target with the key is not accepted.
If we are looking at the receiver, the infrared system is quite simple. A photodiode converts the received light into a current which can then be converted into digital signals by special circuits without a high-power requirement. Higher system costs may result from the use of several receiving diodes due to the increased expense of installation. The costs for the subassemblies of the IR system however will always be low, compared to the RF system.

The RF-System

RF systems operating in the UHF band are not restricted to the line-of-sight coverage of optical systems due to diffraction and reflection of radio waves at edges and conductive surfaces as well as their capability to penetrate dielectric materials. This becomes apparent in an even illumination of space under complicated spatial circumstances as in buildings. Also the necessity to aim with the transmitter at the receiver is removed, because the commonly used small, low-gain aerials show an almost perfect omni-directional radiation pattern. The range of the RF system can not be well defined because of the mentioned propagation characteristic and due to additional polarization losses. These may vary from zero up to approximately 20 dB, depending on the relative orientation of the transmitter and the receiver antennas. Nevertheless in most cases, there is a high statistical probability of sufficient field strength.
One the other side, a problem could be the probability of excess range, such as when several conductive surfaces are coincidentally located close to the transmitter or receiver in a way that they form the elements of a parabolic reflector. Wave guidance occurring along conductive planes, for instance in a multi-storey car park, may increase the operation range as well. In this case, a considerable discrepancy between the optical perception range of the user and the range of the transmission link exists. For applications with higher security claims, misuse must be prevented. Listening-in to the radio frequencies with sensitive special receivers appears to be a problem. Average technically-orientated criminal intelligence is sufficient to receive, store and re-transmit a data telegram without changing code. These problems were mentioned before when infrared transmission links were introduced, but seemed to be not critical owing to the restricted range and directional effect of the IRED.

Dedicated ICs and Transistors for Keyless Entry/ Remote Control

Product	Function	Key Features	Benefits
IR-remote control/ keyless entry			
U2535B-FP	IR preamplifier	f = 20 to 100 kHz; I = typ. 260 µA at 12 V	Lowest power consumption
U2538B-FP	IR preamplifier	AGC; I = typ. 500 µA at 5 V	Wide transmission distance
U426B-FP	IR driver, transmitter	I = 0.2 to 1.2 A; f up to 500 kHz	Universal IRED-driver
RF-remote control/ keyless entry			
U4311B U4311B-FL	UHF receiver, 10.7 MHz, IF amplifier, data filter, and data shaper, log. RSS	AM+FM demodulator, non-inverting clamping comparator	Low-power consumption, typ. 1.0 mA, complete IF- and baseband processing
U4313B U4313B-FL		AM+FM demodulator, inverting clamping comparator	Low-power consumption, typ. 1.0 mA, complete IF- and baseband processing
U4314B-FP	UHF receiver, 10.7 MHz IF amplifier., log. RSSI	AM demodulator, RF-level indicator	Low-power consumption, typ. 0.8 mA
S822T	NPN planar RF transistor, 50 Ω input impedance at 945 MHz	Low noise, low current	
S852T	NPN planar RF transistor, 50 Ω input impedance at 945 MHz	Low noise, low current	
U2740B	UHF AM/FM transmitter	Wide frequency range (200 to 500 MHz), output level control	Increased system performance, compared to SAW-based transmitters: enlarged FM deviation and reduced costs; possibility to use PLL-Ref. XTAL for µC

Microcontrollers: see chapter 3

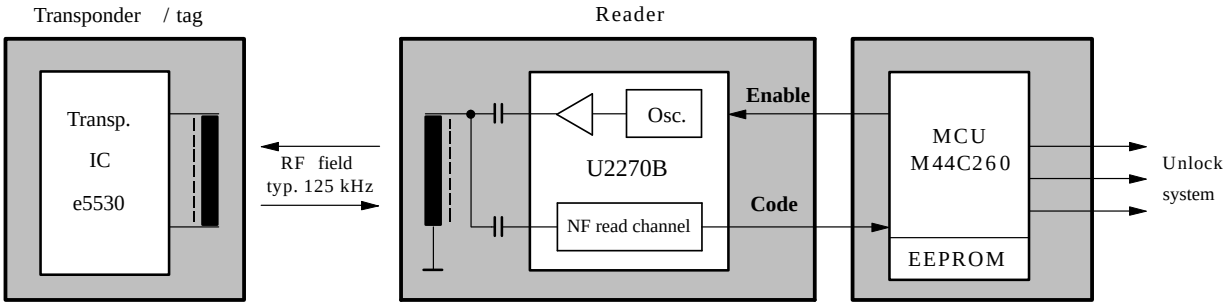
2. Immobilizer

The last years, increasing car theft statistics have shown more and more the urgency for protection. Since 1995, car insurances demand that new cars have to be protected against theft by an immobilizer.

An immobilizer is a passive theft protection, that means, the transponder needs no battery but is supplied via the reader. Therefore, the immobilizer offers best safety and reliability in operation.

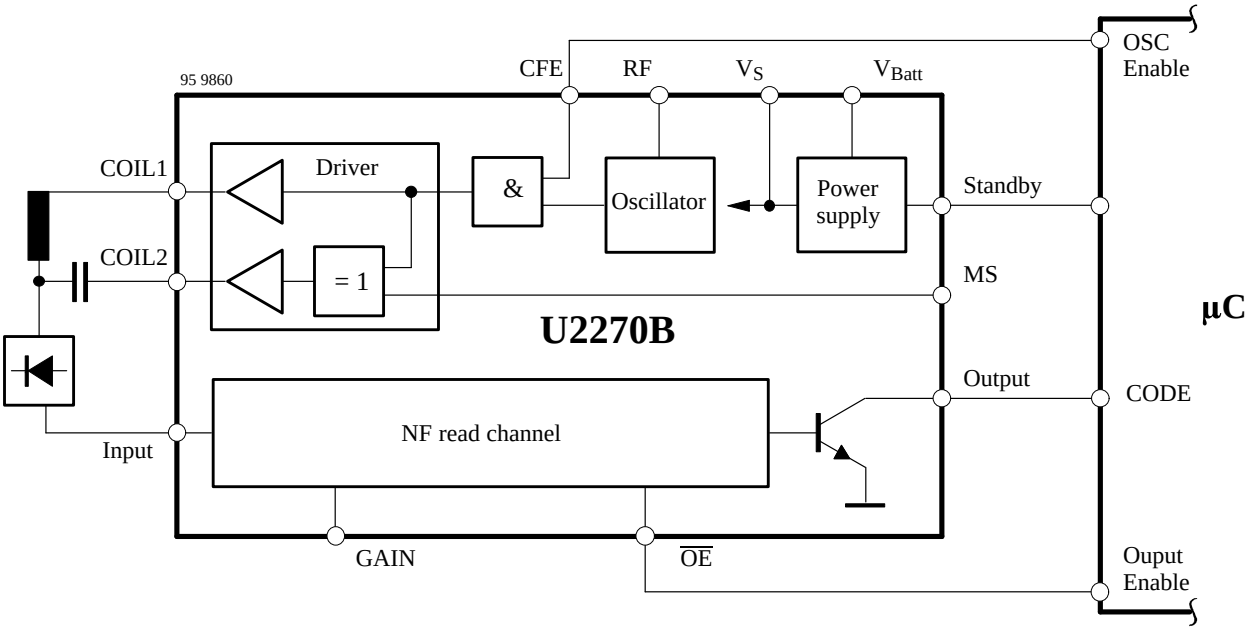
The industry's first single-chip reader IC for automotive immobilizer anti-theft systems was released by TEMIC in November 1994. The U2270B combines flexible reader coil driver circuitry, a highly integrated NF read-channel and an on-chip power supply. Along with TEMIC's e5530 transponder and M44C260 micro-controller, the U2270B can be used to create a complete, compact and effective anti-theft system with a minimum of components.

System Solution for Immobilizer



- Contactless readout of up to 128 bit unique identifier
- Power supply via RF field
- AM modulation by damping the magnetic field by the code
- Tuneable oscillator to optimize the magnetic coupling
- Flexible driver suitable for all kind of antennas
- NF read channel with µC-compatible output
- The demodulated code is compared with the identifier in the EEPROM
- System is only unlocked if codes are matching

Reader IC U2270B



The U2270B serves as interface between the transponder and the microcontroller that compares the received data. This interface operates bidirectional.

One direction is the energy transfer from the reader to the transponder. The reader creates a magnetic field via a reader air coil. This coil is operated by a special driver circuit. The driver consists of two output stages that can be operated in common or in differential mode via the pin MS. Using this feature, the user is flexible in the design of the antenna. The driver is controlled by an on-chip oscillator. The operating frequency is programmed by an external resistor. This enables the user to externally adjust the frequency to the relevant circumstances. This feature is important to compensate frequency tolerances of the antenna and the transponder. The oscillator can be disabled through pin CFE to enable read-write operation.

The other direction is the data transfer from the transponder to the microcontroller. The transponder modulates the magnetic field with its internal data. This leads to a tiny voltage modulation at the reader coil. Via a rectifier, this signal is fed into the input pin of the reader IC. The NF read channel amplifies and conditions the signal to convert it to the appropriate digital output data. The gain of the amplifier can be programmed through pin GAIN to adopt to the relevant reading distance. An open collector output serves as interface to the connected controller. With a logic signal at pin OE, the data output can be disabled.

The reader IC also incorporates an internal power supply. This enables the user to operate the system from a 12-V supply but also from an existing 5-V supply rail. Via the pin Standby, the U2270B can be set to a power-down mode where the supply current is very low.

Dedicated ICs for Immobilizer

Product	Function	Key Features	Benefits
U2270B-FP	Reader IC	RF generator, coil driver, filtering-on-chip	Suitable for R/W- and read-only systems
e5530*	Transponder	Contactless operation	Read-only operation
e5550**	Transponder	Read/ write	
e5560***	Transponder	Read/ write, encryption key (in development, Q1/96)	

Microcontroller: see chapter 3

Note: * = Available in GT (glass tube) and PC (plastic case)
** = Available in PC (plastic case), Q3/96
*** = Available in PC (plastic case), Q4/96

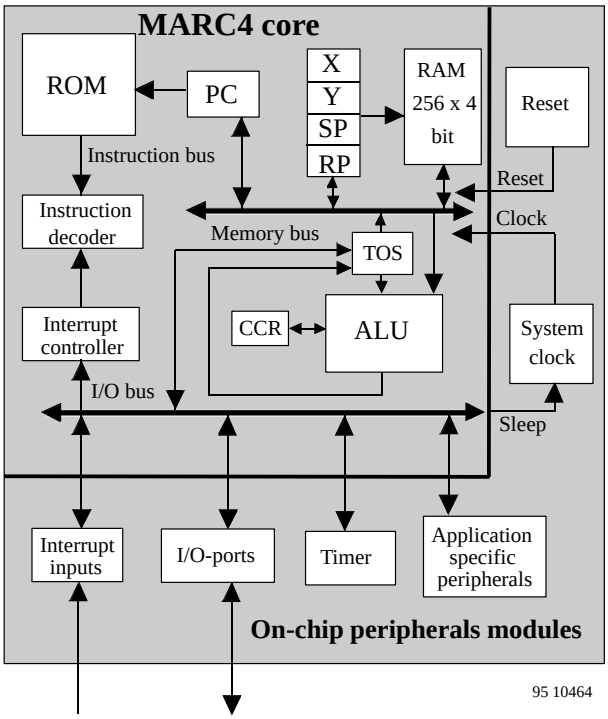
3. MARC4 Microcontroller Family

The TEMIC MARC4 microcontroller family bases on a low-power 4-bit CPU core. The modular MARC4 architecture is HARVARD-like, high-level language oriented and well-suitable to realize high integrated microcontrollers with a variety of application- or customer-specific on-chip peripheral combinations. The MARC4 controller's low voltage and low-power consumption is perfect for hand-held and battery-operated operations. The standard members of the family have selected peripheral combinations for a broad range of applications.

Programming is supported by an easy-to-use PC-based Software Development System with a high-level language qFORTH compiler and an emulator board. The FORTH-oriented microcontroller conception enables the qFORTH compiler to generate a very compact and efficient MARC4 program code.

Features

- 4-bit HARVARD architecture
- High-level language oriented CPU conception
- Three-stage pipeline structure
- 256 × 4 nibbles of RAM
- Up to 9 kBytes of ROM
- Eight vectored prioritized interrupt levels
- Low-voltage operation range
- Low-power consumption
- Power-down mode
- Various on-chip peripheral combinations available
- High-level language programming in qFORTH
- Programming and testing support by an integrated Software Development System



Dedicated ICs for Microcontrollers

Product	Function	Key Features	Benefits	Availability
M43C200	4-bit MCU	10 I/O, 4 IN, 3 interrupts	Low standby current (3 modes), SO 24	Now
M43C201	4-bit MCU	8 I/O, 2 IN, 2 interrupts	Low standby current (3 modes), SO 16 L	Now
M44C260	4-bit MCU	128-bit EEPROM, 2 timers	Optimized for remote control; low power, low current (1 µA)	Q1/96
M48C260	4-bit MCU, EEPROM instead of ROM	User-programmable M44C260	Re-programmable, program memory	Q1/96